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Effect of Increasing Concentrations of Tween 80 and Sorbitol as Surfactants and Cosurfactans Against the Physical Stability Properties of Palm Oil Microemulsion

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Palm oil is one of the fatty oil can used as the oil phase in the microemulsion system. The purpose of this research was to identify the effect of increasing concentration of combination of surfactant and cosurfactant on the physical stability of palm oil microemulsion. This oil was formulated into microemulsion system by increasing concentration of combination of tween 80 and sorbitol (1:1) in various concentrations, which were 54%, 56%, 58% and 60% as surfactant and cosurfactant component. The evaluation included organoleptic, viscosity test, pH, density, surface tension and particle size and zeta potential test. The pH showed in the range 5.8 to 6.4. Viscosity value obtained between 637.47 to 808.20 Cps. Density measurement were between 1.1123 to 1.1235 g/ml. The results of surface tension obtained between 39.76 to 43.07 dynes/cm. The results of particle size measurement results obtained from 21.27 to 23.97 nm and the zeta potential between −10.28 to −18.03. It can be concluded that the increasing of concentration of surfactant and cosurfactant can improve physical stability of the microemulsion.

Keywords: Palm Oil, microemulsion, Physical Stability, Tween 80, Sorbitol.

1. INTRODUCTION

Microemulsion is a system developed dispersion of emulsion preparation. Microemulsion has a droplet size between 10 to 100 nm and can be classified as an oil-in-water (O/W), water-in-oil (W/O) or bicontinuous system depending on their structure.[1] One of the most important components forming the microemulsion is a surface active agent, or better known as surfactants. Surfactants can be used alone or mixed with other surfactants. Combinations of surfactants and cosurfactant can improve the dispersion of oil and water interface. High concentration of surfactant in microemulsion may cause irritation of the skin. To overcome the irritation problem that might arise nonionic surfactants are used. The nonionic surfactant can be widely used because it has a level of toxicity and irritation are relatively low.[2]

Tween 80 is a class of nonionic surfactants which have relatively low levels of toxicity and irritation compared to other surfactants. Previous research[3] have shown that the use of tween 80 as surfactant produces a transparent microemulsion. Tween 80 has HLB 15[4] which was suitable for systems microemulsion-type oil in water (O/W), while sorbitol is a class of alcohol chain being (atom C-6) which qualify as cosurfactant which is to improve the solubilization or solubility. Based on previous exposure, this study conducted by making oil in water microemulsion (O/W) by using palm oil as the oil phase by using a variation of the concentration of tween 80 and sorbitol as a surfactant and cosurfactant. In the previous research, palm oil in nanoemulsion optimization was done using monoester sucrose with optimum yield of palm oil with concentration of 6%.[5] Based on this, palm oil has the potential to be used as an oil phase in the formulation of palm oil microemulsion. This study aims to determine the effect of increasing concentration of tween 80 and sorbitol as surfactant and cosurfactant on stability of physical properties of palm oil in microemulsion.

So that in this study will be the influence increased concentration of tween 80 and sorbitol as a surfactant and cosurfactant in the stability of the physical properties of palm oil microemulsion.

2. EXPERIMENTAL DETAILS

2.1. Equipment and Materials Research

The tools used in this study included: an analytical balance (Ohaus), glass tools, pycnometer pyrex, pH meter metler toledo, Brookfield viscometer type LV-II + Pro, Tensiometer *Du Nouy*,

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Table I. Formula.

Component	Formula (%) 1	2	3	4
Palm oil	6	6	6	6
Tween 80	27	28	29	30
Sorbitol	27	28	29	30
Aquadest ad	100	100	100	100

water bath (Akebonno), weighing bottle, memmert oven, refrigerator, plastic pots, sentrifugator PLC-025, magnetic stirrer and particel size analyzer (Beckman Coulter). The materials used in this study were Palm Oil, Tween 80, Sorbitol, and *Aqua destillata*.

2.2. Research Procedure

In the manufacture of palm oil microemulsion we determined the ratio between palm oil with surfactant and cosurfactant. The determination of the concentration of surfactant and cosurfactant were done by orientation using multiple concentrations of surfactant, cosurfactant, oil phase and the aqueous phase to obtain stable microemulsion region organoleptically. The results obtained test formula specified in Table I.

Microemulsion prepared by dissolving soluble material with a polar solvent dissolved in advance in a polar solvent, then added with the oil phase into it, homogenized with magnetic stirrer then added cosurfactant little by little, stirring until homogeneous and formed microemulsion was clear and transparent. These preparations were evaluated the stability of physical properties for 8 weeks including organoleptic examination, pH, density, viscosity, separation phase by *freeze thaw* method and centrifugation method and also were performed measurements of surface tension, particle size and zeta potential.

3. RESULTS AND DISCUSSION

3.1. The Microemulsion Region

In the manufacture of palm oil microemulsion we first determined the concentration of surfactant. The determination of the concentration of surfactant and cosurfactant done by orientation using multiple concentrations of surfactant, cosurfactant and water phases to obtain the microemulsion region in order to get the optimum concentration of surfactant.

After conducting an experiment determining the microemulsion region with a wide variety of different concentration of surfactant, cosurfactant and water phase, the obtained concentration of surfactant and cosurfactant combinations used in the manufacture of eucalyptus oil microemulsion. The concentration used were combination of surfactant and cosurfactant concentration of 54% (F1), 56% (F2), 58% (F3), and 60% (F4). The concentrations were chosen because after orientation of the formula and storing at room temperature for 1 month, microemulsion unchanged physically.

3.2. Organoleptic

Based on observations during the 8 weeks, the three formula showed that no change in terms of shape, color, and odor during storage organoleptically. The third formula remains in liquid condition, clear yellow and a characteristic odor. This showed that the three formulas have reasonably good physical stability during storage. The microemulsion storage was carried out at a constant room temperature and the preparations were stored in tightly sealed containers, thereby making the microemulsion preparations unaffected by environmental factors.

3.3. Measurement of pH

The results of pH measurements for 8 weeks indicate a decrease and an increase in pH which tends to be less significant during storage, so it can be proved that the preparation was thermodynamically stable and the absence of chemical reactions either from storage containers or the materials contained in the preparation. The pH measurement results showed that with increasing surfactant concentration and cosurfactant it cause an increase the pH of microemulsions, because the use of surfactant has a pH between 6–8,[6] and a cosurfactant pH of between 5.0–7.5.[4] Thus, the more use of tween 80 and sorbitol in the formula may cause the pH of the preparation to increase as well. The resulting pH were between 5.8–6.4 where the pH were still within the pH tolerance range which are still safe for the skin that are in the range of 4.5 to 6.5.

3.4. Viscosity Measurement

The results of viscosity measurements for 8 weeks using a Brookfield-type DV-II + pro viscometer and viscosity data showed hat all formulas have viscosity that tends to increase. The higher the surfactant concentration used, the viscosity became larger. This is because the use of surfactant is getting bigger in the dosage, so it will make medium dispers become more rigid (stiff). The more rigid medium dispers will result in the increased viscosity of the microemulsion system.[7]

3.5. Density

On the results of density measurements of microemulsion palm oil indicated that the increasing concentration of surfactant and cosurfactant then the weight of the type of a preparation will tend to rise. This was linear with previous viscosity measurements, since the surfactant used was tween 80 density of 1.070 g/ml at 25 °C and the cosurfactant used was sorbitol having density of 1.285 g/ml. The more surfactant given to the microemulsion preparation formula, it would increase the weight of dosage type.[8]

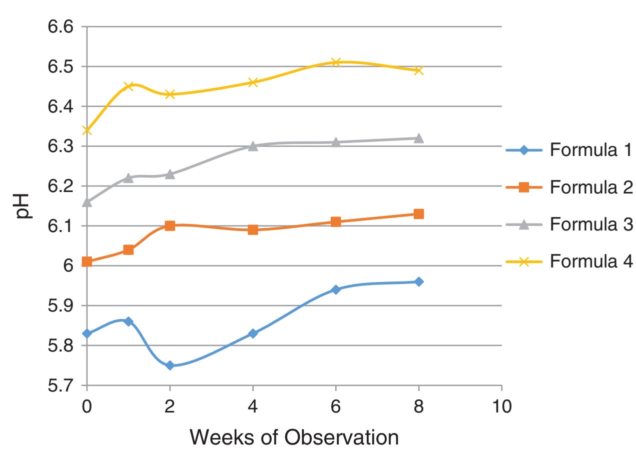

Fig. 1. Result of pH observation.

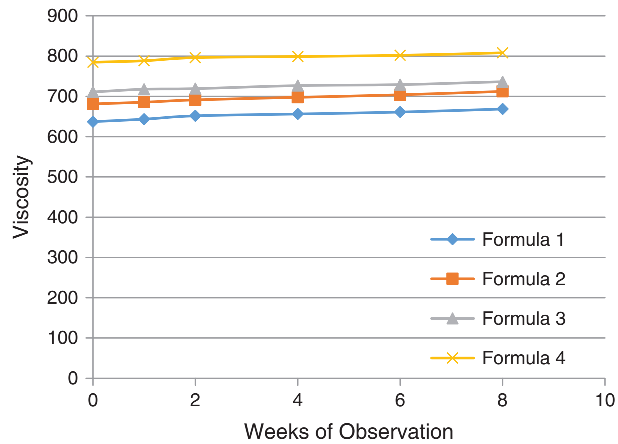

Fig. 2. Result of viscosity observation.

3.6. Phase Separation Test

Observation of phase separation through freeze-thaw method at two different temperatures i.e., temperature 40 °C followed by storage temperature at 40 °C were done for 8 cycles. Based on the results of the observation at 40 °C showed that three formulas did not change the physical appearance. The observation result at 40 °C also did not seem to change physical appearance.

Observation of phase separation by centrifugation method, carried out at 3750 rpm rotation speed for 5 hours without interval. The results of this test showed in F1–F4 obtained the result that there was no change in each formula which means each formula remain stable after this test. From the above description it can be proved that F1–F4 is stable against extreme temperature changes and it can be concluded that the concentration of surfactant and cosurfactant can affect the stability of microemulsions.

3.7. Measurement of Surface Tension

The surface tension was measured using a Tensiometer with *Du Nouy ring* method. Low surface microemulsion tension were generated due to surfactants and cosurfactants which can decrease the oil and water interface tension. The stability of microemulsion is higher when the microemulsion has surface tension smaller than water which is 72 dyne/cm. The surface tension of the microemulsion preparation was obtained between 39.76–43.4 dyne/cm (Fig. 3).

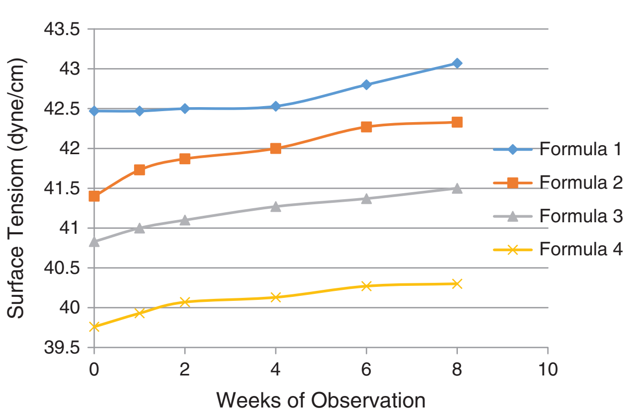

Fig. 3. Result of surface tension observation.

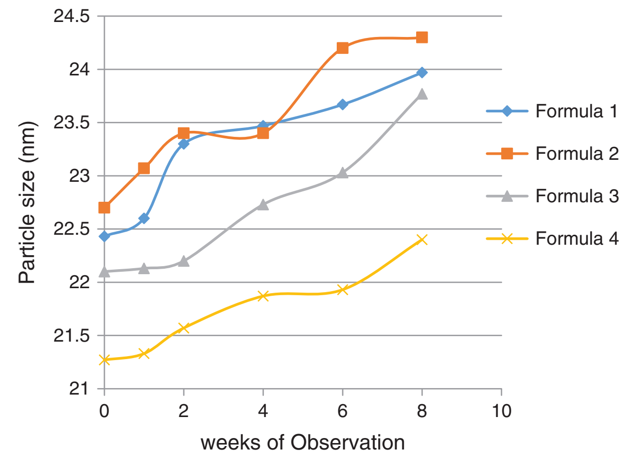

Fig. 4. Results of particle size observation.

3.8. Measurement of Particle Size and Zeta Potential

Measurement of particle size using Particel Size Analyzer tool. The three formulas have particles corresponding to the 10–100 nm microemulsion requirements that have an average particle size between 21.27–24.30 nm (Fig. 4). On a weekly basis the particle size increased as it can be caused by the merging of small particles into large groups and also the distance between adjacent particles making it easier for particles to join.

In addition to particle size, this study was also conducted to determine the value of polydispersity index (PDI). PDI value provides information about an emulsion droplet size uniformity. Figure 2 showed that PDI value resulted close to 0, thus the value of polydispersity index of the most close to zero was F4 (60%), i.e., 0.053 and then F1 (54%) was 0.061, then F3 (56%) was 0.070 and F2 (58%) was 0.082. It can be concluded that the particle size of the resulting microemulsion were relatively uniform.

The zeta potential indicates the charge of the particle in a specific field. The zeta potential indicates the amount of repulsive force between the equal and adjacent particle charge. Generally, high zeta potential values (negative or positive) prevent the aggregation of particles due to the forces of repulsion and the electrical stabilization of the nanoparticle dispersion. The zeta potential value (±) 30 mV is sufficient for good stability of nanodispersi.[9] The result of potential zeta value for oil palm microemulsion were in the range of −10.2283 mV to −18.03 (Table II). The best result was shown in F4 that is −18.03. The negative zeta potential value is due to the nonionic surfactant used to cover the surface of the microemulsion droplets, this causes the mobility of the particles to be reduced and between the particles will not combine to form the aggregate.[10] From the results obtained can be seen that the palm oil microemulsion tend to aggregate because the zeta potential value obtained less than 30 mV.

Table II. Result of zeta potential value.

Formula	Zeta Potential value
1	−10.283 ± 0.72
2	−13.727 ± 1.38
3	−17.37 ± 1.01
4	−18.03 ± 1.36

4. CONCLUSION

Based on the results, it can be concluded that increasing the concentration of surfactant and cosurfactant can improve the stability of the physical properties of palm oil microemulsion.

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