Margarine from RBDPO in Stirred Tanks with Cooling Jacked

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Abstract. The use of RBDPO ingredients for margarine has a positive impact on the increasing value of palm oil, margarine is a promising product to be developed on food industry. It is necessary to have a technology for margarine production process. The purpose of this study using the stirred tanks with cooling jacked to determine the optimum conditions of stirring and length of time in making margarine from palm oil derivatives form RBDPO. The parameters measured to determine the optimum conditions of stirring tank with variations of 50 rpm, 100 rpm, 150 rpm and the length of stirring time at15 minutes, 30 min, 45 min, 60 min. The analysis of the margarine products were includes free fatty acid content, water content, melting point and organoleptic. The results of the study obtained the optimum conditions of the stirring stirred tank process of 150 rpm, a stirring time at 60 min, temperature at 2 °C, margarine analysis results has free fatty acid content of 0.09%, a water content of 13.31%, a melting point of 37.75%, and organoleptic has test results that stated normal in color, smell, and taste.

Keywords: Margarine · RBDPO · Stirred Tank · Stirring Speed · Length of Stirring Time

1 Introduction

Palm oil, which is one of the leading commodities in Indonesia, continues to adapt according to its needs. In the food sector, palm oil which is processed into palm oil or in other words *Crude Palm Oil* (CPO) is processed again through several stages in the form of *degumming, bleaching, deodorization* which the next one will produce RBDPO (*Refined Bleached Deodorized Palm Oil*). RBDPO is rich in palmate acid and oleic acid, and is semi-solid and at a temperature of 20oC forms solids so that it can be used as raw material for making margarine [6]. Margarine according to the definition of SNI 01-3541-2002 is an emulsion (w/o) food product, both semi-solid and liquid made from food fats and or vegetable edible oils, with or without chemical changes including hydrogenation, interesterification, and having gone through a purification process, as the main ingredient and contains water and food additives that is allowed.

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In the process of making margarine, efforts are also needed to processing of fats and their mixtures. From the literature study, at least three types of methods were obtained for the process of converting liquid fat into solid fat or semi-dense, namely blending, hydrogenation, and interesterification. The blending method is physical mixing that is carried out with high-speed stirring and takes quite a long time. Interesterification method which is a reaction of exchange of acyl groups contained in triglyceride compounds at random, so that new triglycerides with a more stable structure are produced and the process can only take place at low temperatures. Then the hydrogenation method is the addition of hydrogen to triglycerides with the help of a Ni, Pt or Pb catalyst to change from a liquid state to a semi-dense one, but in the process Enzygenation can also lead to the onset of Trans saturated fatty acids that can cause coroner's heart disease [7]. Of the three types of methods, each process has disadvantages and advantages based on four aspects, namely, aspects of product stability, equipment economy, operating conditions and toxicity of the material. If the three methods are compared for use in medium to small scale industrial production (IKM) in terms of these four aspects, then the method blending is very appropriate to use. This is because the mixing temperature can be done until it reaches the maximum room temperature with a stirring speed in the range of 50–400 rpm, then there is little possibility of toxicity aspects Material because the process is only carried out with safe materials without special treatment under *batch* conditions.

Several studies have tried to use stirred tanks for hot conditions of 55 °C, 100 rpm, 30 min and three series of stirred tanks for cold conditions (tank operating conditions 1: 39.5 °C, 490 rpm; tank 2: 32.1 °C, 490 rpm; tank 3: 28.1 °C, 490 rpm) to make margarine from RBDPO which produces the best value of free fatty acid test 0.18%, moisture content 97.3%, *slip melting point* 35–36 °C, and organoleptic results close to merial coaxial margarine [8]. In addition, the manufacture of margarine from RBDPO using *mixing* tanks (mixing temperature 65 °C for 15 min) and tubes twice with temperatures of 24 °C and 16 °C, resulted in the best value test of free fatty acids of 0.105%, moisture content of 16.7%, *slip melting point* of 36.3 °C, and organoleptic results close to commercial margarine [8]. Based on this, considering that tools designed for medium to small industrial scale margarine production, must be balanced in a way that streamline the process both in terms of tools and materials used in order to get products that are in accordance with standards. Therefore, a tool design will be carried out in the form of a stirred tank equipped with a *cooled stirred tank* that is flowed through a screw pipe, a tool this serves to streamline the process so that after leaving the tank, margarine can be directly printed and packed or can be directly applied to products which uses margarine ingredients. As for this study, which was reviewed in the form of variations in the speed of stirring against the length of time of stirring in terms of the quality of margarine made from RBDPO with combined parameters of the National Margarine Standard (3541:2014) and the margarine standard from PT SMART Tbk in Table 1.

2 Research Methods

Research variables in this study is in the stirring speed of 50 rpm, 100 rpm, and 150 rpm. Furthermore, gth of the stirring time of 15 min, 30 min, 45 min, and 60 min. While the analysis of margarine product are free fatty acid content, water content, melting point and organoleptic.

Table 1. Margarine Quality Standards

No.	Test criteria	Unit	Requirement
1.	Circumstances:		
1.1	Construction	–	Normal
1.2	Color	–	Normal
1.3	Taste	–	Normal
2	Moisture content (w/w)	%	Max. 18
3	Fat content (w/w)	%	min. 80
4	Free fatty acids	%	max.0,1
5	Slip melting point	°C	35–39

source: SNI 3541–2014 and PT SMART Tbk Standards

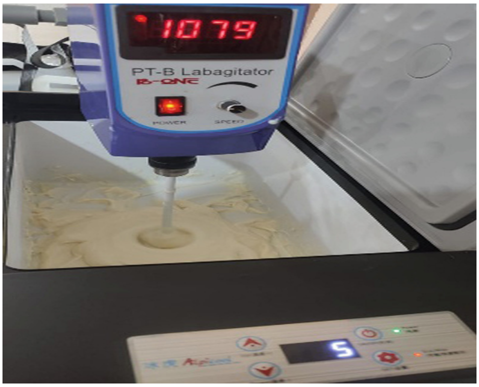

Fig. 1. The Cooled Stirred Tank

2.1 Materials and Instrument

The raw material used was RBDPO. The other supporting raw materials are lecithin, water, salt, BHT, and dyes. The instrument used in this research are a set of Cooled Stirred Tank (Fig. 1).

3 Results and Discussion

Technical analysis on *cooled stirred tanks* equipped with cooling circulation is carried out to determine the technical feasibility of each component of the stirred tank tool. The technical analysis carried out includes the dimensions of the tube, the power used, the influence of rotation speed, the length of stirring time, as well as the analysis of the quality of the margarine products produced in the form of free fatty acid content, water content, melting point, and organoleptic.

Fig. 2. RBDPO-Based Margarine Products

In this stirred tank tool also on the outer side there is a circulation of water flowed through a capillary pipe that is threaded around the outer side of the stirred tank, in this case the water flowed is low temperature due to the manufacture of margarine products. The low temperature is obtained by using ice cubes and assisted by pump components to drain water from the water storage box, as well as set with electro components so that the temperature remains constant with a range of ±2 °C.

The *Cooled Stirred Tank* equipment can be seen from the quality of the margarine produced on the influence of stirring speed and the length of stirring time that is varied to produce margarine products that are close to the appropriate quality standards. The following is a picture of margarine products produced in this study (Fig. 2).

The resulting margarine product is yellow in accordance with the SNI margarine. The yellow color produced in this margarine product is obtained from carotene in CPO. Carotene is a natural color pigment, in CPO the carotene content ranges from 0.03% [9]. The organoleptic odor and taste show normal results such as market margarine and according to SNI margarine.

3.1 Effect of Free Fatty Acid (FFA) Levels in Margarine by Speed and Length of Stirring Time

In this study, the method used to analyze free fatty acid levels in margarine was AOCS Ca 5a-40 1997. The data obtained are stated in Fig. 3.

On the chart, it can be seen that the speed of stirring and the length of time of stirring have an influence on the ALB levels in margarine. Stirring is carried out in order to increase the contact between the substances you want to dissolve with the solvent until a high degree of homogeneity is obtained. The always low stirring speed causes contact between substances not to run optimally as the result in variations with a speed of 50 rpm, which indicates a percent of higher ALB levels high compared to speeds of 100 rpm and 150 rpm. However, if the stirring rotation is faster, it will increase the heat transfer that occurs at a certain time and the greater the contact of the material with the solvent, the result is gained will increase further. In addition, the use of too fast rotation results in shorter contact between the material and the solvent. So that before the material and solvent bind perfectly, the bond is released back [5].

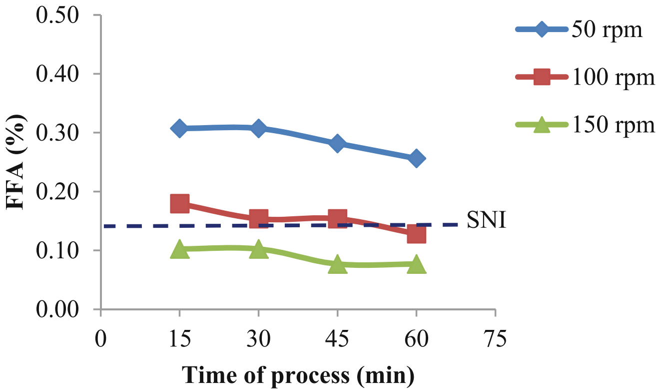

Fig. 3. Effect of FFA Levels OF Margarine on Speed and Length of Stirring Time

Margarine standards produced by PT Smart Tbk. is a maximum value of 0.1%, from the results of product analysis produced at a variation of 150 rpm all samples meet the standard, except for variations of 50 rpm and 100 rpm which produce a percentage of ALB levels respectively at range of 0.31% to 0.26% and 0.18% to 0.13%. The cause of the high ALB value as the stirring speed increases is due to the hydrolysis process. Hydrolysis is the decomposition of substances in chemical reactions caused by water. Due to the insolubility of water in the oil phase, it will produce free fatty acids and glycerol [8]. The more optimal the stirring time and the magnitude of the stirring speed, the more homogeneous the oil and water phases. In addition, the ALB levels in the margarine products produced can also be caused by CPO which has an ALB level of less than 5%. CPO in this study was used to produce natural colors in margarine.

3.2 Effect of Moisture Content of Margarine on Speed and Length of Stirring Time

Analysis of water content in margarine products produced using the SNI margarine method (SNI 3541: 2014). The water added to the margarine formula is 15.8% and this value has been adjusted to the requirements of margarine products based on margarine SNI, which is a maximum of 18%. The following are the results of the analysis of water content in margarine products produced from *the cooled stirred tank* tool listed in Fig. 4.

The moisture content of margarine products made with variations in stirring speed and length of stirring time provides analysis results with levels of 15.75% to 12.78%, and all of these levels meet national margarine standards and the results are also not too different in each difference in the variation in the length of time of stirring. However, from the graph, it can be analyzed that the faster the stirring and the longer the stirring time can reduce the moisture content. This is due to the stirring carried out increasing the contact between the oil phase and the water phase until a high degree of homogeneity is obtained. The oil phase and the water phase can be homogeneous due to the presence of relief from lecithin. Lecithin is a good emulsifying agent or emulgator because the hydrophobic tip of its structure can dissolve in the oil phase and the end of its structure

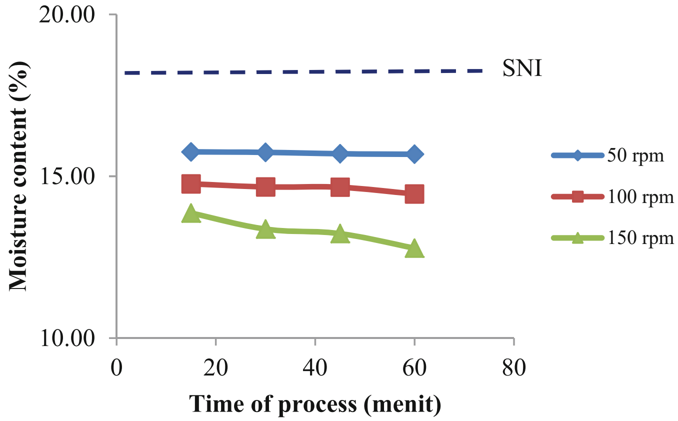

Fig. 4. Effect of Water Content on Speed and Length of Stirring Time

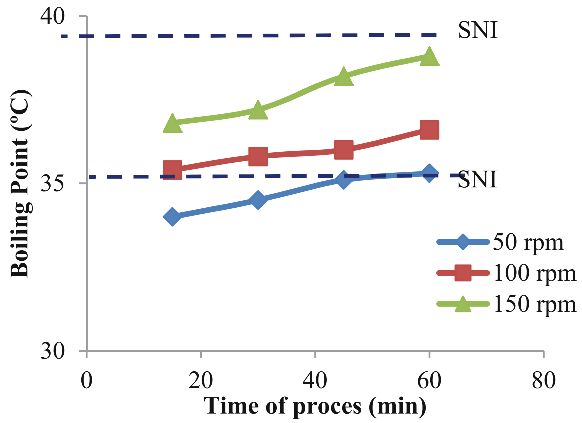

Fig. 5. Effect of Melting Point on Speed and Length of Stirring Time

which is hydrophilic is water-soluble [4]. Therefore, lecithin can create an oil phase and a water phase in an emulsion system so that it becomes more stable.

3.3 Effect of Margarine Melting Point on Stirring Speed and Length of Stirring Time

The method used for the analysis of the melting point of margarine is AOCS Cc 3-25 2005, the following are the results of the analysis of the melting point of margarine made using a *cooled stirred tank* tool shown in Fig. 5.

Based on Fig. 5, margarine products produced at stirring speeds of 50 rpm, 100 rpm, and 150 rpm with a stirring duration of 15 min to 60 min are at temperatures of 34.0 °C to 38.8 °C, which means that all samples meets the margarine quality standards from PT Smart Tbk which are in the range of 35 °C to 39 °C. However, when viewed from the *trend line* graph which shows that the longer the stirring time and the slower the stirring speed will result in a higher melting point. This can be caused by several factors that determine the liquid point of a product, including the average chain length of fatty acids, the longer the chain, the longer the chain, its liquid point is getting higher, then the position of fatty acids in the glycerol molecule and the relative proportion of saturated fatty acids and unsaturated fatty acids. The higher the proportion of unsaturated fatty acids, the lower the liquid point will be [8]. This is clearly seen when Fig. 5 of the melting point analysis results compared to Fig. 3 of the ALB analysis results, that the *trend line* of the value is resulted inversely proportional.

Raw material preparation is carried out by mixing oil and fat in the form of RBDPO, dyes, and lecithin in one mixing tank at normal temperature (room temperature ±27 °C) until it is completely mixed and becomes homogeneous for ±10 min. After the noodle phase is stable and homogeneous, the water phase is fed into the mixing tank. The water phase in the form of BHT, salt, and water must be homogenized first before being put into the mixing tank for ±5 min. Then stirring in the tank is carried out with a total time of 1 h for one variation of stirring. Samples are taken every 15 min to see the optimum operating conditions at the length of the stirring time. During the homogenization process of the oil phase and the water phase, a cooling process is carried out using cooling water which is flowed through the circulation of capillary pipes around the walls of the tank with a temperature of ±15 °C so that it becomes a margarine product. The resulting margarine products are then tested for quality with the parameters of free fatty acid content, water content, melting point and organoleptics which are then compared with SNI Margarine (3541: 2014) and margarine standards from PT SMART Tbk in Table 1.

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