Potential of Edible Oil Production from Rice Bran in Indonesia: A Review

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Abstract. In the year 2018, Indonesia produced 56 million tons of rice paddy. During the paddy milling process, 57-60% rice will be produced, 18-20% husk and 8-10% bran. On this basis, about 4.5 to 5.6 million tons of rice bran is produced every year and unfortunately such massive resource of rice bran is not yet optimally utilized. To this point, rice bran has been used as animal feed. Typically, rice bran contains 15-20% lipids, 12-16% protein, 7-11% crude fibre, 34-52% carbohydrate and 7-10% ash. Since it is rich in lipids, rice bran is economically and commercially feasible to be converted into edible oil. With the embargo of Indonesia palm oil by European Union and more portion of palm oil is converted into biodiesel, rice bran oil would have opportunity to supply the country to meet the demand for edible oil. Rice bran oil offers a number of advantages compared to other edible oils in terms high antioxidant contents and high smoke point. This paper will discuss the potential production of rice bran oil from resources and technological point of views, current processing technology, possible methods to increase the recovery, and future prospect for rice bran oil.

1. Introduction
Currently, Indonesia is ranked 4th as the country with the largest population in the world, reaching 265,950,668 people with a percentage increase of 1.2% per year [1]. Along with an increase in population, the need for food oil is also increasing. So far, the Indonesian people have only relied on crude palm oil (CPO) to meet the need for food oil. As the largest CPO oil producing country in the world supported by oil palm plantation land area which reaches 12,307,677 hectares [2]. The palm oil industry has indeed helped in improving the economy of the community and the country's foreign exchange. However, the presence of oil palm plantations also provides many problems and negative impacts on the environment, food security, and social. The expansion of oil palm land has caused changes in the forest ecosystem, resulting in the loss of biodiversity, germplasm and loss of water resources. This problem has also penetrated into wetlands thereby increasing the amount of CO2 emissions. In addition, oil palm plantations also cause a reduction in water catchment areas that can trigger natural disasters such as floods and landslides. The negative impacts and problems of land

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ownership from the expansion of oil palm land often lead to conflicts between communities and oil palm companies.

Indonesia is one of the biggest rice producing countries in the world. Based on statistical data, the area of paddy fields in Indonesia in 2016 reached 8.19 million hectares [3]. With this vast land, 75.39 million tons of dried paddy is produced annually. Based on research conducted by Hadipernata, Supartono [4], each rice milling process produced rice (67-60%), husks (18-20%) and rice bran (8-10%). This data indicates that Indonesia produces around 6-7.5 million tons of rice bran per year. That is, in addition to millions of tons of rice produced in Indonesia, there is no less abundant bran waste.

The second problem is the low recovery of rice bran oil during the processing of liquid solid extraction generally bran is only used as animal feed, a mixture of natural fertilizer and most of it is burned or left alone. This means that rice bran has not been able to provide added value economically, although it has the potential to be converted into products with higher economic value, such as bioethanol, fibrous foods, cleaners, activated charcoal, and others. Burning is the most popular method used by the community to reduce the volume of rice bran waste. However, this method has a negative impact on the environment and human health. In Thailand, for example, bran is no longer burned but is converted into products that have added value, one of which is cooking oil or vegetable oil. However, the use of rice bran as a raw material for vegetable oil is almost unknown in Indonesia. This is because the government and the community rely more on palm oil as raw material for producing vegetable oil.

There are two problems Indonesia will face if it wants to develop vegetable oil production from rice bran. First, the instability of the free fatty acid content found in the bran, after the grinding process. The content of free fatty acids in bran can increase depending on environmental conditions and storage time. Lipase enzymes help the process of hydrolysis into free fatty acids and glycerol. As a result, bran like this if extracted will produce rancid oil. To avoid rancidity, lipase enzyme inactivation can be done by stabilizing the bran. The second problem is the low recovery of rice bran oil during the processing of liquid solid extraction, which ranges from 6-18% [5-7]. Until now, the extraction method is still used in the bran oil processing industry as the only way to extract oil from the bran. With this condition, economically the production of bran oil is less attractive because there is still a lot of oil left in the bran. Therefore, efforts are needed to increase the acquisition of bran oil in various ways, such as initial treatment of bran so that oil can easily get out of bran later. This paper will examine the efforts that have been made to stabilize existing bran and the technology that has been developed to increase the yield of bran oil.

2. Rice Bran Oil Benefit

Today the interest of society in developed countries against bran oil is increasing because of the benefits that are owned by bran oil. As edible oil, rice bran oil is suitable for frying because of a high smoke point. It is known that the quality of the cooking oil is determined in part by the smoke point, the higher the smoke point the better cooking oil. Rice bran oil has a smoke point of 260 °C, compared with palm oil smoke point that 176 °C. This means that if it is used as cooking oil, palm oil faster than the boiling rice bran oil. From the health side, rice bran oil provides a lot of benefits. Bran oil contains a substance called oryzanol. Oryzanol is an antioxidant that has been known to reduce the content of cholesterol in the human body. Additionally, gamma oryzanol contained in rice bran oil can be a source of power and anti-cancer agents because of the high ability to counteract free radicals. The results also showed that gamma oryzanol beneficial for skin health and beauty. Gamma oryzanol can protect DNA damage of skin cells, increase skin cell regeneration, and prevent damage to collagen and elastin fiber that trigger the occurrence of wrinkles on the skin. In fact, traditionally in Japan, bran is purely used as a mask because of its content of Gamma oryzanol can soften and brighten the skin [8].

In Japan and several Western countries, this oil is known as the "heart of oil" (oil heart), because of the properties for the human heart and has got the category as a healthy food of WHO and FAO. Not only the WHO and FAO, Indian Council of Medical Research also supports the use of rice bran oil is because it is known to have the ability to lower cholesterol, boost the immune system, prevent cancer,
improve skin health, accelerate the process of weight loss, relieve symptoms of menopause, as well as prevent heart disease.

From the above, it is clear that rice bran oil has a number of benefits for human health. It is not surprising in developed countries and some Asian countries people are aware of the importance of health switch to using rice bran oil instead of using other vegetable oils. Unfortunately, even though Indonesia is one of the rice barns, turns oil extracted from rice bran is still to be imported from Thailand so the price is relatively expensive.

3. Rice Bran Stabilization

Rice bran composition varies depending on the rice variety, weather conditions and methods of rice processing. The chemical composition of the rice bran is strongly influenced by rice varieties. In general, the essential nutrition content of the rice bran in bulk include minerals, vitamins, fiber, protein, amino acids and antioxidants. According to Wibowo [9], the composition of the rice bran in fat and high fiber, as shown in Table 1.

| Composition | Content (%) |
|-------------|-------------|
| Water       | 8.33–12.93  |
| Fat         | 2.88–5.96   |
| Protein     | 8.43 to 13.53|
| Ash         | 4.66–17.96  |
| Crude fiber | 6.74–29.98  |

Although an excellent source of nutrients, bran is not suitable for direct human consumption due to rancidity caused by the presence of lipase. When the bran layer separated from the endosperm during the grinding process, the individual cells burst and consequently lipase in contact with fatty cause triglyceride hydrolysis process into free fatty acids and glycerol [10]. The increase in free fatty acids in the bran occurs within a few the first hours after milling and reaches 5-7% after 24 hours. Dedak free fatty acid containing more than 5% and rice bran oil containing free fatty acids of more than 10% categorized as unfit for human consumption.

| Mechanical Stabilization | Condition |
|--------------------------|-----------|
| Hot air drying           | 100 °C for 1 hour |
| Steaming                 | 100 oC for 30 minutes |
| Refrigeration            | 2 °C       |
| Sun drying               | 47 °C (maximum) 7 hours per day for 2 days |
| Drying fireside          | 84 °C for 1 hour |
| Spraying chemical stabilization | HCl 1000 ppm |
| Microwave heating        | 2450 MHz for 2 minutes |
| Radiation infrared rays  | 700 W for 30 minutes |
| Ohmic heating            | Humidity 20-40%; 44–72 V / cm voltage gradient |

To prevent rancidity in the bran, the lipase enzyme activity must be stopped at a certain stabilization process immediately after the rice milling process. Various methods have been used to stabilize bran, as shown in Table 2. It should be noted that the purpose of the stabilization process is to inhibit or halt the activity of lipase without damaging the nutrient content in the bran. However, some methods that have been used visible use heat medium so that the operating temperature can reach more than 70 °C. Methods such as hot air drying, evaporation (steaming), and the methods that can be hot, certainly will damage the protein, or it is called denaturization protein. However, if the protein content of not becoming an important aspect, then the process of heating at high temperature is not a problem.
But in essence, the selection of the appropriate method of stabilization is important because it relates to the effectiveness of the stabilization and operational costs required for stabilization.

How simple and quite effective stabilization developed on the basis of character low lipase activity at low pH. Therefore, the addition of dilute hydrochloric acid so that the pH of the bran changed from 6.9 to 4.0 can reduce lipase enzyme activity. How rice bran stabilization using infrared radiation is also effective for the inactivation of the lipase enzyme that can extend the shelf life of rice bran.

4. Technology of Bran Oil Processing

Considering the abundant raw material of rice bran in Indonesia, rice bran is indeed very potential to be converted into food oil. However, efforts to commercialize rice bran oil up to industrial scale such as palm oil still cannot be implemented. This happens because there is no research that produces rice bran oil with a high acquisition. So that both the private sector and the government are still reluctant in commercializing the rice bran oil. However, studies on rice bran production at the research stage have been carried out [6,12]. However, the research that has been done has not been able to have a major impact on oil production from rice bran. At present, research on rice bran oil is still being carried out in order to produce high-yield rice bran oil. If rice bran oil can be commercialized into edible oil, then palm oil can be converted into other products such as biodiesel, soap, cosmetics, and margarine.

At present, to obtain rice bran oil, rice bran oil is processed using a liquid solid extraction process, which is the extraction process using a solvent. According to Susanti, Ardiana [12], the solvents normally used to extract oil from a vegetable material were ethanol, n-hexane, isopropanol, ethyl acetate, acetone and methanol. The use of this solvent to extract edible oil from 100 grams of rice bran yields a succession of 14.70%; 14.94%; 13.30%; 14.26%; 9.30% and 9.16%. It is seen that the acquisition of oil from bran is still very low, which ranges from 9.16% -14.96%. The acquisition of rice bran oil using liquid solid extraction method is still very little. Therefore, the need for pre-treatment of rice bran to increase the recovery of rice bran oil.

Several studies by providing initial treatment of rice bran have also been carried out. Like the use of microwaves (microwave) and far infrared radiation (far infrared), FIR. The use of this method is done as an effort to increase the acquisition of rice bran oil and maintain the stability of rice bran that is easily rancid. Stabilization using microwaves aims to reduce the water content contained in rice bran. The use of microwaves has succeeded in increasing the acquisition of rice bran oil, although not significantly. Based on research conducted by Hadipernata, Supartono [4], the recovery of rice bran oil obtained on the first day after microwaves was 15.48%, while on the 9th day it was 15.79%.

The use of far infrared radiation (far infrared, FIR) before extracting rice bran oil also aims to reduce the water content contained in rice bran and help improve the quality of bran oil. Based on research also conducted by Hadipernata, Supartono [4], we can find out that the use of FIR radiation as a pre-treatment of rice bran affects the rice bran oil produced. where the yield is 15.59% on the first day and 16.24% on the ninth day. The use of sophisticated methods such as supercritical fluid extraction (SFE) has also been tried to increase oil recovery from rice bran. This method uses supercritical CO₂ liquid at temperatures between 25-60°C and pressures from 150 to 250 bar. Based on research conducted by Sarmento, Ferreira [13], it was found that this method was quite effective in extracting rice bran oil. Where at a pressure of 250 bar and a temperature of 40°C produces the highest oil yield, which is close to 80%.

4.1 Suitability Technology in Indonesia

Related studies have been carried out to obtain rice bran oil with high recovery, so that the commercialization of rice bran oil can be done as one of the edible oils in Indonesia. Comparison of the recovery of rice bran oil that has been obtained from several studies conducted by Hadipernata, Supartono [4], Susanti, Ardiana [12], Sarmento, Ferreira [13] can be seen in Figure 1.

Based on Figure 1, it can be seen that the recovery of rice bran oil using conventional extraction is still very small, only 14.96%. So it needs to be done pre-treatment on rice bran, so that it can increase the recovery of rice bran oil. In the use of microwaves, the increase in yield obtained is relatively
small. It can be concluded that this method is not effective for producing edible oil from rice bran. Besides being ineffective the use of microwaves is also not economical because it requires a large amount of energy which will affect production costs. In the use of FIR rays, these results are not much different from the pre-treatment using microwaves, which is 15.79%. So this method is also not effective to be applied in producing bran oil on a large scale.

![Figure 1. Comparison of rice bran oil recovery by various methods](image)

In the use of supercritical fluid extraction methods to produce rice bran oil obtained a high gain, which is 80%. However, the application of this method is constrained by various factors. Among them is this process requires very high pressure for its operation, which is 250 bar. This high pressure will require enormous energy as well. So that it will increase the cost of rice bran oil production. The use of high pressure also requires a high level of safety supervision. So it can be concluded that this method is not appropriate for use in Indonesia.

In addition, there are other methods that are estimated to be used as a pre-treatment to increase the acquisition of rice bran oil, by using fermentation. Fermentation is a way to produce products using microorganisms under certain conditions [14]. According to Ulfa [15], fermentation is divided into two ways of operation, namely liquid phase fermentation and solid phase fermentation. Solid phase fermentation is a pre-treatment method that can be used to increase oil recovery from bran.

Solid phase fermentation has long been known and applied by the people of Indonesia. This process is not only used to produce edible oil, but also has been used to produce everyday foods, such as tempeh, tape, cheese and so forth. Particularly in Aceh, solid state fermentation has been used by people to produce edible oil, coconut cake and dregs from fermented called pliek u is used as a flavouring of food for generations. For rice bran fermentation can be carried out in the same manner in a way that is done in traditional solid fermentation in Aceh, where a mixture of microbial cultures are used to increase oil recovery from coconut cake [16]. Due to the Indonesian people already familiar with these methods, expected efforts to increase rice bran oil recovery using solid phase fermentation will be more readily accepted by the farmers and people of Indonesia as a method of producing rice bran oil. But these methods to produce rice bran oil has never been done, so it needs to do research related to proved the effectiveness of this method in increasing rice bran oil recovery.

5. Conclusions
From the study of literature that has been described above, it can be concluded that the potential of rice bran oil production in Indonesia is very large considering the valley of bran provided a very abundant. The problems with rancidity caused by the lipase enzyme activity can be overcome by a simple method, namely by lowering the pH of the bran to 4.0 by adding hydrochloric acid. Another
problem is lack of acquisition can be enhanced by providing early treatment of the bran. Traditional ways that have been made to enhance the coconut oil can be replicated, although a detailed study should be done first. The most important is the willingness of the government to encourage the growth of rice bran oil industry, so that Indonesia does not continuously dependent on palm oil.

6. References

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