

Research Article

Eco-Friendly Detachable Heat Insulating Patch

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Abstract: The operating principle of food delivery service is heavily depending on food delivery riders which usually use food delivery bag as the medium to store the food temporarily before it is being delivered to the targeted customer. Therefore, modification on the existing features of food delivery bag is needed to extend its ability to retain heat. The modification involved the integration of additional insulating element onto the inner walls of the interior part of delivery bag. Based on the justification of eco-friendly material selection for the application of thermal insulation on buildings construction such as coconut fiber, hemp fiber, palm oil fiber etc. as an insulating element for the wall, similar rationale is applied for material selection for the additional insulating element for the interior part of delivery bag. In this project, investigation will be carried out to solve the issue regarding the limitation of the existing food delivery bag to extent its heat retention ability by designing and constructing a detachable heat insulating patch. This patch will be made from sugarcane dregs and rice husks which provide non-permanent attachment to the inner part of the existing delivery bag since it is detachable. Based on the temperature difference assessment to determine the insulating effect of the patches, it was found that the attachment of detachable heat insulating patches containing sugarcane dregs and rice husks are capable to retain heat when it is used as thermal insulating element inside a mini delivery bag. This is depicted from the lower value of temperature drop when using detachable patches compared to the reading in the absence of the detachable patches.

Keywords: heat transfer; thermal insulation; eco-friendly; sugarcane dregs; rice husks; food delivery bag.



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1. INTRODUCTION

In recent years, food delivery service is booming rapidly due to its convenience by nature. The operating principle of food delivery service is heavily depending on food delivery riders which usually use food delivery bag as the medium to store the food temporarily before it is being delivered to the targeted customer. Therefore, it is crucial for the delivery bag to deliver its full capacity to ensure that the food being kept inside the delivery bag will have minimal heat loss in order to keep the food in hot condition for customers' satisfaction. Hence, modification on the existing features of food delivery bag

is needed in order to extend its ability to retain heat. This in turn will promote sustainability in food delivery business.

The modification involved the integration of additional insulating element onto the inner walls of the interior part of delivery bag. In doing so, material selection is another important step to be considered for the purpose of optimizing the thermal insulating effect. In addition, the overall cost, materials availability, sustainability issue etc. must be taken into account without compromising quality of material.

Aside from food industry, thermal insulation is often being applied in building construction since there's a demand to have ideal temperature inside the building, depending on climate at a certain region. An eco-friendlier approach of thermal heat insulation for building construction is by utilizing natural fiber such as coconut fiber, rice husks, hemp fiber, palm oil fiber, sugarcane dregs etc. as an insulating element for the wall (Manohar et al. 2002; Mehrzad et al. 2022; Silva et al. 2023). Based on the justification of eco-friendly material selection for the application of thermal insulation on buildings construction, similar rationale is applied for material selection for the additional insulating element for the interior part of delivery bag. The eco-friendly material of choice would be the sugarcane dregs and rice husks which are readily available in Malaysia.

Thermal insulation material can be divided into three main categories: fibrous, cellular and flake/granule (Tye 1989). The fibrous type of insulation has been commonly used in industrial processes especially as piping and furnace insulation. Research on physical and mechanical properties of palm oil wastes have been carried out, and palm oil wastes which contain air gaps in their microstructure have been reported to be poor conductors (Ramli et al. 2001).

Investigation regarding the possibilities of using palm oil waste, particularly oil palm fiber as an insulation material was conducted by Hassan and Al-Kayiem in 2014, it was found that the performance oil palm fiber as an alternative material for thermal insulation was successful investigated for temperature below than 100OC. The focus of their study is to compare the temperature gradient and thermal conductivity between the existing commercial rockwool and the produced oil palm fiber as a thermal insulator for a chimney of steam packaged boiler. By adapting the idea of fibrous thermal insulation attachment to the boiler chimney, this paper aims to design similar attachment for delivery bag.

The existing food delivery bag that is usually used by food delivery rider is designed and constructed by incorporating different layers of material such as sponge in the middle, aluminum foil in the inner layer and thick canvas as the outer layer which is used to retain heat so that the hot food kept inside the delivery bag will have minimal heat loss. However, there are certain limitation on the extent of the heat loss amount that can be prevented with those layering, in which the insulating effect may not be effective anymore and the hot food will become cold at an undesirable rate.

In this project, investigation will be carried out to solve the issue regarding the limitation of the existing food delivery bag to extent its heat retention ability by designing and constructing a detachable heat insulating patch. This patch will be made from agricultural waste such as sugarcane dregs and rice husks and provide non- permanent attachment to the inner part of the existing delivery bag since it is detachable.

2. METHOD & MATERIAL

2.1 Sample Preparation

The agricultural wastes that were used in this project are sugarcane dregs and rice husks. They were obtained from Teluk Intan, Perak. Sugarcane dregs were placed in open air and exposed to sunlight for one week to remove moisture and odour. Then, it is cut and shredded into small pieces. The rice husks are readily obtained in its dried form.



Figure 1. (a), (b), (c) Sugarcane dregs; **Figure 2.** (d) Rice husks

2.2 Design and construction of detachable patch

In this project, the insulation material is not attached directly to the walls of the bag and without the use of any artificial or non-artificial binder. Six sheets of nylon cases with the same dimension as all six sides of the box were designed and sewn.

Approximately 400 g of sugarcane dregs was inserted into 30 cm × 30 cm vacuum roll bag and was subjected to automatic vacuum sealing machine to remove air inside the bag and to hold the inserted material firmly into place. Four sets of similar bags were made for similar dimensions. Approximately 200 g of sugarcane dregs was inserted into 30 cm × 20 cm vacuum roll bag and was subjected to automatic vacuum sealing machine to remove air inside the bag and to hold the inserted material firmly into place. Another set of similar bags was made for similar dimensions.

All of the bags were then inserted into the nylon cases with identical dimensions. All of the six filled nylon cases were attached to each side of the corresponding bag's wall by using self-adhesive Velcro tape to provide insulation lining for the inner part of the bag. These steps were repeated by replacing the sugarcane dregs with rice husks.

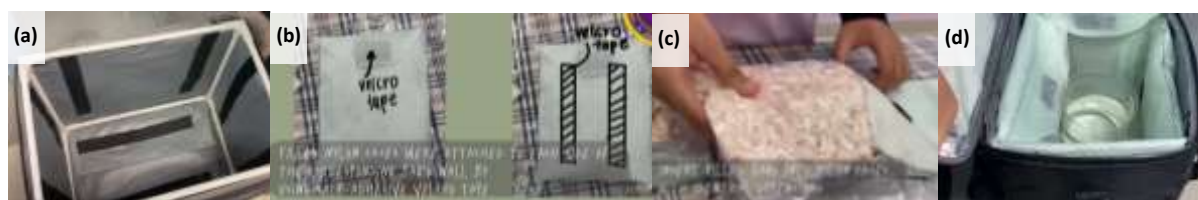


Figure 3. (a) The hook of Velcro tape is attached to the inner sides of food delivery bag, (b) The loop of Velcro tape is attached to the nylon cases, (c) The vacuum sealed sugarcane dregs being inserted into the nylon case, (d) The attachment of insulating patches onto the inner sides of food delivery bag.

2.3 Assessment of thermal insulating effect through measurement of temperature difference

The insulating effect of the detachable patches were assessed through the measurement of temperature difference when a beaker of hot water was placed for one hour inside the bag attached with the detachable patches. The value of initial and final temperature of the hot water were measured using food thermometer and recorded. Similar action was performed with the presence of detachable patches. Finally, the difference between the initial and final reading was calculated and compared with

each other. The reading with the least value of temperature difference would imply that it has minimal heat loss which was indicated by the temperature readings. These steps were repeated by replacing sugarcane dregs with rice husks.



Figure 4. Temperature assessment for control set.



Figure 5. Temperature assessment for sugarcane dregs patch.



Figure 6. Temperature assessment for rice husks patch.

3. RESULTS

The efficiency of the detachable patches in terms of thermal insulating capabilities was determined through one-hour temperature difference assessment.

Table 1. Data tabulation for temperature difference without the presence of detachable patch and with the attachment of detachable patch.

The presence of insulating element	Initial temperature (°C)	Final temperature (°C)	Temperature difference (°C)
Without detachable patch	100	69.3	30.7
Detachables patch containing sugarcane dregs	100	70.6	29.4
Detachables patch containing rice husks	100	73.5	26.5

From Table 1, it can be seen that the value of temperature difference when using the detachable patch is less than the value of temperature difference without the attachment of detachable patch. This implies that the attachment of detachable heat insulating patch containing sugarcane dregs and rice husks is able to minimize the rate of heat loss.

4. CONCLUSION

In conclusion, the detachable patches containing rice husks and sugarcane dregs are capable to retain heat when it is used as thermal insulating element inside a mini delivery bag. This is depicted from the lower value of temperature drop when using detachable patches compared to the reading without using the detachable patches. Moreover, based on the data, it can be said that the detachable insulating patch containing sugarcane dregs and rice husks have fairly significant capability to retain heat when it is used as thermal insulating element. In accordance with the objective of this project, it is evident that the presence of heat insulating patches are capable to extent the capability of the existing food delivery bag to retain heat.

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