Effect of Sucrose and Citric Acid Addition in The Virgin Coconut Oil Emulsion

Lastri Wiyani[1], Andi Aladin[2], Setyawati Yani[3], St. Hadjar Nur Mutmainnah[4] and Hartini Djufri Mandang[5]

[1,2,3,4,5]Department of Chemical Engineering, Faculty of Industrial Technology, Universitas Muslim Indonesia Jl Urip Sumoharjo KM 5 Makassar Indonesia 90231
Email : lastri.wiyani@umi.ac.id

Abstract. Virgin Coconut Oil Emulsion (VCOE) is one of alternative products which is produced to reduce oily taste when consumed directly. In this research, effects of sucrose and citric acid on VCOE were investigated. The emulsions were prepared with ratio of VCO to water (80:20), using mixed emulsifiers of Tween 80 and Span 80 (T80S80) at a concentration of 0.75%. Physical and chemical characteristics as well as a stability of the emulsions were evaluated. It was found that the emulsion viscosity increased with the increase in the sucrose amount. On the other hand, the viscosity and pH of emulsions decreased with the increased in the citric acid amount. In general, both sucrose and citric acid are suitable to be used as additives in emulsions of food products.

Keywords : VCO emulsion; sucrose; citric acid; tween 80; span 80

1. Introduction

Virgin coconut oil (VCO) is produced from fresh and mature coconuts by mechanical or natural techniques without heating, so the nature of the oil is preserved. Unlike copra-derived coconut oil, virgin coconut oil possesses many health benefits so it has attracted substantial interest to be used as functional food.VCO naturally contains a mixture of medium chain fatty acids (MCFA) and long chain fatty acids (LCFA) at a ratio of 3:1. Studies have also reported that virgin coconut oil could aid in reducing total blood cholesterol, triglycerides, and phospholipids in serum and tissues [4]. According to a study, VCO has a higher phenolic content and antioxidant activity compared to copra-derived coconut oil.

Despite of the many benefits, a direct consumption of VCO is not popular due to the oily taste of pure VCO. The transformation of VCO into a more palatable and stable VCO-based emulsion product will be an advantage for the VCO-producing industry.

An emulsion is a thermodynamically unstable system, and it forms the basic of many food products. The emulsion's stability is an important for the quality of emulsions. However, this still a problem for many food industries. Emulsion stability refers to the ability of an emulsion to resist changes in its properties over time: the more stable the emulsion, the more slowly its properties change. The quality of emulsion based food products are strongly influenced by their stability, rheology and appearance. A loss of stability of an emulsion could be indicated by an increase in a droplet mean diameter of the emulsion. The emulsion stability is highly influenced by the specific gravity, droplet size and distribution, as well as the rheological characteristics.

The addition of hydrocolloids to the aqueous phase can yield specific rheological properties to achieve emulsion’s stability. Some hydrocolloids act as surface active gums, having the ability to form a film around the oil droplets. As a result of static stabilization, hydrocolloids aid in delaying this coalescence and prevent emulsion breakdown. Moreover, some hydrocolloids are known to stabilize the emulsions by enhancing the viscosity of the aqueous phase.

Research on VCO emulsions (VCOE) with various emulsifiers have been reported. For example, Permadi investigated the use of Tween 80 and lecithin as emulsifier in the stability of fish oil emulsion, gum arabic lecithin, xanthan gum, glycerin fatty ester acid, gum Odina, roselle extract.

In addition Wiyani et al. Examined the use of Span 80, Tween 80 and lecithin as emulsifiers in the stability of VCOE and mixed emulsifier Tween 80 and Span 80 (T80S80) [18]. The emulsions produced in the previous study were quite stable, however the emulsions were tasteless.

The present study aims to produce more palatable VCOE by additions sucrose and citric acid. The effects of the sweetener and acid on the physical, chemical properties and stability of VCOE are studied. It is expected that by understanding those effects more stable VCOE and palatable could be produced and the knowledge could be applied in VCO home industries.

2. Methods

2.1. *Materials and Equipment*

The main raw material used in this study was virgin coconut oil (VCO) which was obtained from a local VCO producer (CV. Avcol, Makassar, Indonesia). Two types of surfactants were also used. The surfactants are a low hydrophile-lipophile balance (HLB) surfactant namely sorbitan monooleate (Span 80, HLB = 4.3) obtained from Sigma and a high HLB surfactant namely polyoxyethylene sorbitan monooleate (Tween 80, HLB = 15.0) obtained from Merck. The sweetener was sucrose (purchased from Merck) and the acid was citric acid (purchased from Merck).

The emulsions were prepared in an Ultra Turrax homogenizer which has specifications of a minimum speed of 3600 rpm and a maximum speed of 24000 rpm and could produce droplets with particle sizes of 1-10 micron. The viscosity of the emulsions was measured using a Brookfield viscometer model DV-I Prime.

2.2. *Preparation of VCO Emulsion*

The VCOE was prepared by mixing VCO and sucrose solution at a ratio of 80:20. The concentrations of sucrose used in the experimentations were 1, 2, 3, 4 and 5% (w/v), respectively. Into the mixture, a mixed emulsifier was added at 0.75% (w/w). The mixed emulsifier was T80 and S80 at a ratio of 40:60 which was prepared following previous research. The VCOE mixture was mixed using Ultra Turrax homogenizer at 15.000 rpm for 4 minutes. Into the mixture, citric acid with various concentrations, i.e. 0.2 , 0.4, 0.6 , 0.8 , and 1% (w/v , respectively, was added and mixed again for 1 minute. Then the VCOE was ready for characterizations.

2.3. *Peroxide Number Test*

Five grams of VCOE mixture was put in a 300 mL Erlenmeyer flask. 10 ml of chloroform and 15 ml of glacial acetic acid were added into the Erlenmeyer and then shaken to mix it. One ml of saturated KI was added and the Erlenmeyer was immediately closed while shaken roughly for 5 minutes in the dark at a temperature of 15-25°C. Then, 75 ml of distilled water were added and shaken vigorously. The mixture was titrated with standard solution of 0.2 N sodium thiosulphate and starch solution as an indicator. Peroxide number was expressed in meq /kg sample.

2.4. *Viscosity*

The viscosity of VCOE was measured using Brookfield viscometer DV-I Prime. Rotation of spindle on the viscometer could be adjusted according to the type of the fluid sample.

2.5. *Emulsion Stability Test*

Approximately 60 ml of sample was put into a bottle and stored at 5°C for 12 hours, then further stored at a temperature of 35°C for 12 hours. This cycle was repeated for 10 cycles (5 cycles of temperature of 5°C and 5 cycles of 35°C). The stability of VCOE was determined as follows:

% stability = (height of stable emulsion/height of initial emulsion) x 100. Results

To understand the effect of sweetener and acid to the stability of VCOE, viscosity and characteristics of the emulsions are observed and the results are presented in Fig. 1-2 and Table 1-2.

The relationship between the amount of sucrose and the viscosity of the emulsion is shown in Figure 1. It could be seen from the figure that the addition of sucrose to 5 percent increases the viscosity of the emulsion

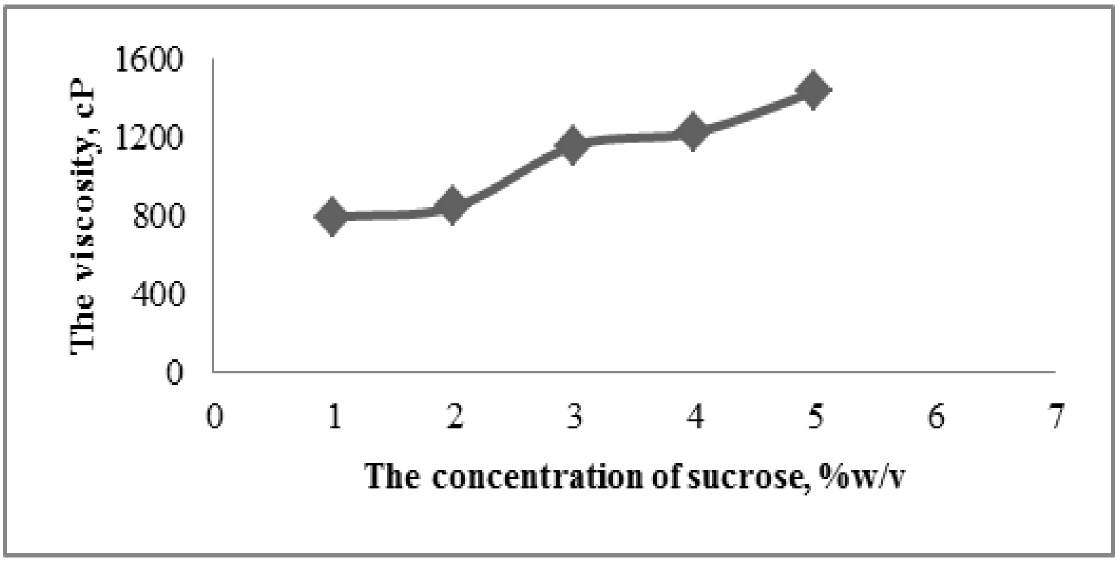

Figure 1. Relation between the viscosity of VCO emulsion and the concentration of sucrose

The relationship between the amount of added citric acid and the viscosity of VCOE is shown in Fig. 2. The concentrations of citric acid added into the VCOE were from 0.2% (w/v) to 1% (w/v). The figure reveals that the viscosity of VCOE decreases with increase in the concentration of citric acid.

Effects of acid additions on VCOE with 3% sucrose were evaluated for the pH, visual stability and peroxide number. The results are presented in Table 1. Fatty acid types and concentrations in the VCOE with 3% sucrose were also analyzed and the results could be seen in Table 2.

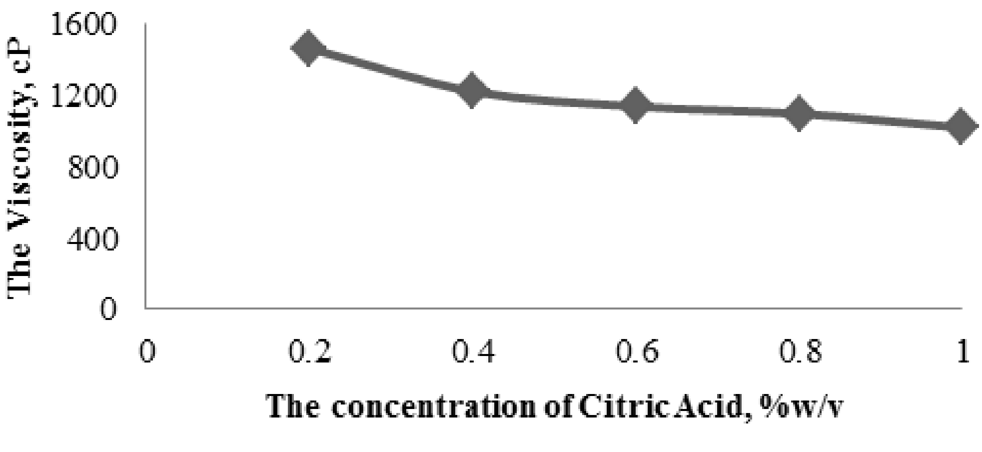

Figure 2. Relation beetwen the viscosity of VCO emulsion and the concentration of citric acid

Table 1. pH, stability and peroxide number of 3% sucrose-VCOE of

Citric acid concentration (%)	***pH***	***Stability***	***Peroxide Number* (meq/kg)**
0,2	2,4	Stable	1,68
0,4	2,2	Stable	1,42
0,6	2,2	Stable	1,08
0,8	2,2	Stable	0,85
1	2,0	Unstable	0,43

Table 2. Fatty Acid Compositins in 3% sucrose-VCOE

Fatty Acids	**Content, wt.%**
Caproic Acid	0,63
Caprylic Acid	8,56
Capric Acid	6,55
Lauric Acid	49,87
Myristic Acid	19,3
Palmitic Acid	7,36
Linoleic Acid	2,2

3. Discussion

The addition of sucrose into the VCOE may serve as a flavor enhancer which could affect the quality of the product. As can be observed from Fig. 1, the addition of sucrose from 1 to 5 percent results in a more viscous VCOE. The viscosity of VCOE at 1% sucrose was 793 cP. The viscosity of VCOE became double at 5% sucrose addition. The addition of the sweetener such as glucose, sucrose, and honey into the emulsion could increase the viscosity and prevent the emulsion from creaming. But if the viscosity is too high, the tendency of creaming formation in VCOE is greater [21].

The high viscosity of VCOE could be an indication that the emulsion is stable. However, at a very viscous VCOE, there is a tendency of flocculation to occur in VCOE. During the flocculation process, the continuous phase or water phase could be trapped and lead to formation of creaming [22]. Another research suggests that the addition of sweetener in the emulsion could increase the viscosity of continuous phase of VCOE and this would prevent the occurrence of creaming, however when the viscosity difference between the dispersed and the continuous phases is too large, this may increase the rate of creaming [23].

The concentration of sucrose in VCOE should be controlled in order to produce palatable yet stable products. From this research, the optimum concentration of sucrose is 3%. The VCOE with 3% sucrose has a good taste as it is not too sweet and it has a viscosity of 1200 cP which is not too viscous. The stability of the emulsion is also observed by adding citric acid into VCOE with 3% sucrose. It can be observed from Fig.2 that adding 0.2% citric acid yields VCOE with a viscosity of 1460 cP. The viscosity of VCOE decreases with increase in citric acid concentration. The stability of the emulsions is also observed from pH, visual stability and peroxide number as presented in Table 1. At 1% citric acid concentration, it could be observed that the VCOE is unstable with pH of 2.0 and very low viscosity. At a low viscosity, droplets in the VCOE will be easy to move in dispersion medium, thus chances of fusion between droplets become higher [24]. This behavior also occurs in the VCO emulsion with vinegar addition [25].

Peroxide numbers of VCOE with various concentration of citric acid are presented in Table 1. It could be found that the peroxide numbers are from 0.43 to 1.68 meq / kg. Rancidity of food products which caused by oxidations of fats in emulsions could be analyzed using peroxide numbers. The maximum peroxide in VCO based on the APCC standard is 3 meq / kg [26], this indicates that the VCOE are not rancid. Using VCO as raw materials for food products has a good benefit as the peroxide number in VCO is low. This is because VCO contains approximately 90% of unsaturated fatty acids which are more resistant to rancidity due to oxidation process in comparison with unsaturated fatty acids [21].

To investigate the effect of the treatments on the profiles of fatty acids of VCOE, the VCOE with 3% sucrose was analyzed using Gas Chromatography. Table 2 presents the results of the analysis. It could be seen from Table 2 that the main component of fatty acids in VCOE is lauric acid. The treatment could preserve the fatty acid profile of VCO, as it is observed that the lauric acid in the VCO was 49 % which is in accordance with Asia Pacific Coconut Community (APCC) standard for VCO, (43-53) % [26].

4. Conclusions

Virgin coconut oil emulsions have been formulated by adding sucrose and citric acid to enhance its stability and quality. It has been found that with the increase in sucrose concentrations the viscosity of VCOE increase, whereas with the increase in acid concentrations the viscosity of VCOE decreases. The stable VCOE products were obtained at 3% sucrose with concentrations of citric acid between 0.2-0.8 %. The VCOE products contain fatty acids which meet APCC standard of VCO.

5. Acknowledgement

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