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Characterization of Cocopeat Growing Media from Coconut Coir using Fermentation Process

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Abstract

One of the wastes of the coconut industry is cocopeat, which comes from about 70% of the coconut fibre. Cocopeat is composed of cellulose (23-43%), hemicellulose (19.25%), lignin (35-45%), as well as pectin (3%) and tannin. This material has a high water absorption capacity and contains micronutrients, so it has the potential to be processed as a growing medium. However, the high tannin content in cocopeat may inhibit nutrient absorption by plants. In addition, the high carbon to nitrogen (C/N) ratio is also an obstacle. Therefore, a fermentation process was carried out to reduce the C/N ratio and tannin content. This study aims to analyse the characteristics of fermented cocopeat by examining the effect of bioactivator type and concentration on tannin content and C/N ratio. The study used a nested Randomised Group Design (RAK) with two factors, namely the type of decomposer (EM4, M21, and Tangguh) and the concentration of decomposer (30 mL/kg, 35 mL/kg, and 50 mL/kg cocopeat). Parameters analysed included pH, C/N ratio, tannin, content, and FTIR analysis. Data were analysed using SPSS 27 software with the Two-Way ANOVA test, and the determination of the best treatment was done with the Multiple Attribute Zeleny method.The results showed that the pH value was in the range of 5.7-6.2, the C/N ratio was 109.26-154.64, and the tannin content was between 2.65-8.40%. The best treatment was obtained from the EM4 decomposer type with a concentration of 30 mL/kg cocopeat, resulting in a pH of 5.7, a C/N ratio of 109.26, and a tannin content of 2.65%. This study concluded that fermented cocopeat has the potential as an environmentally friendly growing medium, supporting sustainable agricultural practices.

Keywords: Decomposer, Cocopeat, C/N Ratio, Tannin Content

Introduction

Indonesia is the largest coconut producing country in the world with a coconut plantation area of 3.8 million ha in 2021 (Ministry of Agriculture, 2022). According to BPS data in 2023, the total production of coconut plants in Indonesia reached 2,890,900 tonnes. Some uses of coconut include food products in the form of coconut oil (VCO and coconut oil), nata de coco, coconut pulp flour, coconut milk, copra, coconut sugar and non-food products in the form of crafts, charcoal, briquettes, wood charcoal, and organic fertiliser (Damanik, 2015; Karouw et al., 2019). Coconut processing will produce by-products in the form of waste. One of the wastes generated from the coconut industry is coconut fibre.

Based on BPS data for 2023, coir production in Indonesia is estimated to reach 1,011,815 tonnes. This level of production is still disproportionate to its use (Bulkaini et al., 2021). According to Nurdin et al. (2021), the copra industry uses only 30% of the

coir produced as fuel, while the rest is discarded and not utilised. One of the products made from coconut fibre is cocopeat (coir powder).

Cocopeat is composed of 23-43% cellulose, 19.25% hemicellulose and 35-45% lignin (Sa'adah et al., 2016) and extractives such as 3% pectin and tannin (Astuti and Kuswytasari, 2013). These components contain carboxyl, hydroxyl and ether groups that make cocopeat highly absorbent (Panamgama and Peramune, 2018). Cocopeat also contains micronutrients such as Fe, Mn, Zn and Cu. The high potassium content is beneficial for plant growth (Xu et al., 2021). Cocopeat is commonly used for growing media such as cultivation in plant growth, whether vegetables, flowers or hydroponic plants (Kalaivani and Jawaharlal, 2019). Cocopeat growing media is able to hold water for a long time.

However, cocopeat still has a high tannin content (Simbolon et al., 2022). Tannins can interfere with the process of plant growth and cause plants to stunt. Tannin substances can also interfere with the absorption of nutrients by plants (Supraptiningsih and Hatarina, 2018). In addition, cocopeat also contains high carbon and low nitrogen and has a high C/N ratio. One method to improve the quality of cocopeat growing media is the fermentation technique. Fermentation can reduce the tannin content and the C/N ratio in cocopeat. There are several factors that affect the fermentation process, including the type of microorganism, concentration, temperature, pH, humidity, C/N ratio and length of fermentation time (Azim et al., 2018).

Research Method

Materials

The materials needed in this study were cocopeat obtained from Sumbertangkil Village, Tirtoyudo District, Malang Regency, EM4, M21, tough, molasses, and water.

Experimental Design

This study used a nested randomised group design (RAK) with the factors of bioactivator type and bioactivator concentration in Table 1. There were 9 treatments in this study and 1 control with 3 replications so there were 30 trials.

Table 1. Experimental Design

Decomposer Type	Decomposer Concentration		
	K1	K2	K3
B1	B1K1	B1K2	B1K3
B2	B2K1	B2K2	B2K3
B3	B3K1	B3K2	B3K3

Keterangan:
B1 = Decomposer EM4
B2 = Decomposer M21
B3 = Decomposer tangguh
K1= Concentration 30 mL/kg
K2= Concentration 50 mL/kg
K3= Concentration 70 mL/kg

Data analysis

Data analysis was performed using Excel 2019 software and SPSS 27. Statistical analysis to select the best treatment using the Zeleny multiple attribute method. Some of the tests carried out are:

pH test

pH measurement was carried out using a digital pH meter based on SNI 06-6989 11-2004 (BSN 2004). pH was determined using a ratio of 1:2.0 (w/v) media to water suspension using a pH meter.

C, N, P, K test

The C test procedure was based on the ignition method, while the N test was based on the Kjehdahl method (SNI 19-7030-2004) and the P and K tests were based on SNI 2803-2010. The N, P and K tests were carried out at the Bioscience Laboratory of the Jember State Polytechnic.

Tannin content test

The method described by Singleton et al. (1965) with some modifications was used to test the tannin content of cocopeat. In the tannin test step, cocopeat extract (1 mg/ml) was mixed with 5 mL of distilled water, 1 mL of sodium carbonate (20%) and 1 mL of Folin-Ciocalteu reagent. The mixture was then allowed to stand for 30 minutes to mix evenly. The sample was then absorbed at 765 nm using a UV-Vis spectrophotometer.

Results and Discussion

Initial characteristics of cocopeat

The pH of cocopeat is 5.59. In another study, the pH value of cocopeat was in the range of 5.5-6.5 (Gohil, 2018). The pH value in this study is not much different from Goille et al. (2021) where the pH value is 5.83 and Chowdhury and Fatema (2016) where it is 5.68. Cocopeat has a C-organic content of 54.4%, where this value is higher than the research of Mazeiklene et al. (2014) with a total carbon value in cocopeat of 28.38%. While the total N value in Cocopeat is 0.38% which shows that the nitrogen value in Cocopeat is quite low. Jusoh et al (2021) mentioned the N value in their research was 5.3 g/kg. then for the C / N value on Cocopeat is 142. This is in agreement with Chowdhury and Fatema, (2016) where the C / N ratio of cocopeat is high around 75-186. This high C / N ratio needs to be reduced for optimal use of cocopeat as a growing medium. The P and K contents were 0.03% and 0.21% respectively. Based on the literature, the value of P is 339 ppm (Jusoh et al., 2021). Meanwhile, the initial tannin content in cocopeat was 17.697%. This content is rather high and needs to be reduced.

Characteristics of cocopeat planting media after fermentation

pH content

After the fermentation process, the pH content of cocopeat planting media is shown in Figure 1. The pH value is in the range of 5.79-6.30 which shows an increase in pH value compared to the initial pH of 5.59. According to Gunawan et al. (2015) the

pH content after fermentation will increase towards neutral, indicating that the raw material is ripe for fermentation.

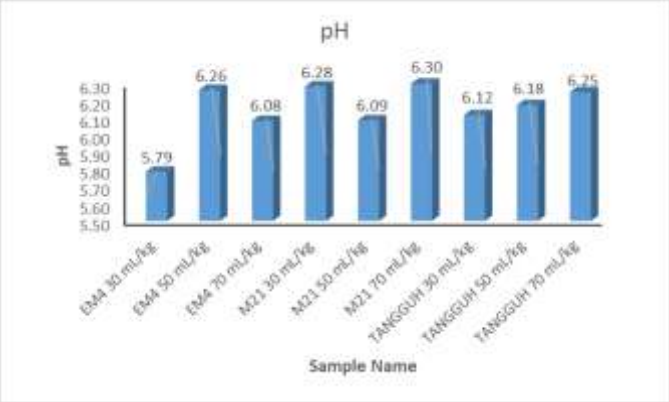

Figure 1. pH in cocopeat growing media

Tannin content

The tannin content after the fermentation process shows that increasing the concentration of decomposers tends to increase the tannin content in the growing media as shown in **Figure 2.** The highest tannin content is at a concentration of 50 mL/kg where the EM4 decomposer reaches a tannin content of 8.23%, M21 4.86%, and tough with 8.40%. However, at a concentration of 70 mL/kg, the tannin content tended to decrease due to microbial imbalance due to excessive concentration. Wardhana et al. (2022) revealed that the type of decomposer affects the effectiveness of fermentation due to different microbial compositions; EM4 contains lactic acid and photosynthetic bacteria, M21 contains specific microbes for lignocellulose weathering, and TANGGUH has a different formulation that may be more aggressive in fermentation.

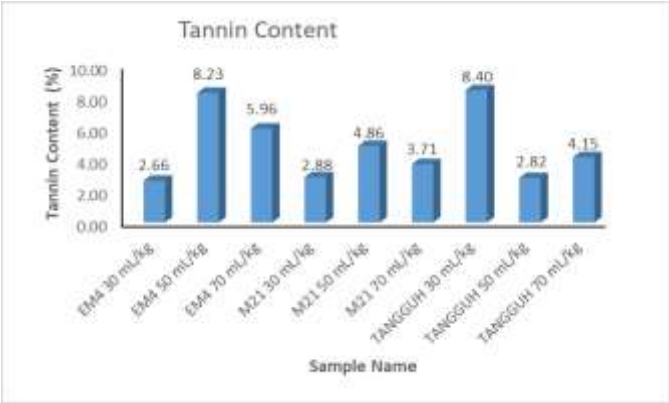

Figure 2. Tanin content of all samples

C/N ratio

The C/N ratio of all samples is in the range of 109.27 - 154.34 as shown in **Figure 3.** The C/N ratio is influenced by the content of carbon (C) and nitrogen (N), with carbon acting as an energy source and nitrogen as a nutrient for microorganisms during the decomposition process. This is in line with the statement of Amnah and Meiliana (2019), where carbon acts as a source of energy for microorganisms during the composting process, while nitrogen provides the nutrients needed by microorganisms

during composting. Different concentrations and types of decomposers will produce different C/N ratios. The C/N ratio of the growing media is still quite high due to the high carbon content.

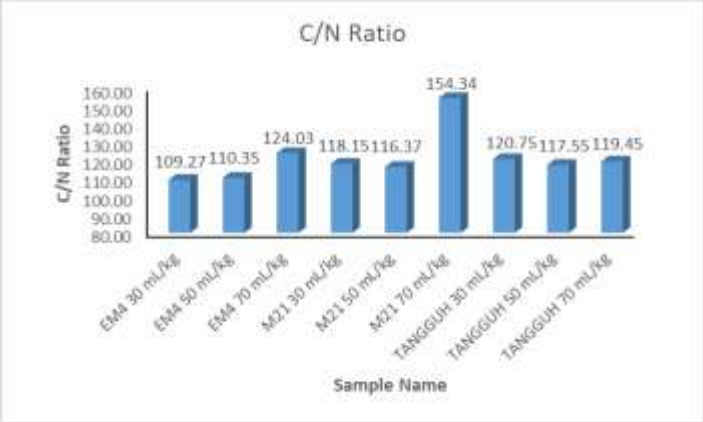

Figure 3. C/N ratio of all samples

Best Treatment

Based on the results of the Zeleny test, the EM4 treatment with a concentration of 30 mL/kg showed the lowest maximum absorbance value of 0.027 as shown in Table 2. This indicates the lowest tannin content and C/N ratio as well as a pH that is close to neutral. The low concentration of EM4 allows the fermentation process to run more stably because the microorganisms work effectively in decomposing lignocellulose without resulting in the accumulation of phenolic compounds such as tannins. In addition, microbes in EM4, such as lactic acid bacteria and yeast, are able to accelerate the weathering of organic matter, thereby reducing the C/N ratio significantly.

Table 2. Maximum absorbance results in the zeleny test

No.	**Treatment**	Maximum Absorbance
1.	**EM4 30 mL/kg**	**0.027160494**
2.	EM4 50 mL/kg	0.22600243
3.	EM4 70 mL/kg	0.185123043
4.	M21 30 mL/kg	0.056555482
5.	M21 50 mL/kg	0.151577503
6.	M21 70 mL/kg	0.112756064
7.	TANGGUH 30 mL/kg	0.228174603
8.	TANGGUH 50 mL/kg	0.100877193
9.	TANGGUH 70 mL/kg	0.120481928

Conclusion

After fermentation, the pH value was in the range of 5.7-6.2, the C/N ratio was 109.26-154.64, and the tannin content was between 2.65-8.40%. The best treatment was obtained from the EM4 decomposer type with a concentration of 30 mL/kg cocopeat, resulting in a pH of 5.7, a C/N ratio of 109.26, and a tannin content of 2.65%. This study concluded that fermented cocopeat has the potential as an environmentally friendly growing medium, supporting sustainable agricultural practices

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