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In Vitro Multiplication of the Ornamental Plant Sente (*Alocasia melo*)

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Abstract: The genus *Alocasia* showed high diversity, including morphological differences among approximately 60 species. One of these species was Alocasia melo, which was distributed on Borneo Island. *A. melo* had high aesthetic and economic value, making it popular among ornamental plant enthusiasts. However, growing *A. melo* naturally was challenging due to specific habitat, such as humidity, temperature, lighting, water supply, soil pH, and indoor storage to increase survival rates. To address this, tissue culture (in vitro) was used as a method for its propagation and conservation. This study aimed to determine the effects of different nutrient components on the in vitro growth of *A. melo* and to find the most effective nutrient combination for its growth. The research was an experimental study with treatments including coconut water + 6-Benzylaminopurine (BAP), algae extract + BAP, coconut water, algae extract, and coconut water + algae extract on solid media. The data were analyzed descriptively, showing the number of shoots and roots in tables and figures. The results showed that the treatment with coconut water (10 mL) + BAP (1 ppm) produced the highest average number of shoots (3.75). Meanwhile, the treatment with coconut water (30 mL) resulted in the highest average number of roots (6.75).

Keywords: Algae extract; *Alocasia melo*; BAP; Coconut water; Multiplication

Introduction

Foliage ornamental plants were identified as potential commodities that could be developed on both small and large scales, as evidenced by the growing public interest in agribusiness involving various types of ornamental foliage plants (Monder et al., 2024; Biella et al., 2025). Cultivated ornamental plants were those with high aesthetic value, often used to beautify gardens or indoor spaces (Ciftcioglu et al., 2019; Toscano et al., 2025). One such ornamental plant with significant aesthetic and economic value was *Alocasia melo*, commonly known as "*melo badak*." *Alocasia melo* belonged to the family Araceae, which comprised 120 genera and approximately 2,000 species. The genus *Alocasia* included about 60 species with diverse morphological forms (Krisantini et al., 2024). Members of the genus *Alocasia* were typically found in the tropical forests of South and Southeast Asia. The species *Alocasia melo* was distributed on Borneo Island and was included in the list of rare plants growing on ultrabasic substrates in Sabah (Ent et al., 2018). The economic value of *A. melo* parent plants ranged from 39 USD to 100 USD (approximately IDR 600,000 to IDR 1,500,000 per individual). However, *A. melo* faced challenges in cultivation due to its limited availability in nature and difficulty in conventional propagation, requiring specialized care, including specific light intensity, humidity, and other factors. Specific care for *A. melo* included avoiding direct sunlight despite its thick leaves, preventing overwatering as the plant could not tolerate wet conditions, and managing its susceptibility to pests and diseases (Anifowoshe et al., 2025). In its natural habitat, *A. melo* was heavily collected by ornamental plant enthusiasts due to its uniquely shaped leaves without conservation efforts, which caused scarcity in the wild (Jain et al., 2021).

Conventional propagation methods using seeds and tubers required considerable time. Therefore, tissue culture (in vitro) techniques were considered necessary

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for the conservation and propagation of this species (Permadi et al., 2024). Tissue culture was an isolation technique of plant parts such as cells, groups of cells, tissues, organs, protoplasts, and others, which were grown in a specially designed aseptic (microorganism-free) environment. This method was used to multiply the plant and regenerate it into a complete plant with the same characteristics as the original one (Chukwu et al., 2025). Compared to conventional propagation methods such as from seeds, cuttings, or grafting, clonal propagation through tissue culture offered several advantages. These included the ability to rapidly produce a large number of seedlings, maintaining a continuous supply of seedlings throughout the year without depending on seasons, and producing seedlings that were identical to the parent plant, ensuring a high level of uniformity in growth in the field (Cui et al., 2019).

Shao & Duan (2022) conducted a study on the characteristics of brown algae, identifying several key features, including its chemical composition, mineral composition, and phytohormone content. The mineral composition of brown algae included elements such as Mg, Fe, K, Na, and Ca. The study also identified several types of phytohormones in brown algae, including IAA, NAA, GA, and kinetin, which could influence growth in tissue culture (Harahap et al., 2023; Rathod et al., 2023). Meanwhile, green algae contained about 26% protein by dry weight and had phytohormones such as IAA, cytokinins, gibberellins, ABA, polyamines, lunularic acid, jasmonic acid, and brassinosteroids (Sabagh et al., 2022). Red algae were found to contain auxins in both young and old thalli. The phytohormones in red algae included IAA, cytokinins, jasmonic acid, polyamines, and rhodomorphin (Wang et al., 2021).

This study tested different nutrients for shoot and root growth of *A. melo* in vitro. The nutrients used included young coconut water and several types of algae: brown algae (*Sargassum sp.*), red algae (*Gracilaria coronopifolia*), and green algae (*Ulva lactucaefolia*). This research was important for the development of *A. melo* ornamental plant cultivation.

Method

Research Timeand Location

This study was conducted in the Immunology Laboratory, Tissue Culture Room, Faculty of Mathematics and Natural Sciences, Mataram University. The research was from December 2022 to October 2023.

Research Design

The type of research used was experimental research, which aimed to examine the effects of specific treatments and determine the outcomes resulting from treatments applied by the researcher. There were five treatment types conducted: coconut water + 6-Benzylaminopurine, algae extract + 6-Benzylaminopurine, coconut water, algae extract, and coconut water + algae extract.

Table 1. Microscopic characteristics of bacterial isolates based on cell shape and gram staining properties

Code	Treatment
A	BAP 1 ppm + Coconut Water 10 mL
B	BAP 1 ppm + Coconut Water 20 mL
C	BAP 1 ppm + Coconut Water 30 mL
GA	BAP 1 ppm + Algae Extract 10 mL
GB	BAP 1 ppm + Algae Extract 20 mL
GC	BAP 1 ppm + Algae Extract 30 mL
AK10	Coconut Water 10 mL
AK20	Coconut Water 20 mL
AK30	Coconut Water 30 mL
EG10	Algae Extract 10 mL
EG20	Algae Extract 20 mL
EG30	Algae Extract 30 mL
KG10	Coconut Water 10 mL + Algae Extract 10 mL
KG20	Coconut Water 20 mL + Algae Extract 20 mL
KG30	Coconut Water 30 mL + Algae Extract 30 mL

Research Materials

The tools used in this study were divided into two categories: laboratory equipment and supporting laboratory equipment. The laboratory equipment included an analytical balance, a general balance, Laminar Air Flow (LAF), air conditioner, autoclave, oven, magnetic stirrer, hotplate, refrigerator, culture racks, and culture bottles. Supporting laboratory equipment included tweezers, knife handles, Bunsen burners, labels, laminar chairs, plastic containers, laboratory tables, laboratory chairs, media tables, chemical storage cabinets, glassware cabinets, plastic baskets, lab coats, masks, glassware, scissors, and cutters. The materials used in this study included explants of the ornamental plant *Alocasia melo*, which were obtained from the SEAMEO BIOTROP laboratory in Bogor, coconut water, brown algae (*Sargassum sp.*), red algae (*Gracilaria coronopifolia*), and green algae (*Ulva lactucaefolia*) collected from Lendang Luar Beach in West Lombok, Pandanan Beach in North Lombok, and Sire Beach in North Lombok. Other materials included complete MS media, sugar, agar, aquades, 96% alcohol, 70% alcohol, NaOH, and HCl.

Preparation of Algae Extract

Brown algae (*Sargassum sp.*), red algae (*Gracilaria coronopifolia*), and green algae (*Ulva lactucaefolia*) were weighed in a 1:1:1 ratio for the three types of algae. The algae were then chopped and placed into a blender, followed by the addition of aquades in a 1:1 ratio with

the algae extract, using 100 grams of algae and 100 mL of aquades (1:1 (w/v) ratio). The mixture was blended until smooth and filtered using filter paper. The resulting paste was centrifuged for 5 minutes at 4°C with a speed of 5.000 rpm. After centrifugation, the supernatant was transferred to a Falcon tube and labeled as the extract with a concentration of 100%.

Preparation of MS Media with BAP and Coconut Water

The preparation of the media began by preparing a 1-liter volumetric flask. The flask was filled with 900 mL of aquades. Then, one packet of MS media was added to the flask. 20 grams of sugar were also added and mixed with a magnetic stirrer until fully dissolved. Once homogenized, the media was divided into three parts and placed into three 500 mL Erlenmeyer flasks. Each Erlenmeyer flask contained 300 mL of the homogenized media. The preparation of the media began by preparing a 1-liter volumetric flask. The flask was filled with 900 mL of aquades. Then, one packet of MS media was added to the flask. 20 grams of sugar were added and mixed with a magnetic stirrer until fully dissolved. After homogenized, the media was divided into three parts and transferred into three 500 mL Erlenmeyer flasks. Each Erlenmeyer flask contained 300 mL of the homogenized media. After the media was divided into three portions, each Erlenmeyer flask was filled with different concentrations of additional hormones.

The first Erlenmeyer flask was added with 1 ppm of the plant growth regulator BAP and 10 mL of coconut water. The second Erlenmeyer flask received 1 ppm of BAP and 20 mL of coconut water. The third Erlenmeyer flask was added with 1 ppm of BAP and 30 mL of coconut water. The addition of coconut water at concentrations of 10, 20, and 30 mL was considered the best for shoot multiplication. After the total media volume reached 1 liter, the three Erlenmeyer flasks were mixed until homogenized. Then, the pH of the solution was adjusted to 5.8. If the pH was below 5.8, KOH was added to raise the pH, and if the pH was above 5.8, HCl was added to lower the pH. After the pH was adjusted, 10 grams of agar were added to each Erlenmeyer flask. The mixture was stirred until it was well combined and heated on a hot plate. When the substrate solution started to boil, the media was transferred into culture bottles, with 20-25 mL per bottle. The bottles were then sealed with aluminum foil, secured with rubber bands, and labeled.

Preparation of MS Media with BAP and Algae Extract

The preparation of the media began by preparing a 1-liter volumetric flask. The flask was filled with 900 mL of aquades. One packet of MS media was then added to the flask. 20 grams of sugar were added and mixed with a magnetic stirrer until fully dissolved. Once homogenized, the media was divided into three portions and transferred into three 500 mL Erlenmeyer flasks. Each Erlenmeyer flask contained 300 mL of the homogenized media. After the media was divided into three portions, each Erlenmeyer flask was filled with different concentrations of additional hormones. The first Erlenmeyer flask was added with 1 ppm of BAP and 10 mL of algae extract. The second Erlenmeyer flask was added with 1 ppm of BAP and 20 mL of algae extract. The third Erlenmeyer flask was added with 1 ppm of BAP and 30 mL of algae extract. After the total media volume reached 1 liter, the three Erlenmeyer flasks were mixed until homogenized. The pH of the solution was then adjusted to 5.80. If the pH was below 5.8, KOH was added to raise the pH, and if the pH was above 5.8, HCl was added to lower the pH. After the pH was adjusted, 10 grams of agar were added to each Erlenmeyer flask. The mixture was stirred until it was well combined and heated on a hot plate. When the substrate solution started to boil, the media was transferred into culture bottles, with 20-25 mL per bottle. The bottles were then sealed with aluminum foil, secured with rubber bands, and labeled.

Preparation of MS Media without BAP and with Coconut Water

The preparation of the media began by preparing a 1-liter volumetric flask. The flask was filled with 900 mL of aquades. One packet of MS media was then added to the flask. 20 grams of sugar were added and mixed with a magnetic stirrer until fully dissolved. Once homogenized, the media was divided into three portions and transferred into three 500 mL Erlenmeyer flasks. Each Erlenmeyer flask contained 300 mL of the homogenized media. After the media was divided into three portions, each Erlenmeyer flask was filled with different concentrations of coconut water. The first Erlenmeyer flask was added with 10 mL of coconut water. The second Erlenmeyer flask was added with 20 mL of coconut water. The third Erlenmeyer flask was added with 30 mL of coconut water. After the total media volume reached 1 liter, the three Erlenmeyer flasks were mixed until homogenized. The pH of the solution was then adjusted to 5.80. If the pH was below 5.80, KOH was added to raise the pH, and if the pH was above 5.80, HCl was added to lower the pH. After the pH of each Erlenmeyer flask was adjusted, 10 grams of agar were added to each Erlenmeyer flask. The mixture was stirred until well combined and then heated on a hot plate. Once the substrate solution began to boil, the media was poured into culture bottles, with 20-25 mL of media per bottle. The bottles were then sealed with aluminum foil, secured with rubber bands, and labeled accordingly.

Preparation of MS Media without BAP and with Algae Extract

The preparation of the media began by preparing a 1-liter volumetric flask. The flask was filled with 900 mL of aquades. One packet of MS media was then added to the flask. 20 grams of sugar were added and mixed with a magnetic stirrer until fully dissolved. Once homogenized, the media was divided into three portions and transferred into three 500 mL Erlenmeyer flasks. Each Erlenmeyer flask contained 300 mL of the homogenized media. After the media was divided into three portions, each Erlenmeyer flask was filled with different concentrations of algae extract. The first Erlenmeyer flask was added with 10 mL of algae extract. The second Erlenmeyer flask was added with 20 mL of algae extract. The third Erlenmeyer flask was added with 30 mL of algae extract. Once the total media volume reached 1 liter, the three Erlenmeyer flasks were mixed until homogenized. The pH of the solution was then adjusted to 5.80. If the pH was below 5.8, KOH was added to raise the pH, and if the pH was above 5.8, HCl was added to lower the pH. After the pH of each Erlenmeyer flask was adjusted, 10 grams of agar were added to each flask. The mixture was stirred until well combined and then heated on a hot plate. Once the substrate solution reached boiling, the media was transferred into culture bottles, with a volume of 20-25 mL per bottle. The bottles were then sealed with aluminum foil, secured with rubber bands, and labeled accordingly.

Preparation of MS Media without BAP, with Coconut Water and Algae Extract

The media preparation began by preparing a 1-liter volumetric flask. The flask was filled with 900 mL of distilled water (aquades). Then, 1 packet of MS medium was added to the flask. After that, 20 grams of sugar were added and mixed using a magnetic stirrer until fully dissolved. Once the solution was homogeneous, the media was divided into three parts and placed into three 500 mL Erlenmeyer flasks. Each Erlenmeyer flask contained 300 mL of the homogeneous media. After dividing the media into three portions, each Erlenmeyer flask was filled with different concentrations of coconut water and algae extract. The first Erlenmeyer flask was added with 10 mL of coconut water and 10 mL of algae extract.

The second flask received 20 mL of coconut water and 20 mL of algae extract. The third flask was added with 30 mL of coconut water and 30 mL of algae extract. Once the total media volume reached 1 liter, the three Erlenmeyer flasks were mixed until homogeneous. The pH of the solution was then adjusted to 5.80. If the pH was below 5.80, KOH was added to increase the pH. If the pH was above 5.8, HCl was added to lower the pH. After the pH of each Erlenmeyer flask was adjusted, 10 grams of agar were added to each flask. The mixture was stirred until homogeneous and then heated on a hot plate. Once the substrate solution boiled, the media was poured into culture bottles with a volume of 20-25 mL per bottle. The bottles were then sealed with aluminum foil, secured with rubber bands, and labeled accordingly.

Sterilization of Equipment, Materials, and Media

The culture equipment, such as Petri dishes, scalpel handles, scalpel blades, and tweezers, were thoroughly washed with soap and dried. After drying, the equipment was wrapped in paper and sealed. The materials used included aquades, which were placed in bottles sealed with plastic and secured with rubber bands. Tissue, cut to fit the size of the Petri dishes, was also placed inside the bottles. The materials that had been prepared earlier were placed in an autoclave basket and arranged properly. The basket was then placed in the autoclave for sterilization, which was carried out for 10-25 minutes at a temperature of 121°C and a pressure of 15 Psi. After sterilization, the culture equipment and materials were transferred to an oven to prevent contamination. The sterilized media were allowed to cool and were then stored on the culture rack in the culture room.

Sterilization of Laminar Air Flow

The sterilization of the Laminar Air Flow (LAF) was conducted using disinfectants and 70% alcohol. The use of the disinfectant and 70% alcohol cleaned the glass walls and work surface of the Laminar Air Flow, preventing contamination from microorganisms present on these surfaces. Sterilization was done twice: before and after the multiplication process. The UV light was turned on at least 30 minutes before the Laminar Air Flow was used. All sterilized tools and materials were prepared and sprayed with 70% alcohol first. The work surface and walls of the Laminar Air Flow were sprayed with 70% alcohol or spirit. The blower of the Laminar Air Flow was turned on to begin operation. Afterward, the light on the Laminar Air Flow was turned on.

Observation

The observation process on the growth of Alocasia melo was conducted once a week with parameters including the number of shoots and roots that grew, and observations were made over a period of 84 days after planting (DAP).

Data Analysis

The data from this study were analyzed using descriptive data analysis. The data collected were both qualitative and quantitative, derived from the

observations of the number of shoots and roots that grew over 84 days after planting (DAP), and the results were presented in the form of diagrams.

Result and Discussion

Based on the results obtained from the initiation of explants of *Alocasia melo* cultured on solid MS medium (Murashige and Skoog) with the addition of 1 ppm BAP plant growth regulator, 60 shoots were produced over 90 days after planting (DAP). These shoots were then subcultured again on MS medium with five different treatments as follows: coconut water and 6-Benzyl Amino Purine (AK + BAP), seaweed extract and 6-Benzyl Amino Purine (EG + BAP), coconut water (AK), seaweed extract (EG), and a combination of coconut water and seaweed extract (AK + EG). The treatments consisted of three concentrations: 10 mL, 20 mL, and 30 mL. The average number of shoots and roots can be seen in Figures 3 and 4.

Treatment of Additional Nutrients for Alocasia melo Explants with the Addition of BAP, Coconut Water, and Seaweed Extract

Based on the results shown in Figure 1, after being subcultured for 84 days after planting (DAP) with the addition of 10 mL of coconut water (AK) and 1 ppm of BAP, the average number of shoots obtained was higher compared to other treatments, reaching 3.75 shoots. Meanwhile, the treatment with 30 mL of coconut water without BAP resulted in a higher average number of roots compared to other treatments, reaching 6.75 roots (Figure 2).

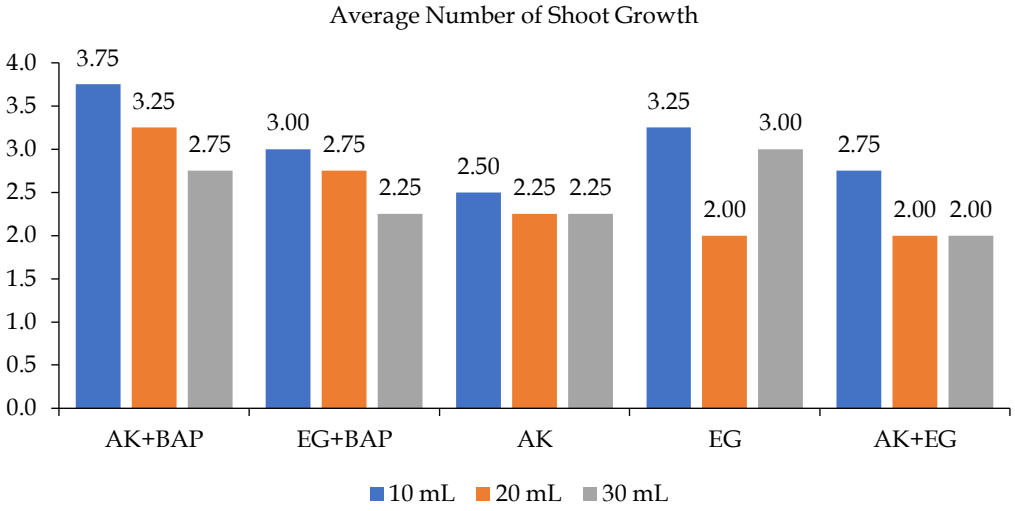

Figure 1. Average number of shoots in *Alocasia melo* explants with five types of treatments at 84 DAP (Days After Planting). Legend: X-axis: Treatment types; Y-axis: Number of shoots

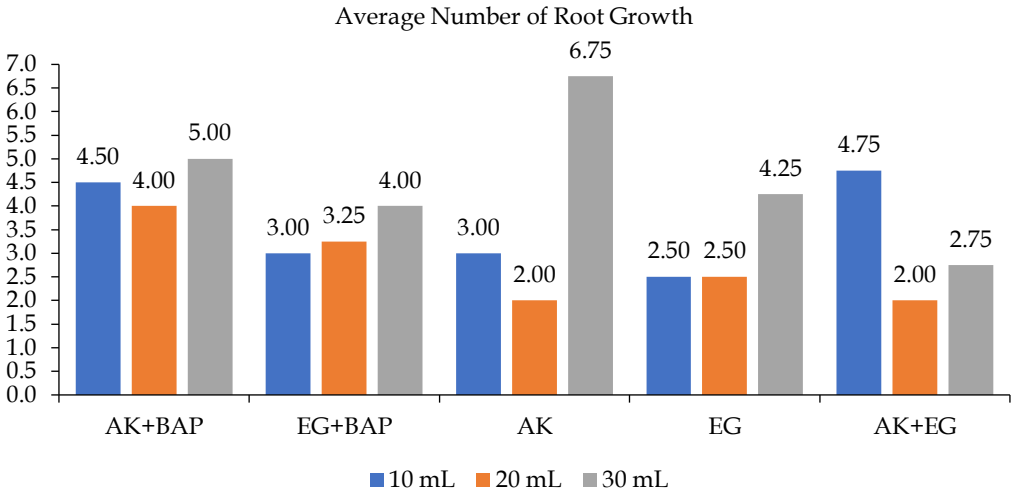

Figure 2. Average number of roots in *Alocasia melo* explants with five types of treatments at 84 DAP (Days After Planting). Legend: X-axis: Treatment types; Y-axis: Number of roots

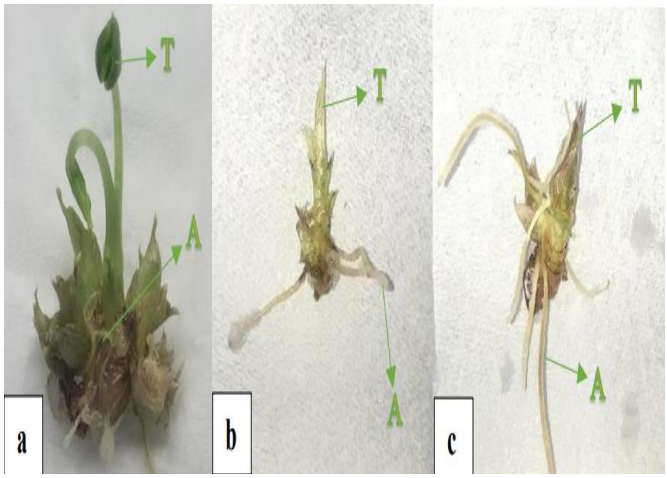

Figure 3. Growth response of shoots and roots on AK + BAP (1 ppm) media at 84 DAP (Days After Planting). Legend: a. AK 10 mL; b. AK 20 mL; c. AK 30 mL; T = Shoots; A = Roots

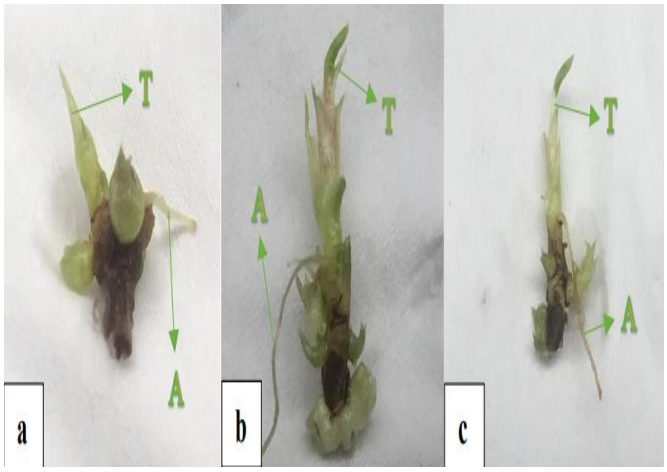

Figure 4. Growth response of shoots and roots on EG + BAP (1 ppm) media at 84 DAP (Days After Planting). Legend: a. EG 10 mL; b. EG 20 mL; c. EG 30 mL; T = Shoots; A = Roots

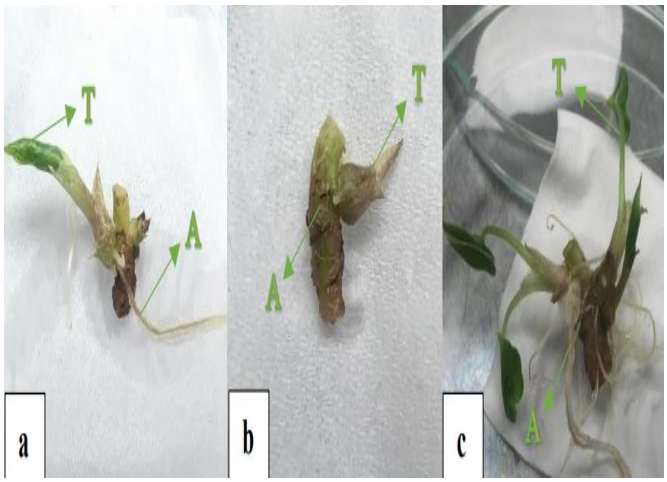

Figure 5. Growth response of shoots and roots on AK media at 84 DAP (Days After Planting). Legend: a. AK 10 mL; b. AK 20 mL; c. AK 30 mL; T = Shoots; A = Roots

Figure 6. Growth response of shoots and roots on AK + EG media at 84 DAP (Days After Planting). Legend: a. AK+EG 10 mL; b. AK+EG 20 mL; c. AK+EG 30 mL; T = Shoots; A = Roots

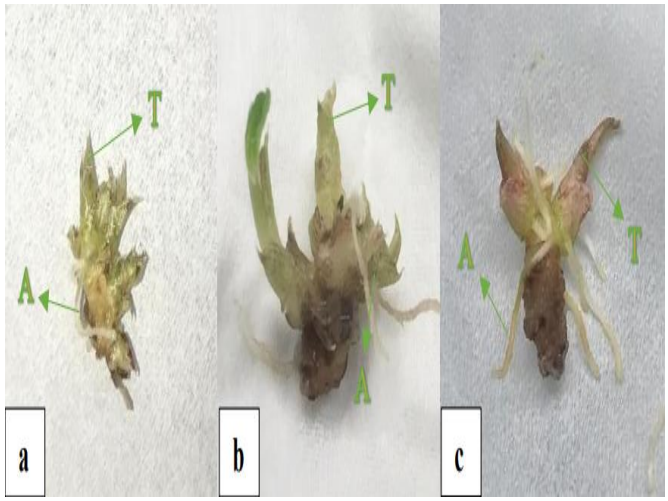

Figure 7. Growth response of shoots and roots on EG media at 84 DAP (Days After Planting). Legend: a. EG 10 mL; b. EG 20 mL; c. EG 30 mL; T = Shoots; A = Roots

The shoot growth of *Alocasia melo* showed that each treatment resulted in a different average number of shoots (Figure 3). The treatment with 10 mL of coconut water (CW) combined with 1 ppm BAP produced an average of 3.75 shoots, which was higher compared to treatments with seaweed extract (SE) plus BAP or treatments without BAP (CW, SE, and CW + SE). This finding demonstrates that the application of 10 mL CW and 1 ppm BAP provides an optimal response for inducing shoot growth in *A. melo*. Cavendish banana plants with 10 mL of coconut water and 1 ppm BAP resulted in an average of 2.25 shoots. Similarly, Meilani (2019) found that the highest shoot multiplication rate in Barangan bananas (*Musa acuminata* L.) occurred with the application of 10 mL of coconut water (Nandariyah et al., 2021), also stated that using coconut water at a

concentration of 10% in multiplication processes is highly recommended for optimal shoot growth. Coconut water contains cytokinin and auxin hormones, which stimulate cell division (Ghani et al., 2023). The utilization of coconut water as a growth regulator has proven effective in tissue culture of *A. melo*. This is consistent with the application of 10 mL coconut water on *A. melo* explants compared to 20 and 30 mL, as higher concentrations tended to inhibit growth (Castañares & Bouzo, 2019).

In Figure 3, the results showed that as the concentration of coconut water increased, the number of shoots produced decreased. This was likely due to the endogenous hormones present in the explants, which were already sufficient to trigger a response at the lower concentration of 10 mL. Maxiselly et al. (2025) stated that the plant growth regulators (PGRs) in coconut water were able to stimulate proliferation in plant tissues, as well as improve respiration and metabolism. In addition to being isolated into cytokinins, the PGRs in coconut water also provided benefits to coconut embryos through the process of cytokinesis (Mu et al., 2024b). Coconut water contained active compounds that supported embryo development, such as cytokinins, which could stimulate cell division (Perner et al., 2022) and accelerate shoot growth (Kumar et al., 2025). Coconut water also contained components similar to those found in MS medium, such as sugars, macro- and micronutrients, amino acids, and organic acids (Manivannan et al., 2018). Besides PGRs, coconut water also contained vitamins C, B5, inositol, thiamine, pyridoxine, as well as macro- and micronutrients like N, P, K, Mg, Fe, Ca, and Zn (Silva et al., 2025).

The addition of 1 ppm BAP to 10 mL of coconut water had a positive effect on the average shoot growth of *A. melo*. According to Misbahuljannah et al. (2025), shoot formation can be triggered by the appropriate concentration of BAP. The cytokinin hormone in BAP plays a role in stimulating plant cell division and interacts with auxins to determine cell differentiation. When the cytokinin to auxin ratio is higher, shoot growth will be stimulated (Zhang et al., 2022). The combination of 10 mL coconut water with 1 ppm BAP is very effective in promoting shoot growth in *A. melo*. Rostami & Azhdarpoor (2019) stated that the use of plant growth regulators (PGRs) can stimulate growth when applied at the correct concentration, but higher concentrations may inhibit growth. According to Shivandu et al. (2025), when plant growth regulators (PGRs) were applied in excessive concentrations, they became inhibitors in the morphogenesis of plant growth. The decrease in the average shoot growth of *A. melo* at 20 and 30 mL concentrations in treatments with coconut water added with BAP and algae extract added with BAP occurred because the nutrients and minerals provided to the explants exceeded the amounts needed, which resulted in a reduction in the number of shoots (Figure 3). This indicated that increasing the coconut water concentration raised osmotic pressure and reduced the water potential of the medium.

This condition hindered the absorption of nutrients necessary for cell division and organogenesis, thus inhibiting shoot growth (Wu et al., 2025). The treatment without the addition of BAP (AK, EG, and AK+EG) showed that the highest average shoot growth occurred in the EG treatment with a concentration of 10 mL, compared to other treatments and concentrations. The treatment with algae extracts alone produced higher average shoots. This was suspected to be due to the content in the algae extract, which provided hormones and nutrients needed by *A. melo*. The algae extract from *Sargassum sp*., *Gracilaria coronopofilia*, and *Ulva lactucaefolia* contain various substances, and at a concentration of 10 mL, they resulted in an average of 3 shoots, compared to 20 and 30 mL concentrations (Figure 3). The low concentration of algae extract was already sufficient to stimulate the development and growth of shoots. The algae extract contains substances such as IAA, NAA, GA, and kinetin in *Sargassum sp*. (Ali et al., 2021), IAA, cytokinin, jasmonic acid, polyamines, and rhodomorphin in Gracilaria coronopofilia, and IAA, ABA, cytokinin, gibberellin, polyamines, and jasmonic acid in Ulva lactucaefolia (García et al., 2020).

The high number of hormones in the algae extract suggests that even a small concentration could stimulate shoot growth in *A. melo*. (Olaetxea et al., 2024) who used algae extract as an organic fertilizer to increase the number of tillers in rice, found that algae extract at the lowest concentration of 25%, when combined with inorganic fertilizers, produced the highest number of rice tillers. However, when the concentration exceeded 25%, the number of rice tillers significantly decreased. The synthetic cytokinin added in the form of BAP caused a significant decrease in the number of shoots in the treatment with 10 mL algae extract and the addition of 1 ppm BAP (Figure 3). The algae extract itself contained many phytohormones. The low concentration of algae extract used was due to the high amount of phytohormones it contained. The high levels of cytokinin and other mineral content in the algae extract were sufficient to promote shoot growth in *A. melo*. However, the high cytokinin content in the algae extract caused toxicity in the explants, leading to a decrease in the number of shoots at concentrations of 20 mL and 30 mL. A study by Xue et al. (2022) demonstrated that the extract from *Gracilaria coronopofilia* contained cytokinin in the form of trans-zeatin at a concentration of 6.26×10^{-2} mg/g. In contrast, the extract from *Ulva lactucaefolia*

contained cytokinin at 370.86 µg/g and auxin at 290.52 µg/g (Kesharwani & Panda, 2024). If the concentration used was too high, it could harm the plant and inhibit the growth and development of shoots (Frank et al., 2020). Shoot induction would not have occurred if the balance between auxin and cytokinin had been disrupted.

The data on the average root growth showed that the highest growth occurred in the treatment with coconut water without BAP at a concentration of 30 mL, compared to other treatments and concentrations. At the 30 mL concentration, the average root growth was 6.75, as shown in Figure 4. According to Yunita & Nugraha (2021), coconut water contained IAA, a type of auxin that stimulated root growth. Root formation began with a group of meristematic cells that continuously divided and formed small cells known as root primordia. These cells developed further, eventually forming the root tip, and the roots lengthened (Echevarría et al., 2025). This was in line with Mu et al. (2024a), statement that coconut water contained thiamine, a form of vitamin B1 that accelerated cell division in root meristems. Additionally, the calcium content in coconut water played a role in the formation of root hairs and root elongation. The phosphorus content in coconut water also helped in the root formation process. According to Nittis et al. (2025), auxins played an essential role in cell division and enlargement, especially during the early stages of root formation. When auxins were absorbed at high levels, cell division occurred more rapidly, resulting in more roots being formed.

Conclusion

Based on the research conducted, the addition of nutrients in the form of coconut water and algae extract had different effects on the growth of shoots and roots in *Alocasia melo*. The best nutrient treatment for optimal shoot growth in *Alocasia melo* was the treatment of AK+BAP, with 10 mL of coconut water (AK) and a 1 ppm BAP concentration, which resulted in an average of 3.75 shoots. The optimal root growth was observed in the treatment with coconut water (AK) alone at 30 mL, yielding an average of 6.75 roots. It is recommended to continue observations through the acclimatization phase. It is crucial to determine whether the high root count (from the 30 mL AK treatment) directly correlates with the survival rate of the plants when transferred from the bottle to the solid growing medium.

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Conceptualization, A.M., B., and N.I.J.; methodology, data processing, article writing, B.; validation, review, A.M. and N.I.J.; funding acquisition, A.M. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

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