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Utilization of Coconut Coir Waste as an Organic Planting Medium (Cocopeat) as a Substitute for Topsoil in Crop Cultivation

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Abstract
According to the Central Statistics Agency (2021), coconut production in Aceh reaches 66.4 thousand tons, and coconut fiber accounts for approximately 12 percent of the total coconut production annually. This substantial coconut fiber potential is not fully utilized in production, leading to environmental problems. The aim of this research is to reduce coconut fiber waste by processing it into an organic planting medium (cocopeat) to replace soil. This research used an experimental method and was conducted from February 25 to April 3, 2025. The subjects used organic planting media consisting of 100% cocopeat, an 80:20 cocopeat and soil ratio, a 50:50 cocopeat and soil ratio, and 100% soil as a control. Results of water absorption tests showed that cocopeat could retain 300% of its water content, and water retention tests showed that cocopeat could retain 200% of its water content after 6 hours of sun exposure. Stem growth and leaf number of mustard greens and spinach were better in the 100% cocopeat growing medium, and observations were made weekly for 30 days. The conclusion of the test results for mustard greens and spinach plants shows that stem growth and the number of plant leaves are better at a concentration of 100% Cocopeat planting media, this proves that Cocopeat can be used as an organic planting media to replace soil.

Keywords: *Coconut Fiber Waste, Cocopeat, Planting Media*

INTRODUCTION

The success of crop production in agriculture is strongly influenced by several factors, one of which is the growing medium. Each plant species has specific requirements; therefore, appropriate growing media are essential to support optimal growth and development. Growing media can be combined to provide suitable physical properties and nutrient availability that promote plant growth, development, and maximum yield. An ideal growing medium should meet several criteria, including being free from pests, diseases, and weeds; having the ability to retain sufficient water while ensuring proper drainage; possessing adequate porosity to support root growth and development; and maintaining an appropriate level of acidity (pH) ranging from 6.0 to 6.5 (Herawati, 2023). Commonly used growing media include soil, sand, rice husk, compost, sawdust, banana stems, cocopeat, and other organic materials (Febriani, 2021).

Coconut coir has considerable potential to be utilized as a growing medium due to its favorable physical structure, which allows a balance between water retention and drainage, as well as its nutrient content that supports plant growth. The utilization of coconut coir waste as a growing medium not

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only reduces negative environmental impacts through efficient waste management but also creates added value for sustainable agricultural practices (Salim, 2019).

Cocopeat, derived from coconut coir waste, functions not only as a growing medium but also as an organic fertilizer and water reservoir that helps fulfill plant nutrient requirements. Cocopeat contains essential nutrients such as phosphorus (P), potassium (K), magnesium (Mg), nitrogen (N), sodium (Na), and calcium (Ca), which contribute to its effectiveness in supporting plant growth (Shafira, 2021).

Cocopeat also exhibits a high capacity for water absorption and retention. Its porous structure allows good aeration, thereby facilitating root respiration and development. In addition, cocopeat contains Trichoderma fungi, which play a role in suppressing plant pathogens and maintaining the fertility of the growing medium. A loose and well-aerated growing medium supports optimal root development, resulting in healthier and more vigorous plant growth. Cocopeat generally has a pH range of 5.0–6.8, making it suitable for a wide range of plant species (Kuntardina, 2022).

According to data from Statistics Indonesia (Badan Pusat Statistik, 2021), coconut production in Aceh Province reached 66.4 thousand tons, with approximately 12% of this amount consisting of coconut coir waste generated annually (Badan Pusat Statistik Provinsi Aceh, 2021). As coconut consumption continues to increase, the volume of coconut coir waste also rises, potentially leading to environmental pollution and aesthetic degradation if not properly managed. The large quantity of underutilized coconut coir waste represents a significant environmental challenge in the agricultural sector. Therefore, efforts to utilize coconut coir waste as an organic growing medium (cocopeat) that can substitute topsoil in crop cultivation are urgently needed.

Although the use of cocopeat as an alternative growing medium has been widely studied and reported to improve the physical properties of growing media as well as enhance water and nutrient availability for plants (Salim, 2019; Shafira, 2021; Kuntardina, 2022), most previous studies have primarily focused on cocopeat as a component of mixed growing media. To date, studies that specifically compare the effectiveness of 100% cocopeat as a sole growing medium on the growth of leafy vegetable crops, particularly mustard greens (Brassica juncea) and spinach (Amaranthus spp.), remain very limited, especially in the Aceh region. Differences in agroclimatic conditions and local environmental characteristics may influence plant responses to growing media. Therefore, further research is required to comprehensively evaluate the effectiveness of pure cocopeat as a growing medium for mustard greens and spinach cultivation in Aceh.

Cocopeat has also been reported as a potential substitute for topsoil in rubber plant cultivation, with an optimal growing medium composition consisting of 80% cocopeat and 20% soil. However, the use of cocopeat as a growing medium should be accompanied by balanced fertilization to meet plant nutritional requirements that are not sufficiently provided by cocopeat alone (Cahyo, 2019).

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RESEARCH METHODS

This study employed an experimental research design using a Completely Randomized Design (CRD) to evaluate the fertility and growth of spinach (Amaranthus sp.) and mustard greens (Brassica juncea) under different cocopeat-based growing media. Four treatments were applied: P0 (100% soil as control), P1 (50% cocopeat : 50% soil), P2 (80% cocopeat : 20% soil), and P3 (100% cocopeat). Each treatment was replicated two times for each plant species, resulting in eight experimental units per crop and sixteen experimental units in total. The experiment was conducted in February 2025 at the researcher's residence in Kampung Jawa, Blangkejeren District, Gayo Lues Regency, Aceh, Indonesia.

Plant growth parameters observed included plant height (cm) and number of leaves (leaves per plant), measured weekly over a four-week period. Data were analyzed using descriptive statistics to illustrate growth trends, followed by one-way analysis of variance (ANOVA) to determine the effect of media treatments on plant growth. When significant differences were detected at $p < 0.05$, a post hoc test was performed to compare the means among treatments.

RESULTS AND DISCUSSION

Table 1. Results of the Water Absorption Capacity Test on Cocopeat and Soil

Sample	Initial weight Grams (gr)	Wet weight	
		gr	%
Cocopeat	100	400	300
Soil	100	120	20

The results of the water absorption capacity test on cocopeat and soil presented in Table 1 indicate that cocopeat is capable of absorbing up to 400 g of water. This result demonstrates that cocopeat has a significantly higher water absorption capacity compared to soil.

Table 2 Results of the Water Retention Capacity Test on Cocopeat and Soil

Sample	Initial weight of water absorbed		Weight of remaining water after drying	
	gr	%	gr	%
Cocopeat	400	300	300	200
Soil	120	20	100	0

The results of the water retention capacity test shown in Table 2 indicate that after being dried under sunlight for 6 hours, the cocopeat growing medium retained 200 g of water from its wet weight. In contrast, the soil growing medium returned to its dry weight after 6 hours of drying.

Table 3. Results of Stem Growth Observation of Mustard Greens Based on Growing Media Concentration

Mustard Greens Sample	Concentration of Planting Media			
	P0	P1	P2	P3
Week 1	7.5 cm	6 cm	7.5 cm	7.5 cm
Week 2	15 cm	12 cm	12 cm	12 cm
Week 3	20 cm	19.5 cm	18.6 cm	22.5 cm
Week 4	21 cm	21 cm	22.8 cm	23.5 cm
Average	15,8	14,6	15,2	16,3

Notes:
P0 = 100% soil (control)

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P1 = Cocopeat and soil (50:50)
P2 = Cocopeat and soil (80:20)
P3 = 100% cocopeat

The stem growth of mustard greens presented in Table 3 shows that the highest growth was observed in treatment P3 with a growing medium concentration of 100% cocopeat, reaching 23.5 cm with an average growth of 16.3 cm.

Table 4. Results of Observation on the Number of Leaves of Mustard Greens Based on Growing Media Concentration

Mustard Greens Sample	Concentration of Planting Media			
	P0	P1	P2	P3
Week 1	4	4	5	5
Week 2	6	7	6	7
Week 3	7	7	6	7
Week 4	7	7	7	8
Average	6	6,25	6	6,75

Based on Table 4, the highest number of leaves in mustard greens was observed in treatment P3 with a growing medium concentration of 100% cocopeat, reaching a total of 8 leaves.

Table 5. Results of Stem Growth Observation of Spinach Based on Growing Media Concentration

Sample Spinach	Concentration of Planting Media			
	P0	P1	P2	P3
Week 1	2.6 cm	2.4 cm	2.5 cm	3.5 cm
Week 2	8 cm	6 cm	6 cm	5 cm
Week 3	10.2 cm	11 cm	9 cm	10.5 cm
Week 4	24.2 cm	21 cm	25.5 cm	28.3 cm
Average	11,2	10,1	10,7	11,8

Observations of spinach stem growth presented in Table 5 indicate that the highest growth was observed in treatment P3 with a growing medium concentration of 100% cocopeat, reaching 28.3 cm with an average value of 11.8 cm.

Table 6. Results of Observation on the Number of Leaves of Spinach Based on Growing Media Concentration

Sample Spinach	Concentration of Planting Media			
	P0	P1	P2	P3
Week 1	4	3	4	4
Week 2	5	5	5	5
Week 3	7	6	6	7
Week 4	13	15	9	17
Average	7,25	7,25	6	8,25

Based on Table 6, the highest number of leaves in spinach plants was observed in treatment P3 with a growing medium concentration of 100% cocopeat, reaching a total of 17 leaves.

The results of the study on the utilization of coconut husk waste as a growing medium showed significant outcomes in the water absorption capacity test, water retention capacity test, and the growing media testing stage using different media concentrations, namely P0 (100% soil), P1 (cocopeat and soil 50:50), P2 (cocopeat and soil 80:20), and P3 (100% cocopeat), on mustard greens and spinach plants. Plant growth and the number of leaves were measured weekly for 30 days.

Based on Table 1, the results of the water absorption capacity test on cocopeat growing media indicate that cocopeat is able to absorb water up to 300% of its dry weight, whereas soil growing media can only absorb 20% water. According to Simamora et al., cocopeat is capable of absorbing water up to five to six times its initial weight. Cocopeat has absorptive properties, enabling it to retain and

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bind oxygen (O_2) effectively (Simamora, 2022).

Table 2 presents the results of the water retention capacity test after 6 hours of sun drying. From an initial water absorption of 300%, cocopeat was able to retain 200% water relative to its dry weight, whereas soil growing media returned to its original dry weight of 100 g. Research conducted by Utami et al. reported that cocopeat can be utilized as a raw material for biotextile production due to its water absorption capacity of 40–80% and water holding capacity (WHC) ranging from 74.41% to 297.59% (Utami, 2023).

In this study, the growing media were tested on mustard greens and spinach by comparing media concentrations of 100% soil, cocopeat and soil 50:50, cocopeat and soil 80:20, and 100% cocopeat to observe stem growth and the number of leaves in each medium. According to Nihlah, the composition of cocopeat growing media significantly affects stem height, number of leaves, and leaf width. The water-holding properties and high air porosity of cocopeat promote excellent seedling growth during germination, create loose soil conditions, and allow roots to grow rapidly and abundantly, thereby reducing plant vulnerability during transplantation (Nihlah, 2018).

Table 3 shows the results of stem growth observations in mustard greens from week I to week IV after planting. The highest average stem growth was observed in treatment P3, with an average height of 16.3 cm, while the lowest growth was recorded in treatment P1, with an average height of 14.6 cm. In week II, stem growth in treatments P1, P2, and P3 showed the same value of 12 cm, whereas treatment P0 (control) exhibited higher stem growth. This growth condition in P1, P2, and P3 during week II occurred due to high rainfall, which caused excessive water absorption by cocopeat. According to Inonu et al., differences in water storage in growing media affect temperature, humidity, and water content. Increasing amounts of coconut husk ameliorant reduce soil temperature and increase moisture. Excessive water conditions cause macropores to become filled with water, reducing air availability and inhibiting root growth (Inonu, 2021).

Table 4 shows that from week I to week IV, the highest number of leaves in mustard greens was observed in treatment P3, with a total of 8 leaves, while the lowest number of leaves was recorded in treatments P0, P1, and P2, with 7 leaves. High rainfall did not affect leaf growth in mustard greens, as indicated by the continuous increase in leaf number each week. Ariessanddy et al. reported that the use of cocopeat as a growing medium resulted in a melon fruit weight of 2.46 kg, which was superior to that produced using conventional growing media (Ariessanddy, 2022).

Observation of Stem Growth in Spinach

Table 5 shows the results of stem growth observations in spinach from week I to week IV. The highest stem growth was observed in treatment P3, reaching 28.3 cm, while the lowest growth was recorded in treatment P1, with a height of 21 cm. High rainfall caused cocopeat to absorb excessive water, which also resulted in slower stem growth in spinach during week II. Excessive water conditions cause macropores to be filled with water, reducing air availability and inhibiting root

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growth (Inonu, 2021). In week III, weather conditions returned to normal, and spinach stem growth improved and exceeded that observed in soil-based growing media.

Table 6 shows that from week I to week IV, the highest number of leaves in spinach was observed in treatment P3, with 17 leaves, while the lowest number was recorded in treatment P2, with 9 leaves. This finding indicates that 100% cocopeat growing media support better leaf development compared to other growing media. According to Siloinyanan et al., the water-holding capacity of cocopeat supports tomato plant activity for up to 8 days, which is twice as long as black soil alone in meeting water requirements (Siloinyanan, 2024).

Based on observations of stem growth and the number of leaves in mustard greens and spinach, the highest stem growth in mustard greens was observed in treatment P3, reaching 23.5 cm, while the highest stem growth in spinach was also recorded in treatment P3, reaching 28.3 cm. The highest number of leaves in mustard greens was observed in treatment P3, with 8 leaves, while the highest number of leaves in spinach was also observed in treatment P3, with 17 leaves. These results indicate that 100% cocopeat growing media provide better plant growth compared to soil-based media. Research by Pinasthika et al. reported that a cocopeat-to-soil growing media composition of 1:1 in stevia plants produced the highest fresh and dry root weights compared to other media compositions (Pinasthika, 2021).

According to Lukita et al., cocopeat improves the physical properties of soil by enhancing aeration and drainage in growing media, thereby supporting root development. Cocopeat significantly affects the number of leaves in oil palm seedlings, with an average leaf number of 3.93 in a growing medium composed of 500 g cocopeat and 1,200 g soil (Lukita, 2023).

CONCLUSION

100% cocopeat planting media provides better stem growth and number of leaves in mustard greens and spinach compared to a mixture of cocopeat and soil (80:20 or 50:50) and soil-based media, so that the level of plant fertility in pure cocopeat media is higher and has the potential to be used as an organic planting medium to replace soil.

RECOMMENDATIONS

It is recommended that the community utilize coconut fiber waste into cocopeat as a planting medium that has economic value and is environmentally friendly, and for further researchers to develop cocopeat processing technology that is more efficient in reducing tannin levels without requiring the use of large amounts of water.

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