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Development of Virgin Coconut Oil Fermented Tank Using Teak Wood Powder Insulator

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ABSTRACT

One of the processed products derived from coconut that has great demand in the world of health and beauty industry is virgin coconut oil or known as VCO. Most VCO is processed manually using conventional methods with unhygienic plastic containers and placement in open spaces by the home industries. This research is to develop a VCO-fermented tank that was able to maintain hygiene and low temperature during the fermentation process by using SS403 and teak wood insulation as the main materials. This research carries on by comparing the fermentation process and results between the conventional method and the new VCO tank. 41% VCO is produced from raw coconut milk using a new VCO tank which is 5% higher than the conventional method. The VCO fermented tank produced more VCO and was able to maintain lower temperatures compared to the conventional method and also can be operated with less procedure order.

1. INTRODUCTION

Indonesia lies in a tropical area consisting of thousands of islands with plenty of natural resources. With these resources, Indonesia is also well known as one of the biggest agricultural product producers in the world. One of its resources is coconut with 3.37 million hectares of plants available (Badan Pusat Statistik, 2021a) and 2.85 million tons of annual coconut production (Badan Pusat Statistik, 2021b).

Coconut has a very high economic value because almost all parts of this variety can be used to fulfil human needs. One of the processed products from coconut that is in great demand and has a high value is virgin coconut oil (VCO). VCO is obtained from the extraction of fresh coconut kernel by cold-pressing the liquid from the fresh part of coconut milk to prevent the loss of vitamin E, pro-vitamin A, and polyphenols (Tan-Lim & Martinez 2020; Umate *et al.*, 2022). Compared to coconut oil which is processed by heating method, VCO has the advantages of low water content free fatty acid content, colourless (transparent), strong fresh coconut aroma, and long storage time (Mohammed

et al. 2021; Tanasale, 2012). Medium fatty acid containment in the VCO could improve human health (Wiyani *et al*., 2020), therefore this VCO was also developed as raw material for medicines and cosmetics (Amit *et al*., 2022) and also good for the health of animals (do Couto *et al*., 2022).

In the region of West Sumatera, Indonesia, VCO still process manually by home industries naturally without any additive agent. Naturally processed VCO without any additive or preservative agent will create a low acid level which is very good for human health (Samantha *et al*., 2020). VCO is made by grinding the coconut kernel and then pouring it with water to be extracted using a fine mesh to obtain the coconut milk. The extracted coconut milk should be kept at 25°C and fermented for 24 hours to form three layers consisting of; coconut oil, chaff and water respectively (Bisong *et al*., 2020). Those processes usually use a plastic container that is tightly closed and then wrapped with several pieces of thick cloth to maintain the VCO temperature from the ambient temperature because the quality of VCO is easily affected by temperature (Pramitha & Juliadi, 2019). The use of plastic containers may cause many health problems and may trigger cancer and tissue damage in the body if used inappropriately, especially if using non food grade plastic containers (Eales *et al*., 2022). Wrapping the VCO container with several pieces of thick cloth and putting it in a storage box will take longer time and effort. This research was aimed to develop a VCO fermentation tank that easier to use and assure better and hygienic fermentation results. This tank will reduce interference of human bare hands, keep it hygienic and keep the VOC temperature lower.

To keep hygienist of the food, it is better to use food-grade material such as stainless steel. In the food and medical industries, stainless steel is one of the common choices to use as equipment materials because it must comply with high purity and quality standards (Zaffora *et al*., 2021). SS 304 is one of the favourable choices because it is suitable and cheaper than other grades to be used in food industries (Santamaria *et al*., 2020). Teak wood sawdust is an insulator that has good thermal conductivity so that it can maintain the temperature in the tank against the ambient temperature, better than plastic does (Pradhan *et al*., 2022; Wibowo & Sulistyo, 2021). Teakwood sawdust is used in this research for its low thermal conductivity values of 0.022W/mK (Baheramsyah *et al*., 2019). Teakwood sawdust is also good to be used as building reinforcement and also for noise insulators (Laksono *et al*., 2019). Moisture content and the wood powder density will have a positive correlation with thermal conductivity (Gong *et al*., 2021). Teakwood sawdust and SS430 are used as the main materials in developing this VCO-fermented tank.

2. MATERIALS AND METHODS

2.1. Materials

The VCO fermention tank developed in this research was using SS304 sheet and teak wood as an insulator and is expected to produce well-maintained temperature and hygienic VCO products. This tank was equipped with a digital thermometer to observe inside temperature, a sight glass window and a draining valve for ease of use and to prevent contamination. Overall materials used to build the VCO tank were: plywood, SS304 sheet, teak wood sawdust, resin, water valve, stainless steel pipe, clear acrylic sheet, digital thermometer and oil base paint (Table 1). A food-grade plastic container and wrapping cloth (sarong) were used in the conventional process. VCO fermentation experiment was using 830ml of coconut milk obtained from 7 pcs of fresh coconut for each experiment.

Table 1. Specification of VCO fermentation tank

Components	Dimensions
Volume	12 litre
Overall size (mm)	200 x 200 x 200
Isolator thickness	20 mm
Plywood wall thickness	6 mm
SS304 Sheet thickness	0,5 mm

2.2. Method

The VCO tank design consists of an inner tank, plywood case and teak wood sawdust collected from the waste of the furniture industry (Figure 1). Teak wood sawdust was compacted into a solid board by mixing it with resin using a 70:30 percentage ratio (Figure 2) and then inserted into the wall of the plywood case. Lastly, the SS304 inner tank was installed in the case (Figures 3).

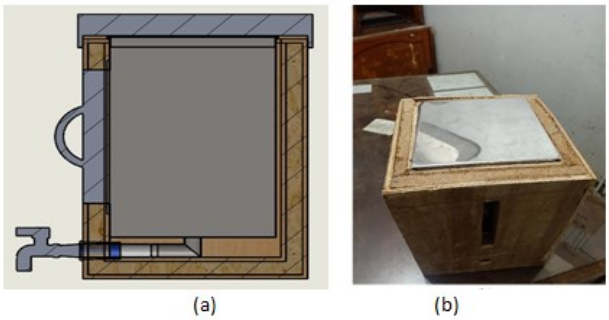

Figure 1. VCO tank (a) design and (b) finishing

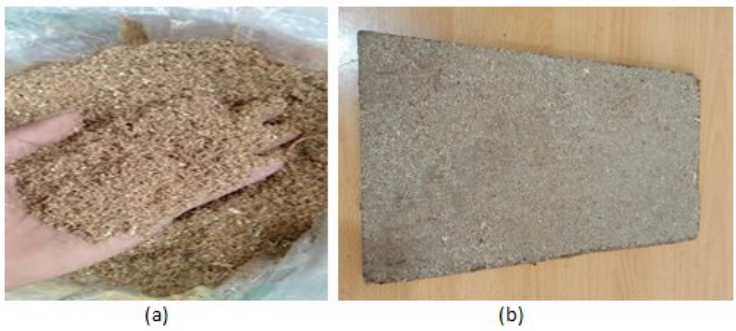

Figure 2. Insulation materials (a) teak wood sawdust and (b) compacted board

The VCO fermentation tank will be tested by comparing it with the conventional method. This fermentation method is conducted by leaving the coconut milk undisturbed without any additive agents and repeating it 3 times. The coconut kernel was ground then proceed to obtain the coconut milk and poured into the VCO tank. In another method, the coconut milk is then poured into a plastic container, close the lid and wrapped using cloth (Figure 4). The next step is to leave coconut milk for 3 hours until the thick coconut milk is separated from the water. Tank inner temperature is monitored using an attached digital thermometer every 30 minutes during this process. After being separated, the water sunk under the tank and was disposed of by opening

the water valve, remaining condensed coconut milk was then stirred for 5 minutes and then left to be fermented for 24 hours. For the conventional method, the floating thick coconut milk is drawn manually using a pail from the container or sucked using a small plastic pipe. Condensed coconut milk then stirred for 5 minutes, poured again into the container and left to be fermented for 24 hours. Three layers of precipitates (VCO, chaff, water) will be formed in this process.

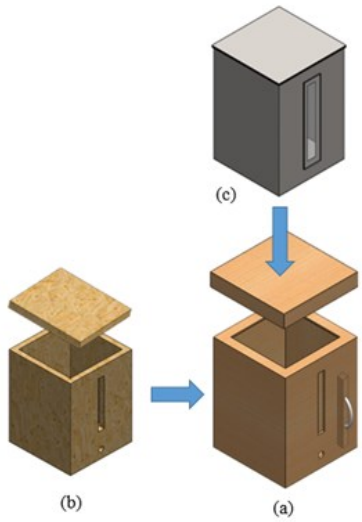

Figure 3. VCO tank components; (a) plywood case, (b) insulator to be inserted, and (c) SS304 inner tank

Figure 4. Conventional fermentation (a) Coconut milk stored in a plastic container and (b) wrapped with a cloth

During this process, the growing volume of the VCO was recorded every 1 hour by observing and measuring the height of VCO thru the sight glass. The VCO height is then calculated using the volume calculation formula to find its growth volume. After 24 hours these 3 precipitates are then separated thru a water valve, where the water will be drained first, then the chaff, and lastly, the VCO obtained (Figure 5). VCO liquid is drawn manually using a pail from the container or sucking using a small plastic pipe for the conventional method, for the process using a VCO tank is simply by opening the water valve then water, chaff and VOC will respectively be drained from the tank. The VCO obtained from this process should be transparently clear and have a fresh coconut odor without any stink taste. The measurement method is observing the liquid clarity, smelling and testing the liquid taste.

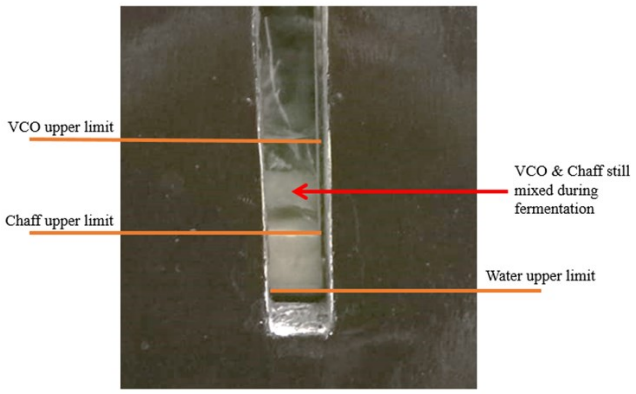

Figure 5. Precipitates formed during the process observed thru the sight glass

3. RESULTS AND DISCUSSION

Results shown in Figures 6 and 7 are the average result of the 3 times repetition experiments. Ambient temperature indeed affected the temperature of the VCO inside the container. The VCO temperature is also raising along with the rise of ambient temperature and also when it is decreased. Compared to the conventional method, the VCO tank is able to maintain the inside temperature up to 0.7°C below ambient temperature while the conventional method could retain 0.5°C below ambient temperature. The inside temperature of the tank is still possible to reduce further by modifying the thickness and density of the insulator.

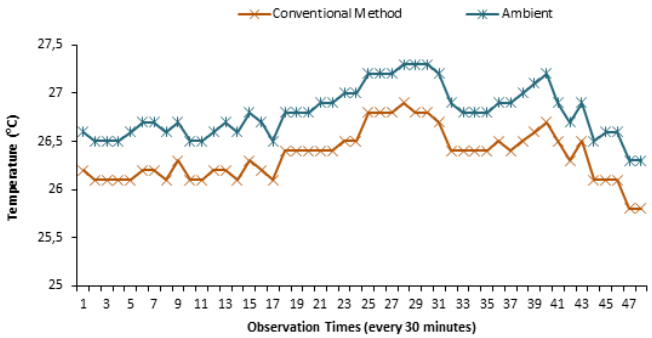

Figure 6. Observation of temperature inside of the plastic container and ambient temperature in the conventional fermentation process

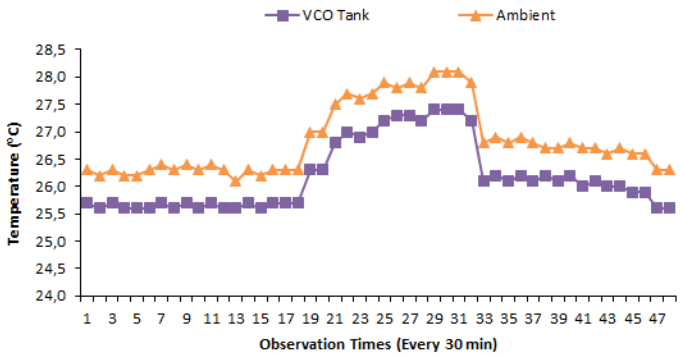

Figure 7. Observation of temperature inside of VCO tank and ambient temperature

It was observed that the growth of the VCO liquid started from the 3rd hour of fermentation until the 22nd hour (Figure 8). From the 22nd to the 24th hour the volume growth is stopped for both methods, this phenomenon shows that 22 hours of the fermentation process is should be enough, but further research required. From 830 ml of fermented coconut milk, the process using a VCO tank yielded 338.7 ml of pure VCO liquid or 41% of coconut milk, while using the conventional method yielded 319.5 ml of 38% of coconut milk. VCO tanks with better insulation and draining method could save up to 5% of VCO compare to the conventional method. No significant differences in the appearance or odour of VCO liquid were obtained using the conventional method or using a VCO tank. Both methods produce clear transparent VCO liquid, fresh coconut odour and no stinky taste when drunk (Figure 9). This happened because of the use of a food-grade plastic container, therefore, experiments using non-food-grade containers might require. The differences might appear if the fresh coconut comes from a different variety or different plantation locations. Even though the result seems less significant but the VCO fermentation tank ensures the quality and hygienist of VCO produced, a clear and transparent liquid with a fresh coconut odour. VCO tank is easier to operate than the conventional method where no need to wrap and unwrap the container and less hand contamination during the separation of pure VCO liquid.

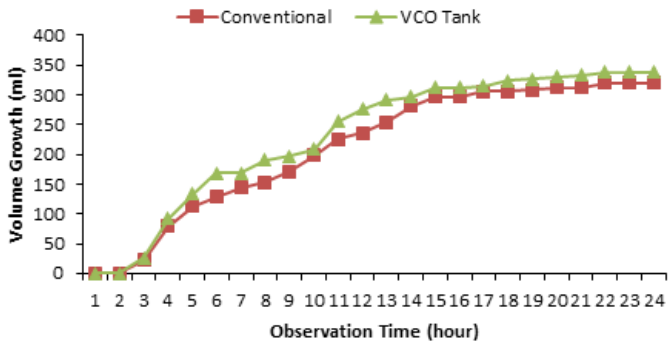

Figure 8. Observation result of VCO growth

Figure 9. VCO result Observation

4. CONCLUSIONS

VCO tank is not only able to keep the inside temperature lower but also produce VCO 5% more than the conventional method. The growth of VCO liquid already stops after

fermented for 22 hours where no more VCO is obtained if keep longer than that. The remaining 2 hours only use to wait until the process settled. Even though this result did not show a very significant result, the VCO tank ensure the hygienist of the VCO produced because the inner tank was covered with food grade stainless steel sheet. VCO tank equipped with water valve to make sure less contamination during VCO retrieval. This tank can keep the inside temperature 0.7°C below ambient temperature, therefore during the hot season, this tank can't keep the temperature below 25°C as required. Therefore further research to develop the ability of the tank to keep the temperature below 25°C is still required. Another further research is to compare the VCO liquid result derived from a different variety or different plantation locations of fresh coconut.

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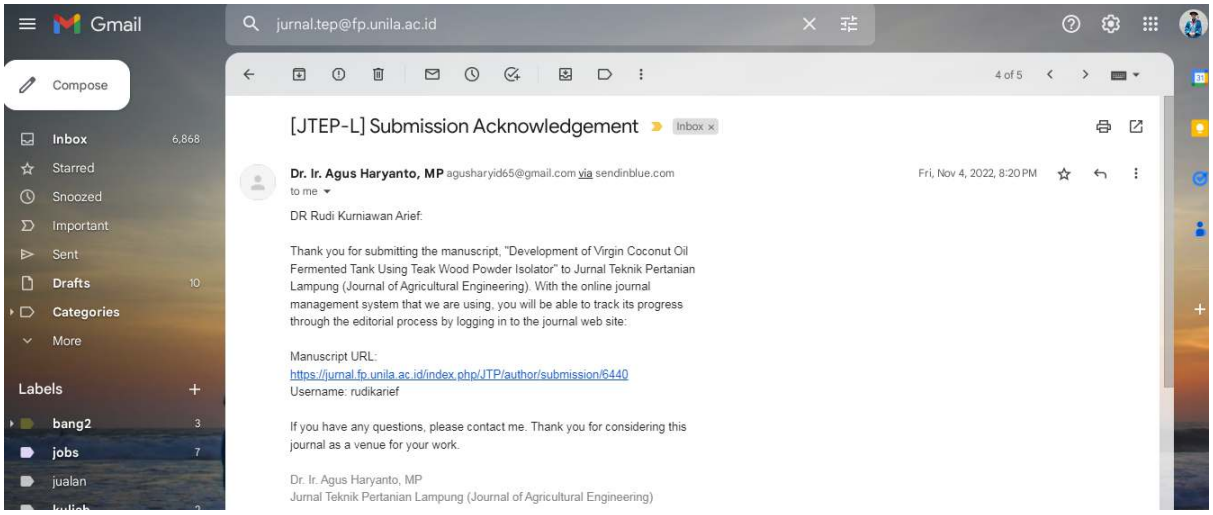
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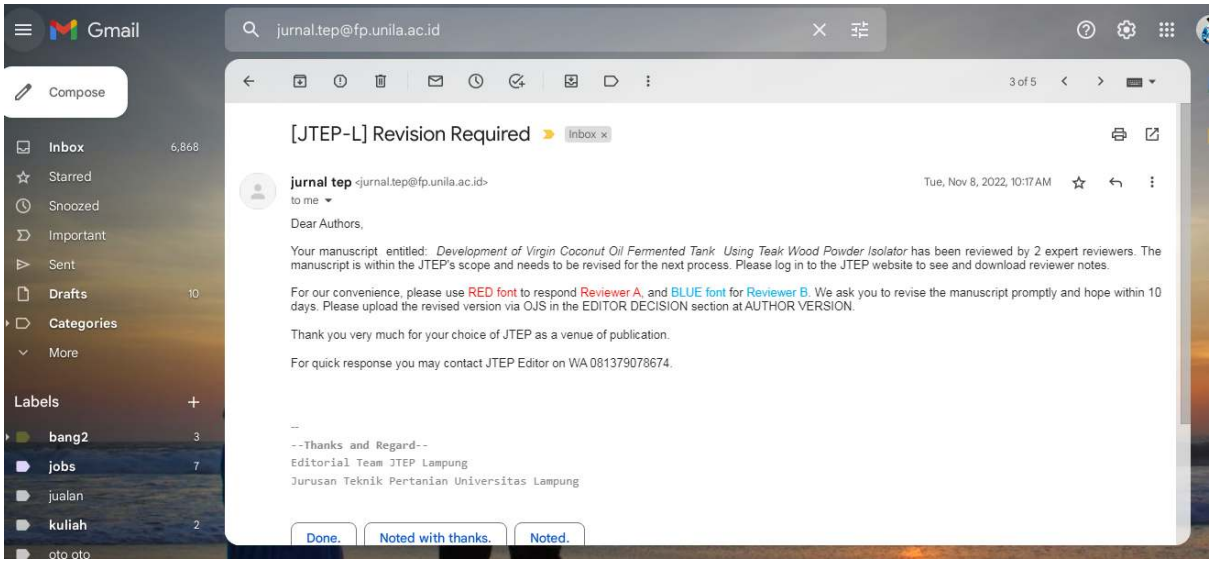
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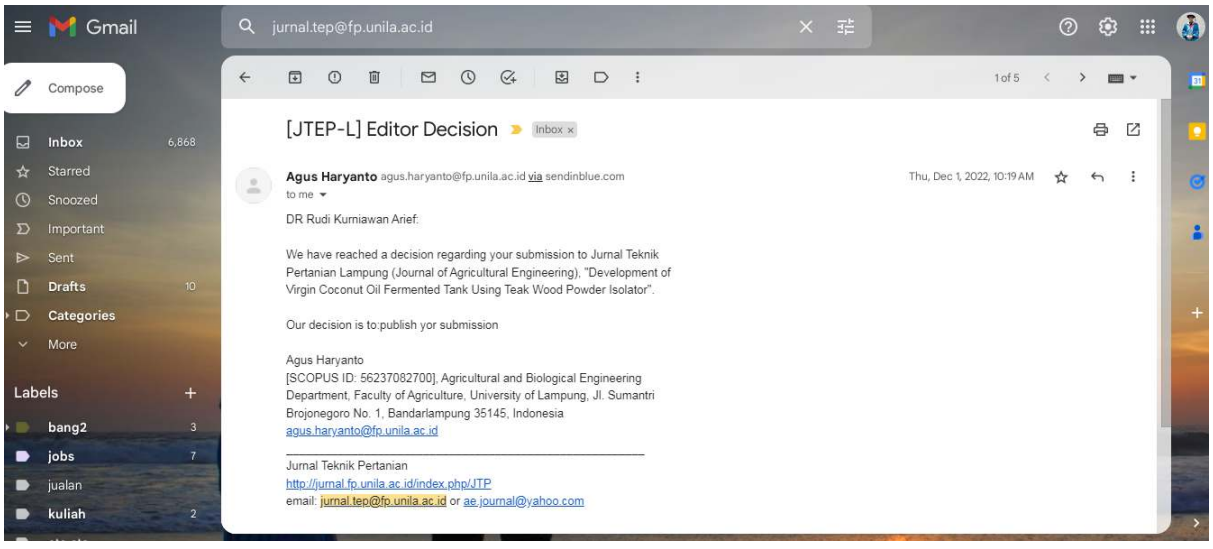
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