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Optimization Of The Rotational Speed Of Homogenizers In The Production Of VCO Emulsion Using Soy Lecithin As The Emulsifier

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Abstract— This research aims to determine the optimum rotational speed of homogenizers in the production of VCO emulsion using soy lecithin as the emulsifier. This research began with determination of the rotational speed, where water and VCO were added into a measuring cup according to the predetermined volume, namely 80:20, which were then mixed and added with 0.5 gram of soy lechitin as the emulsifier and then stirred using different levels of speed. The parameters observed were pH, viscosity, and the creaming index of VCO emulsion. Findings of the research suggest that the optimum rotational speed was fairly stable in terms of viscosity and pH. However, in terms of the creaming index, further attempts are needed to avoid the formattion of creaming in the emulsion generated.

Keywords-component: w/o emulsion, natural emulsifier, soy lecithin, homogenizer

I. INTRODUCTION

The process of mixing (homogenization) is undertaken and required in many food, cosmetic, pharmaceutical, and other industries. Developments in the research into emulsion continue to grow as emulsion offers benefits, among other things is in the pharmaceutical industry in which emulsion formation can reduce odor and unpleasant taste of oil.

Homogenization is the process of converting two fluids that are immiscible (cannot be mixed) into emulsion. Homogenization in mixing, emulsification, and suspension technologies is known as an operation which essentially consists of two stages: first, droplet size reduction in the inner part phase and second, the simultaneous distributing of droplets into the continuous phase [1]. The tool designed to perform the emulsion process is called a homogenizer [2].

According to [3], things which need to be considered during the homogenization process are: (1) the fat globular diameter resulting from the homogenization process should not be too small (the newly produced globular surface is too large and (2) homogenization is carried out at a relatively high temperature (68-70 ^{o}C). The higher the homogenization temperature is, the fewer the membrane-forming materials required to form new membranes, (3) the addition of membrane-forming materials.

According to [4], factors that influence the droplet size generated by homogenization include the type of emulsion used, the temperature, characteristics of the phase components, and the input energy. The small droplet size generated by homogenization can increase the dispersed phase. As a result, viscosity increases and emulsifier absorption may increase as well. Insufficient emulsifier to cover droplets' surface will lead to coalescence. Emulsification also requires the right homogenization time. The intensity and duration of the mixing process depends on the time it takes to dissolve and distribute the materials to be mixed evenly.

Emulsifiers refer to substances which can maintain an emulsion system or substance to help maintain the stability of oil and water emulsion. Generally, an emulsifier is an organic compound having two functional groups, both polar and non-polar ones, allowing the two substances to mix.

Emulsifier can be defined as a compound having surface activities (surfactant) so as to reduce the surface tension between the air and liquid and liquid and liquid contained in a food system [5]. There are two types of emulsifier used in foodstuffs, namely natural and artificial emulsifiers. Examples of natural emulsifiers are lecithin and gum Arabic while the artificial ones are glycerol monostearate and polysorbate or Tween [6]. Research into VCO emulsion has been done by [7] using emulsifiers Tween 80 and Span 80. These two emulsifiers were combined to obtain stable VCO emulsion. The research obtained the comparison between Tween 80 and Span 80 by 40:60, with the ratio of water to VCO by 20: 80 at the following concentrations: 0.5%; 0.75%; 1% and the rotation time and optimum rotational speed by 4 minutes and 15000 rpm, respectively, which generated stable VCO emulsion.

Lecithin is one of the emulsifiers that actively reduces the surface tension in emulsion production. Crude lecithin is usually obtained from soybeans and egg yolks. This lecithin is a mixture of lipids (phospholipids) with phosphatidylcholine, ethanolamine, and inositol as the main components [8].

To make an energized drink with a tasty flavour from VCO emulsion, it is necessary to use a natural emulsifier and technology in the production of VCO emulsion. One of the economical options is the mechanical or agitating method using a homogenizer.

II. METHODOLOGY

A. *Research Instruments and Materials*

The main tool consisted of a set of VCO emulsion solution making tools which consist of an electric homogenizer Ultra Turrax T-25 and a sonicator. The equipment used included a dynamic viscometer Brookfield model DV-1 Prime for viscosity measurement and a digital pH meter to measure changes in the emulsion's pH.

Figure 1. Components of a Homogenizer

The main research material was VCO obtained from a VCO manufacturer based in Makassar (CV AVCOL Makassar). The natural emulsifier used was soy lecithin.

B. *Research Procedures*

To determine the rotational speed of the homogenizer, water and VCO were added to a measuring cup according to the predetermined volume, namely 80:20. Water and VCO were then mixed and 0.5 gram of emulsifier soy lecithin was added, then the process of homogenization was initiated using Ultra Turrax at different levels of rotational speed, namely 7,500; 10,000; 12,500; 15,000; 17,500; 20,000 and 22,500 rpm for 4 minutes, followed by sonication for 9 minutes. Afterwards, viscosity and pH prior to storage were measured. Subsequently, it was put into a 100 mL measuring cup and any changes occurring were observed for 1 x 24 hours. Moreover, stability and resistance of the emulsion were tested under stress conditions at a heat temperature by 35 ºC and a cold temperature by 5 ºC for 5 days, where the condition was changed every 12 hours. After that, measurement was undertaken once again in connection with the viscosity, creaming index, and pH after the cycle.

Creaming was determined using the following formula:

$$Creaming\ index = \frac{H_1}{H_0} x\ 100$$

Description:
H_1 = height of the creaming phase
H_0 = height of the total emulsion

III. RESULT AND DISCUSSION

A. *The Effect of the Rotational Speed of Homogenization on Viscosity*

In the present research, production of water emulsion using VCO was undertaken. The first variable was the rotational speed with the ratio of water to VCO by 80:20, where the emulsion solution refers to emulsion of oil in water. At this stage, the rotational speed was changed, using the same emulsifier. The emulsifier used was 0.5 gram of soy lecithin. Homogenization was undertaken using Ultra Turrax for 4 minutes at different levels of rotational speed, followed by sonication for 9 minutes. Afterwards, the viscosity and pH were measured and then it was left for 24 hours. Then, it underwent the stress cycle for 5 days under the following condition: at a hot temperature by 30 ºC for 12 hours and a cold temperature by 5 ºC for 12 hours. After that, its stability was observed and the amount of cream, viscosity, and the pH was re-measured. Based on the findings of the research, using variations in the rotational speed and emulsifier *soy lecithin*, the following results are generated:

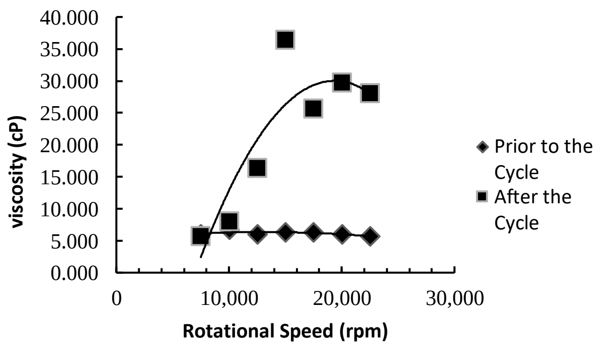

Figure 2. The Effect of the Rotational Speed on the Emulsion's Viscosity using the Emulsifier Soy Lecithin

Figure 2 shows that the speed of agitating will reduce the viscosity of the emulsion formed. Agitating is able to decrease the interfacial tension so as to widen the globular surface [9]. It is evident from the viscosity prior to the cycle which tended to decrease, but the viscosity after the cycle tended to fluctuate which means that the emulsion was unstable due to increased free energy. Agitating can expand the contact area by increasing the agitating speed thereby increasing the homogeneity of a mixture [10].

Agitating or agitation is a process that shows the induced movement of a material or mixture in which this agitation process will form a circulating pattern [11]. Circulation patterns affect the homogenization process. An increase in the speed and duration of agitating plays a role in emulsion formation and the stability level of emulsion [12].

B. *The Effects of the Rotational Speed on the Emulsion's pH*

In addition to changes in viscosity, another parameter that can be used to measure the stability level emulsion is pH. In this research, emulsion's pH was also studied at various homogenizer rotational speed levels with the addition of emulsifier *soy lecithin* to the emulsion before and after the cycle. The pH observation results are shown in Figure 3.

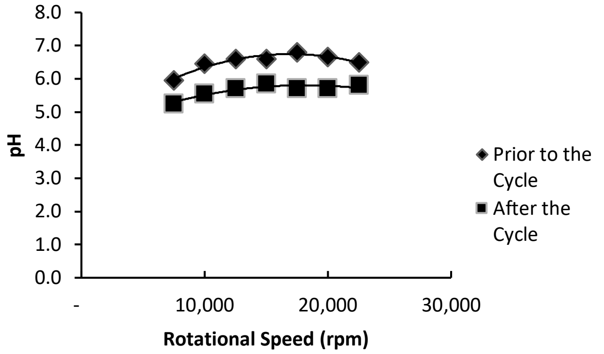

Figure 3. The Effect of the Rotational Speed on the Emulsion's pH using the Emulsifier Soy Lecithin

Figure 3 shows that pH values tend to decrease after storage. This is consistent with the findings presented in the graph which shows that pH values after the stress and storage cycles decrease. The decrease in pH can be attributed to microorganisms which grow rapidly in a suitable environment where these microorganisms convert carbohydrates and their derivatives into alcohol and carbon dioxide so as to trigger acid production [13]. pH that tends to be constant after the stress treatment indicates the stability of the emulsion. Based on the research findings, despite a decrease after the cycle, it did not differ significantly.

C. *The Effect of the Rotational Speed on the Creaming Index.*

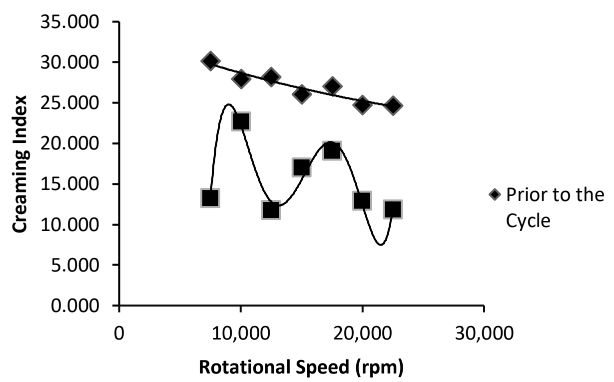

Figure 4. The Effect of the Rotational Speed on the Emulsion's Creaming Index using the Emulsifier Soy Lecithin

Based on Figure 4, there is a decrease in the creaming index or the existence of instability in the emulsion at the agitating speed by 10,000 rpm for 4 min, after it was left for 1 x 24 hours. However, at higher agitating speed by 22,000 rpm for 4 minutes, a small amount of creaming was formed. Based on these findings, it can be seen that the emulsion's stability will increase as the agitating speed increases. This is because higher agitating speed will produce a large amount of energy to make the emulsifier more capable of stabilizing water droplets in the emulsion preparation. Moreover, higher agitating speed can also decrease the size of emulsion globules which eventually increase the emulsion's viscosity so as to slow down the creaming rate of the emulsion.

IV. CONCLUSIONS AND SUGGESTIONS

The stability of VCO oil emulsion in water used natural emulsifier *soy lecithin* at different levels of rotational speed (rpm), namely 7,500; 10,000; 12,500; 15,000; 17,500; 20,000; and 22,500 rpm. Research findings suggest that the optimum condition of the rotational speed for viscosity, the pH and the creaming index of emulsion using emulsifier *soy lecithin* was obtained at the speed by 15,000 rpm for viscosity. In terms of pH, VCO emulsion is stable emulsion because despite a decrease in pH during the treatment period, the change is not significant. Meanwhile, in terms of creaming formation, the most stable emulsion has not been obtained.

The researchers suggest that future research should examine the best process or emulsifier to obtain emulsion which is stable in terms of the whole aspects.

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