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Fish Coolbox using Coconut Fiber (*Cocos nucifera*) and Baggage (*Saccharum* sp) Insulated

Kotak Pendingin Ikan Menggunakan Insulasi Sabut Kelapa (Cocos nucifera) dan Ampas Tebu (Saccharum sp)

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Abstract

The quality of the catch can be seen from the fish storage container used to maintain its temperature. An insulated storage area can maintain ice resistance during the operation of fishing gear, as well as during the transportation of the catch to the fish landing site. Generally, fishermen use fish storage containers made of fiber with insulation in the form of polyurethane. Some fish storage containers are made from polystyrene-insulated styrofoam. This research aims to determine how optimal cooling is using coconut fiber and sugar cane bagasse insulation. The method used in this research was an experimental method using a Completely Randomized Design (CRD) with one control (Styrofoam cooler box), two treatments (Coconut fiber insulated cooler box and sugarcane bagasse), and three repetitions. The dimensions of the coolbox are the same as those on the market, namely 42 cm x 26 cm x 23 cm and a thickness of 2 cm. The lowest temperature of the coolbox made from coconut fiber insulation, 17.7 °C, was reached after the 70th minute. The bagasse was only able to reach the lowest temperature of 19.4°C, achieved in the 60th minute. Temperature stability in the coconut fiber coolbox reached 2 hours 10 minutes (130 minutes) from 80-200 minutes, while the bagasse coolbox reached 3 hours 40 minutes (220 minutes) from 70-280 minutes.

Keywords: Bagasse, Coolbox, Insulation, Coconut Fiber

Abstrak

Kualitas hasil tangkapan dapat dilihat dari tempat penyimpanan ikan yang digunakan dalam mempertahankan suhunya. Tempat penyimpanan yang berinsulasi dapat menjaga ketahan es selama beroperasinya alat tangkap, maupun selama pengangkutan hasil tangkapan sampai ke tempat pendaratan ikan. Umumnya nelayan mengunakan tempat penyimpanan ikan yang terbuat dari serat fiber dengan insulasi berupa polyurethan. Beberapa tempat penyimpanan ikan terbuat dari styrofoam berinsulasi polystyrene. Tujuan penelitian ini untuk mengetahui seberapa optimal pendinginan dengan mengunakan insulasi sabut kelapa dan ampas tebu. Metode yang digunakan dalam penelitian ini adalah metode eksperimen dengan menggunakan Rancangan Acak Lengkap (RAL) dengan 1 control (Kotak pendingin styrofoam), 2 perlakuan (Kotak pendingin berinsulasi serat sabut kelapa dan ampas tebu) dan dilakukan sebanyak 3 kali ulangan. Dimensi *coolbox* disamakan dengan ukuran yang ada di pasaran yaitu 42 cm x 26 cm x 23 cm dan ketebalan 2 cm. Suhu terendah coolbox berbahan

insulasi sabut kelapa yaitu 17,7 °C dicapai setelah menit ke-70. Ampas tebu hanya mampu mencapai suhu terendah 19,4°C yang dicapai pada menit ke-60. Kestabilan temperatur pada coolbox sabut kelapa mencapai 2 jam 10 menit (130 menit) dari menit ke 80-200 sedangkan coolbox ampas tebu mencapai 3 jam 40 Menit (220 menit) dari menit ke 70-280.

Kata kunci: Ampas tebu, Coolbox, Insulasi, Sabut kelapa

1. Introduction

The quality of fish caught by fishermen can be seen from the fish storage containers used to maintain the temperature. An insulated storage area can maintain ice resistance during the operation of fishing gear, as well as during the transportation of the catch to the fish landing site. The amount of ice needed in the hold after capture until unloading is between 20-30% and even reaches 50% (Nasution et al., 2014). Generally, fishermen use fish storage containers made of fiber with insulation in the form of polyurethane. Some fish storage containers are made from polystyrene-insulated styrofoam.

Styrofoam cooler boxes generally use non-environmentally friendly polystyrene (PS) materials. This type of plastic is not recommended for food packaging because it can emit styrene if it comes into contact with food and drinks, scorching food and drinks. Styrene can cause brain damage and interfere with estrogen in women, which results in reproductive, growth, and nerve problems. Apart from that, this material also contains benzene, which is one of the causes of cancer. Polystyrene is also difficult to recycle. Even though it can be recycled, it will require a very long process and time (Meirsaguna, 2016). So, it is essential for fish storage cooler boxes that are environmentally friendly and cheap for traditional fishermen (Nashrullah, 2018).

In cooling techniques, insulation is needed. The insulation used is thermal insulation, which is used to reduce the heat transfer rate. Heat can move from higher temperatures to lower temperatures. The method of heat transfer is through conduction, convection, and radiation. To prevent the rate of heat transfer in a coolbox, sound insulation is needed. Every choice of insulation material must have low thermal conductivity; one of these factors is essential to pay attention to when choosing insulation material. Other factors that need to be considered are not easily damaged when used in work, durability, robustness in holding loads, affordable price, and ease of finding on the market (Arif, 2021).

This cooler box research used natural fiber insulation from coconut fiber and sugar cane bagasse. Coconut fruit waste has the potential to be used as a reinforcement for composite materials with the feature that apart from producing new composite materials that are natural and environmentally friendly, coconut fiber composites have higher tenacity than the matrix, namely polyester and other plastic materials when coconut fiber is made into a composite with polyester, and is heat insulation (Amin & Samsudi, 2010). Sugar cane is a grass-like plant that is very influential in everyday life because sugar cane contains sugar that is needed by the human body. Tropical climate areas such as Indonesia can be found very often with sugar cane plants from the whole sugar cane stalk produces bagasse as much as 30% of the weight of the sugar cane, and the average sugarcane bagasse content is 47.7%, the bagasse fiber contains 62.78% silica. Silica is a ceramic material that acts as an insulator (Wardani, 2017).

From the description above, the researcher tried to research a more excellent box that uses natural fiber insulation from coconut fiber to utilize waste from coconuts and bagasse because it is easy to obtain and also makes use of easily obtained waste. Coconut fiber insulation and sugar cane bagasse can be used to maintain the quality of fishermen's catch. This research aims to determine how optimal the cooling system using coconut fiber and sugar cane bagasse insulation is on the temperature and cooling time in the coolbox. Know the lowest temperature the coolbox can reach. The use of natural fiber as insulation in fish storage coolboxes still needs to be studied further to determine its ability to reach the lowest temperature and how long it takes to reach the lowest temperature stability when compared to styrofoam or whether it is lower/higher.

2. Material and Method

2.1. Methods

The method used in this research was experimental in the laboratory using a Completely Randomized Design (CRD) with one control (Styrofoam cooler box), two treatments (coconut fiber insulated cooler box and sugar cane bagasse), and three repetitions. Laboratory experimental research involves presenting the results on several test objects and then analyzing the data using numbers. The standard dimensions for making coolboxes are the same as coolboxes on the market, namely 42 cm x 26 cm x 23 cm and a thickness of 2 cm, which can be seen in Figure 1. The coolbox has three layers, including the outer layer, which functions as a protector, using jute sacks and fiber, making it possibly resistant to impact and exposure to sunlight, and there is no water seepage from melting ice. The insulation layer uses coconut fiber and sugar cane bagasse as a barrier for heat

coming in and out from the outside, and the inner layer functions as a protector. The construction arrangement can be seen in Figure 1.

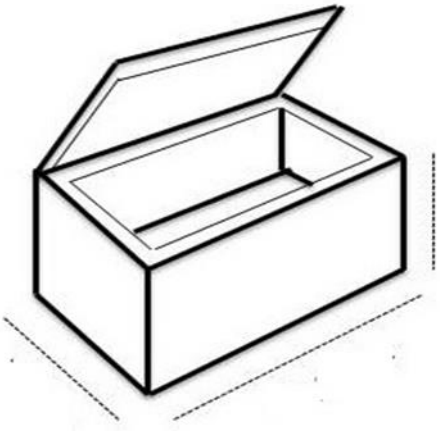

Figure 1. Coolbox dimensions

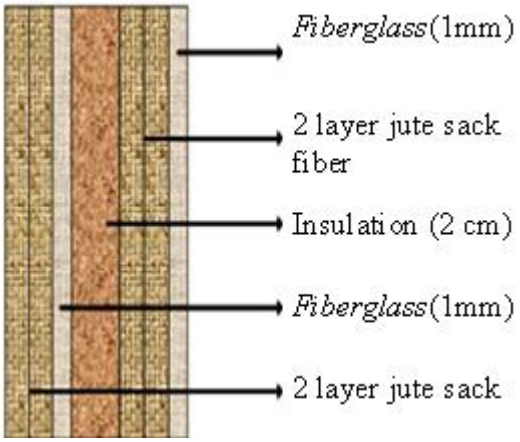

Figure 2. Coolbox construction arrangement

2.2. Data Analysis

Data collection was carried out in the laboratory after the coolbox testing process. The coolbox test is a temperature test with a predetermined time referring to the fishing time for one day of fishing. The data to be collected is changes in coolbox temperature every 10 minutes for 9 hours (540 minutes).

3. Result and Discussion

Temperature testing on the coolbox has been carried out, and data on cooling time and cooling temperature of the Styrofoam coolbox and coconut fiber insulation, sugar cane bagasse, and room temperature have been obtained. The coolbox temperature measurement test carried out for 9 hours (540 minutes) can be seen in Figure 3.

Figure 3. Temperature testing process

3.1. Coolbox Temperature

After the analysis, the test results and temperature observations obtained an average value of coolbox temperature from the three replications. The graph of the average coolbox temperature value can be seen in Figure 4.

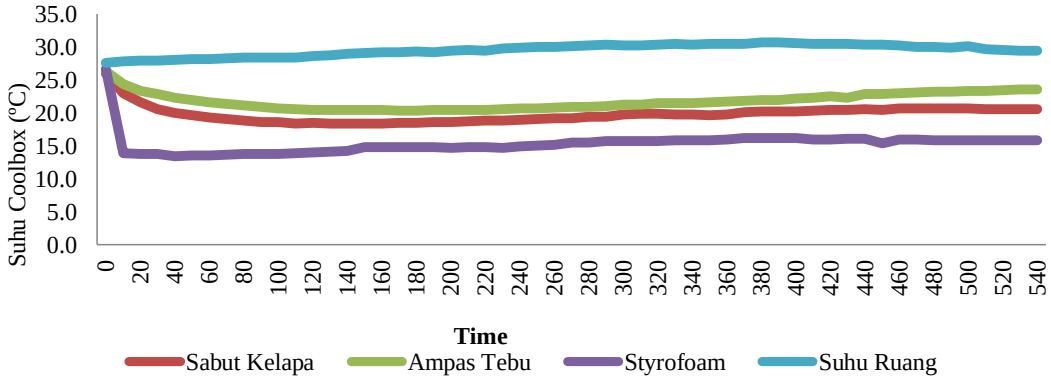

Figure 4. Average coolbox temperature value

A temperature comparison between the Styrofoam coolbox and coconut fibre insulation, bagasse and room temperature can conclude that in terms of reaching the lowest temperature point, Styrofoam is still better than coconut fibre insulation, bagasse. In contrast, coconut fibre insulation is better than sugarcane bagasse.

Analysis of the temperature and cooling time test data that has been carried out shows that the styrofoam coolbox graph curve and the coconut fibre and bagasse insulation graph curves are not parallel, which means that the temperature of the styrofoam coolbox is still lower than the temperature of the coconut fibre and sugarcane bagasse insulation coolbox. The lowest average temperature of the Styrofoam coolbox was 13,679 ℃, obtained from the 10 th to the 140 th minute after the testing process began with an average room temperature of 27.5 ℃. The lowest average temperature measured in the coconut fibre insulated coolbox was 18,555℃ from the 80th to the 200th minute. Meanwhile, the lowest average temperature measured in the coolbox insulated with bagasse fibre was 20.535℃. Data was obtained from the 70th minute to the 280th minute. Until the end of the test, the free air temperature in the coconut fibre insulation coolbox and bagasse fibre insulation was higher than the free air temperature in the Styrofoam coolbox.

3.2. Insulated Coolbox Temperature Comparison

Comparing the free air temperature in the coolbox with the ambient temperature must be considered. Free air contains many microorganisms that can affect the quality of fish when stored at room temperature. Warm temperatures cause microorganisms in the air to multiply and accelerate fish spoilage(Setiawan 2006). The results of the coolbox temperature test can be compared between the average temperatures of Styrofoam coolboxes, coconut fibre insulation and sugar cane bagasse. Comparative data for insulated coolboxes can be seen in Figure 5.

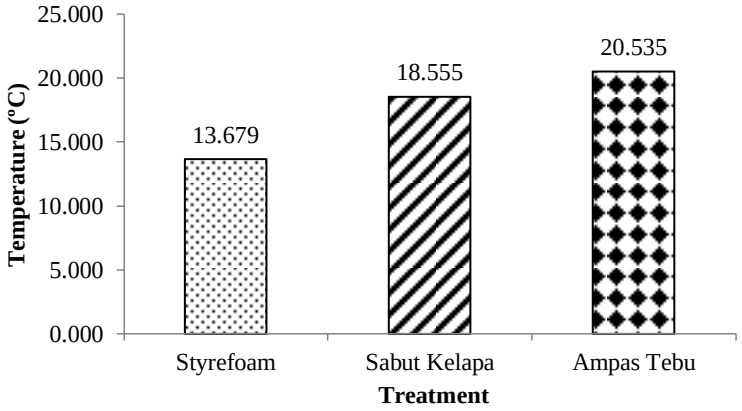

Figure 5. Comparison of coolbox temperatures

The comparison graph above can be analyzed to show that the styrofoam experiment obtained an average temperature13,679 ℃. The coconut fiber insulation coolbox experiment produced an average temperature of 18,555 ℃, lower than the sugarcane bagasse insulation experiment of 20,535 ℃

3.3. Comparison of Coolbox Temperature Stability Times

The results of the comparative data on the stability of the lowest average temperature of the Styrofoam coolbox, coconut fibre insulation and sugar cane bagasse can be seen in Figure 6.

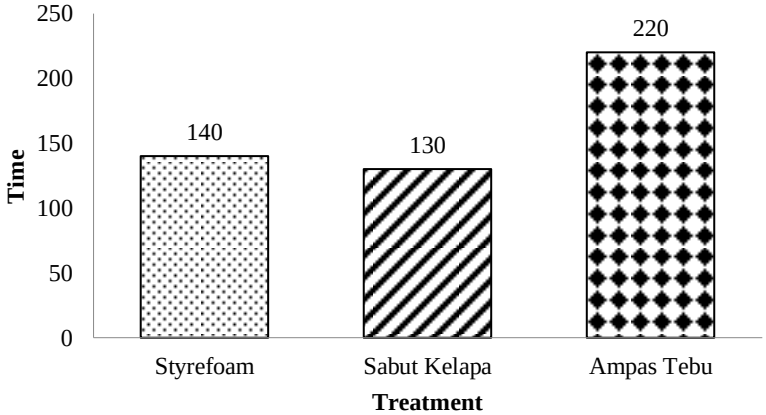

Figure 6. Coolbox temperature stability

The graph above shows that Styrofoam (control) shows the lowest temperature stability, reaching 2 hours 20 minutes (140 minutes) from 10-140 minutes, and coconut fibre insulation reaches 2 hours 10 minutes (130 minutes) from 80-200 minutes, while Bagasse insulation reaches 3 hours 40 minutes (220 minutes) from 70-280 minutes. A comparison of the temperature stability times can conclude that in terms of maintaining the lowest temperature, coconut fibre insulation is still better than bagasse insulation. At the same time, Styrofoam is better than coconut fibre insulation. These results show that natural fibre insulation materials cannot replace Styrofoam when viewed in terms of the lowest temperature the coolbox can achieve. However, the coconut and sugar cane bagasse insulation fibre can maintain their lowest temperature for extended periods.

In previous research on natural fibre insulated coolboxes conducted by Husein (2018), the lowest temperature measured in free air in a coolbox insulated with a composite of coconut coir and palm fibre with a thickness of the insulation material used was 12 mm at 18.9 oC. Wardani (2017), coolbox is made from sugarcane bagasse, the insulation thickness is 12 mm, and the lowest temperature that can be achieved is 9.60 ºC. The lowest temperature could be reached after 80 minutes after the experiment started. Meanwhile, the insulation material of bagasse and sawdust was only able to reach the lowest temperature of 12 ºC, achieved within 70 minutes after the experiment started. Then, it can maintain the ice until it melts entirely for 20 hours.

The thing that needs to be paid attention to when making a coolbox is the material that is the insulation itself, which can influence the temperature test results of the coolbox. An insulator is a material with a low thermal conductivity and a suitable heat inhibitor. In contrast, the high-conductivity material is called a conductor because it can conduct heat well. A suitable material for a heat insulator has a thermal conductivity value of around 0.1 W/m (Utomo, 2019). The high or low temperature of the coolbox is influenced by thermal conductivity. The low temperature of styrofoam is caused by the conductivity value of styrofoam itself being smaller than the thermal conductivity value of coconut fiber and sugar cane bagasse insulation. The high thermal conductivity value of natural fiber insulation is one of the contributing factors to the water content of the insulation. Porous materials containing liquid must also consider the water content contained therein (Tjahjanti, 2019).

This is why the coconut fiber and sugar cane bagasse insulated coolbox temperature is still relatively high compared to the Styrofoam coolbox. The fiber density influences the thermal conductivity of the insulation. If the material has more pores, the thermal conductivity is smaller. Differences in thermal conductivity will depend on structure differences, including fiber size, fiber distribution, and pore or hole relationships (Sana et al., 2020). In making insulation, water is used to mix the fiber and starch so that it mixes evenly and is easy to shape. Apart from that, the drying process of fiber as insulation in making coolboxes is only done by drying it under the sun for a short time. So, there is still water content in the natural fiber insulation. Apart from that, thermal conductivity will decrease with increasing porosity and will increase with increasing density (Pratama, 2016).

The factors that cause the temperature of the bagasse insulation coolbox to stabilize the temperature over a more extended period is because the bagasse insulation is denser compared to coconut fibre insulation and also, in the bagasse fibre, there is alkaline fibre, and the composition of the fibre used can influence the insulation properties. Density is a measure of the compactness of particles in a material and is a typical property of a material, and density can affect temperature (Maiwita, 2014).

4. Conclusions

Based on the research results, it can be concluded that: 1) the lowest temperature of the coolbox made from coconut fibre insulation, 17.7 ℃, was reached after the 70th minute. The bagasse was only able to reach the lowest temperature of 19.4℃, achieved in the 60th minute, 2) temperature stability in the coconut fibre coolbox reached 2 hours 10 minutes (130 minutes) from 80-200 minutes, while the bagasse coolbox reached 3 hours 40 minutes (220 minutes) from 70-280 minutes, 3) the best natural fibre coolbox insulation material is coconut fibre, which produces lower temperatures than bagasse. However, if you look at the temperature stability of the bagasse insulation, it is better because it maintains its lowest temperature for a longer time, and 4) the ability to keep the Styrofoam coolbox cold in this research cannot yet be replaced by coconut fibre and sugarcane bagasse insulation, so further research needs to be carried out.

5. Acknowledgment

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