Characteristics of Virgin Coconut Oil Emulsion with Honey and Citric Acid

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ABSTRACT

The present research was conducted aiming to examine the physical and chemical properties along with the stability of the emulsion of Virgin Coconut Oil (VCO) as an alternative product to decrease the oily taste when consuming the oil directly. The VCO emulsion involved in this research contains honey and citric acid with the ratio prepared of VCO : water : honey : is 80 : 18 : 2. Furthermore, the combination of emulsifiers of Tween 80 and Span 80 was also used at the ratio of 2 : 3, particularly at 0.75% concentration, while the citric acid was prepared in various amount including 0.02, 0.04, 0.06, 0.08 and 0.1 gram in every 100 ml emulsion. As a range of citric acid was provided in the research, it was found that as the citric acid amount increased, the viscosity and pH of emulsions decreased. Stable emulsion was obtained at citric acid amount of 0.02 to 0.06 gr / 100 ml emulsion. As much as 2.6 to 2.9 meq/kg sample of peroxide and 0.07 to 0.09 % fatty acid were obtained, indicating that the emulsion produced was not rancid. Meanwhile, regarding the laurat acid contained, the amount contained was 49.22% which is still suitable as APCC standard for VCO.

***Keywords**: VCO emulsion, honey, citric acid, Tween 80, Span 80*

1. INTRODUCTION

Virgin coconut oil (VCO) has been proven as a very useful product in health science aspect as it can be used for food supplements and cosmetic products' active compound. It its production, no heating processing was involved aiming to keep its properties. Instead, mechanical and natural technique was utilized to produce this alternative product made from fresh and mature coconuts [1] [2]. Recently, novel VCO form has been produced in order to make it more palatable and stable so that it can decrease the oily taste of VCO. Such form is formulated into VCO in the form of emulsion which also provides benefit in for the VCO-producing industry [3].

As emulsion has been utilized numerously as basic ingredients for many types of food product, its quality is essential to be considered. The quality of emulsion can be assessed through its stability in keeping its properties in order to not change over time, which means that the more stable the emulsion, means that the more difficult it is to change in terms of its properties over the time. Since emulsion is basically an unstable system in the context of its thermodynamics, it becomes a challenge for the industry to produce stable emulsion. The physicochemical characteristics of gums added during the aqueous stage of the emulsion is considered to be the ones affecting the emulsion stability [3], [4]. Thus, it was found that in order to achieve stability of emulsion, an addition of hydrocolloids during the aqueous stage is needed since it produces particular rheological properties. Hidrocolloids can act as surface active gums since it has the ability to create film in the oil droplets surrounding, making the coalescence takes slowly and prevent the emulsion to breakdown. In addition, some other hydrocolloids can stabilize the emulsion by increasing the viscosity of the aqueous stage [5] and [6].

There are various factor causing the breaking of emulsion's physical properties, including flocculation, gravitational, coalescence, separation, creaming and phase inversion. In addition, free radical mechanism caused by oil droplet aggregation in lipid oxidation can also decrease the stability of emulsion's physical nature [7]. However, kinetically stable (metastable) of emulsion is possible to be produced if their destabilization rate is adequately low in comparison with the expended lifespan [8], although it is thermodynamically unstable, by the additional of thickening agent or emulsifier before the homogenization [9]. Such addition will increase the system's activiation energy [10].

Numerous research regarding the use of emulsifiers on emulsion has been conducted. A research project [11] was conducted to stabilize sunflower oil emulsion by using various Bambara groundnut flour and starch as the stabilizer. Other stabilizer used in emulsion research are gum arabic [12], lecithin, xanthan gum [13], glycerin fatty ester acid [14], gum Odina [15], roselle extract [16]. Another research project [17] utilized the combination o Tween 80 and Span 80 as well as lecithin as emulsifiers in VCO emulsions stability [18]. The emulsion produced in the study had no taste. The addition of sweeteners and acids is necessary to produce a palatable emulsion. Beside that, the addition acid is very high can unstable emulsions. "Emulsion stability" in this research refers to the ability to keep its chemical and physical properties to stay unchanged over the time. Beverage emulsions physical stability determines its quality to be accepted by consumers. In addition, the long term stability of the emulsion depends on the rate and extent of changes occurs in its structure and properties.

The present study aims to investigate the effect of citric acid on the physical, chemical properties and stability of VCO emulsion containing honey. The expectation of this research is that by obtaining the insight regarding those effects, more stable and palatable VCO emulsion can be produced so that it can be implemented in VCO home industries.

II. METHODS

This research was performed at the Chemistry Laboratory of the Faculty of Industrial Technology and the Pharmacetics Laboratory of the Faculty of Pharmacy UMI, Makassar.

a. Materials and equipment

Virgin coconut oil (VCO) which is the basic material of this research was produced by CV. Avcol, Makassar, Indonesia. Meanwhile, the other materials including Low and high HLB surfactant, sorbitan monooleate (Span 80, HLB = 4.3), polyoxyethylene sorbitan monooleate (Tween 80, HLB = 15.0), honey and citric acid (food grade) were supplied by local chemical supplier.

UltraTurrax T25 IKA homogenizer was used to prepare the emulsions with the specification of 3600 rpm as the minimum speed and 24000 rpm as the maximum speedwith particle size of 1-10 micron. Furthermore, Brookfield viscometer model DV-I Prime was used to determine the viscosity.

This procedure was based on research conducted by Wiyani, [18], in which the VCO emulsion was provided with the ratio of VCO : water : honey = 80:18:2 and 0.75% mixed of emulsifier T80S80 (2:3). Ultra Turrax homogenizer at 15,000 rpm was then utilized to mix it for 4 minutes. Then, a range of citric acid amount was added (0.02 g, 0.04 g, 0.06 g, 0.08 g, and 0.1 g) and stirred again using the same equipment for 1 minute [18].

b. Evaluation

Peroxide Number Test.

A 300 mL Erlenmeyer flask was utilized to mix five grams of samples which was then added by 10 ml of chloroform and 15 ml of glacial acetic acid. Then, the mixture was also added by 1 ml of saturated KI. The Erlenmeyer was immediately closed while shaken roughly for 5 minutes in the dark at a temperature of 15-25^{o}C. After that, 75 ml of distilled water was also added and the Erlenmeyer was shaken vigorously. The solution of 0.2 N sodium thioslphate and starch solution was used as indicator to titrate the mic. The peroxide number was then showed in milieq /kg sample [19].

Viscocity Test.

Brookfield viscometer DV-I Prime was used to determine the emulsion that has been provided . Approximately 60 ml of the emulsion was put in the erlenmeyer and tested for viscosity using a spindle 6. The rotation speed was adjusted to 50 rpm for 30 seconds. The device was then shows the value of the viscosity (cP).

Emulsion Stability Test.

As much as 60 ml of the sample was put into a bottle and stored in two stages. At the first stage it was stored at temperature of 5^{o}C for 12 hours, while the second stage, it was stored at a temperature of 35^{o}C for 12 hours. These stages were repeated for 10 times. The emulsion of VCO will be obtained through the following formula:

% stability = (height of stable emulsion/height of initial emulsion) x 100 [20].

Free Fatty Acid Test.

An Erlenmeyer flask was used to mix 30 grams of sample, 50 ml of hot neutral alcohol and 2 ml of phenolphthalein (pp). As much as 0.1 N NaOH was then use to titrate the mix in the Erlenmeyer flask until it turned pink and stay present for 30 seconds. The content of free fatty acid was shown in the form of % FFA [19].

III. RESULTS AND DISCUSSION

The correlation between the citric acid provided and the viscosity of emulsion is presented in Figure 1. The concentration of citric acid increases in the prepared emulsion, the viscosity of system was lower until the addition of 0.1 g/100 ml of emulsion.

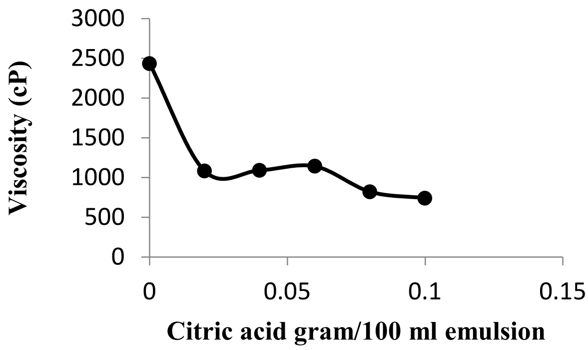

Figure 1. Relation beetwen the viscosity and the citric acid concentration of VCO emulsion

Based on the figure presented above, the emulsion's viscosity decreased as the citric acid amount decreased. However, the emulsion's viscosity can increase through the addition of sweeteners (glucose, sucrose, honey, etc.) since such addition can prevent the emulsion to become cream. However, if the viscosity was too high, it increased to form a creaming [21]. The high viscosity indicated the stability emulsion was good. However, if the viscosity value was too high, it could indicate that emulsion was broken. The emulsions became a flocculation because the structure of flocculation could trap the continuous phase (water) [22]. Other researchers explain, the addition of sugar or honey in the emulsion-shaped beverage can increase the continuous phase viscosity and prevent the occurrence of creaming. but the large viscosity difference between the dispersed and the continuous phases may also increase the rate of creaming [23].

Table 1. Characteristis of VCO emulsion at various concentration of citric acid

citric acid (g/100 ml of emulsion	Stability	pH	Free fatty acid (%)	Peroxide Number (meq/kg)
0	Stable	4.4	0.0952	3.0925
0.02	Stable	4.3	0.0917	2.9802
0.04	Stable	4.2	0.0763	2.7990
0.06	Stable	4.1	0.0750	2.5874
0.08	Unstable	3.9	0.0750	2.5946
0.1	Unstable	3.7	0.0606	2.5822

In order to be able to predict the shelf life of emulsion containing acidic or alkaline additive, producer needs to understand the insight regarding the effect of pH in food stability, pharmaceutical and industrial emulsions. The pH value of the VCO emulsion decreased as the concentration of citric acid increased as presented in Table 1. The VCO emulsion is stable at pH 4. Generally, emulsion stability improves with increasing pH till neutrality, beyond which stability decreases. Thus, both acidity and alkalinity reduces the emulsion stability [11].

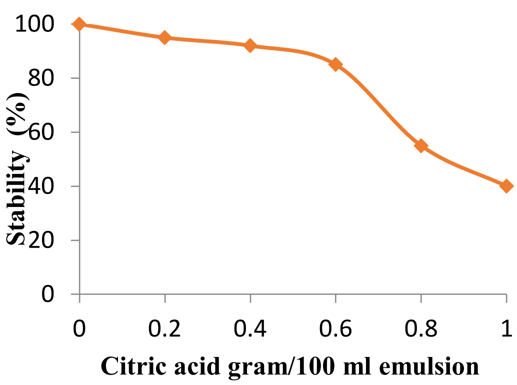

Figure 2. Stability of VCO emulsion

The emulsion stability is also influenced by the addition of citric acid (See Figure 2.) At 0.08-0.1g citric acid /100 ml emulsion resulted in an unstable emulsion. That phenomenons is influenced by components in honey. There are some acids in honey, it called acetate, butyrate, formate, gluconate, lactate, maleate, oxalate, pyroglutamate, citrate, succinate, glycolate, a-ketoglutarate, pyruvate. The excessive addition of citric acid will affect the value of viscosity (decreased). A low viscosity will cause the droplets to easily move to the dispersing medium so that the droplets become very easily diffused. If the diffusion happen in droplets, there will be separation between dispersed substances and dispersing substances (separation of oil and water). This happens in VCO emulsion where the condition of acid are too high and will cause the emulsion to be damaged (unstable). Decrease in viscosity is followed by decreased stability of VCOE (Fig 1. and Fig. 2). The opportunity of fusion of the emulsion droplet is higher when it has low viscosity since it makes it easier to move in dispersion medium [24]. Such behavior occurs in the VCO emulsion containing vinegar [25] and VCO emulsion with sucrose and citric acid [26]. Based on the Table 1, it is known that the free fatty acids amount in the emulsion is quite low compared to the maximum free fatty acid content in VCO allowed by Asian and Pacific Coconut Community (APCC) standard, which is 0.5%. Meanwhile, this research obtained that the free fatty acids contained in the emulsion is only at the range between 0.06 % and 0.095 %. In addition, as a comparative content of free fatty acids, at coconut oil has a maximum of 5% free fatty acids [23]. The free fatty acids was produced for this research of VCO emulsion decreased as citric acid increased. The higher of the free fatty acids contain in the emulsion, the lower quality of the emulsion.

Table 2. Profile Fatty Acid of VCO emulsion with honey

Content	VCO Emulsion	APCC VCO standard [26]
Caproic Acid (%)	0.41	0.10-0.95
Caprylic Acid (%)	6.44	4-10
Capric Acid (%)	5.46	4-8
Lauric Acid (%)	49.22	43-53
Miristic Acid (%)	18.37	16-21
Palmitic Acid (%)	9.72	7.5-10.2
Linoleic Acid (%)	3.38	0.7-2.5

Peroxide compounds may be caused by industrial process treatment. The main damage of oil is due to oxidation and hydrolysis, both enzymatic and non-enzymatic. The results caused by fat oxidation include peroxide. In order to determine the damage level of oil is by determining the peroxide numbers. According to Table 1 presented, the peroxide numbers obtained based on the citric acid concentration provided was at the range between 2.58 and 3.09 milieq/kg sample. Such analysis was conducted aiming to know the amount of peroxide during the fats oxidation which can cause oil' rancidity. Based on the Codex-Stan 210-1999 the maximum level of peroxide number in virgin fat and oils is 15 milieq / kg sample. The maximum peroxide in VCO based on the APCC standard is 3 milieq / kg sample [27], which indicated that the emulsions were not rancid. Peroxide number in VCO is low 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].

The profile fatty acid of the VCO emulsion using Gas chromatography is presented in Table 3. The purpose of this analysis is to investigate the effect of the treatment on the profile fatty acid of VCOE. The main component of fatty acids in VCO is lauric acid. Laurat acid obtained was 49.22% (Table 3), which was in accordance with APCC standard for VCO, (43-53) % [27].

IV. CONCLUSION

Based on the research conducted, it can be known that as the citric acid amount provided is increased, the viscosity and pH of emulsions decreased. The concentration of citric acid which makes the emulsion stable is between 0.02-0.06 gr/100 ml emulsion. The amount of peroxide contained 2.6 to 2.9 meq/ kg sample, while the free fatty acid content were 0.07 to 0.09 %, indicating that there was no rancidity in the emulsion. The amount of laurat acid obtained was 49.22%, which was in at the range of APCC standard for VCO.

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