

Liquid Soap Production from Catfish (*Pangasius hypophthalmus*) Fat Waste

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Abstract

Catfish (*Pangasius hypophthalmus*) fat is a waste that has not been used optimally, especially in the use of soap. This study aimed to determine the effect of operating conditions are temperature, reaction time, and the ratio of volume between catfish oil and KOH. Soap can be formed by saponification reaction with strong alkali by hydrolyzing catfish oil with variations in the volume ratio of reactants (1:2, 1:3 and 1:4), temperature (75 °C and 95 °C) and reaction time (45 minutes and 75 minutes) with a constant stirring speed of 300 rpm. In the variation of the volume ratio of reactants, temperature and reaction time carried out in this study, a good liquid soap obtained is the volume ratio of reactants 1:3, temperature 75 °C and reaction time 45 minutes with pH 9.3 and free fatty acid 2.27%. The soap products produced have met SNI No. 06-4085-1996.

Keywords: *Pangasius hypophthalmus* Fat Waste, Saponification, Temperature, Reaction Time, Liquid Soap

Abstrak

Lemak ikan patin merupakan limbah yang belum dimanfaatkan secara optimal terutama dalam pemanfaatan untuk pembuatan sabun. Penelitian ini bertujuan untuk mengetahui pengaruh kondisi operasi yaitu temperatur dan waktu reaksi serta rasio volume antara minyak ikan patin dan KOH. Sabun dapat terbentuk melalui reaksi saponifikasi oleh basa kuat dengan cara menghidrolisis minyak ikan patin dengan variasi rasio volume reaktan (1:2, 1:3 dan 1:4), temperatur (75 °C dan 95 °C) dan waktu reaksi (45 menit dan 75 menit) dengan kecepatan pengadukan konstan 300 rpm. Pada variasi rasio volume reaktan, temperatur dan waktu reaksi yang dilakukan dalam penelitian ini, maka diperoleh sabun cair yang baik adalah rasio volume reaktan 1:3, Temperatur 75 °C dan waktu reaksi 45 menit dengan pH 9,3 dan kadar asam lemak bebas 2,27%. Produk sabun yang dihasilkan telah memenuhi standar SNI No. 06-4085-1996.

Kata kunci: Lemak Ikan Patin, Saponifikasi, Temperatur, Waktu Reaksi, Sabun Cair

INTRODUCTION

Catfish (*Pangasius hypophthalmus*) is one of the results of aquaculture that produces waste from its consumption. Catfish are mostly used in daily consumption by the people of Indonesia. A high level of consumption of catfish increases the amount of waste produced. Catfish have high fat content. Catfish fat can be used and further developed for its use, this is due to the high oil content when extracted [1]. The most produced waste from catfish is fat which is mostly found in the stomach of catfish [2]. Fish oil consists of the composition of fatty acid triglycerides,

monoglycerides, diglycerides, and free fatty acids [3]. Catfish fat will cause odor pollution caused by decomposition of proteins by bacteria and microorganisms that are abundant in the entrails of fish [1].

Catfish fat is useful because it contains saturated fatty acids such as oleic acid, stearic acid, and the most dominant palmitic acid [4]. Fatty acids contained in fish when reacted with alkali can produce soap through saponification reactions [5,6]. Besides being used as raw material for biodiesel,

catfish fats which have become fish oil can also be used to make bath soap, liquid soap and or shampoo.

Soap can be obtained from the reaction of fish fat waste after being converted to oil through treatment and heating. Fish oil as raw material can be soaped by adding Sodium Hydroxide (NaOH) or Potassium Hydroxide (KOH) [7]. The saponification reaction can produce solid soap and liquid soap. The type of soap depends on the alkali used [8]. Liquid soap can be formed when fatty acids are reacted with KOH [9]. Soap produced from the fat of catfish can be utilized by the community and has a sale value.

The research on catfish fat waste carried out previously was to determine the characteristics of fatty acid content and the manufacture of biodiesel. Research on the use of catfish fat into liquid soap has not been done. Therefore to maximize the potential of catfish fat waste and reduce pollution due to waste, this research needs to be done. The purpose of this study was to determine the effect of the ratio of the volume of reactants, temperature, and reaction time to yield, free fatty acids and pH of soap.

MATERIALS AND METHODS

Materials

Catfish fats used in the study were obtained from fish traders at Pasar KM 5 and bagasse from street vendors in Palembang City, South Sumatera. The chemical NaCl is used for the degumming process and KOH is used for the saponification reaction. The fatty acid content and fat characteristics of catfish are summarized in Table 1 and Table 2.

Methods

Catfish fat is cleaned and weighed 1 kg. Catfish fat is cut into small pieces with a knife and then heated for 2 hours at 47 °C to produce fish oil and fish fat. The fat that has been turned into fish oil is filtered with filter paper and stored in the container. Catfish oil is mixed with 15% NaCl solution of oil weight. The oil mixture is heated for 15 minutes at 70 °C accompanied by stirring. The heating results are put into a separating flask to separate fish oil with water and impurity for 24 hours. Fish oil is added with bagasse which has been dried in the oven at 100 °C to vaporize water that is still lagging for 3 hours and

mashed with a blender then sifted with a 35 mesh sieve [10]. Fish oil is left to stand for 24 hours then filtered with filter paper.

Catfish oil is heated to a temperature of 70 °C. KOH is mixed into catfish oil with a volume ratio of 1:2, 1:3 and 1:4 at a temperature of 75 °C and 95 °C and a reaction time of 45 minutes and 75 minutes with constant stirring of 300 rpm. The soap formed is separated by glycerol as a by-product using separating flask. Soap quality analysis refers to SNI No. 06-4085-1996 [11].

RESULTS AND DISCUSSION

Analyses of raw material

Before reacting with KOH, an initial analysis of catfish fat was carried out. The catfish fat that has become oil is illustrated in Figure 1. Based on the analysis, the fatty acid content and raw material characteristics can be seen in Table 1. The highest fatty acids are oleic and palmitic. The main characteristics of catfish oil are free fatty acid levels, moisture content, low specific gravity and melting point.

Table 1. Fatty Acid Content in Catfish Fat

Parameter	Percentage (%)
Fatty acid composition	
Saturated fatty acids :	
Butyric (C4-0)	0
Kaproat (C6-0)	0
Caprylic (C8-0)	0
Kaprat (C10-0)	0
Lauric (C12-0)	0.17
Miristic (C14-0)	5.28
Palmitic (C16-0)	30.1
Stearate (C18-0)	6.88
Unsaturated fatty acids :	
Oleic (C18-1)	32.3
Linoleic (C18-2)	9.97
Linolenic (C18-3)	1.62



Figure 1. Catfish Fat and Oil

Table 2. Characteristics of Catfish Fat

Parameter	Result	Unit
Boiling point	47	°C
Free fatty acid	0.54	%
Water content	1.33	%
Density	0.87	g/mL

Yield

Soap produced by varying the volume ratio of reactants shows that the greater the volume ratio of reactants, the more soap produced. This is because many fatty acids bind to KOH. Soap products are shown in Figure 2.



Figure 2. Liquid Soap

The volume ratio of the reactants used is calculated based on the reaction stoichiometry with the amount of volume KOH used is greater than the volume of oil so that the oil can be fully soaped [12].

Figure 3 shows that the highest soap yield is at 95 °C and the lowest soap yield is at 75 °C. The increase in temperature will cause a reaction due to the collisions of reactant molecules that move more actively because they get energy. Rising temperatures

will increase the conversion of reactants so that the resulting soap increases.

The longer the reaction time the higher the yield of the yield. But if the reaction has reached equilibrium then increasing reaction time will not increase yield. If the reaction passes through the optimum point of reaction time, the conversion of reactants to products will decrease which results in low yields.

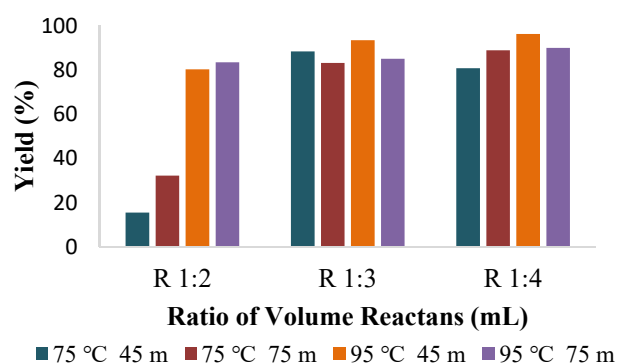


Figure 3. Yield of Soap

Free fatty acids (FFA)

Free fatty acids are fatty acids in soap that are not bound as potassium compounds or triglyceride compounds. The formation of free fatty acids in soap occurs because fatty acids do not react in the reaction of saponification to soap. Good free fatty acids on the soap in accordance with those required by SNI 06-3532-1994 which is <2.5% or <0.5 mg KOH/g accordance with FAO [13]. This test is carried out to determine the levels of free fatty acids in soap.

Figure 4. It can be seen that the greater the ratio of reactants, the more fatty acids that bind to KOH to form soap, so as to minimize the levels of free fatty acids in the soap [14]. The highest free fatty acid levels were in the volume ratio of reactants 1:2 (50

mL of catfish oil and 100 mL of KOH solution) and the lowest free fatty acid levels at the volume ratio of reactants 1:4 (50 mL of catfish oil and 200 mL of KOH solution).

Figure 4. It can be seen that the higher the reaction temperature, the lower the level of soap-free fatty acids because the molecular kinetic energy will increase, so the molecules will often move. Molecules that move more often result in collisions that produce a reaction, so the reaction takes place faster. But if the reaction temperature is too high (past the optimum point) it will cause the oil to be hydrolyzed into free fatty acids, so that the levels of free fatty acids increase. The highest fatty acid level at a temperature of 95 °C and the lowest free fatty acid level at a temperature of 75 °C.

Figure 4. It can be seen that the longer the reaction time the lower the level of soap-free fatty acids, the highest free fatty acid levels at reaction time 45 minutes and the lowest free fatty acid levels at the reaction time of 75 minutes. This is due to the increase in temperature so that the molecules will often move so as to increase the occurrence of collisions so that the levels of soap-free fatty acids can be minimized.

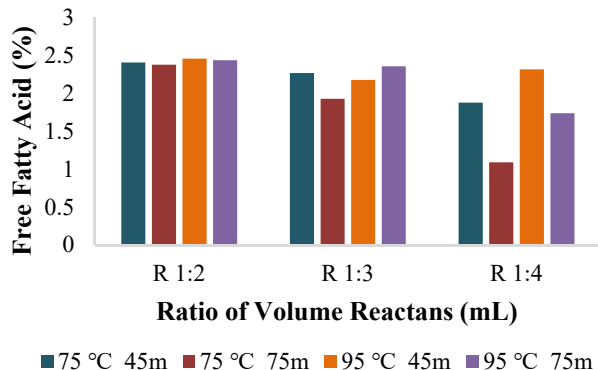


Figure 4. FFA Content of Liquid Soap

pH

The pH test is carried out to determine the pH value of soap. pH of soap generally has a pH value of 8.0-11 in accordance with SNI 06-4085-1996 [11]. The pH of the soap that is too high will cause irritated skin and be harmful to skin health [15].

Figure 5 shows that the greater the ratio of reactants, the lower the pH. This is because the KOH used reacts perfectly with free fatty acids in the oil, so the KOH residue gets lower and the soap is no longer too alkaline. The highest pH on the volume ratio of reactants 1:2 (50 mL of catfish oil and 100 mL of KOH solution) yields 10.1-11.4 and the lowest pH at the volume ratio of raw material 1:4 (50 mL of catfish

oil and 200 mL of KOH) yields 9.5-10.7 and the lower the reaction temperature the lower the pH of the soap because the water is neutral so that the high water content causes the concentration of soap and pH decrease. The temperature and reaction time are directly proportional to the pH of the soap produced (the higher the temperature and reaction time the pH of the soap increases).

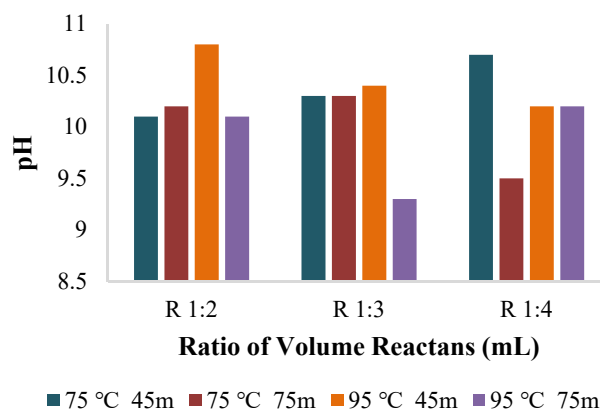


Figure 5. pH of Liquid Soap

CONCLUSION

Variations in the volume ratio of reactants, temperature and reaction time affect the soap formed. Liquid soap is well formed in variations in the volume ratio of reactants 1:3, temperature of 75 °C and reaction time of 45 minutes with the results of water content of 8%, pH 9.3 and free fatty acid levels of 0.44%. All samples produced are in accordance with SNI 06-4085-1996.

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