Bioscientist: Jurnal Ilmiah Biologi
https://e-journal.undikma.ac.id/index.php/bioscientist

June 2026 Vol. 14, No. 2
e-ISSN: 2654-4571
pp. 1119-1132

Effects of Storage Duration of Mature and Young Coconut Water on the Growth of *Dendrobium bigibbum*

[1]Sekar Ode Narendra, [2]Fenny Roshayanti, [3*]Lussana Rossita Dewi
[1,2,3]Department of Biology Education, Faculty of Mathematics, Natural Sciences, and Information Technology Education, Universitas PGRI Semarang, Semarang, Indonesia.
*Corresponding Author e-mail: lussanarossitadewi@upgris.ac.id
Received: March 2026; Revised: May 2026; Accepted: June 2026; Published: June 2026

Abstract: This study evaluated the effects of coconut water type and storage duration on the vegetative growth of *Dendrobium bigibbum*. A completely randomized factorial design was employed, consisting of two coconut water types—mature coconut water and young coconut water—and three storage durations: 0, 1, and 2 days. The experiment included six treatment combinations and an untreated control, with three replicates per treatment. The observed growth parameters were plant height, number of leaves, leaf length, and number of shoots. Data were analyzed using two-way analysis of variance at a 5% significance level. No statistically significant differences were detected among treatments for plant height, number of leaves, leaf length, or number of shoots ($p > 0.05$). Nevertheless, descriptive observations showed that mature coconut water stored for 0 days (AKTL0) produced the highest mean plant height and leaf length, whereas mature coconut water stored for 1 day (AKTL1) produced the highest mean number of leaves and shoots. These findings indicate that, under the conditions of this study, coconut water type and short-term storage for up to 2 days did not produce statistically detectable effects on the vegetative growth of *D. bigibbum*. However, the numerically higher values observed in the AKTL0 and AKTL1 treatments suggest that fresh or briefly stored mature coconut water warrants further investigation using larger sample sizes, longer observation periods, standardized storage conditions, and laboratory analyses of coconut water quality. This result is consistent with previous evidence that the response of *Dendrobium* to coconut water depends on its nutrient composition, endogenous hormones, and physicochemical properties, which may change during storage.
Keywords: *Dendrobium bigibbum*; mature coconut water; young coconut water; storage duration; vegetative growth

How to Cite: Narendra, S. O., Roshayanti, F., & Dewi, L. R. (2026). Effects of Storage Duration of Mature and Young Coconut Water on the Growth of Dendrobium bigibbum. *Bioscientist: Jurnal Ilmiah Biologi*, *14*(2), 1119–1132. https://doi.org/10.33394/bioscientist.v14i2.19951

https://doi.org/10.33394/bioscientist.v14i2.19951

INTRODUCTION

Dendrobium bigibbum is a high-value ornamental orchid in the floriculture industry because of its attractive flower colors and forms and relatively long floral longevity (Bhattacharjee et al., 2023). Strong market demand for this species requires the continuous production of rapidly growing, healthy, and uniform plants, particularly during the seedling stage. Therefore, the development of effective, affordable, and easily applicable growth-promoting treatments is essential for improving the efficiency of *D. bigibbum* seedling production.

Coconut water has been widely investigated as a natural source of plant growth regulators (PGRs) because it contains various bioactive compounds, including auxins, cytokinins, gibberellins, amino acids, sugars, vitamins, and minerals (Yong et al., 2009; Ma et al., 2008). Analytical studies have also confirmed the presence of kinetin, kinetin riboside, and several other classes of phytohormones in coconut water (Ge et al., 2005; Ma et al., 2008). These compounds are involved in essential physiological processes, including cell division, cell elongation, tissue differentiation, shoot meristem development, and vegetative organ formation (Yong et al., 2009; Hönig et al., 2018; Pokimica et al., 2024).

In addition to naturally occurring phytohormones, coconut water contains sugars, amino acids, and minerals that may provide nutritional support for plant growth and tissue development (Hwang et al., 2024; Yong et al., 2009). Its low cost, broad availability, and environmentally friendly characteristics make coconut water a potentially sustainable supplement for plant cultivation. In orchid production, its application may reduce reliance on synthetic growth-promoting compounds while supporting more economical seedling management. Nevertheless, its growth-promoting capacity may vary according to coconut maturity and post-collection handling, particularly storage duration.

The addition of coconut water to in vitro culture media has been reported to enhance plantlet growth in several *Dendrobium* species. Coconut water has long been used as an organic supplement in plant tissue culture because its nutrients and naturally occurring phytohormones can support cell proliferation and plantlet development (Yong et al., 2009). Supplementation of the culture medium with 30% coconut water increased the percentage of sprouting explants and plant height compared with media without coconut water (Inkiriwang et al., 2016).

Comparable growth-promoting responses have also been reported at lower coconut water concentrations in different *Dendrobium* species. In hybrid *Dendrobium* orchids, the addition of 15% coconut water to the regeneration medium promoted root and leaf formation, an effect associated with the presence of cytokinins and calcium that may support cell division and tissue differentiation (Aqidah et al., 2022). In other *Dendrobium* species, coconut water concentrations of 10–20% have been reported to enhance plantlet growth and leaf length (Zakiyah et al., 2025), whereas concentrations of approximately 5–10% have been associated with increased shoot and leaf production during the seedling stage of *Dendrobium* sp. (Nisa et al., 2021).

However, most previous studies have focused on in vitro culture systems. Evidence regarding the direct application of coconut water to conventionally grown *D. bigibbum* seedlings under greenhouse conditions remains limited. Therefore, further investigation is required to determine whether the growth-promoting effects observed under in vitro conditions can also be achieved during greenhouse cultivation.

The effectiveness of coconut water as a natural PGR is strongly influenced by its physicochemical and microbiological quality, which may change during storage. The chemical composition of coconut water also varies according to cultivar, environmental conditions, and fruit maturity, indicating that young and mature coconut water may differ in their initial concentrations of sugars, minerals, and bioactive compounds (Yong et al., 2009).

In addition to differences associated with fruit maturity, storage conditions may substantially alter the quality of coconut water. Storage can reduce pH and sugar content, alter sugar and organic acid profiles, and increase microbial populations, thereby decreasing the quality and stability of coconut water (Detudom et al., 2023). Under refrigerated conditions, major physicochemical changes may occur more slowly than under ambient conditions; however, refrigeration does not completely prevent microbial growth and quality deterioration (Detudom et al., 2023). Detudom et al. (2023) further demonstrated that changes in pH, titratable acidity, turbidity, and sugar composition were closely associated with increasing microbial populations during storage.

These storage-related changes may reduce the suitability of coconut water as a plant growth stimulant. Declining concentrations of sugars, vitamins, and minerals may limit the resources available for cell division, leaf development, and shoot formation. Increased microbial activity may also alter the chemical composition of coconut water and potentially reduce its biological activity. However, these proposed mechanisms require direct verification through physicochemical, hormonal, and microbiological analyses.

Previous studies have demonstrated the potential of coconut water to promote seedling growth and vegetative organ development in several *Dendrobium* species (Inkiriwang et al., 2016; Nisa et al., 2021; Aqidah et al., 2022; Zakiyah et al., 2025). Nevertheless, limited information is available on the combined effects of coconut maturity and storage duration on the vegetative growth of greenhouse-grown *D. bigibbum*. Moreover, direct comparisons between young and mature coconut water stored for short periods remain scarce.

Therefore, this study aimed to evaluate the effects of young and mature coconut water stored for 0, 1, and 2 days on plant height, leaf number, leaf length, and shoot number in *D. bigibbum*. It was hypothesized that coconut maturity, storage duration, and their interaction would influence the vegetative growth of *D. bigibbum* because differences in initial composition and storage-related quality deterioration may alter the biological activity of coconut water.

METHOD

Study Site and Duration

The study was conducted for four months, from July to October 2024, in the greenhouse of CV Candi Orchid, Semarang, Central Java, Indonesia, at an elevation of 86 m above sea level. The greenhouse was selected because its environmental conditions could be controlled, thereby minimizing fluctuations in factors that could affect the growth of *Dendrobium bigibbum*.

Plant Materials and Equipment

The study used 5–6-month-old *Dendrobium bigibbum* seedlings because plants at this age are in a relatively stable early vegetative growth phase. Only healthy seedlings of uniform size and without visible physical damage were selected.

The equipment used included a thermometer, graduated cylinder, plant labels, ruler, string, stationery, paper, scissors, soft pots, and trays. The materials consisted of 5–6-month-old *D. bigibbum* seedlings, mature coconut water, young coconut water, regular water, and kadaka fern roots as the growing medium.

Experimental Design

The experiment was arranged in a two-factor completely randomized design (CRD). Treatment combinations were randomly assigned to the experimental units to minimize the influence of environmental variation on the growth of *D. bigibbum*. The first factor was coconut-water storage duration, consisting of 0, 1, and 2 days. The second factor was coconut-water type, consisting of mature and young coconut water.

The two factors produced six treatment combinations: AKTL0 (mature coconut water stored for 0 days), AKTL1 (mature coconut water stored for 1 day), AKTL2 (mature coconut water stored for 2 days), AKML0 (young coconut water stored for 0 days), AKML1 (young coconut water stored for 1 day), and AKML2 (young coconut water stored for 2 days). A control treatment without coconut-water application was also included. Each treatment was replicated three times, resulting in a total of 21 *D. bigibbum* seedlings.

Coconut-water type and storage duration were selected as experimental factors to evaluate how changes in coconut-water quality might affect the vegetative growth of *D. bigibbum*. The CRD was used to reduce potential bias associated with environmental variation within the greenhouse.

Experimental Procedure

Mature and young coconut water were applied according to the assigned storage duration. Coconut water allocated to the 1- and 2-day storage treatments was stored in a refrigerator before application. For the 0-day treatment, freshly collected mature or young coconut water was applied directly to the seedlings without prior storage.

Each seedling received 100 mL of coconut water per application. The coconut water was poured directly onto the root zone and growing medium to facilitate the absorption of nutrients and naturally occurring plant hormones. The treatments were applied once weekly in the late afternoon to reduce evaporation and ensure consistent treatment of the seedlings.

Data Collection

Growth measurements were recorded at 15-day intervals. The measured variables were plant height, number of leaves, leaf length, and number of offshoots.

1. **Plant height**

   Plant height was measured using a string and ruler. The string was extended from the base of the stem to the tip of the highest leaf and marked at the corresponding point. The marked length was then measured using a ruler and recorded in centimeters. The height of each plant was systematically entered into the data-recording sheet (Yao et al., 2026).

2. **Number of leaves**

   The number of leaves was determined through direct visual observation. All leaves on each stem, including newly emerged young leaves, were carefully counted. The number of leaves per plant was recorded according to the observation date. Leaf number is an indicator of the vegetative growth of orchid plants and can therefore be used to assess plant development (Fritsche et al., 2022).

3. **Leaf length**

   Leaf length was measured using a string and ruler. The string was extended from the point at which the leaf was attached to the stem to the tip of the leaf and marked at the corresponding length. The marked string was subsequently measured with a ruler in centimeters. When a plant had multiple leaves, all leaves were measured, and the mean leaf length per plant was calculated by dividing the total leaf length by the number of leaves. The measurements were systematically recorded according to the observation date (Yao et al., 2026).

4. **Number of offshoots**

   The number of offshoots was determined by counting all newly developed shoots on each plant. Small or newly emerging offshoots were carefully examined to ensure accurate data collection. The total number of offshoots per plant was recorded systematically according to the observation date (Lakshanthi & Seran, 2019).

Statistical Analysis

All growth measurements were treated as quantitative data and analyzed using two-way analysis of variance (ANOVA) to evaluate the effects of coconut-water type, storage duration, and their interaction. Statistical analyses were performed using IBM SPSS Statistics version 23. When the ANOVA indicated significant differences among treatments at $p < 0.05$, the analysis was followed by a least significant difference (LSD) test to identify treatment pairs that differed significantly.

RESULTS AND DISCUSSION
Plant Height

The mean plant height of *Dendrobium bigibbum* under the different coconut water treatments and storage durations is presented in Table 1.

Table 1. Mean plant height of *Dendrobium bigibbum* under different coconut water treatments and storage durations

Treatment	0 days	1 day	2 days
Control	8.27	—	—
AKT	9.28	7.30	8.06
AKM	8.09	8.65	6.90

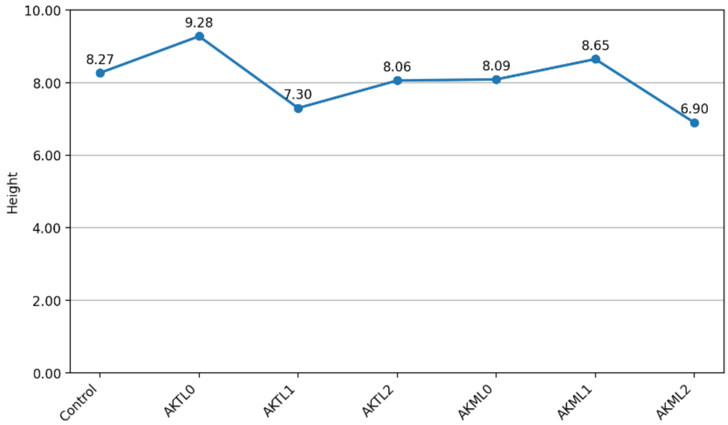

Figure 1. Mean plant height of *Dendrobium bigibbum* under different coconut water treatments and storage durations

The reported ANOVA results for plant height, including the overall model, individual factors, and their interaction, are summarized in Table 2.

Table 2. ANOVA results for plant height

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	11.827[a]	6	1.971	1.274	0.330
Intercept	1349.758	1	1349.758	872.412	0.000
Factor A	6.967	4	1.742	1.126	0.384
Factor B	0.000	0	—	—	—
Factor A × Factor B	0.000	0	—	—	—
Error	21.660	14	1.547	—	—
Total	1415.350	21	—	—	—
Corrected Total	33.487	20	—	—	—

Plant height varied numerically among treatments. AKTL0, representing freshly collected mature coconut water, produced the highest mean plant height of 9.28 cm, whereas AKML2, representing young coconut water stored for two days, produced the lowest mean height of 6.90 cm. The control treatment had a mean plant height of 8.27 cm. Overall, the mature coconut water treatments tended to produce greater plant height than the young coconut water treatments, although this pattern was not consistent across all storage durations.

The ANOVA results showed that the differences among treatments were not statistically significant ($p = 0.330$). Factor A was also not significant ($p = 0.384$). Therefore, the higher mean plant height recorded for AKTL0 should be interpreted as a descriptive numerical pattern rather than evidence of a statistically confirmed treatment effect.

Several factors may explain the absence of significant differences. The chemical and biological quality of coconut water may change during storage, potentially altering its nutrient concentration, endogenous phytohormone activity, and effectiveness as a plant biostimulant. Biological variability among seedlings may also have influenced their responses because minor differences in physiological condition, initial vigor, or developmental stage can produce variation in plant growth. In addition, differences in greenhouse microenvironmental conditions, including light intensity, temperature, humidity, water distribution, and growing-medium heterogeneity, may have increased variability among experimental units.

Storage conditions are important determinants of coconut water quality. Santosa et al. (2025) reported that inappropriate storage may reduce coconut water quality through changes in soluble solids content, expressed as °Brix, alterations in pH, degradation of organic compounds, and increased microbial activity. Microbial proliferation during storage may consume available nutrients or alter biologically active compounds, thereby reducing the potential effectiveness of coconut water as a biostimulant.

Coconut water contains sugars, amino acids, minerals, vitamins, and naturally occurring phytohormones, including auxins, cytokinins, and gibberellins (Irmayanti et al., 2025). These compounds may become less stable during storage. Changes in pH, soluble sugar content, organic compounds, and microbial populations may consequently reduce the biological activity of stored coconut water. However, because these properties were not measured in the present study, their contribution to the observed plant-height responses remains a possible explanation that requires further investigation.

Methodological factors may also have limited the ability of the experiment to detect treatment effects. Tungga et al. (2023) indicated that a relatively short observation period may be insufficient to demonstrate differences in vegetative growth, particularly in slow-growing orchids. Environmental variation that is not strictly controlled may further obscure treatment responses. These findings emphasize the importance of standardizing coconut water quality, storage temperature, storage containers, and environmental conditions to clarify the potential use of coconut water as a natural plant growth regulator in *Dendrobium bigibbum* seedling production.

Number of Leaves

The mean number of leaves produced by *Dendrobium bigibbum* under each coconut water treatment and storage duration is shown in Table 3.

Table 3. Mean number of leaves of *Dendrobium bigibbum* under different coconut water treatments and storage durations

Treatment	0 days	1 day	2 days
Control	4.8	—	—
AKT	5.6	5.8	4.3
AKM	5.4	4.4	4.9

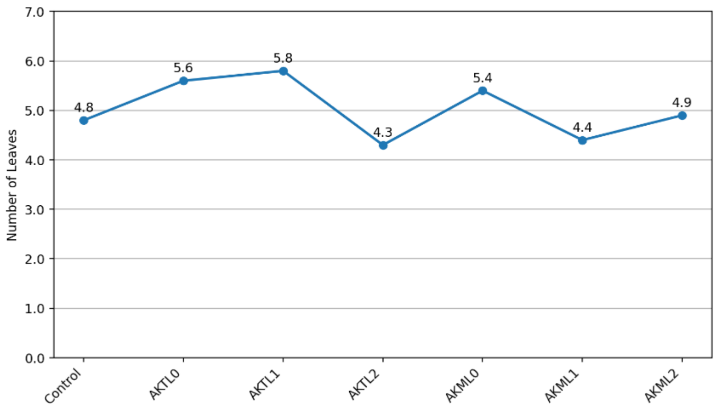

Figure 2. Mean number of leaves of *Dendrobium bigibbum* under different coconut water treatments and storage durations

The reported ANOVA results for the number of leaves, including the overall model, individual treatment factors, and their interaction, are presented in Table 4.

Table 4. ANOVA results for the number of leaves

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6.000[a]	6	1.000	0.368	0.887
Intercept	516.759	1	516.759	190.385	0.000
Factor A	3.722	4	0.931	0.343	0.845
Factor B	0.000	0	—	—	—
Factor A × Factor B	0.000	0	—	—	—
Error	38.000	14	2.714	—	—
Total	569.000	21	—	—	—
Corrected Total	44.000	20	—	—	—

The mean number of leaves varied among treatments. AKTL1, representing mature coconut water stored for one day, produced the highest mean number of leaves at 5.8 leaves per plant. In contrast, AKTL2 produced the lowest mean value at 4.3 leaves per plant. Among the young coconut water treatments, AKML0 produced the highest mean number of leaves at 5.4, whereas AKML1 produced the lowest value at 4.4. The control treatment produced an average of 4.8 leaves per plant.

Although mature coconut water produced relatively high mean values under several storage conditions, the response was not consistent. For example, AKTL1 produced the highest number of leaves, whereas AKTL2 produced the lowest value among all treatments. Consequently, the results do not demonstrate a consistent relationship between coconut maturity, storage duration, and leaf production.

The ANOVA results confirmed that treatment differences were not statistically significant ($p = 0.887$). Factor A also had no significant effect on leaf number ($p = 0.845$). Thus, the numerical differences presented in Table 3 and Figure 2 were insufficient to establish a statistically significant treatment response.

The relatively high number of leaves recorded for some mature coconut water treatments may be associated with naturally occurring phytohormones. Cytokinins promote cell division, tissue differentiation, and the development of vegetative organs. They also stimulate meristematic activity and delay leaf senescence, potentially maintaining a greater number of physiologically active leaves in orchids (Hönig et al., 2018). Auxins may support root development and nutrient acquisition by regulating root growth and cell division (Ahmad, 2023). Gibberellins may also contribute to stem elongation, shoot development, and vegetative growth. Together, these phytohormones provide a physiological basis for the potential use of coconut water as a natural plant growth regulator. Nevertheless, their concentrations were not measured in this study, and their roles in the observed responses therefore remain hypothetical.

The absence of a significant effect may also be related to the growth characteristics of *Dendrobium bigibbum*. Leaf production in orchids is generally slow, particularly during the juvenile vegetative stage. The duration of the experiment may therefore have been insufficient to detect clear differences among treatments. Biological variability among seedlings, including differences in initial size, vigor, and physiological condition, may have further affected leaf development.

Environmental conditions in the greenhouse may also have contributed to variation among experimental units. Temperature, humidity, light availability, and water distribution can influence leaf initiation and expansion. Reduced light intensity caused by shade netting may limit photosynthetic activity and restrict leaf development (Amalia et al., 2022). These factors indicate that future experiments should include stricter environmental control, more experimental replicates, and a longer observation period.

Storage duration may additionally influence the biological quality of coconut water. The relatively low leaf numbers recorded for AKTL2 and AKML1 may have been associated with storage-related changes in nutrients and growth-promoting compounds. Limbad et al. (2023) reported that natural fermentation and microbial activity can modify the chemical composition of coconut water. Such changes may reduce its effectiveness as a source of natural plant growth regulators. However, direct measurements of microbial activity, pH, soluble sugars, and phytohormones are required to confirm this explanation.

Leaf Length

Table 5 presents the mean leaf length of *Dendrobium bigibbum* following the application of mature and young coconut water stored for different durations.

Table 5. Mean leaf length of *Dendrobium bigibbum* under different coconut water treatments and storage durations

Treatment	0 days	1 day	2 days
Control	4.53	—	—
AKT	5.70	4.04	4.65
AKM	4.62	4.48	3.81

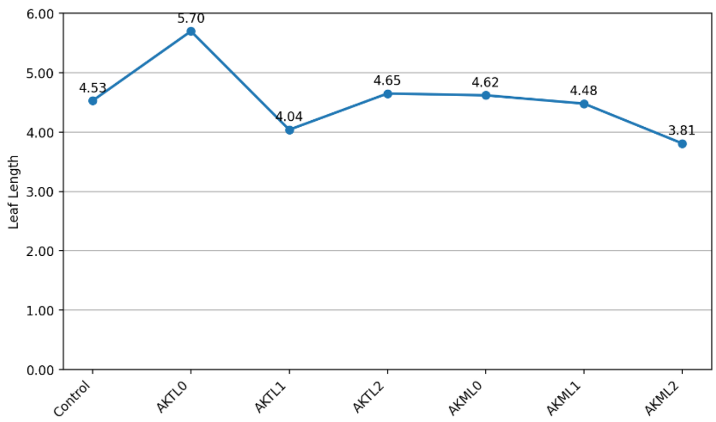

Figure 3. Mean leaf length of *Dendrobium bigibbum* under different coconut water treatments and storage durations

The reported ANOVA results for leaf length, including the overall model, the individual treatment factors, and their interaction, are summarized in Table 6.

Table 6. ANOVA results for leaf length

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6.191[a]	6	1.032	1.136	0.392
Intercept	424.147	1	424.147	466.811	0.000
Factor A	3.710	4	0.928	1.021	0.430
Factor B	0.000	0	—	—	—
Factor A × Factor B	0.000	0	—	—	—
Error	12.720	14	0.909	—	—
Total	455.121	21	—	—	—
Corrected Total	18.911	20	—	—	—

Mean leaf length varied among treatments. AKTL0 produced the longest leaves, with a mean length of 5.70 cm, whereas AKML2 produced the shortest leaves, with a mean length of 3.81 cm. The control treatment produced a mean leaf length of 4.53 cm. Mature coconut water generally produced relatively high values, particularly when applied without storage. However, AKTL1 produced a lower mean value than several other treatments, indicating that the response was not uniform across storage durations.

The ANOVA results showed that differences in leaf length among treatments were not statistically significant ($p = 0.392$). Factor A was also not significant ($p = 0.430$). Therefore, the higher mean leaf length observed under AKTL0 represents a numerical difference rather than a statistically supported treatment effect.

The relatively long leaves recorded under the fresh mature coconut water treatment may be associated with naturally occurring cytokinins and auxins, which are involved in cell division, meristem activity, and cell elongation. Choirunnisa et al. (2024) reported that coconut water application increased leaf size and leaf area in horticultural plants because its bioactive compounds promoted leaf-meristem activity and cell expansion. Coconut water also contains minerals such as potassium and magnesium, which contribute to tissue formation, enzyme activity, and photosynthetic processes (Samad & Mahmud, 2025).

Nevertheless, the absence of a significant difference indicates that other sources of variation may have had a stronger influence on leaf length. Biological variability among seedlings may have affected leaf-development rates, particularly because juvenile orchids generally exhibit slow vegetative growth. The observation period may also have been too short to allow treatment effects to become clearly expressed. Furthermore, environmental variation in light intensity, temperature, and humidity may have increased measurement variability and reduced the statistical detectability of treatment responses.

The findings are consistent with Karmila et al. (2022), who reported that natural biostimulants may produce numerical or visually apparent improvements in leaf growth without resulting in statistically significant differences when the observation period is short or the number of replicates is limited. Orchids may require a longer physiological adjustment period before treatment-related changes in leaf growth become measurable.

AKML2 produced the lowest mean leaf length. This response may be related to changes in young coconut water during storage. Putri et al. (2023) reported that storage-related processes may alter pH, reduce sugar content, and affect the stability of bioactive compounds involved in vegetative growth. Such changes could reduce the effectiveness of coconut water as a natural source of plant growth regulators. However, because coconut water quality was not directly analyzed in the present study, this interpretation should be regarded as a possible mechanism rather than a confirmed explanation.

Number of Offshoots

The mean number of offshoots produced under the different coconut water treatments and storage durations is presented in Table 7.

Table 7. Mean number of offshoots of *Dendrobium bigibbum* under different coconut water treatments and storage durations

Treatment	0 days	1 day	2 days
Control	1.1	—	—
AKT	1.1	1.9	1.3
AKM	1.1	0.7	1.3

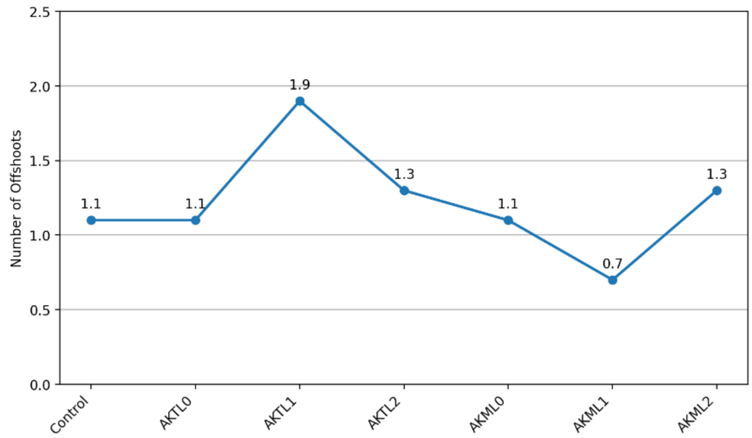

Figure 4. Mean number of offshoots of *Dendrobium bigibbum* under different coconut water treatments and storage durations

The reported ANOVA results for the number of offshoots, including the overall model, the individual treatment factors, and their interaction, are presented in Table 8.

Table 8. ANOVA results for the number of offshoots

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3.238[a]	6	0.540	1.259	0.336
Intercept	29.786	1	29.786	69.501	0.000
Factor A	3.056	4	0.764	1.782	0.188
Factor B	0.000	0	—	—	—
Factor A × Factor B	0.000	0	—	—	—
Error	6.000	14	0.429	—	—
Total	39.000	21	—	—	—
Corrected Total	9.238	20	—	—	—

The mean number of offshoots varied among treatments. AKTL1 produced the highest mean value at 1.9 offshoots per plant, whereas AKML1 produced the lowest value at 0.7 offshoots per plant. The control, AKTL0, and AKML0 treatments each produced an average of 1.1 offshoots, while AKTL2 and AKML2 each produced an average of 1.3 offshoots. These results show numerical variation in offshoot production, but they do not indicate a consistent response to either coconut water type or storage duration.

The ANOVA results demonstrated that differences among treatments were not statistically significant ($p = 0.336$). Factor A also did not significantly affect offshoot production ($p = 0.188$). Thus, the relatively high value recorded under AKTL1 cannot be interpreted as evidence that mature coconut water stored for one day significantly increased offshoot formation.

This result is consistent with Ramadhan and Abror (2022), who reported that natural biostimulants may produce numerical improvements in vegetative growth without yielding statistically significant differences when experiments have substantial internal variability, limited replication, or short observation periods. In the present study, biological variation among seedlings and the slow development of orchid offshoots may have reduced the ability to detect treatment effects.

The relatively high number of offshoots recorded under AKTL1 may be physiologically associated with the cytokinin content of coconut water. Cytokinins play an important role in shoot initiation, cell division, and tissue differentiation. Pokimica et al. (2024) reported that cytokinin signaling contributes to the formation of new shoot apical meristems and the development of new shoots. Yuliana (2021) also indicated that coconut water can serve as a natural source of plant growth regulators because it contains biologically active cytokinins and auxins that may support shoot and vegetative-organ formation. Nevertheless, the phytohormone concentrations in the coconut water used in this study were not measured; therefore, their direct contribution to offshoot formation cannot be confirmed.

Variation among AKML0, AKML1, and AKML2 suggests that the response to young coconut water may have been influenced by changes occurring during storage. Putri and Hartono (2021) reported that coconut water storage may promote the degradation of bioactive compounds and alter pH and soluble sugar content. Such changes may reduce its biostimulatory activity during subsequent application. Storage duration may therefore influence the stability of nutrients and growth-promoting compounds in coconut water (Detudom et al., 2023).

Overall, the treatments produced several numerical differences in plant height, leaf number, leaf length, and offshoot number, particularly under AKTL0 and AKTL1. However, none of these differences was statistically significant. The findings therefore provide preliminary descriptive evidence rather than definitive proof of the effectiveness of mature or young coconut water. Future studies should include more experimental replicates, a longer observation period, stricter control of greenhouse conditions, and direct measurements of coconut water pH, soluble sugars, microbial quality, nutrients, and phytohormone concentrations.

CONCLUSION

Under the conditions of this study, the application of mature and young coconut water stored for 0–2 days did not significantly affect the vegetative growth of *Dendrobium bigibbum*, as indicated by plant height, leaf number, leaf length, and shoot number ($p > 0.05$). Nevertheless, the AKTL0 and AKTL1 treatments showed numerically higher growth responses, suggesting that fresh or briefly stored mature coconut water may have potential as a natural biostimulant.

The absence of significant differences may have been influenced by biological variation among seedlings, the relatively slow growth of *D. bigibbum*, the limited number of replications, and environmental variability within the greenhouse. Further studies with longer observation periods, larger sample sizes, controlled environmental conditions, and analyses of coconut water quality are required to clarify the effects of coconut water type and storage duration on the vegetative growth of this orchid.

RECOMMENDATION

Future studies should evaluate coconut water quality before application by measuring pH, sugar content, and plant growth regulators. Longer experimental periods, stricter environmental control, and improved storage or processing methods are also recommended to clarify the effectiveness of coconut water as a natural biostimulant for *D. bigibbum*.

ACKNOWLEDGMENT

The authors gratefully acknowledge all individuals and institutions that supported and assisted with this study. The authors particularly thank their academic supervisors for their guidance, constructive feedback, and valuable contributions throughout the research and manuscript preparation processes. The authors also thank CV. Candi Orchid for providing the facilities and resources required to conduct the experiment. Appreciation is further extended to colleagues who assisted with data collection, data analysis, and scientific discussions during the study. The authors hope that the findings of this research will contribute to the advancement of knowledge, particularly in the fields of biology and agriculture.

REFERENCES

Ahmad, A. (2023). *Kandungan klorofil, karotenoid, dan flavonoid microgreens sawi hijau (Brassica juncea L.) yang ditanam pada berbagai media tanam dan konsentrasi air kelapa*. https://repository.unhas.ac.id/id/eprint/29494/

Amalia, A. C., Mubarok, S., & Nuraini, A. (2022). Respons anggrek *Dendrobium* terhadap perbedaan naungan dan aplikasi zat pengatur tumbuh. *Kultivasi, 21*(2), 127–134. https://doi.org/10.24198/kultivasi.v21i2.35029

Aqidah, A., Dewanti, P., & Narulita Alfian, F. (2022). Pertumbuhan anggrek *Dendrobium* hibrida pada kultur cair dengan penambahan BA dan NAA. *Journal of Agricultural Science, 20*(1). http://jurnal.unmuhjember.ac.id/

Bhattacharjee, B., Hossain, M. E., Ayesha, M. N., & Islam, S. S. (2023). Morphological diversity analysis of some existing and endangered *Dendrobium* orchid species in Bangladesh. *Journal of Bio-Science, 30*(2), 47–57. https://doi.org/10.3329/jbs.v30i2.68911

Detudom, R., Deetae, P., Wei, H., Boran, H., Chen, S., Siriamornpun, S., & Prakitchaiwattana, C. (2023). Dynamic changes in physicochemical and microbiological qualities of coconut water during postharvest storage under different conditions. *Horticulturae, 9*(12), Article 1284. https://doi.org/10.3390/horticulturae9121284

Fritsche, Y., Vinícius, M., Pinheiro, M., & Pedro, M. (2022). Light quality and natural ventilation have different effects on protocorm development and plantlet growth stages of the in vitro propagation of *Epidendrum fulgens* (Orchidaceae). *South African Journal of Botany, 146*, 864–874.

Ge, L., Yong, J. W. H., Goh, N. K., Chia, L. S., Tan, S. N., & Ong, E. S. (2005). Identification of kinetin and kinetin riboside in coconut (*Cocos nucifera* L.) water using a combined approach of liquid chromatography–tandem mass spectrometry, high-performance liquid chromatography, and capillary electrophoresis. *Journal of Chromatography B, 829*, 26–34.

Hönig, M., Plíhalová, L., Husičková, A., Nisler, J., & Doležal, K. (2018). Role of cytokinins in senescence, antioxidant defence and photosynthesis. *International Journal of Molecular Sciences, 19*(12), Article 4045. https://doi.org/10.3390/ijms19124045

Hwang, J. E., Park, H. B., Jeon, D. Y., Park, H. J., Kim, S., Lee, C. W., Kim, Y. J., & Yoon, Y. J. (2024). Effect of different basal media and organic supplements on in vitro seedling development of the endangered orchid species *Dendrobium moniliforme* (L.) Swartz. *Plants, 13*(19), Article 2721. https://doi.org/10.3390/plants13192721

Inkiriwang, A. E. B., Mandang, J., & Runtunuwu, S. (2016). Substitusi media Murashige dan Skoog/MS dengan air kelapa dan pupuk daun majemuk pada pertumbuhan anggrek *Dendrobium* secara in vitro. *Jurnal Bios Logos, 6*(1). https://doi.org/10.35799/jbl.6.1.2016.16258

Irmayanti, A., Prasetiyo, P., & Rahayu, P. (2025). Effect of young coconut water concentration on the growth of *Dendrobium* orchid seedlings. *Bioscientist: Jurnal Ilmiah Biologi, 13*(1), 318. https://doi.org/10.33394/bioscientist.v13i1.15056

Karmila, R., Zakiah, Z., & Mukarlina. (2022). Acclimatization of black orchid plantlets (*Coelogyne pandurata* Lindl.) with moringa leaf extract (*Moringa oleifera* Lamk.) as a biostimulant. *Jurnal Biologi Tropis, 22*(3), 954–961. https://doi.org/10.29303/jbt.v22i3.3593

Lakshanthi, J. M. T., & Seran, T. H. (2019). Survival rate and growth performance of in vitro-raised plantlets of orchid (*Dendrobium* sp.) in different hardening substrates. *4*(3), 1–9.

Limbad, M., Gutierrez-Maddox, N., Hamid, N., Kantono, K., Liu, T., & Young, T. (2023). Microbial and chemical changes during fermentation of coconut water kefir beverage. *Applied Sciences, 13*(12), Article 7257. https://doi.org/10.3390/app13127257

Ma, Z., Ge, L., Lee, A. S. Y., Yong, J. W. H., Tan, S. N., & Ong, E. S. (2008). Simultaneous analysis of different classes of phytohormones in coconut (*Cocos nucifera* L.) water using high-performance liquid chromatography and liquid chromatography–tandem mass spectrometry after solid-phase extraction. *Analytica Chimica Acta, 610*, 274–281.

Nisa, N. A., Rahayu, T., & Jayanti, G. E. (2021). Peranan BAP dan air kelapa pada medium VW terhadap organogenesis *Dendrobium* sp. *Metamorfosa: Journal of Biological Sciences, 8*(2), 298. https://doi.org/10.24843/metamorfosa.2021.v08.i02.p14

Pokimica, N., Ćosić, T., Uzelac, B., Ninković, S., & Raspor, M. (2024). Dissecting the roles of the cytokinin signaling network: The case of de novo shoot apical meristem formation. *Biomolecules, 14*(3), Article 381. https://doi.org/10.3390/biom14030381

Putri Choirunnisa, J., Marselina Ade Putri, M., Skolandia Lau, M., Yurianti Sartika Unggut, Y., Jefri Suhardi, S., Pangka Program Studi Agronomi, B., & Pertanian dan Peternakan Universitas Katolik Indonesia Santu Paulus Ruteng, F. (2024). The effect of rice-washing water and coconut water on the growth of tomato plants (*Lycopersium esculentum* Mill.) in Manggarai Regency. *Mediagro, 20*(2).

Putri, N. K. I. S., Darmawati, I. A. P., & Astawa, I. N. G. (2023). Pengaruh lama penyimpanan benih dan konsentrasi rendaman air kelapa terhadap viabilitas benih padi (*Oryza sativa* L.). *Agrotrop: Journal on Agriculture Science, 13*(2), 289. https://doi.org/10.24843/ajoas.2023.v13.i02.p12

Ramadhan, J., & Abror, M. (2022). The effect of nutrient concentration and liquid organic fertilizer on pakcoy plant growth and yield using a wick hydroponic system. *2*(2). https://doi.org/10.21070/pels.v2i2.1271

Samad, S., & Mahmud, S. A. (2025). Efek pupuk organik air kelapa pada pertumbuhan dan hasil selada di Bigaro, Halmahera Timur. *Journal of Comprehensive Science, 4*(1). https://doi.org/10.59188/jcs.v4i1.2958

Santosa, F. A., Setiari, N., & Nurchayati, Y. (2025). Effect of different coconut water concentrations on the growth of *Dendrobium spectabile* (Blume) Miq. plantlets on MS medium. *Jurnal Ilmu Pertanian Indonesia, 30*(3), 533–539. https://doi.org/10.18343/jipi.30.3.533

Tungga, W., Tilaar, S. M. T., Tulung, J., Pongoh, J., Mamarimbing, R., & Sumayku, B. R. A. (2023). The effect of the plant growth regulator kinetin and coconut water on the growth and development of *Dendrobium mirbelianum* orchids in vitro. https://doi.org/10.35791/jat.v4i2.51921

Yao, J., Ke, X., Gu, X., Jiang, Z., Ying, Z., Lu, C., & Sun, C. (2026). Optimized substrate selection for enhanced orchid growth based on high-throughput lysimetric arrays. *27*(5), 437–449. https://doi.org/10.1631/jzus.B2500195

Yong, J. W. H., Ge, L., Ng, Y. F., & Tan, S. N. (2009). The chemical composition and biological properties of coconut (*Cocos nucifera* L.) water. *Molecules, 14*(12), 5144–5164. https://doi.org/10.3390/molecules14125144

Yuliana, M. (2021). The effect of local microorganisms (MOL) as liquid organic fertilizer on the growth of *Ipomoea reptans* Poir. *Jurnal Biota, 7*(1). http://jurnal.radenfatah.ac.id/index.php/biota

Zakiyah, A., Setiari, N., & Nurchayati, Y. (2025). The growth of *Dendrobium spectabile* (Blume) Miq. orchid plantlets in Vacin and Went medium with different concentrations of coconut water. *Berita Biologi, 24*(2). https://doi.org/10.55981/berita_biologi.2025.222