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Biofoam from The Waste of Durian Seeds and Corn Cobs

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Abstract

Biofoam is a styrofoam substitute packaging made with starch and fiber as the basic ingredients. This study aims to determine the characteristics (biodegradation test, pressure strength and water absorption) of biofoam produced from durian seed waste and corn cobs. The best treatment in this study was biofoam made using a mixture of durian seeds starch and corn cobs fiber made with 5 % NaOH concentration, where the results obtained were the water absorption test values with 1 minute, 2 minutes, and 3 minutes, namely 11.20 %, 14.22 % and 16.81 %. While the compressive strength test value obtained is 16.85 $\times 10^{-5}$ Pa, and the results of the biodegradation test are obtained at 35.42 % within 14 days of burial in the soil. The FTIR test results showed that the biofoam groups produced from a mixture of corn cob fibers with different concentrations of NaOH still showed similarities in their functional groups, where none gave rise to new peaks. The functional group content of the resulting biofoam includes the CH group (alkane) and the C.≡C Group (alkyne) C=C group (aromatic ring and OH group.

Keywords: Biofoam, corn cobs, durian seeds

Introduction

The use of plastic packaging in Indonesia has become commonplace. Most Indonesians still use plastic packaging and even produce plastic packaging, one example of which is *Styrofoam* (Cavallo et al., 2018). So far, styrofoam contains various chemicals that can harm living things and is not environmentally friendly because it cannot be decomposed (Moshood et al., 2022). Even though the production process produces a lot of waste, the EPA categorizes it as the 5th largest producer of hazardous waste globally (Environmental *Protection Agency*). One option to replace petroleum-based and synthetic polymers is natural polymers such as starch and chitosan (Kaisangsri et al., 2012).

The number of negative impacts caused by using Styrofoam packaging must be considered (Ncube et al., 2020). Therefore, to minimize this impact, using Styrofoam must be reduced by replacing it with environmentally friendly packaging (Ibrahim et al., 2022). One example is biofoam, a replacement packaging for *styrofoam* where the main raw materials come from starch and fiber (Rodrigues et al., 2020). Starch can be obtained from plants rich in carbohydrates such us sago, cassava, corn, wheat and sweet potatoes. Starch can also be extracted from fruit, jackfruit, avocado, and durian seeds (Zalfiatri et al., 2021).

The manufacture of biofoam has been carried out by several researchers, using various materials and different methods. One example is the research conducted by Berutu et al. (2022) examining the effect of NaOH concentration and the fiber ratio of pineapple leaves and bagasse on the manufacture of *biofoam*, using the method of *thermopresisng* and printing time of 30 minutes at a temperature of 170 ºC. The concentrations of NaOH used were 0 %, 2.5 %, 5 %, 7.5 %, and 10 %. And the fiber ratio of pineapple leaves and bagasse is 100:0, 75:25, 50:50, 25:75, and 0:100. The results of the characteristics, *biofoam* best namely 5 % NaOH concentration and the mass ratio of pineapple leaf fiber and bagasse 75:25 have a tensile strength percentage of 16.35 %, compressive strength of 3.70 %, water absorption of 15.60 %, water content of 6.90 % and biodegradable 4.49 %. Gani and Kusumayanti (2021) conducted research by varying glycerol, temperature, and roasting time. The optimum glycerol concentration is 7 % at 135 ºC for 50 minutes. Based on the results of this study, biofoam has high absorption at high temperatures.

Based on this background, the researchers researched making bio foam using materials from

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previous researchers, namely “Biofoam from the waste of durian seeds and corn cobs.”

Methods

The tools used in this study were pressure test equipment (*Universon Testing Mchine*) with ASTM-D368 measurement standard, FTIR, stop watch, knife, blender, oven, filter paper, bucket, closed container, and sieve of 100 *mesh* and 60 *mesh*, erlenmeyer, measuring cup, pH meter, water bath, aluminium foil, gutters, electric bowls, spoons and teflon. The materials used in this study were durian seeds, corn cobs, aquades, NaOH solution with various concentrations of 0 %, 2.5 %, 5 %, 7.5%, and polivinil alcohol (PVA0.

Making durian seeds starch of durian

Durian seeds 3 kg were peeled and cleaned. Furthermore, the durian seeds are cut into smaller pieces and rinsed with water. The fragments of durian seeds are then mashed using a blender with the help of water and then filtered using a sieve. Furthermore, the filter results are filtered again using a fine porous cloth and squeezed several times until the juice is no longer released. The juice is allowed to stand for 24 hours, and the dregs of the juice are discarded. The precipitate obtained was filtered using filter paper, then put in the oven for 2 hours at 70 °C, Then, they were sieved using a 100 *mesh* (Sipahutar, 2020).

Making corn cob fiber corn

Cobs are cleaned using water, cut into small pieces, dried in the sun until dry, mashed using a blender, and then sieved using a sieve of 60 *mesh*. Furthermore, the results of the sieve as much as 50 grams were put into an Erlenmeyer each containing a NaOH solution with a concentration of 0 %, 2.5 %, 5 % and 7 %. Then, it was heated using a water bath at a temperature of 85 °C, For 30 minutes. Corn cob powder that has been heated is then filtered using a fine porous cloth while washing with water until the pH is neutral. After that, it was dried in an oven at a temperature of 105 °C for 1 hour (Coniwanti et al., 2018).

Making biofoam

The manufacture of *biofoam* in this study used the method carried out by Sipahutar (2020). The manufacture of bifoam is done through baking or roasting. In this study, a roasting system using an electric bath at a temperature of 30 °C for 30 minutes, then continued in the oven at 50 °C for 60 minutes. 15 grams of durian seed starch, 5 grams of corn cobs fiber, 5 grams of polyvinyl alcohol (PVA), and 80 mL of distilled water. Then, all the ingredients are stirred until homogeneous, put in teflon, flattened using a spatula, and heated using an electric bath for 30 minutes at a temperature of 30 °C. Then the finished bifoam is stored in gutters and heated again using an oven at 50 °C for 60 minutes.

Results and Discussion

The varying concentrations of NaOH, namely 0 %, 2.5 %, 5 %, and 7.5 % in the manufacture of corn cob fiber, will affect the characteristics of the resulting biofoam, which include water absorption, biodegradation rate, and pressure strength.

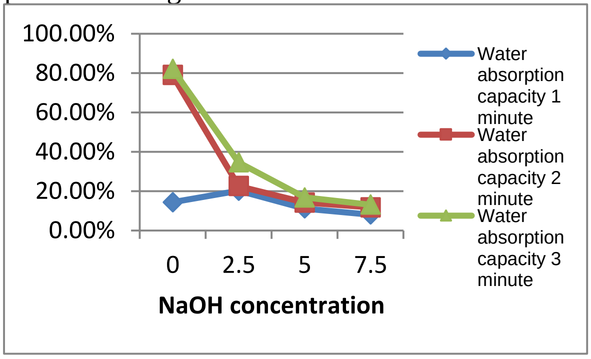


Figure 1. Graph of *biofoam* absorption test

The graph in **Figure 1 shows that the higher the concentration of NaOH, the lower the** absorption of *biofoam where* the *biofoam* produced using corn cob fiber with a concentration of 0 % NaOH at 1 minute, 2 minutes and 3 minutes was 14.35 %, 78.97 % and 82.05 % respectively while the *biofoaam* made with a NaOH concentration of 7.5 % has a water absorption capacity of 8.12 %, 11.75 % and 13.12 % respectively. The higher the concentration of NaOH, the lower the absorption of *biofoam*. This is due to the decreased hemicellulose content in the fiber made with a NaOH concentration of 7.5 %. The higher the NaOH concentration, the lower the hemicellulose content, which has the property of absorbing water (*hydrophilic*) (Coniwanti et al., 2018). The decrease in hemicellulose levels in fiber made with a NaOH concentration of 7.5 % is because hemicellulose is soluble in alkaline NaOH (Kamaruddin et al., 2022).

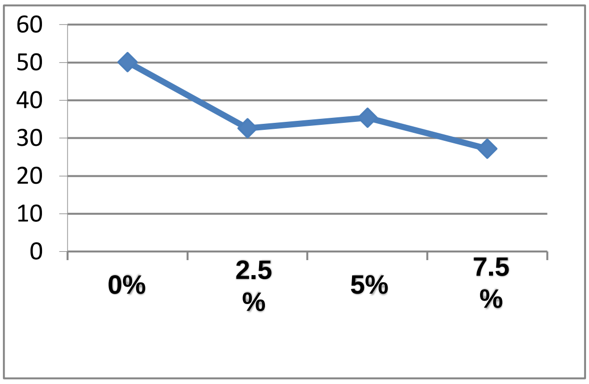


Figure 2. Graph of biodegradation test

A test was conducted to determine the level of biodegradation of biofoam by microorganisms present in the soil. Based on **Figure 2,** the highest level of biodegradation was in biofoam using fiber with a concentration of 0 % NaOH. At the same time, the lowest level of biodegradation was at a

NaOH concentration of 7.5 %. This is because the biofoam made with fiber with 0 % NaOH concentration has a high hemicellulose content, while the biofoam produced using 7.5% NaOH concentration fiber has a small hemicellulose content because hemicellulose is soluble in alkaline NaOH. Hemicellulose has biodegradable properties higher than cellulose. The order of decomposition from the fastest to the slowest is sugar, starch, simple protein, complex protein, hemicellulose, cellulose, fat, and lignin (Cornelia et al., 2013; Iskandar, 2014).

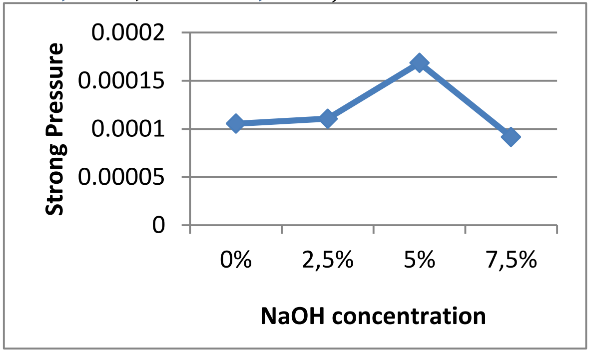
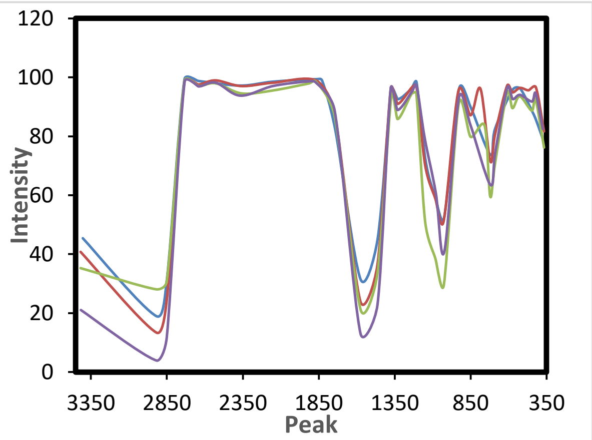


Figure 3. Pressure strength test graph

Figure 3 shows that the highest-pressure strength test value is at 5 % NaOH concentration. This is because NaOH concentration can affect the cellulose content contained in corn cobs fiber. The higher the concentration of NaOH, the higher the cellulose content, because NaOH dissolves lignin and hemicellulose (Pinto et al., 2022). The increase in cellulose content causes a high *biofoam* pressure strength value (Obradovic et al., 2017). While the decrease in pressure strength occurred at a NaOH concentration of 7.5 %, this was because the NaOH concentration was too high, causing the corn cob fiber cellulose to be dissolved in NaOH (Aprilyanti, 2018) so that the pressure test value on *biofoam* produced from fiber with a NaOH concentration of 7.5 % decreased.



Figur 4. FTIR spectrum biodegradable foam

The figure above shows *biofoam* with NaOH concentrations of 0 %, 2.5 %, 5 %, and 7.5 %, with almost the same functional groups. Where the detected groups are OH groups, CH groups (alkanes), C=C groups (aromatic rings), C≡C Groups (alkynes) and CH groups (alkenes). The results show that biofoam made using a mixture of corn cob fiber with different concentrations of NaOH still shows similarities in its functional groups, where none of the new peaks appear.

Conclusions

The conclusion obtained from this study is that the NaOH concentration increases the pressure strength value up to a concentration of 5 %. It decreases at a concentration of more than 5 %; the higher the NaOH concentration, the lower the water absorption value of the biofoam, and the higher the NaOH concentration, the lower the biofoam biodegradation rate.

The best biofoam was obtained from samples with 5 % NaOH concentration, with a ratio of fiber and starch 15:5, which resulted in a compressive strength value of 16.85×10^{-5} Pa, a biodegradation test value of 35.42 % within 12 days, and a strength test value absorption of 16.81 % within 3 minutes.

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