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International Conference on Biology Education, Natural Science, and Technology

"Emerging Issues on Natural Science, Environment, and Its Learning Innovation"

PROCEEDINGS BOOK

International Conference on Biology Education, Natural Science, and Technology (INCOBEST)

June 17th, 2023 - Surakarta

DEPARTMENT OF BIOLOGY EDUCATION
FACULTY OF TEACHER TRAINING AND EDUCATION
UNIVERSITAS MUHAMMADIYAH SURAKARTA

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Proceedings Book

International Conference on Biology Education, Natural Science, and Technology (INCOBEST)

"Emerging Issues on Natural Science, Environment, and Its Learning Innovation"

BUILDING C FLOOR 1, CAKAP ROOM FKIP UMS
Jl. A. Yani Tromol Pos 1 Pabelan Kartasura Surakarta, 57162
Phone. (0271) 717417 ext. 2147 , Fax. (0271) 715448
E-mail: incobest@ums.ac.id
Website: http://incobest.ums.ac.id

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FACULTY OF TEACHER TRAINING AND EDUCATION
UNIVERSITAS MUHAMMADIYAH SURAKARTA
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Proceedings Book of
International Conference on Biology Education, Natural Science, and Technology (INCOBEST) 2023
Emerging Issues on Natural Science, Environment, and Its Learning Innovation

Surakarta, October 25th, 2023

Incobest 2023 Secretariat
Department Of Biology Education
Faculty Of Teacher Training And Education
Universitas Muhammadiyah Surakarta
Email: incobest@ums.ac.id
Website: incobest.ums.ac.id

FOREWORD

Alhamdulillah, with all gratitude for the presence of Allah SWT, who has bestowed His grace, guidance, and inayah so that the Biology Education Study Program, Faculty of Teaching Training and Education (FKIP), Universitas Muhammadiyah Surakarta (UMS) can organize **International Conference on Biology Education, Natural Science, and Technology (INCOBEST) 2023**. The conference with the theme "Emerging Issues on Natural Science, Environment, and Its Learning Innovation" is a manifestation of concern and dedication to the enhancement of research and education quality in Indonesia. Educators (teachers and lecturers) must be aware of strategic issues in the fields of science, environment, and learning innovation in order to adapt and advance their knowledge.

This conference aims to achieve the implementation of the Tri Dharma of Higher Education, encompassing education, research, and community service, and to realize academic freedom by introducing the Biology Education Study Program FKIP UMS as a part of the Institute of Education Personnel, that is capable of collaborating with various educational and non-educational agencies.

The activities of this International Conference have been made possible by the assistance of an array of parties. Thus, on this occasion, appreciation is extended to:

1. Dean of FKIP UMS
2. All committees of INCOBEST 2023.
3. Reviewer team, both internal and external.
4. Participants and speakers.
5. Other parties that cannot be mentioned one by one.

Finally, we hope this International Conference will benefit all parties and improve education in Indonesia.

Surakarta, October 25th 2023

Committee

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FOREWORD

INTRODUCTION

Science and the environment are ever-changing. The world is experiencing one of the most rapid advancements in science and technology. The world has numerous innovations and advancements in various disciplines, including industry, information, and telecommunications, high technology in space, robot technology, and biotechnology and molecular advances. In the era of globalization, where science and technology are one of the indicators of a nation's progress in facing global competition, almost every nation in the world has raced to develop every aspect of their life based on science and technology as a result of the development and progress in these various fields.

John Naisbitt and Patricia Aburdene, in the book 'Megatrends 2000', predicted that one of the 21st-century megatrends is the shift from physical models and metaphors to biological models and metaphors to help us understand today's dilemmas and opportunities. The prediction of John Naisbitt and Patricia Aburdene is realistic. Isn't it that before entering the 21st century, advances in biology have been felt up to the extraordinary advances in modern biology? He continued, we will prepare further on the threshold of a significant era: Biotechnology. In the era of the 21st century, biotechnology, as previously predicted, will be as important as computers. Biotechnology will be booming; at least the first directions of biotechnology that have been developed are in the fields of agriculture and animal husbandry, the food industry, to the clothing and health industries. Biotechnology companies are racing with new drug discovery and development to reach more than 300 drug products and 200 vaccines for diseases worldwide, including cancer, Alzheimer's, heart disease, AIDS, arthritis, and various infectious diseases in developing countries.

The genetic manipulation of plants and animals is another biotechnology development that is advancing rapidly at present. Transgenic vegetation can be produced through genetic engineering. This is an innovation in the development of high-yielding, disease-resistant, and postharvest storage-resistant plants of superior quality.

The accelerated advancement of science and technology has an effect on education. In order to actualize the expectation that education will produce graduates who can compete in the workforce, numerous innovations must be developed. Curriculum modifications at various levels, including elementary, secondary, and tertiary education, seek to equip graduates with life-applicable skills.

The preparation of the Indonesian National Qualifications Framework, a competency alignment framework that can juxtapose, equalize, and integrate between the fields of education and job training as well as work experience in the context of providing recognition of work competence by the structure of work in various sectors, enables the alignment of graduates at various levels of education in Indonesia so that they can compete globally. Regarding Indonesia's national education and training system, the framework is a manifestation of the quality and identity of the Indonesian nation.

Educators (teachers and lecturers), as well as researchers and observers in these disciplines, must be aware of current issues in science, the environment, and learning innovation in order to adapt and continually expand their knowledge. Following the most recent developments in their field is hoped to be a catalyst for improving the quality of research and education in Indonesia.

In response to the extremely rapid development of science, the environment, and learning innovations, the Biology Education Study Program FKIP UMS has scheduled the first **International Conference on Biology Education, Natural Science, and Technology (INCOBEST) 2023 as the continuation of the previous** National Education and

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FOREWORD

Science Seminar (SNPBS) VII 2022 as a form of concern and commitment to the improvement of the quality of research and education in Indonesia. This is the first International Conference to continue SNPBS, which was implemented successfully between 2016 and 2022.

COMMITTEE COMPOSITION OF 1ST INCOBEST 2023

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TABLE OF CONTENT

COVER ..... **i**

FOREWORD ..... **iii**

INTRODUCTION ..... **iv**

COMMITTEE COMPOSITION OF 1ST INCOBEST 2023 ..... **vi**

TABLE OF CONTENT ..... **vii**

KEYNOTE SPEAKERS' MATERIALS

The ecology of Zaprionus genus in Brazil and adaptation process during the bioinvasion
Prof. Dr. Luís Gustavo da Conceição Galego 1

Emerging Innovations In Natural Science Education.
Haniza Hanim binti Mohd Zain, PhD. Assoc Professor 22

Metagenomic studies and their applications.
Dr. Triastuti Rahayu, S.Si., M.Si 23

PARALLEL SESSION SPEAKERS MATERIALS

Development of Android-Based Interactive Teaching Materials Using the Ispring Application with Insight into Sustainable Development.
Nurhasnah, Lufri, Abdul Razak, Festiyed, Prima Aswirna, Windy Kasmita, and Wetri Yesmoneca 33

The Effect of STEM Approach on Students' Critical Thinking Skills.
Media Roza, Minda Azhar, Festiyed, Prima Aswirna, and Rika Purnama Sari 42

Inventory of Montane Zone Weeds in the Selo Tourism Area, Boyolali Regency, Central Java.
Nila Permatasari, and Santhyami 52

Development of Problem-Based HOTS (Higher Order Thinking Skill) Question Instruments on Class VIII Pressure Material.
Rina Irawati, Sukarmin, and Sri Yamtinah 62

The Characteristics of Herbal Tea Combination Between Butterfly Flower with Mint and Pandan Leaf on Drying Duration Variation.
Titik Suryani, Ria Anisa Rahmasari, and Riza Ainun Nisa 68

Preservice Biology Teacher's TPACK Integration into Lesson Planning.
Putri Agustina, Lina Agustina, Rina Astuti, Yesi Chotimah, Putri Gayatri Ramadhanty, and Alanindra Saputra 77

TABLE OF CONTENT

Students' Creative Thingking Ability in view From The Level of Understanding in Waste Management.
Syarifah Zahrah, Rita Retnowati, and Rita Istiana 84

Monitoring The Correlation of Climatics to The Airborne Bacteria at The Manggarai Station, South Jakarta, Indonesia.
Reza Anindita, Auliya Rahmawati, Maulin Inggraini, Melania Perwitasari, Dede Dwi Nathalia, Maya Uzia Beandrade, and Intan Kurnia Putri 91

The Effect of Active Learning Integrated with Everyone Is A Teacher Here Strategy Based on Questioning and Answering on The Critical Thinking Skills and Biology Learning Retention of Class XI Senior High School Students In The Industrial Agriculture Area.
Kurnia Suciningsih, Bea Hana Siswati, Nadyatul Ilma Indah Savira 101

The Effect of STEM (Science, Technology, Engineering, and Mathematics) based Textbooks in Biotechnology Learning Material on The Critical Thinking Skills and Learning Results of Senior High School Students in The Industrial Agriculture Area.
Kamilatul Khoiroh, Bea Hana Siswati, Kamalia Fikri 109

Quality of *Moringa oleifera* Leaf and Kiambang (*Salvinia molesta*) Solid Organic Fertilizer with Banana Peel Bioactivator.
Desvia Puput Apriani, and Aminah Asngad 122

Quality of Solid Organic Fertilizers for Duck Manure and Trembesi Leaves with Papaya Peel Bioactivator.
Musdhalifah Husna Firdausi, Aminah Asngad 133

Inventory of Moss Plants (Bryophyta) in the Montana Zone, Samiran Village, Selo District, Boyolali Regency, Central Java Province.
Eva Diahayu Wardani and Santhyami 143

Diversity of Ferns (Pteridophyta) in the Montana Zone, Samiran Village, Selo District, Boyolali Regency, Central Java Province.
Indah Rahmawati and Santhyami 152

Quality of Solid Organic Fertilizer from Moringa Leaves and Peanut Shells with Banana Peel Bioactivator.
Nur Afifah Mustikasari, and Aminah Asngad 160

Quality of Liquid Organic Fertilizer Peanut Shells and Tofu Dregs With Banana Stems as Bioactivator.
Muhammad Rizal Kahfi, and Aminah Asngad 171

The Quality of Infrastructure Facilities and the Readiness of Biology Laboratories to Support Learning in High School.
Mei Renni Sholikhah, and Lina Agustina 181

Quality of Duck Manure Fertilizer and Paitan Leaves with the Addition of MOL Papaya Skin.

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TABLE OF CONTENT

Hana Khairunnisa, and Aminah Asngad 193

Quality of Liquid Organic Fertilizer Combination Gamal Leaves and Tofu Dregs with Banana Stem Bioactivator.
Feby Istifarini, and Aminah Asngad 204

The Effects of Socio-Scientific Approach on Junior High School Students' Learning Outcomes.
Salsabila Nur Rahmadhani, Putri Agustina, and Sri Mulyani 215

Study of Science Practicum in Junior High School, Sukoharjo, Indonesia.
Farikha Muya Sarah, Putri Agustina and Harini Hastowati 227

Quality of Kefir Combination Between Soy Milk and Skim Milk On Variation of Sugar and Fermentation Duration.
Masithoh Uswatiningtyas and Titik Suryani 241

Coconut Husks and Eggshells Liquid Organic Fertilizer's Effect on The Growth and Calcium Levels of Kale.
Nabila Junisky Susetyawati and Aminah Asngad 248

Phosphate Solubilisation Index and Antagonism Potential of Frangipani Tree Rhizosphere Bacterial Isolates from Cemetery.
Vika Febriyanti, Erma Musbita Tyastuti, Yasir Sidiq, and Triastuti Rahayu 260

Coconut Husk and Eggshell Liquid Organic Feltilizer Effect On Lettuce Growth And Calcium Levels.
Widya Husnul Khotimah, and Aminah asngad 269

Quality of Kirinyuh Leaf Liquid Organic Fertilizer and Coconut Water Waste With Pineapple Skin Bioactivator.
Arisa Putri Jihan Nitami, and Aminah Asngad 280

Isolation and Characterization of Cellulolytic Bacteria from Bonoloyo, Cemetery.
Wanda Datik Risnasari, Erma Musbita Tyastuti, Yasir Sidiq, and Triastuti Rahayu 291

Application of Project Based Learning Model to Improve Critical Thinking Skills of Students SMA Muhammadiyah 1 Sragen.
Tasya Cahya Dwi Purwanti, and Rina Astuti 299

Quality of Kefir Combination Between of Goat's Milk and Skim Milk on Variations of Sugar and Fermentation Duration.
Erna Kurniawati, and Titik Suryani 305

Quality of Herbal Tea Combination Between Corn Silk and Stevia Leaf on Variation of Temperature and Drying Duration.
Feny Nafiza, and Titik Suryani 314

Isolation and Identification of Soil Bacteria in Pracimaloyo Public Cemetery, Kartasura.
Bagas Adityaradja, Erma Musbita Tyastuti, Yasir Sidiq, and Triastuti Rahayu 326

+6281548719313
incobest@ums.ac.id
incobest.ums.id

TABLE OF CONTENT

LOF Kirinyuh Leaves and Liquid Waste Tempeh with Pineapple Peel Bioactivator: Sensory and Macronutrient Content.
Nur Jati Sekaringsih, and Aminah Asngad 335

Glucose Levels and Organoleptic Quality Probiotic Tepache of Pineapple Peel on Variation of Sugar and Fermentation Duration.
Qurota A'yuni Nuha Sabira, and Titik Suryani 348

Empowerment of Animalia Classification Material: A Review of Literature.
Tunjung Nala Puti, Puguh Karyanto, Umi Fatmawati 356

Quality of Herbal Tea Combination Between Corn Silk and Mint Leaf in a Variation of Temperature and Drying Duration.
Imroatul Husna, and Titik Suryani 368

Number of Erythrocytes of White Rats (*Rattus norvegicus*) Sonded with a Combination of Porang Tuber and Moringa Leaf Extract.
Alya Anggitasari, and Endang Setyaningsih 375

Pakcoy *(Brassica chinensis L.)* Growth Using Moringa Leaf Extract with the Addition of Red Onion Skin.
Dwi Putri Widjaya, and Suparti 385

Mustard (*Brassica Juncea* L.) Growth Hydroponically Using AB-Mix and Liquid Organic Fertilizer Tea Pulp.
Dinda Putri Trisnawati, and Suparti 394

The Effect of Cassava Peel Powder on the Productivity of the Brown Oyster Mushroom (*Pleurotus cystidiosus*).
Emmalia Rahmawati, and Suparti 402

Analysis of Misconceptions on Reproductive System Material in Class XI IPS 2 Students of SMA Negeri 6 Madiun.
Jevi Milda Rahmawati, Ima Agung Nurcahyo, and Cicilia Novi Primiani 411

Inventory of Epiphytic Lichen Foliose on Tea Plants in Ngargoyoso, Karanganyar, Central Java.
Dika Dwi Irnawati, and Efri Roziaty 421

Manuscript Writing Guidelines: Analysis of Creative thinking skills profile of Senior High school students in Madiun City on Biotechnology topic.
Herning Nurdiana, Ima Agung Nurcahyo, and Cicilia Novi Primiani 430

Plasma Protein of Obese White Rats Treated with of Glucomannan Porang Tubers and Moringa Extract.
Sabila Dina Ikhsani, and Endang Setyaningsih 438

Effectiveness of *Flipped Classroom* Model with Instagram in Junior High School.
Mega Amartya Istighfarin, and Lina Agustina 438

+6281548719313
incobest@ums.ac.id
incobest.ums.id

TABLE OF CONTENT

Application of the NHT Model Combined with Question Cards on Biology Learning Outcomes.
Nabilla Riska Nurjannah, and Djumadi 455

Growth Red Spinach (*Amaranthus amoena)* by Hydroponics Using Charcoal Media Husk.
Isherdini, Dyah Salma Nurlaila, and Suparti 464

Oxygen Consumption and BB *Rattus novergicus* Obesity Sonde Treatment Glucomanan Porang Tubers and Moringa Leaf Extract.
Mustika Arum Mayang Sari, and Endang Setyaningsih 473

The Effect of Kepok Banana Skin Liquid Organic Fertilizer (*Musa paradisiaca*) on the Growth of Mustard Plants (*Brasicca juncea* L.).
Isherdini, Berliana Putri Athena, and Suparti 484

The Effect of PBL Learning Model Combined with Rewards and Punishment on Science Learning Outcomes.
Annisa' Tri Yudhatami, and Djumadi 489

Antioxidant Activity and Organoleptic Quality of Probiotic Tepache of Pineapple Peel Sugar Variation and Fermentation Duration.
Fithrotul Haq Rabbani Abdurrahman, and Titik Suryani 502

Analysis of Plant Vegetation in Sekipan Forest Tawangmangu District, Karanganyar District.
Ima Aryani, and Shal Syabela Riskawati 509

Health Examination of The Digestion of Proboscis Monkey (*Nasalis larvatus*) Through Bacteriological Tests on Feces.
Camalia Maisya, Anni Nurliani, Amalia Rezeki, and Rusmiati 518

The Phylogeny of Parasitic Hemiptera Using *Multivariate Statistical Package* Cluster Analysis.
Dwi Setyo Astuti, and Murwanto Setyo Nugroho 533

Identification of Intestine Parasite Worms Eggs in Feces Proboscis Monkey (*Nasalis larvatus*).
Fiqita Giulleta Irtifannisa Rahman, Anni Nurliani, Amalia Rezeki, and Rusmiati 541

Ethnobotanical Study of Tea Plants Based on Local Wisdom in Ngargoyoso District, Karanganyar Regency, Central Java.
Kharisma Margiyana Dinda Hapsari, and Efri Roziaty 550

Scientific Learning with PJBL and PBL Models of Science Process Skills Student Learning Outcomes.
Farid Nur Yusron, Sarwanto, Mohammad Masykuri 557

Water Quality in Satui River and Histological Structure Study of Liver of Baung Fish (*Mystus nemurus*).
Dinda Triana, Heri Budi Santoso, and Anang Kadarsah 564

+6281548719313
incobest@ums.ac.id
incobest.ums.id

TABLE OF CONTENT

Profile of Creative Thinking Skill of New Normal Era at Junior High School Students.
Farida Amrul Almuharomah, Widha Sunarno, and Mohammad Masykuri 572

The Feasibility and Effectiveness of High-Level Thinking Tests on Virus to Mapping The Ability of Prospective Science Teacher (Introduction Study on The Development of Integrated Learning Models).
Annur Indra Kusumadani, Sentot Budi Rahardjo, Sri Yamtinah, and Baskoro Adi Prayitno 580

PBL-Based Science Learning on Living Things Interaction in Junior High School.
Hariyatmi, and Hidayatus Sholihah Tisniasari 587

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Universitas Muhammadiyah Surakarta
International Conference on Biology Education, Natural Science, and Technology
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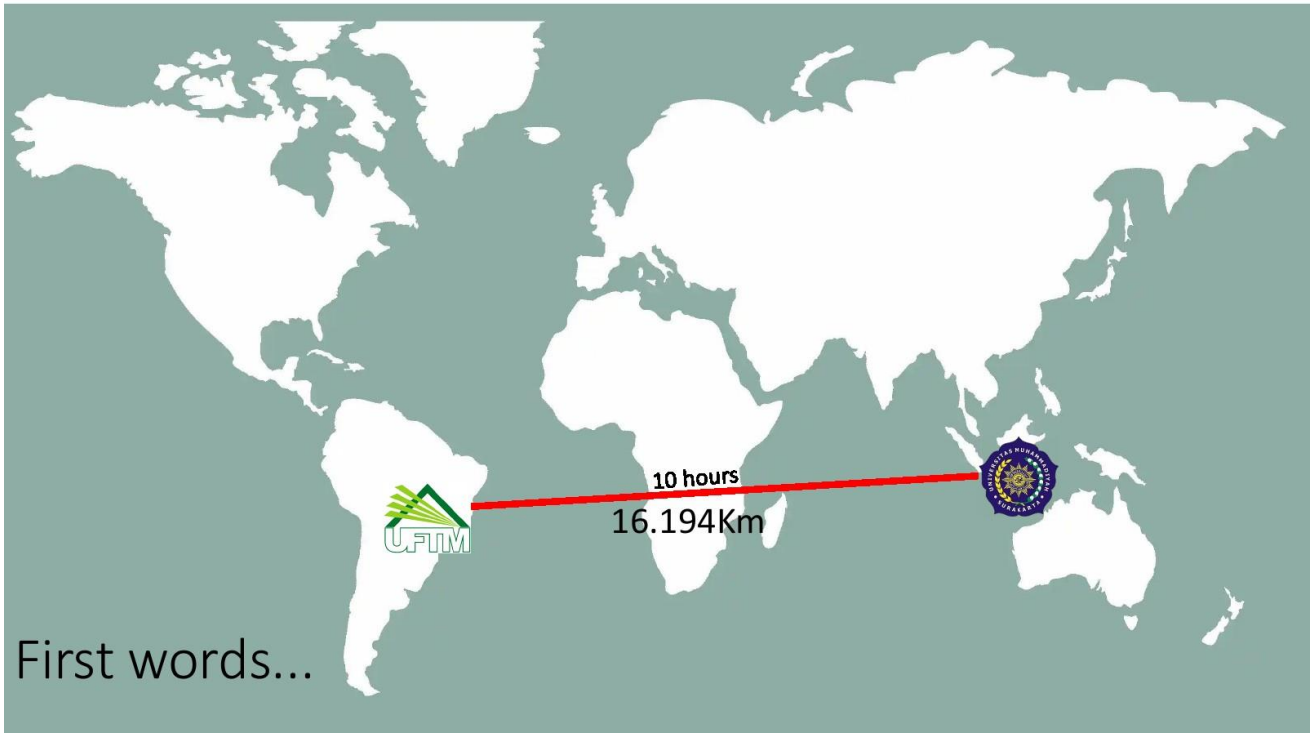
UNIVERSITAS MUHAMMADIYAH SURAKARTA
FAKULTAS KEGURUAN DAN ILMU PENDIDIKAN
PROGRAM STUDI PENDIDIKAN BIOLOGI
Jl. A. Yani Pabelan Kartasura, Tromol Pos 1 Surakarta 57102 Telp. 0271-717417, Psw. 147/326

The ecology of *Zaprionus* genus in Brazil and adaptation process during the bioinvasions.

Prof. PhD. Luís Gustavo da Conceição Galego
Education and Natural and Exact Sciences Institute (ICENE)
Federal University of Triângulo Mineiro (UFTM)



About me:

Majored in:

- Life Sciences

Pos Graduated in:

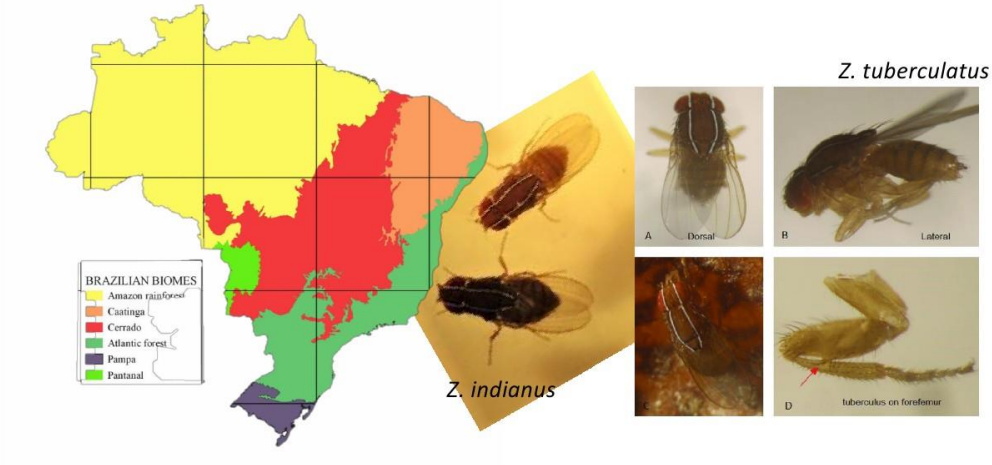
- Genetics (Master e PhD)
- Biosciences (Pos-Doctoral)

I´ve been studying *Zaprionus indianus* since 2000, soon after of their first record in Brazil (1999)

From 2023, we have started studies with *Z. tuberculatus.*

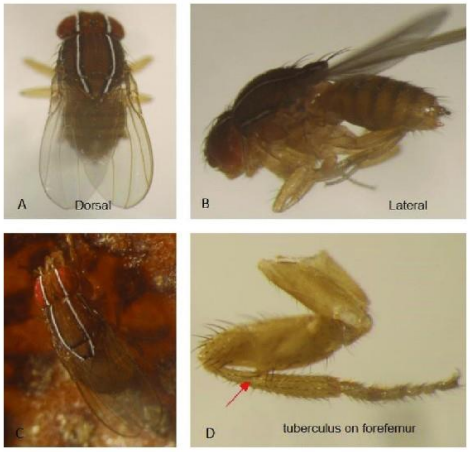
Structure of the talk:

- 1) Introduction
- 2) Bioinvasion throughout Brazil: ecological and adaptation processes
- 3) *Zaprionus tuberculatus* in Neotropical region

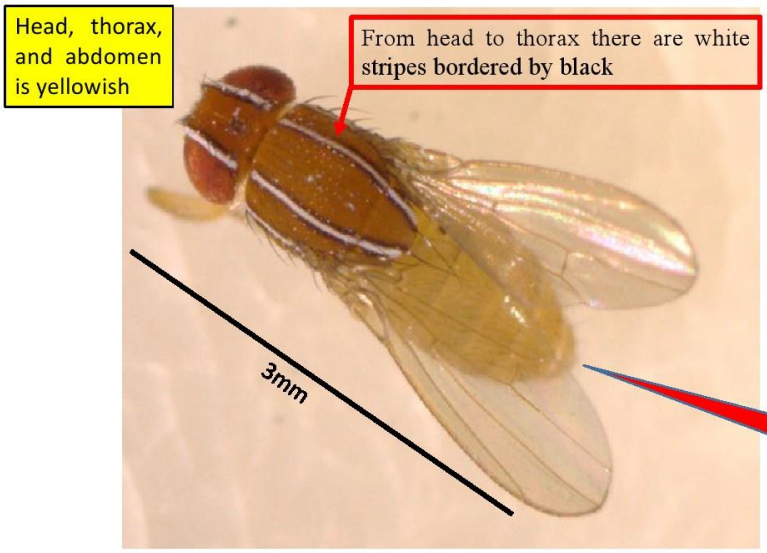


Structure of the talk:

•1) Introduction



Introduction – Morphology and Taxonomy



Animalia
Arthropoda
Insecta
Diptera
Schizophora
Drosophilidade
Zaprionus
Zaprionus indianus

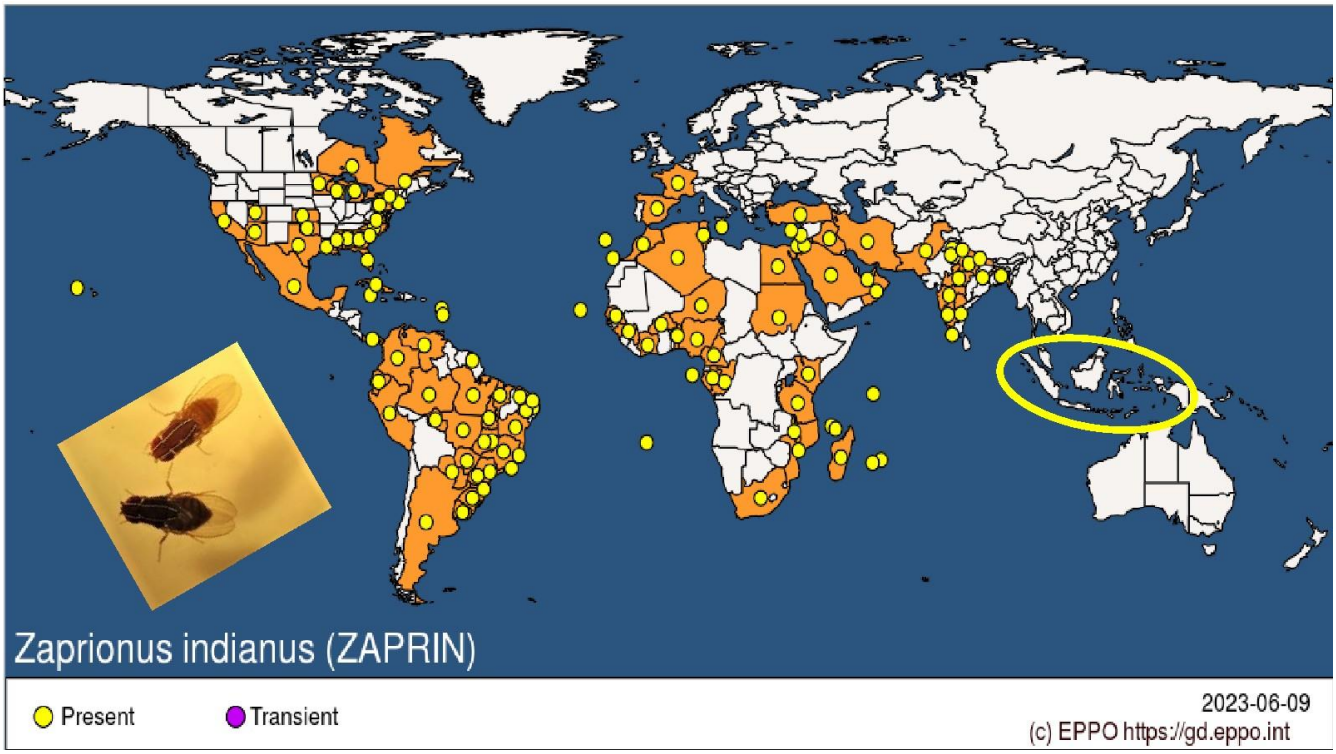
Did you know this fly species before today?

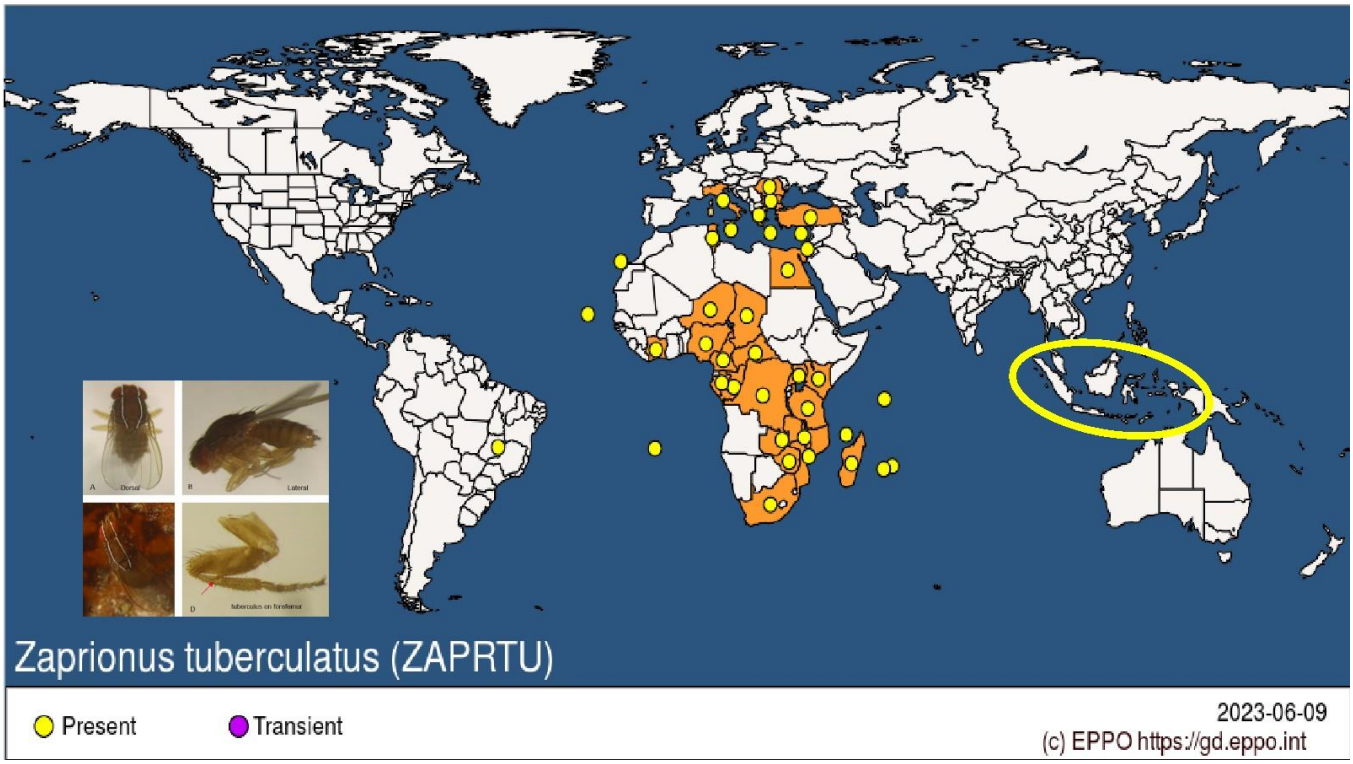
Gupta, 1970

Introduction – Morphology and Taxonomy

Animalia
Arthropoda
Insecta
Diptera
Schizophora
Drosophilidade
Zaprionus
Zaprionus tuberculatus

Gupta, 1970


Zaprionus indianus (ZAPRIN)
Present
Transient
2023-06-09
(c) EPPO https://gd.eppo.int


Zaprionus tuberculatus (ZAPRTU)
Present
Transient
2023-06-09
(c) EPPO https://gd.eppo.int

Structure of the talk:

•2) Bioinvasion throughout Brazil: ecological and adaptation process

Genetics and Molecular Biology, 35, 2, 395-406 (2012)

www.sbg.org.br

Review Article

Taxonomic and evolutionary analysis of *Zaprionus indianus* and its colonization of Palearctic and Neotropical regions

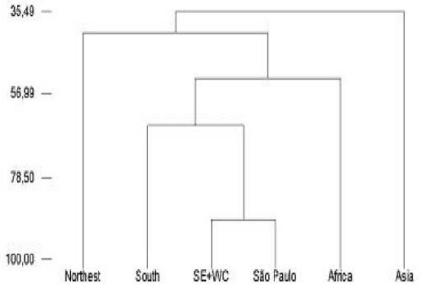
Leliane Silva Commar[1], Luis Gustavo da Conceição Galego[2], Carlos Roberto Ceron[3] and Claudia Marcia Aparecida Carareto[1]

Figure 1 - Migration routes for *Z. indianus* involved in its dispersal throughout the world, based on studies cited in the text. The process that occurred in Brazil is highlighted.

Vilela (1999) and Commar *et al.* (2012)

Analysis of the drosophilid *Zaprionus indianus* introduction in Brazil: contribution of esterase loci polymorphisms.

Galego, Luís Gustavo C., and Claudia Márcia A. Carareto. UNESP – São Paulo State University, Rua Cristóvão Colombo, São José do Rio Preto - São Paulo – Brasil; e-mail: carareto@ibilce.unesp.br.



-After the arrival, *Z. indianus* has spread over the State of São Paulo by highway transportation and from there to the whole country, mainly as a result of fruit commerce.

-After its introduction, *Z. indianus* rapidly spread over the southeastern, southern, and mid-western regions, only reaching the northern and north-eastern regions later on.

Genetics and Molecular Biology, 33, 4, 767-773 (2010)

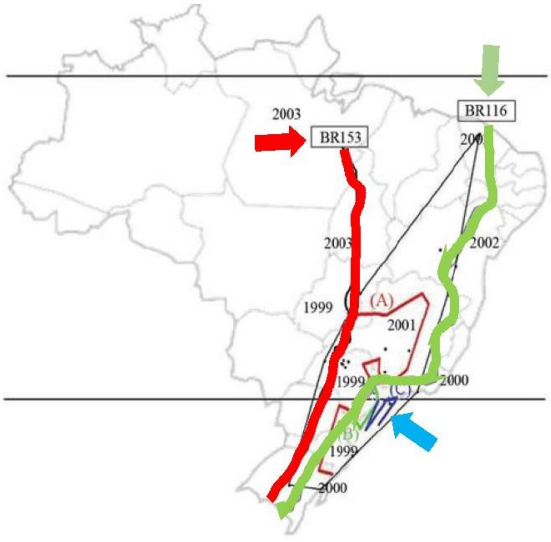
www.sbg.org.br

Research Article

Scenario of the spread of the invasive species *Zaprionus indianus* Gupta, 1970 (Diptera, Drosophilidae) in Brazil

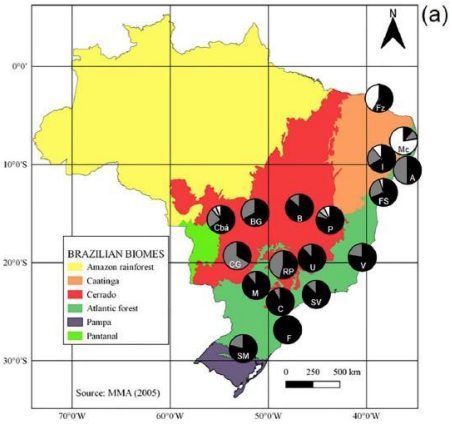
Luís Gustavo da Conceição Galego and Claudia Marcia Aparecida Carareto

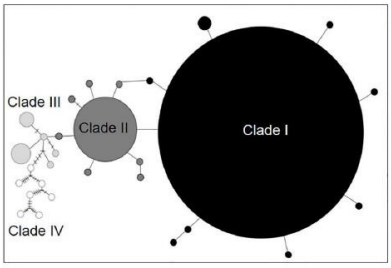
Z. indianus, after first arriving in São Paulo state, spread throughout the country, probably together with the transportation of commercial fruits by way of the two main Brazilian freeways, **BR 153**, to the south and the surrounding countryside, and the **BR 116** along the coast and throughout the north-east.



Networking haplotype (Est6-like)

-There are 4 clades to *Z. indianus* Est-6 like DNA sequences;
-The clades 1 and 2 are widely distributed;
-Clades 3 and 4 are more restricted, and they were detected only in populations from **Pantanal** and **Caatinga** (two Biomes from Brazil)





Galego and Carareto, in preparation

Population size

Z. indianus showed the highest frequencies compared to other drosophilids during the seasons with the highest mean temperatures, but the frequency consistently dropped during autumn and winter to increase again in the spring.

Santos et al., 2005

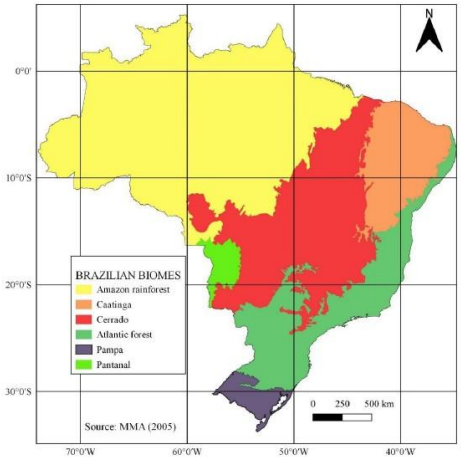
Demography on Brazilian Biomes

Variation in the abundance of *Z. indianus* among Brazilian biomes:

a) The abundance of *Z. indianus* in the **cerrado** and **riverine forests** is greater in the cerrado during rainy periods;

b) Z. indianus is the most abundant species in the urbanized environment;

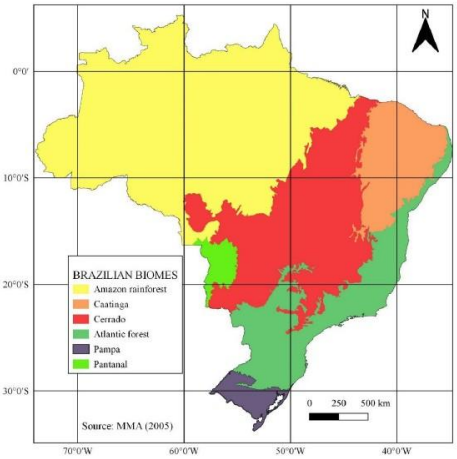
c) In mangrove forests was higher than in the **Atlantic rain forest** but **lower than in the cerrado or in urban environments;**



Tidon *et al.* (2003); Ferreira and Tidon (2005); Tidon *et al.*, (2003); Commar *et al.*, 2012.

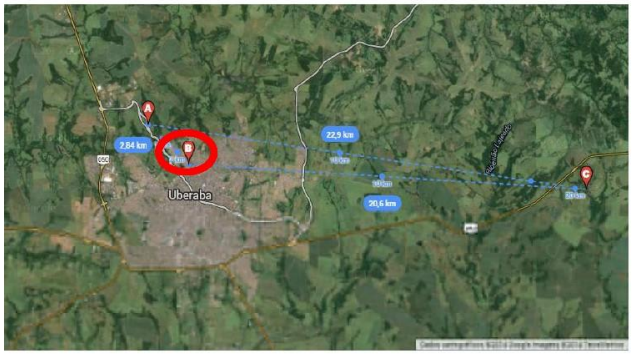
Demography on Brazilian Biomes

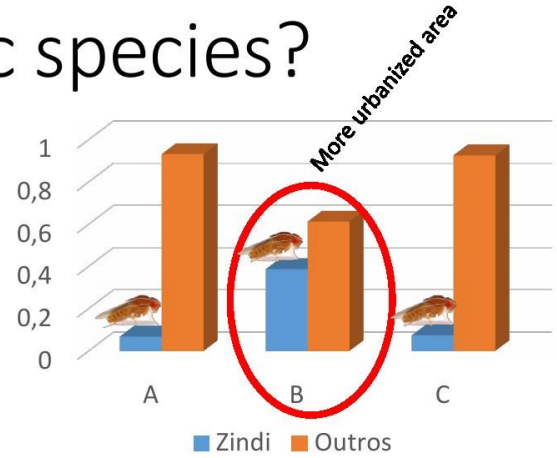
Cerrado > **Caatinga** > **Pampa** > **Pantanal** > **Atlantic rain forest**



Tidon *et al.* (2003); Ferreira and Tidon (2005); Tidon *et al.*, (2003); Commar *et al.*, 2012.

Is it a synurbic species?





Several studies indicate that together with other introduced Drosophilidae, *Z. indianus* could be useful as an **indicator of disturbed areas**.

Ferreira and Tidon (2005); Rodrigues and Galego, in preparation.

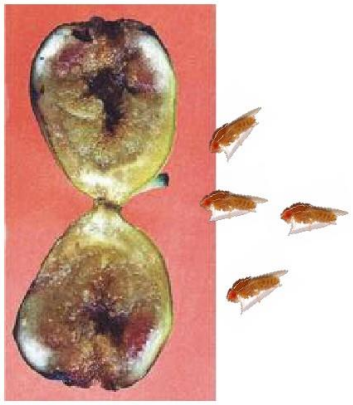
Niche occupation

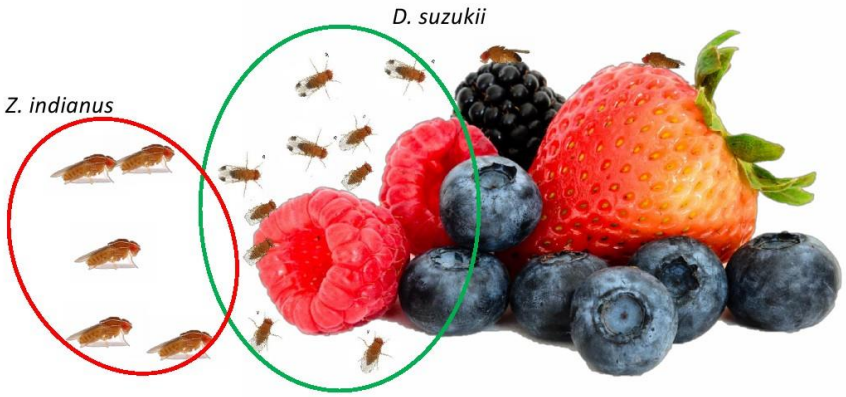
- -It is a polyphagous species and it was detected in more than 80 different species of plants

LACHAISE; TSACAS, 1983; GOTTSCHALK, 2008

Niche occupation

Z. indianus is considered a potential secondary pest in soft fruits and it damaged fig culture in Brazil during their introduction.

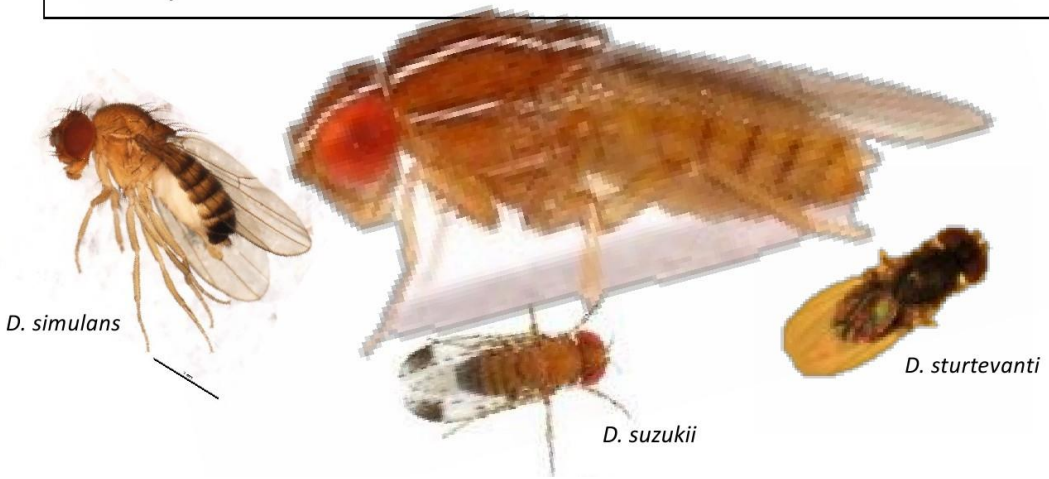




VILELA; TEIXEIRA; STEIN, 2005; PFEIFFER *et al.*, 2019

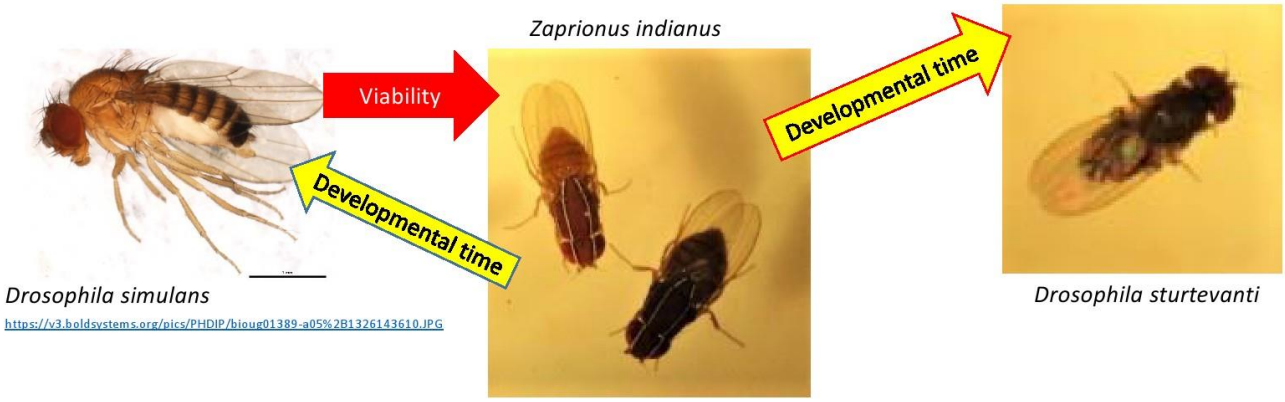
Niche occupation

- *Z. indianus* showed competitive advantage against other species of *Drosophila* with which shares niches.



INTRASPECIFIC AND INTERSPECIFIC PRE-ADULT COMPETITION ON THE NEOTROPICAL REGION COLONIZER *ZAPRIONUS INDIANUS* (DIPTERA: DROSOPHILIDAE) UNDER LABORATORY CONDITIONS [1]

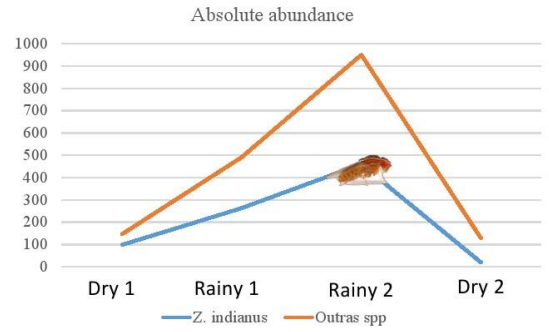
LUÍS GUSTAVO DA CONCEIÇÃO GALEGO [2]; CLAUDIA MARCIA APARECIDA CARARETO [2]

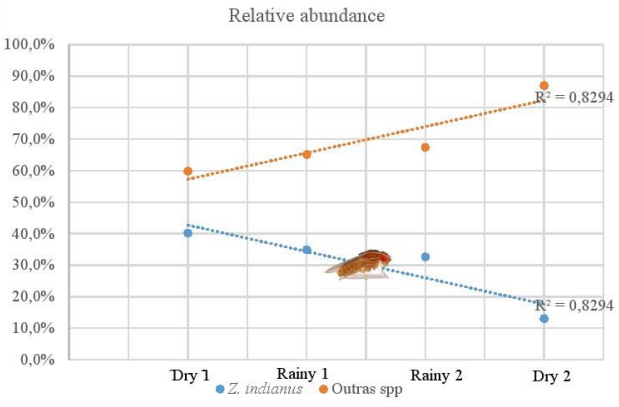


Niche occupation

Seasonal variation in demography, morphometry, and genetics in Cerrado population due to pressures caused by rain distribution and competition during the year.

Greater intraspecific competition in dry seasons and interspecific in rainy ones.

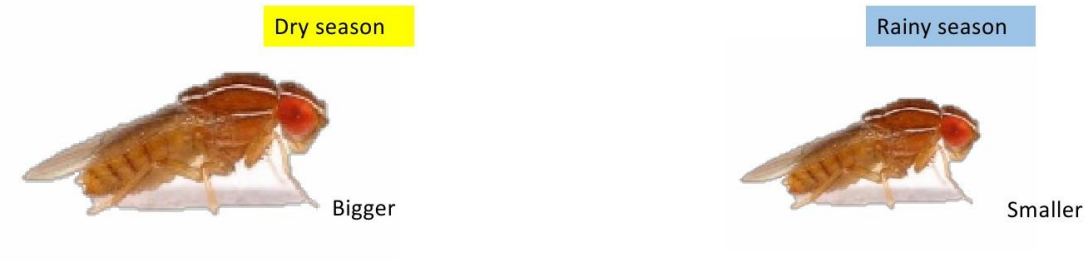




POSSARI; GALEGO, in preparation.

Niche occupation

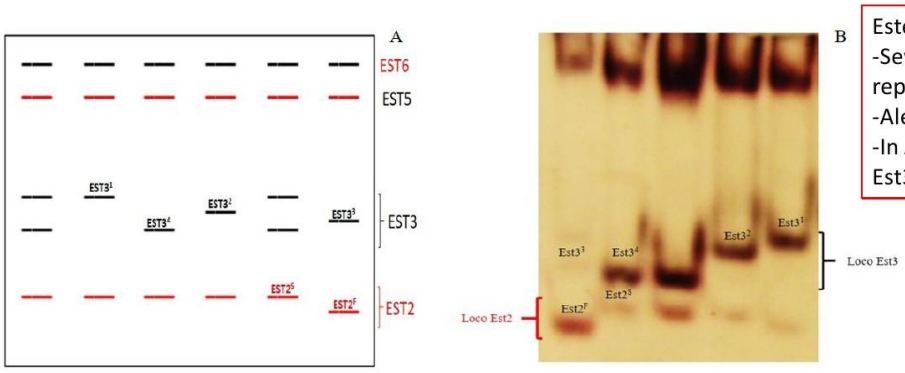
Seasonal variation in demography, morphometry, and genetics in Cerrado population due to pressures caused by rain distribution and competition during the year.



POSSARI; GALEGO, in preparation

Niche occupation

Seasonal variation in demography, morphometry, and genetics in Cerrado population due to pressures caused by rain distribution and competition during the year.

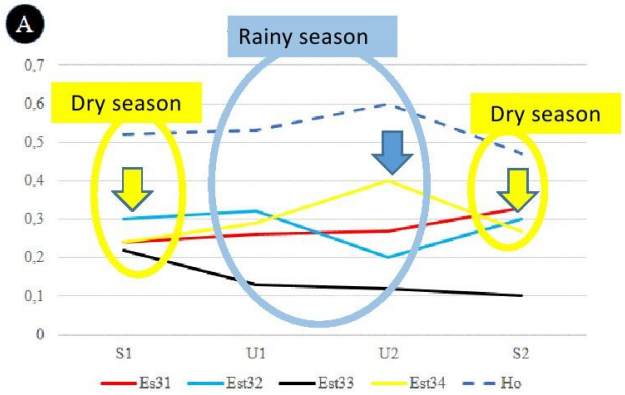


Esterases (enzymes):
-Several biological functions (feed, reproduction, development)
-Alelle polymorphisms
-In *Z. indianus* => Two loci:
Est3 (4 alelles) and Est2 (2 alelles)

Galego, Ceron and Carareto, 2006

Niche occupation

Seasonal variation in demography, morphometry, and genetics in Cerrado population due to pressures caused by rain distribution and competition during the year.



Est2 loci (Esterases)

-Greater frequency of $Est3^2$ allele in the dry season and the $Est3^4$ in the rainy one;

-No significant variation for heterozygosity

POSSARI; GALEGO, in preparation.

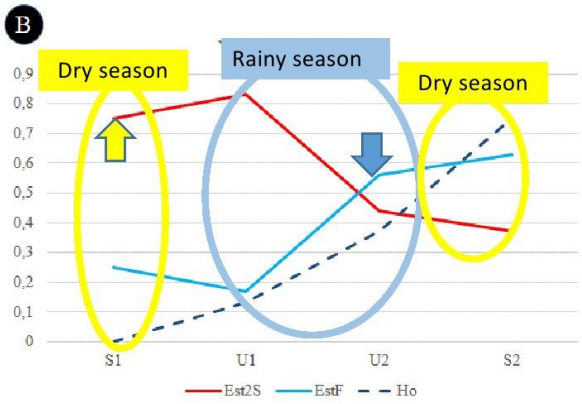
Niche occupation

Seasonal variation in demography, morphometry, and genetics in Cerrado population due to pressures caused by rain distribution and competition during the year.

Est2 loci (Esterases)

-Greater frequency of $Est2^S$ allele in the dry season and the $Est2^F$ in the rainy one;

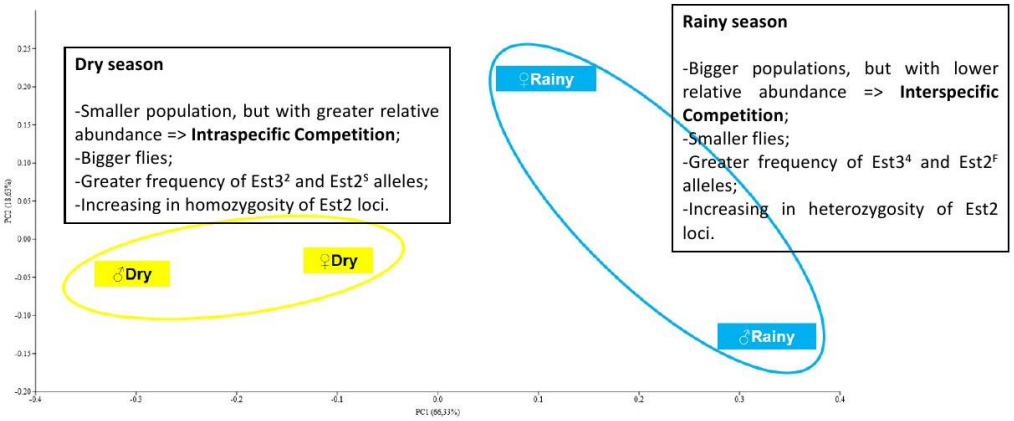
-Increased heterozygosity during rainy seasons

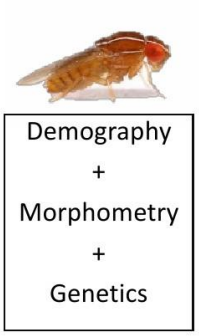


POSSARI; GALEGO, in preparation

Niche occupation

Seasonal variation in demography, morphometry, and genetics in Cerrado population due to pressures caused by rain distribution and competition during the year.

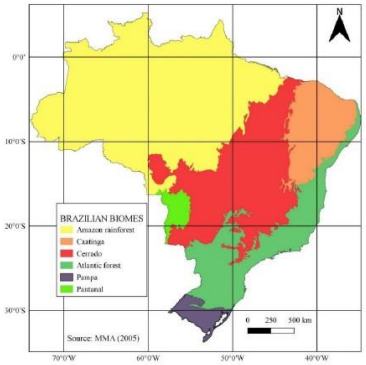


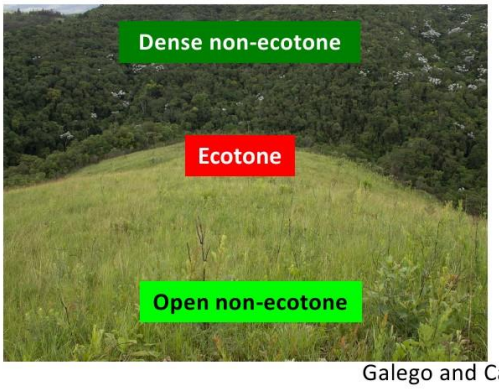


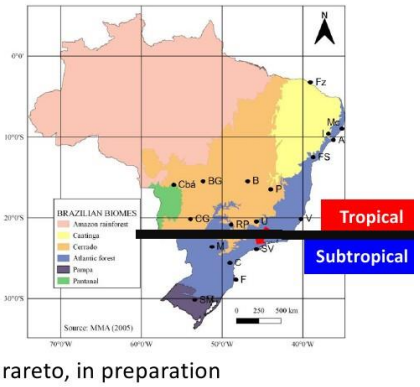
POSSARI; GALEGO, in preparation

Niche occupation

- Genetic structuring in population from biomes (Cerrado and Atlantic forest) and ecotones, or from different climatic zones (Tropical or subtropical)



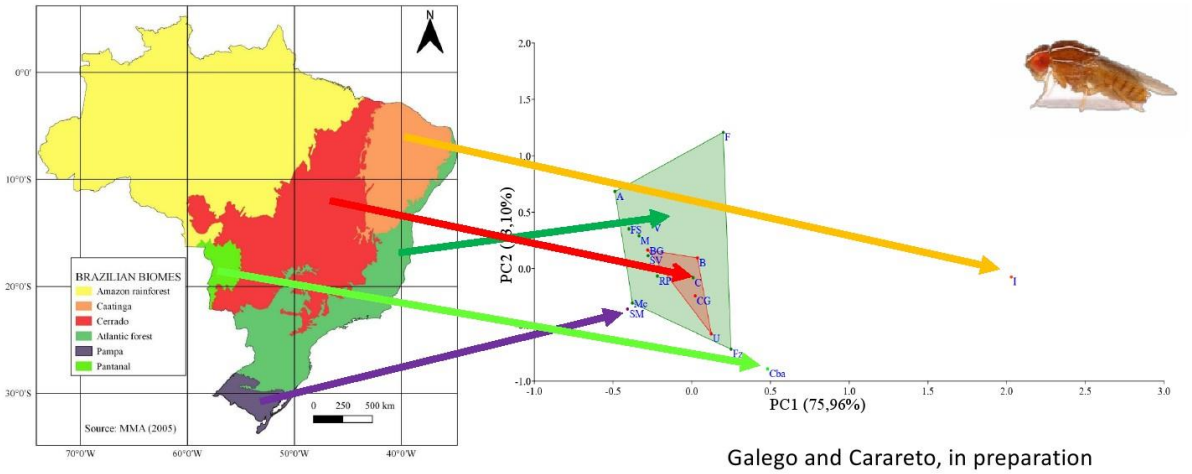




Galego and Carareto, in preparation

Niche ocupation - Biomes

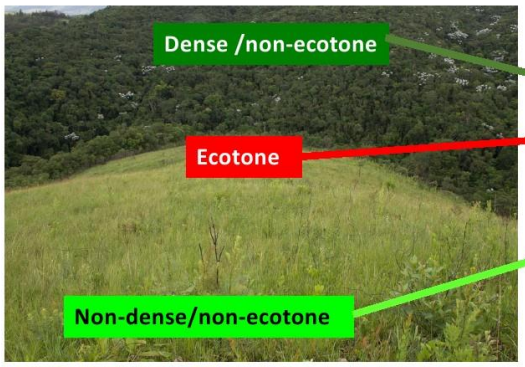
- Genetic structuring in population from biomes (Cerrado and Atlantic forest) and ecotones, or from different climatic zones (Tropical or subtropical)



Galego and Carareto, in preparation

Niche occupation – Ecotones/Non Ecotones (Vegetation)

- Genetic structuring in population from biomes (Cerrado and Atlantic forest) and ecotones, or from different climatic zones (Tropical or subtropical)



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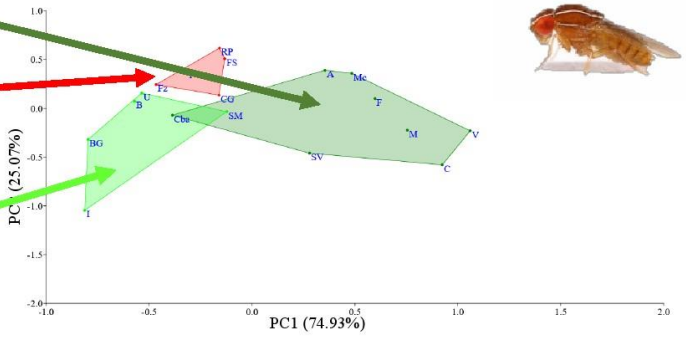
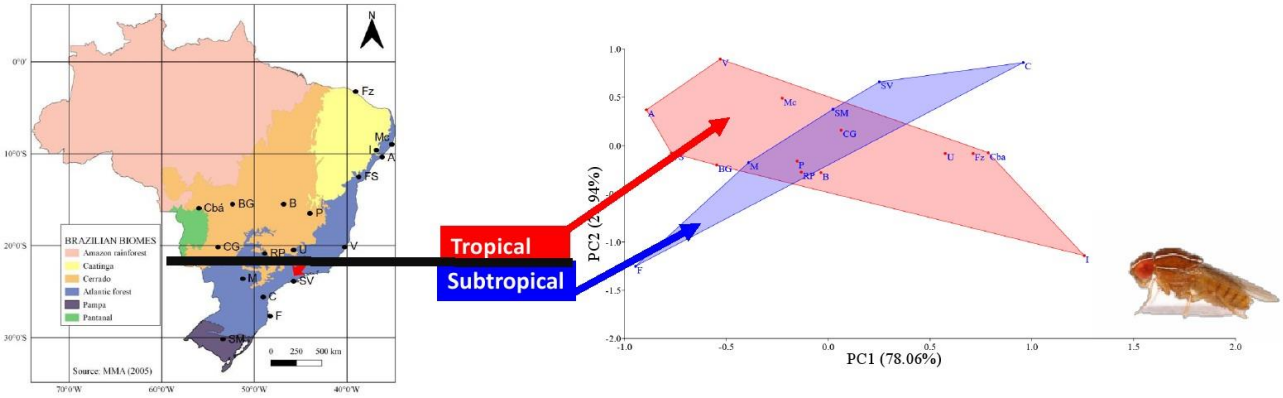


Galego and Carareto, in preparation

Niche occupation – Climatic Zone

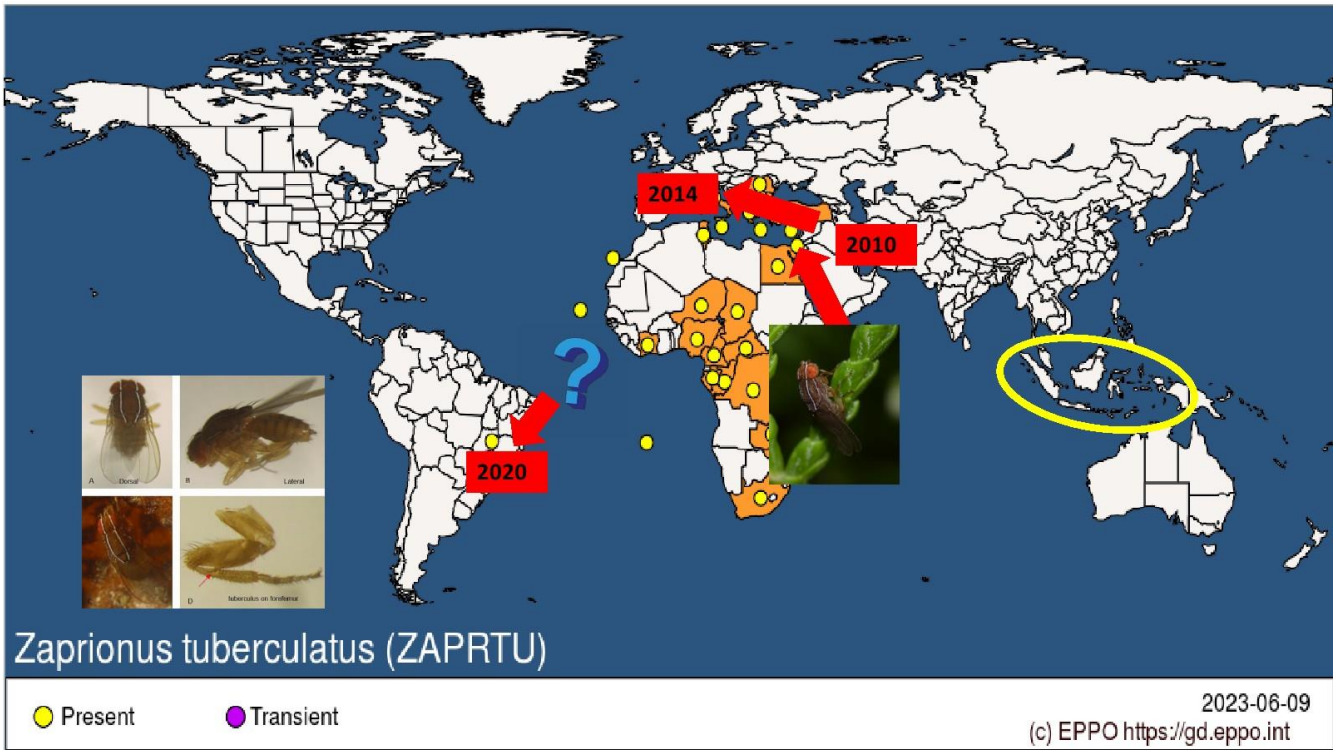
- Genetic structuring in population from biomes (Cerrado and Atlantic forest) and ecotones, or from different climatic zones (Tropical or subtropical)



Galego and Carareto, in preparation

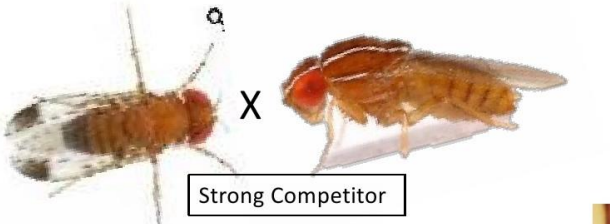
Structure of the talk:

- 3) *Zaprionus tuberculatus* in Neotropical region



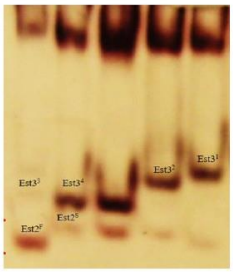
Summing Up

- *What makes Zaprionus indianus a successful colonizing species?*



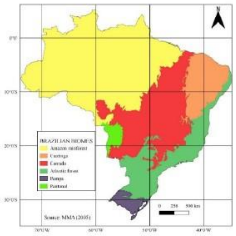
Strong Competitor

Phenotipic plasticity



Genetic variation

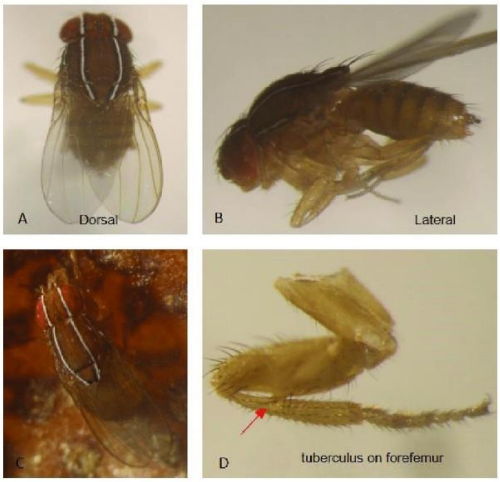
Polyphagous species



Diversity of biomes occupied

Summing Up

- *What about Zaprionus tuberculatus?*



- **Terima kasih!**

- E-mail:
Luis.galego@uftm.edu.br

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International Conference on Biology Education, Natural Science, and Technology
Vol. 1 No. 1 (2023)

Emerging Innovations In Natural Science Education

(Haniza Hanim binti Mohd Zain, PhD. Assoc Professor)
Universiti Pendidikan Sultan Idris Malaysia

ABSTRACT

This presentation explores the emerging innovations in natural science education, highlighting their potential to revolutionize teaching and learning in the field. We focuses on a few key areas of innovation; virtual and augmented reality (VR/AR), citizen science, 3D printing and artificial intelligence. These innovations offer immersive experiences, engage students in authentic scientific research, promote critical thinking and problem-solving skills, and provide access to vast scientific resources. By incorporating these innovations into natural science education, educators can create dynamic and effective learning environments that prepare students for the challenges of a rapidly advancing scientific landscape.

UMS Universitas Muhammadiyah Surakarta

Metagenomic studies and their applications

Dr. Triastuti Rahayu, S.Si., M.Si
Biology Education Study Program
Faculty of Teacher Training and Education,
Universitas Muhammadiyah Surakarta, Indonesia
Email : tr124@ums.ac.id

WHAT IS METAGENOME ?

UMS Universitas Muhammadiyah Surakarta

A metagenome is comprised of all the genetic elements of the host and all those of all the microorganisms (microbiome) that live in or on that host.

Metagenomics is defined as the direct genetic analysis of genomes contained with an environmental sample.

Metagenomic analysis is commonly used to investigate complex microbial communities (MICROBIOME) sampled directly from the environment, without culturing or isolating a single organism.

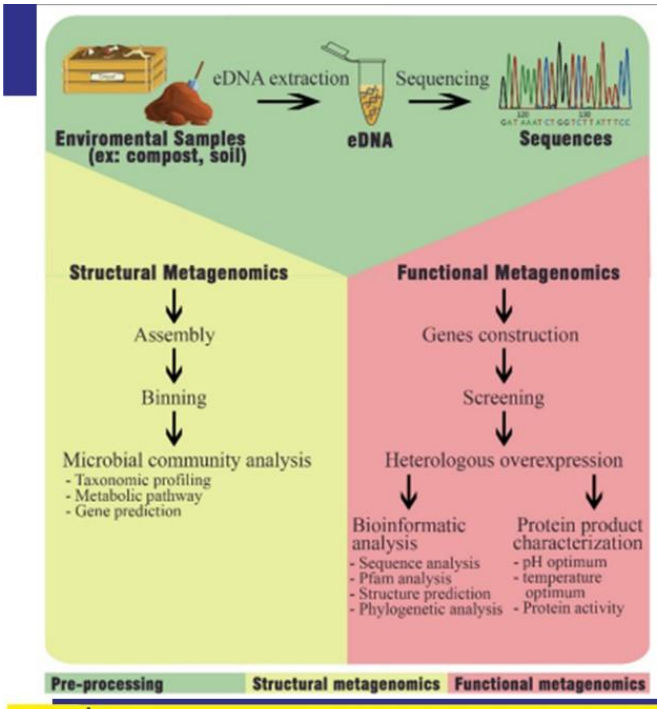

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Fig. Framework for metagenomics with two primary studies, structural and functional metagenomics

Prayogo et al. Journal of Genetic Engineering and Biotechnology (2020) 18:39
https://doi.org/10.1186/s43141-020-00043-9

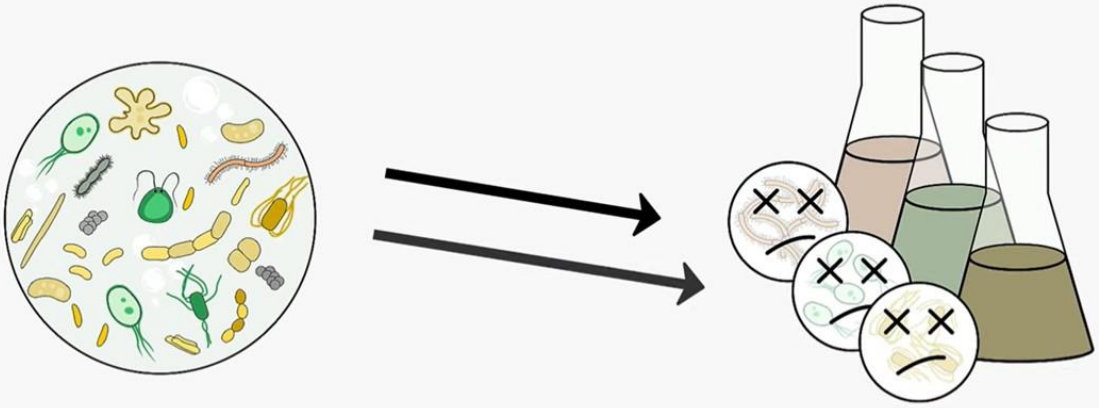
Journal of Genetic Engineering and Biotechnology

REVIEW Open Access

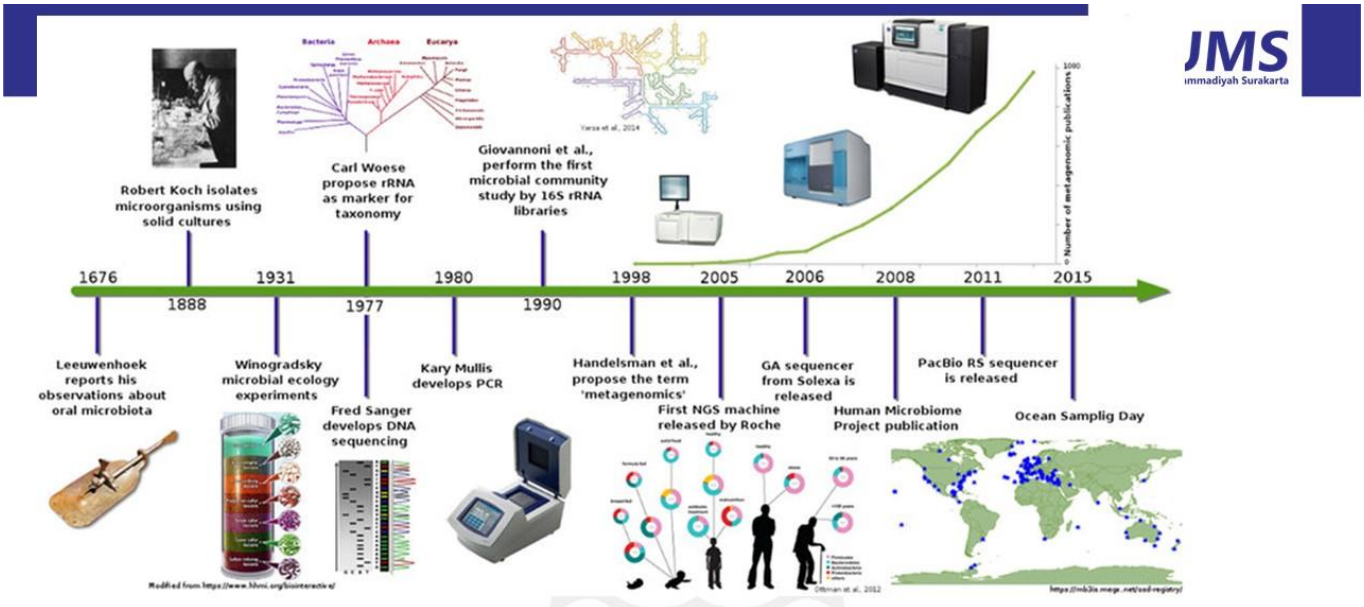
Metagenomic applications in exploration and development of novel enzymes from nature: a review

Fitra Adi Prayogo[1*], Anto Budiharjo[2,3*], Hermin Pancasakti Kusumaningrum[1], Wijanarka Wijanarka[2], Agung Suprihadi[2] and Nurhayati Nurhayati[2]

Why do we study the metagenome?

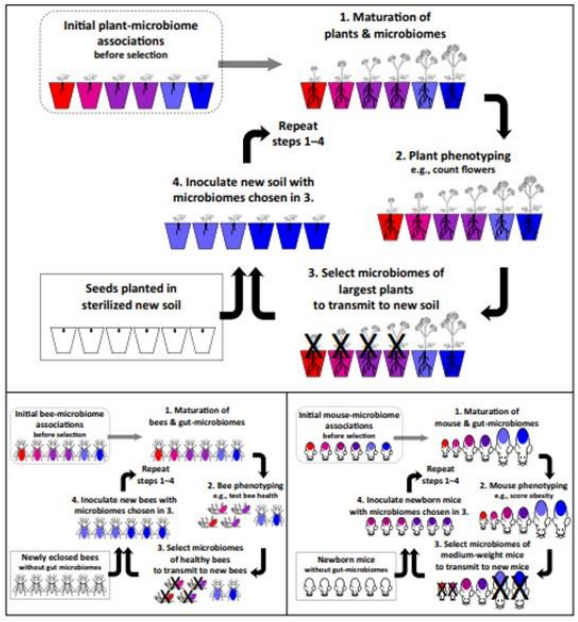


Only approximately 1% of the community of microbes can be cultivated in artificial media.



Metagenomics timeline and milestones. Timeline showing advances in microbial communities studies from Leeuwenhoek to NGS (Ottman et al., 2012; Yarza et al., 2014).

Host-Mediated Engineering of Microbiomes in Animal and Plant Hosts.



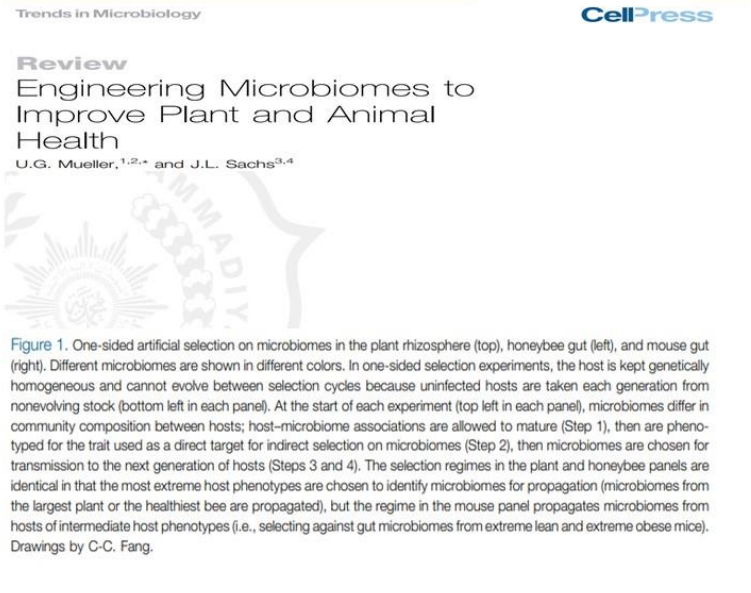


Figure 1. One-sided artificial selection on microbiomes in the plant rhizosphere (top), honeybee gut (left), and mouse gut (right). Different microbiomes are shown in different colors. In one-sided selection experiments, the host is kept genetically homogeneous and cannot evolve between selection cycles because uninfected hosts are taken each generation from nonevolving stock (bottom left in each panel). At the start of each experiment (top left in each panel), microbiomes differ in community composition between hosts; host–microbiome associations are allowed to mature (Step 1), then are phenotyped for the trait used as a direct target for indirect selection on microbiomes (Step 2), then microbiomes are chosen for transmission to the next generation of hosts (Steps 3 and 4). The selection regimes in the plant and honeybee panels are identical in that the most extreme host phenotypes are chosen to identify microbiomes for propagation (microbiomes from the largest plant or the healthiest bee are propagated), but the regime in the mouse panel propagates microbiomes from hosts of intermediate host phenotypes (i.e., selecting against gut microbiomes from extreme lean and extreme obese mice). Drawings by C-C. Fang.

Researchs using the metagenomic approach

1

UMS Universitas Muhammadiyah Surakarta

Research article

Exploration of core endophytic bacteria from different organs of diploid *Musa balbisiana* and triploid *Musa acuminata*

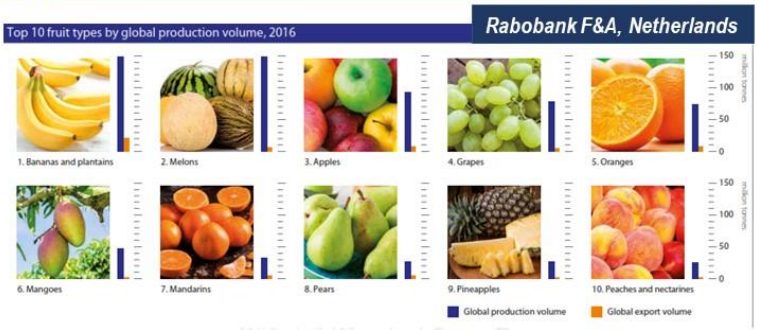
Triastuti Rahayu[a,e,†], Yekti Asih Purwestri[b,†], Siti Subandiyah[c,†], Ahmad Suparmin[d,†], Donny Widianto[d,*]

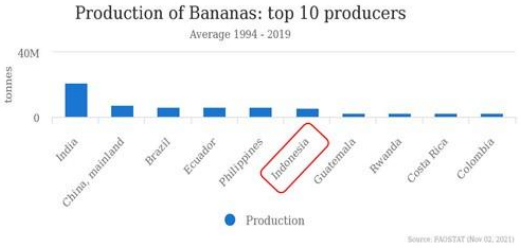
Aims : this study determined the core endophytic bacteria in the Kluthuk and Ambon cultivars

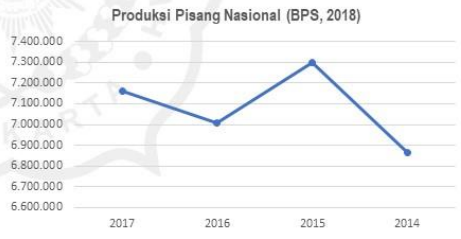
Goal : this report should be valuable for further development of banana resistance through endophytic bacterial amendment based on clear results

Banana production

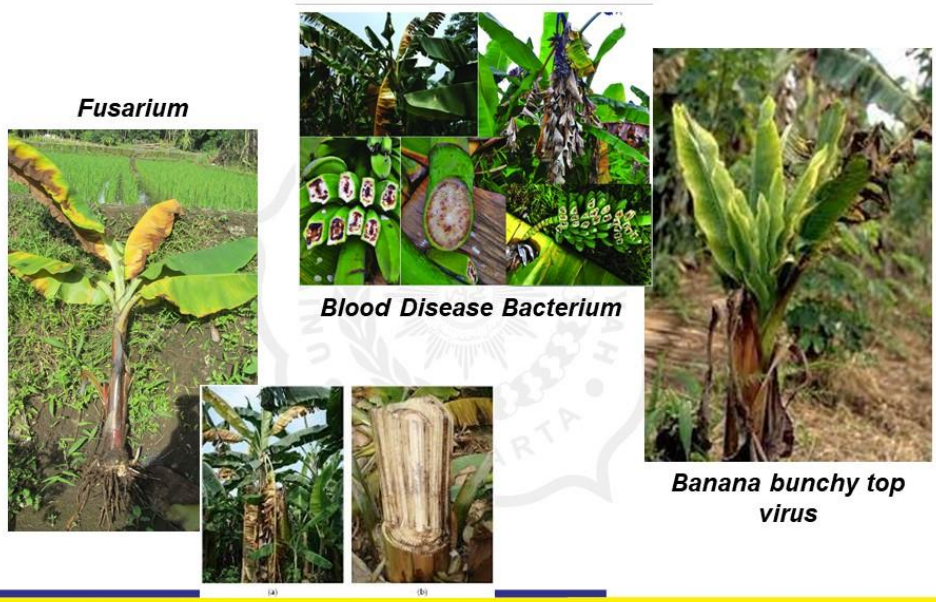
UMS Universitas Muhammadiyah Surakarta



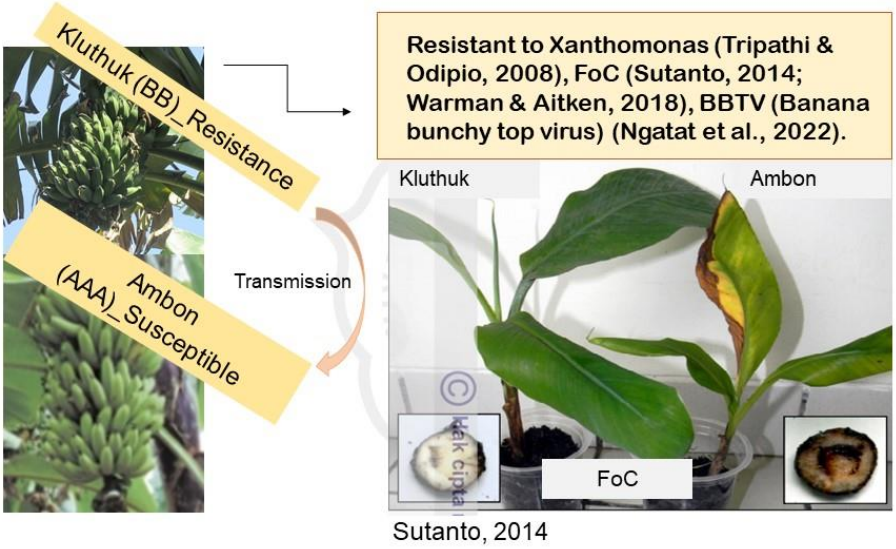




Diseases of banana plants



BANANA PLANT MODEL



Sutanto, 2014

Result

Kluthuk

Ambon

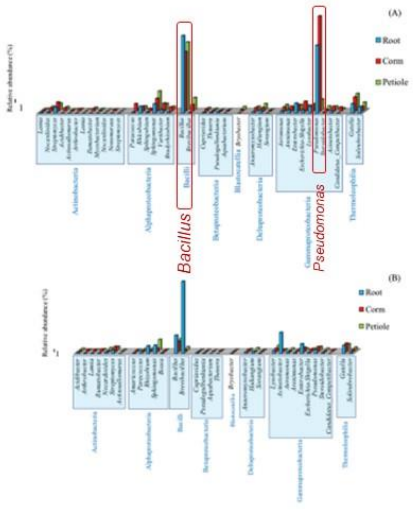
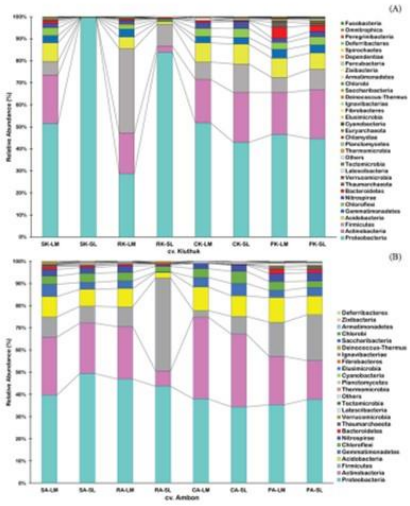


Fig. 5 C
cultivars



3 Relative abundance at phylum level of banana cultivars:
luthuk; (B) Ambon, where x axis label codes are defined in Table S1

Researchs using the metagenomic approach

2

Metagenomic study in the cemetery

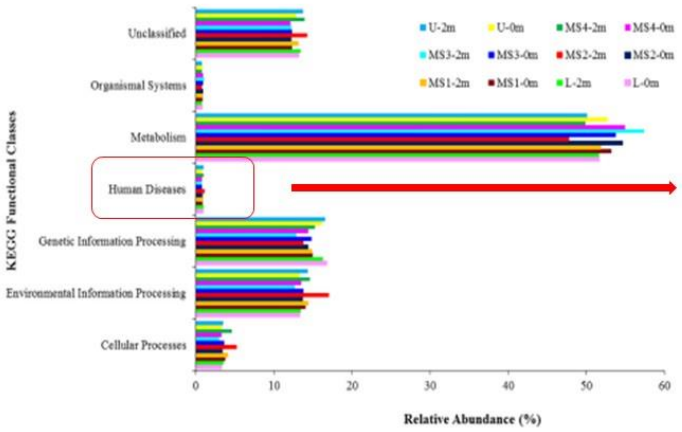


Fig. 8. General predicted functional categories of bacterial populations obtained from different cemeteries based on KEGG (Level 1).

Microbial life beyond the grave: *16S rRNA* gene-based metagenomic analysis of bacteria diversity and their functional profiles in cemetery environments

Akebe Luther King Abia [a,*,1], Arghavan Alisoltani [b,1], Eunice Ubomba-Jaswa [c,d,1], Matthys Alois Dippenaar [e,*,1]

OTUs related to human diseases in cemetery soil (relative abundance; %).

Disease	Maitland cemetery (Cape Town)					
	MS1		MS2		MS3	
	0 m	2 m	0 m	2 m	0 m	2 m
Tuberculosis	0.23	0.22	0.22	0.19	0.22	0.18
Alzheimer's disease	0.12	0.13	0.10	0.17	0.10	0.10
Huntington's disease	0.11	0.14	0.11	0.17	0.10	0.09
Vibrio cholerae pathogenic cycle	0.10	0.11	0.09	0.18	0.10	0.10
Type I diabetes mellitus	0.08	0.07	0.08	0.06	0.08	0.08
Pathways in cancer	0.07	0.08	0.07	0.10	0.07	0.06
Primary immunodeficiency	0.08	0.07	0.08	0.08	0.08	0.08
Parkinson's disease	0.06	0.08	0.05	0.12	0.05	0.04
Amyotrophic lateral sclerosis (ALS)	0.05	0.06	0.05	0.08	0.04	0.08
Type II diabetes mellitus	0.05	0.05	0.05	0.06	0.05	0.05
Pertussis	0.03	0.05	0.02	0.14	0.02	0.04
Epithelial cell signaling in *Helicobacter pylori* infection	0.03	0.04	0.03	0.07	0.03	0.03
Renal cell carcinoma	0.03	0.04	0.03	0.04	0.03	0.03
African trypanosomiasis	0.02	0.03	0.02	0.04	0.02	0.04
Amoebiasis	0.03	0.03	0.03	0.02	0.03	0.01
Prostate cancer	0.02	0.02	0.02	0.03	0.02	0.02
Chagas disease (American trypanosomiasis)	0.02	0.02	0.02	0.03	0.02	0.02
Influenza A	0.02	0.02	0.02	0.02	0.01	0.01
Small cell lung cancer	0.02	0.02	0.02	0.02	0.01	0.01
Viral myocarditis	0.02	0.02	0.02	0.02	0.01	0.01
Toxoplasmosis	0.02	0.02	0.02	0.02	0.01	0.01

Indonesia ??

Bonoloyo Cemetery

Pracimaloyo Cemetery

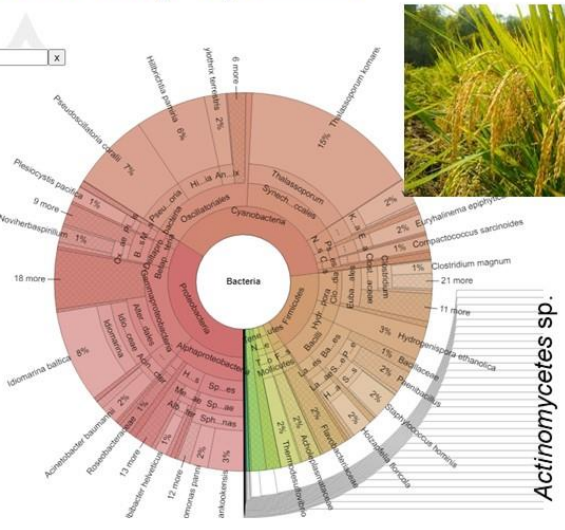
Tax_detail	P12A	P12B	B18A	B18B	B23A	B23B
p__Firmicutes;c__Bacilli;g__Bacillus;	4631	4911	9577	14392	11338	6670
p__Actinobacteriota;c__Actinobacteria;g__Marmoricola;	148	308	132	13206	150	280
p__Actinobacteriota;c__Actinobacteria; g__Nocardioides;	250	1162	344	12789	452	980
p__Proteobacteria;c__Alphaproteobacteria;g__Wolbachia;	0	504	7371	0	597	813
p__Proteobacteria;c__Gammaproteobacteria;g__Buchnera;	0	2528	6658	0	1	6
p__Proteobacteria;c__Gammaproteobacteria;g__Pseudomonas;	3	503	1442	4769	1201	1830
k__Archaea;p__Crenarchaeota;c__Nitrososphaeria;g__Nitrososphaeraceae;	1157	556	81	1045	4709	1346
p__Proteobacteria;c__Gammaproteobacteria;g__Escherichia-Shigella;	20	184	2605	8	115	217
p__Actinobacteriota;c__Actinobacteria;g__Pseudarthrobacter;	72	2233	242	1243	771	2454
p__Actinobacteriota;c__Thermoleophilia;g__Gaiella;	1383	1734	2136	2366	1635	1616
p__Firmicutes;c__Bacilli; g__Pseudbacillus;	263	163	2332	689	405	417
p__Actinobacteriota;c__Actinobacteria;g__Agromyces;	40	407	179	2040	199	297
p__Firmicutes;c__Bacilli; g__Lactobacillus;	0	1243	1963	393	1466	1711
p__Proteobacteria;c__Alphaproteobacteria;g__Asticcacaulis;	1	11	1900	0	4	17
p__Firmicutes;c__Clostridia;g__Romboutsia;	23	1018	1647	47	1150	1387
p__Proteobacteria;c__Gammaproteobacteria;g_Achromobacter;	0	0	1615	1	10	3
p__Proteobacteria;c__Alphaproteobacteria;g__Sphingomonas;	325	795	578	1174	587	1608
p__Proteobacteria;c__Alphaproteobacteria;g__Microvirga;	311	1061	354	379	784	1582
p__Firmicutes;c__Desulfotomaculia;g__Desulfurispora;	2	0	0	1535	0	0
p__Proteobacteria;c__Gammaproteobacteria;g__Pseudoxanthomonas;	2	42	1530	0	81	85
p__Proteobacteria;c__Alphaproteobacteria;g_Devosia;	16	107	572	10	750	1452
p__Verrucomicrobiota;c__Verrucomicrobiae;g__Candidatus_Udaeobacter;	84	113	402	1388	141	102
p__Actinobacteriota;c__Actinobacteria;g__Intrasporangium;	65	395	138	1339	132	403
p__Proteobacteria;c__Alphaproteobacteria;g__Pedomicrobium;	585	251	153	59	1327	623
p__Actinobacteriota;c__Thermoleophilia;g__Solirubrobacter;	198	1204	398	982	414	733
p__Firmicutes;c__Clostridia;g__Sedimentibacter;	0	1160	1	5	0	2
k__Archaea;p__Crenarchaeota;g__Candidatus_Nitrosophaera;	454	255	7	128	1143	532
p__Nitrospirota;c__Nitrospiria;g__Nitrospira;	1134	539	254	269	726	886
p__Firmicutes;c__Bacilli;g__Ammoniphilus;	255	104	297	1059	210	170
p__Proteobacteria;c__Alphaproteobacteria;g__Allorhizobium-Neorhizobium-Pararhizobium-Rhizobium;	29	327	258	8	837	1005
p__Acidobacteriota;c__Vicinamibacteria;g__Vicinamibacteraceae;	952	693	232	946	998	733
p__Actinobacteriota;c__Actinobacteria;g__Microlunatus;	94	548	118	0	568	889
p__Actinobacteriota;c__Actinobacteria;g__Streptomyces;	841	327	142	863	689	740

Rahayu et al., 2023 (unpublished)

Researchs using the metagenomic approach

3

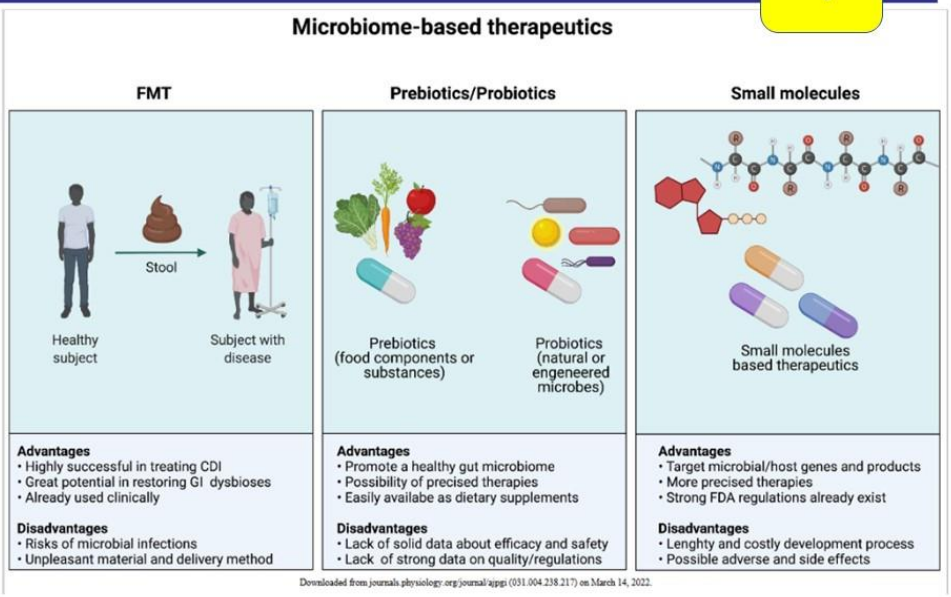
Metagenomic study in paddy (Blast desease – A *vs* Healthy - B)



Sidiq et al., 2023, unpublished)

Researchs using the metagenomic approach

4



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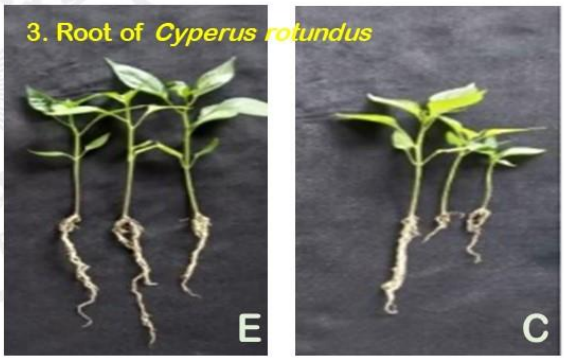
Application → PLANT EXTRACT



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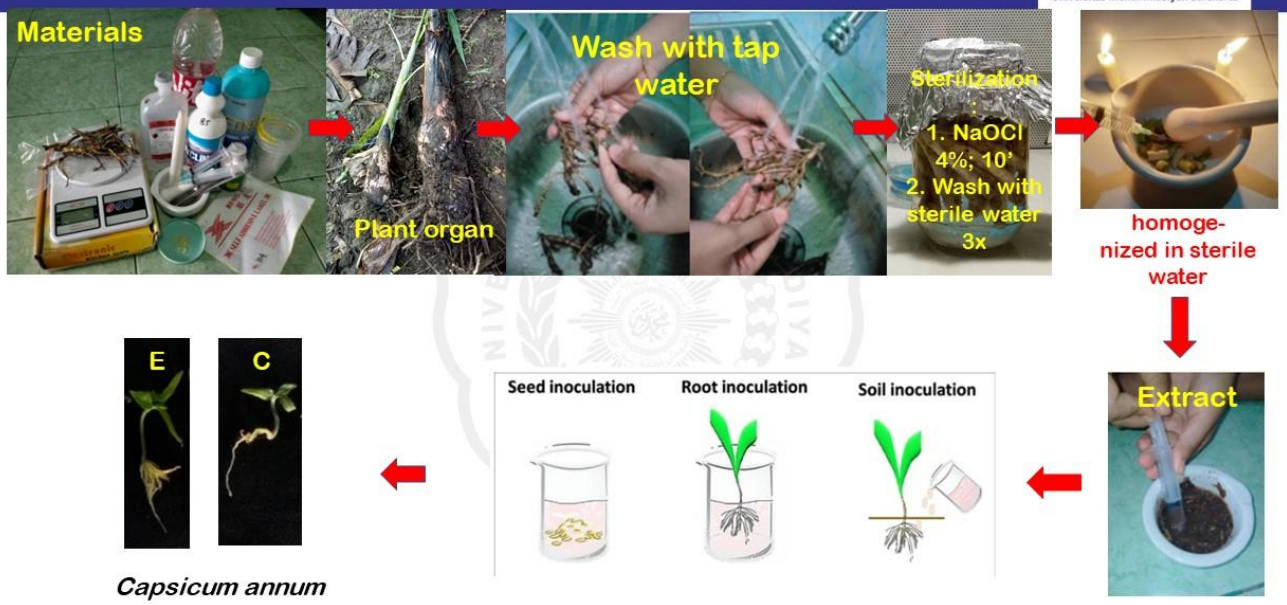
Procedure



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Summary

- Metagenomic studies are essential to know the communities of microorganisms in nature that are related to their respective functions because the microorganisms that can be grown in artificial media are only about 1%.
- Metagenomic approaches can be applied to several fields such as agriculture, environment, and health.

www.ums.ac.id Humanizing * Liberating * Transcending 18

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Development of Android-Based Interactive Teaching Materials Using the Ispring Application with Insight into Sustainable Development

Nurhasnah[1*], Lufri[2], Abdul Razak[3], Festiyed[4], Prima Aswirna[5], Windy Kasmita[6], Wetri Yesmoneca[7]
[1,5,6,7]Department of Tadris IPA Concentration of Physics, Faculty of Tarbiyah and Teacher Training, UIN Imam Bonjol Padang, Jl. Prof. Mahmud Yunus Lubuk Lintah, Kota Padang Sumatera Barat25253, Indonesia.
[2,3,4]Department of Science Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang, Jl. Prof. Dr. Hamka, Air Tawar Barat, Kota Padang, Sumatera Barat 25131, Indonesia.
[*]Corresponding Author. E-mail address: nurhasnah_tipa@uinib.ac.id

KEYWORDS:
Interactive teaching materials, Sustainable Development, Spring application

ABSTRACT

The lack of use of IT-based teaching materials and the low ability of students' scientific literacy in learning science causes the learning objectives to be not achieved in schools. In addition, the use of android among students who are also getting higher can support the learning process if it is used as well as possible. The purpose of this research is to produce Android-based interactive teaching materials using the Ispring application with a sustainable development perspective that is valid and practical to use. This research is a development research with the Plomp three-step development model, namely the preliminary stage, the development stage or the prototype stage and the assessment stage. Based on data analysis, the results of this study produced very valid interactive teaching materials with an average score of 89.22% in terms of material, media and language. Very practical to use by educators and students with an average score of 87.98%. It can be concluded that Android-based interactive teaching material use the Ispring application with an insight into sustainable development with very valid and practical criteria used in science learning.

1. INTRODUCTION

The Sustainable Development Goals (SDGs) replaced the Millennium Development Goals (MDGs) which ended in 2015 within the framework of sustainable development and negotiations and became the standard for sustainable development in countries around the world. Right in 2015, UN members consisting of 195 countries agreed to achieve sustainable development. This makes the world a better place to continue development without harming future generations. This agenda is known as the Sustainable Development Goals (SDGs) or also known as the 2030 Agenda which has 17 goals and 169 targets (Sebestyén et al. 2020). The 2030 sustainable development agenda reflects the urgency to instill the principles of education for sustainable development into all levels of education which has the aim of disseminating competencies that grow people to be able to reflect on what they do, think about their current social, economic and environmental impacts that will be generated in the future that is reviewed from a local and global perspective(Cebrián Bernat et al. 2020).

Education that is integrated with sustainable development is expected to help increase students' awareness of energy-saving attitudes related to environmental conditions and potential. One way that can be done is through the development of teaching materials used in learning. This is one of the principles of sustainable development (Ekantini and Wilujeng 2018). In line with the explanation above, the achievement of sustainable development goals is also related to the development of information and communication technology. In the 21st century, science and technology in various countries have progressed very rapidly (Lee et al. 2011). With this rapid development, the younger generation in this globalization era is required to be able to keep abreast

of information technology developments that are beneficial for developments in various aspects of life, especially in education (Uzunboylu and Aşıksoy 2014). Many strategies have been carried out by the government to meet the demands of the 21st century, one of which is by changing and updating the curriculum used in the learning process in schools.

Organization for Economic Co-operation and Development (OECD) is one of the international organizations involved in developing the world of international education (Schleicher 2016). The OECD regularly organizes the Program for International Student Assessment (PISA) every three years. One of the important aspects assessed from this program is students' scientific literacy skills. Indonesia is one of the countries that routinely participates in the PISA survey. However, the results achieved have never been satisfactory and Indonesia's performance has always been in a position that does not meet standards set internationally and tends to decline (Asyhari 2015). The results of the PISA survey of Indonesian students regarding scientific literacy show that most students in the Republic of Indonesia are at the basic level of scientific literacy 1 and a small proportion of Indonesian students have reached the basic level 2. There are 6 levels in the PISA ranking, so levels 1 and 2 are still considered low (Setiawan et al. 2017).

One way to make teaching and learning activities not boring is to involve technology in these learning activities (Sastrakusumah et al. 2018). Electronic media that students can use have different benefits and characteristics (Smaldino et al. 2004). In this case, the researcher applies the use of Ispring interactive multimedia. Interactive multimedia is an application that can be used to channel messages, stimulate thoughts, emotions, attention, and willingness to learn so that it can control the learning process (Sastrakusumah et al., 2018). Ispring is one of the tools that can convert presentation files to Flash form and SCORM/AICC form used in e-learning. Ispring is not complicated to use and can be easily integrated with PowerPoint (Qomariah and Mistianah 2021). Ispring acts as a powerpoint add-in, making powerpoint files more interesting and interactive, and can be accessed using Android offline anywhere and anytime.

In fact, the teaching materials that teachers use still seem unattractive and a bit boring and there are no teaching materials that are integrated with sustainable development. Based on observations in the field, teachers still tend to teach conventionally and do not utilize technology in learning. Most teachers only rely on handbooks from the government. There is no innovation in the use of teaching materials by teachers, so this method is still considered traditional. Traditional teaching methods are not only inefficient but also a waste of time (Herwinarso et al. 2020). In teaching using this traditional method, time constraints often occur in science classes, and the teacher may miss explaining some concepts in detail. Sometimes, some students cannot follow the material within the allotted time (Herwinarso et al. 2020).

The use of teaching materials that are not optimal is not in accordance with the 2013 curriculum. Learning is carried out to support learning activities using various kinds of teaching materials. One of the suitable teaching materials is Android-based interactive teaching materials. The impact of the underdeveloped use of teaching materials results in students' abilities that are still underdeveloped and limited so there is no better achievement (Reinders and Balcikanli 2011). The lack of development of students' abilities is also caused by the use of more time using smartphones which are not used properly, such as playing games and accessing less useful things, especially in the educational aspect. The research carried out is product development from research that is relevant to this research, namely that carried out by (Manasikana 2017). Based on these problems, the researcher aims to develop an Android-based interactive teaching material using the Ispring application with a sustainable development perspective to support scientific literacy.

The development of this teaching material was developed in accordance with the problems that occur, namely the low ability of scientific literacy and energy-saving attitudes that are still not applied in everyday life by students. The purpose of developing this teaching material is to produce Android-based interactive teaching materials using the Ispring application with a sustainable development perspective that is valid and practical for use by students and teachers. The reference used to develop good teaching materials is that these teaching materials can be used by educators

and students as learning resources. In addition, teaching materials must also be attractive and the appearance can also attract attention and improve students' scientific literacy abilities.

2. MATERIALS AND METHODS

The method used in this study is a research and development method using the Plomp & Nieveen model, (2013). The stages of research and development according to Plomp and Nieveen (2013) are divided into three stages, namely: (1) Preliminary research ; (2) the development or prototyping phase; and (3) the assessment/implementation phase. The three stages are presented in the following figure.

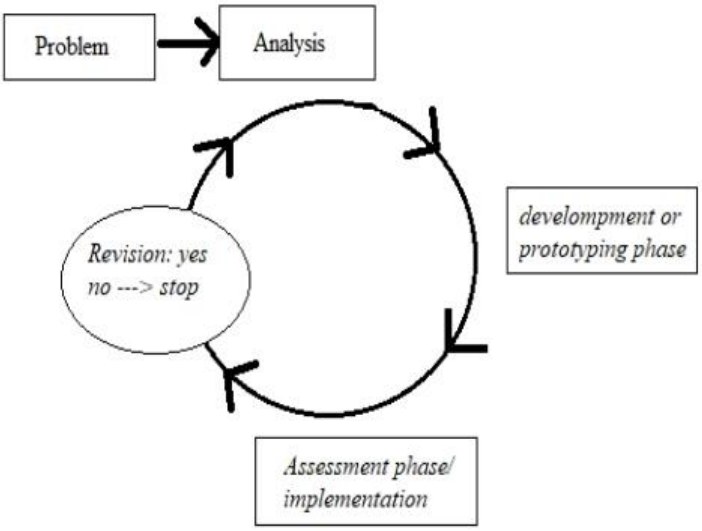
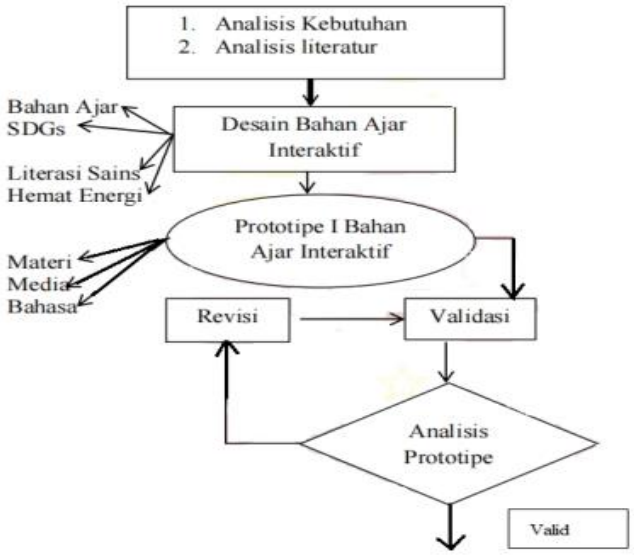
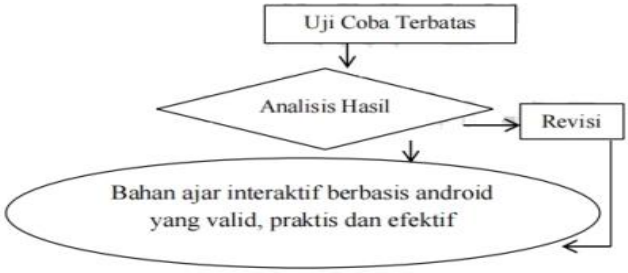


Figure 1. Plomp & Nieveen Development Model, (2013)

Based on the development steps of Plomp and Nieveen (2013), the development procedure in this study can be described in detail as the phases of developing interactive android-based teaching materials with an insight into sustainable development with the Plomp model as follows:

Table 1. The Phases of Developing Interactive Android-Based Teaching Materials with an Insight Into Sustainable Development With The Plomp Model

Stages of Research Activities	**Step** **Plomp & Nieveen Development**
	*PreliminariesResearch*(Preliminary Research) *Prototyping Phase*

Stages of Research Activities	Step Plomp & Nieveen Development
	*Assessment Phase*

This final value indicates the level of validity. The interval for determining these criteria can be seen in **(Table 2.)** follows:

Table 2. Criteria level of validity

No	Score	Criteria
1	81% - 100%	Very Valid
2	61% - 80%	Valid
3	41% - 60%	Valid Enough
4	21% - 40%	Invalid
5	0% - 20%	Invalid

(Sugiyono, 2010)

3. RESULTS AND DISCUSSION

3.1. Preliminary research

Preliminary Research is an initial investigative stage that aims to conduct need and context analysis. The first step taken in this research is Preliminary Research, this activity focuses on gathering information to identify problems. The preliminary research stage is an initial analysis that aims to determine the need for developing Android-based interactive teaching materials (Yustianingsih et al. 2017). researchers collect information about the problems contained in science learning by observing the implementation of learning activities, interviewing science teachers and students in class (Siahaan et al. 2021)

This stage consists of several analyzes, namely:

a. Needs analysis stage (Educators and Students)

At this stage, to collect, analyze and define problems related to the use of learning resources the researcher conducted an interview with Mrs. "A", an integrated science educator at SMPN 3 Solok Selatan. This interview was conducted in person at the residence of Mrs. "A" in Padang Aro, Sangir District, South Solok Regency in July 2021.

Based on the results of interviews conducted with educators, learning is still minimal in terms of the use of technology due to the limited ability of educators in terms of technology. While other factors are due to the need for time and capital to design teaching materials that are in accordance with learning materials, especially interactive teaching materials based on Android. In addition to interviews with educators, to strengthen this research an interview was also conducted with a class VII student at SMPN 3 Solok Selatan. The interview was conducted at the student's residence in Sungai Aro.

Based on the results of the analysis of interviews with students, it can be concluded that most students already have Android, and like learning using technology such as Android. So, one of the teaching materials that can be used is Android-based interactive teaching materials which make it easier for educators in the learning process on temperature and heat, and energy materials. In line with research conducted by Kasmita et al. (2021) who also found that most students use Android and this can have a positive impact if used in

learning. then Android-based learning will maximize the function of technology in the process of understanding science content. Previous research also found that Android-based learning can also improve scientific literacy, conceptual understanding and student learning outcomes (Istighfarini et al. 2022; Manasikana 2017; Nurhamidah et al. 2022; Ramdani et al. 2020).

b. Results of Literature Analysis / Literature Study

This analysis was carried out to find concepts or theoretical foundations that strengthen Android-based Interactive Teaching Materials using the Ispring application with an insight into sustainable development. In this stage, the steps taken are:

1) Curriculum Analysis Stage. The curriculum analysis phase includes core competencies and describes basic competencies into several indicators.
2) Data Analysis Stages. The analysis carried out included identifying what kind of electronic teaching materials were used during online learning during this pandemic, identifying temperature and heat materials and energy materials used in SMP/MTs, as well as the advantages and disadvantages of these interactive android-based teaching materials.
3) Material Analysis Stage. Aims to determine the content and subject matter in accordance with the sustainable development program (SDGs) which can develop students' scientific literacy and energy-saving attitudes. Educators also play a role in the success of the SDGs program, namely the 7th and 15th SDGs programs where everyone supports sustainable development programs by protecting the environment and using renewable energy. Thus, students can apply science learning materials in everyday life.

3.2. Development or prototyping phase ;

This stage is a continuation of the first stage, which aims to produce prototypes of Android-based interactive teaching materials using the Ispring application with a valid sustainable development perspective. The stages in this activity are as follows:

a. Designing Prototypes

The design stage for what is done for Android-based interactive teaching materials using the ispring application with a sustainable development perspective is as follows:

1) Prepare a background design for teaching materials
2) The design of making introductory words, instructions for using teaching materials, as well as the design of making KI, KD, indicators, and learning objectives
3) The design of making the author's bio as an introductory stage before learning begins
4) The design makes matter temperature and heat and matter-energy
5) The design chooses an image that matches the material
6) The design of making learning videos related to the material
7) The design of making sample questions
8) The design makes evaluation questions
9) The design of making a video of the prayer of kafaratul assemblies is a sign of gratitude because learning has been completed.

b. Development of Android-based interactive teaching materials using the ispring application with an insight into sustainable development

1) Product Identity
   Physical form : Electronic Teaching Materials
   Title : Android-Based Interactive Teaching Materials with an Insight into Sustainable Development
2) Android-based display of interactive teaching materials
   The display of interactive teaching materials developed can be seen in the following figure 2.

Figure 2. The appearance of Android-Based Interactive Teaching Materials

3.3. Assessment phase/implementation

The purpose of this stage is to produce interactive teaching materials based on Android using the Ispring application with a sustainable development perspective that is valid and practical. This Android-based interactive teaching material validator consists of 3 lecturers at UIN Imam Bonjol Padang consisting of 1 material expert, 1 media expert and 1 linguist.

a. Content Eligibility
   Indicators for testing the validity of the material/content validity of Android-based interactive teaching materials consist of 12 statements. The lowest score for each statement is 1 and the highest score is 5.
b. Language Eligibility
   Language validity indicators in Android-based interactive teaching materials consist of 4 statements. The lowest score for each language validity statement was 1 and the highest score was 5. The language validity questionnaire was filled out by 1 validator.
c. Media Eligibility
   Android-based interactive teaching material media indicators consist of 15 statements. The lowest score for each statement of media validity is 1 and the highest score is 5. The value of the media validity questionnaire is filled out by 1 validator.

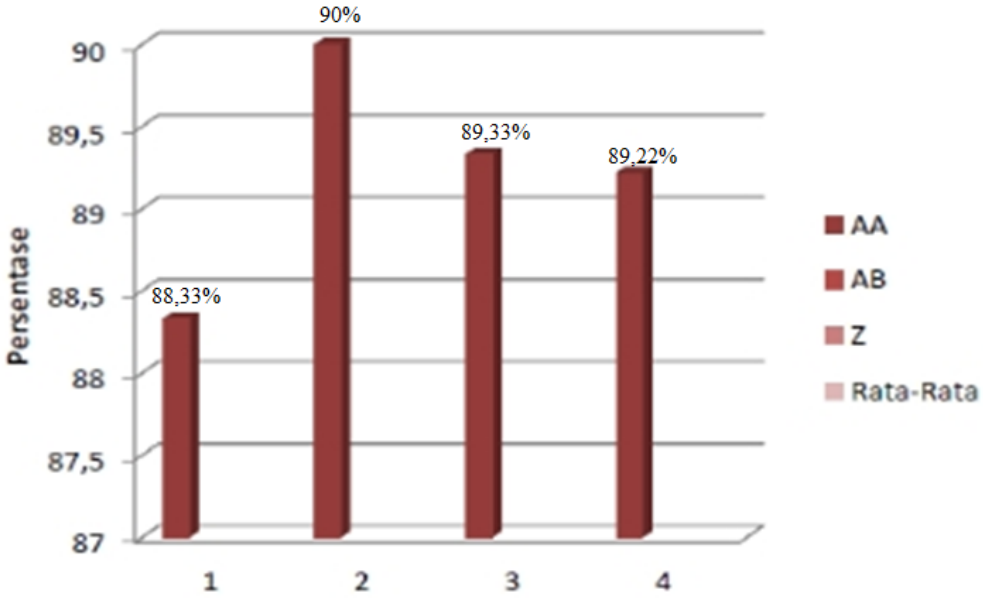


Figure 3. Average Value of Product Validation

Information:
1 Content/Material Validation
2 Language Validation
3 Media Validation
4 Average

If the validation results are at an interval of 81% -100%, it is a very valid category. Judging from the results of the validation analysis by the three validators, the average percentage was 89.22%. So it was revealed that Android-based interactive teaching materials using the Ispring application with an insight into sustainable development are in a very valid category.

Furthermore, a practicality test was carried out using interactive teaching materials based on Android using the Ispring application with an insight into sustainable development for educators and students. As many as 2 science educators and 20 students took this practicality test. The results of the practicality test of educators and students can be seen in the graph below.

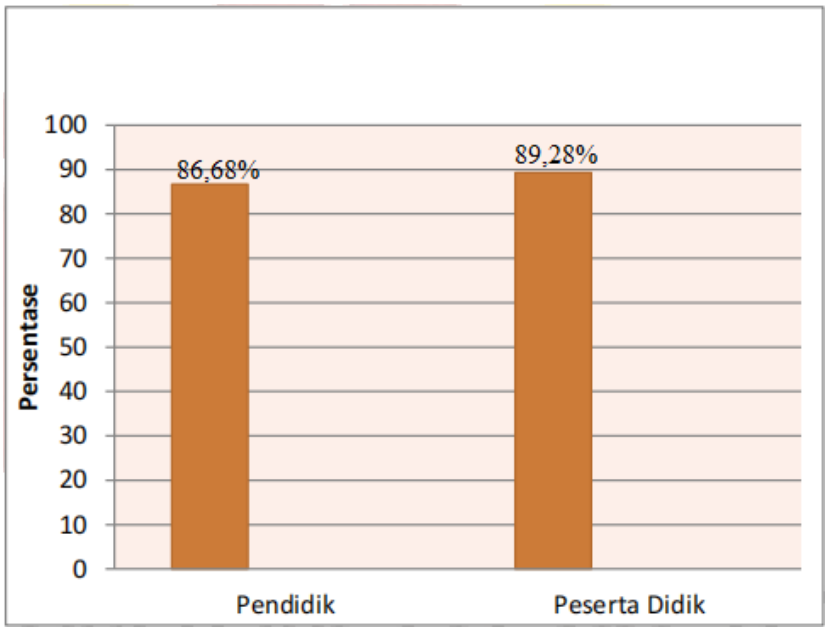


Figure 4. Average Practicality Validation Value

Judging from the results of the analysis of practitioners by educators and students, an average percentage of 87.98% was obtained, it was revealed that Android-based interactive teaching materials used the Ispring application with an insight into sustainable development in a very practical category. This is also supported by several previous studies which also found that the development of teaching materials using ISpring can help students understand science concepts and make learning more interactive (Dasmo et al. 2020; Qomariah and Mistianah 2021; Sari and Ridwan 2020; Sastrakusumah et al. 2018).

4. CONCLUSIONS

Android-based interactive teaching materials using the ispring application with the perspective of sustainable development with very valid, practical, and usable categories. However, this interactive teaching material needs to further see the effectiveness of its use on a larger scale. To be able to see the impact and influence of this interactive teaching material which is more significant for students and educators in learning science.

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The Effect of STEM Approach on Students' Critical Thinking Skills

Media Roza[1,*], Minda Azhar[2], Festiyed[2], Prima Aswirna[3], Rika Purnama Sari[4]
[1,3]Tadris Physics Study Program, Universitas Islam Negeri Imam Bonjol Padang, Jl. M. Yunus Lubuk Lintah Padang, 25153, Sumatera Barat, Indonesia
[2]FMIPA, Universitas Negeri Padang, Jalan Prof. Dr. Hamka, Air Tawar Padang, Sumatera Barat, 25132, Sumatera Barat, Indonesia
[4]SMP Islam Terpadu JUARA, Jl Abdul Hamid Hakim, Komp. STAI Imam Bonjol, Kota Padang Panjang, Sumatera Barat, Indonesia
*Corresponding Author. E-mail address: mediaroza@uinib.ac.id

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Critical Thinking, Science Learning, STEM Approach

ABSTRACT

The influence of the STEM approach has been widely studied. However, a summary of how much influence STEM has on critical thinking skills from these various studies has not been done well. This article examines the impact of the STEM approach on students' capacity for critical thought when studying physics and science. This type of research is quantitative research with meta-analysis methods. Articles from recent four-year publications in national and international journals serve as data sources. Only 16 articles met the criteria for further analysis. This study's method of data analysis involved calculating the effect size to provide a summary effect size. There are four moderator variables analyzed: learning models, teaching materials, subject matter, and education level. Based on the study's findings, it can be said that the STEM approach to fostering students' critical thinking abilities has the largest impact size when used in motion systems courses at the high school level, using media schoology and worksheets for the students. The STEM approach is proven to have a high summary effect size on students' critical thinking skills, with a score of 1.37 (high category).

1. INTRODUCTION

The era of globalization requires qualified, competitive, and adaptive Indonesian human resources in all situations. The best way to be able to compete in a global world is to equip human resources with various 21st-century skills through education. The Partnership for 21st Century Skills states that the competencies needed in the industrial revolution era 4.0 are "The 4 Cs," namely communication, collaboration, critical thinking, and creativity (Lufri et al., 2022; Roza, et al., 2022; Moser, 2017; Mumford & McIntosh, 2017).

Everyone is racing to find innovation by strengthening the quality of education. Competence and high competitiveness in humans will be tips for winning competence in the 4.0 revolution era. Competence in the 21st century era is crucial for students to have in implementing learning to guide them to have creative, innovative abilities, think critically in solving problems, and be communicative (Ananda et al., 2021). As a result, it is reasonable to predict that education in the 4.0 or 21st century age will continue to be important and will serve as a complement to the phenomena of digital penetration in daily life.

Education 4.0 prepares students to directly address digital concerns, where the essence of this phenomenon is the mindset, creativity, and great curiosity of students, so that in the future they can produce graduates who have good quality and skills. Therefore, learning activities in education 4.0 units should be carried out systematically, actively, inspiringly, and fun, and should provide motivation for students to actively participate in providing ideas and creativity and be independent in expressing their talents and interests. To support this, learning must meet at least four principles: student-centeredness, collaboration, integration with real life, and having clear context and goals (Asrizal et al., 2018).

In the fourth industrial revolution, critical thinking abilities are the main emphasis of educational activities (Linh et al., 2019). Critical thinking skills can be formed from several habits, including understanding concepts, classifying, analyzing, collecting, and evaluating information obtained through scientific methods (Siegel, 2013). Whereas the scientific method itself entails observation, formulation of issues, formulation of theories, gathering of information, testing of theories, and formulation of conclusions. If students have fulfilled some of these skill criteria, it can be said that they already have the capacity for critical thought in their learning. In addition, this critical thinking focuses on reflective thinking (Hand et al., 2018), and leads to the analysis of arguments or certain opinions, admit mistakes and bias, and provide conclusions based on the evidence and considerations obtained (Arends & Kilcher, 2010) .

Learning activities should help students enhance their critical thinking abilities by relating what they are learning to real-world context issues. One of the main objectives of education is to help pupils become more adept at critical thinking (Tee et al., 2018), where the development of critical thinking abilities emphasizes the learning process through analysis in order to foster the capacity for clear, logical thought (Higgins, 2014). Of course, to do this effectively and help students develop their critical thinking abilities, educators must play a crucial part in learning activities. However, this ability cannot be maximized in schools. 16 years old, Indonesia is in a position of low science ability level. Besides that, based on PISA (Program for Student Assessment) data for a period of 15 years, Indonesia is still in a low science ability position (OECD, 2016). The results of the study show a similar thing: the average score for critical thinking abilities among students for each indicator is on average below 50% (Hidayanti et al., 2016).

Other evidence that shows the lack of capacity for critical thought in students is shown in several studies, including research in Thailand, where it was found that students' critical thinking skills were still low due to teaching methods that were less varied and the school system (Boa, 2018). In addition, the low critical thinking ability of students is caused by learning that is still teacher-centered, where this condition causes students' critical thinking skills to not be improved (Hairida, 2016). If this condition occurs continuously, students' critical thinking skills cannot develop optimally as expected, and will have an impact on student learning outcomes. Among the subjects that can develop critical thinking skills are science and physics learning.

Studying physics and science is expected to run according to the demands of the current curriculum. However, the fact is that science learning in the field is not as expected, especially with the spread of COVID-19, which requires educators to keep up with changes in technology, learning theory, and changes in educational needs and students (Jowsey et al., 2020). Likewise, physics instruction attempts to educate students to deal with changing situations in life and in a world that is experiencing change (Alistiana, L., Aswirna, P., & Y, A., 2020). Physics learning is usually less desirable, considered difficult, and feared by many students. This condition originates from learning experiences where students find physics learning that only addresses conceptual issues and solves questions with high difficulty through mathematical formulas. Additionally, because of the class's inadequate learning environment, students only participate passively in the learning process (Ananda et al., 2021).

Knowledge and technology that are developing rapidly in the current era are expected to be important factors in supporting the quality of students. Educational challenges also increase with the development of technology (Putriyani & Irawan, 2021). So, based on this, an approach is needed to strengthen pupils' capacity for critical thought, one of which is using the STEM (Science, Technology, Engineering, and Mathematics) learning approach (Onsee & Nuangchalerm, 2019).

STEM approach stands for science, technology, engineering, and mathematics (Estapa & Tank, 2017). The STEM approach is considered to be able to encourage students to develop 21st-century skills (Techakosit & Nilsook, 2018). The STEM learning approach is effectively used in learning because students do not always feel suitable for all conventional learning conditions and environments (Jowsey et al., 2020). If STEM is connected to the environment, it will be able to grow, and students will learn about real-world situations that they encounter every day (Sagala et al., nd). STEM applications can help students plan, construct, and utilize technology well,

improving affective, psychomotor, and cognitive skills. According to certain research findings, STEM can enhance conceptual understanding and critical thinking abilities (Fan & Yu, 2015; Lufri, L., & Asrizal, 2023).

The results of searching for national and international journal articles using Harzing's Publish or Perish application obtained 400 articles related to the effect of the STEM approach on students' capacity for critical thought in learning science and physics. However, from the results of the investigation based on the criteria for the articles needed in this study, 16 research articles were found with various conclusions expressed in relation to the use of learning models, teaching materials or learning media used, materials used, and educational level.

Based on the problems described above, it can be seen that the impact of using the STEM approach has been extensively researched. However, a summary of how much influence STEM has on critical thinking skills from these various studies has not been done well. Therefore, a meta-analysis study is needed to see how much the impact of the STEM approach on students' capacity for critical thoughts. This article aims to analyze the effect of the STEM approach on students' critical thinking skills in learning science and physics based on the four moderator variables; learning models, teaching materials or learning media used, materials used, and educational level.

2. MATERIALS AND METHODS

This kind of research uses a meta-analysis methodology and is quantitative. The meta-analysis aims to determine the relevance of the research topic after the treatment. This study analyzes publications in international and national journals from 2018 to 2021. Literature search using keywords through the Publish or Perish application. After searching, there were more than 400 articles related to the influence of the STEM approach to learning science and physics in junior and senior high schools on students' critical thinking skills. However, after being evaluated, only 16 papers met the requirements for further investigation.

This research was obtained by collecting various research journals from various accurate sources, such as Google Scholar, Scopus, the Directory of Open Access Journals, and others in international, national, and other similar sources, which were then arranged and selected according to the specified criteria. Descriptive statistical analysis techniques used to examine the data acquired for this investigation were the effect size of each article and the summary effect size of the influence of the STEM approach on students' critical thinking abilities. The effect sizes were calculated using the Cohen formula based on the mean, standard deviation, calculated t-value, and sample size (Retnawati, et al., 2018). How to calculate the effect size can be seen in Table 1.

Table 1. The formulas used to calculate the effect size

Statistical Data	Formula
If known, only the mean value of the control group, the mean value of the experimental group, the standard deviation of the control group, and the standard deviation of the experimental group.	$ES(d) = \frac{\bar{X}post_E - \bar{X}post_C}{SD_{within}}$ Where : $SD_{within} = \sqrt{\frac{(n_E-1)SDpost_E^2+(n_C-1)SDpost_C^2}{n_E+n_C-2}}$
For the two groups of independent samples, the mean value and posttest-pretest posttest-pretest standard deviation of the experimental class were identified. and known, the mean value of the posttest-pretest and the standard deviation of the posttest-pretest control group.	$ES(d) = \frac{(\bar{X}post_E - \bar{X}post_E) - (\bar{X}post_C - \bar{X}pre_E)}{SD_{within}}$ Where : $SD_{within} = \sqrt{\frac{(n_E-1)SDpre_E^2+(n_C-1)SDpre_C^2+(n_E-1)SDpost_E^2+(n_C-1)}{2(n_E+n_E-2)}}$

Statistical Data	Formula
For a comparison test of two independent samples, if the number of samples in the control group, the number of samples in the experimental group, and the value of tcount are known	$ES\ (d) = \frac{\bar{X}post_E - \bar{X}post_C}{SD_{within}}$ If the number the number of the control group is the same as the experimental group then: $SD_{within} = \frac{\bar{X}post_E - \bar{X}post_C}{t_h\sqrt{\frac{2}{n}}}$ If the number of the control group is different from the number of the experimental group, then: $SD_{within} = \frac{\bar{X}post_E - \bar{X}post_C}{t_h X \sqrt{\frac{1}{n_E} + \frac{1}{n_C}}}$
For the pretest-posttest contrast design, and if it is known, the average value of posttestE and pretestE	$ES\ (d) = \bar{X}post_E - \bar{X}pre_E$ where: $SD_{within} = \sqrt{\frac{(n_1-1)xS_1^2 + (n_2-1)x\,S_2^2}{n_1+n_2-2}}$
To find the value of variance d	$V_d = \frac{n_E + n_C}{n_E x n_C} + \frac{d^2}{2(n_E + n_C)}$ $Sed = \sqrt{V_d}$
To change d to Hedge's g, use the correction factor (J). The (J)	$J = 1 - \frac{3}{4df-1}$ after: $g = J \times d$ $Vg = J^2 \times V_d$ $Seg = \sqrt{Vg}$

The criteria for determining the effect size are categorized using the reference from Glass can be seen at Table 2.

Table 2. Criteria effects size

No	Effects sizes	Category
1	ES 0.15	Negligible
2	0.15 < ES < 0.40	Low
3	0.40 < ES < 0.75	Medium
4	0.75 < ES < 1.10	High
5	ES > 1.10	Very high

(Modified from Glass, 1976)

The research procedure consists of seven steps: determining the research topic, choosing the type of publication to be collected, collecting the results of the study or literature, recording the

research variables, calculating the effect size for each source or literature, interpreting the report, and making conclusions.

3. RESULTS AND DISCUSSION

The results obtained are a calculation of how much the summary effect influences the STEM Approach on Students' critical thinking abilities based on four the moderator variable is the learning model used, teaching materials or media used, materials and educational levels.

3.1. The effect of the STEM Approach on Students' Critical Thinking Skills

The results of 16 articles that met predetermined criteria regarding the effect of the STEM approach on students' critical thinking ability, found various effect sizes that varied. The effect size of each analyzed article can be seen in Table 3.

Table 3. Effect size of each article

Code Article	d	V_d	SE_d	Category
J01	2.56	0.121	0.348	Very high
J02	3,26	0.086	0.294	Very high
J03	2.44	0.114	0.337	Very high
J04	0.45	0.064	0.253	Medium
J05	3,41	0.194	0.441	Very high
J06	1.05	0.048	0.220	High
J07	0.55	0.065	0.255	Medium
J08	0.80	0.089	0.298	High
J09	4.37	0.036	0.190	Very high
J10	0.21	0.009	0.093	Low
J11	0.60	0.031	0.175	Medium
J12	0.60	0.069	0.262	Medium
J13	0.61	0.056	0.238	Medium
J14	0.51	0.070	0.265	Medium
J15	0.47	0.037	0.192	Medium
J16	0.36	0.041	0.202	Low

where:
d = Cohend's effect size
V_d = Cohend's effect size variance
SE_d = Cohend's standard error effect size

There are 5 articles with a very high effect size, 2 articles in the high category, 7 articles in the medium category, and 2 articles in the low category. Therefore, it is crucial to analyze the overall effect size of the STEM approach's effects on students' capacity for critical thought as well as the moderator factors that have been established, namely learning models, teaching materials or media, subject matter, and level of education.

The use of the STEM approach in learning science and physics in junior and senior high schools is able to improve students' critical thinking skills. As explained by Asigigan and Samur, STEM practice positively improves students' critical thinking skills (Asigigan & Samur, 2021) . The conclusion that STEM practices improve students' critical thinking abilities is supported by a number of research in the literature (Hacioglu & Gulhan, 2021; Mutakinati et al., 2018).

3.2. The Influence of The STEM Approach on Students' Critical Thinking Skills Based on The Learning Model

The description from table 4 explains that the meta-analysis of the use of the STEM approach to students' critical thinking skills based on the learning model used gives an effect with medium,

high, and very high categories. The summary effect size of the influence of the STEM approach using various learning models on students' critical thinking skills can be seen in Table 4.

Table 4. Summary of the effect size of the STEM approach on students' critical thinking skills based on the learning model

Learning model	N	Summary ES	Category	p.s	95% Confidence Interval	
					Lower	Upper
STEM	10	1,087	High	0.000	0.461	1,714
Blended Learning	1	3,237	Very high	0.000	2.665	5.309
PBL	3	0.574	Medium	0.002	0.217	0.932
PJBL	1	1.024	High	0.000	0.603	1.229
Discovery Learning	1	4,357	Very high	0.000	3.985	7.847

If the p-value = 0 < 0.05, then the hypothesis tested using the fixed effect is rejected. So that there is an influence of the STEM approach on students' critical thinking skills in science and physics learning in all learning model analyzed. The highest influence of the STEM approach was found in the discovery learning model with a summary effect size of 4.357, the second highest in the Blended Learning model with a summary effect size of 3.237, the PJBL model in the high category with a summary effect size of 1.024, and so on, followed by the PBL model with a summary effect size of 0.574.

The learning model is a design that is arranged systematically to achieve the goals of learning (Alistiana et al., 2020). STEM learning is effectively combined with Discovery Learning, Blended Learning, and PJBL models because the STEM-based Discovery Learning Model in Biology that is linked to real life is in a good category, thereby increasing the interest and activeness of students and making material easier to remember, as well as ensuring that participants have good concentration during learning (Fadlina et al., 2021).

3.3. The influence of the STEM approach on students' critical thinking skills based on the teaching materials/media used

The results of further research in this research activity are related to the summary effect size analysis of the influence of the STEM approach on learning science and physics through the use of teaching materials or learning media. The summary effect size of the influence of the STEM approach using various teaching materials on students' critical thinking skills can be seen in Table 5.

Table 5. Summary of the effect size of the STEM approach on students' critical thinking skills based on the teaching materials/media used

Teaching Materials	N	Summary ES	Category	p.s	95% Confidence Interval	
					Lower	Upper
Schoology	1	3.237	Very high	0.000	2.665	5.309
Students' worksheets	4	2.637	Very high	0.002	0.931	4.344
PhET	1	0.787	High	0.007	0.212	0.501
Digital Books	1	0.440	Medium	0.079	-0.050	-0.036

The p-value test obtained is smaller than α (0.05), which means that the null hypothesis is rejected when it is tested for schoology or media, student worksheets, and PhET. However, the

results of testing the null hypothesis for digital book media show that the null hypothesis is accepted because the p-value is greater than α (0.05). This means that using instructional materials or media in learning with the STEM approach to students' critical thinking skills has a very significant influence on teaching materials or schoology media, students' worksheets, and PhET. Based on the summary effect size value that has been obtained, the highest summary effect size value is on teaching materials, school media, and students' worksheets. So, using instructional materials or media in learning with the STEM approach to students' critical thinking skills has a very significant influence on teaching materials or schoology, students' worksheets, and PhET.

In the world of education, the teaching and learning process is very dependent on factors that affect the quality of the learning process. The quality of learning can be seen in students' responses to the media or teaching materials used (Izzah et al., 2021). One of them is learning media, or learning aids, which are very important to use to communicate messages from the sender to the recipient so that the learning process can achieve learning objectives effectively by stimulating students' thoughts, feelings, interests, and readiness (Ariska et al., nd).

3.4. The Influence of the STEM Approach on Students' Critical Thinking Skills Based on Subject Matter

In the Summary Effect Sizes in Table 6, which is 4.38, it is presented that the meta-analysis results of the influence of the STEM approach on students' critical thinking ability have different effects ranging from low to very high categories on natural science learning materials and physics in middle and high school. The summary effect size of the influence of the STEM approach using various subject matter on students' critical thinking skills can be seen in Table 6.

Table 6. Summary of the effect size of the STEM approach on students' critical thinking skills based on the subject matter

Subject Matter	N	Summary ES	Category	p.s	95% Confidence Interval	
					Lower	Upper
Sound Wave	1	2.528	Very high	0.000	1.854	-0.036
Light waves	1	2.386	Very high	0.000	0.212	3.520
Light and Optics	1	0.440	Medium	0.079	-0.050	-0.036
Optical	1	0.787	High	0.007	0.212	0.501
Dynamic Fluids	2	1.713	Very high	0.000	1.336	2.09
Static Fluids	2	0.775	High	0.000	0.506	1,043
Motion System	1	4.357	Very high	0.000	3.985	7.847
Ecosystem	1	0.213	Low	0.022	0.031	0.070
Newton's laws	1	0.589	Medium	0.023	0.083	0.229
Electricity (Energy Transformation)	1	0.501	Medium	0.055	-0.010	0.048
Equilibrium	1	0.346	Low	0.078	-0.039	-0.037

The results of testing the null hypothesis on the material sound waves, light waves, optics, dynamic fluids, static fluids, motion systems, ecosystems, and Newton's laws show that the hypothesis was rejected because the p-value test obtained was smaller than the value of α (0.05). However, the results of testing the null hypothesis for the materials light and optics, electricity, and equilibrium show that the null hypothesis is accepted because the p-value test obtained is greater than the value of α (0.05).

This means that the STEM approach influences critical thinking skills in every material except for light and optics, electricity, and equilibrium. Based on the summary effect size value that has been obtained, the highest summary effect size is in motion system material, sound waves, light waves, and fluid dynamics. It may be concluded that the STEM approach to teaching science and physics has a significant positive impact on student's ability to think critically about these four subjects.

The application of the STEM approach is considered to be able to help improve students' critical thinking skills (Khoiriyah, 2018). The characteristics of subjects also influence the success of the STEM approach. Karakoc (2016) argues that when students think critically, they are encouraged to think independently, question hypotheses, analyze and synthesize events, and go further by developing new hypotheses and testing them against facts that occur in real life.

3.5. The Influence of the STEM Approach on Students' Critical Thinking Skills Based on Educational Level

Analysis using the fixed effect model obtained a summary effect size of 0.325 for the effect of the STEM approach on learning science and physics on students' critical thinking skills at the junior high school level, with a 95% confidence interval tested using JASP software ranging from 0.190 to 0.460. The summary effect size of the influence of the STEM approach using various educational level on students' critical thinking skills can be seen in Table 7.

Table 7. Summary of the effect size of the STEM approach on students' critical thinking skills based on the educational level

Educational Level	N	Summary ES	Category	p.s	95% Confidence Interval	
					Lower	Upper
Junior High School	7	0.325	Low	0.000	0.190	0.460
Senior High School	9	2,111	Very high	0.000	1.183	3.038

The results of the analysis using the RE model obtained a summary effect size of 2.111 for the effect of the STEM approach on science and physics learning on students' critical thinking skills at the high school level, with 95% confidence intervals ranging from 1.183 to 3.038. The results of testing the null hypothesis for both levels of education show that the null hypothesis is rejected because the p-value obtained is 0.000, which is smaller than the value of (0.05). It can be concluded that the STEM approach to science learning has a significant influence on students' critical thinking skills at the junior and senior high school levels.

Approaching STEM has a significant impact when applied to high school students. This is because the higher the level of education and the older the person, the more their ability increases. In Bujuri's (2018) research, children aged 11 to 12 years and over are experiencing a formal operational phase, where they are able to think of something that will or may happen and is abstract in nature.

4. CONCLUSIONS

Based on the meta-analysis carried out, it can be stated that there are two research results. First, the summary effect size of the effect of the STEM approach in science and physics learning on students' critical thinking skills is 1.375 in the high category, so the STEM approach in science and physics learning has a significant effect on students' critical thinking abilities. Second, the effect of the STEM approach in science and physics learning on students' critical thinking skills gives the highest summary effect size to the discovery learning model with an effect size of 4.36

in the very high category and to the use of schoology with a summary effect size of 3.24. In the subject matter of motion systems with a summary effect size of 2.56 in the very high category and at the high school level with a summary effect size of 2.11 in the very high category. It can be concluded that the STEM approach has a very high effect on students' critical thinking skills. Educators are required to be able to develop teaching materials or STEM-based learning media to improve critical thinking skills as a support when learning takes place.

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Inventory of Montane Zone Weeds in the Selo Tourism Area, Boyolali Regency, Central Java

Nila Permatasari[1], Santhyami[1,2]*
[1]Biology Education Department, Faculty of Teacher Training and Education, Universitas Muhammadiyah Surakarta. Jl. A. Yani Tromol Pos I, Pabelan, Kartasura, Surakarta 57162, Jawa Tengah, Indonesia
[2]Environmental Study Centre, Universitas Muhammadiyah Surakarta, Jl. A. Yani Tromol Pos I, Pabelan, Kartasura, Surakarta 57162, Jawa Tengah, Indonesia
*Correspondence Author, E-mail address: san915@ums.ac.id

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ABSTRACT

The weed is a plant that develops in undesirable areas and harms surrounding plants. Nonetheless, this herb can be used as a source of organic material, as a soil coating to prevent erosion, and as a traditional medicine. Weed growth can vary depending on the weed's characteristics and environmental conditions. The Selo region is a verdant tourist destination in the montane zone's highlands. The land clearing caused a change in the area's vegetation. This study seeks to determine the Montane zone's weed vegetation varieties, composition, and structure. It is also connected to the release of land in Selo as a tourist area. This form of research is conducted at three different altitudes (1.600m asl, 1.700m asl, dan 1.800m asl). The intercept-point and exploration method is used, as well as data analysis involving the determination of summed dominance ratio (SDR) values and diversity index analysis. Consequently, there are variations in the composition and dominance of herbaceous vegetation at each height. There are 27 species of vegetation, with Imperata cylindrica (SDR 55.67% and 27.73% at 1.600m asl and 1.800m asl, respectively) dominating at 1.600m asl and 1.800m asl, and Ageratina riparia (SDR 20.86%) dominating at 1.700m asl. The highest diversity of grass species at the altitude of 1.800 m asl (H' 2,17). The highest sorensen's similarity index is at altitudes of 1.600 m asl and 1.700 m asl (SSI 52,17%). The ecosystem conditions influenced by abiotic factors and the management of ecosystems impact the diversity and uniformity of grass species in the mountainous region of the Selo Tourist Area.

1. INTRODUCTION

The weed is all plants that thrive in an area the farmer does not want them to, so their presence can harm other plants or the tree plant (Oksari, 2017). Due to competition for nutrients, water, light, and other essential development elements, weeds can be detrimental to the growth and yield of plants in agriculture (Faisal, et al., 2011). However, weeds can be used as a source of organic material, soil coating to prevent erosion, and as constituents in traditional medicines (Hasan, 2019). Competition between weeds and plants is affected by the type and density of weeds, horticultural culture, plant varieties, fertilization, soil conditions, and climate (Tantra & Santosa, 2016). The risky characteristic of weed, namely that it can germinate and grow in conditions of low light and water, that its seeds do not die or go dormant when the environment is less conducive for its growth, and that its vegetative growth and development are rapid (Widaryanto & Zaini, 2021). The stems are generally triangular, occasionally spherical, and typically not loose; the leaves are arranged in three rows and lack leaf languages (ligula) (Nugraha, 2023).

Montane zone is situated between 1.500 and 2.400 m asl (Rozak, 2016). The zone is characterized by dense vegetation, decreasing stem diameter, and abundant wood-dwelling mollusks and nails. This area has a variety of trees that are decreasing in number. The vegetation

formation above is becoming increasingly open, allowing more sunlight to enter the forest and increasing the presence of weed and weed (Anesta, 2020). Different climates can cause differences in the species and population's vegetation in response to differences in height (Budi, 2018). Weed growth varies based on the weed's characteristics or constitution, environmental conditions, treatment, and environmental adaptability (Andalusia, 2018). Research on weed species is required to understand the distinctions in type, dominance, density, and distribution of weeds in the montane zone. In addition, more research needs to be conducted on vegetation in the tropical montane zone.

Selo area is a Mount Merapi Montane region municipality in Boyolali district, Central Java Province. It is situated on the foothills of Mounts Merapi and Merbabu (Suyana, 2020). Where the topography of Selo's territory ranges from 1.600 to 1.800 m asl. The region offers a variety of tourist destinations with breathtaking natural scenery. The creation of a tourist destination necessitates a large amount of land for its management in order for the land to serve its purpose. The opening of land by humans can alter the structure of previously extant plant life (Blegur, 2022). During land preparation, vegetation control is typically accomplished by soil processing. This causes a change or transition in the plant life in an area, including the growth of weeds.

As a foundation for using and conserving biodiversity and other natural resources, vegetation data is indispensable. These vegetation data are used for scientific purposes and a variety of practical applications, such as forest harvesting, land use, soil protection, water management, mining, etc (Julianto, Putri, and Safi'i, 2020). Selo is one of the tourist destinations close to Mount Merapi, which transforms this region into the high plains. In addition, the region is rich in vegetation, with weed being one of the lesser-known species. Where inventory research has been limited and information on the types of weed in the area to be studied is unavailable, it is necessary to gather data on the types of cereal in the Selo Area. This research is required to identify the zone montane weeds type, particularly in the tropics. In addition, understanding the type of weed vegetation is essential for determining the success of a society's weed control efforts. The land opening causes a shift in the region's vegetation, so it is necessary to update the vegetation data of the weeds zone of the Selo Tourism Area's montane. Therefore, this study aims to identify the weed varieties, composition, and structure of the montane weed zone in the Selo Tourism Area, Boyolali, Central Java.

2. MATERIALS AND METHODS

Sampling Location and Sampling

Observational investigation on the inventory of montane zone weeds in the Selo Tourism Area, Boyolali Prefecture, Central Java at coordinates -7.512369°,110.453935° (1.600m asl), -7.515583°,110,453307 (1.700m asl), and -7.519806°,110452495 (1.800m asl), sampling is conducted. The region's topography consists of highlands in mountainous regions with altitudes between 1.600m asl and 1.800m asl and brown lithosol and grey regosol soil types. This region has a climate of type C, which is sufficiently moist to support agricultural endeavors. This region's average temperature and humidity range from 24-28°C and 75-90%, respectively. In the monsoon season, precipitation ranges from 0 to 256 mm^3, whereas in the dry season, it ranges from 277 to 439 mm^3. The air pressure is between 1.008,80 and 1.011,00 mb, and the wind speed is between 6,90 and 11,00 kph. In the interim, the solar eclipse was between 61 and 86%.

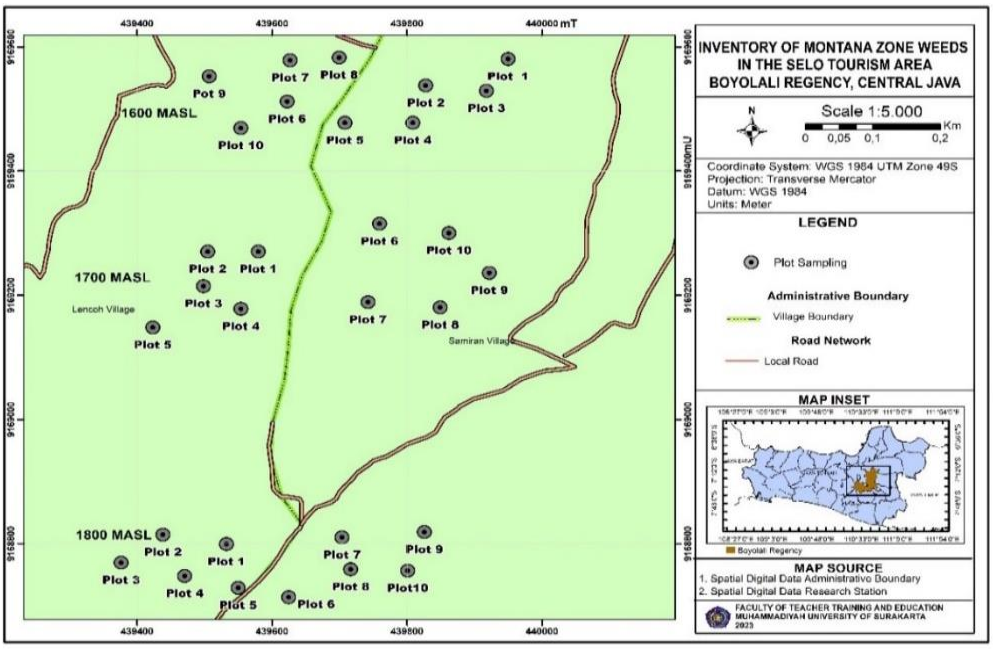

Figure 1. Map and location of research

The study was conducted at three distinct altitudes: 1.600 m asl, 1.700 m asl, and 1.800 m asl. Intercep-point and exploration are the methodologies used. According to Firmansyah et al. (2020), plot placement is conducted using a technique based on the large quantity of weed vegetation. Sampling each plot's weed vegetation using 100cm x 100cm squares (Kartawinata & Abdulhadi, 2016). Roll meters, rafia rope, wooden rods, and small square meter sampling instruments for vegetation are utilized for plotting. The thermohygrometer, altimeter, and soil tester are the instruments that are used to determine environmental conditions. Cutter, plastic bags, cameras, sprayers, petri containers, lups, and writing instruments are employed for plant sampling. Where weed vegetation at various altitudes of the montane zone area (1.600m asl, 1.700m asl, and 1.8000m asl) in the Selo Tourism Area, Boyolali Prefecture, Central Java was utilized for this study.

Figure 2. Sampling tools square meters (1m x 1m)

Herbarium Specimen Collection and Identification

Herbarium collections by gathering specimens of all vegetation species discovered. Thus, the results of the herbarium were identified at the Muhammadiyah University of Surakarta's Biological Laboratory. Identification and nomenclature are accomplished through desk research utilizing the books Flora (Steenis, C.G. G.J., 2013) and Flora of Java (C.A. Backer, R.C. Bakhuizen Van Den Berg, 1963).

Data Analysis

Summed Dominance Ratio (SDR) values are calculated based on Cox (1967) and Mueller-Dombois and Ellenberg's (1974), i.e., the SDR values are derived from the calculation of the Relative Species Density (RD), the Dominance of a Species (RDo), and the Frequency of Reference of a Species (RF), and the Important Value (IV). We also calculated the species diversity index (Shannon & Wiener, 1963) and sorensen's similarity index (Mueller-Dumbois & Ellenberg, 1974).

3. RESULTS AND DISCUSSION

The structure and composition of the weed species found in the ecosystem of the montane zone in the Selo Tourist Area consists of 27 species from 11 families identified during the investigation at three altitude points (1.600m asl, 1.700m asl and 1.800m asl). At an altitude of 1.600m asl, 9 species of vegetation from 3 families were discovered; at 1.700m asl, 14 species from 7 families; and at 1.800m asl, 17 species from 7 families. Asteraceae, Poaceae, Balsaminaceae, Onagraceae, Cyperaceae, Polygalaceae, Urticaceae, Marsileaceae, Umbelliferae, Caryophyllaceae, and Melastomataceae are families of herb species discovered there.

The classification of wheat based on its morphology yields two categories of weed: Large leaf and narrow leaf grass. Large leafy weed is a weed whose blade breadth exceeds half its length. The leaf shapes are oblong, round, triangular, long, round, or kidney-shaped (Tosang, 2019). Typically, the return of the leaves of this group, i.e., the stitching, is dominated by the typical Dicotyledoneae plant group. The narrow-leafed weed is one in which the leaf length and width are tiny or narrow. The shape of the foliage is tapered, linear, needle-like, and elongated. This group's leaf returns are typically straight or linear and dominated by Monocotyledoneae (Firmansyah, 2017). At three different altitudes, it is determined that weedes with broad leaves are the most prevalent (Figure 3). The abundance of broad-leaved weeds makes them the predominant vegetation in the ecosystem, and they can inhibit the growth of weeds. This is due to the fact that seeds are used to cultivate the majority of weed foliage. At the time of soil processing, the seeds in the soil are extracted and germinated if water and light requirements are met (Putra et al., 2018). In addition, broad-leaved weeds are more resistant to heat, water, and light than weeds, stitching, and spotting weeds (Ramlan et al., 2019). Therefore, weeds with broad leaves tend to be more adaptable than narrow ones (Suryanto et al., 2017).

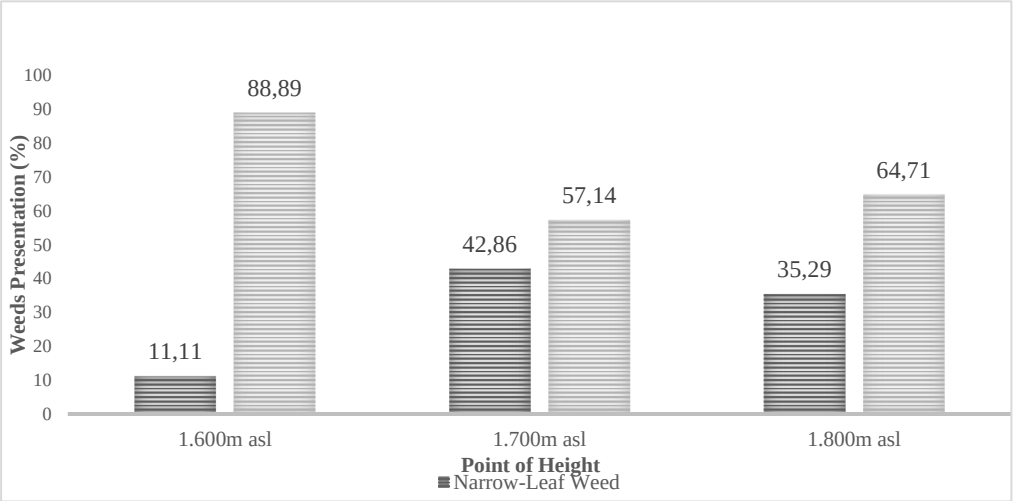

Figure 3. Three-dimensional visualization of the number of large leaf and narrow leaf weed types

The importance of each variety of weed can be used to determine the dominant type of weed in an ecosystem. The variety of weeds that grows in the Selo Tourist Area's montane zone has significant value differences. At 1.600 m asl and 1.800m asl, *Imperata cylindrica* has the highest

significant value and summed dominance ratio (SDR) value (Tables 1 and 3), whereas, at 1.700m asl, *Ageratina riparia* has the highest significant value and Summed Dominance Ratio (S DR) value (Table 2). Where, according to the results of calculations, species *Imperata cylindria* (SDR 55.67%), *Tridax procumbens* (SDS 12.3%), and *Ageratina riparia* (SDR 8.89%) dominate at an altitude of 1.600m asl. At an altitude of 1.700m asl, *Ageratina riparia* (SDR 20.86%), *Pennisetum purpureum* (SDR 18,8%), and *Imperata cylindria* (SDR 18.36%) were found to be the dominant species. At an altitude of 1.800m asl, it was determined that *Imperata cylindria* (SDR 27.73%), *Ageratina riparia* (SDR 17.46%), and *Cyperus odoratus* (SDR 9.68%) predominated. This indicates that *Imperata cylindrica* and *Ageratina riparia* dominate the ecosystem of the Selo Tourist Area's montane zone.

Table 1. Important Value (IV) and Summed Dominance Ratio (SDR) of weed montane zone vegetation at 1.600m asl altitude, in The Tourist Area of Selo, Boyolali, Central Java

No	Name of Species	RD (%)	RF (%)	RDo (%)	IV (%)	SDR (%)
1.	*Imperata cylindrica* Beauv	64.29	31.25	71.45	167	55.67
2.	*Tridax procumbens* L.	13.14	12.5	11.26	36.9	12.3
3.	*Ageratina riparia* (Regel) King & H. Rob.	9.06	9.37	8.51	26.94	8.98
4.	*Bidens tripartita* L.	4.44	9.37	4.52	18.34	6.11
5.	*Ageratum conyzoides* L.	1.59	12.5	1.68	15.78	5.26
6.	*Artemisia vulgaris* L.	4.44	9.37	0.89	14.7	4.9
7.	*Cosmos caudatus* H.B.K	1.95	6.25	0.79	9.002	3
8.	*Crassocephalum crepidioides* (Benth.)	0.71	6.25	0.79	7.76	2.59
9.	*Impatiens platypelata*	0.36	3.12	0.08	3.57	1.19
	Total	100	100	100	300	100

Table 2. Important Value (IV) and Summed Dominance Ratio (SDR) of weed montane zone vegetation at 1.700m asl altitude, in The Tourist Area of Selo, Boyolali, Central Java.

No	**Name of species**	**RD (%)**	**RF (%)**	**RDo (%)**	**IV (%)**	**SDR(%)**
1.	*Ageratina riparia*	28.07	15.22	19.29	62.57	20.86
2.	*Pennisetum purpureum*	17.68	15.22	23.5	56.4	18.8
3.	*Imperata cylindrica* Beauv	15.03	13	27.07	55.14	18.38
4.	*Artharaxon hispidus*	13.15	6.52	10.21	29.88	9.96
5.	*Parietaria judaica* L.	9.39	6.52	4.13	20.05	6.68
6.	*Ludwigia palustris* (L.) Elliot	7.51	2.17	3.4	13.09	4.36
7.	*Crassocephalum crepidioides*	1.88	6.52	4.05	12.45	4.15
8.	*Cyperatus cyperoides*	1.22	8.69	1.13	11.05	3.68
9.	*Tridax procumbens* L.	2.43	4.35	3.57	10.34	3.45
10.	*Cyperatus odoratus*	1.22	6.52	0.57	8.3	2.77
11.	*Polygala paniculata*	1.1	4.35	1.29	6.75	2.25
12.	*Solidago canadensis* var. lepida L.	0.33	4.35	0.24	4.92	1.64
13.	*Ageratum conyzoides*	0.22	4.35	0.32	4.89	1.63

14.	*Impatiens platypelata*	0.77	2.17	1.22	4.16	1.39
	Total	100	100	100	300	100

Table 3. Important Value (IV) and Summed Dominance Ratio (SDR) of weed montane zone vegetation at 1.800m asl altitude, in The Tourist Area of Selo, Boyolali, Central Java

No	Name of Species	RD (%)	RF (%)	RDo (%)	IV (%)	SDR (%)
1.	*Imperata cylindrica* Beauv	24.93	15,.22	43.1	83.2	27.73
2.	*Ageratina riparia* (Regel) King & H. Rob.	26.6	8.7	17.1	52.37	17.46
3.	*Cyperus odoratus* L.	9.9	6.52	12.62	29.04	9.68
4.	*Parthenium hysterophorus* L.	3.73	15.22	2.14	21.1	7.03
5.	*Eclipta prostrata*	9.25	4.35	6.83	20.43	6.81
6.	*Drymaria cordata* Willd	6.04	4.35	3.1	13.48	4.5
7.	*Centella asiatica* Urb.	3.21	6.52	1.75	11.48	3.83
8.	*Arthraxon hispidus* (Thunb.) Makino	4.11	4.35	1.99	10.44	3.48
9.	*Conyza sumatresis*	1.16	6.52	1.51	9.19	3.06
10.	*Tridax procumbens* L.	3.6	2.17	3.1	8.87	2.96
11.	*Marsilea crenata*	2.7	4.35	0.87	7.92	2.64
12.	*Eleusine indica* Gaertn	0.77	4.35	1.91	7.03	2.34
13.	*Briza minor*	1.16	4.35	1.27	6.78	2.26
14.	*Crassocephalum crepidioides* (Benth.)	1.54	4.35	0.71	6.61	2.2
15.	*Ageratum conyzoides* L.	0.64	4.35	1.35	6.34	2.11
16.	*Gamochaeta purpurea (*L.) Cabrera	0.39	2.17	0.4	2.96	0.99
17.	*Melastoma candidum*	0.26	2.17	0.32	2.75	0.92
	Total	100	100	100	300	100

Important value and value of high Summed Dominance Ratio *Imperata cylindrica* are attributable to the weed's ability to survive in extreme conditions, allowing it to develop to nearly any height on the territory. *Imperata cylindrica* can proliferate wildly in various soil types, particularly on unused and infertile soils with few migrants (Subagia et al., 2021). *Impera cylindrica* is aggressive and invasive because its primary organ is a crust. This is consistent with Sayfulloh's study (2020), which has been categorized as one of the most invasive plants, particularly in tropical and subtropical regions of the world (Invasive Species Specialist Group, 2008) due to its capacity to grow rapidly on formerly processed soils such as gardens, open land for buildings, and roadside. Because it grows in the forest, *Ageratina riparia* also governs the ecosystem of the Montane Zone in the Selo Area. This plant thrives in a subtropical climate between 975 and 1.706 m asl. This plant is dominant because it is a member of a group of invasive species yuliare capable of rapid growth, particularly in tropical regions (Perianto, 2019). In addition, this plant can thrive anywhere, particularly in wet environments, such as open forests and lawns with heavy precipitation (Respitosari & Pujiastuti, 2022).

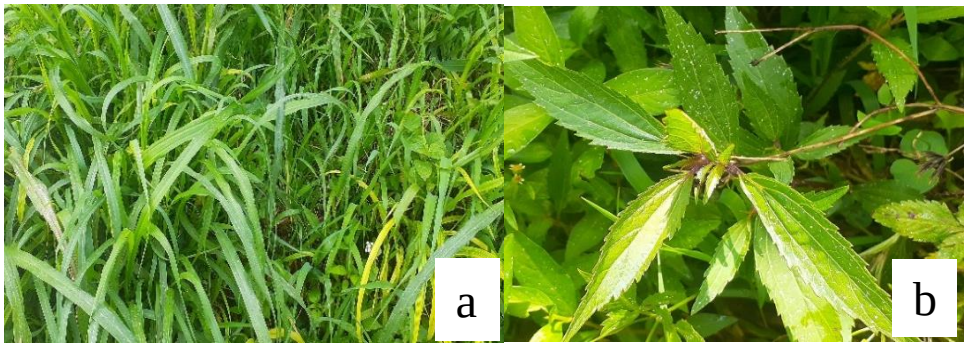

Figure 4. *Imperata cylindrica* (a) dan *Ageratina riparia* (b)

It has been stated that the diversity of grass species with H'<1 includes low, 1 < H' <3 includes medium, and H' >3 includes high. The result of the level of diversity of weed species at three points of altitude in the Selo Tourist Area's montane zone is medium, with the highest Shannon-Wiener diversity index (H') at 1.800m asl and the lowest diversity index at 1.600m asl (Table 4). The diversity values of the grain varieties obtained indicate that differences in ecosystem conditions significantly impact the diversity of grain species because if the ecological environment is not conducive to growth, the weed weeds will go dormant. However, if the ecosystem environment is conducive to flora, then the weed propagules will germinate and develop into weed vegetation, which can cause problems for the primary plants (Setiawan & Sarjiyah, 2021). In addition to the conditions of ecosystems, weed species diversity is also affected by ecosystem management.

Table 4. Type diversity index (H') vegetation weeds zona montane on Selo, Boyolali, Central Java Tourist Areas

Point of Height (m asl)	H’
1.600	1.24 (Medium)
1.700	2.02 (Medium)
1.800	2.17 (Medium)

The condition of the ecosystem in the Selo Tourism Area's montane zone can be determined by measuring the abiotic factor. Differences in height, soil pH, atmospheric pressure, light intensity, temperature, and humidity exist between the ecosystems of three altitude locations (Table 5). The weed's development can be affected by the weed's height. The investigation by Sintayehu (2019) indicates that weed can grow well up to 2.400m asl. There is a highest diversity of vegetation species at higher elevations than at lower elevations. Among the three altitude locations, the type diversity index is at an altitude of 1.800m asl highest compared to 1.600m asl. These differences in height impact the diversity of weedes because they result in variations in climate conditions, such as temperature and humidity, which influence weed growth (Nurnasari & Djumali, 2010).

The measurements of abiotic factors revealed a highly significant correlation between the intensity of light at three different altitudes and abiotic factors (Table 5). The relationship between light intensity and the ecophysiological processes of plants is close. The intensity of light has a significant impact on the efficacy of photosynthesis in plants. Adaptation of shadow plants and heat-resistant plants to the intensity of light results in efficient photosynthesis, allowing both types of plants to survive and produce abundantly (Yustiningsih, 2019). *Imperata cylindrica* plants are C4 plants; these plants require a high intensity of sunlight for photosynthesis and thrive on open ground (Fujiyanto, 2015). Therefore, *Imperata cylindrica* is found near all elevations. The *Ageratina* riparia plant is a C3 plant, so it is typically found in frigid climates and can photosynthesize more efficiently than a C4 plant at 25°C. In addition, a higher tree cover at 1.800m asl than at other heights influenced the diversity of the herbicides discovered.

In addition to the abiotic factors described previously, using herbicides and managing the mountain ecosystem in the Selo Tourism Area are human-controllable factors that can influence the diversity of weed species. Observations indicate that local communities at an altitude of 1.600m asl tend to employ herbicides as weed degradants, thereby reducing the diversity of weeds at that altitude. This is due to herbicidal properties that inhibit or destroy certain types of weeds without harming the crops (Yuliana & Ami, 2020). Furthermore, vegetation is also routinely carved at the height of 1.600m asl, unlike at 1.700m asl and 1.800m asl. Thus, the diversity of vegetation species at an altitude of 1.800m asl is highest than at other research sites.

It has been stated that grass similarity rates >75% are incredibly high, 50%-75% are high, 25%-50% are low, and 25% are deficient. Following the differences in the presence of grass species as measured by the Sorensen diversity index (Table 6), the diversity indices at an elevation of 1,600m dpl and 1,700m dple was 52.17 percent. corresponds to the mean as indicated by the index value. However, the diversity index at altitudes of 1.600 m asl and 1.800 m asl was low at 38.46%, and the diversity index at altitudes of 1.700 m asl and 1.800 m asl was also low at 45.16%. This is due to a variety of ecosystem conditions, including altitude, air temperature, soil pH, and air humidity. At altitudes of 1.600m asl and 1.800m asl, there is a slight variation in weed species due to differences in abiotic factors; consequently, the varieties of weeds that grow at these altitudes are quite distinct from one another. This is evidenced by the morphology of weed at an altitude of 1.600m asl, which tends to be more broad-leafed than weed at 1.800m asl. This weed leaf morphology is related to the light intensity and tree cover at each altitude, where the light intensity at an altitude of 1.600m asl is highest than at altitudes of 1.700m asl and 1.800m asl.

Table 5. Montane zone abiotic factors in Selo, Boyolali, Central Java

Abiotic Factors	Point of Height		
	1.600m asl	**1.700m asl**	**1.800m asl**
Temperature of air (°C)	28.7	20.6	21.3
Humidity of the air (%)	57	94	73
pH of soil	6	5,5	6
The atmospheric pressure (atm)	835.4	825.3	815.6
The intensity of light (Cd)	18200	11460	2180

Table 6. Sorensen's Similarity Index (SSI) vegetation weeds montane zone in Selo, Boyolali, Central Java Tourist Areas

Point of Height	SSI (%)
1.600m asl and 1.700m asl	52,17 (High)
1.600m asl and 1.800m asl	38,46 (Low)
1.700m asl and 1.800m asl	45,16 (Low)

According to the vegetation data of the mountain weeds zone in the Selo Tourism Area, the composition of the region's weeds is highly diverse. This research's conclusions can be utilized as a supplement material for biodiversity-related education in schools. For further research, students can use these accounts as references for future research. For the community to provide information about the various vegetation of the plant weed zone Montana in the Selo Tourism Area, it can take advantage of the types of weeds that exist (potential use) and know the weed control techniques in the montane zone.

4. CONCLUSIONS

In research related to the inventory of montane zones, disparities in composition and dominance of weed vegetation at each height (1.600m asl, 1.700m asl, and 1.800m asl) were discovered in the Selo Tourist Area. The quantity of weeds at each ecosystem height varies, with a total of 27 weeds belonging to 11 families. The vegetation species *Imperata cylindrica* and *Ageratina riparia* are the most prevalent. The diversity of vegetation species in the mountainous zone ecosystem of the Tourist Area at an altitude of 1.800 m asl is highest than at altitudes of 1.700 m asl and 1.600 m asl. At an altitude of 1.600m asl and a height of 1.700m asl, the sorensen's similarity index of vegetation species in the ecosystem is high. The conditions of the ecosystem are influenced by abiotic factors and the management of ecosystems impacts the diversity and uniformity of weed species in the mountainous region of the Selo Tourist Area. Where the research is limited to a certain height (1.600-1.800m asl), it is necessary to conduct additional inventory at higher montana heights (>1.800 m asl) in order to increase the data on montane weeds vegetation. The data on this region's vegetation must be continuously updated because this region is becoming a tourist destination, necessitating advanced research.

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Development of Problem-Based HOTS (Higher Order Thinking Skill) Question Instruments on Class VIII Pressure Material

Rina Irawati*, Sukarmin, Sri Yamtinah
Science Education Department, Faculty of Teacher Training and Education, Universitas Sebelas Maret. Jalan Ir. Sutami 36 Kentingan, Jebres, Surakarta, 57126, Jawa Tengah, Indonesia
*Corresponding Author. E-mail address: irinairawatii@student.uns.ac.id

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ABSTRACT

The HOTS question instrument is important in learning. Through HOTS students are trained to learn things at a higher level, think critically in receiving information, think creatively in problem solving, and make the right decisions in complex situations. These various abilities are certainly needed in the face of changing life dynamics. This situation requires us to continue to adapt, so the ability of HOTS is very important to be developed as an effort to improve the ability to think at a higher level and prepare ourselves to face problems in life. This makes the author interested in developing a problem-based HOTS problem instrument on pressure material. This research uses R&D techniques that refer to Thiagarajan's (1974) 3-D procedural model. The instrument consists of 10 description questions that refer to 5 indicators, namely: analyzing; Evaluate; Created; Troubleshooting; and critical thinking skills. The instrument was validated by 7 experts with the validity analysis technique Aiken (1950). The results of the analysis obtained: suitability of the question with bloom's taxonomy (88%), suitability of the question with the answer (86%), feasibility of language (85%); and the feasibility of presenting the question (84%). This proves that all aspects of the instrument are declared valid because $V_{count} > V_{table}$ Aiken, V_{table} Aiken 75%, so it is concluded that this instrument is declared valid and feasible to be used to test the higher-order thinking skills of learners.

1. INTRODUCTION

The teaching and learning process that has been carried out between teachers and students can be measured for success through the provision of learning evaluation, which is an assessment or measurement of the ability of students, (Permatasari, A, 2014). Teachers in assessing learning outcomes require assessment instruments in the form of questions (Dewi, 2016). An instrument is a tool that can be used to assess how well learners have learned certain skills (Desilva 2020; Septiani et al, 2022).

Making question instruments certainly adjusts to the learning indicators that have been set based on learning objectives. Learning applied in Indonesia has several goals that must be achieved, these goals include: (1) critical thinking and problem solving, (2) communication and collaboration skills, (3) creativity and innovation, (4) technology and communication literacy, (5) contextual learning. (6) media and information literacy, (Gradini, 2019). Based on the goals that must be achieved, it can be seen that higher-order thinking is one of the important points that must be developed in students and there needs to be measurement at the end of each lesson. This is supported by a survey conducted by an expert in the United States regarding the needs in the world of work. The survey shows that critical thinking skills are at the top, then new mastery of information, the ability to think collaboratively and innovatively, (Angraini, 2019).

Based on the learning objectives to be achieved, the assessment instrument of student learning outcomes must be adjusted, by means of questions given must be based on HOTS (Higher Order Thinking Skill). Lewis and Smith (1993) state that higher-order thinking skills (HOTS) include critical thinking, creative thinking, problem solving, and decision making. Meanwhile, according to Anderson and Krathwohl (2001) the cognitive process of HOTS includes analyzing (analyzing) or C4 equivalents in Bloom's Taxonomy, evaluating (evaluating) or C5 equivalents in Bloom's Taxonomy, and creating (creating) or C4 equivalents in Bloom's Taxonomy. So the author took 5 indicators in the assessment of higher-order thinking skills on pressure material and its application in life for class VII. HOTS indicators are: analyze (C4); evaluate (C5); create (C6); Troubleshooting; critical thinking skills. Based on the opinions of experts, it can be concluded that the HOTS problem instrument is not just a problem that relies on memorization skills for students, but measurement using HOTS questions is more about how students think about a certain situation that is packaged in the form of a problem so that students must analyze, evaluate, create, think critically, or have to find solutions to solve problems well.

2. METHODS

The type of research used in this research is Research and Development (R&D) which means research and development. R&D research is used to produce certain products and test the effectiveness of these products (Sugiyono, 2014: 407). This R&D study has three stages: definition, design, and development, which refers to Thiagarajan's (1974) 3-D procedural model.

2.1. Define Stage

At the defining stage, the author defines the needs in the field by collecting various information through questionnaires that are distributed online in various schools in Surakarta. Junior high school science teachers fill in the obstacles faced through the google form provided by the researcher. In addition, respondents also revealed the desired product developments in the future so that learning can be maximized in the pandemic era by utilizing various existing technologies to improve students' higher-order thinking skills (HOTS).

2.2. Design Stage

At this design stage, it is hoped that the resulting question instrument can measure the higher-order thinking skills of students after learning science class VIII pressure material. Here are some stages of design carried out by researchers:

2.2.1. Test preparation

Test instruments that fall into the HOTS (Higher Order Thinking Skill) category are questions that accompany students in thinking according to Bloom's taxonomy, namely C4 analysis, C5 evaluation, and creating C6, Anderson and Krathwohl (2001). In addition, Lewis and Smith (1993) add that higher order thinking skills (HOTS) include critical thinking and problem solving. Therefore, the author in compiling an evaluation test instrument includes 5 indicators, namely C4 to C6, critical thinking, and problem solving. The preparation of questions is equipped with matrices, grids, and the results of the analysis of learning objectives on pressure material and its benefits in the daily life of grade VIII junior high school.

2.2.2. Format selection

After the stage of determining the type of HOTS question based on the needs analysis, the researcher determines a good and appropriate format. The author designs the questions attractively in the form of pictures so that students can imagine according to the application in their daily lives. The number of questions developed is 10 points by taking into account the indicators that have been set as a benchmark for students' higher-order thinking skills (HOTS). Preparation pays attention to the layout, size, and clarity of the image so that the problem can be understood appropriately by students.

2.2.3. Early Desai

The instruments that have been made by researchers then assess their feasibility by validators who are experts in the fields of language, ISIS feasibility, and presentation feasibility. After going through reviews and assessments from experts, the author received a lot of suggestions and input so that the question instrument was revised to be better according to the advice of experts. The results of the revision of the HOTS (Higher Order Thinking Skill) question instrument become Prototype 1 which is ready to be used as a measuring tool for evaluating the learning outcomes of grade VIII students on pressure material and its application in everyday life.

2.3. Develop Stage

This development stage aims to produce prototypes or products that have been developed and then validated and input by validators, lecturers, experts, and practitioners. At the development stage, this is in the form of expert appraisal, which is to assess the validity of the prototype that has been developed using a validation questionnaire. Expert validation was carried out by 2 expert lecturers and 6 practitioners. Expert lecturers are lecturers of S2 Science Education at Sebelas Maret University, practitioners consist of 6 including: 2 science teachers of SMP Negeri 26 Surakarta; 3 science teachers of Al Abidin Islamic Junior High School Surakarta; and 1 teacher Indonesian Al Abidin Islamic High School Surakarta. Each practitioner was chosen by the researcher because he has experience in teaching for approximately 10 years.

On the validity of the researcher used the analytical technique provided by Aiken. In 1985, Aiken proposed the concept of content validity in more detail. There are three levels that determine the quality of the validity of the content, namely sensual E, useful but not essential (G), and not necessary (T). In this study the author used the V Aiken foumulation written by (Azwar, 2012, p. 113; Aiken, 1985, p. 133) with the following formulation:

$$V = \frac{\sum(ri - lo)}{[n\ (c - 1)]}$$

Information:
r = number given by the appraiser
lo = lowest validity assessment number
c = highest validity assessment number
n = number of experts & practitioners performing
assessments i = integers from 1,2,3 to n
The validity classification range corresponds to the following table 1.

Table 1. Range of Validity Categorization

Quality	Score Range	Category
E	4 Score 5	Worth using without revision
G	Score 3	Worth using with revisions as suggested
T	1 Score 2	Not worth using

The results of the question instrument are said to be valid and feasible to be used as a measure of students' higher-order thinking skills (HOTS) when the results $V_{count} > V_{table}$ aiken.

3. RESULTS AND DISCUSSION

The HOTS (Higher Order Thinking Skill) question instrument that has been made by researchers is then tested for feasibility and validity to experts. The aspects assessed are the content aspect (the suitability of the question with the answer and the suitability of the question with Bloom's taxonomy), the language aspect, and the presentation aspect. Researchers use Aiken analysis techniques. For the results of the validator assessment of the content aspect of the HOTS question instrument product, the pressure material and its application in life for grade VIII junior high school can be seen in table 2 (suitability of the question with bloom's taxonomy) and table 3 (suitability of the question with the answer).

Table 2. The results of the validation of HOTS instrument products in the aspect of conformity of questions with Taxonomy Bloom

Question Point	V Aiken	Information
1	0.91	Valid
2	0.88	Valid
3	0.88	Valid
4	0.94	Valid
5	0.81	Valid
6	0.91	Valid
7	0.81	Valid
8	0.91	Valid
9	0.88	Valid
10	0.91	Valid
Average	0.88	
Percentage	88%	

Based on the calculation results, it was found that question items number 1 to 10 were all above the Aiken index of 0.75 so that an average of 0.88 or 88% of the conformity of the questions with Bloom's taxonomy was obtained from C4, C5, C6, critical thinking, and problem solving. When $V_{count} > V_{table}$ or $0.88 > 0.75$ then it can be stated that the instrument is valid and feasible to be used as a measure of higher-order thinking skills.

Table 3. The results of the validation of the HOTS instrument are aspects of the suitability of the answer questions with the questions

Question Point	V Aiken	Information
1	0.78	Valid
2	0.78	Valid
3	0.94	Valid
4	0.91	Valid
5	0.88	Valid
6	0.88	Valid
7	0.78	Valid
8	0.91	Valid
9	0.86	Valid
10	0.88	Valid
Average	0.86	
Percentage	86%	

Based on the calculation results, it was found that question items number 1 to 10 were all above the Aiken index of 0.75 so that an average of 0.87 or 87% of the match with the answers was obtained. When $V_{count} > V_{table}$ or 0.87 > 0.75 then it can be stated that the instrument is valid and suitable for use as a measurement of higher order thinking skills (HOTS).

After the feasibility of the content, the validator also assesses the HOTS question instrument of class VIII material about pressure and its application in life in terms of language. The following results of expert validators can be seen in table 4.

Table 4. The results of the validation of HOTS questions from the language aspect

Question Point	V Aiken	Information
1	0. 81	Valid
2	0.78	Valid
3	0.91	Valid
4	0.84	Valid
5	0.91	Valid
6	0.88	Valid
7	0.84	Valid
8	0.88	Valid
9	0.81	Valid
10	0.88	Valid
Average	0.85	
Percentage	85%	

Based on the calculation results, it was found that question items number 1 to 10 were all above the Aiken index of 0.75 so that an average of 0.85 or 85% of the feasibility of the language used in the question was obtained. When $V_{count} > V_{table}$ or 0.85 > 0.75 then it can be stated that the instrument is valid and suitable for use as a measurement of higher order thinking skills (HOTS).

The last and no less important aspect in the validation process is the feasibility test of the questions in terms of presentation. Both font size, image selection, image clarity, image placement and so on related to the presentation of question instruments. These results can be seen in table 5 as follows.

Table 5. The results of the validation of the HOTS question from the aspect of material presentation

Question Point	V Aiken	Information
1	0. 84	Valid
2	0.88	Valid
3	0.88	Valid
4	0.81	Valid
5	0.88	Valid
6	0.81	Valid
7	0.88	Valid
8	0.78	Valid
9	0.84	Valid
10	0.85	Valid
Average	0.84	
Percentage	84%	

Based on the calculation results, it was found that question items number 1 to 10 were all above the Aiken index of 0.75 so that an average of 0.84 or 84% of the feasibility of the language used in the question was obtained. When $V_{count} > V_{table}$ or 0.84 > 0.75 then it can be stated that the instrument is valid and suitable for use as a measurement of higher order thinking skills (HOTS).

4. CONCLUSIONS

From this study, it can be concluded that the level of validity or feasibility achieved by the HOTS question instrument in learning science pressure material and its application in everyday life for class VIII is declared valid and feasible to be used as a measure of students' higher-order thinking skills. This is evidenced by the results of V aiken analysis, the suitability of the question with bloom's taxonomy (88%), the suitability of the question with the answer (86%), the feasibility of the language (85%); and the feasibility of presenting the question (84%). This proves that all aspects of the instrument are declared valid because $V_{count} > V_{table}$ Aiken, V_{table} Aiken 75% or 0.75.

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The Characteristics of Herbal Tea Combination Between Butterfly Flower with Mint and Pandan Leaf on Drying Duration Variation

Titik Suryani*, Ria Anisa Rahmasari, Riza Ainun Nisa

Biology Education Department, Faculty of Teacher Training and Education, Universitas Muhammadiyah Surakarta.

Jl. A. Yani Tromol Pos I, Pabelan, Kartasura, Surakarta 57162, Jawa Tengah, Indonesia

*Corresponding Author. E-mail address: ts169@ums.ac.id

KEYWORDS:

herbal tea, butterfly flower, mint leaf, pandan leaf, drying duration, antioxidant activity, organoleptic quality

ABSTRACT

Herbal tea is a functional bevarage made from leaf or flower. Butterfly flowers contain flavonoids, anthocyanins and flavonol glycosides. Mint leaf contain 1-2% essential oil and 80-90% menthol. Pandan leaf contain 10% essential oil, aromatic compounds 2-acetyl-1 pyrroline, flavonoids. The purpose of this study was to determine the characteristics (antioxidant activity and organoleptic quality) of herbal tea combination between butterfly flowers with mint leaf and pandan leaf on drying duration variations. This research method was an experiment with Completely Randomized Design (CRD), two factors. Factor I: combination of flowers butterfly : mint leaf (6 g : 2 g) and combination of butterfly : pandan leaf (6 g : 2 g). Factor II : drying duration of 90 minutes and 120 minutes The results showed that the highest antioxidant activity was K_1L_1 treatment (combination of butterfly flower: mint leaf with drying duration of 90 minutes) that was 83.147%. The best organoleptic quality of herbal tea in K_1L_1 treatment (combination of butterfly flowers: mint leaf with drying duration of 90 minutes), dark blue color, mint aromatic, not bitter taste, fresh and quite like.

1. INTRODUCTION

Herbal tea is one of the functional bevarage made from leaf or flowers processed as tea making (Yamin, 2017), can improve taste without reducing its taste (Mu'nim, 2008), also can be consumed as a practical drink to maintain health. One type of plant can be used as an ingredient herbal tea is the butterfly flower. Butterfly flowers are indigo blue (purple) with the middle of white color (Putri, 2018), contain antioxidants, Flavonoids (20.07 ± 0.55 mmol/mg flowers), Anthocyanins (5.40 ± 0.23 mmol/mg flowers), Flavonol glycosides (14.66 ± 0.33 mmol/mg flower), Kaempferol glycoside (12.71 ± 0.46 mmol/mg flower), Querserin glycoside (1.92 ± 0.12 mmol/mg flower), and also myricetin glycosides (0.04 ± 0.01 mmol/mg flowers) (Kazuma, 2003). Flavonoids are potential antioxidants, anti-radicals of butterfly flowers (Soeharto, 2004). Antioxidants are compounds that can delay, slow, or inhibit oxidation reactions and can fight free radicals (Agustina, 2017). Free radicals are highly reactive molecules because they have one or more unpaired electrons. Excess free radicals can attack any compound and have implications for the

emergence of various diseases such as heart disease, cancer, arteriosclerosis and symptoms of aging (Kusumowati, 2012).

The flavor of herbal tea enhances the taste due to the loss or reduction of aromatic compounds which are partly composed of volatile alcohols, aldehydes and ketones. Butterfly flower tea does not smell like grass (Jeremy, 2019), therefore, in processing herbal tea, it is necessary to add flavor. The addition of the flavor of butterfly flower tea is mint leaf. Peppermint extract is menthyl acetate produces "minty" aroma and flavor of lemon tea, while pandan leaf (Sukardi, 2009) have a fragrant and fresh aroma due to the essential oil content of mint leaf and fragrant pandan leaf as a flavor of tea bevarage (Wartini, 2015).

Mint leaf (*Mentha piperita*) contain essential oil 1% essential oil, 78% free menthol, 2% menthol mixed with esters, tannins, menthone (21.45%), isomenthone (2.87%), menthofuran (1-17%), carvone, linalool and piperitone oxide (Moghtader, 2013). The most ideal content of mint leaf in herbal tea is 3%, because the higher the percentage of mint content, the spicier it tastes when brewed. The addition of mint leaf to reduce the bitter and astringent taste so that it is fresh and has a distinctive minty flavor (Anggraini, 2014).

Pandan leaf as an ingredients of bevarage and aroma contain tannins, alkaloids, flavonoids, and polyphenols as antioxidant activity, antidiabetic of water extracts, antioxidants of water and methanol extracts, anticancer of ethanol and methanol extracts, and antibacterial of ethanol and ethyl extracts acetate (Prameswari and Widjanarko, 2014). The addition of antioxidants can reduce the level of oxidative stress, therefore slowing the occurrence of premature aging and complications of various diseases. Fragrant pandan leaf have a distinctive aroma of essential oil, consisting of 6–42% sesquiterpene hydrocarbons and 6% monoterpene linalool and 10% aromatic compound form of 2-acetyl-1 pyrroline (Priastomo, 2018). 2-acetyl-1-pyrroline (2-AP) is the largest component of pandan leaf, volatile oils, alcohols, aromatic aldehydes, ketones and esters. Pandan leaf extract can act as a natural antioxidant (Tasia & Widyaningsih, 2014).

The addition of flavor or taste, drying time in the making of herbal tea affects antioxidant activity (Adri,2013). The longer the drying, the lower the levels of flavonoids and phenolics (antioxidant compounds). Drying at high temperatures and for quite long time can reduce antioxidant activity of dry material (Yamin, 2017). The results of the study (Yamin, 2017) state that ketepeng leaf of herbal tea has the highest antioxidant activity at 110 minutes of drying time. The results of Rofiah's research (2018) state the highest antioxidant activity were in tin leaf of herbal tea with drying time of 120 minutes. The longer the drying, the higher the temperature and the lower the antioxidant activity.

The purpose of this study was to determine the characteristics (antioxidant activity and organoleptic quality) of herbal tea combination of butterfly flowers with mint and pandan leaf on drying duration variations.

2. METHODS

This research used experimental method and completely randomized design (CRD), two factors. Factor 1 : combination between butterfly flower and mint leaf K1 (6 g : 2 g) and combination between butterfly flower and pandan leaf K2 (6 g : 2 g), Factor 2 : drying durations of L1 (90 minutes) and L2 (120 minutes), 3 repetitions. The research procedurs included: making herbal tea, drying duration, testing antioxidant activity with the DPPH method and organoleptic quality as well as public acceptance involving 15 panelists. The research data were analyzed descriptively qualitatively and quantitatively.To find out the results of this study, the data analysis used was descriptive qualitative to determine the differences in each treatment. Data collection was carried out using experimental methods, measuring antioxidant activity, organoleptic quality, observation methods, literature methods and research documentation.

3. RESULTS AND DISCUSSION

3.1. Antioxidant Activity

The results of the antioxidant activity herbal tea of the combination between butterfly flower with mint leaf and pandan leaf on variations of drying duration for 90 minutes and 120 minutes at 55°C can be seen in the table below:

Table 3.1. Average Antioxidant Activity of Herbal Tea Combination between butterfly Flower with Mint Leaf and Pandan Leaf on Variations of Drying duration

Treatment	Antioxidant activity (%)
K_1L_1 (butturfly flower : mint leaf) + drying duration 90’	83,147**
K_2L_1(butterfly flower : pandan leaf)+ drying duration 90’	60,589
K_1L_2 (butterfly flower : mint leaf)+ drying duration 120’	78,664
K_2L_2(butterfly flower :pandan leaf)+ drying duration 120’	59,473*

Explanation: * the lowet of Antioxidant activity terendah, ** the highest of Antioxidant activity

Table 3.1 showed that the highest antioxidant activity was in the K_1L_1 treatment (butterfly flower : Mint leaf) + 90 minutes drying duration of 83.147%, while the lowest antioxidant activity was in the K_2L_2 treatment (butterfly flower: Pandan leaf) + 120 minutes drying duration of 59.473%. This showed that the variations of drying duration provide different antioxidant activity.

The longer the drying, the less the antioxidant activity, because the longer the drying, the antioxidant compounds will be damaged so that it will affect the antioxidant activity. This is supported by research (Rusnayanti, 2018) stated that antioxidant activity will decrease if the drying temperature and drying time are higher, because the higher the temperature and drying duration result in secondary metabolite compounds that act as antioxidants being damaged. In accordance with Yamin's research (2017), showed that drying Chinese ketepeng leaf at 55°C with a drying duration of 110 minutes provided the highest antioxidant activity of 43.79 µg/ml (IC50 µg/ml unit) compared to 130 minutes of drying that was 60 .18µg/ml. The IC50 value is inversely proportional to the ability of the compound to act as an antioxidant. The smaller the IC50 value, the greater the antioxidant activity.

This was supported by Andesa research (2020) stated that the antioxidant activity of herbal tea of butterfly flowers and basil leaf at 90 minutes of drying duration was higher than 120 minutes of drying duration. There was the highest antioxidant activity of the herbal combination between butterfly flowers and mint leaf. According to Cahyaningsih research (2019) stated that butterfly flowers have antioxidant activity with an IC50 value of 87.86 ppm. Specifically, an antioxidant is categorized as very strong if the IC50 value is less than 50 ppm,however it is strong if the IC50 is 50-100 ppm,and moderate if the IC50 is 100-150 ppm, and an antioxidant is categorized as weak if the IC50 is 150-200 ppm. The smaller the IC50 value means the stronger the antioxidant activity. This shows that the greater the ratio of the composition of the butterfly flower, the higher the antioxidant activity. This was confirmed by Rohmadianto's research (2009) stated that antioxidant activity was concentration of corn-rosella hair 55:45 with a drying duration of 2.5 hours was 90.63%, while the lowest antioxidant activity was concentration of corn hair : rosella (85:15)at drying time 1.5 hours is 63.15%. The reason for the high antioxidant activity is due to the high concentration of rosella. The higher the concentration of rosella, the higher the antioxidant activity. This is because rosella contains flavonoid compounds and anthocyanin pigments which act as antioxidants.

Variation of drying duration gives different antioxidant activity. The longer the drying, the lower the antioxidant activity. This is because the longer the drying time, the antioxidant compounds will be damaged so that it will affect the antioxidant activity. Strengthened by Hartiati's research (2009) states that raw materials that through the drying process, the antioxidant activity produced is smaller, this is due to damage or degradation of the gossyperin, antiocyanin and glucoside hibiscin compounds in rosella damaged during the drying process. The longer the drying process. it will increase the damage to the antioxidant constituent compounds. In accordance with Yamin's research (2017) showed that drying Chinese ketepeng leaf at 55°C with

drying time of 110 minutes provided the highest antioxidant activity of 43.79 µg/ml (IC50 µg/ml unit) compared to 130 minutes of drying that 60 .18µg/ml. The IC50 value is inversely proportional to the ability of the compound to act as an antioxidant. The smaller the IC50 value, the greater the antioxidant activity. This is supported by Andesa research (2020) that the activity of herbal tea of butterfly flowers and basil leaf at 90 minutes of drying duration has higher antioxidant activity than 120 minutes of drying duration.

3.2. Organoleptic Quality and Acceptance

The results of organoleptic quality are presented in the table below:

Table 3.2. Organoleptic Quality of Herbal Tea Combination betweeen butterfly Flower with Mint Leaf and Pandan Leaf on Variation of Drying Duration.

Treatments	Organoleptic quality			Acceptability
	Color	Smell	Flavor	
K_1L_1	Dark blue	Mint specific	Not bitter, fresh	Quite like
K_1L_2	Purplish blue	Mint specific	No bitter, fresh	Quite like
K_2L_1	Dark blue	pandan specific	No bitter, fresh	like
K_2L_2	Purplish blue	Pandan specific	No bitter, fresh	like

Explanation:

K_1L_1 = Butterfly : Mint leaf + 90 minutes of drying duration

K_1L_2 = Butterfly : Mint leaf + 120 minutes of drying duration

K_2L_1 = Butterfly : Pandan leaf + 90 minutes of drying duration

K_2L_2 = Butterfly : Pandan leaf + 120 minutes of drying duration

Table 3.2 showed that the color of the herbal tea combination between butterfly flower and mint leaf was purplish blue and dark blue because the anthocyanin contains 14.66 ± 0.33 nmol/mg flowers (Wiyantoko, 2020). Differences in the color of the tea produced in each sample The combination between butterfly flower and mint leaf of herbal tea showed that the butterfly flower dominates the color of the herbal tea . The more the butterfly flower composition is added, the darker or blue color of the herbal tea will be. This was reinforced by Fizriani's research (2020) stated that the addition of 0.75 gram of butterfly extract, the color of the cendol is blue than the addition of 0.25 gram of butterfly extract, so the more powdered butterfly extract is added to the cendol, the bluer the color of the resulting cendol. The aroma of herbal tea combination between butterfly flowers and mint leaf is specific mint, because mint leaf contain 0.5 - 4% essential oil, 30-55% menthol (Setiawan, 2019). This is in accordance with Kamilia's research (2009) stated that butterfly flowers do not contain essential oils, but are influenced by mint leaf. The taste of

herbal tea can be influenced by the ingredients used. The taste of the herbal tea of combination between butterfly flowers and mint leaf is not bitter and fresh. Butterfly flowers and mint leaf contain tannins which cause an astringent taste (Hussein, 2019 and Manjula, 2013). The low tannin content is covered by the high essential oil content of mint leaf,

The color of the herbal tea is a combination between butterfly flowers and pandan leaf, dark blue and purplish blue, has a distinctive pandan aroma, tastes not bitter and fresh, and like acceptance. The acceptability, color, aroma of the herbal tea is in accordance with SNI 3836 (2013). The difference in the color of the herbal tea indicated that the drying duration and the combination between butterfly flowers and pandan leaf had an effect on the color of the herbal tea. The shorter the drying time and the greater the mixture of butterfly flower and pandan leaf, the resulting darker blue color causes the color of the anthocyanin pigments in the butterfly flower to dissolve in water. Agree with Pratimasari's research (2018) which shows that the color of the syrup with 0.25% butterfly extract shows better color stability compared to 0.5% butterfly extract. The difference of color herbal tea is caused by the quality of vision and sharpness of the panelists. The aroma of herbal tea mixed with butterfly flowers and pandan leaf is typical of pandan produced in accordance with SNI 3836 (2013) the aroma of good tea is typical of tea products. This is in accordance with Faras' research (2014) that pandan leaf contains essential oils and aromatic compounds which are volatile or easily evaporate so that it has a strong distinctive aroma of pandan. Pandan leaf have a distinctive aroma from a derivative of the amino acid phenylalanine, that is 2-acetyl-1pyroline. According to Fabra (2009) 2-acetyl-1pyroline is a component very soluble in water and alcohol, the same as in the combination between butterfly flower and pandan leaf in herbal tea, 2-acetyl-1pyroline is much extracted by water so that the aroma is characteristic of pandan. The taste of the herbal tea, which is combination between butterfly flowers and pandan leaf, is not bitter and is quite fresh or fresh. The butterfly flower is not bitter, however the fresh taste of pandan leaf, the tannin content which is very low in the butterfly flower and pandan leaf produce a taste that is not bitter. The acceptance of the combination between butterfly flower and pandan leaf of herbal tea was liked by the panelists.

4. CONCLUSION

The characteristics of the best herbal tea of combination between butterfly flowers and mint leaf and drying duration of 90 minutes was antioxidant activity of 83.147% and the best organoleptic quality of herbal tea was dark blue color, mint aroma, taste not bitter, fresh and quite like.

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Preservice Biology Teacher's TPACK Integration into Lesson Planning

Putri Agustina[1*], Lina Agustina[1], Rina Astuti[1], Yesi Chotimah[1], Putri Gayatri Ramadhanty[1], Alanindra Saputra[2]

[1]Biology Education Department, Faculty of Teacher Training and Education, Universitas Muhammadiyah Surakarta. Jl. A. Yani Tromol Pos I, Pabelan, Kartasura, Surakarta 57162, Jawa Tengah, Indonesia

[2]Biology Education Department, Faculty of Teacher Training and Education, Sebelas Maret University. Jl. Ir. Sutami 36A, Kentingan, Jebres, Surakarta 57126, Jawa Tengah, Indonesia

[*]Corresponding Author. E-mail address: pa182@ums.ac.id

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Preservice teacher

ABSTRACT

This research was aimed to investigate preservice Biology teacher's performance in integration TPACK into lesson plans. The subjects in this study were preservice biology teacher taking Biology lesson planning and microteaching course. The object of this research was all of lesson plan developing by preservice biology teacher. The aspects of TPACK that were examined for integration of TPACK in the lesson plans included content knowledge (CK), pedagogical knowledge (PK), technological knowledge (TK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), pedagogical content knowledge (PCK), and technological pedagogical and content knowledge (TPACK). TPACK integration data on the lesson plan was obtained through documentation techniques and analyzed using an identification sheet. The result of identification were analyzed descriptively using percentage techniques. The results of the identification show that the integration of TPACK aspects into lesson planning at the microteaching course is: learning objectives of 66.67%, opening activities of 30.77%, core activities of 89.74%, closing activities of 7.69%, student worksheet of 38.46%, and assessment instruments of 12.82%. While the integration at the biology lesson planning course is: learning objectives of 78%, opening activities of 33%, core activities of 89%, closing activities of 22%, student worksheet of 51%, and assessment instruments of 13%.

1. INTRODUCTION

Currently we live in the era of technology. The Industrial Revolution 5.0 refers to technological developments which include artificial intelligence, robotics, Internet of Things (IoT), big data, virtual reality, and other technologies. In this era, learning demands underwent significant changes. The rapid development of technology has had a major impact on the development of life, one of which is education. Aydın Günbatar et al. (2017) said that technology has been integrated in the curriculum and instruction. Teachers have a crucial role in the implementation of technology in classrooms so that they need to be teachers are one of the keys to the successful integration of technology in learning so that teachers should have the essential skills and knowledge needed to carry out effective integration of technology in the teaching and learning process. One of the essential types of knowledge that teachers must have in integrating technology in learning is TPACK.

TPACK is a specialized, highly applied type of knowledge that supports content-based technology integration. It has been characterized as the multiple intersections of teachers' knowledge of curriculum content, general pedagogies, technologies, and contextual influences upon learning. Nurhidayah and Suyanto (2021) TPACK level component that integrates with technology is TPACK which is a combination of technological knowledge, pedagogy, and content. TPACK is an understanding, knowledge, and communication of concept representations using

technology, pedagogical techniques, knowledge of concepts whether difficult or easy to learn and knowledge of how to help and develop students.

The TPACK framework indicates that teachers need to have a deep understanding of technology, pedagogy, and content in learning and be able to manage them. TPACK helps teachers to integrate technology effectively in learning. They learn how to use technology as a tool to support teaching and learning, thereby enhancing the quality of student learning experiences. Teachers with a good understanding of TPACK can choose and use technological tools that are appropriate to learning content and learning objectives (Akhwani 2020).

TPACK integration can increase student involvement in learning. By using the right technology, teachers can create interesting, interactive, and relevant learning experiences for students. Teachers can incorporate technology into their teaching strategies to facilitate student collaboration, exploration, and problem solving, which in turn increases student engagement in the learning process. Through TPACK, teachers can understand and respond to students' needs in using technology. They can identify students' technological preferences and abilities and adapt technology methods and tools to suit students' needs. This helps create relevant and personalized learning for each students (Bwalya and Rutegwa 2023).

TPACK was very important knowledge in preservice teacher education. TPACK helps preservice teacher to develop an understanding of how technology can be used effectively in learning contexts. They learn about technology tools and resources relevant to their teaching materials, and how to use them to facilitate active, student-centered, and engaging learning. Through TPACK, preservice teacher learns to combine pedagogical knowledge with content knowledge and knowledge about how to use technology to meet students' needs. They learn student-centered teaching strategies and leverage technology as a tool to facilitate better understanding, student engagement, and learning differentiation. TPACK encourages student teacher candidates to develop creativity and innovation in their learning designs. With knowledge of technology, they can design learning experiences that are interesting, diverse, and relevant to students' needs. Student teacher candidates can use technology to create interactive learning resources, collaborative projects, or creative activities that encourage students' critical and creative thinking (Sari and Mega 2022).

Aspects of TPACK can be developed in the teaching and learning process if integrated explicitly in the lesson plan. Learning devices occupy an important role in order to achieve success in the learning process. Therefore, all preservice teachers are equipped with the ability to develop learning tools. One of them is by compiling learning tools in the form of lesson plans. The TPACK aspect can be seen from the preparation of the lesson plan, because the lesson plan contains elements of pedagogy, content and technology.

This research was aimed to investigate preservice Biology teacher’s performance in integration TPACK into lesson plans

2. MATERIALS AND METHODS

This research is a descriptive study that aims to describe TPACK integration in lesson planning by preservice biology teacher at the course of biology lesson planning and microteaching in Biology Education Department Faculty of Teacher Training and Education Universitas Muhammadiyah Surakarta. The aspects of TPACK studied in this research were aspects of PCK, TCK, TPK, and TPACK. Subjects of this research were 342 lesson plans developed by preservice biology teacher in the biology lesson planning and microteaching course. Technique of data collection in this research was the documentation namely collecting all lesson plans documents developed by preservice Biology teacher students. This documents then analyzed using an identification sheet to determine the integration of TPACK. Data analysis was performed by qualitative descriptive analysis using percentage techniques.

3. RESULTS AND DISCUSSION

Teaching and learning planning has an important role in determining the success of learning. Learning devices occupy an important role in order to achieve success in the learning process. One of the learning tools is the lesson plan. The integration of TPACK aspects was obtained from the identification results of lesson plan for preservice Biology teacher taking microteaching and Biology lesson planning courses presented in Table 1.

Table 1. TPACK Integration in Lesson Planning by Preservice Biology Teacher

Course	Aspect	Percentage of integration in… (%)					
		Learning outcomes	Learning Activity			Student Worksheet	Assessment
			Opening	Main Activity	Closing		
Microteaching	PCK	97.44	87.18	100	100	92.31	94.87
	TCK	66.67	30.77	89.74	7.69	38.46	12.82
	TPK	66.67	30.77	89.74	7.69	38.46	12.82
	TPACK	66.67	30.77	89.74	7.69	38.46	12.82
Biology Lesson Planning	PCK	83.00	72.00	100.0	71.00	62.00	82.00
	TCK	78.00	33.00	89.00	22.00	51.00	13.00
	TPK	78.00	33.00	89.00	22.00	51.00	13.00
	TPACK	78.00	33.00	89.00	22.00	51.00	13.00

3.1. Preservice Biology Teacher's PCK Integration in Lesson Planning

Pedagogical Content Knowledge (PCK) is a concept used in education to describe a teacher's knowledge and understanding of how to teach a particular subject matter effectively. PCK combines two important aspects, namely knowledge about subject matter (content knowledge) and knowledge about effective teaching strategies (pedagogical knowledge).

Based on Table 1, it is known that the integration of PCK aspects into lesson planning at the microteaching course is: learning objectives of 97.44%, opening activities of 87.18%, core activities of 100%, closing activities of 100%, student worksheet of 92.31%, and assessment instruments of 94.87%. While the integration at the biology lesson planning course is: learning objectives of 83%, opening activities of 72%, core activities of 100%, closing activities of 71%, student worksheet of 62%, and assessment instruments of 82% (**Fig 1**).

In order to improve the quality of learning, it is important to integrate PCK into learning tools. This assists teachers in conveying learning materials effectively, improves student understanding, and facilitates a better overall learning process. By integrating PCK into learning tools, teachers can develop appropriate teaching strategies to deliver material effectively. This helps improve students' understanding and facilitates a better learning process (Sukaesih et al. 2017).

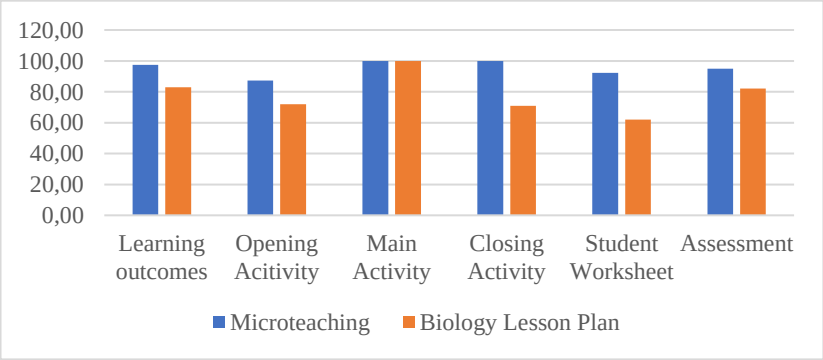

Fig. 1. PCK Integration by Preservice Biology Teacher in Lesson Planning

Every student has a different learning style and needs. With PCK integrated into learning tools, teachers can better identify and respond to individual student needs. They can provide clearer explanations, relevant examples, and adapted learning strategies to help students overcome their learning difficulties. The application of PCK in learning tools requires a deep understanding of learning materials and effective teaching strategies. By paying attention to PCK, teachers are expected to continue to develop themselves in the field of pedagogy and content. This encourages the professional development of teachers and ensures that they continuously improve the quality of their teaching (Shopie Azizah et al. 2021).

3.2. TCK integration in lesson planning

Technological content knowledge (TCK) refers to the knowledge of how technology can create new representations for specific content. It involves the intersection of technological knowledge and content knowledge. It suggests that teachers understand that, by using a specific technology, they can change the way learners practice and understand concepts in a specific content area (Schmidt et al. 2009).

Based on Table 1, it is known that the integration of TCK aspects into lesson planning at the microteaching course is: learning objectives of 66.67%, opening activities of 30.77%, core activities of 89.74%, closing activities of 7.69%, student worksheet of 38.46%, and assessment instruments of 12.82%. While the integration at the biology lesson planning course is: learning objectives of 78%, opening activities of 33%, core activities of 89%, closing activities of 22%, student worksheet of 51%, and assessment instruments of 13% (**Fig 2**).

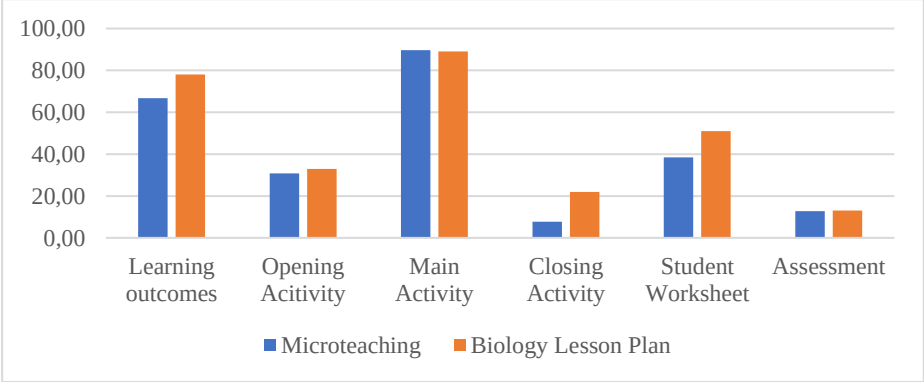

Fig. 2. TCK Integration by Preservice Biology Teacher in Lesson Planning

3.3. TPK integration in lesson planning

According to Schmidt et al (2009) TPK refers to the knowledge of how various technologies can be used in teaching, and to understand that using technology may change the way teachers teach. TPK refers to understanding technology's benefits and limitations as an enhancer of various teaching styles. It pertains to the knowledge of how various technologies can be used in the classroom and the potential for technology to alter how teachers teach (Bwalya and Rutegwa 2023). Based on Table 1, it is known that the integration of TPK aspects into lesson planning at the microteaching course is: learning objectives of 66.67%, opening activities of 30.77%, core activities of 89.74%, closing activities of 7.69%, student worksheet of 38.46%, and assessment instruments of 12.82%. While the integration at the biology lesson planning course is: learning objectives of 78%, opening activities of 33%, core activities of 89%, closing activities of 22%, student worksheet of 51%, and assessment instruments of 13% (**Fig 3**).

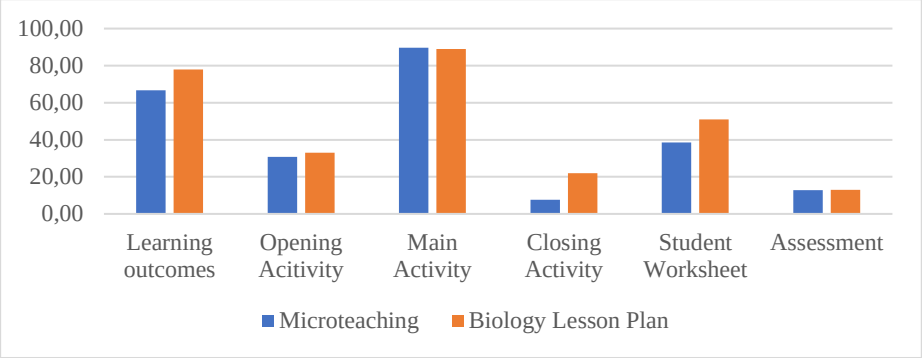

Fig. 3. TPK Integration by Preservice Biology Teacher in Lesson Planning

3.4. TPACK integration in lesson planning

TPACK defined by knowledge of the interaction between content, pedagogy, interrelated technology in the learning process (Akhwani 2020). Based on Table 1, it is known that the integration of TPACK aspects into lesson planning at the microteaching course is: learning objectives of 66.67%, opening activities of 30.77%, core activities of 89.74%, closing activities of 7.69%, student worksheet of 38.46%, and assessment instruments of 12.82%. While the integration at the biology lesson planning course is: learning objectives of 78%, opening activities of 33%, core activities of 89%, closing activities of 22%, student worksheet of 51%, and assessment instruments of 13% (**Fig 4**).

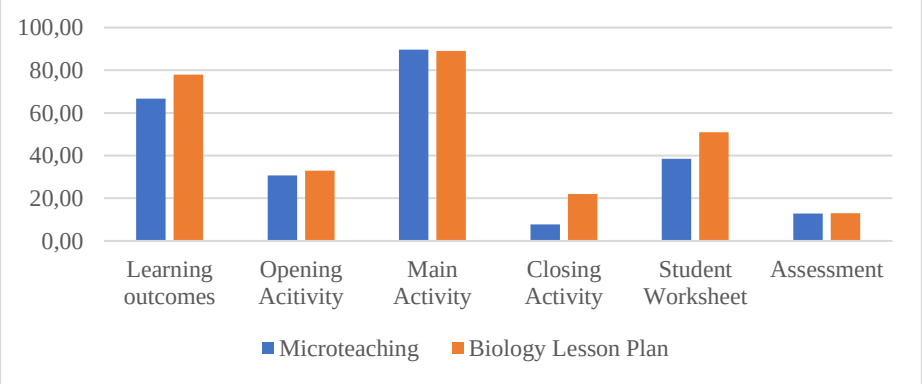

Fig. 4. TPACK Integration by Preservice Biology Teacher in Lesson Planning

TPACK helps teachers to integrate technology effectively in learning. They learn how to use technology as a tool to support teaching and learning, thereby enhancing the quality of student learning experiences. Teachers with a good understanding of TPACK can choose and use technological tools that are appropriate to learning content and learning objectives. Through TPACK, teachers can understand and respond to students' needs in using technology. They can identify students' technological preferences and abilities and adapt technology methods and tools to suit students' needs. This helps create relevant and personalized learning for each student. Overall, TPACK is important for teachers because it helps enhance their ability to integrate technology effectively in learning, increases student engagement, and prepares students for success in an evolving digital world (Chapoo et al. 2014).

It is important for student teacher candidates to integrate TPACK in learning for the following reasons: (1) TPACK integration helps student teacher candidates to design and implement more effective and meaningful learning experiences. They can use technology appropriately in delivering learning content, encouraging student interaction, and creating a relevant and interesting learning environment (Tafli and Atici 2016); (2) The current generation of students grew up in the

digital age and often have access to and familiarity with technology. By integrating TPACK, student teacher candidates can confront this digital trend and connect learning to students' real lives. This helps create greater connectedness and relevance in learning; (3) The use of appropriate technology in learning can increase student engagement and participation. Through TPACK, student teacher candidates can combine interesting and interactive technological tools and resources to activate students in the learning process. Technology can facilitate collaboration, exploration, and experimentation that encourages active student engagement (Güneş and Bahçivan 2016); (4) TPACK integration helps prospective teacher students to equip students with relevant skills to succeed in the digital world. They can teach students about digital literacy, digital ethics, and the ability to use technology as a tool for solving problems, communicating ideas, and working collaboratively. This helps students to be ready to face the demands of an increasingly digital world of work.; and (5) TPACK encourages student teacher candidates to be innovative in their learning approaches. They can use technology as a tool to create learning experiences that are creative, interesting, and in accordance with the needs of students. By utilizing technology effectively, prospective teacher students can present innovative and interesting learning for students.

4. CONCLUSIONS

The integration of PCK aspects into lesson planning at the microteaching course is: learning objectives of 97.44%, opening activities of 87.18%, core activities of 100%, closing activities of 100%, student worksheet of 92.31%, and assessment instruments of 94.87%. While the integration at the biology lesson planning course is: learning objectives of 83%, opening activities of 72%, core activities of 100%, closing activities of 71%, student worksheet of 62%, and assessment instruments of 82%. While the integration of TPK, TCK, and TPACK aspects into lesson planning at the microteaching course is: learning objectives of 66.67%, opening activities of 30.77%, core activities of 89.74%, closing activities of 7.69%, student worksheet of 38.46%, and assessment instruments of 12.82%. While the integration at the biology lesson planning course is: learning objectives of 78%, opening activities of 33%, core activities of 89%, closing activities of 22%, student worksheet of 51%, and assessment instruments of 13%

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Students' Creative Thingking Ability in view From The Level of Understanding in Waste Management

Syarifah Zahrah*, Rita Retnowati, Rita Istiana
Biology Education Department, Faculty of Teacher Training and Education, Pakuan University.Jl. Pakuan PO Box 452 Bogor 16143 Wets Java, Indonesia
*Corresponding Author. E-mail address: Safanisaputriazzahra25@gmail.com

KEYWORDS:
creative thinking skills, environment, student understanding, managing waste.

ABSTRACT

Creative Creative thinking is an important nature in the learning process, the weak ability of students' creative thinking is caused by a static learning process. This study aims to analyze the factors that cause high and low students' creative thinking abilities in terms of their level of understanding and identify other factors that influence creative thinking abilities. The subjects of this study were students of class XI MIPA at SMAN 1 Ciomas, Bogor Regency. The research was conducted in November 2022 – May 2023. The method used in this study was a mixed method with a sequential explanatory research design. The research sample was 123 students, the sampling technique used proportional random sampling technique. Quantitative data analysis techniques use descriptive and inferential analysis or hypothesis testing, namely correlation and regression, and qualitative data analysis techniques include data reduction, data presentation and drawing conclusions. The instrument used for Y and X variables is a multiple choice test instrument and for qualitative use interview guidelines, observation and documentation studies. The results showed that there was a fairly high positive correlation, with an r^2 value of 24.1%, students' creative thinking ability was influenced by understanding and the remaining 75.9% was influenced by internal factors including interests, hobbies and external factors including teacher guidance, environment, and some school activities. such as organization, performing arts, social media. The solution to overcome these problems is to develop learning designs for environmental materials that can increase understanding so that students are better trained to have the ability to think creatively in solving environmental problems. The existence of collaboration between schools in developing learning designs can increase understanding so that students have the ability to think creatively.

1. INTRODUCTION

Thinking is a mental activity that helps in solving problems, making decisions and fulfilling desires. This shows that someone who is solving problems and making decisions is doing thinking activities. Creative thinking has a very important role in the educational process, because students will play a role as a driver of social change.

Creative thinking is a cognitive characteristic of creativity or the process of seeing things from a new perspective forming new concepts from several concepts that have been mastered, creative thinking helps students create new ideas to solve problems from different perspectives, creative thinking skills are also needed to produce innovation new approach involving analysis and intuition, a new component in creative thinking refers to an emphasis on acquiring new insights, new approaches, and new perspectives on understanding things (Pratiwi et al. 2019). It can be assumed that creative thinking is the ability to solve problems by forming new concepts or a process of seeing things from a different perspective in order to form new concepts. Creative thinking has a very important role in the educational process, because students will play a role as

a driver of social change. Creative thinking refers to the concept of mental activity in students which refers to five aspects including fluency, flexibility, originality, detailing, and judging (Tri Agustiana et al. 2020).

Creative education and environmental education are related fields, not all creative efforts are good for the environment. cultivating the ability to think creatively results in good consequences so that it is not ignored in the field of education, several governments around the world have identified the development of the ability to think creatively (Cheng 2019). Several countries have curricula that also focus on the ability to think creatively. The aim of their curriculum is to increase students' ability to think creatively to manage the environment (Putra et al. 2019). With the ability to think creatively students can create ideas and ideas to solve environmental problems, especially waste problems that can damage and pollute, so that the environment looks clean and comfortable.

Waste management requires creativity and the active role of the community in reducing the amount of waste, classifying the types of waste, selecting types of waste that can be reused to meet the needs of the community and the surrounding environment. Several areas in Bogor City have provided waste banks, if one pays attention to their existence they are very effective in reducing the amount of waste and empowering waste to be managed with the aim of protecting the environment (Nasution et al. 2021). Protecting the environment by managing waste is not difficult, everyone can do it, but if everyone is not used to protecting the environment from an early age then it will be difficult to do, so families need to instill awareness in protecting the environment (Çelik and Yüce 2019)

Based on the results of interviews in qualitative research that understanding contributes quite a bit in creating ideas to solve problems, especially environmental problems, there are several inspirations to solve waste problems for example plastic bottle waste that is used as a planting medium, apart from the problem of waste understanding also influences the concepts that will be assembled to make a waste reuse product. Based on the level of understanding that triggers the ability to think creatively, the research aims to analyze the factors that cause the high and low levels of students' creative thinking ability in terms of the level of understanding and identify other factors that influence the ability to think creatively besides understanding.

Understanding in managing waste is the ability of humans to understand and know how to deal with waste problems by looking at various points of view in solving them. Learning at school has an important influence on the level of students' understanding, especially on the introduction of the environment which can provide an overview of good waste management patterns such as the 3Rs, namely: reduce, reuse, and recycle. The (reduce) pattern of reducing waste is that students are expected to reduce the use of materials that are difficult to recycle such as plastic. Patterns (reuse) of reusing waste such as utilizing organic waste left over from food and vegetables as compost. The pattern of (recycle) waste is recycling waste into new items of use value such as packaging waste into various types of bags, flower vases, and others (Purnami 2021).

Waste is a substance that is produced from a production process of human activities, both household, industrial and mining. The more people, the more waste is produced. The presence of waste can have a negative impact on the environment, especially for health, so it is necessary to deal with waste problems. The increase in population makes more and more community settlements, so that it has an impact on the production of waste that is produced, whether it is waste from household activities or other waste (Sunarsih 2014). Waste has a small volume but there will be a lot of waste production because it can be seen from the amount produced by humans every day for a long period of time, this small volume of waste will become a mountain of problems that will cause air, soil and water pollution which will cause global problems (Abdulredha et al. 2017).

There needs to be sufficient understanding and good creative thinking skills in order to be able to deal with waste problems properly and get ideas for waste management so that the environment is better. The level of understanding in waste management is needed to regulate waste management starting from the selection, utilization as well as the destruction of the waste (Wahdah et al. 2020). The ability to think creatively here involves understanding related to experience factors whether students are in difficulty either to generate ideas based on knowledge or understanding they have

or get out of control by doing something without considering the impact. Based on this research, most students can master how to think and consider what needs to be done, this shows that learning outcomes that link understanding with experience can produce good ideas (Mulatti and Treccani 2023).

The low ability of students' creative thinking affects students' concern for the environment, based on school observations that students' creative thinking skills regarding waste management reach an average score of 78 in the moderate category, this is due to the absence of school activities for students to develop their creativity. So that researchers are interested in conducting research on creative thinking analysis in terms of students' understanding of waste management at SMA Negeri 1 Ciomas with the aim of knowing whether there is a relationship between creative thinking abilities and students' understanding of waste management and what factors influence creative thinking abilities besides understanding.

2. MATERIALS AND METHODS

2.1. Methods

The method used is sequential explanatory. The sequential explanatory combination research method is a research method that combines quantitative and qualitative research sequentially (Khairunnisya 2017).

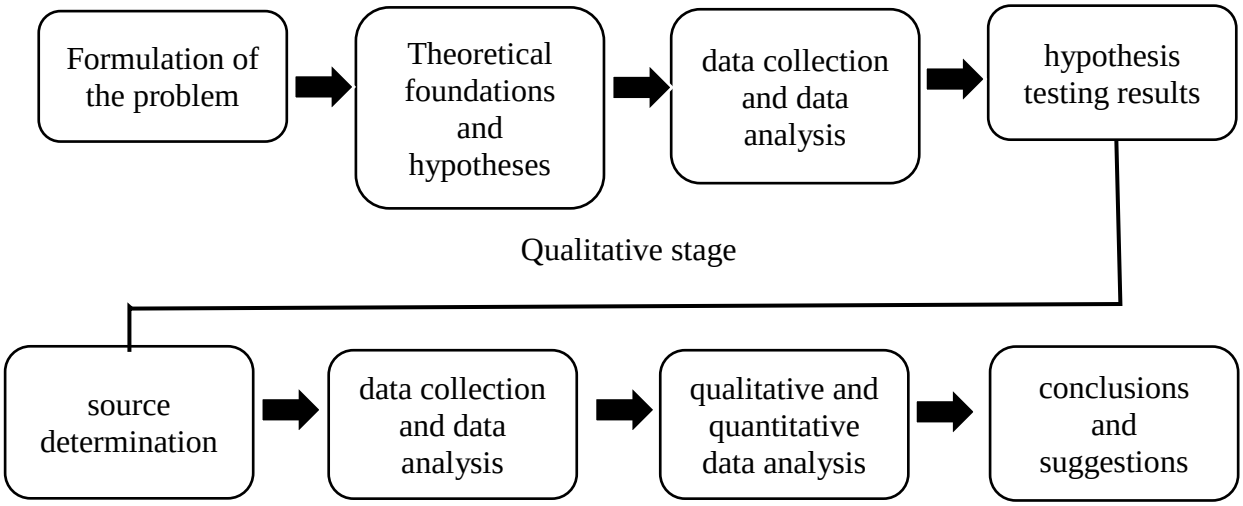

Figure 1. Sequential explanatory design research steps

2.2. Time and research instruments

When the research was conducted in February-March 2023, the instrument used to examine creative thinking skills (Y) and understanding (X) used multiple choice with a variable number (Y) of 25 questions and a variable (X) of 30 questions, variable question indicators (Y) includes (1) Developing knowledge about waste management, (2) Conceptualizing waste management, (3) Knowing current waste management issues, (4) Solving waste management problems in creative and innovative ways, (5) Managing or conserving natural resources so that damage does not occur. Variable indicators (X) include (1) Categorizing recyclable and non-recyclable waste, (2) Distinguishing between organic and inorganic waste, (3) Providing examples of proper waste management, (4) Estimating the impact of indiscriminate waste disposal, (5) Determining products to be made based on waste.

2.3. Data analysis technique

Quantitative data analysis technique uses the estimated error normality test using the Liliefors test and homogeneity test using the Barlett test with the help of Excel 2016 software. If the data is normally distributed and homogeneous, then hypothesis testing is carried out using descriptive

statistics in the form of a simple Pearson Product Moment regression correlation technique using the t test. Qualitative data analysis includes data reduction, data presentation and conclusion.

3. RESULTS AND DISCUSSION

The results of the study are strongly recommended to be presented in tables and figures. The table is made in an open form and given the title above which describes the contents of the table as shown in the example (**Table 1**).

Table 1. Summary of Normality Test Results

group variance regression (Y-Ŷ)	Price L		Conclusion
	X^2count	X^2 table	
	0,067	0,079	Normal

Table 1 shows the results of the calculation (Lomax) of the estimated book error (Y-Ŷ) of 0.067 and Lt of 0.079, thus Lo < Lt = 0.067 < 0.079, so the estimated book error (Y-Ŷ) comes from a normally distributed population. The normality test is carried out to see whether the data obtained is normally distributed or not because if the data is normally distributed there will be little possibility of bias (Doddy et al. 2018).

Table 2. Summary of Homogenity Test Results

Group Varians Y score in terms of X	Price L		Conclusion
	X^2count	X^2table	
	116,07	149,88	Homogen

Table 2 is the result of calculating the X^2 price with the X^2 table. if X^2 count (116.07) < X^2 table (149.88) then the data comes from a homogeneous population. This homogeneity test is carried out to find out whether the variance in each population is the same or not and to find out differences between groups of variables (Sianturi 2022). This homogeneity test is carried out when the data is normally distributed.

Table 3. Correlation test calculation results

N	Correlation coefficient	Coefficient determination	Tcount	Significance	Conclusion
	(r)	(r^2)		5%	
123	0,490	0,240	2,011	1,979	HO Rejected

This shows that there is a positive relationship between understanding (X) and creative thinking (Y) at a significance level of $\alpha = 0.05$, the coefficient of determination (r^2) is 0.2401 or 24.1%, which means an increase or decrease in students' creative thinking skills in managing waste is determined by an understanding of 24.1% while the remaining 75.9% is another factor that plays a role in students' creative thinking abilities.

Based on qualitative research that the ability to think creatively is not only important for driving schools but also for public schools because creative thinking is the most important essence during the learning process, with the ability to think creatively students will be more active in participating in the learning process so that the atmosphere will be more comfortable during learning going on. Creative thinking will also affect the variety of questions students ask so that it refers to increasing student knowledge so that it plays an important role when solving problems. Students' creative thinking abilities can be seen when formulating problems, looking for solutions to every problem they experience, there will be lots of ideas from students conveyed at the time of completion. Such as environmental problems, students will deal with these problems through two aspects, namely

environmental friendliness and entrepreneurship, students will use used bottles as planting media and use trash around their homes to make fertilizer, then sell the crops to meet the needs of class equipment. The ability to think creatively is influenced by several factors besides understanding including teacher guidance factors, environmental factors, hobby factors, organization and several school activities as well as participating in creativity webinars and finally social media factors.

Understanding plays an active role in students' creative thinking abilities, with understanding students will know what to do to deal with waste so that the environment is maintained, waste greatly contributes to environmental damage, educational institutions need to provide understanding and also emphasize creative thinking skills so that students can reduce use waste that is difficult to recycle and recycle waste into items that can be reused (Lee and Lee 2023). The ability to think creatively with students' understanding of waste management are two interrelated aspects. When students have the ability to think creatively, they will have many ideas that can be created and channeled properly. In learning, the ability to think creatively needs to be developed, especially learning based on solving problems such as environmental problems (Evans and Jirout 2023).

Intelligence and creative thinking are two things that are related to each other based on knowledge and with the ability to think creatively, a person can be said to be intelligent because he is able to argue based on strong references so that when people have this ability they can be said to be intelligent people (Corazza et al. 2021). This intelligence can occur in students on the basis of encouragement from educational institutions, because the low ability to think creatively in students is based on a learning process that does not dominate students so that students are not trained in expressing their knowledge (Ernaeni and Gunawan 2019). Therefore the ability to think creatively is something that needs to be fostered in 21st century learning so that students' knowledge can develop according to changing times, learning based on changing times can encourage students to compete in the 21st century with good skills and intelligence. so as to encourage progress in educational institutions (Bullard and Bahar 2023).

The ability to think creatively is currently the most important goal of educational institutions, because learning is currently all based on problems so that students are trained to solve various problems, students need to be based on sufficient understanding so that they are able to know effective ways of solving problems (Swanzy-impraim et al. 2023). It can be assumed that the ability to think creatively is closely related to understanding, because understanding can be realized so as to generate ideas in solving various problems effectively.

4. CONCLUSIONS

Based on the results of the study it can be interpreted that there is a positive relationship between understanding and the ability to think creatively, with a regression value of $\hat{Y} = 44.464 + 0.458X$ and a correlation coefficient / $r = 0.490$ and a coefficient of determination / $r^2 = 0.2401$. in accordance with qualitative research that students' creative thinking abilities possessed by students can affect the learning process seen from the price of r^2 means that 24.1% of students' creative thinking abilities are influenced by understanding and the remaining 75.9% are influenced by internal factors (hobbies) and external factors (teacher guidance, environment, and several school activities such as organizations (osis) and performing arts (pensi), social media). There is cooperation between schools and teachers in developing learning designs so as to improve the quality of education which encourages the achievement of learning outcomes in order to improve students' creative thinking skills.

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Monitoring The Correlation of Climatics to The Airborne Bacteria at The Manggarai Station, South Jakarta, Indonesia

Reza Anindita[1*], Auliya Rahmawati[2], Maulin Inggraini[3], Melania Perwitasari[4], Dede Dwi Nathalia[5], Maya Uzia Beandrade[6], Intan Kurnia Putri[7]
[1,4,5,6,7]Department of Pharmacy, Stikes Mitra Keluarga, East Bekasi, Indonesia
[2,3] Department of Medical Laboratory Technology, STIKes Mitra Keluarga, East Bekasi, Indonesia
[*]Corresponding Author. E-mail address: rezaaninditaa@gmail.com

KEYWORDS:
Temperature, humidity, light intensity, manggarai station, bacteria

ABSTRACT

The highest of microorganisms suspended in the air were bacteria with a percentage of 80.8%. If the intensity of bacterial exposure occurs in large quantities, it will accumulate in the respiratory tract which has the potential to trigger allergic reactions and respiratory infections. Given the problems and impacts caused by air microorganisms on public health, it is necessary to monitor the distribution of air bacteria. The purpose of this study was to determine the relationship between temperature and humidity with the number of bacteria in the Manggarai station area. Type of research is correlation. The sampling location is Manggarai Station, East Jakarta, Indonesia. The 10 sampling points in this study include the station hall, motorbike parking, prayer rooms, train platform 1-2, train platform 2-3, train platform 3-4, and train platform 5, toilet, and underpass. The results of this study included the highest number of bacteria found in the station hall 331 colonies, the highest percentage of bacterial morphology is monobacilli was 78%, the distribution of gram positive was more than gram negative with spore bacteria being more dominant than non spore. The correlation coefficient between temperature and number of bacterial colonies (0.134) and humidity with number of bacterial colonies (0.380) showed weak positive correlation, while the correlation coefficient for light intensity with the number of bacterial colonies -0.140 (very weak negative).

1. INTRODUCTION

According to Bragoszewska and Pastuszka (2018), the percentage of airborne microorganisms is 10% of the 24% of the total particles suspended in the air. Cho *et al*. (2019) reported that the highest types of microorganisms suspended in the air were bacteria with a percentage of 80.8%. The dominant bacterial phyla identified in the air were Proteobacteria (32.2%), Cyanobacteria (18.0%), Actinobacteria (16.5%), Firmicutes (15.5%), and Bacteroidetes (11.6%) (Liu *et al*., 2018).

Kallawicha *et al*. (2015) explained that bacteria are components of bioaerosols that are abundant in the air both outdoors and indoors. In addition to bacteria, other bioaerosol components are viruses, fungi, pollen, metabolites of microorganisms (mycotoxins), and endotoxins as the outer membrane of bacterial cells that are released during bacterial lysis and growth. The presence of bacteria and endotoxins as components of bioaerosols were identified as important factors affecting human health. According to Jones and Harrison (2004) bacteria have a size of 0.25–8 m. This size makes it easier for bacteria to enter the human body through inhalation of the respiratory tract. If the intensity of bacterial exposure occurs in large quantities, it will accumulate in the respiratory tract which has the potential to trigger allergic reactions and respiratory infections such as asthma, rhinitis, pneumonia, and atopic dermatitis.

Cho *et al*. (2019) reported that bacteria with a size of 5-10 m that accumulate in the upper respiratory tract can trigger rhinitis, while bacteria with a size of <5 m that accumulate in the alveoli can trigger allergic reactions. However, these reactions vary between individuals. This effect tends to be more dangerous in someone with a weakened, moderate, or weakened immune system, such as children, pregnant women, and the elderly.

Given the problems and impacts caused by air microorganisms on public health, it is necessary to monitor the distribution of air microorganisms. Monitoring can be done by conducting research on the relationship between physical quality and outdoor air bacteria, especially at stations as one of the centers of crowds in densely populated urban areas.

This research was conducted at the Manggarai Station in South Jakarta, Indonesia. This station is a transit center for trains that is full of people and is a source of spreading airborne bacteria in the outside environment through coughing, breathing, and exposure to human skin. The selection of research that focuses on outdoor air bacteria at the Manggarai station refers to previous studies which were more dominant in monitoring indoor air bacteria.

Several previous studies that examined the relationship between temperature and humidity on air microorganisms, among others, research Menteşe *et al*. (2009); Wu *et al*. (2012) ; Kumar *et al*. (2011); Bragoszewska and Pastuszka (2018) ; Cho *et al*. (2019) ; Goudarzi *et al*., (2017). The difference between this research and previous research is in terms of location, this research was conducted in Indonesia, especially at the Manggarai Station. The novelty of this research is that there has never been data on air bacteria in the outdoor environment in the Manggarai station area, East Jakarta, Indonesia, considering that research on air bacteria in Indonesia is more dominant indoors.

The purpose of this study was to determine the relationship between temperature and humidity with the number of bacteria in the Manggarai station area. The existence of data on airborne bacteria can be used as a reference in formulating better policies regarding Indonesian public health guidelines outdoors.

2. MATERIALS AND METHODS

This type of research is a correlation. The sampling location is Manggarai Station, East Jakarta, Indonesia. Samples were examined at the Microbiology Laboratory of STIKes Mitra Keluarga, East Bekasi.

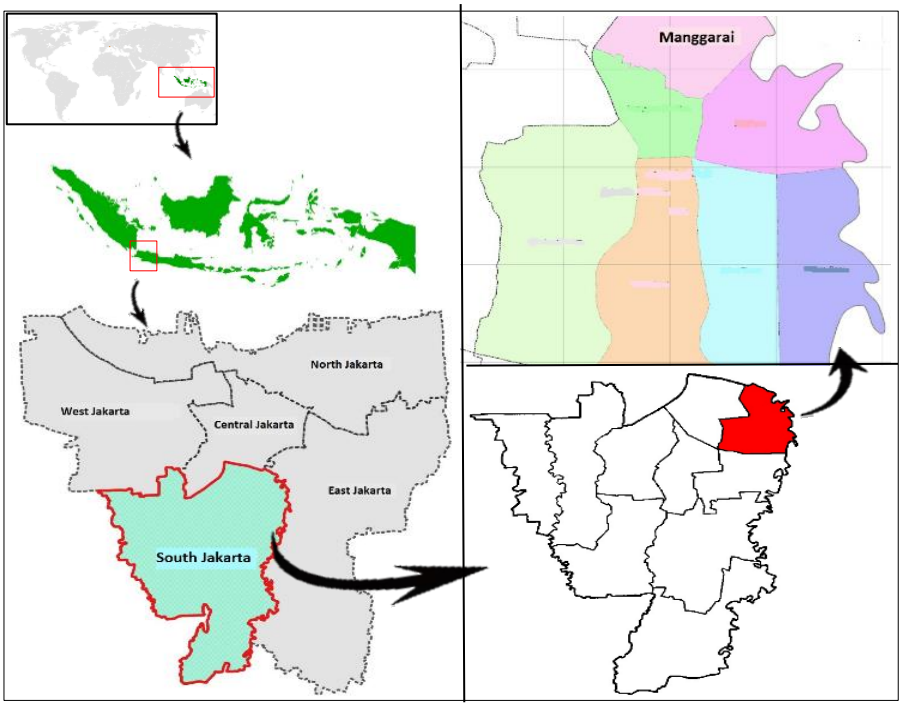


Figure 1. Map manggarai station location, south jakarta, indonesia

The instrument used in this study include Autoclave (Hirayama HG-50), Incubator (DNP), Analytical Balance (Adam), Microscope (Olympus CX22), Showcase (polytron), BSC (JSR), Hot plate and stirrer (Ika HS-10), Colony counter (KJY-020), petri dish (pyrex), bunsen's burner, Erlenmeyer (pyrex), spatula, beaker (pyrex), Thermohygrometer, Lux meter, tripod, needle loop, stirring rod, matches, dropper, object glass (sail brand) and coloring tub. The materials used in this study were 70% alcohol, spirits, aquadest, Nutrient Agar media (Himedia), Crystal violet (Be Reagent), Lugol's iodine (Merck), 95% alcohol, safranin, and Malachite Green (Riedel-De Haen).

The population in this study is the entire area of the Manggarai station. Determination of the sample area in this study using a purposive sampling technique with the criteria of a crowded area and frequently visited by passengers. The 10 sampling points in this study include the station hall, motorbike parking, prayer rooms, train platform 1-2, train platform 2-3, train platform 3-4, and train platform 5, toilet, and underpass.

The procedure of this research include pre-analytic, analytic, and post-analytic stages :

The Pre-analytic

The pre-analytic stage starts by making Nutrient Agar (NA) media to grow bacteria, measuring temperature and humidity with a thermohygrometer, light intensity with a lux meter, and taking bacterial samples at 10 points in the Manggarai station area. Each point is repeated three times on the same day and at different times, at 07.00 - 09.00 WIB. This time is the departure time of passengers at Manggarai station based on the results of a preliminary survey. The air sampling process is carried out using NA media that has been coded in the form of date, time, and location of collection placed in a predetermined sampling area with a height of 1.5 m. The NA medium was placed in an open petri dish for 10-15 minutes. The NA medium was closed again and incubated at 37°C for 2x24 hours. After incubation, the NA medium was observed and the number of bacterial colonies counted using colony counter.

The Analytic

The analytical stage is laboratory tests which include gram staining and spores. The staining results were observed using a light microscope with a magnification of 100x.

The post-analytic

The post-analytic stage is in the form of recording data on temperature, humidity, light intensity, number of bacteria, and types of bacteria based on morphology, gram, and presence of spores. All data were then analyzed by the Spearman Correlation test to determine the relationship between air physical factors such as temperature, humidity, and light intensity with the number of bacterial colonies.

The research has been conducted an ethical feasibility test by the Ethical Committee for Research health of Jakarta III Ministry of Health Polytechnic (KEPK-PKKJ3) with certificate ethic No. KEPK-PKKJ3 / 5 /II /2019

3. RESULTS AND DISCUSSION

3.1. Results

The results of examination bacteria after 2x24 hours incubation in this study showed that all areas showed the growth of bacterial colonies on petri dishes containing NA media. The results of the growth of bacterial colonies can be seen in **Figure 2.**

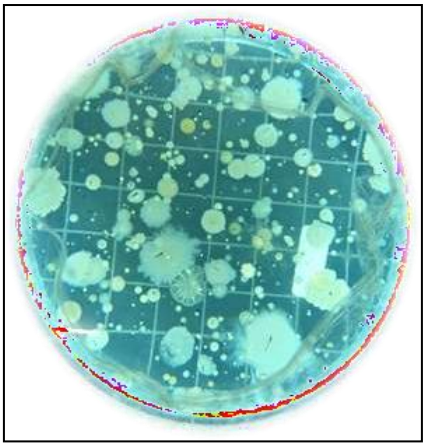


Figure 2. Bacterial colonies on NA media placed at the Manggarai station

The results of the calculation of the number of bacterial colonies after incubation of 2x24 NA media placed in 10 areas of Manggarai station in this study can be seen in **table 1.**

Table 1. The results of the calculation of the number of bacterial colonies

No	Areas	Colonies (CFU's)
1	The station hall	331
2	motorbike parking	189
3	Woman prayer rooms	33
4	Man prayer rooms	11
5	train platform 1-2	224
6	train platform 2-3	128
7	train platform 3-4	134
8	train platform 5	220
9	Woman toilet	169
10	Underpass	210

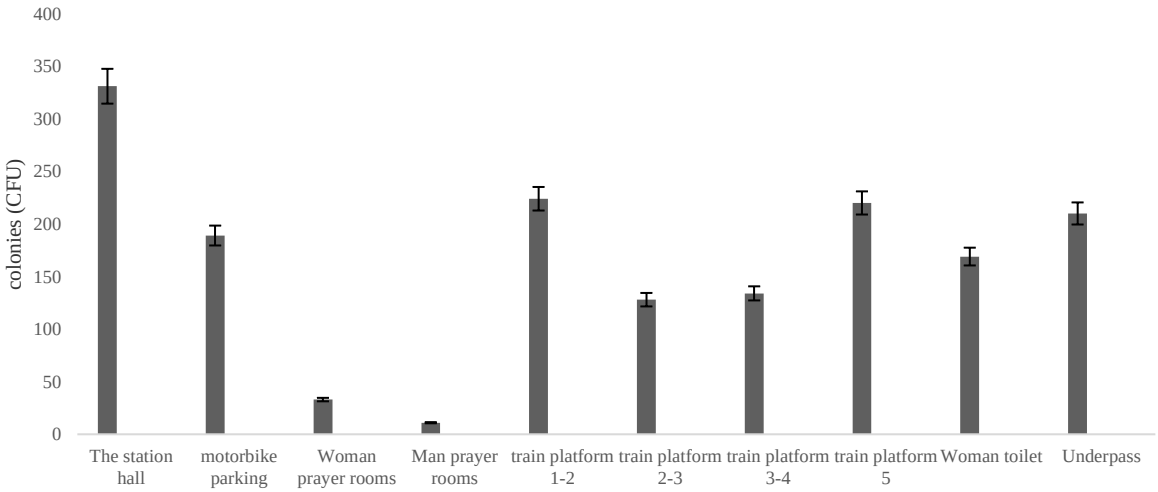


Figure 3. The number of bacterial colonies at Manggarai station

Table 1. shows that the average interval of the number of bacterial colonies found in 10 areas at the Manggarai station is between 11-331 colonies. The lowest number of bacterial colonies were found in the man prayer room as many as 11 colonies, while the highest was found in the hall area as many as 331 colonies (**Figure 3**). The distribution percentage of the number of bacteria based on their morphology can be seen in **Table 2** and **Figure 4**.

Tabel 2. The distribution percentage of the number of bacteria based on their morphology

Areas	Percentage of the number bacteria (%)								
	Monobacilli	***Diplobacilli***	***Streptobacilli***	***Coccobacilli***	***Monococci***	***Diplococci***	***Streptococci***	***Staphylococci***	***Sarcina***
The station hall	14	2	6	0	4	2	0	4	0
motorbike parking	12	7	7	1	8	5	10	10	1
Woman prayer rooms	3	0	0	0	1	0	0	0	0
Man prayer rooms	6	8	8	2	2	0	0	7	0
train platform 1-2	10	3	3	1	2	1	1	7	1
train platform 2-3	1	2	2	4	2	1	0	2	0
train platform 3-4	4	1	1	0	8	0	1	7	0
train platform 5	9	1	1	0	6	1	4	7	0
Woman toilet	7	1	1	0	7	1	2	4	0
Underpass	12	2	2	0	6	2	0	12	0
Total	78%	27%	31%	8%	46%	13%	18%	60%	2%

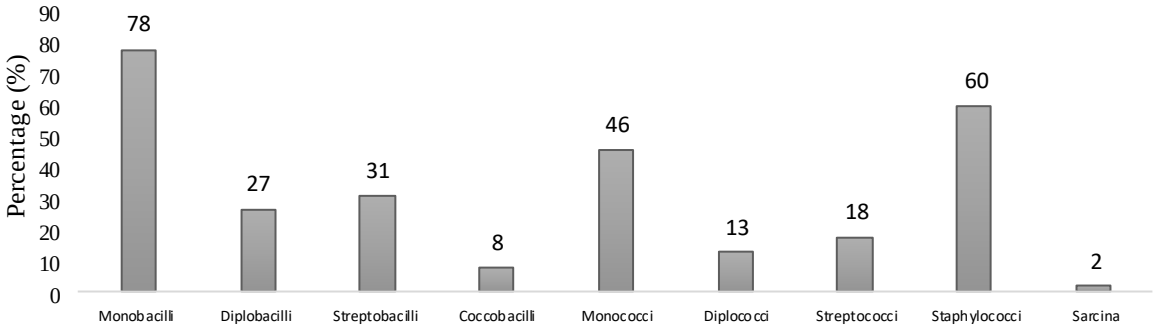


Figure 4. Diagram of the percentage number of bacterial colonies based on morphology

Table 2. show that there are 9 bacterial morphologies found in 10 areas of the Manggarai station, namely monobacilli, diplobacilli, streptobacilli, cococobacilli, monococci, diplococci, streptococci, staphylococci, and sarcina. The percentage of bacterial morphology that had the highest number was monobacilli, while the lowest was sarcina (**Figure 4**).

The results of the distribution of the number of bacteria based on gram staining can be seen in **Table 3**. and **Figure 5**.

Table 3. Distribution of bacteria based on gram staining

Area	Gram	
	Positive	**Negative**
The station hall	12	6
motorbike parking	19	7
Woman prayer rooms	2	2
Man prayer rooms	9	5
train platform 1-2	12	6
train platform 2-3	11	2
train platform 3-4	13	6
train platform 5	17	9
Woman toilet	1	15
Underpass	1	22

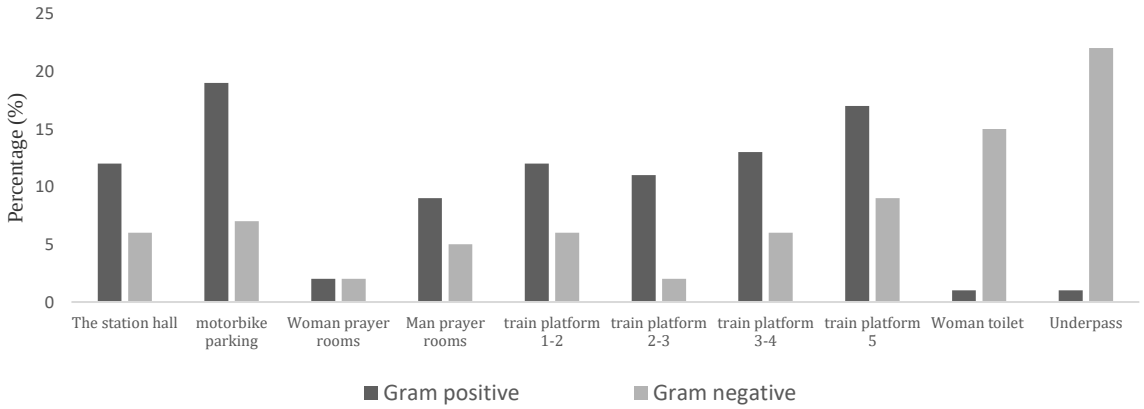
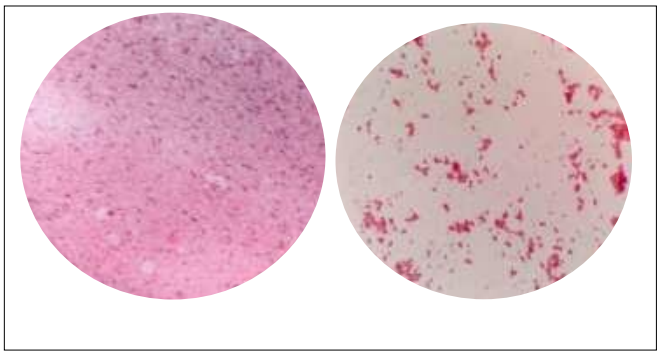


Figure 5. Distribution of bacteria based on gram staining



A **B**

Figure 6. Gram-positive (A) and Gram-negative (B) bacteria.

In this study, the number of bacterial colonies based on the presence/absence of spores showed that the number of bacteria that did not have spores was more dominant than bacteria that had spores. The results of the number of bacterial colonies based on the presence or absence of spores are shown in **table 4** and **figure 7**.

Table 4. The number of bacterial colonies based on spores.

Area	Spora	
	Spore	**Non-spore**
The station hall	12	6
motorbike parking	12	14
Woman prayer rooms	3	1
Man prayer rooms	6	8
train platform 1-2	9	9
train platform 2-3	5	8
train platform 3-4	3	16
train platform 5	3	23
Woman toilet	5	11
Underpass	11	12

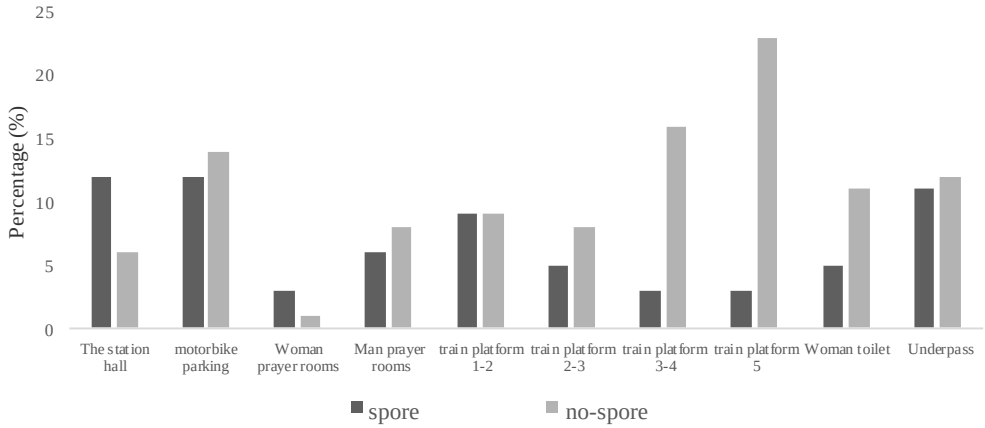


Figure 7. Diagram of the distribution of bacteria based on the presence of spores

The results in **table 4** and **figure 8** show that the percentage of bacteria that have spores in the hall (67%), motorbike parking (46%), women's prayer room (75%), men's prayer room (43%), platform 1-2 (50%), platform 2-3 (38%), platform 3-4 (16%), platform 5 (12%), women's toilet (31%), and underpass (48%), while the percentage of bacteria that did not have spores in the hall (33%), motorbike parking (54%), women's prayer room (25%), men's prayer room (57%), platform 1-2 (50%), platform 2-3 (62%), platform 3-4 (84%), platform 5 (88%), women toilets (69%), and underpass (52%). The microscopic picture of the structure of spore and non-spore bacteria can be seen in **Figure 8.**

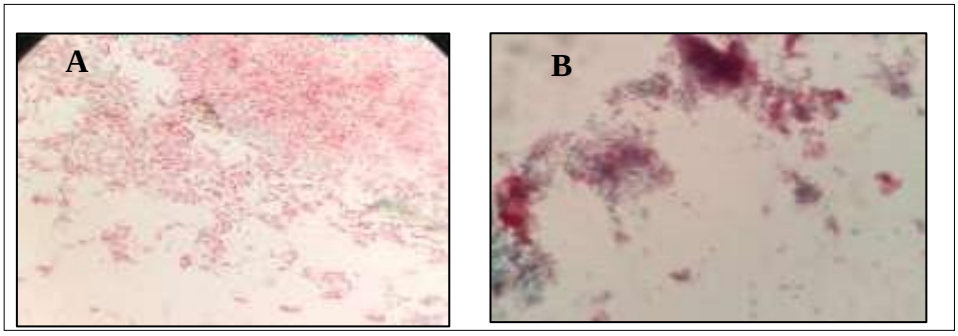


Figure 8. Spore bacteria (a) and bakteri non-spore bacteria (b) (1000x).

In this study, measurements of physical factors at Manggarai Station were carried out simultaneously with air sampling at Manggarai Station. Measurement of physical factors was carried out at 10 sampling points at Manggarai Station. The data obtained consisted of temperature, humidit, and light intensity which can be seen in **table 5.**

Table 5. Results of measuring physical factors

Area	Temperature (°C)	Humidity (%)	Light Intensity (lux)
The station hall	31.8	63	405
motorbike parking	32.4	61	9324
Woman prayer rooms	30.1	64	1015
Man prayer rooms	29.8	66	83
train platform 1-2	31.6	63	3613
train platform 2-3	31.7	62	4100
train platform 3-4	32.1	60	2865
train platform 5	31.8	61	3057
Woman toilet	31	63	260
Underpass	31.1	63	67

Table 5. shows that the interval of the average temperature is between 29.8°C-32.4°C, humidity 60%-66%, and light intensity 83-9324 lux. The results of statistical tests on the correlation of physical factors of air quality toward the number of bacterial colonies using the Spearman correlation test with a 95% significance level can be seen in **table 6.**

Table 6. Correlation test results of temperature, humidity, and light intensity on the number of bacterial colonies

Test variable	Result	correlation coefficient
Temperature with the number of bacterial colonies	p = 0,000	r = 0,134
Humidity with the number of bacterial colonies	p = 0,000	r = 0,380
Light Intensity with the number of bacterial colonies	p = 0,000	r = -0,141

Table 6. shows that all test variables produce a p-value <0.05 or that there is a correlation between physical factors of air quality and the number of bacterial colonies. The correlation coefficient value between temperature and the number of bacterial colonies and humidity with the number of bacterial colonies showed a weak positive correlation, respectively 0.134 and 0.380, while the correlation coefficient (r) for light intensity with the number of bacterial colonies was -0.140 or classified as correlation. very weak negative.

3.2. Discussion

The results of the Spearman correlation test in this study showed that there was a correlation between temperature and the number of bacterial colonies at the Manggarai station (P<0.05). However, this correlation is included in the very weak category (r=0.134). The results of this study are in accordance with the research of Bragoszewska and Pastuszka (2018); Saadati *et al*. (2022) reported that there was a positive correlation between air temperature and the number of bacterial colonies.

According to Zhong *et al*. (2016), the correlation between temperature has a weak positive correlation with the number of bacterial colonies due to the presence of too high a temperature which can also inhibit bacterial growth. This is shown in the research results of Wu *et al*. (2012) who reported that increasing the temperature of UV light can significantly reduce the number of bacterial colonies outdoors. Therefore, the correlation between temperature and the number of bacterial colonies is very weak, considering that each bacterium has varying optimum temperature characteristics.

Another factor that correlates with the number of bacterial colonies is humidity. The correlation between humidity and the number of bacterial colonies in this study resulted in a positive correlation with a weak category. The results of this study are in accordance with the research of Kallawicha *et al*. (2015)**;** Hwang and Yoon (2017) who reported that air humidity was positively correlated with the number of bacterial colonies. The difference in previous studies is that the correlation is strong, while in this study it is weak.

Hwang and Yoon (2017); Zhong *et al*. (2016); Hiwar *et al.* (2021) stated that humidity is related to the amount of water vapor in the air needed to increase cell wall strength and bacterial metabolism so that increasing air humidity can increase bacterial growth. However, humidity that is too high is often accompanied by very low temperatures that can inactivate protein enzymes that play a role in bacterial growth. Therefore, the correlation of humidity with the number of bacterial colonies often results in a weak positive correlation.

In contrast to temperature and humidity, in this study, the correlation between light intensity and the number of bacterial colonies resulted in a very weak negative correlation. The results of this study are in accordance with the research of Kamel *et al*. (2016); Fithri *et al*. (2016) who reported that light intensity was weakly negatively correlated with bacterial colonies. This is because some bacteria can have mutations that make them resistant to light exposure.

Gola *et al.* (2019) added that light intensity has bactericidal activity and plays an important role in spontaneous sterilization in natural conditions because sunlight contains ultraviolet light. Examples of bacteria that die from exposure to high light intensity are Streptococcus and other bacteria that cause respiratory tract infections.

Research result Gladka *et al.* (2021) ; Santos *et al*. (2011) ; Mohana *et al*. (2013) explained that although light intensity can inhibit the growth of some airborne bacteria, there are some bacteria that are resistant to high light intensity, such as *Micrococcus* sp. The resistance of these bacteria is obtained because some bacteria are able to form spores to survive and grow to spread to the environment without being affected by the intensity of sunlight. Therefore, the negative correlation between light intensity and the number of bacterial colonies is weak.

In this study, areas with a high number of bacterial colonies were station halls, platforms, and underpasses. The high number of bacteria is due to the fact that these three areas are the center of crowds at the station, thereby increasing the number of bacterial colonies carried by dust and humans as station users (Fang *et al*., 2007); (Maier *et al*., 2010).

The results of this study also showed that the dominant forms of airborne bacteria in the Manggarai station area were coccus and bacillus. These results are in accordance with the research of Menteşe *et al*. (2009) which states that the most common bacteria found in outdoor areas are coccus and bacillus with the dominant genus Micrococcus sp. Streptococcus sp and Bacillus sp. Goudarzi *et al*. (2017) added that in addition to the dominant fungal genus bacteria in the outdoor, among others, *Aspergillus* sp., *Penicillium* sp., and *Cladosporium* sp.

The results of this study also found the spread of the number of gram-positive and spore-forming bacterial colonies in large numbers. Kumar *et al*. (2011) explained that gram-positive bacteria are more resistant than gram-negative bacteria to high UV exposure. The resistance of bacteria to extreme environments is influenced by the presence of spores, pigments and high amounts of Guanine (G) and Cytosine (C), considering that bacteria with endospores and DNA with high G and C content are more resistant to temperature, humidity, light intensity, UV rays, chemicals, and free radicals.

The advantages of this research are the locations that have never been studied and the research variables are large in number. The limitation of this study is the identification of bacterial and fungal species in the Manggarai station area has not been carried out

4. CONCLUSIONS

This study concludes that there is a correlation between temperature, humidity, and light intensity in the number of bacterial colonies in the Manggarai station with a weak category. As for further researchers, besides analyzing the correlation between environmental factors and the number of bacterial colonies, it is also recommended to identify bacteria and fungi in the Manggarai station environment.

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The Effect of Active Learning Integrated with Everyone Is A Teacher Here Strategy Based on Questioning and Answering on The Critical Thinking Skills and Biology Learning Retention of Class XI Senior High School Students In The Industrial Agriculture Area

Kurnia Suciningsih, Bea Hana Siswati*, Nadyatul Ilma Indah Savira
Biology Education Department, Faculty of Teacher Training and Education, University of Jember. Kalimantan Street Number 37, Sumbersari, Jember 68121, Jawa Timur, Indonesia
*Corresponding Author. E-mail address: beahana.fkip@unej.ac.id

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Critical Thinking, Everyone is A Teacher Here, Questioning and Answering, Retention

ABSTRACT

This study aimed to improve student's critical thinking skill and student retention in learning biology through active learning strategy innovation Everyone Is A Teacher Here (ETH) based on Questioning and Answering (Q&A). Moreover, the type of research used is a quasi-experimental research using a pre-test, post-test, and re-test research pattern. In addition, the research was conducted at SMAN 3 Jember in the even semester of the 2022/2023 academic year. The XI MIPA 2 class was selected as the experimental class and XI MIPA 4 as the control class. Based on the results of this study, the ETH strategy based on Q&A has a significant effect on students' critical thinking skills and retention in biology class XI. This is evidenced by the results of the significance of the Anakova test using SPSS, critical thinking skills have a significance of 0.000 ($p<0.05$) and student retention has a significance of 0.000 ($p<0.05$). The innovative learning strategy used in this study can be applied in class because it can increase student focus and motivation, especially in biology.

1. INTRODUCTION

The revised 2013 curriculum in its implementation emphasizes affective, cognitive, and psychomotor aspects that are in accordance with the characteristics of students and integrates 4 important things namely Strengthening Character Education (PPK), Literacy, (basic literacy, library, media, technology, and visual), 21st Century Skills (4C), and *Higher Order Thinking Skills* (HOTS) (Sholekah, 2020; Effendi et al., 2021).

Student's critical thinking skills in Indonesia are in the low category, as evidenced by data from the *Program for International Student Assessment* (PISA) which stated that in 2015, student's' critical thinking skills in Indonesia had a score of 397, which was 62nd place out of 72 countries, while in 2018 it had a score of 371, which was 74th place out of 79 countries, (Agnafia, 2019; Hewi dan Shaleh, 2020). One way to hone students' thinking skills is through learning activity that involves critical thinking processes. According to research by Kartimi & Liliasari (2012) that to improve critical thinking there needs to be a training process, such as getting students used to work on questions that develop critical thinking (Susilawati et al., 2020).

Retention is the ability to remember material that has been studied. It is related to memory, which the output is student learning outcomes (Sudirman and Yusnaeni, 2022). The ability to remember previously learned material is one of the student problems found in classroom. According to Astuti and Muldayanti (2018) that some of all students in the class have low memory,

this was proven during the next meeting only a few students could answer the teacher's questions when reviewing the material with simple questions and answers.

Student's critical thinking skills and learning retention must be improved, one of which is by making changes from Teacher-Centered Learning to Student-Centered Learning through active learning. The principle of active learning is student-centered (Hartikainen et al., 2019). One of the active learning strategies is Everyone is A Teacher Here (ETH). Students get a card containing questions, then the student is given the opportunity to answer questions that behave like teachers to other students in their own style and language (Pratama and Pratiwi, 2019). Questioning and Answering (Q&A) activities are method in the form of reciprocity between teachers and students or students and students (Syahrir, 2018). According to Sulfemi (2017) and Sadariya (2021) that the question-and-answer (Q&A) method for students can increase thinking stimulus, learning motivation, and adding insight, communication strengthening between teachers and students, which can train learning independence. Research by Pratama and Pratiwi (2019) used questions from students. This is less effective because the questions are still basic. So, researchers innovate by preparing critical question cards that are displayed through a projector so that all students can focus and follow the learning process properly.

Biology subjects requires students to be able to find a scientific fact through the process of observing, analyzing, comparing with theory, and concluding (Senisum, 2021). Biology subject is classified as a difficult material for students at SMAN 3 Jember. Based on the observation results, the UAS average score for biology class XI MIPA has not reached the KKM, which is still below 75. Therefore, innovation is needed in the learning process to improve students' critical thinking skills and biology learning retention. The material used by researchers were in accordance with what is being taught at the beginning of the even semester, namely the human respiratory system. Respiratory system material is one of the difficult materials, because during the learning process students cannot see directly the organs of the respiratory system and the processes that occur in the respiratory system (Panjaitan et al., 2020). Biology learning at SMAN 3 Jember, which is an industrial agricultural area, can be connected to phenomena in the surrounding environment to trigger students' thinking stimulus.

Based on the background above, the authors conducted a study entitled The Effect of Active Learning with Everyone is A Teacher Here Strategy Based on Questioning and Answering on Critical Thinking Ability and Retention in Learning Biology for Class XI High School Students in Industrial Agricultural Areas.

2. MATERIALS AND METHODS

The type of research used was quasi-experimental. This study used a pre-test, post-test, and re-test research pattern on 2 classes, one class as the control class and the other class as the experimental class.

Table 2.1 Research design pre-test, post-test, and re-test

E	O1	→	X1	→	O2	→ O3
K	O1	→	X2	→	O2	→ O3

Information:
E : experimental class
K : control class
O1 : pre-test results
O2 : post-test results
O3 : re-test result
X1 : using Q&A based ETH strategy
X2 : using the lecture method

Research in the experimental class applied The ETH learning strategy based on Q&A. While the control class used the lecture method learning model. The material used in this study is the human respiratory system. The research was conducted at SMAN 3 Jember in the even semester

of the 2022-2023 academic year, in January-March 2023. The meetings were held 3 times, both in the control class and the experimental class. The research population were all students of grade XI at SMAN 3 Jember. The research sample was selected through equality test of the classes that would be sampled using the ANOVA test, so XI MIPA 2 and XI MIPA 4 classes were selected as sample classes.

The data collection techniques used in this study were interview, observation, documentation, and test (pre-test, post-test, and re-test). Interview and observation activity were held at SMAN 3 Jember. The data collection techniques of this study can be seen in the following table:

Table 2.2 Data Collection Techniques

Data	Data Collection Technique	Instrument
Validity of ETH learning strategy based on Q&A	Expert validity (validated by lectures)	Validation Sheet
Critical Thinking Ability and Retention	Test	Test Questions
Implementation of learning	Observer response	Observation Sheet

In this study, all samples were tested using the normality and homogeneity tests first. Then, test the equality of the classes that will be sampled using the Anova test. The analysis of covariance (anakova) data analysis approach was applied in this study. Critical thinking skills in control and experimental classes were measured by using the pre-test and post-test. The questions tested used multiple choice questions and essays. The test results then were analyzed by using anakova. The following was the formula for scoring students' critical thinking skills:

$$\text{Skor} = \frac{score\ obtained}{skor\ maximum} \text{ x } 100\%$$

Student retention in the experimental and control classes measured through post-test and re-test scores and then analyzed using anacova. The test results are calculated by the following formula:

$$\text{Skor} = \frac{score\ obtained}{skor\ maximum} \text{ x } 100\%$$

3. RESULTS AND DISCUSSION

3.1. The impact of Everyone is A Teacher Here Based on Questioning and Answering for Student's Critical Thinking Skills

The results of the hypothesis test for critical thinking skills can be seen in the following table.

Table 3.1 Hypothesis Test Results of Students' Critical Thinking Skills

Class	N	Average		Sig.
		Pretest	Posttest	
Control Class	31	64,77± 6,88	73,54± 9,88	0,00
Experiment Class	31	66,06± 7,65	87,09± 8,24	

Based on the table 3.1 of data analysis results of students' critical thinking skills, the significance value was 0.00 ($p < 0.05$) which indicated that the Everyone is A Teacher Here strategy based on Questioning and Answering had a significant impact on students' critical thinking skills. This was in accordance with Sari's research, (2014) that the ETH strategy is able to optimize learning independence and students' ability to think critically. This research was also supported by

Liasari, Sudjarwo & Purnomo, (2017) that the ETH strategy has a significant effect on learning outcomes and students' critical thinking skills.

The implementation stages of the ETH strategy based on Q&A were as follows. The first step was orientation by showing video and introduction according to the material. This stage triggers students to explore a phenomenon that can increase students' curiosity (Jeffery et al., 2016; Arsal, 2017; Mcnew-birren & Kieboom, 2017). Then students formed groups of 4-5 people. Group activities involved students to discuss so they can explore, explain, and refute opinions and consider the most reasonable answers to solve the problems given (Wood and Shirazi, 2020). Fauzan et al., (2022) stated that group discussion activities were effective in increasing critical thinking skills in high school students.

The second step was the teacher chooses one student randomly to answer the question by selecting question cards randomly. According to Usman et al., (2020) stated that asking questions can stimulate students to answer and express opinions. So, through this stage students had carried out the basis of the critical thinking process.

The third step was students conducted discussion sessions under the guidance of the teacher in conducting investigation and gathering information. According to Kurniahtunnisa (2016) learning that involves students to understand, formulate problems, search for and analyze data to find alternative solutions to a problem can improve students' critical thinking skills.

The fourth step was the questioning and answering session where the selected students had to answer questions in front of the class, then the teacher gave an opportunity to one of the students from a different group to provide feedback. This stage trained students' communication skills. According to Andriyani (2020), communication skills are one of the aspects in 4C so it needs to be trained to improve. The last step was that students summarized and concluded the material followed by a reflection from the teacher regarding the material that students had learned. Self-reflection based on Dewey's reflective thinking theory and Marzano's opinion, can train students to control themselves and is a process that aims to encourage students to know how effective the learning process for them (Saputri et al., 2019).

The results of the frequency distribution of student's critical thinking skills can be seen in the following table :

Table 3.2 Frequency Distribution Table of Critical Thinking Skills

No.	Critical Thinking Indicators	Experiment Class			Control Class		
		***Pre-Test* Average**	***Post-Test* Average**	**Average Difference**	***Pre-Test* Average**	***Post-Test* Average**	**Average Difference**
1	Provides a simple explanation	2.87	4.32	1.45	3.88	4.30	0.42
2	Building basic skills	3.48	4.68	1.20	2.97	3.03	0.06
3	Building conclusions	3.48	4.39	0.91	2.87	3.68	0.81
4	Make further explanations	2.77	4.35	1.58	2.97	3.52	0.55
5	Organize strategies and tactics	3.84	4.03	0.19	3.48	3.84	0.36
Total				**5.33**			**2.20**

Based on table 3.2 of data frequency distribution of students' critical thinking skills, it can be seen that the experimental class got better scores than the control class. Assessment of critical thinking skills were also measured through 5 critical thinking indicators. The maximum point for

each indicator was 5. The first indicator was to provide a simple explanation, the experimental class scored 4.32 (very high) and the control class got 4.30 (very high). This score was in the very high category because students were able to identify problems in the questions and the answers they write aligned with the answer key (Putri and Latisma, 2022).

The second indicator was building basic skills, in the experimental class got a score of 4.68 (very high) and in the control class got a score of 3.03 (enough). Students in the experimental class obtained very high scores, meaning that they were able to examine information through relevant sources and then process and analyze problems using the information they found (Putri and Latisma, 2022). Whereas in the control class students were still have difficulty in analyzing and finding evidence relevant to the problems given. This was characterized by thinking that was not according to proper standards, irrelevance and limited thinking stages (Nugraha et al., 2017).

The third indicator was making conclusions, in the experimental class got a score of 4.39 (very high) and in the control class got a score of 3.68 (high). Students in the experimental class got very high scores because they were able to find solutions and draw conclusions appropriately based on existing facts. Students in the control class were able to conclude problems but could not explain in detail about the analysis of the answers they found. One of the characteristics of someone with optimal critical thinking skills were being able to draw conclusions and provide alternative solutions with valid arguments and evidence (Nugraha et al., 2017).

The fourth indicator was making further explanations, in the experimental class got a score of 4.35 (very high) and in the control class got a score of 3.52 (high). This indicated that students in the experimental class had been able to think comprehensively in solving a problem. Characterized by being able to solve problems using an open, broad, and detailed mind consistently and being able to use their instincts for existing concepts and then linking these concepts to solving problems (Nugraha et al., 2017). Students in the control class obtained lower scores because they were able to think deeply and solve problems, but they were still could not explain completely.

The fifth indicator was organizing strategies and tactics, in the experimental class got a score of 4.03 (very high) and in the control class got a score of 3.84 (high). Students got very high scores because they had been able to find the right alternative answers and describe conclusions according to the problem (Putri and Latisma, 2022). Students with high critical thinking skills can consider the several options provided to determine the most effective problem solving solutions (Nugraha et al., 2017). Meanwhile, students in the control class obtained lower scores because they were able to explain answers correctly, but they were incomplete in finding alternative answers. As a result, additional information is required. (Putri and Latisma, 2022).

The implementation of the ETH strategy based on Q&A created interaction between students that helped students to understand the material in their own way. The understanding that was 'self-created' through students' own language can make it easier for students to remember what they had learned so that they can complete evaluation questions and have better cognitive learning outcomes (Yusuf, 2018). In addition, questions at the beginning of learning can hone students' critical thinking skills to a higher level.

3.2.The impact of Everyone is A Teacher Here Based on Questioning and Answering for Student's Retention

The results of the student learning retention hypothesis test can be seen in the following table.

Table 3.3 Student Learning Retention Hypothesis Test Results

Class	N	Average		Sig.
		Posttest	Retest	
Control Class	31	82,54± 4,65	64,35± 11,46	0,00
Experiment Class	31	87,03± 6,14	80,93± 8,38	

Based on table 3.3 of student learning retention results, the significance value is 0.00 ($p < 0.05$). It can be interpreted that the implementation of ETH strategy based on Q&A had a significant effect on student learning retention. Retention of students' knowledge using an active learning approach in class can increase long-term retention of students than the lecture approach (Wood and Shirazi, 2020). Learning using the ETH strategy in the experimental class manifested a better change in students compared to conventional methods (lectures) in the control class. According to Kurniawan (2014) that conventional learning which is usually teacher-centered can lead to low retention (memory) of students on the material being studied.

The implementation stages of the ETH strategy based on Q&A were as follows. The first step was orientation by showing the video and introduction. This can be the first step to train students' memory because students can use their minds to explore a phenomenon that can increase students' curiosity (Saputri et al., 2021).

Then students formed groups of 4-5 people. Group activities involved students in discussing so they can explore, explain, and refute each other's opinions and consider the most reasonable answer to solve the given problem (Wood and Shirazi, 2020). This can increase student retention because they go through the learning process by experiencing directly so that information can last longer in their minds and learning becomes meaningful (Candra and Yanto, 2020).

The second step was the teacher chose one student randomly to answer the question by selecting question cards randomly. Giving questions can stimulate students to think scientifically, understand problem-based concepts, and make them into hypotheses. Students will also plan alternative solutions based on previously understood concepts (Pedaste et al., 2015; Lotter et al., 2016). Well-trained questioning skills will develop higher-order thinking skills, curiosity, creativity, critical thinking skills, and one's character as a lifelong learner (Yang et al., 2005; Tofade et al., 2013). This means that these stages can help students to store material in long-term memory.

Discussion activities were still guided by the teacher in conducting investigations and gathering informations. The information exploration stage trained students to analyze and develop several attitudes such as being honest, conscientious, polite, communicative, and increasing good learning habits so that they got learning experience from the discussion activities that had carried out (Musfiqon & Nurdiansyah, 2015; Maybee et al., 2016). The more often students took an active role in learning, the more they will maximize their memory of the material being studied.

The third step was the questioning and answering (Q&A) session so that the selected students had to answer questions in front of the class, then the teacher invited other group members to present their arguments. Discussion and Q&A activities between groups can train students' communication skills with one to another. In addition, this stage trained students' analytical skills, those who were able to analyze well mean that they were able to process information well. According to Widayati et al., (2015) that students' memory abilities will be good if they are able to understand information well.

The final step was that students concluding the material followed by a reflection from the teacher regarding the material that had been learned. Based on Dewey's reflective thinking theory, explaining activities in front of the class can train students to conclude the results of information findings to answer questions or problems presented. Self-reflection based on Dewey's reflective thinking theory and Marzano's opinion, can train students to control themselves and is a process that aims to encourage students to know how effective the learning process for them (Saputri et al., 2019).

The syntax of the ETH strategy based on Q&A had a high impact because students were trained to use their thinking power and memory to solve problems through the questions given. According to Wahyuni et al., (2019) that someone who is able to remember well will trigger a cognitive process stimulus to develop critical thinking skills. Critical thinking skills were related to students' memory in biology learning. The ETH strategy based on Q&A attracted more students' attention

to focus while studying, triggered student stimulus to hone thinking and memory, then can increase students' courage and skills to express opinions.

4. CONCLUSIONS

Based on the description of the results of the data analysis that had been carried out, the ETH strategy based on Q&A on critical thinking skills had a Sig value. 0.00 ($p < 0.05$), meaning that it had a significant effect on students' critical thinking skills. The ETH strategy based on Q&A on student retention had a Sig. 0.00 ($p < 0.05$), meaning that it had a significant effect on student retention.

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The Effect of STEM (Science, Technology, Engineering, and Mathematics) based Textbooks in Biotechnology Learning Material on The Critical Thinking Skills and Learning Results of Senior High School Students in The Industrial Agriculture Area

Kamilatul Khoiroh, Bea Hana Siswati*, Kamalia Fikri
Biology Education Department, Faculty of Teacher Training and Education, Universitasity of Jember, Kalimantan Street Number 37, SUmbersari, Jember 68121, Jawa Timur, Indonesia
*Corresponding Author. E-mail address: beahana.fkip@unej.ac.id

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ABSTRACT

The study entitled the effect of STEM (Science, Technology, Engineering, and Mathematics) based textbooks in biotechnology learning material on the critical thinking skills and learning results of senior high school students in the industrial agriculture area. The purpose of this study was to determine the effect of STEM-based textbooks on the subject of biotechnology on critical thinking skills and student learning outcomes in industrial agriculture areas. This type of research is quasi-experimental research (quasi experiment). The sampling technique was carried out through the normality test and ANOVA homogeneity test using the end of semester exam scores for biology subject then the determination of the sample was carried out randomly (random sampling). The research samples were class XII MIPA 2 as the experimental class and XII MIPA 4 as the control class. The place of this research is at SMAN 3 Jember. Data analysis used the covariance analysis test (Anacova) and Independent Sample T-Test for data that met the parametric test requirements, namely normal and homogeneous. The significance value obtained was <0.05 so it can be concluded that there is an influence of STEM (Science, Technology, Engineering, and Mathematics) based textbooks on the subject of biotechnology on critical thinking skills and learning outcomes.

1. INTRODUCTION

The 21st century is characterized by the implementation of learning that is balanced due to the rapid development of science and technological advances so that information can be accessed easily (Angin, 2020). The ease of accessing information needs to be balanced with critical thinking so that the information obtained can be filtered properly (Hasibuan and Prastowo, 2019). Thus, the skills to deal with learning in the 21st century era must be mastered by students, one of which is critical thinking skills (Rusyati *et al.*, 2019). Critical thinking skills according to Mustafa and Dwiyogo (2020) are important for learners to master because the ability to conclude logically requires a directed mindset so that the assessment of certain information or situations can be considered carefully and based on the assessment of evidence in the form of knowledge, thoughts, and experiences (Girsang *et al.*, 2022). Meanwhile, critical thinking skills in Indonesia as shown by data in 2015 with a score of 397 are still ranked 62nd with a total of 72 countries participating, while data in 2018 Indonesia is still ranked 71 out of 79 participating countries based on the Program for International Student Assessment (PISA). So it can be concluded that the critical thinking skills of students in Indonesia are still relatively low (Agnafia, 2019; Sa'adah *et al.*, 2020).

In addition to critical thinking, student learning outcomes are an important indicator in learning that describes students' mastery of certain knowledge or skills (Sulfemi and Mayasari, 2019). In this case, if student learning outcomes meet the minimum assessment criteria, it can be indicated

that students' critical thinking skills are also good (Dakhi, 2020). The problem found is that student learning outcomes are still classified as a low category in the results of research by Zulpadly (2016) that out of 644 students, 574 students' biology grades, especially in biotechnology material, are declared incomplete or have not met the KKM (minimum completeness criteria). Other data that support this statement are research by Inayatin (2020) that the average value of learning outcomes in biotechnology material is still not complete, with a percentage of learning completeness of 56.2% of the desired target of 85%. Factors that cause low learning outcomes are caused by external factors and internal factors. External factors, for example, school facilities such as laboratories and the availability of textbooks, while internal factors such as students' interest, motivation, and talent. External factors get a percentage of 44% followed by internal factors with a percentage of 43% with details of the factors causing the availability of textbooks of 45% which is ranked second highest after internal factors, namely talent at 50% (Nasution *et al.,* 2022; Rahmadani *et al.,* 2017).

External factors, namely textbooks, play an important role because textbooks contain all teaching materials that must be mastered by students during the learning process (Kosasih, 2020). According to Yuanita and Kurnia (2019) the use of textbooks during learning can support students to learn independently and with this opportunity students will be free to explore the knowledge being studied. In addition, the use of textbooks in the classroom can concretize something abstract so that it can facilitate students' difficulties in understanding the material. One of the abstract biology materials is biotechnology material. This material is actually an interesting topic because the application of this material is very related to everyday life, it should be easier to convey to students. But in fact, this material is difficult to convey because the explanation of molecular biotechnology and textbooks supporting this material in Indonesian are still limited (Purwaningsih, 2019). Biotechnology includes material that explains how to apply living organisms to services and manage the environment, which is closely related to activities in industrial agricultural areas. Learning about this material in industrial agricultural areas should be packaged and delivered to be more meaningful (Anantyarta and Sholihah, 2020). One of the industrial agricultural areas is Jember Regency (Reykasari *et al.,* 2021). Industrial agricultural areas are characterized by an abundance of natural resources with good soil fertility, making them suitable for the agricultural or agro-industrial sector because they have the potential to produce various products and can support a variety of consumption needs in the form of food or as raw materials for other industries (Husniah *et al.,* 2019). Thus, these environmental conditions have the potential to be associated with learning activities for surrounding schools so that the learning carried out in the classroom is in line with the conditions around industrial agricultural areas. This is different from the current situation where many schools have not yet associated and accommodated learning that features activities or problems in industrial agricultural areas (Pasuari, 2022). Based on this, an alternative that can be applied is to use STEM-based textbooks, especially on the subject of biotechnology in the learning process in industrial agricultural areas. The STEM-based textbook is a book that is integrated with four aspects of scientific disciplines (science, technology, engineering, and mathematics) so that students can gain an understanding that the knowledge gained is very useful and can explain phenomena that occur in the real world (Izzah *et al.,* 2021).

2. MATERIALS AND METHODS

The type of research included quasi-experiment research at SMAN 3 Jember in the even semester of the 2022/2023 school year through random sampling techniques through the equality test. The research samples selected were XII MIPA 4 class as the control class and XII MIPA 2 as the experimental class with the number of students in each class as many as 31. The research design used was Pre Test Post Test Control Group Design which is as follows.

Table 1. Research Design

Class	*Pre Test*	Learning	*Post Test*

E	O1	X1	O2
K	O3	X2	O4

(Source: Rahma, 2021)
Information:
E : Experimental class
K : Control class
O1 : Pre test results of the experimental class
O2 : Post test results of the experimental class
O3 : Pre test results of the control class
O4 : Post test results of control class
X1 : Learning using STEM-based textbooks
X2 : Learning using ordinary textbooks

Data collection techniques in this study include interviews, observation, tests, and documentation. Interviews were conducted to obtain initial data regarding conditions, models, and textbooks used during learning. Observations are used to retrieve data on affective and psychomotor learning outcomes. The indicators of affective learning outcomes that are measured include focus on learning, active participation, respect, and responsibility. Indicators of psychomotor learning outcomes that are measured include preparing practicum tools and materials, carrying out practicum according to procedures, criticizing the results of the observation data obtained, and concluding the observations. The instrument used to measure cognitive learning outcomes or the domain of students' cognitive knowledge and critical thinking skills uses tests, namely through pre-test and post-test. The critical thinking indicators that are measured include focusing questions, analyzing arguments, identifying assumptions, understanding situations, explaining the meaning of key terms, and determine the results of the conclusion. Other supporting data is in the form of photo documentation during learning activities during this research.

The analysis technique used in this study for cognitive learning was analyzed using a parametric test, namely the *Anacova Test* after the prerequisite test was carried out, namely the data must be normal and homogeneous. The *Anacova Test* used to analyze critical thinking skills data and cognitive learning outcomes while affective and psychomotor learning outcomes data used the *Independent Sample T-Test* analysis.

3. RESULTS AND DISCUSSION

3.1. Data Results of Critical Thinking Skills

Data on students' critical thinking skills obtained are shown in **Table 2.** The summary of the data is as follows.

Table 2. Summary of Critical Thinking Data

Component	Class			
	Experiment		Control	
	Pre Test	Post Test	Pre Test	Post Test
The Highest Score	66,6	100	62,5	100
The Lowest Score	37,5	79	33,3	79

Based on **Table 2.** it is obtained that the average value of critical thinking in the experimental class is greater than that of the control class, but further data analysis is needed to determine the difference in significance between the two classes using Anakova.

Based on the results of the *Anacova Test*, critical thinking data obtained Sig. (2-tailed) namely 0.000 <0.05, so that it can be interpreted that H_0 is rejected and H_1 is accepted, namely there is a significant difference in the use of STEM-based textbooks on students' critical thinking skills between the experimental class and the control class. Can be seen in **Table 3.** below:

Table 3. *Anacova* Hypothesis Test for Critical Thinking Skills

Class	N	Average				F	Sig.
		Pre Test	Std. Deviation	Post Test	Std. Deviation		
Experiment Class	31	51,02	8,11	91,50	5,75	16,9	0,00
Control Class	31	47,40	7,25	87,45	6,20		

Then, to find out the difference in the value of critical thinking on each indicator for the experimental class and the control class is shown in **Table 4.** below:

Table 4. Frequency Distribution of Critical Thinking Skills

Num.	Critical Thinking Indicator	Experiment Class			Control Class		
		Average *PreTest*	Average *PostTest*	Average Difference	Average *PreTest*	Average *PostTest*	Average Difference
1	Focusing questions	2,74	4,00	1,26	2,77	4,00	1,23
2	Analyze arguments	1,68	3,00	1,32	1,29	2,61	1,32
3	Identify assumptions	1,61	3,35	1,74	1,39	3,10	1,71
4	Understanding the situation in thinking	1,77	3,61	1,84	1,52	3,32	1,80
5	Explain the meaning of key terms	2,13	4,00	1,87	2,13	4,00	1,87
6	Determine the results of the conclusion	2,32	4,00	1,68	2,32	4,00	1,68
	Total			9,71			9,61

Based on **Table 4.** It is well known that each critical thought indicator is increasing in both experimental and control classes. As for the same indicators that increase in experiment and control classes, that are indicators that analyze arguments, explain the meaning of key terms and determine the outcome of conclusions. While the indicator of improvement is higher in experimental classes than the control class is on indicators of focusing questions, identifying assumptions, and understanding the situation in thinking.

3.1.1. The Effect of STEM-Based Textbooks on Biotechnology Subjects on Critical Thinking Skills

This study aims to find out how the influence of the use of STEM-based textbooks, especially on Biotechnology material, is compared to the use of textbooks commonly used by teachers at SMAN 3 Jember on students' critical thinking skills. Critical thinking is self-regulation in making a decision that involves an intellectual process through interpretation, analysis, evaluation, and considering the presentation of information using evidence as a basis for making decisions (Syafitri *et al.*, 2021). According to Herunata *et al.* (2020) critical thinking skills can be trained and developed through various fields of study such as Biotechnology. Students' critical thinking flow can also be trained by solving test questions or contextual problems related to everyday life. The 6 indicators of critical thinking put forward by Ennis are focusing questions, analyzing arguments, identifying assumptions, understanding situations in thinking, explaining the meaning of key terms, determining the results of conclusions, which are relevant to the material and subject matter contained in STEM-based textbooks .

In this study, it was found that STEM-based textbooks had a significant effect on students' critical thinking skills (**Table** 4.2). This is in accordance with the results of research by Nugraha

and Syafi'ah (2020) which state that STEM-based textbooks can improve students' critical thinking skills because students' interest in learning science is much higher than using ordinary textbooks. Aspects which include *Science, Technology, Engineering and Mathematics* contained in textbooks have an impact on increasing students' skills in critical thinking. In addition, textbooks that contain contextual problems become reinforcement for students to understand the material being studied with problems that exist in everyday life (Oktaviani *et al.*, 2022).

Besides that, according to Setyowibowo and Prasetyo (2017) Jember Regency, which is an industrial agricultural area, has a community that develops one of the biotechnology products, namely tofu and tempeh as an alternative food in the village so that real phenomena in life are discussed directly in class. This also helps students to understand the difference between knowledge and its direct application in their environment so that students gain good mastery of concepts and improve their critical thinking skills (Puspitasari *et al.,* 2021). Other research that explains the superior product of the Jember industrial agricultural area, namely edamame, is currently still being developed through improvements starting from planting, using pesticides and fertilizers to maintain its quality (Munir and Masyhuri, 2021). With the existence of a phenomenon that is closely related to biotechnology material, it is then discussed together and students can explain the material and give examples of certain events that are around them. This can motivate students further so that students are able to connect the concepts obtained with the real world. Thus, patterns of thinking and reasoning that are trained continuously during learning can trigger students' critical thinking skills (Oktaviani *et al.*, 2022).

In addition, STEM-based textbooks that are attractively packaged make students more enthusiastic and not bored while learning. also the use of language that is easily complemented by appropriate text and image captions will increase the reader's interest in acquiring new knowledge so that their critical thinking skills will also increase (Rizkika *et al.*, 2022).

Based on **Table 4.** it is found that the first indicator of critical thinking is focusing on the question of the difference in the average experimental class being higher than that of the control class. This indicator requires students to identify the problems and elements contained in the problem so students can understand and reformulate the problem to be simpler (Apiati and Hermanto, 2020). Students' ability to focus on questions can increase because STEM-based textbooks provide certain book features, in this case, "Case Studies" which increase students' understanding of basic concepts by presenting interesting and reliable data so that they can help students with difficulty in interpreting and condensing information. Zulaiha and Kusuma, 2020). This indicator according to Sa'adah *et al.* (2020) aims to train students to focus on determining the questions contained in the questions.

The second indicator is analyzing the argument that the difference in the average values obtained by the experimental class is the same as the difference in the average values obtained by the control class. However, the average post-test score for the experimental class was higher than that for the control class. This is because in STEM-based textbooks, reading is presented about contextual problems related to everyday life, both local, national and global problems. According to Santosa *et al.* (2021) material packaged in this way can lead students to understand the concept of biotechnology effectively and facilitate students during learning to practice analyzing readings and arguing. In addition, students also find it easier to generate their own arguments and present them after going through the stages of evaluating information sources and identifying appropriate reasons to support the conclusions of these arguments (Roviati and Widodo, 2019). According to Agoestanto *et al.* (2019) analyzed arguments including critical thinking skills which involve aspects of logic to think so that in this indicator students are presented with a problem and then students are asked to give opinions on this problem. Thus, students can provide arguments and defend them from the results of the interpretation of the information or evidence obtained.

The third indicator is identifying assumptions that have a higher average value in the experimental class than the control class. Identifying assumptions is defined as the student's ability to determine which opinion is correct or which opinion is wrong by considering rational reasons

and also based on understanding the correct basic concepts (Agustina, 2019). The increase in students' abilities towards this indicator is because STEM-based textbooks are equipped with the "Did You Know?" feature. so that this feature can train students' reasoning and representation abilities. This opinion is reinforced by Nurhidayat and Asikin (2021) who state that the presentation of additional features regarding the material is accompanied by interesting illustrations, examples that are closely related to everyday life, and the use of the latest technology related to the material being studied makes it easier for students to understand the concept thoroughly so that students can distinguish the appropriate assumptions.

The fourth indicator is understanding the situation, which means students' ability to understand and maintain situations in thinking to help clarify questions and know meaning as a support for decisions taken (Affandy *et al.*, 2019). The average value obtained for this indicator is higher in the experimental class compared to the control class. This is because in STEM-based textbooks it has been reconstructed in a simple way so that it can enrich students' knowledge by inserting additional information that can strengthen the concept of the material being discussed (Rusyati *et al.*, 2019). The additional information referred to is the “Info at a Glance” feature in STEM-based textbooks that can provide students with learning opportunities to explore Biotechnology material in more detail so that the learning experience obtained is more meaningful (Davidi *et al.*, 2021). To measure students' ability on this indicator, students are given questions that are faced with a situation regarding one of the manufacture of biotechnology products, then students have to answer what will happen to the product if it is in conditions like the problem.

The fifth indicator, namely explaining the meaning of key terms, has the same average value between the experimental class and the control class, meaning that in this indicator students do not experience any difficulties. Explaining the meaning of key terms, which means students are asked to identify and understand the relationship between the statement and the concept of the problem given so that they are able to describe the description correctly (Hidayati *et al.*, 2021). The similarity in the average scores obtained is because students are used to understanding the key issues that cause a certain situation and then providing an explanation of the meaning of the terms used after re-examining in making decisions (Harianada *et al.*, 2022). In line with the opinion of Maziyah and Hidayati (2022) who stated that STEM-based textbooks are suitable for use during learning because they can stimulate students' critical thinking skills so that students are able to analyze and carry out investigations when asked to interpret certain terms into a statement.

The sixth indicator determines the results of conclusions, namely the ability of students to determine results based on a background of facts and consider them into rational final conclusions (Rohmah *et al.*, 2021). Based on the results obtained, the total average difference of the six indicators of critical thinking in the experimental class is higher than that of the control class. This shows that the use of STEM-based textbooks has an effect on students' critical thinking skills because STEM-based textbooks provide learning material facilities for students with STEM aspects that occur in real life so that they can develop students' reasoning and analytical abilities (Andini *et al.*, 2022) . Part of the STEM-based textbook that trains students is the presentation of information about the material compiled in relation to new knowledge so as to increase students' understanding of concepts as a whole. Agnesi *et al.* (2019) also strengthens this opinion based on the results of his research which states that STEM-based textbooks can support students' critical thinking skills.

3.2. Data Results of Cognitive Learning Outcomes

Learning outcomes are competencies or abilities that can be achieved by someone after following a certain learning process which includes cognitive, affective, and psychomotor abilities (Nurrita, 2018). In this study, the learning outcomes measured were cognitive, affective, and psychomotor learning outcomes.

Data on cognitive learning outcomes were obtained from the assessment of the pre-test and post-test question sheets. The following is a summary of cognitive learning outcomes data presented in **Table** 5.

Table 5. Summary of Cognitive Learning Outcomes Data

Component	Class			
	Experiment		Control	
	Pre test	***Post test***	***Pre test***	***Pots test***
The Highest Score	69	100	61	100
The Lowest Score	37	81	25	71
Average	52	92,7	45,8	84,6

Based on **Table 5.** it is obtained that the average value of learning outcomes in the cognitive domain in the experimental class is greater than the control class, but further data analysis is needed to determine the difference in significance between the two classes using anacoa analysis. The results of the ANAKOVA hypothesis test are shown in **Table** 6 below.

Table 6. Ancova Hypothesis Test on Cognitive Learning Outcomes

Class	N	Average				F	Sig.
		Pre Test	**Std. Deviation**	***Post Test***	**Std. Deviation**		
Experiment Class	31	52,03	8,84	92,70	4,99	20,64	0,00
Control Class	31	45,83	8,80	84,58	6,42		

Based on the **Table 6.** above, the value of Sig. namely 0.00 <0.05, so that it can be interpreted that H_0 is rejected and H_1 is accepted, namely there is a significant difference in the use of STEM-based textbooks on cognitive learning outcomes between the experimental class and the control class.

3.2.1. The Effect of STEM-Based Textbooks on Biotechnology Subjects on Cognitive Learning Outcomes

Based on **Table 6.** the results of the analysis are 0.00 <0.05 proving that STEM-based textbooks have a significant effect on students' cognitive learning outcomes and the experimental class obtains better learning outcomes compared to the control class. The difference in student learning outcomes in the two classes was due to the fact that in the experimental class students learned to use STEM-based textbooks while the control class used biology textbooks as usual. This statement is in line with the results of Pangesti *et al.* (2017) which states that STEM-based textbooks provide opportunities for students to understand the concept of material better because they have been integrated with the four STEM elements namely Science, Technology, Engineering and Mathematics during learning activities that take place through discussion and practicum activities so that it has implications for improving learning outcomes. student cognitive. According to Fitria and Asrizal (2021) that STEM-based textbooks are effective for improving learning outcomes in cognitive, affective and also psychomotor aspects because students can study with various scientific disciplines directly and systematically.

Increased cognitive learning outcomes are also due to the fact that the textbooks used during learning accommodate up-to-date material according to the student's study area, namely the industrial agricultural area, namely Jember Regency (Hariyadi, 2023). It is also due to the fact that biotechnology material which focuses on technology, engineering, and support for biological agents uses knowledge in the scientific field, then this concept can develop well if it is brought up in learning in harmony with industrial agricultural areas (Siswati, 2020).

Then, the four aspects of STEM namely Science, Technology, Engineering, Mathematics which are contained in textbooks have different functions. Science in a book that contains contextual biotechnology material so that it can lead to building curiosity and openness to new ideas. Technology, contains knowledge about the use of technology in daily activities as an aspect of solving problems in the environment as well as the development of certain new products. Engineering in the form of experiments and knowledge of science in product manufacturing so that students can build on their own experiences and develop more meaningful knowledge skills about the biotechnology material being studied. Meanwhile, Mathematics is shown to evaluate or solve certain problems using calculations of formulas and numbers (Yuanita and Kurnia, 2019). The application of these STEM elements contained in textbooks can make students learn more relevant so as to stimulate the emergence of broader learning experiences and support students to develop their thinking skills and can improve their cognitive learning outcomes (Andaresta, 2021).

3.3. Data Results of Affective Learning Outcomes

Affective learning outcome data were obtained from the assessment of student activity observation sheets during learning. The following is a summary of affective learning outcomes data presented in **Table** 7.

Table 7. Summary of Affective Learning Outcomes Data

Component	Class	
	Experiment	**Control**
The Highest Score	84,375	84,375
The Lowest Score	68,75	65,625
Average	77,9	73,7

Affective learning outcome data have fulfilled the prerequisite test for further analysis using the parametric test using the *Independent Sample T-Test* based on the normal and homogeneous prerequisite test results. Following are the results of the *Independent Sample T-Test* hypothesis test analysis presented in the form of **Table** 8. below:

Table 8. *Independent Sample T-Test* Hypothesis Test on Affective Learning Outcomes

Class	N	Average	Std. Deviation	F	Sig.
Experiment Class	31	77,92	5,07	12,907	0,001
Control Class	31	73,68	5,01		

Based on the **Table** above, the value of Sig. namely 0.001 <0.05, so that it can be interpreted that H_0 is rejected and H_1 is accepted, namely there is a significant difference in affective learning outcomes between the experimental class and the control class.

3.3.1. The Effect of STEM-Based Textbooks on Biotechnology Subjects on Affective Learning Outcomes

Affective learning outcomes or attitudes are obtained from observation sheets of student activity during learning. Based on the analysis of the data, it was found that there were differences in the average learning outcomes of the attitudes of the students in the experimental class and the control class, namely the experimental class obtained a score of 77.9 and the control class of 73.7. Then studied the differences in learning outcomes in the domain of attitudes in the two classes using the *Independent Sample T-Test* to obtain a significance value (2-tailed) of 0.001 <0.05. These results state that the learning outcomes in the attitude domain of the experimental class are better than the

control class. This proves that the use of STEM-based textbooks has a significant effect on learning outcomes in the attitude domain.

The affective learning outcomes measured in this study included a focus on learning, active participation, respect and responsibility. The STEM-based textbooks used during the learning process encourage students to actively participate and focus on paying attention so that there are differences in student learning outcomes with classes that do not use STEM-based textbooks. This statement is in line with the opinion of Zulfa *et al.* (2022) which states that learning using STEM-based textbooks can create fun learning between teachers and students.

The next aspect regarding respect for the elements of Science, Technology, Engineering and Mathematics in student textbooks that have been combined can then help students to teach care for the environment, foster students' creative and innovative souls so as to improve affective learning outcomes or attitudes from students. The reading context that has been understood makes students more sensitive to the conditions around them and respects when there are differences of opinion (Zulfa *et al.* 2022). In line with the opinion expressed by Yulanda and Rahmi, (2022) that the material contained in STEM-based textbooks contains trigger material that can train students to practice problem-solving skills, critical thinking skills, and good communication so that students have high enthusiasm. during the learning process. Thus, the attitude of students in respecting the opinions of other students during discussion activities.

As for the aspect of responsibility according to Muliawan *et al.* (2022) STEM-based textbooks are considered suitable for use in learning because they provide opportunities for students to analyze material themselves in depth on the guidance contained in textbooks so that learning activities run smoothly due to active involvement of students in class. Thus, each student feels they have a responsibility with the same role contribution in solving the problems given tends to increase. Another opinion was conveyed by Fitria *et al.* (2022) in his journal said that the STEM components contained in textbooks that make it easier for students to learn to use the book, and the presentation of teaching materials with good quality in terms of format clarity and equipped with pictures, videos, and other supporting features can improve students' interest in studying the material in the classroom which also has implications for increasing student learning outcomes both in terms of knowledge, attitudes and skills.

3.4. Data Results of Psychomotor Learning Outcomes

Psychomotor learning outcomes data were obtained from the assessment of student activity observation sheets during practicum activities. The following is a summary of psychomotor learning outcomes data presented in **Table 9.**

Table 9. Summary of Psychomotor Learning Outcomes Data

Component	Class	
	Experiment	Control
The Highest Score	96,875	90,625
The Lowest Score	81,25	78,125
Average	89,1	85,7

To analyze data using a parametric test, the data must meet the requirements that it must be normally distributed and homogeneous. After the test was carried out, the result was that the psychomotor learning outcomes data fulfilled the prerequisite test for further analysis using the parametric test using the Independent Sample T-Test. Following are the results of the *Independent Sample T-Test* hypothesis test analysis presented in the form of **Table 10.** below:

Table 10. *Independent Sample T-Test* Hypothesis Test on Psychomotor Learning Outcomes

Class	N	Average	Std. Deviation	F	Sig.

Experiment Class	31	89,11	6,02	20,110	0,00
Control Class	31	85,68	5,19		

Berdasarkan tabel di atas diperoleh nilai Sig. yaitu 0,000<0,05, sehingga dapat diartikan bahwa H_0 ditolak dan H_1 diterima yaitu ada perbedaan yang signifikan hasil belajar psikomotor antara kelas eksperimen dan kelas kontrol.

3.4.1. The Effect of STEM-Based Textbooks on Biotechnology Subjects on Psychomotor Learning Outcomes

Based on the analysis of the data, it was found that there were differences in the average psychomotor learning outcomes of students in the experimental class and the control class, namely the experimental class obtained a score of 89.1 and the control class of 85.7. Then studied the differences in learning outcomes in the skills domain in the two classes using the Independent Sample T-Test so that a significance value (2-tailed) was obtained of 0.00 <0.05. These results state that the learning outcomes of the experimental class are better than the control class. This proves that the use of STEM-based textbooks has a significant effect on learning outcomes in the skills domain.

According to Widodo *et al.* (2021) the difference in skills learning outcomes between the 2 classes is due to the STEM-based textbooks used in the experimental class helping to provide effectiveness to improve skills learning outcomes because the book is equipped with STEM aspects, especially in this case Technology and Engineering. Technology is reflected in the feature of scanning barcodes and inserting videos in books, facilitating students to access supporting materials and visualization videos so that students can fully understand the concept of the material. The Engineering aspect in the book displays a simple experimental design to find a solution which is then conveyed through the provision of practicum activities to train students' skills (Pratiwi and Rachmadiarti, 2022).

STEM-based textbooks can involve students in real contexts so that they are able to support skills learning outcomes through fun, simple variations of experiments that allow students to improve psychomotor learning outcomes (Lukitasari *et al.*, 2022). According to Syafei *et al.* (2019) practicum activities carried out in class can encourage students to improve their skills in discussing, conveying ideas in groups so that learning takes place collaboratively. Students' psychomotor learning outcomes have also increased based on the development of mental processes through aspects of moving muscles so as to shape student skills (Samsuar *et al.*, 2023).

The use of STEM-based textbooks in which experimental designs are contained and then practiced can meet students' needs to learn abstract material concepts to become more concrete (Ate *et al.*, 2022). Thus, it can improve students' psychomotor learning outcomes. This statement was later reinforced by Mawaddah *et al.* (2022) which states that students' skills learning outcomes have increased through the use of STEM-based learning resources so that students feel interested and can be actively involved when learning activities are carried out.

Furthermore, with regard to the integration of scientific disciplines in STEM, it can foster a more meaningful understanding between the principles and concepts of biotechnology material. Students are also trained to collaborate in scientific investigations and problem solving through thinking, learning, and doing directly (Suroto, 2021). Therefore, increasing students' active participation in learning is in line with increasing student skills learning outcomes (Alaini *et al.*, 2022). The problems that are reviewed and used as learning topics are taken from problems that exist in the student's industrial agricultural area itself, so that learning becomes more applicable because the surrounding area is indirectly used as a means of supporting student learning in the classroom. this makes it easier for students to understand the learning that takes place (Damayanti *et al.*, 2021).

4. CONCLUSIONS

Based on the results of the research that has been described, the following conclusions can be obtained: a). There is an influence of STEM-based textbooks on the critical thinking skills of class XII students of SMAN 3 Jember with a Sig (2-tailed) value of 0.00 <0.05 which obtained the highest score of 91.50 in the experimental class with the very high category. b). There is an influence of STEM-based textbooks on the cognitive, affective, and psychomotor learning outcomes of class XII students of SMAN 3 Jember with a Sig (2-tailed) score of 0.00 <0.05 for cognitive learning outcomes that get a score of 100 in the very high category, next namely the value of Sig. 0.001 <0.05 for affective learning outcomes which scored 84.375 in the high category, and 0.00 <0.05 for psychomotor learning outcomes which scored 96.875 in the very high category.

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Quality of *Moringa oleifera* Leaf and Kiambang (*Salvinia molesta*) Solid Organic Fertilizer with Banana Peel Bioactivator

Desvia Puput Apriani, Aminah Asngad*
Biology Education Department, Faculty of Teacher Training and Education, Universitas Muhammadiyah Surakarta.
Jl. A. Yani Tromol Pos I, Pabelan, Kartasura, Surakarta 57162, Jawa Tengah, Indonesia
*Corresponding Author. E-mail address: aa125@ums.ac.id

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ABSTRACT

Moringa oleifera leaves and kiambang (*Salvinia molesta*) can fulfill plants' N, P, and K elements to become solid organic fertilizers with banana peel waste as a bioactivation. This study aimed to determine the quality of solid organic fertilizers for *Moringa oleifera* leaves and Kiambang with banana peels as a bioactivator based on sensory tests and nutrient content. This study used an experimental method with a factorial pattern. As for factor 1, namely the comparison of ingredients, K1 = 300 g: 200 g and K2 = 200 g: 300 g. Factor 2 is the concentration of bioactivator, M1 = 25 mL and M2 = 30 mL. The results showed that the best quality of Fertilizer from sensory characteristics was demonstrated by the K2M2 treatment in black color, less pungent scent, crumb texture, and a pH of 7. In contrast, the N, P, and K content test was shown by the K1M1 treatment with N content (3.29%), P (0 .10%), and K (0.24%). So that, it can be concluded fertilizers for *Moringa oleifera* leaves and Kiambang (*Salvinia molesta*) with banana peel waste as bioactivator have good quality according to SNI 19-7030-2004.

1. INTRODUCTION

Waste is leftover material from human or community activities that, if appropriately managed, will positively impact the environment. The waste generated by the community is in the form of solid, liquid, and gas waste. Therefore, waste management in society could be more optimal. One of the solid wastes is household waste, both vegetable and fruit waste. An alternative to treating solid waste is to use it as organic Fertilizer. Fertilizer is an additional material given to agricultural land that can support plant growth and development. Fertilizers can be divided into two, namely organic fertilizers and inorganic fertilizers. Excessive use of inorganic fertilizers will cause a decrease in soil fertility. The use of organic fertilizers is more environmentally friendly than inorganic fertilizers. Solid organic fertilizers can improve soil structure and increase the soil's ability to retain water content (Anggraeni et al., 2019). One of the organic materials from a combination of moringa leaves and kiambang plants, with the addition of fruit peel waste as a bioactivator, can be used to make solid organic Fertilizers.

Moringa leaves are one part of the plant that contains many benefits. Moringa leaves have benefited from nutritional value, agriculture, therapy, industry, and health. Moringa leaf extract contains flavonoids, alkaloids, terpenoids, saponins, and tannins (Tenri & Rivai, 2020). Based on research that has been done (Wahyudi & Agustina, 2018) that Moringa leaf extract has a burn healing effect of up to 10 %. Moringa leaves can be used optimally in agriculture because contain many nutrients. Moringa leaves contain nutrients N (4.02%), P (1.17%), K (1.80%), Ca (12.3%), Mg (0.10%), and Na (1.16%) (Adiaha, 2017). The nutrient content in Moringa leaves is beneficial for plant growth, so it can be used as material for making organic Fertilizers.

Kiambang plant or apu wood (*Salvinia molesta*) is a plant that is often considered a pest in rice fields. Kiambang is abundant in nature; it is easy to find floating in pond waters and weed plants

in rice fields (Ashari, 2021). Kiambang has yet to be used optimally by the community. Kiambang (*Salvinia molesta*) has a reasonably high nutrient content and can be used for plant growth. Based on research (Sismiyanti et al., 2018), kiambang plants contain nutrients that have not been composted, namely C (39.90%), (N 4.50%), P (0.50%), K (2.90%), S (0.62%), lignin (17.00%), C/N 8.87, C/P 64.35, C/S 64.35. The high content of nutrients in the kiambang plant can be used to make solid organic Fertilizers to benefit plant growth.

The manufacture of solid organic Fertilizers is produced through a fermentation process for 30 days. The duration of fermentation will affect the physical and chemical characteristics of the fertilizer. Based on research (Tallo & Sio, 2019), the best fermentation time is 35 days. Microorganisms are needed to help speed up fermentation in fermenting solid organic fertilizers. Biological decomposition during fermentation can be assisted by bacteria, actinomycetes, fungi, protozoa, worms, and several types of larvae (Widyastuti et al., 2021). Materials that are commonly added to speed up the decomposition process are bio activators (Andriany, 2018). The bioactivator used can be derived from natural ingredients. Bioactivator materials that can be used are fruit waste, including bananas, mangoes, papayas, and apples, which are called local microorganisms (MOL) (Ali, 2016). The material for making bioactivator can use banana peels. Banana peel contains *Pseudomonas* sp. and *Bacillus* sp., which can accelerate the fermentation process to manufacture solid organic Fertilizers (Moiedi, 2013). Based on research (Fauzi, 2021), adding 30 mL MOL with a composting time of 23 days is the best treatment for making fertilizers. Based on research (Almastin, 2022), the combination of Moringa leaves and 300 grams of Kiambang leaves has the highest nitrogen content. Solid organic fertilizers can be tested by sensory tests, including smell, color, and texture, and can be tested for N, P, and K content. Based on research (by Asngad et al., 2019) states that the total N-value of solid organic fertilizers meets the requirements, namely >0.40%.

Based on the above background, the problem in this research is: What is the quality (N, P, and K content) of the solid organic fertilizer combination of Moringa leaves and Kiambang plant (*Salvinia molesta*) with the addition of fruit peel as a bioactivator based on SNI 19-7030-2004. Therefore, the objectives to be achieved in this study were: to determine the quality (N, P, and K content) of a solid combination organic fertilizer for Moringa leaves and kiambang (Salvinia molesta) with the addition of fruit peel as a bioactivator based on SNI 19-7030-2004.

While the benefits the results of this study are expected to provide information to 1). Provide information to researchers about the benefits of combining moringa leaves and kiambang (*Salvinia molesta*) with adding fruit peels as a bioactivator as solid organic Fertilizer. 2). Providing information to the public that combining moringa leaves and kiambang plants with fruit peels as a bioactivator can be used as solid organic Fertilizers. 3). Providing ideas in the field of biology, especially the use of a combination of moringa leaves and kiambang plants with the addition of fruit peels as a bioactivator that can be used as solid organic Fertilizers.

2. MATERIALS AND METHODS

This research was conducted at Tlangu RT 03 RW 01, Bulan, Wonosari, Klaten. This study used tools including basin, plastic, analog scales, knives, blenders, hoses, stirring rods, filters, containers, bottles and 1000 ml beaker glass, pH indicators, stationery, and documentation tools. In comparison, the materials used in this study were moringa leaves, kiambang plants, brown sugar, leri water, and water.

The research procedures include making banana peel waste bioactivator is mixing leri water and brown sugar water in a ratio of 1:1 as a food source for microorganisms, stirring and mixing with mashed banana peels, stirring and covering the container with a plastic bottle with holes perforated which is plugged with a hose (air can enter but flies cannot enter), ferment 5-7 days. Making solid organic fertilizer is prepare the activator solution that has been made, weigh the solid organic Fertilizer and activator solution according to the formulation, mix the dough until it is clenched by hand, then no water will come out of the dough, and if the fist is released the dough

expands again, the dough is closed using a lid for 4-5 weeks during the fermentation or incubation process.

The method used is the experimental method and completely randomized design (CRD) with two factors: a combination of moringa leaves and kiambang (*Salvinia molesta)* with adding a banana peel waste bioactivator. As for factor 1, namely the comparison of ingredients, K1 = 300 g: 200 g and K2 = 200 g: 300 g. Factor 2 is the concentration of bioactivator, M1 = 25 mL and M2 = 30 mL. This study used four treatments with three repetitions, and the technique used to analyze the data was descriptive qualitative analysis.

3. RESULTS AND DISCUSSION

3.1 N, P and K Content

Based on the results of laboratory tests for the macronutrient content, including nitrogen (N), phosphorus (P), and potassium (K) in the solid organic fertilizer combination of *Moringa oleifera* leaves and Kiambang plants (*Salvinia molesta*) with the addition of banana peel waste as a bio activator, it can be seen content test results in the following table 1.

Table 1. N, P, and K content in solid organic fertilizer combination of moringa leaves and kiambang plants (*Salvinia molesta*) with the addition of banana peel waste as a bioactivator

Combination	Average Analysis Results		
	N (%)	P (%)	K (%)
K_1M_1	3,29	0,10**	0,24**
K_1M_2	2,22*	0,08	0,22
K_2M_1	2,45	0,08	0,20
K_2M_2	3,38**	0,07*	0,19*

Information : (*) highest result
(**) lowest result

The results of the analysis of the average content of N, P, and K in Table 2 show that the highest percentage of nitrogen (N) is owned by the K2M2 treatment combined with a test result of 3.38%, and the lowest percentage is owned by the K1M2 treatment combined with a test result of 2.22 %. In the test for the content of phosphorus (P) and potassium (K), the highest percentage was owned by the K1M1 combination with test results of 0.10% and 0.24%, and the lowest percentage content was in the K2M2 treatment combination with test results of 0.07% and 0.19%.

3.1.1 Nitrogen Content (N)

Based on the test results for the N, P, and K content in Table 1, nitrogen (N) has a higher percentage of content test results than P and K. The total N content in each treatment combination shows a percentage difference; the highest nitrogen content is found in the combination of the treatment of moringa leaves and plant kiambang (*Salvinia molesta*) and more activators, namely 3.38%. Meanwhile, the lowest nitrogen content was found in the combined treatment of moringa leaves and kiambang (*Salvinia molesta*) with more bioactivators, namely 2.22%. This shows that the nitrogen content of four treatments obtained meets the excellent quality of solid organic Fertilizers according to SNI 19-7030-2004, which states that the

quality standard for solid organic fertilizer content is a minimum of 0.40% (Andriawan, 2022).

Table 2. The results of a two-way ANOVA statistical analysis of the nitrogen content of a combination of Moringa leaf and kiambang (*Salvinia molesta*) fertilizer with the addition of banana peel waste as a bioactivator

Tests of Between-Subjects Effects

Dependent Variable: Nitrogen Content Test Results

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3.091[a]	3	1.030	877.021	.000
Intercept	96.447	1	96.447	82082.298	.000
Faktor_2	.015	1	.015	12.511	.008
Faktor_1	.077	1	.077	65.362	.000
Faktor_2 * Faktor_1	3.000	1	3.000	2553.191	.000
Error	.009	8	.001		
Total	99.548	12			
Corrected Total	3.101	11			

a. R Squared = ,997 (Adjusted R Squared = ,996)

The Two Way Anova analysis results in Table 2 show a significant result: the combination of Moringa leaf and *Salvinia molesta* treatments has a significant probability. 0.000 < 0.05. The probability of the number of moles factor has sig. 0.008 < 0.05. The probability is sig in the interaction between treatment combinations and the number of moles. 0.000 < 0.05. From these results, factor 1, factor 2, and the interaction of both have significant results in solid organic Fertilizers that affect the level of nitrogen content produced. The nitrogen analysis test results showed that the K2M2 treatment combination had the highest nitrogen content, 3.38%. This is under the statistical calculations of the mean K2, 2.9150, and M2, 2.8700. So that the results of the mean statistical calculations are by the results of the nitrogen content test that the K2M2 treatment has the highest nitrogen content.

When viewed from the composition of the essential ingredients, Fertilizer with a higher concentration of *Salvinia molesta* will have the highest percentage of nitrogen content test results because it has a protein content of 15.90% (Warasto et al., 2013), while young Moringa leaves have a protein content of 1.3092 % and old Moringa leaves 11.3473 % (Saputri, 2019). The fermentation process used in making solid organic Fertilizer, a combination of moringa leaves and kiambang (*Salvinia molesta*), affects the results of nitrogen tests on fertilizers; in research (Arafat, 2017) that during the fermentation process using bioactivators, the final result of the fermented product will experience a decrease in protein content.

3.1.2 Fosfor Content (P)

Based on the test results for the content of N, P, and K in Table 1, the content of phosphorus (P) in each treatment combination showed a percentage difference;

the highest test results were found in the K1M1 treatment combination, which was 0.10%, while the lowest test results were in the K2M2 treatment combination, namely 0.07%. The high and low content of phosphorus (P) can be influenced by the content of the nutrient phosphorus (P) found in Moringa leaves based on research (Adiaha, 2017) 1.17% more than in kiambang plants 0.50%.

Table 3. The results of a two-way ANOVA statistical analysis of the phosphorus content of a combination of Moringa leaf and kiambang (*Salvinia molesta*) fertilizer with the addition of banana peel waste as a bioactivator

Tests of Between-Subjects Effects

Dependent Variable: Phosphorus Content Test Results

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.001[a]	3	.000	.905	.480
Intercept	.082	1	.082	155.571	.000
Faktor_2	.001	1	.001	1.286	.290
Faktor_1	.001	1	.001	1.286	.290
Faktor_2 * Faktor_1	7.500E-005	1	7.500E-005	.143	.715
Error	.004	8	.001		
Total	.087	12			
Corrected Total	.006	11			

a. R Squared = ,253 (Adjusted R Squared = -,027)

Based on the Two Way Anova analysis results in Table 3, there were insignificant results, namely the combination of Moringa leaf treatment and *Salvinia molesta* sig. 0.290 > 0.05 while the number of moles is sig. 0.290 > 0.05. The probability of the interaction of the two has a significant value. 0.715 > 0.05. From these results, the combination of treatments and the number of moles used in solid organic fertilizers did not affect the level of phosphorus content produced. In terms of the results of the average test for phosphorus content, there is a difference. However, statistically, there is no significant difference because the test results for each treatment are slightly different. The results of the phosphorus analysis test found that the K1M1 treatment combination had the highest phosphorus content, namely 0.10%. This follows the statistical calculations of the mean K1, which is 0.0900, and M1, which is 0.0900. So that the results of calculating the mean statistic are under the results of the phosphorus content test that the K1M1 treatment combination has the highest phosphorus content.

3.1.3 Potassium Content (K)

Based on the test results for the content of N, P, and K in Table 1, the content of potassium (K) in each treatment combination showed a percentage difference; the highest test result could be seen in the K1M1 treatment combination, which was

0.24%, while the lowest test result was in the K2M2 treatment, namely 0.19%. The potassium nutrient content influences this in the raw material for Moringa leaves from research (Adiaha, 2017), 1.90%, while the potassium nutrient content in *Salvinia molesta* is 2.90% (Sismiyanti et al., 2018).

Table 4. The results of a two-way ANOVA statistical analysis of the potassium content of a combination of Moringa leaf and kiambang (*Salvinia molesta*) fertilizer with the addition of banana peel waste as a bioactivator.

Tests of Between-Subjects Effects

Dependent Variable: Potassium Content Test Results

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.004[a]	3	.001	4.538	.039
Intercept	.542	1	.542	1667.308	.000
Faktor_2	.001	1	.001	2.077	.188
Faktor_1	.004	1	.004	11.308	.010
Faktor_2 * Faktor_1	7.500E-005	1	7.500E-005	.231	.644
Error	.003	8	.000		
Total	.549	12			
Corrected Total	.007	11			

a. R Squared = ,630 (Adjusted R Squared = ,491)

Based on the Two Way Anova analysis results in Table 4, there were significant results, namely the combination of Moringa leaf treatment and *Salvinia molesta* sig. 0.010 <0.05 while not significant for the number of sig moles. 0.188 > 0.05. The probability of the interaction of the two has a significant value. 0.644 > 0.05. From these results, the combination of treatments used in solid organic fertilizers affects the level of potassium content produced. In contrast, the number of moles and the interaction between the two does not affect it. From the results of the potassium analysis test, it was found that the K1M1 treatment combination had the highest phosphorus content, namely 0.24%. This is by the statistical calculations of the mean K1, 0.2300, and M1, 0.2200 so that the results of the mean statistical calculations follow the potassium level test results that the K1M1 treatment combination has the highest potassium content.

3.2. Sensory Test

Based on the results of sensory observations that have been carried out, including color, scent, texture, and degree of acidity (pH) in solid organic Fertilizer, a combination of moringa leaves and kiambang plants (*Salvinia molesta*) with the addition of banana peel waste as a bioactivator can be seen in the following table 5.

Table 5. The results of sensory observations on solid organic fertilizer combinations of moringa leaves and kiambang (*Salvinia molesta*) with the addition of banana peel waste as a bioactivator after being fermented for 30 days.

Combination	Average Observation Results			
	Color	**Scent**	**Texture**	**pH**
K_1M_1	Dark brown	Pungent	Rather rough	7
$K1M_2$	Black	Less Pungent	Rather subtle	7
K_2M_1	Dark brown	Pungent	Rather rough	7
K_2M_2	Black	Less Pungent	Crumb	7

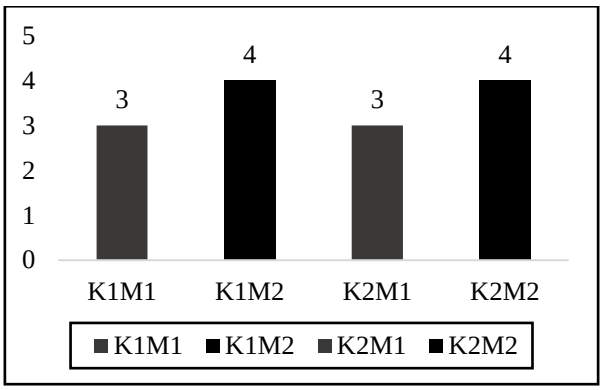
Information:
K_1M_1 = Solid organic Fertilizer with a concentration of 300 g of Moringa leaves and 200 g of Kiambang with the addition of 25 mL banana peel bioactivator.
$K1M_2$ = Solid organic Fertilizer with a concentration of 300 g of Moringa leaves and 200 g of kiambang with 30 mL banana peel bioactivator.
K_2M_1 = Solid organic Fertilizer with a concentration of 200 g of Moringa leaves and 300 g of Kiambang with the addition of 25 mL banana peel bioactivator.
K_2M_2 = Solid organic Fertilizer with a concentration of 200 g of Moringa leaves and 300 g of Kiambang with the addition of 30 mL banana peel bio activator.

Based on the table data, it is known that the sensory observations in the samples have similarities, namely in the sensory test results for the pH parameter. Meanwhile, the sensory test results for color, scent, and texture have differences.

3.2.1 Color Parameters

After observing the color of the solid organic fertilizer combination of Moringa leaves and Kiambang (*Salvinia molesta*) with the addition of banana peel waste as a bioactivator, which was carried out by organoleptic or sensory tests using the senses, the observations showed that the colors were different. Treatment samples K1M1 and K2M1 were blackish brown, while K2M1 and K2M2 were black. The color difference occurs due to the decomposition activity of the Fertilizer by bacteria. In addition, the compounds in these fertilizers' organic matter can affect the Fertilizer's color from brown to black. Moringa leaves have phenolic color pigments. This aligns with research (Kurang, 2020) that the phenolic compounds in Moringa leaves can cause a black color.

The sensory observations show that the four combination fertilizer treatments of Moringa leaves and Kiambang (*Salvinia molesta*) with the addition of banana peel waste as a bioactivator had color differences caused by the organic matter in the solid organic fertilizer can be seen in following figure.



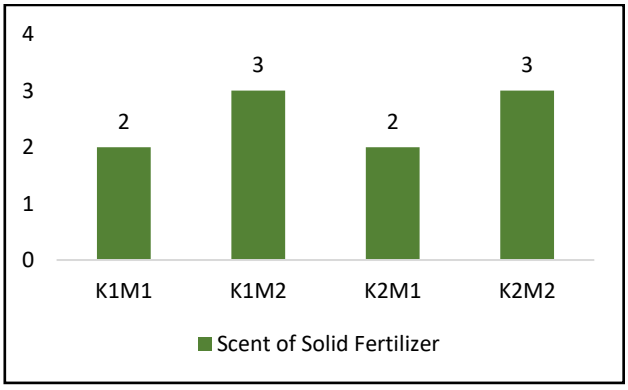
Information: 1 = light brown; 2 = brown; 3 = dark brown; 4= black

Figure 1. Color parameters of solid organic fertilizer combination of moringa leaves and kiambang (*Salvinia molesta*) with the addition of banana peel waste as a bioactivator

Based on Figure 1, there are color differences in the four treatment combinations observed. In the treatment combinations, K1M1 and K2M1 had a blackish brown color, while in the treatment combinations K1M2 and K2M2, the Fertilizer had a black color. This difference is influenced by mixing solid organic fertilizer ingredients, which were initially green in color, to produce a blackish brown Fertilizer to very black. This follows research (Mustika, 2019) that was seen in SNI 19-7030-2004. The process of composting organic Fertilizers will gradually change the color of the compost material towards blackish brown due to the ongoing transformation of organic matter and forming humus substances so that the four treatments have fertilizer colors that follow SNI 19-7030-2004.

3.2.2 Scent Parameters

Sensory observations of scent in solid organic fertilizer combination of moringa leaves and kiambang (*Salvinia molesta*) with the addition of banana peel waste as a bioactivator with organoleptic tests using the sense of smell can be seen in the following figure.



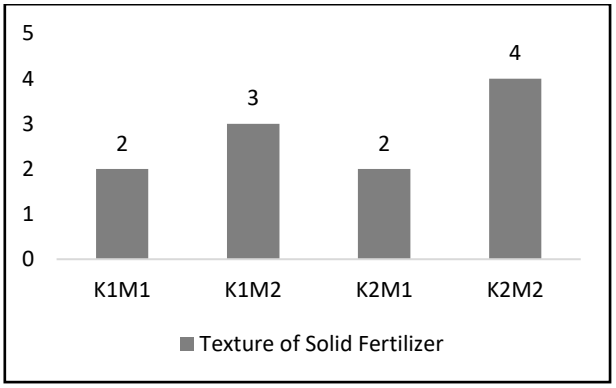
Information: 1 = sewage; 2 = pungent; 3 = less pungent; 4 = earthy.

Figure 3. Scent parameters in solid organic fertilizer combination of Moringa leaves and Kiambang (*Salvinia molesta*) with the addition of banana peel waste as a bioactivator.

Based on the research results on the scent parameters in Figure 3, it is known that the scent of the four combinations of fertilizer treatments smells less pungent than pungent. For example, combining treatments K1M1 and K2M1 had a pungent odor, while K1M2 and K2M2 had a less pungent scent. This indicates the presence of a fermented scent influenced by using a bioactivator from banana peels. The four treatments show that the quality of solid fertilizers follows SNI-19-7030-2004 following Mustika's research (2019), which states that mature compost is characterized by an odor that does not sting or smell like earth because the material it contains resembles soil. This follows the National Standardization Agency SNI-19-7030-2004, which states that ripe compost will smell of earth.

3.2.3 Texture Parameters

After sensory observation of texture on solid organic fertilizer combination of moringa leaves and kiambang (*Salvinia molesta*) with the addition of banana peel waste as a bioactivator with organoleptic tests using the sense of touch can be seen in the following figure.



Information: 1 = rough; 2 = rather rough; 3 = rather subtle; 4 = crumb.

Figure 4. Texture parameters of solid organic fertilizer combination of moringa leaves and kiambang (*Salvinia molesta*) with the addition of banana peel waste as a bioactivator.

The results of the texture parameter research can be seen in Figure 4 that there are differences in each treatment combination; K1M1 and K2M1 have a somewhat rough texture, K1M2 has a relatively smooth texture, and K2M2 has a crumbly texture. In the fermentation process of solid organic fertilizers, the coarse material will break down into smaller sizes, causing the texture of the Fertilizer to become relatively smooth and even crumbly. According to Mustika's research (2019), the characteristics of good compost are crumb structure and loose consistency. Based on the research results, four treatments of solid organic fertilizer combination of Moringa leaves and Kiambang (*Salvinia molesta*) with the addition of banana peel waste as a bioactivator meets good quality based on the National Standardization Agency for SNI 19-7030-2004.

3.2.4 pH Parameters

Sensory observations on solid organic fertilizer combinations of Moringa leaves and Kiambang (*Salvinia molesta*) with the addition of banana peel waste as a bioactivator were carried out by measuring the degree of acidity in the Fertilizer which can be observed in the image below.

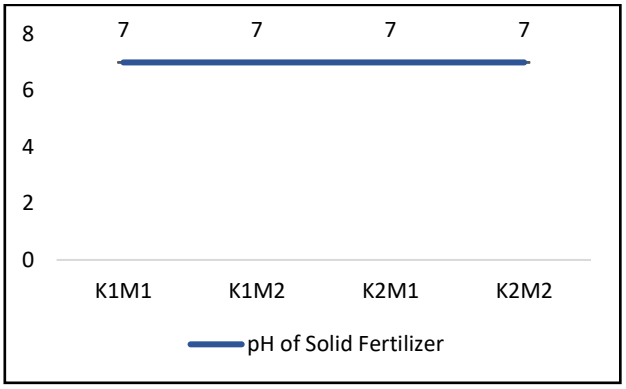


Figure 5. Line Diagram of pH Parameters of Solid Organic Fertilizer Combination of Moringa Leaves and Kiambang Plant (*Salvinia molesta*) with the Addition of Banana Peel Waste as a Bioactivator.

Based on the research results, the degree of acidity (pH) parameter can be observed in Figure 5 that the four treatment combinations have the same pH, namely 7. The pH value or degree of acidity is measured after a solid organic fertilizer combination of Moringa leaves and *Salvinia molesta* with the addition of banana peel waste as a bioactivator ripe. The pH value is 7, according to the requirements for solid organic Fertilizers based on the National Standardization Agency for SNI 19-7030-2004, and the standard pH for good quality compost is between 6.80 – 7.49. The pH value dramatically influences decomposer organisms' growth in the fermentation process. The pH value can increase; according to research by Dewilda (2017), the increase in pH is due to the composting process producing nitrogen and ammonia gas, so the pH value changes to alkaline due to increased bacterial activity. Based on the results of the study, the results showed that the pH content of four treatments of solid organic fertilizers combined with Moringa leaves and *Salvinia molesta* with the addition of banana peel waste as a bioactivator was classified as good because it met the quality standards of SNI 19-7030-2004.

4. CONCLUSIONS

Based on the study's results, it was shown that moringa leaves and kiambang plants (*Salvinia molesta*) could be used as solid organic Fertilizers with banana peel waste as activators. This can be seen from sensory observations: the color is brown-black, the smell is less pungent, the crumb texture, and the pH is acidic, namely, 7. Furthermore, in the observations of tests for the content of N, P, and K, it also meets good fertilizer quality standards. Thus, by using sensory observations and testing the content of nitrogen (N), phosphorus (P), and potassium (K), the average quality of fertilizers is good because the quality of the four combinations of fertilizers follows SNI 19-7030-2004.

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Quality of Solid Organic Fertilizers for Duck Manure and Trembesi Leaves with Papaya Peel Bioactivator

Musdhalifah Husna Firdausi, Aminah Asngad*
Biology Education Department, Faculty of Teacher Training and Education, Universitas Muhammadiyah Surakarta.
Jl. A. Yani Tromol Pos I, Pabelan, Kartasura, Surakarta 57162, Jawa Tengah, Indonesia
*Corresponding Author. E-mail address: aa125@ums.ac.id

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ABSTRACT

Organic fertilizers can replace inorganic fertilizers that are not environmentally friendly. Duck manure and trembesi leaves can be used as raw materials for fertilizer. Adding local papaya peel microorganisms can help the decomposition process of organic fertilizers. This study aims to determine the quality of solid organic fertilizer made from duck manure and trembesi leaves by adding local papaya peel microorganisms as bioactivation. This study used a completely randomized design (CRD) with a factorial pattern and was repeated three times. The treatment factors are as follows: Factor 1 Raw materials (B1 = Duck Manure 300g: 200g Trembesi Leaves. B2 = Duck Manure 200g: 300g Trembesi Leaves). Factor 2 Papaya Peel Local Microorganisms (P1 = Papaya Peel Bioactivator 25 ml, P2 = Papaya Peel Bioactivator 30 ml). The results showed the best sensory quality in the B2P2 treatment; the fertilizer was blackish brown, smelled of soil, had a crumbs texture like soil, and had a pH of 7. The highest Nitrogen and Phosphorus content was found in the B1P2 treatment, while the highest Potassium content was in the B2P1 treatment. Thus, the quality of solid organic fertilizer is by SNI 19-7030-2004.

1. INTRODUCTION

Fertilizer has a crucial role in plant growth and development. Fertilizers can be divided into two types based on the constituent materials: organic and inorganic fertilizers. Organic fertilizers are made from organic materials, while inorganic fertilizers are made from chemicals. The use of inorganic fertilizers can cause problems in the environment. The negative impacts of the excessive use of inorganic fertilizers can damage the soil and the balance of natural nutrients. They can also kill microorganisms, thereby inhibiting the decomposition of organic matter (Kurniawan and Chusnah, 2021).

The existence of organic fertilizers can be used as a solution to replace the use of inorganic fertilizers. Organic fertilizers have many benefits for the environment compared to inorganic fertilizers, which harm the environment. According to Kurniawan's research (2017), organic fertilizers can trigger and increase the microbial population in the soil far better than inorganic fertilizers. Organic fertilizers can also improve soil structure and fertility. Therefore, organic fertilizers can prevent soil erosion.

Organic fertilizers can make from two different materials, a combination in the manufacture of organic fertilizers is needed to improve the quality of organic fertilizers. Duck manure contains the nitrogen, phosphorus, and potassium that plants need. According to Safriyani's research (2020), the results showed that duck manure had 1.03% N, 0.92% P, 0.53% Potassium, and 32.38 Organic C. With these contents, duck manure can be used as organic fertilizer. Besides being made from animal manure, organic fertilizer can make from organic waste from plant residues such as leaves. Trembesi leaves are not only useful as shade and animal feed but also have the potential to be used

as organic fertilizer. According to Darma's research (2020) regarding the content of fruit leaves for organic fertilizer, trembesi leaves contain 4.20% nitrogen, 0.12% phosphorus, and 0.62% potassium.

Fermentation is required to manufacture solid organic fertilizers that decompose organic matter. The fermentation process requires bioactivation to help decompose organic matter. Bioactivators are microbial isolates that have been purified and can digest organic matter containing cellulose (Suwahyono, 2017). Bioactivators made from organic materials can also be called local microorganisms. Fruit peel waste is often used as a natural bioactivator in the fermentation process of organic fertilizers. Fruit peel waste has microorganisms that can help in the decomposition process of organic matter. According to Wicaksono's research (2022) regarding the manufacture of liquid organic fertilizer using local microorganisms of papaya peel, the microbes found in local microorganisms of papaya peel are *Pseudomonas*, *Bacillus*, and *Aspergillus ninger*. The three microbes that act as phosphorus solvents in organic matter. The existence of microbial content in local microorganisms papaya peel, papaya peel waste can be used as a natural bioactivator or local microorganisms.

Based on the explanation above, the problems in this study are: What are the sensory characteristics and levels of nitrogen, phosphorus, and potassium content in solid organic fertilizers made from duck manure and trembesi leaves with the addition of microorganisms local to papaya peel as bioactivation? This study aims to determine the sensory characteristics and nutrient content of nitrogen, phosphorus, and potassium in solid organic fertilizers made from duck manure and trembesi leaves by adding microorganisms local to papaya peel as bioactivation.

Doing this research will provide the following benefits: 1). Providing new information and innovations to the public regarding solid organic fertilizers made from duck manure and trembesi leaves with the addition of papaya peel waste as a bioactivation 2). Be an alternative organic fertilizer for farmers to avoid adverse risks in long-term use.

2. MATERIALS AND METHODS

We conducted this research in Tlangu, Bulan, Wonosari, Klaten to manufacture organic fertilizers and sensory tests. Test for Nitrogen, Phosphorus, and Potassium nutrients at the Soil and Fertilizer Laboratory, Faculty of Agriculture, UMY Jl. Brawijaya Tamantirto, Bantul, Kasihan.

The research occurred on the stairs from February 4 to March 11, 2023. The tools used included: plastic, used gallons, baskets, measuring cups, knives, pH sticks, pH indicators, and stationery. The materials used include duck manure, trembesi leaves, and local microorganisms from papaya peel.

This study uses experimental research methods. This study uses a complete random design (CRD) with factorial patterns and is repeated three times. The treatment factors are as follows: Factor 1 Raw materials (B1 = Manure Duck 300 gram: Trembesi Leaves 200 gram. B2 = Manure Duck 200 gram: Trembesi Leaves 300 gram.). Factor 2: Local microorganisms of papaya peel (P1 = papaya peel local microorganisms 25 ml, P2 = papaya peel local microorganisms 30 ml).

The data analysis used is descriptive qualitative data analysis and quantitative data analysis. Qualitative data analysis is needed to explain the sensory properties of solid organic fertilizers. Using the Two Way ANOVA test, quantitative data analysis was used to test nitrogen, phosphorus, and potassium levels.

3. RESULTS AND DISCUSSION

3.1 Sensory Test

The results obtained regarding the quality of solid organic fertilizer, a combination of duck manure and leaf trembesi with the addition of papaya peel waste as bioactivation, sensory test results (color, smell, texture, and pH) are presented in the following table:

Table 1. Sensory Test (Color, Smell, Texture, and pH) Solid Organic Fertilizer Combination of Duck Manure and Trembesi Leaves with the Addition of Local Microorganisms Papaya peel as a bioactivator

No.	Treatment	Result of Observation			
		Color	Smell	Texture	pH
1	B_1P_1	Brown	Less stinging	Slightly Rough	7
2	B_1P_2	Blackish Brown	Less stinging	Slightly Smooth	7
3	B_2P_1	Brown	Less stinging	Slightly Rough	7
4	B_2P_2	Blackish Brown	Soil	Crumbs	7

Explanation:

B1P1: Manure duck 300g + Trembesi leaves 200g with local microorganism peel of papaya 25 ml.

B1P2: Manure duck 300g+ Trembesi leaves 200g with local microorganism peel of papaya 30 ml.

B2P1: Manure duck 200g+ Trembesi leaves 300g with local microorganism peel of papaya 25 ml.

B2P2: Manure duck 200g+ Trembesi leaves 300g with local microorganism peel of papaya 30 ml.

Fermentation of solid organic fertilizer with a combination of duck manure and trembesi leaves with the addition of local microorganisms papaya peel as a bioactivation obtained the following results:

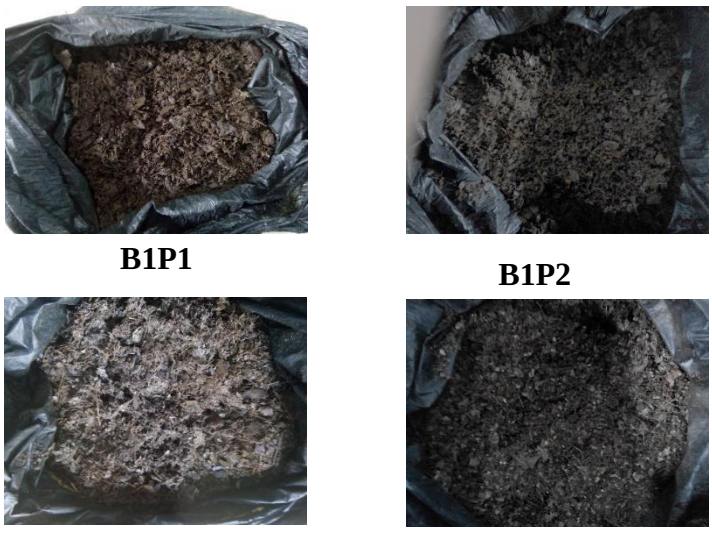
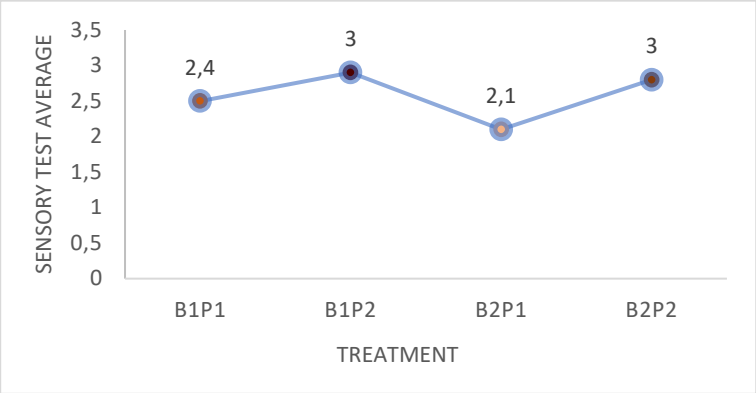


Figure 1. Solid Organic Fertilizer Combination of Duck Manure and Trembesi Leaves with the addition of local microorganisms from papaya peel

3.1.1 Color Parameters

Based on Table 1. and Figure 2. Sensory test results with color parameters on solid organic fertilizer, a combination of duck manure and trembesi leaves with the addition of local microorganisms papaya peel as a bioactivation, showed that the results obtained from the four treatments that had the best results were in the B1P2 and B2P2 treatments with fertilizer that was blackish brown.



Explanation: 1 = Yellowish Brown; 2 = Brown; 3 = Blackish Brown; 4= Blackish

Figure 2. Observation of the color of duck manure organic fertilizer and trembesi leaves with the addition of local microorganisms' papaya peel as a bioactivator.

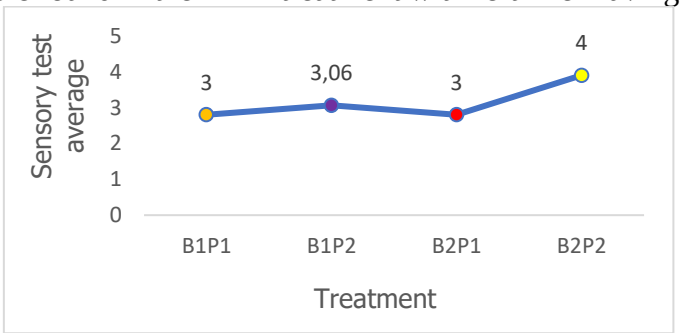
The color of the fertilizer at the beginning of the fermentation is different at the end. The discoloration of solid organic fertilizers is caused by the decomposition of organic matter carried out by microbes in the local microorganisms of papaya peel. These results align with Puspitasari's research (2022), which states that organic matter decomposes and changes during fermentation, forming microbial cell substances and turning into a dark amorphous form. This substance is called matter, like soil. After fermentation, the organic matter changes color to a blackish brown.

In addition, the decomposition process causes organic matter to lose its pigment color, causing the color to change to blackish brown. This statement is in line with the idea of Kumalasari (2016), which states that color change occurs because the decomposition process changes organic matter with complex C carbon chains into simple C carbon chains.

During the decomposition process, the organic matter loses its pigment so that it changes color to blackish brown according to the color of its constituents. Then, solid organic fertilizer with a blackish brown color is formed by standard provisions (SNI No 19-7030-2004), which state that solid organic fertilizer that has matured will have a blackish brown color like soil.

3.1.2 Smell Parameters

Based on Table 1. and Figure 3. Sensory test results with scent parameters on solid organic fertilizer, a combination of duck manure and trembesi leaves with the addition of local microorganisms papaya peel as a bioactivation, the results obtained from the four treatments that had the best results were found in the B2P2 treatment with fertilizer having a scent like soil.



Explanation: 1 = Waste; 2 = Stinging; 3 = Less Stinging; 4 = Soil

Figure 3. Observation of the smell of duck manure organic fertilizer and trembesi leaves with the addition of local microorganisms' papaya peel as a bioactivator.

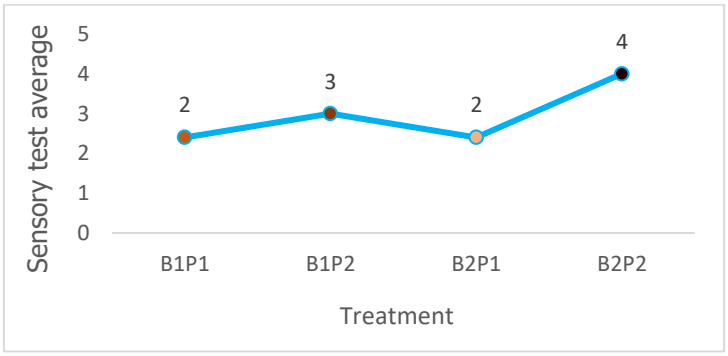
At the beginning of the fermentation, the solid organic fertilizer gave off the dominant rotting smell of duck manure. Still, on the 35th day or 5th week, the scent of solid organic fertilizer changed to a soil smell in the B2P2 treatment and a less pungent scent in the other three treatment

combinations. Changes in scent in solid organic fertilizers occur due to the activity of microorganisms. This statement aligns with research by Akbar & Asngad (2022), which states that the scent in organic fertilizer comes from microorganisms that decompose organic matter. In addition, microorganisms also produce volatile compounds, namely ammonia. This compound causes solid organic fertilizers to have a less stinging scent at the end of composting.

During the fermentation process, microorganisms decompose organic matter, which causes the scent in the fertilizer to change at the end of composting. This idea is in line with Amalia's research (2016), which states that when organic matter begins to be degraded by microorganisms, at that time, the smell of a mixture of organic matter will slowly disappear and will smell like soil. Then the resulting fertilizer with a soil smell by standard provisions (SNI No 19-7030-2004) states that when organic fertilizer is ripe, it will smell like soil (Andriawan, 2022).

3.1.3 Texture Parameters

Based on Table 1. and Figure 4. Sensory test results with textural parameters on solid organic fertilizer, a combination of duck manure and trembesi leaves with the addition of local microorganisms' papaya peel as a bioactivation, the results obtained from the four treatments that had the best results were found in the B2P2 treatment with fertilizer having a texture the crumbs.



Explanation: 1 = Rough; 2 = Slightly Rough; 3 = Slightly Smooth; 4 = Crumbs

Figure 4. Observation of the texture of duck manure organic fertilizer and trembesi leaves with the addition of local microorganisms papaya peel as a bioactivator

Adding local microorganisms aims to accelerate the process of decomposing organic matter. Fertilizers have a rough texture because microorganisms cannot decompose organic matter properly enzymatically. According to Kurniawan's research (2021), microorganisms produce cellulose enzymes that can degrade plant cellulose bonds. Cellulose bonds in organic matter will degrade, resulting in a smooth texture. *Bacillus* is one of the microbes found in local microorganisms of papaya peel. *Bacillus* microbes can degrade cellulose by secreting their cellulose enzymes so that they can degrade organic matter so that it compacts like soil (Rahman, 2022).

The sensory results of the texture parameter show that the fertilizer has a crumbly texture according to the standard provisions (SNI No 19-7030-2004). Fertilizers that have a crumbly texture are easy for plants to absorb because the nutrient content in the fertilizer has adequately decomposed.

3.1.4 Parameters pH

Based on Table 1. the results of sensory test observations with pH parameters on solid organic fertilizer, a combination of duck manure and trembesi leaves with the addition of papaya peel local microorganisms as bioactivators, of the four treatments showed a pH of around 7, with neutral properties. This pH result complies with the standard requirements (SNI No 19-7030-2004), namely 6.8 to 7.49.

High or low pH levels produced in fertilizers can be influenced by microbial activity that decomposes organic matter into organic acids. This statement aligns with Suwatanti's research (2017), which stated that microorganisms convert nitrogen into ammonia, accelerating the pH's increase to alkaline. Microbes will denitrify it and convert half of the ammonia into nitrate, bringing the pH of the fertilizer to a neutral level. *Pseudomonas* microbes contained in papaya peel local microorganisms can affect the increase in pH levels in fertilizers (Mangungsong, 2019). Local microorganisms of papaya peel can affect the rise in pH levels in fertilizers.

3.2 Content of Nitrogen, Phosphorus, and Potassium

Based on the results of laboratory tests of solid organic fertilizer combined with duck manure and trembesi leaves, the following results were obtained:

Table 2. Content of Nitrogen, Phosphorus, and Potassium in a solid organic fertilizer combination of duck manure and trembesi leaves with the addition of papaya peel as a bioactivator.

Combination	Results Content Test		
	Nitrogen (%)	Phosphorus (%)	Potassium (%)
B1P1	3.26	0.16	0.17*
B1P2	3.64**	0.18**	0.18
B2P1	3.10*	0.11*	0.20**
B2P2	3.43	0.13	0.19

Explanation: (*) lowest yield; (**) highest yield

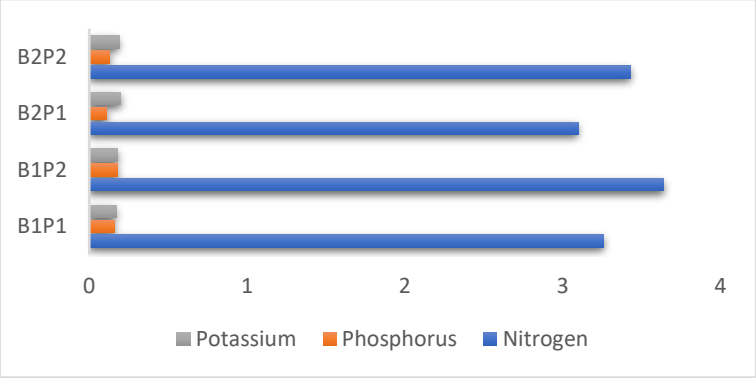


Figure 5. Content of Nitrogen, Phosphorus, and Potassium in solid organic fertilizers

Figure 5. and Table 2. show that the four combinations have different percentages of nitrogen content. The highest nitrogen percentage was found in the B1P2 treatment, with a nitrogen percentage of 3.64%. The highest phosphorus content was found in the B1P2 treatment, with a phosphorus percentage of 0.18%, while the highest potassium percentage was in the B2P1 treatment, with a potassium percentage of 0.20%.

3.2.1 Nitrogen Content

The data in Figure 5. and Table 2. shows that the four combinations have a high nitrogen content above 3%. The high nitrogen content is due to the increase in the value of nitrogen during the decomposition process. This statement is according to Ekawandani's research (2018), which stated that during the CO2 decomposition process, evaporation would occur so that C/N levels would decrease and nitrogen levels would increase. In addition, the high nitrogen content is due to the microbes found in the local microorganisms of papaya peel. One of the microbes in the local

microorganisms of papaya peel is *pseudomonas* which has an essential role in increasing nitrogen (Darmawan, 2018).

Table 3. Results of Two-Way ANOVA Nitrogen Content Analysis

Tests of Between-Subjects Effects

Dependent Variable: Nitrogen_Content

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.483[a]	3	.161	386.527	.000
Intercept	135.408	1	135.408	324979.220	.000
Main_Ingredient	.103	1	.103	246.420	.000
Bioaktivator	.378	1	.378	907.380	.000
Main_Ingredient * Bioaktivator	.002	1	.002	5.780	.043
Error	.003	8	.000		
Total	135.895	12			
Corrected Total	.486	11			

a. R Squared = .993 (Adjusted R Squared = .991)

Based on Figure 5. the bar chart shows that the four treatments have different nitrogen percentages. This difference was caused by differences in the concentrations of the main ingredients of the fertilizer, namely duck manure and trembesi leaves, as well as differences in the concentrations of local microorganisms of papaya peel in each treatment. The bar chart results align with the statistical analysis performed with a two-way ANOVA. The results of the two-way ANOVA analysis between the concentration of the main ingredient with nitrogen content and the concentration of the bioactivator with nitrogen content showed sig. 0.00 <0.05 means that there is a difference in the average nitrogen content in each treatment combination, so the concentration of the main ingredient and bioactivator significantly affects the nitrogen content. Meanwhile, the interaction between the main ingredient and the bioactivator showed sig. 0.043 <0.05 means an interaction between the two ingredients on the nitrogen content. It can also be seen in Table 2. that the treatment with a 30 ml bioactivator has a high nitrogen content compared to the 25 ml bioactivator. The treatment with a higher concentration of duck manure has the highest nitrogen content, so the B1P2 (300g duck manure: 200g trembesi leaves + 30 ml papaya peel local microorganisms) treatment obtained the highest nitrogen percentage of 3.64%.

The high nitrogen content is due to the microbes in the papaya peel degrading organic matter to decompose proteins (complex compounds) into simple compounds, one of which is nitrogen, to obtain solid organic fertilizer by the standard provisions of SNI 19-7030-2004 where the nitrogen content contained in organic fertilizer is at least 0.40%.

3.2.2 Phosphorus content

Based on the results of laboratory tests on a solid organic fertilizer combination of duck manure and trembesi leaves with the addition of local microorganisms papaya peel as a bioactivator in the Phosphorus content test in Table 2. it was found that the B1P2 treatment had the highest phosphorus percentage of 0.18%. In comparison, B2P1 had the lowest phosphorus percentage, with a phosphorus percentage of 0.11%. During the maturation process, microbial fertilizers will die, and the phosphorus levels in the microbes will be mixed with compost material, thus increasing the phosphorus levels of organic fertilizers (Kaswinarni, 2020).

The high levels of phosphorus content in the B1P2 treatment were due to the large concentration of local microorganisms of papaya peel used, namely 30 ml. Microbes contained in the local microorganisms of papaya peel play an active role in dissolving phosphorus in organic matter. This statement is according to the research of Wicaksono (2022), which states that Pseudomonas bacteria will utilize previously formed ATP to dissolve phosphorus.

Table 4. Results of Two-Way Anova Analysis of Phosphorus Content

Tests of Between-Subjects Effects

Dependent Variable: Phosphorus_Content

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.009[a]	3	.003	16.571	.001
Intercept	.252	1	.252	1441.714	.000
Main_Ingredient	.007	1	.007	42.857	.000
Bioaktivator	.001	1	.001	6.857	.031
Main_Ingredient * Bioaktivator	.000	1	.000	.000	1.000
Error	.001	8	.000		
Total	.262	12			
Corrected Total	.010	11			

a. R Squared = .861 (Adjusted R Squared = .809)

Based on the bar graph of Figure 5. there are differences in each treatment combination. These results align with the statistical analysis results using two-way ANOVA analysis. The results of the ANOVA show that the main ingredients with phosphorus content are sig. 0.00 < 0.05, then there is a difference in the results of the average phosphorus content based on the main ingredient. From the results of this analysis, we can interpret that the concentration of the main ingredients significantly affects the phosphorus content. This is similar to the result between the bioactivator with phosphorus content and sig. 0.031 <0.05, then there is a difference in the average phosphorus content based on the bioactivation, and the concentration of the bioactivator significantly affects the phosphorus content. Meanwhile, the interaction between the main ingredient and the bioactivator was sig. 1.000 > 0.05 results show no interaction between the concentration of the main ingredient and the bioactivator on the percentage of phosphorus content. It can also be seen in Table 2 and Figure 5. B1P1 treatment with a 25 ml bioactivator has a higher percentage of 0.16% phosphorus content than B2P2 with a 30 ml bioactivator having a proportion of 0.13%. However, the concentration of duck manure in the B1P1 treatment was higher than in B2P2.

The treatment with higher duck manure had a higher percentage of phosphorus than with higher trembesi leaves. This is because the phosphorus content in duck manure is 0.92% higher (Safriyani, 2020) compared to trembesi leaves, which have a phosphorus content of 0.12% (Darma, 2020), so a solid organic fertilizer with phosphorus content is obtained by the provisions of SNI 19-7030-2004, where the phosphorus content contained in organic fertilizer is at least 0.10%.

3.2.3 Potassium content

Based on Table 2. and Figure 5. the B2P1 treatment has the highest percentage of potassium content of 0.20%, while the B1P1 treatment has the lowest potassium percentage of 0.17%. These results indicate that the treatment with higher concentrations of trembesi leaves had a higher percentage of potassium than the treatment with higher concentrations of duck manure.

Table 5. Results of Two-Way Anova Analysis of Potassium Content

Tests of Between-Subjects Effects

Dependent Variable: Potassium_Content

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.002[a]	3	.001	4.563	.038
Intercept	.414	1	.414	3108.063	.000
Main_Ingredient	.001	1	.001	10.562	.012
Bioaktivator	8.333E-006	1	8.333E-006	.062	.809
Main_Ingredient * Bioaktivator	.000	1	.000	3.062	.118
Error	.001	8	.000		
Total	.417	12			
Corrected Total	.003	11			

a. R Squared = ,631 (Adjusted R Squared = ,493)

Based on Table 2. and Figure 5. the B2P1 treatment has the highest percentage of potassium content of 0.20%, while the B1P1 treatment has the lowest potassium percentage of 0.17%. The two-way ANOVA analysis showed that the main ingredients with potassium content obtained sig. 0.012 < 0.05, so there is a difference in the average percentage of potassium based on the main ingredient. These results indicate that the concentration of the main ingredient significantly affects the presence of potassium content. Based on Table 2, the treatment with a higher concentration of trembesi leaves has a higher potassium percentage. While the results of the two-way ANOVA analysis between bioactivators with potassium content sig. 0.809 > 0.05, so there is no significant difference in the average potassium percentage based on the bioactivator. These results indicate that there is no effect of bioactivation concentration on the percentage of potassium content. As seen in Table 2. the B2P1 treatment with 25 ml of papaya peel local microorganisms had a potassium percentage of 0.20% higher than the B2P2 treatment with 30 ml of papaya peel local microorganisms. The interaction between the main ingredient and the bioactivator obtained sig. 0.118 > 0.05 results indicate no interaction between the main ingredient and the bioactivator on the percentage of potassium content.

Treatment with higher concentrations of trembesi leaves had a higher percentage of potassium than treatments with higher concentrations of duck manure. This is because the potassium content in trembesi leaves is 0.62% higher (Darma, 2020) compared to the potassium content in duck manure which has potassium of 0.53% (Safriyani, 2020). So that organic fertilizer is produced by the provisions of SNI 19-7030-2004, where the potassium content in organic fertilizer is at least 0.20%.

Microbial speed can affect the nutrient content level in fertilizer during fermentation. Each microbe has a different speed in decomposing organic matter. This statement is in line with Kusumadewi's research (2019); The results showed that the nutrient content of fertilizers in each treatment was different because the speed of microbes decomposing organic matter was different, where microbial activity during the fermentation process could be influenced by environmental factors such as temperature and pH.

4. CONCLUSIONS

Based on the results of the study, it can be concluded that a solid organic fertilizer combination of duck manure and trembesi leaves with the addition of local microorganisms papaya peel as a bioactivation has sensory quality by standard provisions (SNI No 19-7030-2004) with the color of the fertilizer being blackish brown, having a scent like soil, crumbly textured, and a pH of around 7, as well as the nutrient content of Nitrogen, Phosphorus, Potassium which meets the minimum requirements of the standard provisions of SNI No 19-7030-2004. Of the four treatments, the best sensory quality was found in the B2P2 treatment (200 g duck manure + 300 g trembesi leaves with 30 ml papaya fruit peel local microorganisms). While the highest Nitrogen and Phosphorus content was found in the B1P2 treatment (300 g duck manure + 200 g trembesi leaves with 30 ml papaya

peel local microorganisms), and the highest Potassium content was in the B2P1 treatment (200 g duck manure + 300 g trembesi leaves with microorganisms local papaya peel 25 ml).

5. ACKNOWLEDGMENTS

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Inventory of Moss Plants (Bryophyta) in the Montana Zone, Samiran Village, Selo District, Boyolali Regency, Central Java Province

Eva Diahayu Wardani[1] and Santhyami[1,2*]
[1]Biology Education Department, Faculty of Teacher Training and Education, Universitas Muhammadiyah Surakarta. Jl. A. Yani Tromol Pos I, Pabelan, Kartasura, Surakarta 57162, Jawa Tengah, Indonesia
[2]Environmental Study Centre, Universitas Muhammadiyah Surakarta, Jl. A. Yani Tromol Pos I, Pabelan, Kartasura, Surakarta 57162, Jawa Tengah, Indonesia
[*]Corresponding Author. E-mail address: san915@ums.ac.id

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ABSTRACT

Green plants known as moss plants (Bryophyta) are considered low plants. Mosses can dwell in tropical regions, the highlands, and the lowlands, and some species even live in water. Temperature, humidity, living conditions, light intensity, habitat pH, substrate, and altitude are all known to have an impact on moss growth. At a height of 1,500–2,400 meters, in the montana zone, the diversity of species declines. Samiran Village, Selo District, Boyolali Regency, Central Java Province is one of the locations in the montana zone. Numerous variables in this location contribute to the habitat for moss growth. This study aims to ascertain the diversity and distribution of moss plants (Bryophyta) in the montana zone, Samiran Village, Selo District, Boyolali District, Central Java Province. There has never been researching on the inventory of moss plants in the montana zone of Samiran Village, Selo District. The study's findings revealed three divisions, Bryopsida, Hepacopsida, and Anthoceropsida, which were further divided into seven families, Marchantiaceae, Hypnaceae, Pottiaceae, Polytrichaceae, Lejeuneaceae, and Anytoniaceae. At an elevation of 1600–1800 meters above sea level, in the montana zone of Samiran Village, Selo District, Boyolali Regency, Central Java Province, the index value of moss plant diversity is 1.679, which is categorized as moderate. This is so because the study site functions well as a moss plant habitat.

1. INTRODUCTION

A less-noticed part of biodiversity is moss. The humidity, temperature, the environment in which it lives, the amount of light, and the pH of the environment all have an impact on moss growth. Its development may also be aided by the presence of substrates including dirt, rocks, and bark (Santi 2021). The degree of moss dominance can be impacted by abiotic factors including height. The group of epiphytic plants also includes moss plants, which are poikilohydric, meaning that the turgor pressure of their body cells depends on the humidity of the surrounding environment.

Green plants known as moss plants (Bryophyta) are considered low plants. Bryopsida, Hepaticopsida, and Anthocerotopsida are the three major divisions of the phylum Bryophyta. The three Bryopsida divisions can easily be distinguished from vascular plants due to their very distinctive features. Because they initially appear unsightly and are frequently blamed for making the environment appear unclean, moss plants are a type of biodiversity plants that have not been investigated very extensively (Wati et al. 2016).

The montana zone is a mountainous region located between 1500 and 2400 meters above sea level. Typically, this area is covered in dense vegetation with skinny stems. Ferns and mosses can be found in the montana zone. Only the second stratum in the sub-mountain zone restricts the height of the trees in this zone (Anesta et al. 2020). Moss is one of the main plant types that may be found in the montana zone. Because they can protect themselves and rehydrate when moisture

is present, even when they lose a lot of water, mosses can survive in extremely dry or cold settings. (Jayanti 2020). One of the wet tropical forest formations that develops in high places is mountain forest, also known as montane forest (Hilwan and Wiraatmadja 2021). This forest is notable for its frequent cloud cover, which typically occurs at the height of the canopy roof. These forests have a lot of moss, which covers the trees and the ground frequently. The ability to withstand soil erosion, lessen the risk of flooding, absorb water during the dry season, maintain moisture, produce oxygen through a quick photosynthesis process, and act as a pollutant absorber are just a few of the traits and functions that moss species possess.

Based on the background above, research on the inventory of moss plants in the montana zone of Samiran Village, Selo District, Boyolali Regency, Central Java Province has never been carried out and information about the types of moss plants that exist is not yet available, so it is necessary to find information about the types and distribution of moss plants in the montana zone, Samiran Village, Selo District, Boyolali Regency, Central Java Province. Therefore, this study aims to determine the species diversity and distribution of moss species (Bryophyta) in the montana zone of Samiran Village, Selo District, Boyolali Regency, Central Java Province.

2. MATERIALS AND METHODS

Sampling Location and Sampling

This sort of observational research is concerned with the cataloging of moss plants (Bryophyta) in the montana zone of Samiran Village, Selo District, Boyolali Regency, Central Java Province. This study was carried out in the Central Java Province's montana Zone, Samiran Village, Selo District, and Boyolali District. This study was done at a height of between 1600 and 1800 meters above sea level, which is where the montane zone begins. The study site is situated in Samiran Village, Selo District, Boyolali Regency, Central Java Province, along the Mount Merapi climbing route. Area maps, a GPS, digital cameras, thermohygrometers, stationery, lux meters, lups, altimeters, soil testers, and meters are among the equipment utilized. The moss plants (Bryophyta) employed in this study are located in the montana zone of Samiran Village, Selo District, Boyolali Regency, Central Java Province, between an altitude of 1600 masl and 1800 masl. The procedures for carrying out the research are as follows: 1) Determining the stations and points to be carried out based on the type of research and limiting moss plants in the montana Zone, Samiran Village, Selo District, Boyolali Regency, Central Java Province. Determination of the station is chosen based on the height of the montana zone and the cost of the point totaling 21 points, each of which is 10 meters (Susilo et al. 2022). 2) Conduct investigation. 3) Calculate the coordinates, height, temperature, air humidity, soil pH, and light intensity of the area. 4) With a distance of 10 meters between each location, calculate the cruising point vertically, or up, from 1600 meters to 1800 meters above sea level. 5) Conducting research to locate moss plants at each location. 6) Identify and note the many kinds of moss plants you come across.

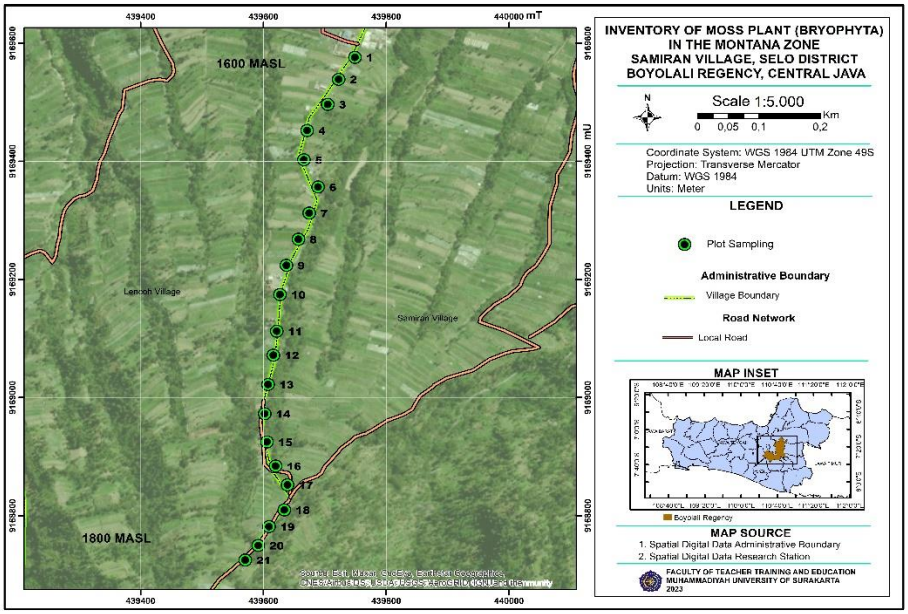

Figure 1. Locations for the map and research

Specimen Collection and Identification

Collections by gathering moss specimens of all species discovered. Thus the results of moss plants were identified at the University Muhammadiyah Surakarta's Biological Laboratory.

Data Analysis

Using the Species Diversity Index formula (Shannon & Wiener 1963), a search was conducted to ascertain the distribution of bryophytes discovered. The bigger the value of, the more diverse the species are. The following criteria are used to define Shannon species diversity value: 1) $\hat{H} > 3$ exhibit high species expertise in an area. 2) $1 \leq \hat{H} \leq 3$ indicates the current species' expertise in an area. 3) $\hat{H} < 1$ show low species yields in an area.

3. RESULTS AND DISCUSSION

The result of an inventory of moss plants found in the montana zone ecosystem of Samiran Village, Selo District, Boyolali Regency, Central Java Province, at an altitude of 1600–1800 meters, include the identification of 7 families: Marchantiaceae, Hypnaceae, Pottiaceae, Polytrichaceae, Lejeuneaceae, Anthocerotaceae, and Anytoniaceae. (Table 1). The Marchantiaceae family of moss plants, specifically *Marchantia treubii* Schiffn and *Marchantia polymorpha* L, were discovered based on the observations. One species was found in the Hypnaceae family, namely *Hypnum cupressiforme* Hedw. In the Pottiaceae family there is 1 species, namely *Barbula consanguiena* A. Jeger. In the family Polytrichaceae, 1 species was found, namely *Pogonatum neesi*. There are one species from the Lejeuneaceae family, namely *Cheilolejeunea meyeniana*. One species was found in the Anthocerotaceae family, namely *Phaeoceros laevis* L. This species lives on moist soil substrates. A total of 1 species from the Anytoniaceae family was found, namely *Reboulia hemisphaerica* L.

The ability of moss plants to survive can be impacted by host availability (Marhento and Zaenab 2021). Three substrates soil, aged trees, and rocks are employed as a place for mosses to live, according to the data collected. How well moss plants can support life depends on the presence of hosts. From the data collected, it has been determined that soil, worn trees, and rocks are the three substrates that serve as homes for mosses. (Table 1). This is consistent with research Fanani et al (2019) that shows lower plants like mosses may grow on a variety of substrates, such as rocks,

soil, trees, worn wood, and litter. The damp soil has the maximum moss growth on it of the three substrates that are covered in moss at a height of 1600–1800 meters above sea level. According to research Krisnawati (2022) moss habitats are on the ground because soil may create a variety of substrates that serve as a stable platform for spore germination and moss growth. Moss spores fall to the ground during the rainy season where they germinate to become new moss plants. The reason worn wood is a favorable substrate for moss growth, according to study Putri et al (2019) is because it holds water between its wood cells, creating a high humidity and the nutrients mosses require to grow.

The moss plants that inhabit a habitat are influenced by a number of additional elements in addition to the substrate. According to studies Purbasari and Akhmadi (2019) in addition to substrate, living moss plants need abiotic elements to support their growth, including humidity, light intensity, temperature, and soil pH.

Table 1. Types and Habitats of Moss Plants (Bryophyta) in the Montana Zone, Samiran Village, Selo District, Boyolali Regency, Central Java Province.

Num	Species	Family	Division	Number of Individuals	Habitats	Altitude and literature source
1	*Hypnum cupressiforme* Hedw.	Hypnaceae	Bryopsida	589	Soil, rocks, weathered trees	800 m asl (Kartikasari et al. 2023)
2	*Marchantia treubii* Schiffn	Marchantiaceae	Hepaticae	294	Soil and rocks	50-100 m asl (Azwir et al. 2022)
3	*Barbula consanguiena* A. Jeger	Pottiaceae	Bryopsida	222	Soil, rocks, weathered trees	<100 m asl, 100-200 m asl, 200-500 m asl, and >500 m asl (Aripulis and Sujadmiko 2019) 108 m asl (Salamah et al. 2019)
4	*Pogonatum neesi*	Polytrichaceae	Bryopsida	142	Soil	Around 1.000 m asl (Roziaty et al. 2019)
5	*Reboulia hemisphaerica* L.	Anytoniaceae	Hepaticopsida	118	Soil and rocks	<100 m asl, 100-200 m asl, 200-500 m asl, and >500 m asll (Aripulis and Sujadmiko 2019)
6	*Phaeoceros laevis* L.	Anthocerotaceae	Anthoceropsida	81	Soil	700-1.500 m asl (Pratama et al. 2022)
7	*Marchantia polymorpha* L.	Marchantiaceae	Hepaticae	31	Soil	1400 m asl (Febriansyah et al. 2019)
8	*Cheilolejeunea meyeniana*	Lejeuneaceae	Hepaticae	15	Soil	Lowland (Putrika et al. 2017)

Bryophyta has 3 divisions namely Bryopsida, Hepaticopsida, and Anthocerotopsida (Figure 2). Three of these divisions were discovered by observation and identification of moss plants at altitudes between 1600 and 1800 meters. This is evident from the varied morphologies and properties of the moss plants in each division. The three Bryopsida divisions can easily be distinguished from vascular plants due to their very distinctive features. Although most moss plants lack vascular tissue or are sometimes referred to as nonvascular plants, some species nevertheless contain water-carrying vessels (Lukitasari 2019).

Due to the complexity of the gametophyte and sporophyte, leaf mosses (Bryopsida) are the most developed mosses. The upright habitus and the body's differentiation into rhizoids, cauloids,

and phylloid are traits of the Bryopsida class (Sujadmiko and Vitara, Pantalea 2021). The liverworts, or Hepaticopsida class, are mosses with gametophytes that have differentiated into stems and leaves and are shaped dorsoventrally. The sporophyte develops elongated after the development of the capsule. While liverworts have a similar body structure to hornworts (Anthocerotopsida), the only distinction is the sporophyte phase. Elongated capsules known as hornwort sporophytes develop into horns (Mulyadi 2014).

Figure 2. Hepaticopsida: *Marchantia treubii* Schiffn (a), Bryopsida: *Barbula consanguiena* A. Jeger (b), dan Anthocerotopsida: *Phaeoceros laevis* L. (c).

The upper montana zone, which has relatively closed environmental conditions and high humidity, is where this species of big moss may be found (Nadhifah 2018). According to information obtained from the identification of the moss type *Marchantia treubii* Schiffn, it can be found living on soil and rock substrates, but is primarily found on soil substrates. It has a slightly thick thallus with a purple center line. In addition to growing in the montana zone, *Marchantia treubii* Schiffn can also be found at elevations lower than 1,000 meters above sea level. This is consistent with studies Azwir et al (2022) showing the *Marchantia treubii* Schiffn species can be found in the Great Mosque Forest of Aceh Besar District at an elevation range of 50 to 100 meters above sea level.

The species *Marchantia polymorpha* L. identified in this study has a light green, branching, thick, stiff, and fleshy thallus that forms a flat rosette. It is also found in damp soil. According to studies Solihat and Kurnia (2021), the talus's base and end are both blunt or flat, its tip is wavy and branch-like, and the talus itself is thick and stiff. This variety of moss can be found in areas with favorable conditions for moss plant life, not just in the montana zone. According to research Febriansyah et al (2019), *Marchantia polymorpha* was found growing on a soil substrate with an altitude range of 1400 m above sea level in the Parangkikis waterfall which is one of the mountainous areas in Gambiran Village, Pagerwojo District, Tulungagung.

The *Hypnum cupresiforme* species, which has a green thallus and is found growing and crawling on weathered rocks, soil, and trees, belongs to the Hypnaceae family. This moss has overlapping and intersecting leaves. The size of this moss is modest to medium. The branched stalks have leaves on them. It is well known for this species to dwell outside of its natural habitat. so that it might have a habitat that is not limited to the montana region. According to research Kartikasari et al (2023), *Hypnum cupresiforme* has a stem that is almost entirely covered in leaves and long, curved, green leaves with a pointed tip. About 800 meters above sea level is the altitude at which this kind of moss can be found.

A *Consanguineous barbula* A. Jeger has a low, fringed talus that is distinguished by its pale green hue. langued leaves. A spore capsule with a diameter of 0.3 cm, a reddish-brown color, and

a tube-like shape with a point is present. The moss *Barbula consanguiena* A. Jeger is a member of the Pottiaceae family. This particular variety of moss is typically found 1,300 meters above sea level. According to Aripulis and Sujadmiko (2019), the species *Barbula consanguiena* A. Jeger was discovered to grow at altitudes of 100 masl, 100–200 masl, 200–500 masl, and >500 masl. According to research, *Barbula consanguiena* A. Jeger was discovered in the Selarong Cave Area, which is situated in Bantul at an altitude of around 108 m asl (Salamah et al. 2019). This demonstrates that the moss plant *Barbula consanguiena* A. Jeger is not restricted to the montane zone.

The group of leaf mosses includes the moss plant species *Pogonatum neesi*. *Pogonatum nesii* typically grows between 700 and 2210 m above sea level, ranging from the lowlands to the highlands. *Pogonatum neesi* is a species that grows at an altitude of roughly 1,000 m asl (Roziaty et al. 2019). This shows that *Pogonatum neesi* is not only found in the montana zone.

Cheilolejeunea meyeniana is a moss that belongs to the class of leafy liverworts. The thallus of the *Cheilolejeunea meyeniana* moss has lateral leaves that are light green to yellowish in color. The shape is ovoid to elongated with a blunt tip and flat leaf edges. This moss has rhizoids with a length of 0,5 cm - 1 cm which are light brown in color. This type of moss is also found as an epiphyte in urban forests and on the main roads of the University of Indonesia campus (Putrika et al. 2017)

The thallus of *Phaeoceros laevis* L. is light green in color and measures 2 cm long by 2 cm wide. The thallus shape forms clusters with horn-shaped sporophytes. This species can be found elsewhere besides the montana region. However, it is also present at elevations lower than 1600 meters above sea level. *Phaeoceros laevis* L. is a type of hornwort that belongs to the Anthocerotophyta division, according to research Pratama et al (2022). This species can be found at the Nature Conservation Education Center Bodogol (PPKAB), which is a part of the Mount Gede Pangrango National Park (TNGGP), at an elevation of between 700 and 1,500 meters above sea level.

Reboulia hemisphaerica has a thick talus that widens from light green to dark green. The rhizoid is the place where the moss attaches to its substrate. The rhizoid or root of *Reboulia hemisphaerica* has a size of 4 cm, brownish white, cylindrical and fibrous. According to research Aripulis and Sujadmiko (2019) that at a range of altitudes, namely <100 masl, 100-200 masl, 200-500 masl, and >500 masl in Sleman Regency, *Reboulia hemisphaerica* was found, this is because the ambient temperature at that altitude is still optimal for growth. mosses in the tropics.

At an altitude of 1600 masl–1800 masl, moss plants (Bryophyta) with the division of leaf mosses (Bryopsida) are most frequently found. The leaf moss species with the highest population at the study site is *Hypnum cupressiforme* Hedw., which has a good survival rate. According to research Ivone et al (2022), mosses are frequently found in a variety of environments because they have a very wide geographic range and the greatest number of species when compared to other classes. These leaf mosses (Bryopsida) can flourish in grasses, amid rocks, on tree trunks, and on barren land that occasionally encounters drought. The identified division of hepaticopsida has a smaller number of individuals than the division Bryopsida. *Marchantia treubii* Schiffn is included in the liverwort which has a smaller number of individuals than the *Hypnum cupressiforme* Hedw species which is included in the leaf moss division. Meanwhile, the number of individuals from the division of anthocerotopsida has the least number, because the moss plants from this division are more susceptible to growth. This is in line with research Gista et al (2020) that few or even no hornworts are found due to the small distribution of hornworts in nature and are a small group in Bryophyta of less than 100 species with 8-9 genera.

Table 2. Species Diversity Index (H') Mosses (Bryophyta) in the Montana Zone, Samiran Village, Selo District, Boyolali Regency, Central Java Province.

Altitude Point	H’	Information
1.600 m asl-1800 m asl	1,679	Moderate

The level of diversity of moss species from an altitude of 1600 masl to 1800 masl in the montana zone of Samiran Village, Selo District, Boyolali Regency, Central Java Province is classified as moderate, as indicated by the Shannon-Wiener (H') diversity index value of 1.679 (Table 2). The significance of the derived moss species diversity demonstrates how variations in an ecosystem's or environment's conditions can have an impact on the diversity of moss plant species. In addition, removing land may result in less plant diversity of a particular kind.

Although the environment at the research site is suitable for moss growth, human activities and the opening of natural attractions have led to a moderate level of species diversity. According to research Raihan et al (2018), a community is said to have high species diversity if there are many species present together with a fairly even distribution of each species' members. The presence of physical-chemical elements in the environment, as well as the availability of nutrients, can contribute to the high or low values of diversity at each research location. These factors also have a significant impact on the diversity of the moss itself.

Table 3. Abiotic factors of moss plants (Bryophyta) in the Montana Zone, Samiran Village, Selo District, Boyolali Regency, Central Java Province.

Abiotic Factors	Altitude Point	
	1.600 m asl	**1.800 m asl**
Air temperature (°C)	28,7	21,3
Humidity (%)	57	73
Soil pH	6	6
Atmospheric pressure (atm)	835,4	815,6
Light intensity (Cd)	18200	2180

Moss growth is generally influenced by several factors including temperature, humidity, living habitat, light intensity, and habitat pH and altitude. The research location at an altitude of 1600 masl has an air temperature of 28.7 °C and at an altitude of 1800 masl has an air temperature of 21.3 °C, this supports moss plants living on the available substrate. According to studies Azwad et al (2020), mosses grow best at temperatures between 15 and 25 °C and can tolerate temperatures between 40 and 50 °C. Samiran Village, Selo District's montana zone has a temperature that is still suitable for moss growth and development since mosses can survive in environments with air temperatures between 40 and 50 degrees Celsius.

Altitude can affect the growth of moss plants. Air humidity at an altitude of 1600 masl, namely 57%, can be found to be less optimal for moss growth while at an altitude of 1800 m asl, it is 73% which indicates that 73% humidity can support moss growth. This is in line with research Sopacua et al (2020) that humidity also supports moss growth, in general, mosses require relatively high humidity to support their growth. Moss can live in a humidity range between 70% -98%.

Moss plants require a strong amount of light to perform photosynthesis. The level of humidity will drop if the light intensity is quite high. This is due to the fact that the ambient temperature rises when more light is allowed to reach the moss-growing region or substrate. 10,000 lux is the recommended light intensity for moss plants to grow at in order to support photosynthesis Yohendri et al (2021). At an altitude of 1600 masl, it has a light intensity of 18200 Cd, while at an altitude of 1800 masl it is 2180 Cd. So that at an altitude of 1800 meters above sea level, it is still a good habitat for mosses.

4. CONCLUSIONS

Based on the results of the research and discussion it can be concluded that the identified mosses consist of 3 divisions namely Bryopsida, Hepacopsida, and Anthoceropsida which consist of 7 families namely Marchantiaceae, Hypnaceae, Bryaceae, Polytrichaceae, Lejeuneaceae, Anthocerotaceae, and Anytoniaceae. From the observations, 2 species were found from the family

Marchantiaceae, namely *Marchantia treubii* Schiffn and *Marchantia polymorpha* L. In the family Hypnaceae, 1 species was found, namely *Hypnum cupressiforme* Hedw. This species has the most number of individuals found. In the Pottiaceae family there is 1 species, namely *Barbula consanguiena* A. Jeger. In the family Polytrichaceae, 1 species was found, namely *Pogonatum neesi*. One species was found in the Lejeuneaceae family, namely *Cheilolejeunea meyeniana*. A total of 1 species from the Anthocerotaceae family, namely *Phaeoceros laevis* L. One species was found from the Anytoniaceae family, namely *Reboulia hemisphaerica*. There are 3 substrates used as a place for moss to live, namely rocks, weathered bamboo, and soil. Based on these three substrates, moss grows the most on moist soil substrates. On these three substrates, not all moss plant species can be found. According to the Shannon-Wiener (H') diversity index value of 1.679, the diversity of moss plant species in the montana zone of Samiran Village, Selo District, is in the moderate range.

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Diversity of Ferns (Pteridophyta) in the Montana Zone, Samiran Village, Selo District, Boyolali Regency, Central Java Province

Indah Rahmawati[1] and Santhyami[1,2*]
[1] Biology Education Department, Faculty of Teacher Training and Education, Universitas Muhammadiyah Surakarta. Jl. A. Yani Tromol Pos I, Pabelan, Kartasura, Surakarta 57162, Jawa Tengah, Indonesia
[2]Environmental Study Centre, Universitas Muhammadiyah Surakarta, Jl. A. Yani Tromol Pos I, Pabelan, Kartasura, Surakarta 57162, Jawa Tengah, Indonesia
*Corresponding Author. E-mail address: san915@ums.ac.id

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ABSTRACT

Ferns (Pteridophyta) are one of the Indonesian flora groups with high diversity and wide distribution, one of which is in the montana zone, an ecosystem zone at an altitude of 1500-2400 m asl. Samiran Village is located in the District of Selo, Boyolali Regency, between two mountains, namely Mount Merapi and Mount Merbabu. This type of research was conducted at an altitude of 1600 m asl to 1800 m asl in Samiran Village, Selo District, Boyolali Regency. This study aims to determine the types of ferns and their distribution in the montane zone of Samiran Village, Selo District, Boyolali Regency. The method used is purposive sampling, a data collection technique based on points determined deliberately with a distance of 10 meters with a total of 21 points carried out in the Montane zone of Samiran village. Fern (Pteridophyta) that have been found in the montana zone of Samiran Village, are group into 2 families of 6 species consisting of *Adiantum raddianum* C. Presl, *Notholaena copelandii* c.c. Hall, *Adiantum hispidulum* Sw., *Pityrogramma austroamericana* Domin, *Cyathea arborea* L. Sm, *Antrophyum sessilifolium* (Cav.) Spr. The Diversity value (H') is 1.22, a category as relatively low. Ferns are most commonly found on soil hosts. The most abundant species were dominated by *Adiantum raddianum* C. Presl with 107 individuals at 14 out of 21 points. This species is one type of terrestrial fern that is also often found growing between rocks, pool walls, fences, wells, ditches, river banks other damp places. Therefore, this location is a suitable environment for the growth of *Adiantum raddianum*.

1. INTRODUCTION

Ferns (Pteridophyta) are a type of Indonesian plant that have a diverse range of species (Kurniawati et al., 2016). In addition to flourishing in moderate regions, woodlands, and streams, this plant is frequently seen in tropical rainforests. Additionally, this plant can be found in water (hydrophytes), adhering to other plants (epiphytes), and growing on plant remains (saprophytes) (Hutasuhut & Febriani, 2019). Ferns in the montana zone are exposed to a lot of sunlight so that their fast growth and assisted by the right environmental factors can encourage the growth of ferns so that many variations are found.

Generally speaking, ferns take the shape of herbs, bushes that resemble trees, spores in clustered sporangia, and immature spores that are typically green in color and dispersed or small. On the underside or edge of the leaf, spores are communally living organisms. Whether solitary or complex, ferns have dark green leaves. In most cases, the stems grow on the ground, creep on trees as epiphytes, or float freely in the water; they are rarely visible. The spores' morphological characteristics serve as ferns' defining characteristics. One of the criteria for identifying ferns is

based on their spores (Pranita et al., 2017). Ferns (Pteridophyta) are an important component of biodiversity as a plant community that aids in the development of soil and serves as a cover for vegetation for organisms in the forest. Another function of ferns is as germplasm, as well as food and medicine (Mowata et al., 2020).

The montana zone is an ecological zone located between 1500 and 2400 meters above sea level. Smaller diameter stems vegetation, and lots of mosses and ferns are characteristic of the region. Compared to the submontane zone, this montana zone has lower tree heights. The diversity of tree species in the montana zone is not very high. Exposure to direct sunlight on forest soil can encourage the growth of grass and other plants. The montana zone has shorter trees than the submontane zone. In the mountainous zone, trees are 8–20 m high and have fewer species than the area beneath, the irregular shape of the trunks and low tree density create a lot of bare soil. Plants also became scarce and were replaced by lichens, lichens, bamboo, and shrubs (Anesta et al., 2020) such as needle leaf plants (*Dacrycarpus imbricatus* and *Podocarpus neriifolius*) and puspa plants (*Schima wallichii*) whose species diversity decreases with increasing soil altitude (Supriatna, 2014).

A village called Samiran is located between 1500 and 1800 meters above sea level. Samiran Village is specifically located in Selo District, flanked by Mount Merapi and Mount Merbabu. According to PPID Boyolali, this district experienced quite high rainfall in 2011, with a total of 4.232 mm and 229 rainy days. In general, the Selo sub-district has a moist type C climate that is suitable for the growth of ferns in the region. There are numerous locations and varieties where this fern grows and spreads. Cool environments are ideal for ferns to flourish. Ferns can also be found close to running water, and they have a substrate that is rooted to the ground. Numerous fern species, including those from the tribes Lycopodiaceae, Nepenthes, and Hymenophyllaceae, as well as Coniogramme, Dipteris, Gleichenia, and Blechnum, can be found in the montana zone (Muhaimim et al., 2018).

Ferns were chosen as the subject of the study because they are crucial to the humus-forming process, shield the soil from erosion, and preserve soil moisture. It is vital to conduct a study on ferns in the montana zone of Samiran Village because there is little data and knowledge about the different kinds of ferns there. The purpose of this study is to identify the fern species that can be found in the montana zone, specifically in Samiran Village, Selo District, and Boyolali Regency.

2. MATERIALS AND METHODS

Sampling Location and Sampling

This research was conducted in the montana zone of Samiran Village, Selo District, Boyolali, Central Java (Figure 1). The research was conducted in the montana zone of Samiran Village at an altitude of 1,600–1,800 m asl, with an average air temperature of 20–30 °C and an average humidity of 75–90%. The research was conducted in February - March 2023. The tools used included a thermohygrometer, altimeter, GPS, Lux meter, and soil tester. The materials used are ferns that live in the montana zone (1.600m asl, up to 1.8000m asl) in Samiran Village, Selo District, Boyolali District, Central Java.

The procedures used include 1) Determining stations and points; 2) Measuring location altitude, temperature, air humidity, soil pH, light intensity, and location coordinates; 3) Exploring; 4) Identifying and recording the types of ferns found.

This study used a survey method with a purposive sampling technique. This method was used in the montana zone of Samiran Village in the Selo District of the Boyolali Regency of the Central Java Province. Purposive sampling, which means a data gathering technique based on points that are determined intentionally with a distance of 10 meters and a total of 21 points.

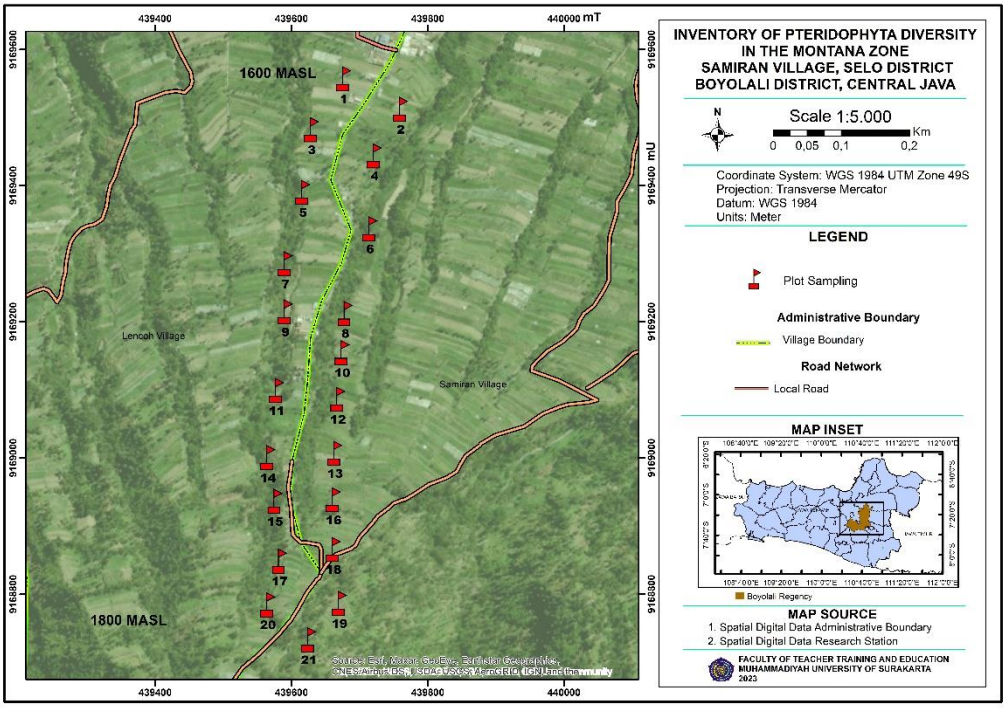

Figure 1. Research map

Specimen Collection and Identification

Collected specimens were identified in the Biology Laboratory Universitas Muhammadiyah Surakarta. Identification was carried out by observing using a monocular microscope and desk study based on the book Flora (Steenis, C.G.G.J., 2013) and Plant Taxonomy (Schizophyta, Thallophyta, Bryophyta, Pteridophyta) by Tjitrosoepomo (1989).

Data Analysis

To determine the distribution, use the Species Diversity Index (Shannon & Wiener 1963) to calculate the value of diversity by dividing the number of individuals of a species by the total number of individuals. Then divide into three groups H<1.5 is low, 1.5<H<3.5 is moderate, or H>3.5 is high (Magurran, 1988).

3. RESULT AND DISCUSSION

From 21 points of the sampling site, we found two families of ferns, namely Pteridaceae and Cyatheaceae (Table 1). The most abundant species was from Pteridaceae. This is due to the fact that certain Pteridaceae fern species may grow at a particular height from open, dry areas to damp, shaded locations (Muswita et al., 2013).

Table 1. Types of Ferns (Pteridophyta) In Montana Zone, Selo District, Boyolali Regency

Num	Species	Family	Number of Individuals	Habitats	Altitude (m asl)	Literature
1	*Adiantum raddianum* C. Presl**	Pteridaceae	107	Land and rock	250 – 2000	Perwati, L. K (2009)
2	*Notholaena copelandii* c.c . Hall	Pteridaceae	87	Land	300 – 1500	Flora Komite Editorial Amerika Utara (1993)

Num	Species	Family	Number of Individuals	Habitats	Altitude (m asl)	Literature
3	*Adiantum hispidulum* Sw	Pteridaceae	39	Land and roc	1345	Taslim, E (2019)
4	*Antrophyum sessilifolium* (Cav.) Spr	Pteridaceae	6	Tree	1836 – 2270	Astuti (2017)
5	*Pityrogramma austroamericana* Domin	Pteridaceae	10	Land	876	Yuskianti, (2018)
6	*Cyathea arborea* L.Sm*	Cyatheaceae	5	Land	1836	Astuti (2017)

Note:
** : The highest number of individuals found
* : The lowest number of individuals found

In the Pteridaceae family, five species have been identified based on the findings of the identification process, including *Adiantum raddianum* C. Presl, *Notholaena copelandii* C.C. Hall, *Adiantum hispidulum* Sw., *Pityrogramma austroamericana* Domin, and *Antrophyum sessilifolium* (Cav.) Spr. However, only one species, *Cyathea arborea* (L) Sm, has been recognized within the Cyatheceae family.

Based on the sorus shape, plant height, and host site, these species are divided into 6 species. The section of the spore that is found in the space between the leaf veins is known as *Cyathea arborea* (L) Sm, and *Pityrogramma austroamericana* Domin. On the leaf's margin is *Adiantum raddianum* C. Presl, *Notholaena copelandii* c.c. Hall, and *Adiantum hispidulum* Sw. Meanwhile, plants that do not have spores are *Antrophyum sessilifolium* (Cav.) Spr. Leaf dots on ferns are signs that a sporangium, or spore box, is present. Ferns produce spores in their sporangium as a way of reproduction (Ulum & Dwi, 2015). Spore morphological traits can be detected by the form, size, and kind of spore laesura. Fern sporangium is found on the underside of the leaf and forms a brown or black circle (Yunita et al., 2021). Sofiyanti et al (2020) investigated spore properties, identifying ferns as having two types of spore laesura, namely monolete and trilete with round, kidney, elliptical, and triangle shapes.

There is also a difference in the growth of these six plants, which is the height of the plants. *Cyathea arborea* L.Sm. is a tall plant that can reach heights of nearly 2-5 meters. *Adiantum raddianum* C. Presl, *Notholaena copelandii* c.c. Hall, *Adiantum hispidulum* Sw, *Pityrogramma austroamericana* Domin, and *Antrophyum sessilifolium* (Cav.) Spr. are among the plants that grow tiny. The tallest ferns, including those in the genus Cyathea, may grow to heights of several meters (Tjitrosoepomo, 2011).

The area where growth is split into three areas, namely land, rocks, and trees. *Notholaena copelandii* c.c. Hall, *Pityrogramma austroamericana* Domin, and *Cyathea arborea* L.Sm. live on the land. The plant's *Adiantum raddianum* C. Presl and *Adiantum hispidulum* Sw. occupy the soil and rock locations. Meanwhile, only *Antrophyum sessilifolium* (Cav.) Spr. grows at the tree location. The soil's habitus, which has a wide canopy form, allows for enhanced humidity and lower solar intensity, resulting in a low temperature and relatively damp zone under the canopy. The amount of ferns that grow is also affected by the height of the ground surface (Nainggolan, 2014). This fern thrives on flat soil, ditches, cliffs, and other types of habitat. The quantity of fern species and individuals present in the soil shows that the soil is an appropriate area to act as a host. This is connected to epiphytic plant spores that fall on appropriate places and can result in the formation of new epiphytic individuals (Darma et al., 2018).

When compared to other fern species, *Adiantum raddianum* ferns have the most individuals. From the 21 locations that were observed spots, 14 points of this variety of fern were discovered at altitudes ranging from 1600 to 1800 meters above sea level. The location is ideal for the growth of a few fern species. This is a terrestrial fern that is commonly found growing among rocks. Their preferred habitats include pond walls, fences, wells, ditches, river banks, and other wet areas (Lestari, 2011). *Adiantum raddianum* is a fern found from the lowlands to the mountains.

Adiantum raddianum grows wild on the sides of rocks or cliffs in chilly mountain environments. When kept in the lowlands, growth barriers exist (Ramndana et al., 2023).

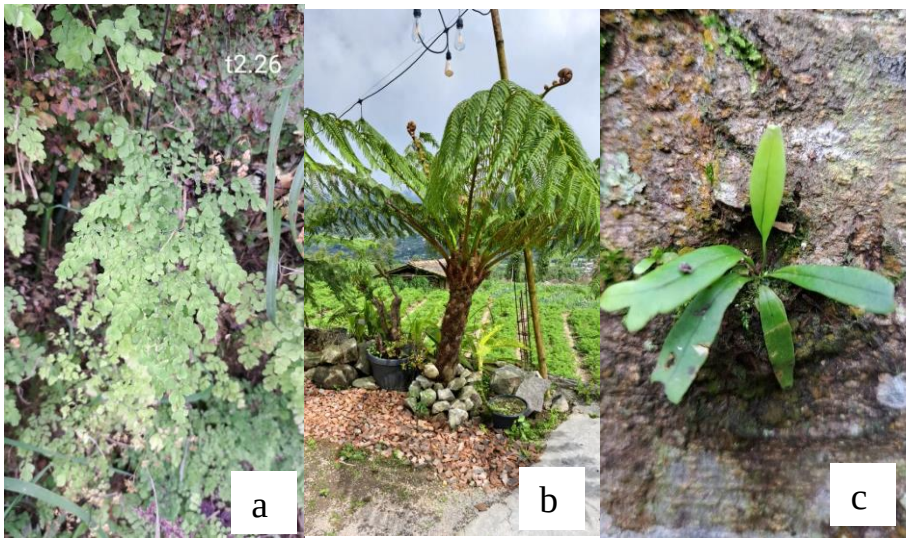

Figure 2. a. *Adiantum raddianum* C. Presl; b. *Cyathea arborea* L.Sm; c. *Antrophyum sessilifolium* (Cav.) Spr

The species diversity index (H') can be used to assess the diversity of fern species. It is possible to observe the H' value derived from each observation location. The H' value takes place between 1600 m asl to 1800 m asl and is 1.22. The criterion for identifying the level of diversity is H'<1.5, which indicates a low level of species diversity, 1.5<H<3.5 which indicates a moderate level of species diversity, and H'>3.5 which indicates a high level of species diversity (Magurran, 1988). According to Indriyanto (2006), if the diversity of species in a community is low, this is due to an area dominated by only a few species. According to Zulkarnain (2004), a community has high species diversity if several species are reasonably uniformly dispersed. However, if a community is made up of only a few species with an unequal number of members, the community has low diversity. Diversity can be used to assess the stability of a community. The size of the Diversity Index is related to environmental circumstances. The unequal distribution of individuals has an impact on species diversity, which is now deemed low.

Table 2. Abiotic factors of ferns in the Montana Zone in the Selo Region, Boyolali, Central Java

Abiotic Factors	Altitude Point (m asl)	
	1.600	**1.800**
Air Temperature (ºC)	28,7	21,3
Humidity (%)	57	73
Soil pH	6	6
Atmospheric pressure (atm)	835,4	815,6
Light Intensity (Cd)	18200	2180

The environment is a collection of numerous abiotic and biotic components that interact with one another to dramatically influence the conditions in which plants, particularly ferns, thrive (Nasrandi et al., 2022). Based on the table of abiotic parameters (Table 2) above, it is known that the altitude of 1600 m asl - 1800 m asl has a little temperature difference. At a height of 1600 m asl, the average temperature is 28.7 °C, while at 1800 m asl, the temperature drops to 21.3 °C. The average temperature at each elevation is ideal for the growth of ferns. According to Hoshizaki & Moran (2001), ferns that grow in the tropics require a temperature range of 21-27 °C to thrive. Many varieties of ferns spread in tropical forest environments due to ideal temperature conditions. Types of nails that reside in a temperature range of 27°C are often more tolerant of dim and bright environmental conditions.

Abiotic variables including soil pH influence Pteridophyta (ferns). The results of the research on soil pH ranged from 6 which means it is acidic. A pH of 6 indicates that the soil is acidic, however, fern rock regions require a more alkaline pH, precisely 7-8. Ferns (Pteridophyta) prefer chilly temperatures and high humidity, and soil pH should be between 6-7. If the pH of the soil is less than 7, it is acidic if the pH is greater than 7, it is alkaline (Permana, 2017). According to Lestari et al (2019), environmental conduciveness permits more plant species to grow in locations with a pH close to neutral and lower temperatures.

Soil moisture also affects the growth of Pteridophyta (ferns). Pteridophyta (ferns) in the montana zone of Samiran Village is classified as normal and good, with air humidity ranging from 57% to 73%. Each height has a pretty high average humidity because the research site is in a tropical rainforest with high rainfall and is at an altitude ranging from 1600 to 1800 meters above sea level, where the air temperature is lower. Because air temperature lowers with increasing altitude, humidity is highly influenced by it. The lower the temperature, the more air available. Because this humidity range is favorable for fern growth, it contributes significantly to the proliferation of ferns in this area. According to Hoshizaki & Moran (2001), the appropriate relative humidity for the growth of ferns normally varies from 60 to 80%.

The intensity of sunlight is also one of the environmental parameters examined in this study. The light intensity is 2180-18200 lux at an altitude of 1600-1800 m asl. According to Imaniar (2017), light intensity affects air humidity, the larger the light intensity, the faster the evaporation rate. According to Rizky et al (2018), canopy cover and clouds influence the high and low intensity of sunlight. Ferns prefer shady environments or those that are shaded by the intense sun. This variety of terrestrial fern requires moist climatic circumstances, thus it tends to form groups in the shade where the light intensity is lower (Katili, 2013).

Several types of ferns can only be found in the montana zone area, one of which is a plant of the Cyatheaceae family at an elevation of 1700 m above sea level. According to Astuti et al. (2017), *Cyathea* sp. lives at an elevation of 1836 m above sea level. This fern is commonly found in terrestrial environments, where it prefers moist conditions (Sengka et al., 2022). According to Suin (2022), stating the ideal humidity and temperature might cause specific types to thrive and reproduce properly. The largest ferns, such as those in the genus Cyathea, can grow to be several meters tall (Adlini et al., 2021). This is owing to the poor level of mastery over environmental variables in the fight for nutrients and growth space for the survival of this fern species.

4. CONCLUSIONS

From these findings, it was concluded that there are 2 families of ferns consisting of 6 species in the montana zone, Samiran village, Selo sub-district, Boyolali district, consisting of *Adiantum raddianum* C. Presl, *Notholaena copelandii* c.c. Hall, *Adiantum hispidulum* Sw., *Pityrogramma austroamericana* Domin, *Cyathea arborea* L.Sm, and *Antrophyum sessilifolium* (Cav.) Spr. The Diversity Index (H') is low, with a value of 1.22. The low diversity score is due to an imbalance in the number of individuals in each live fern species. *Adiantum raddianum* C. Presk had the most individuals from 14 points, with 107. The majority of ferns grow in dirt. Abiotic parameters at the study site include air temperature ranging from 21°C to 28°C, which is considered normal, air

humidity of 57%-73%, which is ideal for fern development, and soil pH of 6, which is acidic. The growth of the fern *Adiantum raddianum* in Samiran Village is highly influenced by diversity and abiotic conditions.

5. SUGGESTIONS

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Quality of Solid Organic Fertilizer from Moringa Leaves and Peanut Shells with Banana Peel Bioactivator

Nur Afifah Mustikasari, Aminah Asngad*
Biology Education Department, Faculty of Teacher Training and Education, Universitas Muhammadiyah Surakarta.
Jl. A. Yani Tromol Pos I, Pabelan, Kartasura, Surakarta 57162, Jawa Tengah, Indonesia
*Corresponding Author. E-mail address: aa125@ums.ac.id

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Peanut shells
Solid organic fertilizer

ABSTRACT

Fertilizer is a material added to the soil to meet the needs of plant growth and production. Moringa leaves and peanut shells can be used as solid organic fertilizer with the addition of banana peel bioactivator. The purpose of this study was to determine the quality of solid organic fertilizer from moringa leaves and peanut shells with banana peel bioactivator through observation of sensory properties and testing nutrient content. This study used an experimental research method with a complete randomized design (CRD) with a factorial pattern. The first factor was the ratio of ingredients (K_1 = 300 g of moringa leaves and 200 g of peanut shell soil; K_2 = 200 g of moringa leaves and 300 g of peanut shells). The second factor was dose of banana peel bioactivator (B_1 = 25 ml, B_2 = 30 ml). The K_1B_2 treatment had the characteristics of mature organic fertilizer. K_1B_1 and K_1B_2 treatments have the highest pH, which is 7. The K_1B_1 treatment has the best nutrient content with 3.42% nitrogen, 0.11% phosphorus, and 0.22% potassium. The study can be concluded to be that quality organic fertilizer is in accordance with SNI 19-7030-2004.

1. INTRODUCTION

Fertilizer is a material added to the soil to meet the needs of plants for growth and production. Based on the constituent materials, fertilizers are divided into organic and inorganic fertilizers. Currently, farmers still utilize a lot of inorganic fertilizers to supply the nutrients plants need. However, the use of inorganic fertilizers will have a negative impact. The long-term use of inorganic fertilizers will damage the soil, plants, and environment. To avoid the negative impact of using of inorganic fertilizers, switching to organic fertilizers is necessary.

Organic fertilizers function to meet the needs of plants for nutrients. The advantages of organic fertilizers are the availability of more balanced elements, increased soil biological activity, and increased soil organic matter content. Fertilizer is classified based on its form. Solid organic fertilizers and liquid organic fertilizers are the two categories of organic fertilizers. Solid organic fertilizer is a type of fertilizer made from solid organic ingredients. Solid organic fertilizer can be used as an alternative to inorganic fertilizers. Solid organic fertilizers can help improve soil structure, which was initially hard or dense to loosen. Solid organic fertilizer can use organic materials such as moringa leaves and peanut shells, with banana peel waste as a bioactivator.

Moringa leaves contain high levels of nitrogen, phosphorus, and potassium, so they can be used to make organic fertilizers. Based on the results of research by Adiaha (2017), the phytochemical content of Moringa leaves is nitrogen (N) 4,02%, phosphorus (P) 1,17%, and potassium (K) 1,80%. In addition, moringa leaves contain essential minerals such as Ca, Na, Mn, Zn, Fe, Mg, and Cu. One combination of ingredients that can be used is peanut shells. So far, peanut shells have yet to be utilized by the public, even though peanut shells contain nutrients that are good for plants. According to Torkashvand (2015), the phytochemical content of peanut shells was 0.87% N,

1.87% P, and 1.19% K. Therefore, the nutrient content in peanut shells is quite high, so they have the potential to be processed into organic fertilizer.

In the manufacture of solid organic fertilizers, bioactivators can be added to speed up the fermentation process. Bioactivators function as activating agents in the form of microorganisms and help start the process of transforming an organic material into a different product by causing changes in its physical and chemical properties. In addition to bioactivators that are already on the market, bioactivators can be made yourself with organic material waste, such as banana peel waste. The addition of bioactivators can speed up the fermentation process because there are microorganisms contained in them. According to Ozabor (2020), the microorganisms found on banana peel are *Pseudomonas* sp. and *Bacillus* sp.

Based on the explanation of the background above, it can be formulated how quality is determined from solid organic fertilizer made from moringa leaves and peanut shells with the addition of bioactivator made from banana peels through sensory tests and nutrient content (nitrogen, phosphorus, and potassium) based on SNI 19-7030-2004. This research aims to determine the quality of solid organic fertilizer from moringa leaves and peanut shells by adding bioactivators from banana peels through sensory tests and nutrient content (nitrogen, phosphorus, and potassium) based on SNI 19-7030-2004.

This research is expected to provide information and benefits to: 1) society regarding the use of moringa leaves, peanut shells, and banana peel waste processed as solid organic fertilizer. 2) Other researchers can add new knowledge about the benefits of moringa leaves, peanut shells, and banana peel waste and how to process them as solid organic fertilizers.

2. MATERIALS AND METHODS

This research was conducted in Tlangu, Bulan Village, Wonosari District, Klaten Regency for the manufacture of organic fertilizers and sensory tests. Test the content of nitrogen, phosphorus, and potassium, carried out at the Soil and Plant Nutrition Laboratory of the Agrotechnology Study Program at Universitas Muhammadiyah Yogyakarta used the Kejdahl method for testing nitrogen content and the wet ashing method with HNO_3 and $HClO_4$ for phosphorus and potassium content. The research took place on February 4–March 11, 2023.

Tool materials used in the manufacture of fertilizers include plastic, scales, chopping machines, knives, cutting boards, measuring cups, stationery, pH sticks, and pH indicators. Tools used in testing levels of N, P, and K include measuring cups, beakers, measuring flasks, digestion tubes, hot plates, Erlenmeyer dropper pipettes, spatulas, spectrophotometers, and test tubes. Materials used to manufacture fertilizers include moringa leaves, peanut shells, banana peels, rice washing water, and granulated sugar. Materials used in testing the levels of N, P, and K include distilled water, 40% NaOH, concentrated H_2SO_4, 60% $HClO_4$, 65% HNO_3, H_3BO_3, and methyl red indicators.

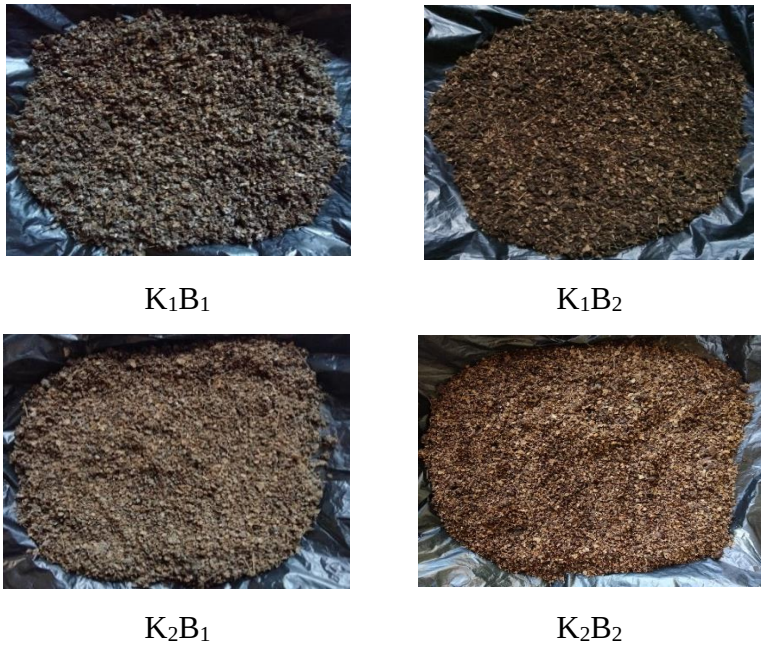
The research procedures include: 1) Preparation of tools and materials; 2) Manufacturing banana peel bioactivators 3) Making solid organic fertilizer: preparing 12 plastic bags labeled with a treatment combination. Put the moringa leaves and peanut shells in plastic according to the treatment combination. Added banana peel bioactivator, 25 ml and 30 ml, according to the treatment label. 4) Sensory test. Making sensory observations on the results of solid organic fertilizer in the form of color, aroma, texture, and pH. 5) Test nutrient content. Conduct a nutrient content test on the results of solid organic fertilizer, including nitrogen (N), phosphorus (P), and potassium (K).

This study used an experimental research method with a complete randomized design (CRD) with a factorial pattern. The treatment factors were as follows: The first factor was the ratio of ingredients (K_1 = 300 g of moringa leaves and 200 g of peanut shell; K_2 = 200 g of moringa leaves and 300 g of peanut shells). The second factor was dose of banana peel bioactivator (B_1 = 25 ml, B_2 = 30 ml). Data analysis used descriptive qualitative analysis and quantitative statistical analysis.

3. RESULTS AND DISCUSSION

3.1. Result

Documentation of the results of solid organic fertilizer from moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator can be seen as follows:



K_1B_1 K_1B_2

K_2B_1 K_2B_2

Figure 1. Documentation of color sensory observations on solid organic fertilizer.

Based on the results of research on the use of moringa leaves and peanut shells as solid organic fertilizer with the addition of banana peel waste as a bioactivator, the results of sensory testing (color, smell, texture, and pH) are obtained in table 1.

Table 1. Sensory test (color, smell, texture, and pH) on solid organic fertilizer from moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator

Num.	Treatment	Average Observation Results			
		Color	Smell	Texture	pH
1	K_1 B_1	Blackish brown	Less stinging	Rather subtle	7
2	K_1 B_2	Blackish brown	Earthy smell	Crumb	7
3	K_2 B_1	Brown	Sting	Rather subtle	6
4	K_2 B_2	Brown	Less stinging	Crumb	6

Notes:
Color: 1 = Light Brown, 2 = Brown, 3 = Blackish Brown, 4 = Very Black
Smell: 1 = Sewage smell, 2 = Sting, 3 = Less stinging, 4 = Earthy smell
Texture: 1 = Rough, 2 = Rather Rough, 3 = Rather Subtle, 4 = Crumb
K_1 B_1 : 300 g of moringa leaves and 200 g of peanut shell with 25 ml banana peel bioactivator.
K_1 B_2 : 300 g of moringa leaves and 200 g of peanut shell with 30 ml banana peel bioactivator.
K_2 B_1 : 200 g of moringa leaves and 300 g of peanut shell with 25 ml banana peel bioactivator.
K_2 B_2 : 200 g of moringa leaves and 300 g of peanut shell with 30 ml banana peel bioactivator.

Based on the results of research on the use of moringa leaves and peanut shells as solid organic fertilizer with the addition of banana peel waste as a bioactivator, the results of chemical testing (nitrogen, phosphorus, and potassium content) are obtained in table 2.

Table 2. Results of nitrogen, phosphorus, and potassium content in solid organic fertilizer from moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator.

Num.	Treatment	The Average Yield of Macro-nutrient Content		
		N (%)	P (%)	K (%)
1	$K_1 B_1$	3,42**	0,11**	0,22**
2	$K_1 B_2$	2,28*	0,10	0,19
3	$K_2 B_1$	2,93	0,09*	0,20
4	$K_2 B_2$	3,05	0,10	0,19*

Notes:
* = Lowest Value, ** = Highest value
$K_1 B_1$: 300 g of moringa leaves and 200 g of peanut shell with 25 ml banana peel bioactivator.
$K_1 B_2$: 300 g of moringa leaves and 200 g of peanut shell with 30 ml banana peel bioactivator.
$K_2 B_1$: 200 g of moringa leaves and 300 g of peanut shell with 25 ml banana peel bioactivator.
$K_2 B_2$: 200 g of moringa leaves and 300 g of peanut shell with 30 ml banana peel bioactivator.

3.2. Discussion

3.2.1. Color Parameter Sensory Test

Based on table 1 and figure 2. the results of sensory observations on solid organic fertilizer from moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator obtained the color on each treatment sample is different. Of the four treatments, the best result were obtained from the treatment K_1B_1 and K_1B_2 with blackish brown fertilizer color. Discoloration of solid organic fertilizer brown and blackish brown due to the presence of active microorganisms work during the fermentation process. According to Andriany (2018), the physical properties of the compost change the color of the compost from brownish yellow to blackish brown due to the process of fermentation or decomposition carried out by microorganisms. The blackish-brown color indicates that the fertilizer has matured.

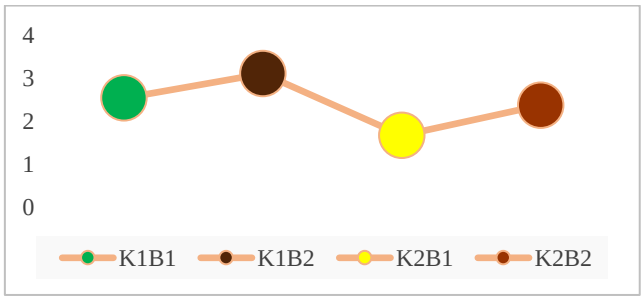


Figure 2. The results of observations of the color of solid organic fertilizer from moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator.

The change in color of the fertilizer to blackish brown occurs due to microorganisms decomposing organic matter into simpler ones. Research shows that the color shift happens as a result of microorganisms converting organic matter with a complicated C arrangement to a simple C arrangement during the decomposition process (Kumalasari, 2016). So that the end result is a solid organic fertilizer for moringa leaves and peanut shells with a blackish brown color in accordance with the standard provisions (SNI No. 19-7030-2004), which state that solid organic fertilizer that has matured will have a blackish color.

3.2.2. Smell Parameter Sensory Test

Based on table 1 and figure 3, the results of sensory observations on solid organic fertilizer made from moringa leaves and peanut shells with the addition of shell waste banana as a

bioactivator showed that among the four treatments, the fertilizer that smelled the best was the K_1B_2 treatment, which smelled of earth.

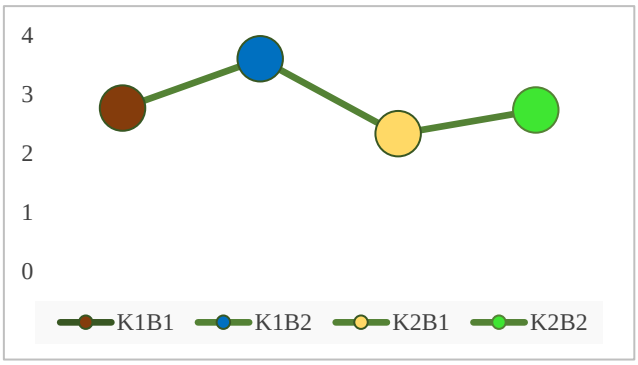


Figure 3. The results of observations on the smell of solid organic fertilizer from moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator.

In the K_1B_1 treatment, initially, it had a smell like fertilizer ingredients, which at the end of the fermentation turned into a less stinging one. The K_1B_2 treatment has an initial smell like fertilizer ingredients, which turns into an earthy smell at the end of the fermentation process. In the K_2B_1 treatment, the initial smell was like fertilizer ingredients, which turned into a sting at the end of the fermentation process. Also, there is the K_2B_2 treatment, which has an initial smell like fertilizer that turns into less stinging at the end of the fermentation process. This is in accordance with the fertilizer quality standards based on the national standard agency (SNI 19-7030-2004), which state that mature fertilizer will smell of earth.

The smell of the fertilizer is a sign that decomposition activity has occurred among microorganisms. Unripe fertilizer can be characterized by a pungent odor. According to Nafis (2021), during the decomposition process, the fertilizer smells pungent because the decomposition of the material releases gas in the form of NH_3 (ammonia). This pungent smell is getting longer and will decrease and be replaced with an earthy smell, indicating that the compost has been composted ripe. This is in accordance with the opinion of Zain (2022), which states that at the end of the process of decomposition of organic matter, mature fertilizer produces an earthy odor. The smell of earth on mature fertilizer occurs because the material it contains already resembles soil. According to Puryanto (2022), good compost does not emit a strong, pungent smell but gives off an odor like the smell of earth or the smell of humus.

3.2.3. Texture Parameter Sensory Test

Based on table 1 and figure 4, the results of sensory observations on solid organic fertilizer of Moringa leaves and peanut shells with the addition of shell waste banana as a bioactivator showed that among the four treatments, the texture of the fertilizer was the best in the K_1B_2 and K_2B_2 treatments, namely crumbs.

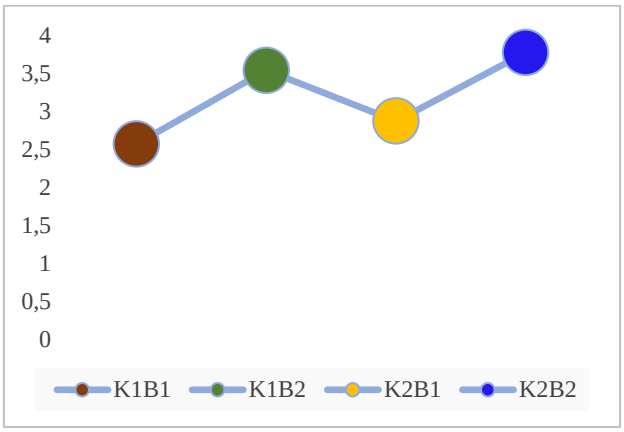


Figure 4. The results of observations on the texture of solid organic fertilizer from moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator.

In this study, the peanut shell material was chopped beforehand to simplify the decomposition process. The particle size of the fertilizer is related to its level of maturity. According to Natsir (2022), the more mature the fertilizer, the fewer fibers will result and the particle size will be smaller. The texture of the fertilizer changes due to the decomposition by microorganisms in the fertilizer. This is in accordance with research by Suwatanti (2017), who found that a good fertilizer texture is when the final fertilizer no longer resembles its initial form because it has been destroyed due to natural decomposition by microorganisms living in the fertilizer.

The sensory results of texture parameters show that fertilizer has resulted with small particles. This is in accordance with government regulations regarding quality standards for compost, namely 0.55–25 mm (SNI-19-7030-2004). In the K_1B_2 and K_2B_2 treatments, there was a crumb texture, which was considered good fertilizer characteristic. Crumb texture will make the process of absorbing water into the soil easier, thereby preventing erosion.

3.2.4. pH Parameter Sensory Test

Based on table 1 and figure 5, the results of sensory observations on solid organic fertilizer of moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator showed that among the four treatments, the pH of the fertilizer was the best in the K_1B_1 and K_1B_2 treatments, namely 7.

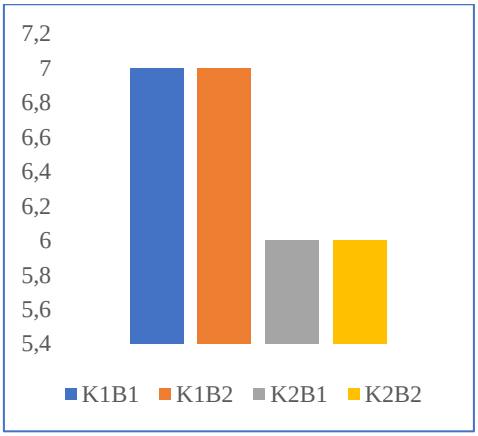


Figure 5. The results of observations on the pH of solid organic fertilizer from moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator.

The figure 5 shows the results for each treatment with a different pH value. Different pH values can be affected by the ratio of ingredients used. From the results obtained, it can be said that the pH level is good because it has a pH content range of 6-7. This is reinforced by SNI 19-7030-2004, which states that fertilizer's pH range is 6.80–7.49. The stable pH value can be said to be good for the growth of decomposing microorganisms. This is in accordance with research by Subula (2022), who found that if the pH value is too high, the nitrogen in the fertilizer material will turn into ammonia. Conversely, if the pH is too low, the microorganisms will die.

Different pH values for each treatment indicate that decomposition has taken place. According to Aditya (2015), the decomposition activity that occurs in fertilizers is the overhaul of complex compounds such as carbohydrates, proteins, and fats into simpler compounds to produce organic acids. The K_1B_1 and K_1B_2 treatments had a pH of 7, indicating that the pH is neutral. The neutral pH value of solid organic fertilizer will be easy to determine for used plants. This is in accordance with research by Setyawati (2021), who found that the pH value of solid organic fertilizers that are in neutral range will be easily absorbed and used by plants and is useful for reducing soil acidity. Based on the research results, it is known that the pH content of solid organic fertilizers for moringa leaves and peanut shells with the addition of banana peel waste is a good bio activator because it meets pH quality standards.

3.2.5. Nitrogen Content

Based on table 2 and figure 6, results of nitrogen content in organic fertilizer from moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator showed that the K_1B_1 treatment had the highest nitrogen content of 3.42%, and the lowest nitrogen content was found in fertilizer with the K_1B_2 treatment of 2.28%.

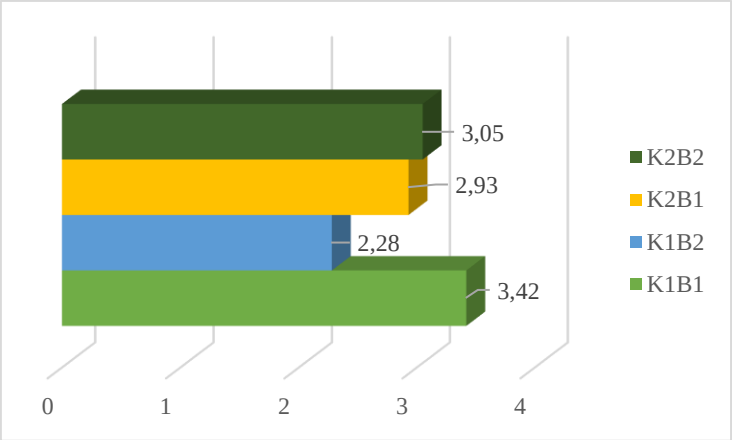


Figure 6. The results of the nitrogen content of solid organic fertilizer for moringa leaves and peanut shell soil with the addition of banana peel waste as a bioactivator.

Based on the figure 6, the nitrogen content formed after undergoing a fermentation process with the raw materials of moringa leaves and peanut shells with banana peel bioactivator has a different nitrogen content in each treatment. A comparison of ingredients and the amount of bioactivator can affect the difference in nitrogen content.

Based on the results of the two-way ANOVA test for nitrogen content, the comparison of ingredients and the amount of bioactivator shows a probability value (sig.) of 0.00 < 0.05, which means there is an effect of the ratio of ingredients and the amount of bioactivator on nitrogen content. This can be seen by the significant difference in the average nitrogen content of each treatment (Fig. 6).

The high nitrogen content in solid organic fertilizers is caused by the fact that moringa leaves have a high nitrogen content. This is in accordance with research by Adiaha (2017), who found that the phytochemical content of moringa leaves is nitrogen (N) 4.02%, phosphorus (P) 1.17%, and potassium (K) 1.80%. In addition to moringa leaves, peanut shells can increase the nitrogen

content of solid organic fertilizer. This is in accordance with research by Khomami (2015), which states that peanut shell compost contains N 2.43%, P 0.67%, K 1.19%, Ca 33.6%, and C/N 9.80.

The addition of banana peels as a bioactivator is also able to increase nitrogen content in solid organic fertilizers because banana peels contain *Bacillus* sp. *Bacillus* sp. is able to fix N_2 so as to increase the availability of nitrogen in the soil. Low nitrogen content can be affected by microbial activity in the decomposition process. According to research by Rosalina (2020), microbes are very active in the decomposition process and use a lot of nitrogen, which causes nitrogen content to drop. Based on the results of the study, the results of the nitrogen (N) content obtained are good and meet SNI 19-7030-2004 because the nitrogen content is above the minimum limit of 0.40%.

3.2.6. Phosphorus Content

Based on table 3 and figure 7, the results of the phosphorus content in organic fertilizer from Moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator showed that the K_1B_1 treatment had the highest phosphorus content of 0.11% and the lowest phosphorus content was found in fertilizer with the K_2B_1 treatment of 0.09%.

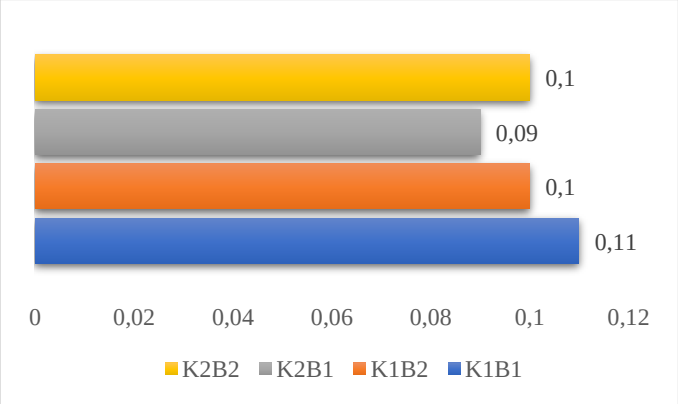


Figure 7. The results of the phosphorus content of solid organic fertilizer for moringa leaves and peanut shell soil with the addition of banana peel waste as a bioactivator.

Based on figure 7, the proportion of moringa leaves to peanut shells and the amount of bioactivator used can both have an impact on the phosphorus content. The highest phosphorus content was obtained in the K_1B_1 treatment using 300 g of moringa leaves and 200 g of peanut shells with the addition of 25 ml of banana peel bioactivator.

Based on the results of the two-way ANOVA test for phosphorus content , the comparison of ingredients and the amount of bioactivator shows a probability value (sig.) of 0.227 > 0.05, which means there is no effect of the ratio of ingredients and the amount of bioactivator on phosphorus content. This can be seen by the average phosphorus content of each treatment (Fig. 7), which shows no significant difference.

Phosphorus content in solid organic fertilizers from moringa leaves and peanut shells and the addition of banana peel as a bioactivator showed different results. Differences in phosphorus content in fertilizers can be affected by *Pseudomonas* sp., which is contained in banana peel bioactivators. According to Asril (2020), several groups of bacteria, such as *Pseudomonas*, *Bacillus*, and *Rhizobium*, have the highest phosphate solubilizing potential. The *Pseudomonas* bacteria group was found to be the best phosphate-solubilizing bacteria. Pseudomonas sp. helps break the chain of other compounds that bind to phosphate elements.

Microorganisms really need phosphorus to build their cells. The decomposition of organic matter and the assimilation of phosphorus occur due to the presence of phosphatase enzymes produced by microorganisms. According to research by Tumimbang (2016), if there is a shortage of compost microorganisms, the process of decomposition of organic matter and assimilation of phosphate will be reduced, so that phosphorus is not used, and if the number of microorganisms

in the fertilizer is sufficient, the decomposition of organic matter takes place perfectly. Based on the results of the study, the phosphorus (P) content in the K_1B_1, K_1B_2, and K_2B_2 treatments complied with SNI 19-7030-2004 because the nitrogen content was above the minimum threshold of 0.10%. Meanwhile, the content of phosphorus (P) in the K2B1 treatment did not meet SNI 19-7030-2004 because the potassium content was below the minimum limit of 0.10%.

3.2.7. Potassium Content

Based on table 3 and figure 10, the results of potassium content in organic fertilizer from leaves of moringa and peanut shells with the addition of banana peel waste as a bioactivator showed that the K_1B_1 treatment had the highest potassium content of 0.22%, and the lowest potassium content was found in fertilizers with K_1B_2 and K_2B_2 treatments of 0.19%.

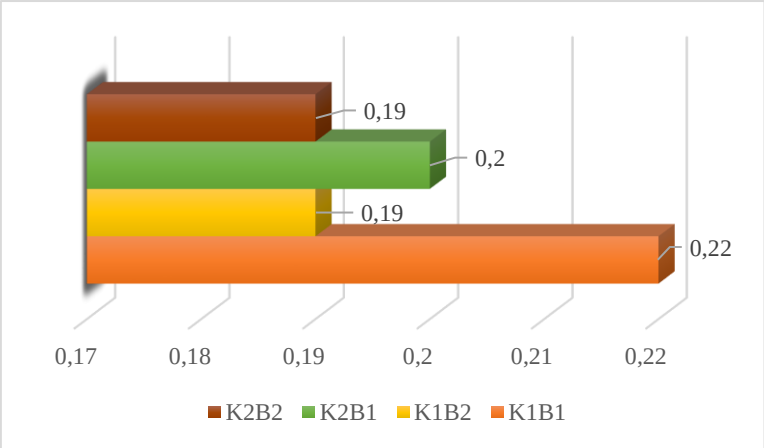


Figure 8. The results of the potassium content of solid organic fertilizer for moringa leaves and peanut shell soil with the addition of banana peel waste as a bioactivator.

Potassium content is formed after experiencing a fermentation process with raw moringa leaves and peanut shells, with the addition of banana peel waste as a bioactivator. Each treatment has a different potassium content. A difference in potassium value can be caused by the comparison of fertilizer ingredients and the number of different bioactivators. The results showed that the addition of 25 ml of banana peel bioactivator could result in higher potassium content. This can be interpreted as meaning that the amount of potassium in the best banana peel bioactivator to get high potassium levels is 25 ml.

Based on the results of a two-way ANOVA test for potassium content on the ratio of ingredients and the number of bioactivators show a probability value (sig.) 0.122 > 0.05, which means there is no effect of the ratio of ingredients and the amount of bioactivator on potassium content. Although the amount of bioactivator has a probability value of 0.009 < 0.05, which means there is an effect of the amount of bioactivator on potassium content, the effect that occurs is not significant and does not affect the potassium content. This can be seen in the average potassium content of each treatment (Fig. 8), which did not show a significant difference.

The potassium content of solid organic fertilizer is influenced by the activity of microorganisms that decompose organic matter. According to research by Bachtiar (2019), the difference potassium content can be caused by differences in the speed at which microorganisms carry out the decomposition process of organic matter during the fermentation process. In essence, potassium is already present in organic stuff, but because it is still complicated, plants cannot directly absorb it. According to research by Worotitjan (2022), during the decomposition process, complex organic waste will break down into simpler organic matter, creating potassium that plants can absorb.

Potassium content below the minimum standard can be caused by microorganisms need for potassium in the decomposition process of organic matter. According to Trivana (2017), which

states that potassium is used by microorganism as a catalyst, the presence of bacteria and their activity will greatly affect the increase in potassium content.

The results showed the potassium (K) content in the K_1B_1 and K_2B_1 treatments were good and fulfilled SNI 19-7030-2004 because of the potassium content above the minimum limit of 0.20%. Meanwhile, the content of potassium (K) in the K_1B_2 and K_2B_2 treatments does not meet SNI 19-7030-2004 because the potassium content is below the minimum limit.

4. CONCLUSIONS

Based on the results of research, solid organic fertilizer from moringa leaves and peanut shells with the addition of banana peel waste as a bioactivator average has good quality in terms of sensory observations and tests of nutrient content (nitrogen, phosphorus, and potassium) according to SNI 19-7030-2004. This solid organic fertilizer study did not show a significant difference in each treatment. The K_1B_2 treatment (300 g of moringa leaves and 200 g of peanut shells with 30 ml of banana peel bioactivator) had the characteristics of mature organic fertilizer, namely blackish brown in color, a crumbly texture, and an earthy aroma. The K_1B_1 treatment (300 g of moringa leaves and 200 g of peanut shells with 25 ml of banana peel bioactivator) and the K_1B_2 treatment (300 g of moringa leaves and 200 g of peanut shells with 30 ml of banana peel bioactivator) had the highest pH, namely 7. The K_1B_1 treatment has the best nutrient content with 3.42% nitrogen, 0.11% phosphorus, and 0.22% potassium. The results of the study can be concluded to be that the quality organic fertilizer is in accordance with SNI 19-7030-2004. Suggestion from researchers are: 1) It is hoped that further testing will be carried out on the application of solid organic fertilizers made from moringa leaves and peanut shells with banana peel bioactivator on plants. 2) It is hoped that in future studies, variations will be made on bioactivators other than banana peels.

5. ACKNOWLEDGMENTS

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Quality of Liquid Organic Fertilizer Peanut Shells and Tofu Dregs With Banana Stems as Bioactivator

Muhammad Rizal Kahfi, Aminah Asngad*
Biology Education Department, Faculty of Teacher Training and Education, Universitas Muhammadiyah Surakarta.
Jl. A. Yani Tromol Pos I, Pabelan, Kartasura, Surakarta 57162, Jawa Tengah, Indonesia
*Corresponding Author. E-mail address: aa125@ums.ac.id

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Peanut Shells
Tofu Dregs

ABSTRACT

Liquid organic fertilizer is nutrition given to plants to improve the supply of nutrients so that plants can grow well. The utilization of peanut shells and tofu dregs has the potential as liquid organic fertilizer and banana stems as a bioactivation. This study aimed to determine the quality of liquid organic fertilizer, a combination of peanut shells and tofu dregs, adding moles of banana stems as a bioactivator. This study used experimental methods and a Completely Randomized Design (CRD) consisting of 2 factors and 4 combinations with 3 repetitions. Factor 1 combines peanut shells and tofu waste K1 = 100 ml: 200 ml and K2 = 120 ml: 180 ml. Factor 2 is the local microorganism concentration, namely M1 = 100ml and M2 = 200ml. Data were analyzed using descriptive qualitative and quantitative. The results showed that the fertilizer had a yellowish brown and light brown color, a slightly pungent fermented to not overpowering, and a pH of 4. The highest N was in K1M1 combination of 0,57%, the highest P in K1M1 and K2M1 was 0,05%, and the highest K in K1M1 of 0,08%. It can be concluded that liquid organic fertilizer has good quality complies with SNI 19-7030-2004.

1. INTRODUCTION

Plants need nutrients to support their growth. The addition of ingredients with sufficient nutrients will make the plants grow well. Using fertilizers can improve and add nutrients required for plants to grow. Fertilizers are materials added to growing media or plants to meet the nutrients plants need to grow correctly. In fertilizers, the availability of anions for plant growth, such as nitrate, phosphate, borate, and chloride, as components function to increase nutrients for plant needs is one of the functions of fertilizer use. Fertilizers are divided into inorganic fertilizers (chemical) and organic fertilizers (natural).

Organic fertilizers are materials added to improve the supply of nutrients for plants and consist of organic materials derived from plants or animals that have undergone a fermentation process and are used as a source of plant nutrition. Organic fertilizers are divided into solid and liquid forms. Liquid organic fertilizer is a solution containing one or more soluble carriers of the elements needed by plants, and solid organic fertilizer is organic matter in solid form from plant residues or animal waste. Liquid organic fertilizer has the advantage of being able to provide nutrients according to plant needs more easily and quickly evenly distributed because of its liquid form. According to Roidah (2013), liquid organic fertilizer can use organic materials such as animal manure, animal body parts, and plants. Waste can also be used to make liquid organic fertilizer, namely peanut shell waste, leri water, tofu dregs, and others.

In general, peanuts are only used for seeds for consumption and food purposes, while the skin produces waste and has not been widely used. Peanut shell waste is a waste that is often found in the surrounding environment and is simply thrown away. Peanut skin has an essential substance

for the fulfillment of plant nutrients. According to Sihite (2020), peanut shell waste contains several nutrients: N 2.64%, P2O5 3.56%, K2O 1.67%, and organic C 4.93.

Other materials are needed to manufacture liquid organic fertilizer so that the nutrients required by plants can be fulfilled. One of the ingredients that is easily found around us is tofu dregs. Tofu dregs are solid waste from the tofu processing industry, which is underutilized. Discarded tofu waste can pollute the environment. One effort to overcome this is by utilizing tofu waste as fertilizer. Tofu dregs contain 8.66% protein, 3.79% fat, 51.63% water, and 1.21% ash (Kusumaningtyas et al., 2020). Sunarsih et al. (2018) found that tofu dregs contained nutrients namely N 0.09%, phosphorus 0.062%, and K 1.82%.

Liquid organic fertilizer production occurs anaerobically or does not require oxygen and is fermented without sunlight. The manufacture of organic fertilizers requires MOL (local microorganisms). Local microorganism is a bioactive component that can break down organic matter. Specifically, bioactive agents are purified microbial isolates that uniquely digest organic materials, including cellulose fibers. Hadi (2019) stated that adding local microorganism to manufacture liquid organic fertilizer can accelerate the fermentation process. Local microorganism can be obtained by utilizing household waste or crop residue, vegetables and fruits, animal waste, etc. Local microorganism that can be used as a decomposer is local microorganism which contains many decomposing microorganisms, such as the local microorganism of banana stems.

Banana stems can be used as an alternative to making organic local microorganism. Banana stems can be used as ingredients for local microorganisms that can increase soil fertility. Local microorganisms can help accelerate the fermentation process. These decomposing bacteria help make compost faster, easier, and of better quality. Yuliansari & Endina (2020) stated that in banana stems, there is the bacterium *Pseudomonas* sp. and *Citrobacter freundii* which can speed up the fermentation process. This shows that banana stem is one of the ingredients that can be used as a local microorganism or activator.

Based on the background above, the problem is: How is the quality of liquid organic fertilizer combined with peanut shells and tofu dregs with adding banana stems as a bio activator? This study aims to determine the quality of liquid organic fertilizer combined with peanut shells and tofu dregs with the addition of banana stem local microorganism as a bio activator in terms of sensory characteristics (color, aroma, and pH) and nitrogen, phosphorus, and potassium content.

The benefits of the results of this study are expected to provide information to 1). Providing information to the general public about using peanut shells, tofu dregs, and banana stems as liquid organic fertilizer. 2). Provide information to fertilizer makers about the quality, content, and content of good plant nutrients. 3). Farmers and materials for consideration for the Government regarding alternatives to making organic fertilizer using peanut shells and tofu dregs with adding banana stem bio activators as a substitute for chemical fertilizers.

2. MATERIALS AND METHODS

This research was conducted at the UMS Biology Laboratory Greenhouse. This study used 16L jars, 5L jars, blenders, basins, digital scales, analog scales, wooden stirrers, basins, stoves, filters, 250ml measuring cups, 1000ml measuring cups, knives, pH indicators, and bottles. At the same time, the materials used in this study included peanut skins, tofu dregs, banana stems, water, brown sugar, molasses, leri water, groundwater, bran, pH stick, raffia, and label paper.

The research procedures include: 1). Making the bioactivation: chopping and grinding 3 kg of banana stems into a jar, adding 3 liters of leri water, coconut water, and 800 grams of brown sugar, stirring until homogeneous, and fermenting for two weeks. 2). Extracting peanut shells: Grind 3 kg of peanut skins with 3 liters of water, filter the crushed material, and extract it. 3). Making tofu dregs flour: 3kg of tofu dregs is heated in a pan on the stove for 45 minutes and pureed with 1 liter of water. 4) Manufacture of fertilizer: the extract and local microorganism of banana stems are put into a jar according to the treatment, 5). add 90 ml of molasses and 90 gr of bran in each jar, then

homogenize, close the jar, ferment for 14 days, and do sensory observations every three days (Nasution and Rizka 2022).

The method used was an experimental method and completely randomized design (CRD) with two factors: the composition of peanut shells with tofu pulp waste and adding a banana stem bioactivation. This study used 4 treatments with 3 repetitions, and the data analysis technique used was descriptive qualitative and quantitative analysis.

3. RESULT AND DISCUSSION

3.1 Result

3.1.1 Sensory Test

After going through fermentation for 14 days, and sensory tests were carried out on ten panelist to test of sensory characteristic, the results of the liquid organic fertilizer combined with peanut shells and tofu dregs and the addition of banana stems as a bio activator can be seen as follows:

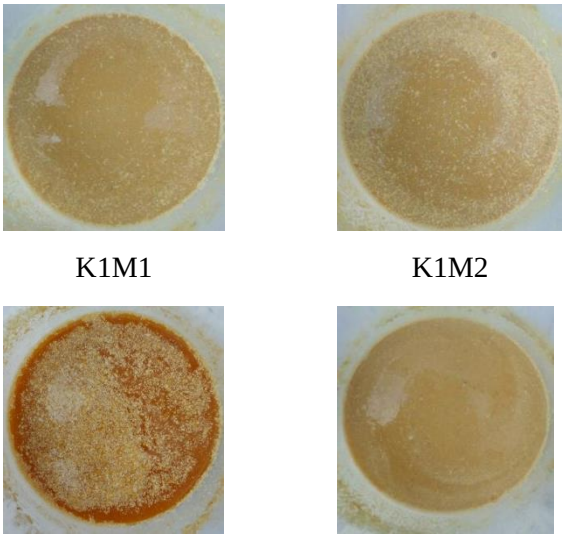


Figure 1. Liquid organic fertilizer result

The results of sensory observations that have been made regarding the color, aroma, and degree of acidity (pH) in the liquid organic fertilizer combination of peanut shells and tofu dregs with the addition of banana stems as a bioactivator can be seen in the following table:

Table 1. Sensory test results of liquid organic fertilizer combination of peanut shells and tofu dregs with the addition of banana stems as a bioactivator

Combination	Sensory Observation Result		
	Color	Aroma	pH
K1M1	Light brown	Fermentation smell not overpowering	4
K1M2	Light brown	Fermentation smell not overpowering	4
K2M1	Yelloowish-brown	Slightly pungent fermented smell	4
K2M2	Light brown	Fermentation smell not overpowering	4

Noted:
K1 M1 = Liquid organic fertilizer with a concentration of 100 ml of peanut shell extract and 200 g of tofu dregs with 100 ml local microorganism of banana stem.
K1 M2 = Liquid organic fertilizer with a concentration of 100 ml of peanut shell extract and 200 g of tofu dregs with 150 ml local microorganism of banana stems.
K1 M2 = Liquid organic fertilizer with a concentration of 120 ml of peanut shell extract and 180 g of tofu dregs with 100 ml local microorganism of banana stems.
K2 M2 = Liquid organic fertilizer with a concentration of 120 ml of peanut shell extract and 180 g of tofu dregs with 150 ml local microorganism of banana stems.

Based on the results of the table analysis above, it can be seen that sensory observations of all samples have a light brown and yellowish brown color with a pH of 4 and a slight difference in aroma.

3.1.2 N, P and K Content

Based on the results of laboratory tests regarding the macro-nutrient content including nitrogen (N), phosphorus (P), and potassium (K) in the liquid organic fertilizer combination of peanut shells and tofu dregs with the addition of banana stems as a bioactivator, it can be seen from the test results for the content in following table:

Table 2. The content of N, P, and K in liquid organic fertilizer a combination of peanut shells and tofu dregs with the addition of psiang stems as a bioactivator

Combination	Analysis Result		
	N (%)	**P (%)**	**K (%)**
K1M1	0,55	0,05**	0,08 **
K1M2	0,57 **	0,04 *	0,07
K2M1	0,52	0,05	0,06 *
K2M2	0,48 *	0,04	0,06

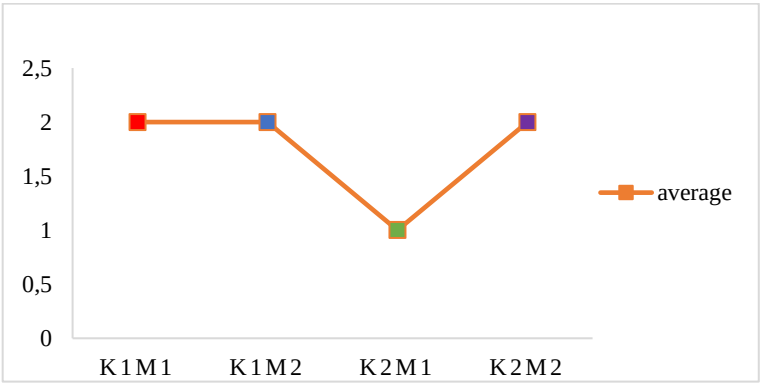
Where: (*) lowest yield
(**) highest yield

The analysis of N, P, and K content in Table 2 shows that the highest nitrogen (N) content was found in the K1M2 combination of 0.57%. In contrast, the lowest nitrogen content was found in the K2M2 combination, which was 0.48%. the highest phosphorus content was in the combination K1M1 and K2M1, namely 0.05%, while the lowest phosphorus content was in the combination K2M1 and K2M2, namely 0.04%. The highest potassium (K) content was found in the K1M1 combination, 0.08%, and the lowest in the K2M1 combination, 0.06%.

3.2 Discussion

3.2.1 Color parameters

After sensory observations on liquid organic fertilizer from peanut shells and tofu dregs with the addition of banana stems as a bioactivator, it showed that each treatment sample had the slight different color. Then the data can be presented in the form of a bar chart as follows:



Description: 1 = yellowish brown; 2 = light brown; 3 = dark brown; 4 = blackish brown

Figure 2. Color parameter of liquid organic fertilizer

Color is one of the determining factors for the quality of liquid organic fertilizer and determining the maturity of liquid organic fertilizer. It can be seen from the results of the average color observation of liquid organic fertilizer peanut shells and tofu dregs with the addition of banana stems as a bio activator that there is no significant difference in color. In the treatment combinations K1M1, K1M2, and K2M2, the POC was light brown, while in the K2M1 treatment combination, the color was yellowish brown.

The color change in liquid organic fertilizer can be affected by the color of the ingredients used. The ingredients used in this fertilizer are light brown extracted banana stems, white tofu dregs flour, brownish white banana stem MOL, and other additives such as molasses, rice bran, coconut water, and leri water, which can also affect the color of the fermented product liquid organic fertilizer. The activity of microorganisms from adding banana stem bio-activators accelerated the change of the liquid organic fertilizer color from each treatment. Its relevant research by Situmorang (2018) states that adding a bio activator in the manufacture of liquid organic fertilizer can cause a color change from blackish brown to brown due to the activity of microorganisms during the decomposition process. This also follows research by Siregar (2016) which states that microorganism activity can affect the color change in liquid organic fertilizer during fermentation.

Mixing all these ingredients makes the resulting liquid organic fertilizer a yellowish-brown color at first; after being fermented, it produces a light brown color. It is appropriate Tsaniya's research (2021) that in SNI 19-7030-2004, physical indicators of fertilizer maturity in color are between brown and blackish brown.

3.2.2 Aroma Parameters

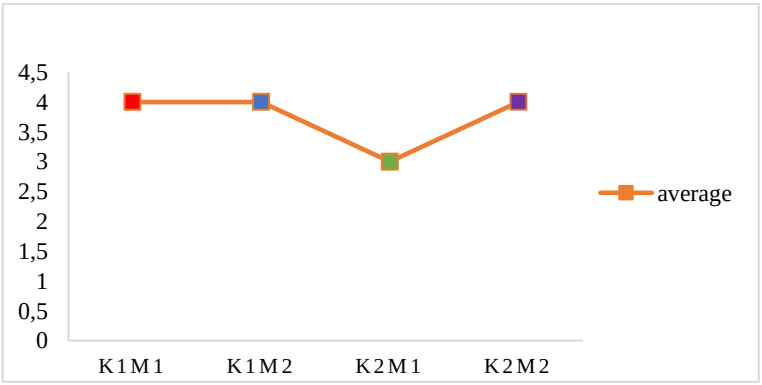


Figure 3. Aroma parameter liquid organic fertilizer

Description: 1 = bad smell; 2 = pungent fermented odor; 3 = slightly pungent fermented smell; 4= fermentation smell not overpowering

The results showed that the four treatment samples had a non-stinging aroma. At the beginning of the fermentation process, the aroma is like the aroma of peanut butter. This is due to the raw material used, peanut shells, and the addition of bran and molasses as a source of nutrition for microorganisms to decompose organic materials. On the 3rd to 12th day of observation, the fertilizer gave off a change in aroma to fermented tape, which over time, was pungent. However, on the 14th day of observation, the fertilizer did not show a pungent odor.

During 14 days of making fertilizer, there is a fermentation process by microorganisms present in liquid organic fertilizer with the help of a banana stem bioactivator. The decomposition activity of the material by microbes causes the smell of tape. The pungent smell of tape or alcohol indicates microbial activity that is currently active, and a smell that gradually decreases indicates microbial activity that has started to become inactive or that the fertilizer is ripe. It is appropriate with research by Lestari et al. (2019), which states that liquid organic fertilizer fermented for 7-14 days will smell like tape. So the liquid organic fertilizer produced is of good quality.

3.2.3 pH Parameters

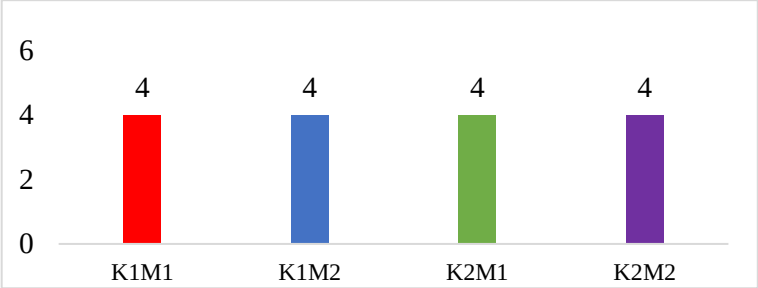


Figure 4. pH parameter of liquid organic fertilizer

After conducting sensory observational research on liquid organic fertilizer, a combination of peanut shells and tofu dregs with the addition of banana stems as a bio activator, it was shown that there was a similarity in pH value in each treatment. The pH of the treatment sample indicated that the pH of the fertilizer was 4. At the beginning of the fermentation process, the pH of the four treatments was acidic, namely, 5. The activity of actively developing bacteria could affect the decrease in acidity. It is according in Kurniawan's research (2017) that the degree of acidity in fertilizers that is experiencing an increase or decrease is caused by bacterial activity.

This shows that the pH of the liquid organic fertilizers in this study was still in the acidic pH category, so they were still suitable for the growth of microbes that decompose organic matter in liquid fertilizers. The advantage of pH, which tends to be acidic, can produce many nitrogen elements and kill the nymphs or eggs of pathogenic organisms (Setyaningsih et al. 2017). Too high a pH increases oxygen consumption and damages the environment. Conversely, if the pH is too low, some microorganisms will die. This pH value follows the requirements for liquid organic fertilizer from the Decree of the Minister of Agriculture of the Republic of Indonesia concerning Minimum Technical Requirements for Organic Fertilizers, Biological Fertilizers, and Soil Improvement, which states that the pH value of Liquid Organic Fertilizer is between 4-9 (Tsaniya et al. 2021).

3.2.4 N, P dan K Content

Based on the results of laboratory tests regarding the macro-nutrient content, including nitrogen (N), phosphorus (P), and potassium (K) in the liquid organic fertilizer combination of peanut shells

and tofu dregs with the addition of banana stems as a bioactivator, it can be seen from the test results for the content in following diagrams:

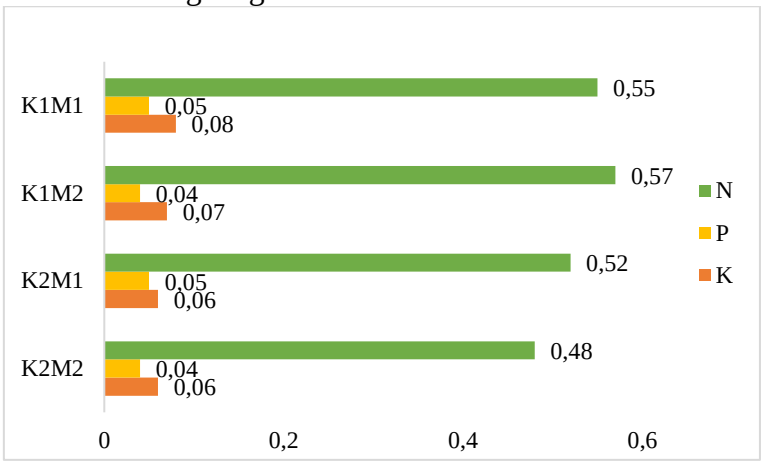


Figure 5. NPK content

3.2.4.1 Nitrogen Levels (N)

The test results for the N, P, and K content in Figure 5 shows that the nitrogen content has a higher percentage content than the P and K content. The highest average nitrogen content found in the K1M2 combination of 0.57%, while the average content is the lowest nitrogen average found in the K2M2 combination, namely 0.48%. It follows the results of statistical tests (means) that the highest average nitrogen content is in the K1M2 combination, and the lowest is in K2M2.

The statistical analysis by two way anova showed significant results with a significance level of less than 0.05, namely 0.011, which meant significant differences between the four liquid organic fertilizer treatment combinations. The fermentation process can influence the difference in nitrogen levels. Following research by Mulyadi et al. (2013), the nitrogen content of each treatment combination was different because the speed of the microbes in decomposing the fermented material was different. According to Meriatna et al. (2019), the nitrogen content decreased after the 16th day of fermentation. The decreasing nitrogen level was also caused by the reaction of N with water, which produced NO3- and H+ (Trivana et al. 2017).

The quality of Nitrogen can decrease quite drastically. It is presumably because the element nitrogen can evaporate together with the evaporation of water. The quality of liquid organic fertilizer can decrease during storage; even though it has been appropriately stored, nutrients can still evaporate and become unavailable, so the longer it is stored, the lower the fertilizer quality can be (Nurlaila et al. 2017). The nitrogen (N) content in liquid organic fertilizer combined with peanut shells and tofu dregs with adding banana stems as a bio activator has met the Indonesian National Standard regarding BSN (Badan Standarisasi Nasional) 2004 standard liquid organic fertilizer. Good fertilizers have a total N parameter that is at a percentage of more than 0.40%.

3.2.4.2 Phosphorus Levels (P)

The observations showed that the highest average phosphorus content was in the combination of K1M1 and K2M1, namely 0.05%, while the lowest average phosphorus content was in the combination of K1M2 and K2M2, 0.04%. The four treatment combinations did not show a significant difference. It follows the results of statistical tests (means) that the highest average phosphorus content is in the combination of K1M1 and K2M1, and the lowest phosphorus content is K2M1 and K2M2. The two way anova statistical analysis did not show a significant difference between the four treatments. This also follows the significance test, which shows a sig value (1) >

0.05, so there is no significant difference between the four liquid organic fertilizer treatment combinations.

The phosphorus content in liquid organic fertilizer combined with peanut shells and tofu dregs with adding banana stems as a bio activator does not meet the minimum standard because phosphorus is less than 0,10%. This can be caused by a need for phosphorus nutrient content in the essential ingredients of liquid organic fertilizer. Nur et al. (2016) in their experiments reported that each waste or waste has a different level of phosphorus and can affect the speed of the fermentation process. Phosphorus-decomposing microorganisms also affect the phosphorus content, whereas in the banana stem, bio activator, there is a phosphorus-decomposing bacteria, namely Citrobacter freundii, which will increase phosphorus levels. The minimum nutrient content in the fertilizer is due to the activity of microorganisms which, apart from breaking down phosphorus, also use it for living activities. This is also because the decomposing microorganisms have reached the death phase before the fermentation process ends.

The fermentation time also affects the final yield of phosphorus content in liquid organic fertilizer. Kusumadewi et al (2019) explained that the longer the fermentation time, the more nutrients will be used for the activities of microorganisms, and over time, the availability of nutrients will be exhausted, and the activity of microorganisms in breaking down organic compounds will decrease. The resulting phosphorus content will be less. The high N content in liquid organic fertilizer can cause a high P content. This is according to research by Situmorang (2018) that the high content of phosphorus is influenced by the high content of nitrogen, where the higher the nitrogen content, the activity of microorganisms that break down phosphorus will increase, causing the phosphorus content in liquid organic fertilizer to increase.

3.2.4.3 Potassium Levels (K)

Based on observations of the results, the highest average potassium level was in the K1M1 combination, which was 0.08%, and the lowest was in the K2M1 and K2M2 combination, which was 0.06%. From the research results, the potassium content in liquid organic fertilizer combined with peanut shells and tofu dregs with the addition of banana stems as a bio activator in the four combinations showed that the results did not meet SNI 2004 because the K content had a percentage of less than 0.20%.

The results of statistical analysis by two way anova showed a significance value of 0,644 > 0,05. These statistical results indicate no significant difference between the four treatment combinations because the significance results are more than 0,05. The K content is affected by the nutrient content in the raw materials for peanut shells and tofu dregs used to manufacture liquid organic fertilizer. The nutrient content of potassium contained in peanut shells can be seen from research by Sihite et al. (2020) which is equal to 1.67%, while the potassium content in tofu dregs is seen from research by Sunarsih et al (2018) at 1.82%. Microorganisms use potassium as a catalyst, and the activity of microorganisms dramatically influences the increase in potassium levels. The higher the activity of microorganisms, the higher the potassium level. The low potassium content in liquid organic fertilizer is also because the microorganisms in it have yet to develop optimally. The organic matter in liquid organic fertilizer has not entirely decomposed, and the microorganisms are still in adaptation (Sulfianti et al. 2021).

The low potassium content in liquid organic fertilizer is also because the microorganisms in it have yet to develop optimally. The organic matter in liquid organic fertilizer has not been wholly decomposed, and the microorganisms are still in the adaptation phase (Sulfianti et al. 2021).. From the K content in the peanut shell, it can be concluded that the greater the material used, the more potassium nutrient content is obtained. The content of nutrient elements contained in organic fertilizers is usually relatively small for N, P, and K. However, the amount available for each element can be quite a lot, of the concentration of materials in organic fertilizers is higher (Mustamu 2020).

4. CONCLUTIONS

Based on the research results, peanut shells and tofu waste, adding banana stems as activators can be used as liquid organic fertilizer. It can be seen from the observations of sensory characteristics, namely the color of yellowish brown and light brown, slightly pungent to not overpowering fermented aroma and a pH of 4. So liquid organic fertilizer from peanut shells and tofu dregs with local microorganism banana stems as a bioactivation has good quality. Furthermore, meet the sensory requirements of SNI 19-7030-2004. The percentage of nitrogen (N), phosphorus (P), and potassium (K) content of liquid organic fertilizer combined with peanut shells and tofu dregs with the addition of local microorganism of the banana stem as a bio activator with N content complies with SNI 19-7030-2004 and shows a significant difference in treatment. At the same time, P and K did not meet or show a significant difference in treatment. Suggestions that the author can convey are it is necessary to test the content of each ingredient before making liquid organic fertilizer, and further tests regarding applying liquid organic fertilizer, a combination of peanut shells and tofu dregs waste with banana stems as a bioactivator.

5. ACKNOWLEDGMENTS

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The Quality of Infrastructure Facilities and the Readiness of Biology Laboratories to Support Learning in High School

Mei Renni Sholikhah, Lina Agustina*
Biology Education Department, Faculty of Teacher Training and Education, University of Muhammadiyah Surakarta. Jl. A. Yani Tromol Pos I, Pabelan, Kartasura, Surakarta 57162, Central Java, Indonesia
*Corresponding Author. E-mail address: la263@ums.ac.id

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ABSTRACT

Biology learning is the mastery of collecting knowledge information in concepts, principles, and facts, as well as learning and comprehending how the process of acquiring knowledge is achieved directly through the practicum. Physical and social skills can be developed through the use of practicum activities as a learning supplement. The implementation of practicum activities must be supported by a high-quality laboratory infrastructure. The laboratory equipment and infrastructure of Cal must comply with the laboratory requirements outlined in Permendiknas Number 24 of 2007. The research aimed to determine the quality of infrastructure facilities and the readiness of biology laboratories to support learning at SMA Negeri 1 Cawas. This research is qualitative descriptive research through observation, interviews and documentation. The results showed that the quality of biological laboratory infrastructure based on Permendiknas Number 24 of 2007 was included in the perfect category with an average percentage of 95%. Meanwhile, laboratory readiness obtained an average readiness percentage value of 92%, including in the ready category, so the biology laboratory in this school is ready to be used to support learning.

1. INTRODUCTION

In a learning environment, learning is the process of interaction between participants, instructors and learning resources. Education give learning so that the process of obtaining knowledge can occur (Suardi, 2018). Biology is a discipline of study that examines the variety and interdependence of all living organisms on Earth. Thus, biology is among the sciences that contribute considerably to the growth of science (Susilawati & Bakhtiar, 2018). As a field of study, biology stands out due to the investigation of all living things, the theme of problems affecting biological objects that arise in nature, and the use of scientific methods to resolve concerns. Biology education is impacted by the characteristics of biology as a science (Trianto, 2010).

Learning biology involves not only mastery of the collection of knowledge information in the form of concepts, principles, and facts, but also learning and comprehension of how knowledge is acquired. Biology education should stress direct experiential learning in order to give students with meaningful learning in the cognitive, psychomotor, and affective domains. Biology education teaches and comprehends how knowledge is acquired through practical actions (Daba et al., 2017). Practical activities in biology learning are carried out to arouse student learning motivation, develop basic skills in conducting experiments, and as a promoter of the delivery of teaching materials, hence biology education and practicum are linked (Neji et al., 2014). This demonstrates the importance of laboratories in aiding biology teaching and accomplishing educational goals (Kalsum et al., 2018). Practical activities can take place well when the availability of the means and facilities of the biological laboratory in supporting the practice is available in a good condition

and a sufficient amount, it must comply with the Permendiknas Number 24 of 2007 standard on the medium and facility of high school or madrasah aliyah (SMA or MA), so that the laboratory is one of the most important facilities in support of biological practice (Poedjiadi, 2007).

A laboratory is a location where observations, scientific research, experiments, and other scientific endeavors are conducted. The laboratory is one of the most important components for supporting biology education in schools, needing confirmation between theory and reality (Daud & Pratiwi, 2017). Through problem solving, educators can also strengthen their critical thinking abilities in a laboratory. Without a school laboratory, it will be difficult to develop the competence and quality standards of educators therefore, it is necessary to have a laboratory with quality infrastructure in accordance with Permendiknas Number 24 of 2007 that is managed professionally, as laboratory infrastructure is one of the most essential laboratory resources and should not be neglected (Gusnani et al., 2019).

To facilitate practicum activities, students must be laboratory ready in order to cultivate scientific attitudes and promote learning. Aspects of laboratory preparedness, such as laboratory room design, laboratory administration, storage of laboratory material instruments, and well-managed laboratory management, will give students with a genuine laboratory experience (Russel et al., 2018). The establishment of standardized biology laboratories will facilitate the optimal operation of the laboratory-dependent learning process and the attainment of educational objectives (Rahmiyati, 2018).

In support of the school's vision and goal, SMA Negeri 1 Cawas develops numerous facilities that can be utilized by all school components. One of the school's facilities is the biology laboratory. Based on observations and interviews, it has been determined that the biology laboratory at this school has been utilized actively to enhance learning. To yet, there has been no research on the quality of infrastructural facilities and the readiness of biological laboratories. Even though SMA Negeri 1 Cawas is one of the state schools and holds the title of Adiwiyata for his many accomplishments, the research aims to provide information on the description of the quality of infrastructure facilities and the readiness of laboratories biology to support learning, so that it can be used as evaluation material for all parties involved.

2. RESEARCH METHODS

2.1. Types of Research

This qualitative descriptive research aims to provide an overview of the quality of infrastructure facilities and the readiness of biological laboratories to support learning at SMA Negeri 1 Cawas.

2.2. Place and Time of Research

This research was carried out in the biology laboratory of SMA Negeri 1 Cawas, which is based on Jl. Tembus Cawas-Pedan, Tugu, Cawas, Klaten, Central Java 57463. The study will be conducted from February 2023 to May 2023 and calculated from submitting titles to reporting research results.

2.3 Data and data sources

Data is collected in the form of laboratory rooms, laboratory furniture, experimental tools and materials, educational media, consumables, and other equipment for the aspect of biological

laboratory infrastructure quality, while data is collected in the form of laboratory room design, laboratory administration, laboratory management, storage of tools and materials, and completeness of equipment for the aspect of biological laboratory readiness. Laboratory management instructors and laboratory spaces are the sources of the data for both elements.

2.4 Data Collection Techniques

2.4.1 Observation

Observation in this study aims to determine the quality of facilities and infrastructure and the readiness of biological laboratories. This is done using non-participatory techniques. Namely, researchers are not involved in the learning process but only as observers. Hence, researchers make direct observations to see and observe laboratory rooms, furniture, experimental tools and materials, educational media, consumables, teaching aids and other equipment based on the standards listed in Permendiknas Number 24 of 2007.

2.4.2 Interview

To gather information about the standard of infrastructure facilities and the readiness of biological laboratories, this study interviewed laboratory management teachers. To determine laboratory readiness, interviews are conducted in closed settings with a restricted number of response options such as always, frequently, never, and sometimes and in open settings with unlimited response options.

2.4.3 Documentation

Documentation is done in biological laboratories to provide tangible proof of observations. According to Permendiknas Number 24 of 2007, the information was obtained in the form of images or photographs related to laboratories.

2.5 Research Procedure

The process in this study begins with the stage of preparation, which takes the form of problem formulation, draft question preparation, instrument validation submission, and practice of research licensing letter. The second stage is implementation, which entails doing research on the infrastructure facilities' quality and biological laboratories readiness to assist learning while using predetermined data collection methods and documenting all study findings. The last stage is when data processing, inference, and compilation are completed.

2.6 Data Analysis Techniques

Data obtained from observations of the quality of infrastructure facilities and closed interviews of biological laboratory readiness are then analyzed. There is an observation of the quality of infrastructure facilities obtained compared with the standards written in Permendiknas Number 24 of 2007. The results of the study can be calculated by the percentage formula (Agustina & Ningsih, 2017):

$$P = \frac{n}{N} \times 100\%$$

Information:

P: percentage
n: the number of scores obtained
N: maximum number of scores
The percentage results are interpreted based on their respective criteria:

a. Quality of laboratory infrastructure

81% – 100% : Excellent
61% – 80% : Good
41% – 60% : Good enough
21% – 40% : Not Good
0% – 20% : Very Not Good
(Agustina et al., 2019)

b. Laboratory Readiness

76% – 100% : Ready
56% – 75% : Simply Ready
41% – 55% : Less Prepared
≤ 40% : Not Ready
(Sugiyono, 2013)

3. RESULTS AND DISCUSSION

3.1. Quality of Laboratory Facilities and Infrastructure In Supporting Learning

The laboratory has a crucial role in learning biology in schools, especially at the high school level, because the activities there can support the achievement of competencies and learning objectives related to psychomotor and actual experience in the field. Facilities and infrastructure in educational institutions are supporting factors for teaching and learning in schools, and one of them is the laboratory. Standardizing the caliber of optimum infrastructure and facilities for biological laboratories alludes to Permendiknas Number 24 of 2007 (Jannah & Sontani, 2018).

The observation results regarding the quality of biological laboratory facilities and infrastructure refer to the Permendiknas Number 24 of 2007 standards. This standard is used as a reference for minimum research standards regarding the quality of biological laboratory facilities and infrastructure at SMA Negeri 1 Cawas. According to standardizing natural laboratory infrastructure must meet predetermined criteria, including laboratory space, furniture, teaching aids, experimental tools and materials, educational media, consumables, and other equipment in the laboratory. Data on the quality of biological laboratory infrastructure are presented in Table 1.

Table 1. Quality of Biology Laboratory Infrastructure Facilities SMA Negeri 1 Cawas

No	Observed aspects	Percentage	Category
1.	Laboratory Room	100%	Excellent
2.	Furniture	100%	Excellent
3.	Props	96%	Excellent
4.	Experimental Tools and Materials	97,2%	Excellent
5.	Educational Media	100 %	Excellent
6.	Consumables	92,3 %	Excellent
7.	Other Equipment	80%	Good
	Average	95%	Excellent

Based on Table 1, it is known that the quality of biological laboratory infrastructure in supporting learning in the school shows an average score of 95%, which is included in the category of high school even though it has not 100% satisfied the requirements of Permendiknas Number 24 of 2007 while also supporting practical activities to aid in the school's biology curriculum. The indicators given below show that each aspect noticed has a distinct percentage of the value:

3.1.1. Laboratory Room

The laboratory room is used to carry out practicum or research activities supported by complete facilities. According to Permendiknas Number 24 of 2007, a good laboratory room can accommodate at least one study group with a minimum ratio of 2.4 m^2 /student for a study group of fewer than 20 students, a minimum laboratory area of 48 m^2 including storage and preparation space of 18 m^2, and the minimum width of the laboratory is 5 m, with the laboratory room having adequate lighting facilities for reading books and observing experimental objects. The laboratory room must also be clean water available. The observations on the laboratory room indicator obtained a percentage value of 100%, indicating that the laboratory room aspect is included in the perfect category and meets the standards.

The biology laboratory room in this school has met the minimum ratio of space, with a room area of 100 m^2 and a biology laboratory width of 9 m, with a group of 36 students. The laboratory room is spacious, so students are free when doing a practicum. The laboratory room is neat, clean, comfortable and organized. The laboratory room is divided into two parts: the practicum and separate storage rooms for tools and materials. The storage room is in front of the practicum room with an area of 20 m^2. Research Kurniawan (2021), the separation of practice rooms from tool and material rooms is intended so that students and teachers have no difficulty finding tools and materials. Besides, it aims to prevent practicum tools and materials from being damaged due to accidents in practicum activities in the laboratory.

Figure 1. Biology laboratory room at SMA Negeri 1 Cawas

This school's biology lab provides good lighting, which makes it simpler for students to read textbooks and carefully inspect experimental objects. The laboratory has a fan inside and numerous vents at the top of each window, which improves air circulation and adds to the comfort of the pupils. Ample clean water is also available in the lab space from sinks located on the west and east sides of the student desks. Research Maharani & Sasi (2019), the environmental conditions of biological laboratories also need to be considered, among others, with adequate air circulation and ventilation systems, adequate water needs, and room temperatures that are maintained constant and safe from interference.

3.1.2. Furniture

Furniture is equipment items that function to support the course of practicum. According to Permendiknas Number 24 of 2007, laboratory furniture facilities include chairs, student tables, demonstration tables, preparation tables, tool cabinets, material cabinets, and sinks. Based on observations about laboratory furniture at SMA Negeri 1, Cawas obtained a percentage value of 100%, included in the perfect category, where aspects of furniture in the biological laboratory have met the minimum standards.

The biological laboratory equipment consists of nine student desks that are large enough to accommodate groups of students, one presentation table, and 50 seats, divided into 46 student chairs and four teacher chairs that are sturdy, stable, safe, and easy to move. There are two long preparation tables so that they can add all the necessary tools and materials to be used. The trail is in the front, the table is extended to accommodate the materials tools to be used, spacious, strong, suitable for use, and adequate height, allowing students to observe the experiment demonstrated. Next to the wall and perpendicular to the sink is the prep table. Tool cabinets and materials that are large enough and plentiful enough to hold all tools are not readily corroded, closed, and lockable. For practicum activities, six sinks have smooth, clear water faucets. According to research Rahman (2017), laboratory water installations are utilized to wash hands after practicum if they become unclean or are exposed to dangerous substances.

3.1.3. Props

Teaching aids are learning aids and objects used to demonstrate learning materials. Based on the observation of teaching aids in the biology laboratory of SMA Negeri 1, Cawas obtained a percentage of 96%, indicating that the teaching aids facilities of the biology laboratory in this school are included in the perfect category even though they have not 100% met the standards of the Ministry of National Education Number 24 of 2007. The teaching aids facilities listed by Permendiknas Number 24 of 2007 consist of 25 types of tools namely: human skeleton models, human body models, various preparations, chromosome images, DNA images, RNA images, Mendelian inheritance images, plant examples drawings from multiple divisions, animal examples drawings from different species, drawings or models of various systems in animals and humans, and draw the evolution tree. Of the 25 types of props observed, 24 kinds of equipment follow the standard, namely having good conditions, suitable for use, and ratios and descriptions that follow the norm. The thing that causes teaching aids not to meet 100% of the standards of the is that there is no image of an evolutionary tree, so it is necessary to strive for a picture of an evolutionary tree that can provide more insight to students about evolutionary material more efficiently.

But since the teaching materials in the school's biology lab are thorough, they are helpful for the learning that takes place there. Students will be better able to understand the material given that there is complete educational equipment available and a variety of tools that adhere to the requirements. This is supported by Trisianawati (2020), that the state of complete practicum tools and materials will make teachers maximize the use of laboratories in supporting the implementation of learning and students will be easier to understand and learn the principles and Natural Sciences, so that they can be used in everyday life.

3.1.4. Experimental Tools and Materials

Before practicum, tools and materials are necessary since research or training cannot be conducted without tools and experimental materials. The comprehensiveness of tools and materials

facilitates the success and simplicity of practical activities, hence facilitating the accomplishment of educational objectives. This study observed 36 types of experimental instruments and materials, including microscopes, thermometers, balance sheets, test tubes, measuring pipettes, watch glasses, funnels, Petri dishes, universal clamps, tricycles, measuring cups, stopwatches, and other material tools that support practicum operations.

Based on the observation results of experimental tools and materials obtained a percentage value of 97,2%, which indicates that the facilities of biological laboratory practical tools and materials at SMA Negeri 1 Cawas are included in the perfect category even though they have not 100% met the standards of the Permendiknas Number 24 of 2007, but have been able to support the process of implementing biology practicum activities in supporting learning. The availability of useful tools and materials is what prevents experimental tools and materials from meeting norms. There are still some ratios, though, that do not adhere to the standards. For instance, there aren't enough long and short stative rod devices; the norm calls for six sets each lab. In order to make it simpler for students to use the instrument, it is important to try to add a static rod device to satisfy a predetermined ratio. Research Hayati (2020), the availability of experimental tools and materials in a laboratory is the basis for achieving good practices.

3.1.5. Educational Media

Educational media can deliver learning materials to attract students' attention, interests, thoughts and feelings in learning activities to achieve specific learning goals (Sumiharsono & Hasanah, 2017). Educational media contained in the biology laboratory is a whiteboard with a standard of 1 piece per laboratory with a minimum size of 90 cm x 200 cm placed in a position that allows all students to see it. The whiteboard is an essential object in the teaching and learning process, one of whose functions is as a medium for writing learning materials.

Based on the results of observations of educational media in the biology laboratory, SMA Negeri 1 Cawas obtained a percentage of 100% which indicates that the educational media facilities in the biology laboratory are included in the perfect category and have met the standards of the Permendiknas Number 24 of 2007. The blackboard contained in the biology laboratory at this school follows the minimum requirements of the biology laboratory, which is one piece measuring 120 cm x 200 cm with good conditions and suitable for use. The whiteboard is placed at the front so students can see clearly. There are other educational media in the biology laboratory room, namely LCD projectors teachers use to explain material when using laptop media. Research Mastika (2014), which shows that the whiteboard facilities in the Science/Biology laboratory room at SMA Negeri Kota Denpasar obtained 100% data, indicating that the furniture facilities at SMA Negeri Kota Denpasar mean that they meet the minimum standards listed in Permendiknas Number 24 of 2007.

3.1.6. Consumables

Consumables are materials that are used and run out quickly or are not durable. The consumables listed in Permendiknas Number 24 of 2007 are Sulfuric Acid, HCL, Acetokarmin, Eosin, Ethanol, Glucose, Universal Indicators, Iodine, KOH, $MnSO_4$, NaOH, Vaseline, and filter paper. Based on the observation of consumables at the biology moratorium of SMA Negeri 1, Cawas obtained a percentage value of 92,3%, indicating that the consumables of the biology laboratory at this school are included in the perfect category. However, they have not 100% met

the standards of the Permendiknas Number 24 of 2007 but have been able to support the process of implementing biology practicum activities so that they can support learning in the laboratory.

According to the findings of observation sheets used in the biology lab at SMA Negeri 1 Cawas, the reason why experimental instruments and materials don't meet criteria is because consumables are still available but don't have the right ratio of them. The balance established by Permendiknas Number 24 of 2007 is four rolls/lab, however these consumables, universal indicators, are only offered in four rollers/lab. The supplies used in the biology lab at SMA Negeri 1 Cawas are all in good shape and kept in durable glass cabinets made of wood. As a result, they do not rust easily, and all consumables are excellent for usage because both solid and liquid materials have a long shelf life. The government has lately provided this school with funding for a substantial quantity of consumables that meet the requirements of Permendiknas Number 24 for the of 2007.

3.1.7. Other Equipment

Other equipment is additional equipment to support practicum learning in biology laboratories. Biological laboratory facilities in the aspect of other equipment consisting of electrical sockets, fire extinguishers, P3K, trash cans, and wall clocks at SMA Negeri 1 Cawas obtained a percentage of 80% which indicates that other equipment facilities in the biology laboratory at this school are included in the excellent category even though they have not 100% met the standards set in Permendiknas Noumber 24 of 2007.

According to the findings of observation sheets in this school's biology lab, the availability of alternative equipment is what prevents experimental tools and materials from meeting criteria. However, several still fall short of the ratios and description requirements for the measurements. Another piece of equipment is an electrical socket; there are only four electrical outlets available for the nine desks that students are assigned, and the electrical socket is faulty and dangerous to use. As a result, given that the electric socket ratio is one of the laboratory's major supporters, improvement and expansion are required. According to research Adilah (2021), water facilities are used to wash hands if filthy or exposed to toxic chemicals, and to wash dirty practicum equipment after usage. Electrical installation facilities are necessary for voltage sources in carrying out practicums that require electricity. Additionally, pure water can be used in laboratories. Because mishaps during practicum can happen at any time, biological laboratories must have P3K equipment and fire extinguishers available to cope with incidents in the lab.

3.2. Readiness of Biology Laboratory in Supporting Learning

Laboratory administration, facility completion, equipment and material storage, and room design are all important factors. Planning, organizing, structuring, maintaining, and overseeing are some of the components of laboratory management (Candra & Hidayati, 2020). With adequate laboratory readiness, it will also affect the biology learning process that requires a laboratory.

Based on research that has been conducted on the readiness of biology laboratories in supporting learning at SMA Negeri 1 Cawas from the results of closed interviews with laboratory management teachers and observations of the completeness of laboratory material equipment facilities referring to the standards of the Permendiknas Number 24 of 2007. Each question item has a short answer, such as never, sometimes, often and consistently, so a short but definite answer is obtained. The four answers have their value weight. Data on the readiness of biological laboratories are presented in Table 2.

Table 2. Readiness of Biology Laboratory of SMA Negeri 1 Cawas

No	Indicators	Percentage	Category
1.	Laboratory Room Design	85%	Ready
2.	Laboratory Administration	95%	Ready
3.	Laboratory Management	88%	Ready
4.	Storage of Tools and Materials	95%	Ready
5.	Completeness of tools and materials	96,5%	Ready
	Average	92%	Ready

Based on Table 2, it can be seen that the readiness of the biology laboratory to support learning in this school shows an average score of 92%, which is included in the ready category even though it has not reached a percentage of 100%. Where each aspect observed has a different ratio of value, it can be seen from the indicators described as follows:

3.2.1. Laboratory Room Design

From the results of closed interviews, the laboratory room design obtained a readiness percentage value of 85%, indicating that the creation of the biology laboratory room at SMA Negeri 1 Cawas was included in the ready category. However, it had not yet reached the percentage of 100% value. The design of the biology laboratory room at this school was prepared to be used in supporting practicum activities. Questions regarding the design of laboratory rooms, made referring to the standards of the Permendiknas Number 24 of 2007, such as the area of laboratory space, laboratory layout, setting the distance between experimental and storage rooms, specifying the number of students to maintain student comfort during the practicum process, availability of water, and sufficient lighting. The interview results show that the biology laboratory in this school has been designed following standards, namely the distance between the laboratory and other buildings is about 4 m, with an area of 100 m to allow 36 students to enter, the availability of water is adequate as evidenced by the presence of 6 sinks in the room complete with water faucets and three pieces outdoors in front before entered the laboratory.

The biology laboratory is equipped with a good light source, making it easier for students to conduct experiments or activities because there is no lack of lighting. This is in line with Research Mastika (2014), that the distance between the laboratory and other buildings is at least equal to the height of the nearest building ± 3 meters so that the room can be optimal in getting direct lighting from sunlight and not located in the wind direction, to avoid air pollution. Almost all criteria referenced in the biological laboratory design readiness assessment are met. Only a few aspects have not been met by some high schools, namely: lack of the number of electric sockets, because many electric sockets have broken and do not function, so it is necessary to improve and add sockets to support the learning process better.

3.2.2. Laboratory Administration

The readiness of laboratory administration is indicated by criteria stating that in the laboratory, several aspects need to be administrated, including Administration of biological laboratory rooms, Administration of biological laboratory facilities, Administration of experimental tools and materials, Administration of personnel and Administration of activities laboratory. From the results of closed interviews regarding laboratory administration, the readiness value of 95% indicates that the biology laboratory administration at SMA Negeri 1 Cawas is

included in the ready category. Although it has not yet reached the percentage of 100% marks, the laboratory administration carried out by the manager is classified as ready where the school Always make an inventory of tools and materials, both new and old, makes a list of material equipment needs every semester, record all material tools that have been damaged both after and before practicum begins, make inventory data on the receipt of material tools both from schools and the government and do all inventories associated with other biological laboratories. Everything related to Administration is neatly arranged in soft files and complex files booked.

It will be simpler for the school to know the state of the lab and make future changes with good administration. Research Rahmiyati (2018), effective administration helps with planning for the purchase of equipment or materials, monitoring the effectiveness of budget use, facilitating the implementation of activities, presenting reports objectively, facilitating supervision, and protecting laboratory wealth, which is one of the costly investments made by the government in the education sector.

3.2.3. Laboratory Management

Laboratory management, or laboratory management, is an activity to plan, maintain, secure and administer to develop the laboratory efficiently and effectively to achieve a goal (Astuti, 2017). From the results of closed interviews regarding laboratory management, a readiness percentage value of 88% was obtained, indicating that the management of the biology laboratory at SMA Negeri 1 Cawas was included in the ready category. However, it had not yet reached the percentage of 100% marks. The management of the biology laboratory at the school was prepared to support learning.

Almost all criteria referenced in the readiness assessment of the management aspect of biological laboratories are met. Only some elements have not been met, such as periodic chemical maintenance following the way and place of storage. That is because the laboratory staff is minimal. In contrast, the biology laboratory in this school only amounts to 1 person who doubles as a subject teacher, so the time to carry out maintenance is irregular.

3.2.4. Storage of Tools and Materials

Storage of tools and materials consists of giving codes, names and specifications on practicum tools and materials, storing hazardous materials separately from other materials, storing tools and practicum materials based on function and use, storage of practicum tools is carried out in the form of sets, avoiding tools and materials from harmful environmental influences. The results of closed interviews regarding the readiness of storage of tools and materials obtained a readiness percentage value of 95% which indicates that the storage of biological laboratory tools and materials at SMA Negeri 1 Cawas is included in the ready category. However, it has not reached the percentage of 100% value. The storage of tools and materials carried out follows the standards in this study.

Storage of tools and materials is placed in cabinets whose doors can be closed tightly but are still easy to reach to facilitate the retrieval of glass tools are also placed in the same cabinet, making it easier to supervise. Equipment that is three dimensional such as a torso, is stored in a glass cupboard and separated from other tools. Therefore, this school's laboratory equipment and materials storage aspect is ready to support learning. Research Maharani & Sasi (2019), tools that are often used are usually placed in separate cabinets with instruments made of glass grouped or

stored in one cupboard. In addition, there is a cabinet to store tools made of glass and tools used to store microscopes. The chemicals used for practicum are also stored in a separate cupboard to make it easier to prepare for practicum activities. Likewise, three dimensional props such as the human torso and its constituent organs are stored in a joint cabinet.

3.2.5. Completeness of Tools and Materials

The completeness of physical laboratory facilities and infrastructure is essential in smoothly implementing practicum activities following learning objectives. The available budget and laboratory arrangements support factors that support the entirety of practicum material equipment in the laboratory. From the observation of the completeness of experimental equipment and material facilities, obtaining a readiness percentage value of 96,5% indicates that the entirety of equipment and material facilities in the biology laboratory of SMA Negeri 1 Cawas is included in the ready category, even though it has not met 100% of the standards of the Permendiknas Number 24 of 2007 but has been able to support the process of implementing biology practicum activities so that it can support learning in this school. All equipment and material facili ties are in adequate condition and suitable for use. This is because all material tools are cared for by a laboratory worker assisted by subject teachers.

The completeness of equipment and material facilities observed in this study consisted of 82 observation items comprised of furniture, props, consumables, educational media, and other equipment to support the running of the practicum. Based on the results of observation sheets in biological laboratories, things that cause the completeness of laboratory equipment and material facilities are not 100% ready because there is some completeness of equipment and material facilities that do not exist or already exist but with ratios that are not following standards such as non-existent evolutionary tree images, lack of electric socket and lack of universal indicator ratios, so that there is still a need for improvement so that tools and materials are following standards which will also affect the learning process that is getting smoother, with that the purpose of learning will be easier to achieve. Research Agustina (2019), to create a good teaching and learning process and quality learning outcomes, the laboratory must have all the facilities and infrastructure needed and meet laboratory standards.

4. CONCLUSIONS

The quality of the biological laboratory infrastructure at SMA Negeri 1 Cawas is included in the perfect competition with a percentage value of 95%. Although it has not met 100% of Permendiknas Number 24 of 2007 standards, the quality of biological laboratory infrastructure is following standards. It can support learning as for the level of laboratory readiness included in the ready laboratory with a percentage value of 92% so that it is prepared to help with biology learning in the school. The level of laboratory readiness studied includes laboratory design, laboratory administration, laboratory management, completeness of laboratory material equipment facilities and storage of laboratory material equipment.

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Quality of Duck Manure Fertilizer and Paitan Leaves with the Addition of MOL Papaya Skin

Hana Khairunnisa, Aminah Asngad*
Biology Education Department, Faculty of Teacher Training and Education, Muhammadiyah University of Surakarta. Jl. A. Yani Tromol Pos I, Pabelan, Kartasura, Surakarta 57162, Central Java, Indonesia
*Corresponding Author. E-mail address: aa125@ums.ac.id

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Solid Organic Fertilizer
Duck Manure
MOL Papaya Skin
Paitan Leaf

ABSTRACT

The use of organic materials for the manufacture of fertilizers is an alternative to reduce waste in the environment. Fertilizer can be made using duck manure and paitan leaves (Tithinia diversifolia) which produce high levels of nutrients.The purpose of this study was to determine the quality of N,P, and K as well as sensory test results which included color, texture, pH, and aroma of duck manure and paitan leaves with the addition of papaya peel bioactivator.This study used an experimental research method with a completely randomized design (CRD) with a factorial pattern.The treatment factors were: Factor 1 weight of duck manure and sick leaves (B1: 300g duck manure+200g paitan leaves, B2: 200g duck manure + 300g paitan leaves), Factor 2: Addition of papaya skin waste bioactivator (P1: 25ml MOL of papaya skin waste , P2: MOL of papaya skin waste 30ml) data analysis used a qualitative descriptive study.The results showed that the best quality was the N test, namely the B1P2 treatment (5.34%), the P test, namely the B2P2 treatment (0.15%),the K test, namely the B2P2 treatment (0.47%).The results showed that the best quality was B1P2 which produced black fertilizer, loose texture, earthy aroma and had a pH of 6.

1. INTRODUCTION

Indonesia is part of a country with a tropical climate, so it is easier for most people to grow crops. In terms of farming, land with adequate soil elements is needed. Please note that the tropical climate can fertilize the soil. Through fertilization, the plants will thrive well because of the nutrients provided. Unfortunately, fertilizers that are often used by the community are inorganic. Inorganic fertilizers have terrible impacts, such as environmental pollution, if used continuously. In addition, the price of inorganic fertilizers, which is too high, affects the quality of the farmers' crops. Overcoming this problem requires another alternative replacing inorganic fertilizers with fertilizers derived from organic materials.

Organic fertilizers can meet the needs required by the soil in meeting the needs of nutrients and improve the earth's physical, chemical, and biological properties (Ketut et al., 2019). The organic materials needed are used as solids and liquids from plant or animal waste. Organic fertilizers can be used as plant fertilizers in solid form. Solid organic fertilizers must contain macro and micronutrients such as Nitrogen, phosphorus, and Potassium. With organic matter in the form of duck manure, the nitrogen and phosphorus content needed by plants can be adequately fulfilled.

Duck manure is still a waste that the community needs to utilize more effectively. The utilization of duck manure includes quality organic matter as fertilizer. However, this requires processing that plant roots can absorb. This duck manure will be processed into fertilizer material that can provide fertility for the soil and plants. Based on research , Duck manure as an organic material can provide the nutrients needed by plants, including the elements of Nitrogen, phosphorus, and Potassium, so the more significant the content of duck manure N: 2.37%, P:

6.89% and K: 0.37%. Adding paitan leaves (Tithinia diversifolia) was carried out to increase the value of the quality of the nutrient content of the duck manure.

Paitan leaves contain active ingredients, especially in the leaves, namely: alkaloids, Flavonoids, saponins, tannins, terpenoids phenolic compounds(Syahputra et al., 2022). Therefore, this part of the leaf, which has bioactive properties, can be used as a plant insecticide. Paitan leaves are wild plants or invasive weeds usually found in tropical areas. According to researchAnnisa (2017), paitan contains N: 3.5%, P; 0.37%, and K 4.10%, so applying paitan compost can reduce inorganic fertilizer doses. Therefore, Paitan has the potential as an inorganic fertilizer supplement to support plant growth and production, reduce pollutants and reduce active P, Al, and Fe adsorption levels.

Papaya peels MOL contains microbes that degrade organic matter as protein decomposition (complex compounds) into more specific elements, including Nitrogen. According toDwiyogo et al. (2022), Nitrogen can be absorbed by plants in the form of ammonium ions or nitrate ions. Therefore, it can be utilized by plants; protein compounds must be broken down into more superficial elements. Microbes contained in MOL from papaya fruit skin are Pseudomonas, Bacillus, and Aspergillus niger. These microbes and fungi also act as phosphorus solvents in the organic matter (Fryatama, 2016). Therefore, the MOL manufacturing solid organic fertilizers also affect the nitrogen content produced.

Based on this background, the problems found with this research are: What is the nutrient content of N, P, and K, and what are the results of sensory observations, which include color, pH, texture, and aroma in solid organic fertilizer (POP) from duck manure and paitan leaves with the addition of papaya peel MOL bioactivator. Therefore, the objectives of this study were as follows: to determine the nutrient content of N, P, and K, to observe sensory input, including color, texture, pH, and aroma in solid organic fertilizer (POP) from duck manure and paitan leaves with the addition of papaya skin MOL bioactivation. This research is expected to provide benefits: 1). Providing innovations as materials for making solid organic fertilizer in the form of duck manure and paitan leaves; 2). Be an alternative organic fertilizer for farmers so that it is not at risk for long-term use.

2. MATERIALS AND METHODS

This research was conducted in Tlangu, Bulan, Wonosari, and Klaten to manufacture organic fertilizers and sensory tests. The Muhammadyah University, Yogyakarta, Faculty of Agrotechnology laboratory, conducted the N, P, and K elemental tests. The research took place from 12 February – 11 March 2023.

The tools used in this study were measuring cups, knives, cutting boards, basins, stirrers, plastic containers, blenders, spoons, label paper, rags, kjdahl flasks, destruction tools, distillation tools, titration tools, pipettes, kjdahl tablets, tubes reaction, volumetric flask, spectrophotometer, and beaker. In addition, the materials used in this study were papaya peel, rice washing water, granulated sugar, aqua dest, paitan leaves, and duck manure.

The research procedures included: 1) preparing four pieces of plastic, each labeled to mark the treatment combination. 2). Put 25 ml and 30 ml of papaya skin MOL bioactivator into the plastic according to the treatment combination. 3). Add 200g and 300g of duck manure into the plastic according to the treatment combination 4). Finally, put as much as 200g and 300g of paitan leaves into the plastic according to the treatment combination. 5). Stir all the ingredients that have been mixed until smooth. 6) Stir and open every three days.

This study uses experimental research methods in descriptive qualitative and quantitative methods Two Way Anova. This study used a completely randomized design (CRD) with a factorial pattern consisting of 4 treatments and three replications. The treatment factors are as follows: Factor 1 is the weight of the duck manure and pain leaves (B_1: 300g duck manure + 200g paitan leaves, B_2: 200g duck manure + 300g paitan leaves), Factor 2: Addition of papaya skin MOL bioactivation (P_1: MOL papaya skin 25 ml, P2: MOL papaya skin 30 ml).

3. RESULTS AND DISCUSSION

Based on the test results of each treatment in laboratory tests (N, P, and K) on the average test results of solid organic fertilizer duck manure and paitan leaves with the addition of MOL papaya skin bioactivator, presented as follows:

Table1. Average laboratory test results for N, P, and K on solid organic fertilizer from duck manure and paitan leaves with the addition of papaya peel MOL bioactivator

No	Treatment	N total (%)	P total (%)	K total (%)
1	B_1P_1	3.52	0.11	0.41
2	B_1P_2	5.34	0.14	0.47*
3	B_2P_1	4.01*	0.14	0.39
4	B_2P_2	3.92	0.15*	0.39

Description: * = Highest element value

3.1. Nitrogen

Nitrogen (N) levels based on Table 1 contained in solid organic fertilizer of duck manure and paitan leaves with the addition of papaya skin MOL bioactivation in four treatments, namely B_1P_1, B_1P_2, B_2P_1, and B_2P_2 after fermentation for four weeks are as follows:

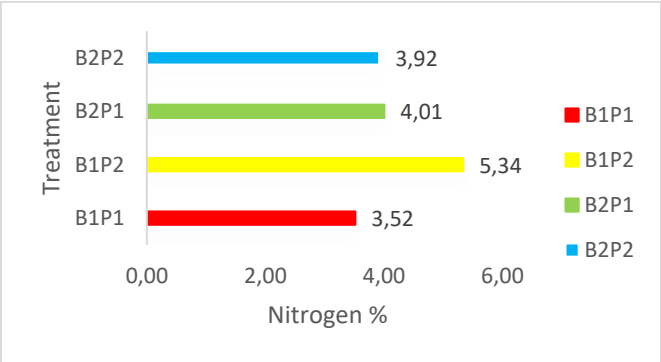

Figure 1. Elemental N test results

Nitrogenase nutrients are needed by plants in large quantities and are absorbed by plants in the form of ammonium (NH4) and nitrate (NO3); these ions come from the decomposition of compounds in the form of proteins by decomposer microorganisms. According to Mustofa (2022), ammonia is the nitrogen produced in the fermentation process. The amount of oxygen in the fermentation process is minimal, so the ammonia obtained in the fermentation process cannot be converted into nitrate, and nitrogen can be lost in the form of NH3 gas at high pH and temperature conditions. Nitrogen plays an essential role in stimulating plant vegetative growth. The research data results in Figure 2 shows that the highest nitrogen content was found in the B_1P_2 treatment, 5.34%, and the lowest nitrogen content was in the B_1P_1 treatment, 52%. The B_2P_1 treatment was 4.01%, and the B_2P_2 treatment was 3.92%. The observed data above shows that the N content in this organic fertilizer complies with the standard quality criteria for organic fertilizer, namely a minimum total N content of 0.40% (SNI-19-7030-2004). This is reinforced by conducting tests using Two Way Anova data analysis in the following table: From the observed data above, it shows that the N content in this organic fertilizer complies with the standard quality criteria for organic fertilizer, namely a minimum total N content of 0.40% (SNI-19-7030-2004). This is reinforced by conducting tests using Two Way Anova data analysis in the following table: From the observed data above, it shows that the N content in this organic fertilizer complies with the standard quality criteria for organic fertilizer, namely a minimum total N content of 0.40% (SNI-19-7030-2004). This is reinforced by conducting tests using Two Way Anova data analysis in the following table:

Table 2. Dependent Variable: Nitrogen Content

Tests of Between-Subjects Effects

Dependent Variable: Kandungan_N

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	5.629[a]	3	1.876	10722.714	.000
Intercept	211.428	1	211.428	1208160.429	.000
Bahan_Utama	.649	1	.649	3706.714	.000
Bioaktivator	2.245	1	2.245	12826.714	.000
Bahan_Utama * Bioaktivator	2.736	1	2.736	15634.714	.000
Error	.001	8	.000		
Total	217.059	12			
Corrected Total	5.631	11			

a. R Squared = 1.000 (Adjusted R Squared = 1.000)

On Two-Way Anova results in Table 2. The main ingredients are duck manure, and Paitan leaves in sig. i.e. 0.000<0.05. In bioactivators with sig. 0.000 <0.05, and the interaction between the main ingredient and the activator affects the nitrogen content. Due to the high N content in the duck manure, which is 2.37%, pain leaves at 3.5%, and the bacteria in the MOL of papaya skin, which causes the effect on nitrogen content. Based on this treatment, the high nitrogen content in solid organic fertilizer from duck manure and paitan leaves with the addition of MOL papaya peel bioactivator was due to the large composition of the main ingredients and additional ingredients given. The amount of concentration in this solid organic fertilizer's ingredients will affect the nitrogen yield. On the other hand, the low nitrogen content in solid organic fertilizers of duck manure and paitan leaves with the addition of the MOL papaya skin bioactivator in the B_1P_1 treatment was 3.52% because this treatment used less MOL of papaya skin, namely 25 ml; this is evidenced in table 1. The low nitrogen content is caused by also the loss of nitrogen levels in the form of ammonia gas during the fermentation process, characterized by the appearance of gas from the container during the fermentation of solid organic fertilizers when it is opened.

3.2. Phosphorus (P)

Test results Phosphorus (P) levels in Table 1 contained in solid organic fertilizer of duck manure and Paitan leaves with the addition of the papaya skin MOL bioactivator, which was carried out with four levels of treatment, namely B_1P_1, B_1P_2, B_2P_1, and B_2P_2 after four weeks of fermentation were as follows:

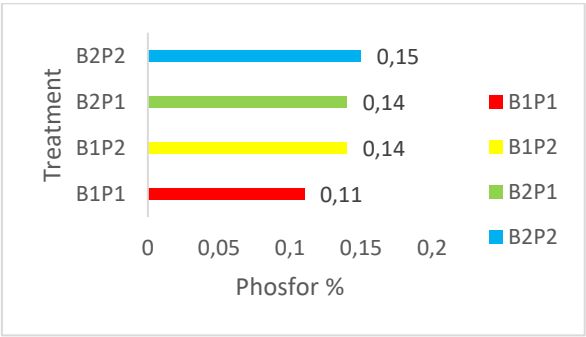

Figure 3. P element test results

Based on research data in Figure 3, it was found that the highest content of element P was in the B_2P_2 treatment with a value of 0.15%, and the treatment with the lowest value was in B_1P_1, namely 0.11%. The results were the same in the B_1P_2 and B_1P_2 treatments, namely 0.14%. The

results of the P content test were 0.11% - 0.15%. The observation data above show that the elemental content of phosphorus resulting from the treatment meets the criteria for solid organic fertilizer quality raw materials by SNI 1970-30-2004 with a minimum total requirement of 0.10%. The low content of P produced can be caused by the content of total N from papaya fruit skin is also low, which is 0.14% (Syahputriani, 2017). Because protein is a complex compound composed of elements C, H, O, and N, and sometimes P and S will be broken down into simpler compounds, and one of them is phosphorus. Therefore, based on the research data results, the nitrogen content is greater than the P element content because the P element in the chemical formula of protein is only a side chain. The P element content in fertilizers is related to the nitrogen element content in the material from the manufacture of fertilizers. The higher the nitrogen content in the material, the multiplication of microorganisms that will break down the P element will increase, and the P element content in fertilizers will increase along with the higher the P content in the material (Fryatbhanneet, 2016). According to Syahputriani (2017), the P content contained in papaya fruit skin is relatively small, namely 0. 02%, so the P element produced in this study was relatively small. This is by the data obtained in the Two Way Anova test as follows:

Table 3. Dependent Variable: Phosphorus Content

Tests of Between-Subjects Effects

Dependent Variable: Kandungan_P

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.003[a]	3	.001	2.400	.143
Intercept	.219	1	.219	583.200	.000
Bahan_Utama	.001	1	.001	3.200	.111
Bioaktivator	.001	1	.001	3.200	.111
Bahan_Utama * Bioaktivator	.000	1	.000	.800	.397
Error	.003	8	.000		
Total	.224	12			
Corrected Total	.006	11			

a. R Squared = .474 (Adjusted R Squared = .276)

Based on the Two-Way Anova test results for phosphorus elements in Table 3, the duck manure and Paitan leaves with sig. 0.111> 0.05, MOL papaya skin bioactivator with sig. 0.111> 0.05, and the interaction with the content of the element phosphorus has no effect. With this, the content of each ingredient, namely duck manure, is 6.89%, and pain leaves 0.37%, with the addition of a bio activator so that there is no effect or interaction between the ingredients and the activator. In the B_1P_1 treatment, with a bioactivator concentration of 25 ml, it was seen to produce a low phosphorus content. In contrast, compared to the B_2P_2 treatment, which used a bioactivator concentration of 30 ml, the phosphorus content was higher; this could happen because the 30 ml bioactivator contained microorganisms that were actively growing. This is in line with Kusumadewi's research (2019) that phosphorus-degrading microbes grow and spread the fastest, causing an increase in microbial activity in the decomposition of organic matter and contributing to an increase in phosphorus levels.

3.3. Potassium

ResultsTesting the levels of potassium (K) in Table 1 contained in solid organic fertilizer of duck manure and Paitan leaves with the addition of papaya skin MOL bioactivation in 4 treatments B_1P_1, B_1P_2, B_2P_1, and B_2P_2 after four weeks of fermentation were as follows:

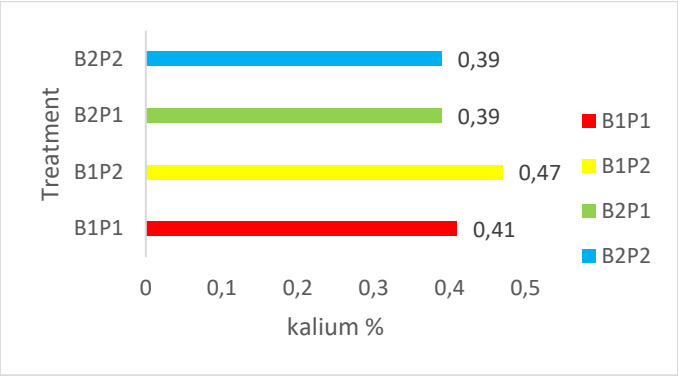

Figure 4. K-element test results

Based on the observational data in Figure 4, the Potassium test was found in the B_1P_2 treatment with the highest elemental yield of 0.47%, while the lowest treatment results were found in B_2P_1 and B_2P_2. In the B_1P_1 treatment, the result was 0.41%. The testing results on potassium levels obtained in this study were between 0.39% - 0.41%. The value of potassium content from the observations meets the criteria for organic fertilizer-quality raw materials according to SNI 1970-30-2004, which requires a minimum potassium content of 0.20%. Rahmawati (2020) states that the element potassium contained in potassium dioxide (K_2O) compounds in the substrate is used by microorganisms as a catalyst; this will affect the presence of bacteria and their activity in the fermentation process. Element K is stored and bound by bacteria and fungi in cells; potassium will be available again if it is degraded again by microorganisms. In another source Safitri et al. (2017), Potassium is an element produced from the process of bacterial metabolism; in bacteria, it will use free K+ ions contained in organic matter as a catalyst so that the potassium level will increase along with the increasing number of bacteria. According to Afiyah et al. (2021) that the activity that occurs in microorganisms during the process of degrading organic matter in the process of making fertilizer will cause the carbon chains in organic matter to break down into more specific elements so that it will cause an increase in the element of Potassium in the fertilizer produced. Potassium levels increase along with growing and increasing the number of bacteria. Reinforced by the data generated in the data analysis test using Two Way Anova, namely as follows:

Table 4. Dependent Variable: Potassium Content

Tests of Between-Subjects Effects

Dependent Variable: Kandungan_K

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.013[a]	3	.004	14.333	.001
Intercept	2.067	1	2.067	6889.000	.000
Bahan_Utama	.008	1	.008	25.000	.001
Bioaktivator	.003	1	.003	9.000	.017
Bahan_Utama * Bioaktivator	.003	1	.003	9.000	.017
Error	.002	8	.000		
Total	2.082	12			
Corrected Total	.015	11			

a. R Squared = .843 (Adjusted R Squared = .784)

Two-Way test results ANOVA in Table 4 of the potassium element in the dirt and pain leaves with a sig. 0.001<0.05, bioactivator with sig. 0.017< and the interaction between the main ingredient and the activator significantly affects the potassium element content. With this, the content of 0.70% duck manure and 4.10% pain leaves with the addition of MOL papaya skin causes an effect on potassium content. Potassium content in organic fertilizers in the combination of materials between treatments with the highest and lowest content yields has a different concentration composition, causing different potassium content results. The difference between

the highest and lowest treatment results is in the content of the materials used; it can affect the results of the potassium content.

Table 5. Average sensory testing (aromatic, texture, color, and pH) on fertilizer from duck manure and paitan leaves with the addition of papaya peel MOL bioactivator

No	Treatment	Observation result			
		Color	Texture	Aroma	pH
1	B_1P_1	Dark brown	Rather subtle	Land	6,6
2	B_1P_2	Very black	Crumb	Land	7
3	B_2P_1	Chocolate	Rather rough	Less stinging	6
4	B_2P_2	Chocolate	Rather rough	It stings enough	6,3

Information :

Color : 1 = Yellow, 2 = Brown, 3 = Dark Brown, 4 = Very Black

Texture : 1 = Coarse, 2 = Slightly Coarse, 3 = Slightly Smooth, 4 = Crumbly

Smell: 1 = Very pungent, 2 = Quite pungent, 3 = Less pungent, 4 = Smells of earth

B_1P_1 : 300 grams of duck manure and 200 grams of paitan leaves with the addition of 25 ml of MOL

B_1P_2 : 300 grams of duck manure and 200 grams of paitan leaves with the addition of 30 ml of MOL

B_2P_1 : 200 grams of duck manure and 300 grams of paitan leaves with the addition of 25 ml of MOL

B_2P_2 : 200 grams of duck manure and 300 grams of paitan leaves with the addition of 30 ml of MOL

B_1P_1

B_1P_2

B_2P_1

B_2P_2

Figure 5. Fertilizer sensory test results (aroma, texture, and color) on fertilizer from duck manure and paitan leaves with the addition of papaya skin MOL bioactivator

3.4. Color parameters

Based on Table 2. And figure 1. The results of observations on the sensory test with the color parameters of organic fertilizer from duck manure and paitan leaves with the addition of the papaya skin MOL bio activator showed that of the four treatments, the best results were obtained according to Figure 5, namely in the B_1P_2 treatment with fertilizer color, namely black on number 4.

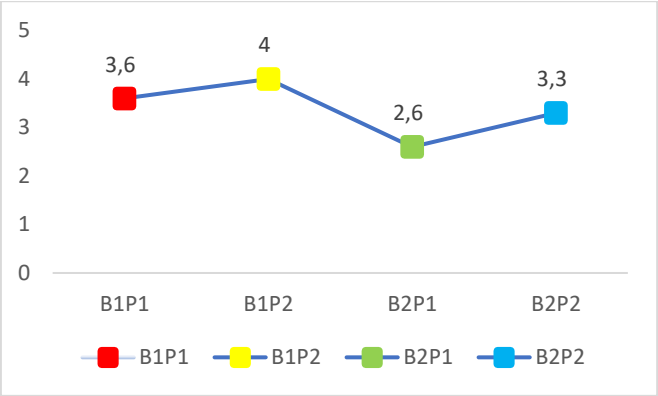

Figure 6. Average color test results

At the beginning of the fermentation, all treatments had the same color as the raw material, namely light brown. Until the end of the fermentation, there was a change in each treatment. Per Figure 5, the results of the color test on B_1P_1 are blackish brown, B_1P_2 is very black, B_2P_1 and B_2P_2 are brown. In the fermentation process, there is a decomposition of organic matter by microbes that take water, oxygen, and nutrients from organic matter, which will then undergo decomposition and release CO_2 and O_2. The color change in the fertilizer is due to organisms that work actively in the decomposition process, namely in the form of duck manure and pain leaves, which are present in each treatment. This is appropriate Abdullah, (2018) states that a color change during composting is caused by the decomposition process carried out by microbes. The color change in solid organic fertilizer is caused by comparing the materials used to manufacture solid organic fertilizer. These organic materials will be converted into nutrients to lose their color pigments which causes the color to turn black. This is in opinion Sarpong et al. (2019) state that the color change that occurs is due to the composting process, which changes organic matter with complex C chains into simple C forms. This process will cause the composted material to lose its color pigment, so the color turns black according to its constituent elements so that the final result of fermenting fertilizer with a black color is obtained according to the standard provisions (SNI No 19-7030-2004), which states that when solid organic fertilizer is ripe, it will have a black color like soil.

3.5. Texture Sensory Test

Based on the sensory observation test results of solid organic fertilizer from duck manure and Paitan leaves with the addition of papaya skin MOL bioactivator with texture parameters in Table 2. And figure 1. Shows that the texture of fertilizer in the B_1P_2 treatment has the best texture, namely crumb-like soil, compared to other treatments.

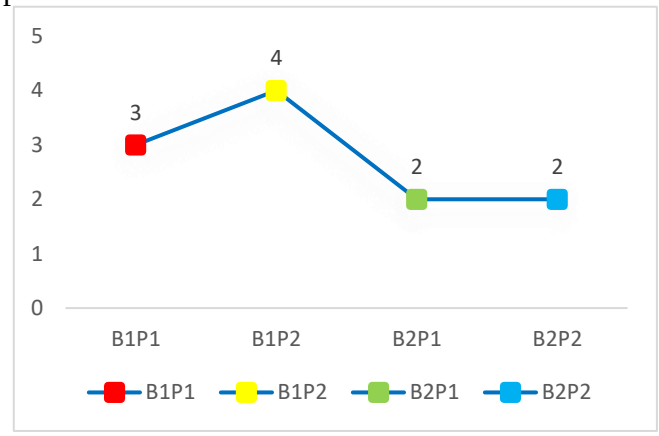

Figure 7. Average texture test results

Differences in texture in fertilizers are caused by the decomposition process using different combinations that affect the final fertilizer yield. The addition of decomposers to fertilizers aims to speed up the decomposition process of fertilizers. The smaller the available particles, the faster the decomposition process will be. The treatment with a rough texture because the decomposing organisms in the fertilizer cannot decompose organic waste quickly. The final results of the sensory parameters of the texture show that the fertilizer has resulted in small particles. Figure 6 shows the results for the B_1P_1 treatment with a rather fine texture at number 3 and the B_2P_1 and B_2P_2 treatments with a slightly rough texture at number 2. This is by government regulations in the form of compost quality standards, namely 0.55-25mm (SNI-19- 7030-2004). Fertilizers with a crumb texture, like soil, will be more easily absorbed by plants. So that the nutrient content in the fertilizer has decomposed, when it is applied, it will be directly absorbed by plant roots.

3.6. Aroma Sensory Test

Based on the sensory observation test results of organic fertilizer from duck manure and Paitan leaves with the addition of papaya skin MOL bioactivator with texture parameters in Table 2. And Figure 7. The aroma of fertilizer in the B_1P_1 and B_1P_2 treatments had the best aroma, namely an earthy smell.

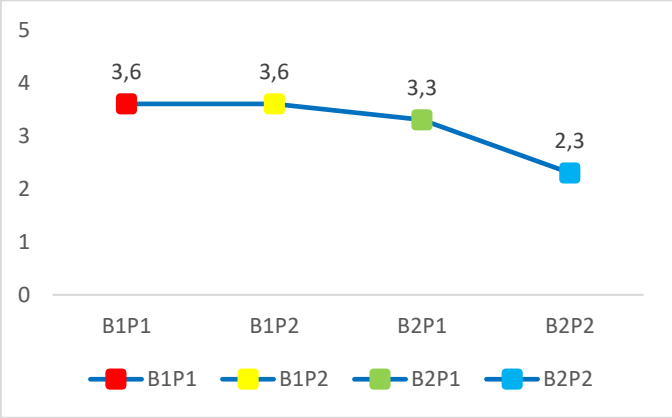

Figure 8. Average aroma test results

The aroma produced by the fertilizer is a sign of decomposition activity by decomposer organisms. The organisms used as decomposers will break down the organic matter into ammonia so that the gas produced can affect the odor present in the material. The odor generated can also come from materials that are too wet. The odor produced will decrease over time, and the pungent smell at first will be replaced with an earthy odor which indicates that the compost is ripe. In the B_2P_1 treatment, the results of a less pungent odor are shown in number 3.3, in the B_2P_2 treatment, the odor is quite pungent. This is by the opinionMentari et al. (2021), which states that the odor produced will decrease over time, and the rotten smell at the beginning of composting will be replaced by an earthy odor indicating that the compost is ripe. The unpleasant smell of compost is due to the process of forming ammonia from the organic matter due to decomposition activity by decomposer organisms where this compound is volatile. At the end of the fermentation, it was found that the fertilizer had an earthy aroma, which by the government decree stated that ripe compost would have an earthy smell (SNI No 19-7030-2004).

3.7. pH content

Based on Table 1. and Figure 4. Observations on the sensory test with the color parameters of organic fertilizer from duck manure and Paitan leaves with the addition of papaya skin MOL bioactivation show that of the four treatments, the pH results obtained can be said to be good because it has a susceptible pH content between 4-9. This is by the Minister of Agriculture

Regulation No. 70/Armenian/SR.140/10/2011 and is reinforced by stating that for good growth, the range of pH content is from 4 to 9 (SNI No 19-7030-2004).

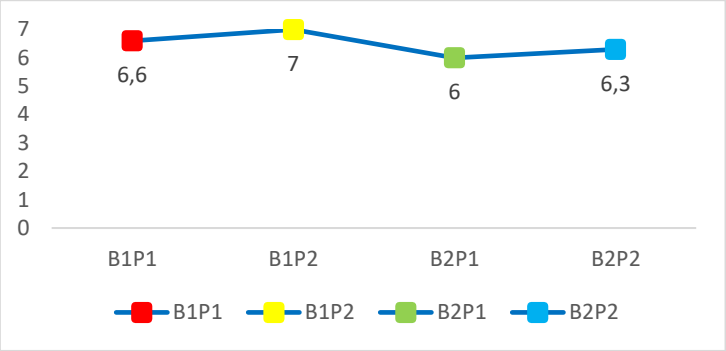

Figure 8. Average fertilizer pH test results

High and low pH can be affected by the activities of decomposing organisms due to the process of converting organic matter into organic acids. This is by research Suwatanti, (2017), which states that changes in pH that occur at the composting stage are thought to be due to the formation of acids by decomposing organisms. The process of decomposition of organic matter by these organisms produces lactic acid and other organic acids, which are weak. In addition, the experimental results showed that the pH was close to neutral, which was caused by mature compost. The increase in pH close to the neutral number can be due to the mineralization process. This is in line with the opinion that the pH of mature compost is usually close to a neutral pH. The increase in neutral pH is due to the addition of organic matter due to the mineralization of organic anions into CO2 and H2O or due to the alkaline nature of the organic matter. Duck manure and paitan leaves, with the addition of papaya peel MOL bioactivator, can be used as a solid organic fertilizer that provides macro-nutrients for plants. This solid organic fertilizer can provide alternatives to farmers as a substitute for chemical fertilizers.

4. CONCLUSIONS

Based on the results of the study, it was shown that the organic fertilizer from duck manure and Paitan leaves with the addition of papaya peel MOL bio activator had, on average good quality in terms of the quality of the elements N, P, and K, and quality tests in the form of color, texture, aroma, and pH by SNI No. 19-7030-2004. In the B_1P_2 treatment with the highest yield, namely the highest N element, namely 5.34%, Potassium element, namely 0.47%, and in the best organic fertilizer quality test, which had black fertilizer results, crumb texture, soil aroma with a pH of 7. The highest phosphorus test result was 0.15% in the B_2P_2 treatment. The limitations of the researchers in this study were obtaining fertilizer materials in large quantities. It is hoped that in the future, further research will be carried out on organic fertilizers for duck manure and paitan leaves with the addition of MOL papaya skin with a larger organic matter composition, and it is necessary to carry out further tests on the application of solid organic fertilizers It's in plants.

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