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EFFECT OF LIQUID ORGANIC APPLICATION OF ORGANIC FRUIT PEEL LOCAL MICROORGANISMS *Musa acuminata x balbisiana* Colla. AND *Manihot esculenta* Crantz. ON PHYSICAL AND CHEMICAL FERTILITY OF INCEPTISOL SOIL

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Abstrak

The use of waste from the stems of Kepok bananas (Musa acuminata x balbisiana Colla.) and cassava (Manihot esculenta Crantz.) as Local Microorganisms (MoL) can increase the levels of essential nutrients in Inceptisol soil, both in terms of its chemical and physical properties. The application of Local Microorganisms (MoL) derived from these natural materials makes Inceptisol soil fertile and improves soil fertility levels. Based on the research findings, in Inceptisol soil, the application of corms from the Kepok banana (Musa acuminata x balbisiana Colla.) and cassava (Manihot esculenta Crantz.) significantly increased soil fertility levels and improved the fertility of Inceptisol soil compared to soil without the application of Local Microorganisms (MoL). Furthermore, the soil pH reached a neutral level of 6.60.

INTRODUCTION

Local Microorganisms (MoL) is a solution derived from biological sources that has been fermented. The Local Microorganisms (MoL) solution contains macro- and micro-nutrients, as well as bacteria that act as decomposers of organic matter and plant stimulants, and can control pests and diseases in plants.

The raw materials used in the production of Local Microorganisms (MoL) vary in terms of their physical and chemical properties and nutrient content; consequently, the quality of the resulting Local Microorganisms (MoL) will vary, depending on the completeness of the nutrient profile and the activity of the Local Microorganisms (MoL).

According to Hidayanto (2017), as cited in Nadilia (2023) and Lubis (2026), local microorganisms (MoL) fermented using food materials can produce beneficial outcomes as well as harmful changes if the compost or the local microorganisms (MoL) are managed incorrectly.

In this regard, as cited from Budiyani *et al*. (2020) in Nadilia (2023), Local Microorganisms (MoL) are fermentation products derived from biological sources, one of which comes from natural materials such as fruits or vegetables and natural plant waste. According to Lubis (2026), Local Microorganisms (MoL) contain nutrients for plants. These include macro-nutrients required in large quantities, and micro-nutrients needed by plants; among the macro-nutrients are Carbon (C), Oxygen (O), Hydrogen (H), Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), Magnesium (Mg), and Sulphur (S), whilst the micro-nutrients include Manganese (Mn), Iron (Fe), and Molybdenum (Mo), and others that can support plant growth through the local microorganisms they contain.

The application of MoL (Local Microorganisms) derived from banana stems (*Musa acuminata x balbisiana* Colla.) yields good results in Latosol and Ultisol soils; however, Latosol soil requires significant improvement due to its high salinity and severe nutrient deficiency. In organic compost from banana stems, the nutrient content after 14 days of fermentation is as follows: NO_3^- content of 3,087 ppm or approximately 0.3087%, NH_4^+ content of 1,120 ppm or 0.112%, P_2O_5 content of 439 ppm or 0.0439%, and K_2O content of 574 ppm or 0.0574%.

The use of organic material derived from cassava, commonly known as yam (*Manihot esculenta* Crantz.), is an excellent source of organic fertilizer for both soil and plants. Organic fertilizer derived from cassava or cassava peel serves as a source of carbohydrates and nutrients for soil microorganisms.

An important role in the application of organic fertilizers or compost is that of decomposers in the composting process. Beneficial bacteria found in the soil, which are advantageous to both the soil and plants as a result of the application of liquid organic fertilizers or Local Microorganisms (MoL), include *Rhizobium sp*., *Azospirilium sp*., and *Azotobacter sp*., which play a role in nitrogen fixation and benefit the soil and plants. Bacteria of the *Pseudomonas sp*. and *Bacillus sp*. play a role in the solubilisation of phosphate required by plants, whilst bacteria of the *Saccharomyces sp*. and *Lactobacillus sp*. play a role in the fermentation process.

A microbiological study of local microorganisms (MoL) in Kepok bananas (*Musa acuminata x balbisiana* Colla.) and cassava (*Manihot esculenta* Crantz.) found that they contain 66% and 65% carbohydrates, and 4.35% and 4.40% protein, respectively. According to research by Inrianti & Paling (2019) cited in Nisya (2023), the role of MoL in compost is not only to provide nutrients but also to act as a bioreactor in the process of optimal plant growth. The function of a bioreactor is highly complex, acting as a nutrient supplier through exudate mechanisms and regulating soil microorganisms to support plant growth. According to research by Sulastyo (2011) cited in Lubis (2026), the types of microorganisms found in banana corms include *Bacillus sp*., *Aeromonas sp*., and *Aspergillus niger*.

METHOD

This study was conducted at the Soil Management Field Laboratory at the Indonesian Palm Oil Institute (ITSI) in Medan. The study was carried out from March 2025 to July 2025.

In the use of Local Microorganisms (MoL), 20 kg of Kepok banana (*Musa acuminata x balbisiana* Colla.) stems were used.

In the use of Local Microorganisms (MoL), 20 kg of cassava (*Manihot esculenta* Crantz.) was used.

In this study, a non-factorial randomised block design (RBD) was used, involving the application of local microorganisms (MoL) derived from the stems of Kepok bananas (*Musa acuminata x balbisiana* Colla.) and cassava (*Manihot esculenta* Crantz.).

By way of comparison, we examined the initial soil analysis—which assessed soil fertility based on the physical and chemical properties of the Inceptisol soil prior to treatment—against the final soil analysis following the application of Local Microorganisms (MoL) derived from the stems of Kepok bananas (*Musa acuminata x balbisiana* Colla.) and cassava (*Manihot esculenta* Crantz.) to the Inceptisol soil.

Soil media observations were carried out at the Soil, Plant, Fertilizer and Water Laboratory at the Agricultural Technology Research Centre (BPTP) in Johor, North Sumatra. Analysis of the Inceptisol soil was carried out at the Soil Laboratory on two occasions, namely the initial soil analysis and the final soil analysis, comprising physical properties, namely soil texture consisting of sand, silt and clay (%), and soil chemical properties consisting of soil organic carbon content (C-Organic) (%), total soil nitrogen content (N-Total) (%), available soil phosphorus (P_2O_5-Available) (ppm P), soil potassium (K_2O-Potential Ex. HCl 25%) (me.100 g^{-1}), cation exchange capacity (CEC) (me.100 g^{-1}), and soil acidity (pH) at a H_2O ratio of 1:1.

RESULT AND DISCUSSION

The results of the study, which produced initial and final soil analyses of the Inceptisol soil medium, are as follows:

1. Initial Soil Analysis Results – Inceptisol Soil

The results of the study, as shown in Table 1, present the findings of the initial soil analysis conducted on Inceptisol soil as follows:

Table 1. Initial Soil Analysis Results – Inceptisol Soil

Texture	Methods of Analysis	Units	Results	Description
Sand	Hydrometer	%	45,00	*Clay*
Dust			38,77	
Clay			27,55	
C-Organic	Spectrofotometry	%	1,78	l
N-Total	Kjedhal	%	0,30	l
P_2O_5-Available	Spectrofotometry	ppm P	4,88	l
K_2O-Potential Ex. HCl 25%	AAS	me.100 g^{-1}	0,51	l
CEC	Volumetry	me.100 g^{-1}	3,27	vl
pH H_2O	Electrometry	-----	4,30	*Sour*

Description : Criteria for Planting Media, h = High, l = Low, m = Medium, sl = Slightly Low, vl = Very Low, vh, Very High, nm = Not Measurable.

The results of the initial soil analysis of the Inceptisol soil are presented in Table 1, which includes several textural analyses, namely the analysis of the physical properties of the soil in relation to its texture. In the soil texture analysis, the Sand fraction yielded 45.00%, the Silt fraction 38.77%, and the Clay fraction 27.55%; thus, this meets the criteria for a Clayey Loam soil. These results align with the findings of Lubis *et al*. (2023), who state that soils with a loam texture are highly suitable for plant root growth; however, soils with a clay loam texture are unlikely to be suitable for root growth due to their high clay content, which makes it difficult for plant roots to penetrate the soil to access water and mineral nutrients.

The analysis of organic carbon (C-Organic) presented in Table 1 shows that the organic carbon (C-Organic) content was 1.78%, which is classified as low, whilst the total soil nitrogen (N-Total) content was 0.30%, also classified as low. Low levels of organic carbon (C-Organic) and total soil nitrogen (N-Total) cause the physical and chemical properties of the soil to become harsher, rendering the nutrients in the soil unavailable. A denser soil structure leads to waterlogging, preventing plant roots from accessing water in the soil and reducing the ability of soil microbes to provide nutrients to plants. This is consistent with the view of Lubis (2025) that the addition of organic matter to the soil makes the soil more crumbly, thereby facilitating microbial activity in supplying nutrients to plants.

The analysis of available phosphorus in the soil (P_2O_5-Available) yielded a result of 4.88 ppm P, classified as low, whilst the soil potassium content (K_2O-Potential, HCl 25%) yielded a result of 0.51 me.100 g^{-1} , also classified as low. This is related to the soil cation exchange capacity (CEC), which yielded 3.27 me.100 g^{-1} and was classified as very low. These analysis results demonstrate that phosphorus and potassium are not available, and nutrient status falls within the low category; similarly, the cation exchange capacity is very low. According to Hamzah *et al*. (2024) as cited in Lubis (2025), soil suffering from nutrient deficiency will limit a plot's potential to supply nutrients, causing plants to experience stunted growth and ultimately die due to nutrient deficiency.

Analysis of soil acidity (soil pH) yielded a value of 4.30, classifying the soil as acidic. This confirms that Inceptisol soil has a high level of acidity. Inceptisol soil with acidic properties will disrupt the availability of nutrients and the activity of soil microorganisms. Soil with a high acidity level will suffer from a deficiency in essential macro- and micro-nutrients, and soil with a high acidity level often contains high levels of dissolved aluminium (Al), iron (Fe), or manganese (Mn), which will inhibit plant root growth.

2. Final Soil Analysis Results – Inceptisol Soil

The final soil analysis results obtained following the application of Local Microorganisms (MoL) derived from the stems of the Kepok banana (*Musa acuminata x balbisiana* Colla.) and cassava (*Manihot esculenta* Crantz.) are presented in Table 2 as follows:

Tabel 2. Hasil Analisis Tanah Akhir – Tanah Inceptisol

Texture	Methods of Analysis	Units	Results	Description
Sand Dust Clay	Hydrometer	%	42,51 30,20 11,15	*Sandy Clay*
C-Organic	Spectrofotometry	%	10,85	vh
N-Total	Kjedhal	%	0,96	h
P_2O_5-Available	Spectrofotometry	ppm P	11,27	m
K_2O-Potential Ex. HCl 25%	AAS	me.100 g^{-1}	0,51	m
CEC	Volumetry	me.100 g^{-1}	41,22	vh
pH H_2O	Electrometry	-----	6,60	*Neutral*

Description : Criteria for Planting Media, h = High, l = Low, m = Medium, sl = Slightly Low, vl = Very Low, vh, Very High, nm = Not Measurable.

The final analysis results for the Inceptisol soil at the Soil Laboratory are presented in Table 2. As shown in Table 2, the soil texture of the Inceptisol soil is classified as sandy loam, with analysis results indicating 42.51% sand, 30.20% silt and 11.15% clay. In this regard, it is stated that the soil has a sandy texture which is highly suitable for plant root development, and that soil with a sandy loam texture is highly suitable for agricultural land.

The final soil analysis results showed that the organic carbon (C-Organic) content was 10.85%, meeting the ‘very high’ criterion, whilst the total soil nitrogen (N-Total) content was 0.96%, meeting the ‘high’ criterion. This indicates that the organic carbon (C-Organic) and total soil nitrogen (N-Total) levels demonstrate the chemical fertility potential of the Inceptisol soil, as the stored organic matter can retain nutrients. The presence of organic matter in the soil, evidenced by the very high organic carbon content, can improve soil structure, enhance microbial activity, and increase cation exchange capacity (CEC). The CEC (Cation Exchange Capacity) analysis result of 41.22 me.100 g^{-1} falls within the very high criterion. This implies that if nitrogen and organic carbon levels are very high, this is highly conducive to the decomposition of organic matter, ensuring nutrients are readily available in the soil. According to Saidi (2018) as cited in Salsavira (2024), the application of organic matter and local microorganisms to the soil increases nitrogen and carbon levels in the soil; thus, the minimum organic carbon and soil nitrogen (C/N) ratio required for soil fertility is 2%, but if it falls below 2%, there will be a decline in plant growth and a reduction in soil aggregates.

The results of the Inceptisol soil analysis showed that the available phosphorus (P_2O_5-Available) content was 11.27 ppm P, classified as moderate, whilst the soil potassium (K_2O-Potential) content was 0.51 me.100 g^{-1}, also classified as moderate. This is consistent with the findings of Yosephine *et al.* (2022) and Lubis *et al.* (2023), who noted that slightly low phosphorus levels can lead to reduced growth, as can low potassium levels. However, if there is an excess or the nutrient levels are very high, growth will be stunted; excessively high phosphorus levels will bind micronutrients such as zinc (Zn), iron (Fe) and copper (Cu), whilst excessively high potassium levels will inhibit the uptake of calcium (Ca) and magnesium (Mg).

CONCLUSION

The conclusion of this study states that the application of Local Microorganisms (MoL) derived from the stems of Kepok bananas (*Musa acuminata x balbisiana* Colla.) and cassava (*Manihot esculenta* Crantz.) can significantly increase nutrient levels in Inceptisol soil and make these nutrients available to plants. Furthermore, the application of these local microorganisms (MoL) will be able to enhance plant nutrition, including both essential macro- and micronutrients.

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