Journal of Vocational Studies on Applied Research

The Effect of Rotational Speed of Homogenization on Emulsion Results Obtained Using Soy Lecithin Emulsifier

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Abstract - *Homogenization is the process of homogenizing particle size in an effort to maintain the stability of a mixture formed from 2 phases that cannot be fused or commonly called emulsions. This study aims to analyze the effect of homogenization speed and differences in solid concentration in homogenization process using homogenizer. The ingredients used are Virgin Coconut Oil as a solute, Aquadest as a solvent, and soy lecithin as an emulsifier. Several stages of analysis are density, viscosity, microscopic, and emulsion stability analysis. The results obtained from this study were optimum stirring speed of 22,000 rpm with optimum homogenization time of 4 minutes, solid concentration of 60% obtaining density of 0.78 gr/mL, viscosity of 5.86 cP, stability of 100%, and most stable microscope test. The results showed that the greater the stirring speed and time, the smaller the density and viscosity value produced and the greater the stability value obtained. The greater the concentration of solids, the greater the density, viscosity, and stability of the emulsion.*

Keywords *– emulsion, homogenization, homogenizer, virgin coconut oil*

Submission : April 27, 2021 Correction: April 30, 2021 Accepted: May 4, 2021

Doi: http://dx.doi.org/10.14710/jvsar.3.1.2021.14-17

[How to cite this article: Namira, Z.R., Paramita, V., and Kusumayanti, H. (2021). The Effect of Rotational Speed of Homogenization on Emulsion Results Obtained Using Soy Lecithin Emulsifier. *Journal of Vocational Studies on Applied Research, 3*(1), 14-17. doi: http://dx.doi.org/10.14710/jvsar.3.1.2021.14-17]

1. 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: (i) the fat globular diameter resulting from the homogenization process should not be too small (the newly produced globular surface is too large) and (ii) 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, (iii) 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.

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]. 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 [6].

The purpose of the study was to analyze the effect of homogenization speed and differences in solid concentration in homogenization process using homogenizer. It is necessary to study the influence of time, stirring speed, and concentration of solids on density, viscosity, stability, and microscopic. In this study, stirring speed was set at 18000 rpm and 22000 rpm, time 2 minutes and 4 minutes with solid concentrations of 40% and 60%. Homogenization in vegetable oils has been widely done. In this study, the raw material used is Virgin Coconut Oil.

2. Methodology

2.1 Materials

The main ingredient for this study was Virgin Coconut Oil which was purchased from Indrasari Chemical Shop Semarang and aquadest as solven as well as soy lecithin as an emulsifier to reduce surface tension in emulsion production.

The main equipment used in this study was the D-500 homogenizer. As for the purposes of analysis, used piknometer, viscosimeter ostwald, and microscope.

2.2 Procedure

2.2.1 Emulsification of Virgin Coconut Oil

The emulsification process of Virgin Coconut Oil is carried out by mixing VCO, aquadest, and soy lecithin into beaker glasses with solid concentrations of 40% and 60% and the ratio between soy lecithin and VCO is 1;16. After all the ingredients are mixed then done homogenization with homogenizer. The homogenization process is carried out at a speed of 18000 rpm and 22000 rpm for 2 minutes and 4 minutes. The composition of each sample is shown in Table 1.

Table 1. Composition of each Virgin Coconut Oil Emulsion Sample

Sample	Stirring Speed (rpm)	Stirring Time (minutes)	Solids Concentration (%)
1	18000	2	40
2	22000	2	40
3	18000	4	40
4	22000	4	40
5	18000	2	60
6	22000	2	60
7	18000	4	60
8	22000	4	60

3. Analysis

3.1 Density Analysis

Density measurements are performed to measure the density of emulsions formed using a piknometer [7]. Sample density is calculated using the formula:

$$\rho = \frac{mass\ pycnometer\ content - empty\ pycnometer}{pycnometer\ volume}$$

3.2 Viscosity Analysis

Viscosity analysis is conducted to see viscosity condition after homogenization. This analysis was conducted using the Ostwald Viscometer, where later the processed VCO is inserted into the Ostwald Viscometer, then sucks it with a suction ball to the upper limit mark. When the suction ball is released, calculate the time it takes for the fluid to reach the lower limit mark [8]. The viscosity of the sample can be calculated by the following formula.

$$\mu = \frac{\mathrm{t \times \rho}}{\mathrm{to \times \rho o}}\mu\mathrm{o}$$

3.3 Stability Analysis

Emulsion stability tests are conducted to determine the condition of the emulsion after processing with a predetermined and varied treatment. After homogenized observed emulsion stability for 24 hours and put in the refrigerator temperature 4° C. Further observations are made so that it can be seen if there is separation during the observation time [9]. Performed calculations using formulas:

$$\text{creaming index} = \frac{\text{height of the creaming phase}}{\text{height of the total emulsion}} \times 100\%$$

3.4 Microscopic Analysis

This microscopic analysis refers to research conducted by Suprobo & Rahmi [10], which has been adapted. In the emulsion that has been formed microscopic testing using a microscope so that it can be known the particle size of the emulsion that has been produced is uniform. Where the smaller the particle size indicates the emulsion formed is stable.

4. Results and Discussion

In this study aimed to homogenize Virgin Coconut Oil and aquadest with soy lecithin as an emulsifier with variations in length of time, stirring speed, and concentration of solids against density, viscosity, stability, and microscopic values.

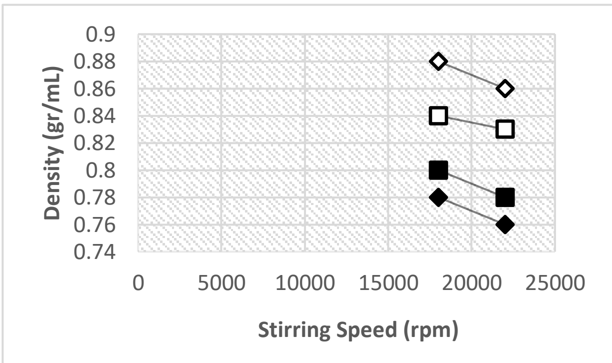


Figure 1. The Effect of Stirring Speed, Time, and Concentration of Solids (◇ 40% (2 minutes); □ 60% (2 minutes); ◆ 40% (4 minutes); ■ 60% (4 minutes)) against Density

Can be seen in Figure 1. That the longer the stirring time and the increasing stirring speed will decrease the density value [11]. The higher the emulsifier concentration added to the VCO emulsion will increase the overall emulsion weight [12]. Density is directly proportional to viscosity. The greater the density, the greater the viscosity value and vice versa.

From the graphic in Figure 1. obtained the lowest density value in sample 8 with a homogenization time of 4 minutes and a speed of 22000 rpm of 0.76 gr/mL, while the highest density value in the sample 1 with a homogenization time of 2 minutes and a speed of 18000 rpm is 0.88 gr/mL.

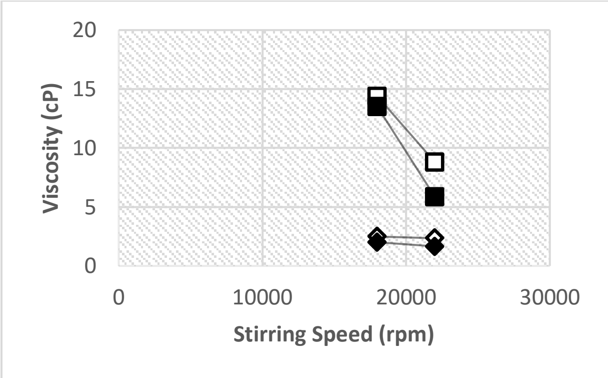


Figure 2. The Effect of Stirring Speed, Time, and Concentration of Solids (◇ 40% (2 minutes); □ 60% (2 minutes); ◆ 40% (4 minutes); ■ 60% (4 minutes)) against Viscosity

Can be seen in Figure 2. That the longer the stirring time and the increased speed at the time of homogenization of the resulting viscosity value the smaller. According to [11] the longer the stirring time and the increased speed can decrease the viscosity value of the emulsion. According to [13] the viscosity of the emulsion is increasing, where the higher the emulsifier concentration of soy lecithin, the greater the viscosity obtained. This means that the length of stirring time and homogenization speed are directly proportional to the viscosity value and the concentration of solids is inversely proportional to the viscosity value.

From the graph in Figure 2, it can be seen that the viscosity value decreases with the length of time and the speed of homogenization of the emulsion. The highest viscosity value is obtained at a concentration of 60% with a lap time of 2 minutes and a speed of 18000 rpm of 14.38 cP and the lowest viscosity value obtained at a concentration of 40% with a lap time of 4 minutes and a speed of 22000 rpm of 1.66 cP.

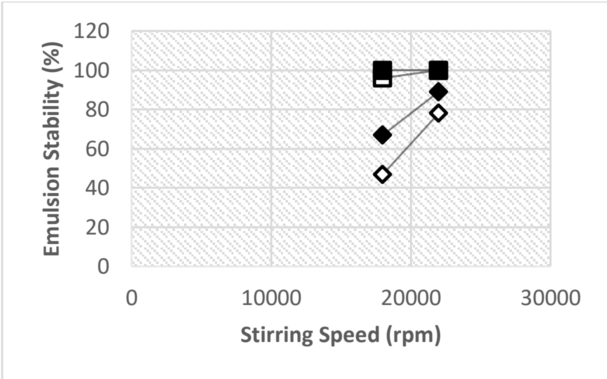
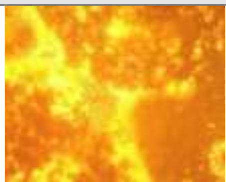
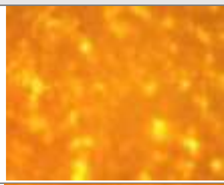
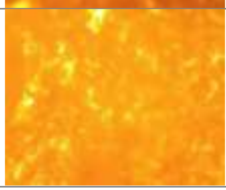


Figure 3. The Effect of Stirring Speed, Time, and Concentration of Solids (◇ 40% (2 minutes); □ 60% (2 minutes); ◆ 40% (4 minutes); ■ 60% (4 minutes)) against Emulsion Stability

Table 2. Microscopic Analysis Test Results Using a Microscope With 10 Times Magnifications

	40%	60%
Stirring Speed 18000 rpm		
2 minutes		
4 minutes		
Stirring Speed 22000 rpm		
2 minutes		
4 minutes		

Can be seen in Figure 3. That the value of % stability increases with increasing time, homogenization speed, and concentration of solids. This is because increased speed, length of stirring time, and concentration of solids play an important role in emulsion formation and emulsion stability levels. According to [14] increasing time and increased homogenization speed play a role in emulsion formation and emulsion stability. According to [15] the stability of the emulsion is increasing, where the higher the emulsifier concentration of soy lecithin, the greater the stability obtained.From the graph in Figure 3 can be seen the result of % stability is in accordance with the stated by [15] that is the highest obtained at a concentration of 60% with a homogenization time of 4 minutes and a speed of 22000 rpm that is 100% and the lowest stability % obtained at a concentration of 40% with a length of 2 minutes and a speed of 18000 rpm that is 47%.

In Table 2. is the result of observation using a microscope with magnification 10 times. From the picture above it can be seen that sample 1 with stirring speed of 18,000 rpm with a time of 2 minutes and solids concentration of 40% have a poor level of stability among the eight samples observed because the particle size of the water is not the same and the distribution is uneven. As for sample 8 with a speed of 22,000 for 4 minutes the concentration of solids 60% can be said to be the most stable sample where it can be seen that the size of the water particles are uniform and the distribution is evenly distributed.

The results are in accordance with the theory that the higher the stirring speed, time, and concentration of solids lead to increased homogenity, resulting in increased emulsion stability [15].

5. Conclusions

The effect of speed and length of time at the time of homogenization process increases the homogenization that plays a role in the formation of emulsions. The higher the stirring speed and the longer the stirring time, the density and viscosity values will decrease. However, the increased stirring speed and the longer the stirring time will prolong the separation time of the oil emulsion in water. The stability of the emulsion is increasing, where the higher the emulsifier concentration of soy lecithin, the greater the stability obtained. Similarly, density and viscosity increase as solid concentrations increase. The optimum results obtained in this study for the homogenization process of VCO emulsions are at a speed of 22000 rpm and stirring time of 4 minutes.

References

[1] Wirakartakusuma, M.A. Subarna, Arfah, M. Syah, D. dan Budiwati,S.I. (1992). Peralatan dan Unit Proses Industri Pangan. Bogor: PAU. IPB.

[2] Loncin, M. and R.L. Merson. (1997). Food Engineering: Principles and Selected Applications. New York: Academic Press.

[3] Widodo. (2013). Teknologi Proses Susu Bubuk. Yogyakarta: Lacticia Press.

[4] McClements DJ. (2014). Food Emulsion Principles, Practices, and Techniques. New York: CRC Press.

[5] Hasenhuettl, G.L. (1997). Overview of food emulsifiers. In *Food Emulsifier and Their Application.* New York, USA: Chapman and Hall.

[6] Wiyani, Lastri., Aladin, Andi., Yani, Setyawati. (2016). Stability of Virgin Coconut Oil Emulsion with Mixed Emulsifier Tween 80 and Span 80. ARPN J. Eng. Sci.

[7] Saputra, A. T., Wicaksono, M. A., & Irsan. (2017). Pemanfaatan Minyak Goreng Bekas Untuk Pembuatan Biodiesel Menggunakan Katalis Zeolit Alat Teraktivasi. *Jurnal Teknik Kimia*, 1-20.

[8] Nurachmandani, S. (2011). *Fisika : Untuk SMA/MA Kelas X.* Pusat Perbukuan Departemen Pendidikan Nasional.

[9] Perrechil, F., & Cunha, R. (2011). Oil-in-water Emulsions Stabilized by Sodium Caseinate : Influence of pH, High-pressure Homogenization and Locust Bean Gum Addition. *Journal of Food Engineering*, 1-8.

[10] Suprobo, G., & Rahmi, D. (2015). Pengaruh Kecepatan Homogenisasi Terhadap Sifat Fisika dan Kimia Krim Nano Partikel dengan Metode High Speed Homogenization (HSH). *Jurnal Teknologi Pangan*, 1-12.

[11] Tri, N. (2008). Pengaruh Formulasi Sediaan Losio Terhadap Efektivitas Minyak Buah Merah Tabir Surya Dibandingkan Terhadap Sediaan Tabir Surya yang Mengandung Oktinoksat. Jakarta: Universitas Indonesia.

[12] Angkadjaja, A. (2014). Pengaruh Konsentrasi Stabilizer HPMC SS-12 terhadap Sifat Fisikokimia dan Organoleptik Mayones Susu Kedelai Reduced Fat. Surabaya: Universitas Katolik Widya Mandala.

[13] Amertaningtyas, D & Jaya, F. (2011). Sifat Fisiko-Kimia Mayonnaise dengan Berbagai Tingkat Konsentrasi Minyak Nabati dan Kuning Telur Ayam Buras. *Jurnal Ilmu - Ilmu Peternakan*, ISSN: 0852-3581. Volume: 21. No: 1. Halaman: 1-6.

[14] McClments, D. (2011). Food-grade nanoemulsions: formulation, fabrication, properties, performance, biological fate, and potential toxicity. *Critical Reviews in Food Science and Nutrition*, 51:285-330.

[15] R. F. Siregar, A. H. (2012). Perubahan Sifat Fungsional Telur Ayam Ras Pasca Pasteurisasi. *Animal Agriculture Journal*, 521-528.