Characteristics of Oil Mixed Red Palm Oil with Catfish Oil (*Pangasius hypothalmus*)

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Abstract. Riau Province is the region that has the largest plantation area in Indonesia with 2.4 million hectares of land in 2017 and production contributes 6 million tons per year and contributes 28.2 percent of Indonesia’s total CPO exports. On the other hand, the Kampar and Pelalawan districts are centers for the production of special freshwater fish for catfish (*Pangasius hypoptalmus*), where from year to year they have increased rapidly. This study aimed to characterize oil mixed of red palm oil and catfish oil byproduct of catfish fillet. This research was conducted using a one-factor factorial experimental method, namely the difference in the ratio of the mixture between red palm oil and catfish oil. Red palm oil and catfish are stirred in a ratio of 70:30 (B1), 60:40 (B2), and 50:50 (B3). A serial of organoleptic and chemical test (saponification rate, iodine number, number acid, and fatty acid profile) were carried out. The results showed saponification rate was 295.36, iodine concentration was 80.33 and acid number was 0.05. Furthermore, the fat content of each ratio B1 (14.28%), B2 (16.21%) and B3 (17.11%), while the types of fatty acids obtained are saturated fatty acids (SAFA), unsaturated fatty acids single (MUFA) and polyunsaturated fatty acids (PUFA). The quality of the mixture of red oil and catfish oil produced in this study meets the FDA (Food and Drug Administration) standards, in which the best one was B3 (50:50). It can be interpreted that the mixture can be used as a source of fatty acids needed by the body which contains omega-9 fatty acids, omega-6 and omega-3.

1. Introduction
Riau Province is known as the largest palm plantation area in Indonesia with a land area of 2.4 million hectares in 2017 and production of at least 6 million tons per year and contributes 28.2 percent of Indonesia’s total CPO exports [1]. In addition, Riau was also determined by the central government as one of the clusters of catfish cultivation development (*Pangasius hypoptalmus*) especially in Kampar and Pelalawan districts, where from year to year it has experienced rapid development.

Both types of commodities have their respective advantages, on the one hand oil palm is rich in carotene and on the other hand catfish are rich in omega-9, 6 and 3 fatty acids. Thus, if the two types of raw materials are combined it will produce high nutritional value products. This can be done by blending it physically, including the encapsulation method. Blending method is an easy and economical method in modifying oil or fat, with the aim of increasing the melting point of oil obtained as desired, because the fatty acid content of the mixed oil has a fatty acid composition with a high melting point [2].

In Riau Province, Kampar district was designated as a center for catfish development, where the production of catfish produced by Kampar district was around 57,868.63 tons. [3]. So far, the catfish processing industry that has developed in Riau is fish fillets and smoked fish. The byproducts are lumps of fat, head, viscera, and leftover meat on the bone, generally discarded. Therefore it is necessary to utilize these byproducts in an effort to develop the food industry with the zero waste concept.

Catfish are a source of fish oil with a yield of around 12.11%. with the content of the dominant fatty acids are omega-9 fatty acids (oleic acid) with levels of 20.34% of the total fatty
acids. Omega-9 fatty acids (oleic acid) are part of monounsaturated fatty acids (MUFA), which recently attracted the attention of scientists [4]. Recent research has shown that omega-9 plays a very important role in human health [5]. Processing fish oil rich in omega-9 from the byproducts of fillet processing is one of the efforts to increase the economic added value of catfish. Given its easily oxidized nature, the omega-9 rich catfish oil needs to be stabilized by encapsulation techniques and blended with red palm oil. Encapsulate catfish oil rich in omega-9 and red palm oil can be applied to various food products to improve public health.

Given that Riau Province is a potential producer of catfish and palm oil, special research is needed in order to exploit this potential. Therefore this study was designed to extract omega-9 fatty acids from the byproducts of the fillet processing industry and smoked fish industry then mixed with red palm oil by encapsulation. The objective of this study was to utilize the byproduct of the processing of catfish fillets and the specific objectives doing extraction of fish oil rich in omega-9 of byproducts derived from the industrial processing of fillets and catfish smoke, blending red palm oil and fish oil pangasius as encapsulation, and chemical, and sensory quality tests, and profiles of fatty acid blending of red palm oil and catfish oil.

2. Materials and Methods

2.1. Material
The main material used in this study was catfish obtained from the businessman of catfish and red palm oil in Riau province. The by-products used are part of belly fat and stomach contents.

2.2. Research Procedure
This research was conducted by experimental methods in Table 1

| Tabel 1. Processing process blending palm oil and encapsulated fish oil |
|-------------------------|-----------------|-----------------|
| Input | Process | Output |
| Production process | 1. Extracting catfish oil from the side results of processing catfish fillets | 1. He obtained blending of red palm oil and encapsulated catfish oil |
| Blending of red palm oil and encapsulated catfish oil | 2. Perform encapsulation of red palm oil and catfish oil produced | 2. Organoleptic data (color, texture, taste and ash) |
| | 3. Perform organo-leptic and chemical quality tests for blending of red palm oil and encapsulated catfish oil | 3. Data on chemical properties (saponification rates, acid numbers, iodine numbers and fatty acid profiles) |

2.3 Procedure Analysis

2.3.1 Organoleptic
Sensory (organoleptic) tests of color, smell, taste and general acceptance of omega-9-rich fish oil and instant porridge will be carried out with 30 panelists. Tests are carried out based on the level of preference with a score of 1 - 7, where a score of 7 states very like, 6: likes, 5: somewhat likes, 4: neutral, 3: somewhat dislike, 2: dislike, even 1: very dislike.
2.3.2 Chemical Analysis
Analysis of the chemical properties of fish oil rich in omega-9 extracted from catfish byproducts including saponification rates, iodine numbers, and acid numbers and fatty acid profiles carried out [6].

2.4 Analysis of catfish oil encapsulation
The recovery of encapsulated oil of catfish is rich in omega-9 calculated by the formula $X = \frac{\text{weight of oil encapsulate (g)}}{\text{weight of by-product (g)}} \times 100\%$.

3. Result and Discussion

3.1 Rendement
The percentage of catfish oil is calculated by comparing fish oil produced with the initial weight of fish byproducts so that the percentage of fish oil yield is obtained. The yield of catfish oil is carried out using extraction temperature 80 - 100 °C for 60 minutes. The results showed that the yield of catfish oil was 12.1%.

3.2 Characteristics of catfish oil
The physical characteristics of Siamese catfish oil produced are brownish yellow and less thick; while the chemical characteristics of the analysis of the quality of fish oil were carried out, the following results were obtained:

| Parameters               | Value      |
|--------------------------|------------|
| Oil content              | 121.05 gr  |
| Saponification Number    | -295.361   |
| Iodine number            | 80.334     |
| Acid Number              | 0.05       |

From Table 2 above, it can be seen that Siamese catfish oil has an oil content of 121.05 gr, saponification rate of -295.361, iodine number 80.3344 and acid number 0.05. The saponification rate is defined as a reaction that occurs due to the boiling process of oil / fat with alkyl compounds and then acidification of the resulting solution is then obtained by glycerol and a mixture of fatty acids. The saponification number or the number of mg KOH needed to soap 1 g of fat obtained from the results of this study is 295.36 mg/gr. Determination of rate of sapling is done to determine the nature of oil and fat. Testing these properties can be used to distinguish between one fat and another. In addition to knowing the level of rancidity, it’s easy to experience rancidity or not. The higher the saponification number means the higher the fatty acid so that the oil is easily rancid.

The iodine number can indicate the degree of unsaturation of oil or fat and can also be used to classify “drying” oils and "non-drying" oils. Type of oil dries (drying oil) is oil that has the properties that can dry out if exposed to oxidation, and will turn into a thick layer, thick and form a type of membrane if left in the open air. The term "half-drying oil" is oil that has slower drying power [7].

Determination of iodine numbers in this study aims to determine the number of double bonds contained in fish oil. The results showed that iodine content in Siamese catfish was 88.41 mg / gr, this content was still far below the FDA standard iodine quality standard, which was a maximum of 210 mg/gr.

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Acid numbers are used to measure the amount of free fatty acids contained in oil due to hydrolysis reactions such as chemical reactions, heating, physical processes or enzymatic reactions. The amount of acid depends on the purity and age of oil or fat. The acid number obtained from the results of research on Siamese catfish oil is 0.46 mg / gr; means that it is still below the maximum limit for FDA free fatty acids which is 1.5 mg / gr.

Large numbers of fatty acids indicate the formation of large free fatty acids from oil hydrolysis or due to poor processing. In addition, the presence of free fatty acids is usually used as an initial indicator of fat damage, because free fatty acids are more easily oxidized when compared to their esters. The quality of an oil is influenced by the free fatty acids contained in the oil. The higher the free fatty acid, the lower the quality of the oil, because free fatty acids produce unpleasant flavor in the oil.

3.3 Encapsulation of oils

Microencapsulation process using a spray dryer. The process condition uses the inlet 180C temperature parameter and 90C outlet temperature. The air flow velocity is 20 minutes and the emulsion flow rate is 5 mL / minute. The encapsulation formulation used is the filling material is maltodextrin and twin with a ratio of 1:1. The composition is as follows: The desired volume of solution is 500 mL one time process. Comparison of the material to be overlaid is filled with fillers 1:1, the remaining distilled water as a solvent.

In this study the composition of the material to be coated was 66.66 grams of oil, 30 grams of maltodextrine and 30 grams of protein isolates, distilled water as a solvent was added until the emulsion volume became 500 mL. The results of microencapsulation on samples used in fish oil are fine grain forms with particle sizes of 0.3 - 0.2 um.

The results of this encapsulation process are expected to reach 75%, but in the process there is a loss of encapsulation results because of the attachment to the surface of the drying tube and also wasted through the air flow. The results of the encapsulation of catfish oil using a combination of maltodextrin coating and soybean protein isolates produced a yield of about 60%.

3.4 Profile of Fatty Acids

The profile of blending fatty acids of red palm oil and catfish oil with various ratios can be seen in Table 3 below.
Table 3. Profile of fatty acid blending of red palm oil and catfish oil Encapsulated

| Fatty Acids                  | Ratio Blending MSM and MIP |
|------------------------------|----------------------------|
|                              | 50 : 50                    |
| C12:0 (laurate)              | 0.14                       |
| C14:0 (Meristate)            | 0.52                       |
| C16:0 (palmitate)            | 27.09                      |
| C18:0 (stearate)             | 2.95                       |
| C20:0 (arachidate)           | 0.22                       |
| C22:0 (Behenic)              | 0.1                       |
| Σ SFA                       | 31.02                      |
| C14:1 meristoleate)          | 0.05                       |
| C16:1 (Palmitoleate)         | 2.91                       |
| C18:1 (Olate)                | 37.14                      |
| C20:1 (Eicosanoate)          | 0.04                       |
| C24:1 (Mervanoate)           | -                          |
| Σ MUFA                      | 40.14                      |
| C18:2 (linoleate)            | 17.26                      |
| C18:3 (linolenate)           | 0.71                       |
| C18:3 (gama-linolenate)      | 0.23                       |
| C20:2 (Eikosadienaet)        | 0.28                       |
| C20:3(eikosatrionate)        | 0.35                       |
| C20:4 (Arachidonate)         | 0.24                       |
| C20:5 (Eicosapentanoate)     | 0.02                       |
| C22:2 (Decasadienete)        | -                          |
| C22:6 (Dokosaheksanoate)     | 0.06                       |
| PUFA                        | 19.15                      |
| Saturated Fatty Acids        | 18.56                      |
| Unsaturated Fatty Acids      | 59.29                      |
| Omega 3                     | 0.79                       |

In Table 3, it can be seen that the most saturated fatty acids are found in the blending ratio of 50: 50, which is 31.02% and the lowest in the 60: 40 ratio of 18.56%. Based on the length of the chain, saturated fatty acids found in the blending of fish oil and palm oil are included in the long chain saturated fatty acid group; where one of the most dominant types of saturated fatty acids is palmitic acid. Palmitic acid in the blending of fish oil and palm oil ranges from 14.46 - 27.09%. In terms of nutrition, palmitic acid is an important source of calories but has a low antioxidant power.

Furthermore, unsaturated fatty acids from blending fish oil and palm oil are more than saturated fatty acids. The degree of unsaturation of unsaturated fatty acids is divided into 3 groups, namely monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) [4]. In Table 2 monounsaturated fatty acids (MUFA) blending of fish oil and palm oil ranges from 30.39 - 40.14%; whereas polyunsaturated fatty acids (PUFA) range from 9.29 - 19.15%. Unsaturated fatty acids are considered better nutritional value because they are more reactive and are antioxidants in the body. Unsaturated fatty acids are also very useful for maintaining body health and maintaining cholesterol levels.
4. Conclusion
The yield of catfish oil was carried out using extraction temperature 80 - 100 °C for 60 minutes, with the yield of catfish oil by was 12.1%. The results of the analysis of the composition of catfish oil fatty acids obtained total SFA, MUFA, PUFA, EPA and DHA of 26.79%, 25.47%, 10.38%, 0.73%, 2.53%, respectively. The level of Siamese catfish oil obtained is high compared to other freshwater fish, and the quality of catfish oil in this study is still below the FDA's maximum standard (Food and Drug Administration), which means the quality of fish oil is still good. The results of the encapsulation of catfish oil using a combination of maltodextrin coating and soybean protein isolates produced a yield of about 60%.

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