Jurnal Agroqua
Volume 24 No. 1 Tahun 2026

DOI: https://doi.org/10.32663/ja.v24i1.5445

EFFECTS OF LOCAL MICROORGANISMS AND VARIETY INTERACTION ON GROWTH, YIELD, AND FRUIT QUALITY OF MELON (*Cucumis melo* L.)

(Pengaruh Interaksi Mikroorganisme Lokal dan Varietas Terhadap Pertumbuhan, Hasil, dan Kualitas Buah Melon (Cucumis melo L.))

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ABSTRACT

The increasing demand for melons has not been accompanied by a proportional increase in production. This study was conducted from January to April 2024 in Kandang Limun, Bengkulu, Indonesia, and aimed to evaluate the most suitable melon varieties and types of local microorganisms (MOL) to improve plant growth, yield, and fruit quality. The experiment was arranged in a factorial Completely Randomized Design (CRD) with two factors: three melon varieties (Gracia, Sonya, and Tavia) and four MOL treatments (MOL from stale rice, papaya MOL, bamboo shoot MOL, and a control without MOL). These factors produced 12 treatment combinations, each replicated three times, resulting in 36 experimental units and a total of 108 plants. The results showed a significant interaction between melon varieties and MOL types on fruit diameter, sweetness, and hardness. The largest fruit diameter (15,2 cm) was obtained from the Tavia variety treated with papaya MOL. The highest fruit sweetness (11,9 ºBrix) was observed in the Sonya variety with papaya MOL, while the highest fruit hardness (3,2 kg cm^{-2}) was recorded in the Gracia variety without MOL. Overall, the Tavia variety exhibited the best performance in terms of growth, yield, and fruit quality. Among the treatments, papaya MOL showed the most favorable effect, particularly in enhancing fruit diameter and sweetness.

Keywords: crop production; cultivar response; fruit quality; indigenous microbial inoculants; sweetness.

INTRODUCTION

Melon (*Cucumis melo* L.) is an important horticultural commodity that is widely favored by consumers due to its sweet taste, refreshing characteristics, and versatility in consumption. Melon fruits can be consumed fresh or processed into a wide range of value-added products such as juices, desserts, jams, and functional foods (Manchali et al., 2021). In addition to its sensory appeal, melon is also recognized for its high nutritional value. It contains essential vitamins, particularly vitamin C and provitamin A, as well as minerals and antioxidants that contribute to maintaining human health and preventing various diseases (Zhang et al., 2024). These nutritional and economic advantages make melon a highly valuable crop with strong market demand, both domestically and globally.

Despite its potential, melon production in Indonesia has shown a declining trending recent years. National melon production decreased from approximately 129,147 tons in 2021 to 118,696 tons in 2022, and further declined to

DOI: https://doi.org/10.32663/ja.v24i1.5445

117,794 tons in 2023, accompanied by a reduction in harvested area (BPS, 2022; 2023; 2024). This decline indicates the presence of constraints limiting productivity, including suboptimal cultivation practices, declining soil fertility, and excessivereliance on synthetic fertilizers and pesticides. Continuous use of these inputs may degrade soil quality reduce microbial diversity, and threaten long-term agricultural sustainability.

Improving melon productivity requires the integration of suitable varieties and sustainable soil management practices. Hybrid melon varieties generally exhibit higher yield potential, better fruit quality, and greater adaptability to environmental conditions (Napolitano et al., 2020). However, varietal performance is strongly influenced by environmental factors and cultivation inputs, making it necessary to identify appropriate combination for specific growing conditions.

In addition to varietal improvement, enhancing soil fertility and nutrient availability is crucial for optimizing plant growth and yield. One sustainable approach is the application of beneficial soil microorganisms, which play a vital role in nutrient cycling, organic matter decomposition, and plant growth promotion (Zhang et al., 2025). Among these, local microorganisms (MOL) have gained increasing attention as an affordable and environmentally friendly alternative to commercial biofertilizers. MOL is a consortium of microorganisms derived from locally available organic materials and propagated using natural nutrient sources such as carbohydrates, proteins, vitamins, and minerals (Mirwandono et al., 2018; Hudha et al., 2022).

Various organic substrates can be utilized for MOL production, including stale rice, papaya fruit, and bamboo shoots. Each of these materials provides distinct microbial communities and nutrient compositions that may influence the effectiveness of MOL in promoting plant growth. For instance, MOL derived from stale rice is known to enhance vegetative growth by improving microbial activity and nutrient availability in the soil. Papaya-based MOL contains natural enzymes and bioactive compounds that can stimulate plant growth and improve yield components. Meanwhile, bamboo shoot-based MOL is rich in beneficial microbes that may contribute to soil health and root development.

Previous studies have demonstrated the positive effects of MOL application on various crops. The use of MOL derived from stale rice has been reported to increase plant height, fresh biomass, and bulb production in shallots. Similarly, papaya-based MOL has shown significant effects on vegetative growth and yield performance in several horticultural crops under experimental conditions (Juniawan et al., 2023; Sari & Karnilawati, 2020). However, these studies generally evaluated MOL effects independently without considering plant genetic variation. However, limited information is available regarding the interaction effects between melon genotypes and different indigenous MOL sources.

Therefore, this study aims to evaluate the interaction between melon varieties and different types of MOL in order to determine the most effective combination for improving plant growth, yield, and fruit quality. The results are expected to support the development of sustainable melon cultivation

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practices and provide practical recommendations for farmers.

MATERIAL AND METHODS

This study was conducted from January to April 2024 in Kandang Limun, Bengkulu, Indonesia, under environmental conditions representative of lowland tropical agroecosystems. The research aimed to evaluate the effects of different melon (*Cucumis melo* L.) varieties and types of local microorganisms (MOL) on plant growth, yield, and fruit quality. Three commercial melon varieties, namely Gracia, Sonya, and Tavia, were used as plant materials due to their differing agronomic characteristics and market preferences.

Local microorganism (MOL) solutions were prepared from three organic substrates: stale rice, papaya fruit, and bamboo shoots. The preparation followed a fermentation method adapted from the Agricultural Training Agency (2016), using rice washing water as a microbial medium and brown sugar as an energy source for microbial growth. The mixture was fermented anaerobically for 15 days in sealed containers until it produced a characteristic fermented aroma, indicating active microbial development. The microbial population of each MOL solution was analyzed in the Agronomy Laboratory, Faculty of Agriculture, University of Bengkulu. The total microbial counts were 1.63×10^4 CFU mL^{-1} for stale rice MOL, 3.69×10^6 CFU mL^{-1} for papaya MOL, and 1.10×10^6 CFU mL^{-1} for bamboo shoot MOL.

Melon seeds were first soaked in water at 25–30 °C for 24 hours to enhance germination. The seeds were then sown in polybags containing a mixture of soil and well-decomposed manure at a ratio of 2:1 (w/w). After 14 days, uniform seedlings were transplanted into larger polybags (10 kg capacity; ±30 cm diameter) filled with soil and cow manure at a ratio 2:1. Initial soil analysis indicated acidic soil conditions with a pH of 4.8. Therefore, dolomite was applied at a rate equivalent to 2 t ha^{-1} prior to transplanting to improve soil pH and increase calcium and magnesium availability. Soil fertility improvement after MOL application was reflected in enhanced plant growth and yield performance.

. Basal fertilizers were applied at 50% of the recommended dosage consisting of urea, TSP, and KCl fertilizers. Fertilizers were applied in split applications according to the growth stage of the plants to support vegetative and reproductive development.

MOL treatments were applied in liquid form after dilution at a ratio of 1:10 (v/v) with water. The application was carried out weekly through soil drenching, with a volume of 200 mL per plant, starting from 2 weeks after planting (WAP) until 8 WAP. This method ensured direct contact between the microbial solution and the root zone, facilitating nutrient availability and microbial activity in the soil.

The experiment was arranged in a factorial Completely Randomized Design (CRD) with two factors. The first factor was melon variety (Gracia, Sonya, and Tavia), and the second factor was MOL type (control without MOL, stale rice MOL, papaya MOL, and bamboo shoot MOL). The combination of these factors resulted in 12 treatment combinations. Each treatment was replicated three times, resulting in 36 experimental units. Each unit consisted of three plants, for a total of 108 experimental plants.

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Observations included plant growth (plant height and leaf number), yield components (fruit weight and diameter), and fruit quality attributes (fruit sweetness and firmness). Fruit sweetness was measured using a handled refractometer, while fruit firmness was determined using a fruit penetrometer.

Observations were conducted on various parameters, including plant growth (such as plant height and leaf number), yield components (fruit weight and diameter), and fruit quality attributes (fruit sweetness and firmness). Data obtained from the experiment were subjected to analysis of variance (ANOVA) to determine the significance of treatment effects. When significant differences were detected, mean comparisons were performed using Duncan's Multiple Range Test (DMRT) at a 5% significance level to identify differences among treatments.

RESULTS AND DISCUSSION

The analysis of variance revealed a significant interaction between local microorganism (MOL) treatments and melon varieties on fruit diameter, fruit sweetness, and fruit firmness. The interaction effect of MOL types and melon varieties on fruit diameter is presented in Table 1.

Table 1. Effect of interactions of local microorganisms (MOL) and melon varieties on fruit diameter

Varieties	Without MOL	Stale rice-MOL	Papaya MOL	Bamboo shoots MOL
Gracia	14,5 a	12,7 b	12,8 b	14,0 a
	A	A	B	A
Sonya	14,4 a	13,7 a	14,3 a	14,3 a
	A	A	A	A
Tavia	13,2 ab	13,7 c	15,2 a	14,4 ab
	A	A	A	A

Notes: numbers followed by the same letter have not significantly different at 5% DMRT level. Notations with uppercase letters are read vertically, while notations with lowercase is read horizontally.

The Tavia variety treated with papaya MOL produced the largest fruit diameter. In contrast, the Sonya variety showed not significantly differences across all MOL treatments, indicating a relatively stable response.

The superior response of Tavia to papaya MOL may be associated with its genetic potential for higher assimilate partitioning to fruit (sink strength). The availability of nutrients facilitated by microbial activity in papaya MOL likely enhanced cell expansion and fruit development. Beneficial microorganisms are known to improve nutrient mineralization and availability, particularly nitrogen and phosphorus, which play important roles in cell division and enlargement (Silva et al., 2023; Chen et al., 2024).

In addition, potassium availability influenced by microbial activity may contribute to fruit enlargement, as potassium regulates carbohydrate translocation and osmotic balance in plant tissues (Wu et al.,

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2024). This suggests that the effectiveness of MOL depends not only on its microbial composition but also on the compatibility with plant genotype. Potassium, one of the nutrients absorbed by plants, plays a vital role in enhancing fruit sweetness (Wu et al. 2024).

The interaction between MOL treatments and melon varieties significantly affected fruit sweetness (Table 2). The highest sweetness (11,9 ^{o}Brix) was recorded in the Sonya variety treated with papaya MOL.

Table 2. Effect of interactions of local microorganisms (MOL) and melon varieties on the level of sweetness of the fruit

Varieties	Without MOL	Stale rice-MOL	Papaya MOL	Bamboo shoots MOL
Gracia	8,3 a	7,6 a	8,5 a	8,5 a
	B	B	B	A
Sonya	10,5 ab	8,7 b	11,9 a	9,3 b
	A	AB	A	A
Tavia	10,8 a	10,5 a	9,6 ab	7,0 b
	A	A	B	A

Notes: numbers followed by the same letter have not significantly effect on DMRT 5% rate. Notations with uppercase letters are read vertically, while notations with lowercase is read horizontally.

This result indicates that papaya MOL may enhance sugar accumulation in melon fruit. Microbial activity can improve nutrient availability, particularly potassium, which plays a key roles in sugar synthesis, translocation, and accumulation in fruits (Hasanuzzaman et al. 2018). Increased potassium uptake enhances photosynthate transport from leaves (source) to fruits (sink), leading, to higher soluble solids content.

The variation in sweetness among varieties also reflects genetic differences in carbohydrate metabolism and sugar accumulation capacity. Sonya showed a stronger response in terms of sweetness, suggesting that this variety has a higher efficiency in converting assimilates into soluble sugars under favorable conditions.

The interaction between MOL treatments and melon varieties significantly affected fruit firmness (Table 3). The highest firmness was observed in the Gracia variety under control conditions, while MOL application generally resulted in lower firmness values.

This reduction in firmness may be associated with accelerated fruit ripening due to microbial activity. During ripening, structural polysaccharides such as pectin and hemicellulose are degraded into simpler compounds, resulting in softer fruit texture (Peng et al., 2022). The application of MOL may enhance metabolic activity and promote earlier maturation, which in turn reduces fruit firmness.

This finding is consistent with previous studies indicating that softer fruits are often associated with advanced maturity stages and may have shorter shelf life (Gonçalves et al., 2025). Therefore, while MOL improves certain quality attributes such as sweetness, it may also influence postharvest characteristics.

DOI: https://doi.org/10.32663/ja.v24i1.5445

Table 3. Effect of interactions of local microorganisms (MOL) and melon varieties on the level of fruit hardness

Varieties	Without MOL	Stale rice-MOL	Papaya MOL	Bamboo shoots MOL
Gracia	3,2 a	2,3 b	2,9 ab	3,1 a
	A	B	A	A
Sonya	2,2 a	1,7 a	1,7 a	2,0 a
	B	B	B	B
Tavia	3,0 a	3,0 a	2,5 ab	2,0 b
	A	A	A	B

Notes: numbers followed by the same letter have not significantly different at 5% DMRT level. Notations with uppercase letters are read vertically, while notations with lowercase is read horizontally.

Melon varieties had a significant effect on several growth parameters, including the number of internodes, the timing of male and hermaphrodite flower emergence, leaf area, leaf greenness, and stem dry weight (Table 4). Gracia and Tavia varieties produced a significantly higher number of internodes than the Sonya variety. Differences in internode number influenced internode length, where plants with fewer internodes tended to have longer segments. Longer internodes provide more space for fruit development, which may contribute to improved fruit quality, as each melon plant typically supports only one optimal fruit.

Table 4. Recapitulation of the results of observations of the variable number of stem segments, male flowers appearing, hermaphrodite flowers, leaf area, leaf greenness and dry weight of stalks

Varieties	Number of sections (segments)	Male flower appears (hst)	Hermaphrodite flower appears (hst)	Leaf area (cm^2)	Leaf green level (unit)	Dry weight (g)
Gracia	30 a	17,3 a	24,5 a	240,3 a	46,1 b	30,5 a
Sonya	27 b	15,5 b	22,1 b	203,9 b	47,9 a	21,1 b
Tavia	30 a	15,7 b	20,6 c	187,8 b	44,7 b	29,9 a

Note: the numbers in the same column followed by the same letters are not significantly different at the DMRT level of 5%

The Sonya and Tavia varieties showed similar and faster male flower emergence compared to Gracia, while the Tavia variety exhibited the earliest appearance of hermaphrodite flowers. Early flowering is closely associated with earlier harvest time, as flowering age has a positive correlation with harvest age (Abua et al. 2024). Faster flower emergence generally leads to shorter harvesting periods, indicating better growth efficiency (Katuuramu et al. 2023).

Flowering age is closely related to harvest time; plants with earlier flowering generally reach harvest sooner, making

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flowering age a reliable indicator of early maturity. Leaf area also differed among varieties, with the Gracia variety producing the largest leaf area, significantly higher than Sonya and Tavia. Larger leaf area enhances photosynthetic capacity and assimilate production, which supports overall plant growth and development. Since all plants received similar light conditions, these differences were mainly attributed to genetic variation among varieties.

The Sonya variety exhibited the highest leaf greenness, followed by Gracia and Tavia. Leaf greenness reflects chlorophyll and nitrogen status; however, all varieties showed relatively low greenness values, likely due to cloudy and rainy conditions that limited light absorption (Liu et al. 2019). In melon plants, photosynthesis products are primarily stored as sucrose in the fruit, and higher leaf greenness is positively correlated with fruit quality, particularly sweetness.

Plant dry weight was highest in the Gracia variety and comparable to Tavia, but significantly greater than Sonya. Higher dry weight indicates greater accumulation of organic compounds resulting from efficient nutrient uptake and favorable growth conditions (Zhang et al. 2023).

Regarding yield, varietal differences significantly affected harvesting age, with the Tavia variety reaching harvest earlier than Sonya and Gracia, while Gracia showed the longest harvesting period (Table 5). Gracia variety showed the longest harvesting age with an average of 81.04 DAS, while the Tavia variety reached harvest the fastest at 64.79 DAS. The harvest ages of Sonya (70.58 DAS) and Tavia were consistent with their varietal descriptions, whereas Gracia exhibited a longer harvesting period than expected. These differences were statistically significant at the 5% DMRT level.

Table 5. Recapitulation of the yields of the observation of the harvest age

Varieties	Harvest age (DAP)
Gracia	81,04 a
Sonya	70,58 b
Tavia	64,79 c

Note: the numbers in the same column followed by the same letters are not significantly different at the DMRT level of 5%

The application of local microorganisms (MOL) significantly affected fruit flesh thickness. Bamboo shoot and papaya MOL resulted in the greatest flesh thickness and were comparable to the control, but significantly thicker than fruits treated with stale rice MOL (Table 6).

Variations in flesh thickness were closely related to nutrient availability influenced by microbial activity in the soil. Papaya MOL had the highest microbial density, followed by bamboo shoot and stale rice MOL (Table 7). Higher microbial populations enhance organic matter decomposition and nutrient availability, leading to improved nutrient uptake and thicker fruit flesh.

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Table 6. Recapitulation of the yields of the thickness variable of the fruit

Varieties	Fruit thickness
Control	3,51 ab
Stale rice	3,25 b
Papaya	3,72 a
Bamboo shoots	3,76 a

Note: the numbers in the same column followed by the same letters are not significantly different at the DMRT level of 5%

Table 7. Laboratory test results of total microbial count in stale rice MOL, papaya MOL, and bamboo shoot MOL

No.	MOL types	Results (CFU/Ml)
1.	Stale rice	$1{,}63 \times 10^4$
2.	Papaya	$3{,}69 \times 10^6$
3.	Bamboo shoots	$1{,}1 \times 10^6$

Source: Analysis results from the Agronomy Laboratory, Faculty of Agriculture, University of Bengkulu, 2024

Papaya-based MOL likely contained a higher diversity of beneficial microorganisms and bioactive compounds compared to other MOL sources. Fermented papaya substrates are known to contain phosphorus-solubilizing bacteria, lactic acid bacteria, and Actinomycetes that enhance nutrient mineralization and phytohormone production. These microorganisms may improve root activity, nutrient uptake efficiency, and carbohydrate translocation toward developing fruits, resulting in increased fruit diameter and sweetness (Simarmata et al. 2022). Phosphorus plays a crucial role in plant energy metabolism through its involvement in ATP and ADP formation, thereby improving photosynthate translocation to the fruit and increasing flesh thickness.

Bamboo shoot MOL contains growth-promoting bacteria such as *Azotobacter* and *Azospirillum*, which are known to produce phytohormones that stimulate vegetative growth. The high gibberellin content in bamboo shoot MOL supports the development of shoots, leaves, roots, and stems prior to the flowering stage (Kabatia and Bimantara, 2023).

CONCLUSION

Significant interactions between melon varieties and MOL types affected fruit diameter, sweetness, and firmness. Papaya MOL improved fruit diameter and sweetness, while the Tavia variety showed superior agronomic performance and earlier harvest. Therefore, the combination of Tavia variety and papaya MOL is recommended for sustainable melon production. The application of locally available MOL materials may reduce dependency on synthetic fertilizers and provide a cost-effective and environmentally friendly alternative for melon farmers in tropical agroecosystems.

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