# The effect of addition of emulsifier mixture with various HLB value on the emulsion stability of coconut milk

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**Abstract**. Coconut milk is a liquid that is an oil-in-water emulsion. There needs to be an emulsifier mixture formula that functions to keep oil suspended in the water, to maintain the stability of the coconut milk emulsion. In this study, an emulsifier mixture formulation from ethanolysis products of palm kernel oil (PKO) with a Hydrophobic-Lipophilic balance (HLB) value of 3.0 and Tween 80 (HLB 15) was used in several compositions to produce an emulsifier mixture with HLB values of 6, 7, 8. , 9, 10, 11, and 12. The purpose of this study was to determine the effect of adding emulsifier mixtures on the stability of coconut milk emulsion after 18 hours of storage at room temperature. There are four types of coconut milk used, namely coconut milk with the addition of water: 1:0; 1:1; 1:2; and 1:3 (v/v). Mains coconut milk is made using 1000 g of coconut and 500 mL of boiling water. The water content values of coconut milk with the addition of water: 1:0; 1:1; 1:2; and 1:3 (v/v) were 71.55% (± 0.63%); 85.85% (± 0.28%); 90.46% (± 0.30%) and 92.34% (± 0.26%), respectively. The results of the highest viscosity in this study were coconut milk without the addition of water (1:0, v/v) of 8.80 Mm²/s, while coconut milk with the addition of water (1:1; 1:2; 1:3, v/v) was lowering each their viscosities, respectively to be 1.62; 1.40; and 0.86 Mm²/s. The average density of coconut milk with the addition of water: 1:0; 1:1; 1:2; and 1:3 (v/v) were 0.979 (± 0.011); 0.987 (± 0.002); 0.988 (± 0.001); and 0.990 (± 0.002), respectively. The results showed that the stability value of fresh coconut milk emulsion without the addition of water (1:0; v/v) was the highest in the addition of the emulsifier mixture treatments with HLB 12 (61.22 ± 2.18%) and the lowest was at HLB 3 (43.95 ± 2, 60%) with the emulsion stability of coconut milk as control was 44.84 ± 1.34%. Stability values of coconut milk emulsion with the addition of water were 1:1; 1:2; and 1:3 (v/v) decreased drastically, that are 26.72 ± 1.32% (HLB 12 treatment; control 26.07 ± 0.44%), 21.08 ± 0.46% (HLB 10; control 18.06 ± 3.33%), and 20.24 ± 2.38% (HLB 9; control 13.92 ± 0.95%), respectively.

## 1. Introduction

The main product of the coconut plant is coconut fruit which consists of 4 components, namely 33% coir, 15% shell, 22% coconut water, and 30% pulp. The pulp is part of the coconut fruit which is widely used for food products because it contains essential nutrients for the body such as fat, protein, minerals, and fiber. Coconut flesh is a component of coconut fruit that is most widely used for food products. Ripe coconut flesh has a water content of 42.2%, has a protein content of 7.5%, and 37.0%

fat [1]. Coconut flesh will change its chemical composition as the fruit ages. Increasing the age of coconut fruit will increase the fat content, while the air content will decrease [2]. Pure coconut milk contains 54% water, 35% fat, and 11% non-fat solids. The emulsification ability of protein in coconut milk due to protein in coconut milk is reliable and envelops fat globules so that it can inhibit the separation phase [3].

Coconut milk is a liquid that is an oil-in-water emulsion. The emulsion is a mixture of two liquids that do not dissolve in each other under normal conditions but tend to separate because they have different densities. Therefore an emulsifier is needed to keep the oil grains suspended in the water. An emulsifier or emulsifying agent is a compound or component that is on the surface between two immiscible liquids. Research on the production of ethanolysis products and/or glycerolysis products (containing monoglycerides and diglycerides (DG) from various natural sources has been carried out for a long time, especially using palm kernel oil (PKO) and/or a mixture with crude palm oil (crude palm oil). CPO). Research results (4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15) proved that PKO oil and/or its mixture with CPO have the potential to produce derivative products that have good functions as antimicrobial compounds and/or emulsifiers that can be used as a suitable emulsion food preservative.

## 2. Material and Methods

***Materials and Tools***. The ingredients used are fresh PKO which is obtained directly from PTPN VII Bekeri Central Lampung and several fresh old coconuts. The chemicals consist of absolute ethanol p.a., technical ethanol, NaOH, HCl 35%, distilled water, Tween 80, and some chemicals for analysis. The tools used: Erlenmeyer 1 L for PKO ethanolysis reaction, hot plate-magnetic stirrer, rotary evaporator, oven, separating flask, water bath, vortex, pycnometer, 15 mL centrifuge tube, viscometer, and supporting tools.

***Preparation of Ethoxy Solutions.*** The preparation of the ethoxy solution, namely 90% ethanol solution containing 1% NaOH (w / w PKO) was carried out following the method of Murhadi *et al* [15] with modifications. The calculation for the best mole ratio treatment for the ethanolysis reaction of PKO is the mole ratio of ethanol (in ethoxy solution) to PKO moles = 16, as follows. The molecular weight of ethanol (C2H5OH) = 46 and the molecular weight of PKO (assuming it is trilaurine) are 638. For the production of ethanolysis products from PKO 120 g is equivalent to 120/638 x 1 mol PKO = 0.1881 mol, then for a mol ratio of = 16, it is necessary The ethanol solution is 16 x 0.1881 mol = 3.0094 moles of ethanol or the equivalent of 3.0094 x 46 g = 138,43 g 100% ethanol. To make an ethoxy solution containing 90% ethanol - 1% NaOH (w/w PKO) with 120 g of PKO experimental unit weight, using 138.43 g absolute ethanol (100%), it is necessary to mix 15.38 g of distilled water (so that the ethanol concentration to 90%). Then into the 15.38 g distilled water was added 1.2 g NaOH (1% w / w PKO) so that the total weight of the ethoxy solution became 155.01 g, which is 138.43 g absolute 100% ethanol + 15.38 g distilled water + 1.2 g NaOH. A total of 1.2 g NaOH pellets are dissolved in 15.38 g distilled water until completely dissolved (heat will arise), then add 138.43 g absolute ethanol (100%), resulting in 155.01 g ethanol 90% containing NaOH 1% (w/w PKO) or called ethoxy solution.

***Production of Ethanolysis Products from PKO.*** The mole ratio of ethoxy solution to PKO used was 16. A total of 120 g of PKO was mixed with 155.01 g of ethoxy solution in a special 1L Erlenmeyer flask, then placed on a hot-magnetic stirrer with a rotating speed of 1000 rpm for 3 minutes at an ethanolysis reaction temperature of 60 °C. The reaction is stopped by dropping 30 drops of 35% HCL solution. The reaction product mixture was put into a separating flask and left for 30 minutes. So that the separation between the layers is clear. The top layer (crude ethanolysis product, pale yellow) is separated from the bottom layer (residual PKO, etc, is bright yellow).

***Making Coconut Milk***. Some old coconuts are peeled and the flesh is taken, shredded, weighed 1000 g to make the main coconut milk by adding 500 mL of boiling water, then stir and knead until evenly, squeezed using a filter cloth to obtain the main coconut milk.

***Research methods.*** Research consists of two factors. The first factor is the thickness of the coconut milk consisting of four levels, namely the main coconut milk mixed with water with a ratio of 1:0; 1:1; 1:2; and 1:3 (v/v). The second factor is the formulation of the emulsifier mixture (ethanolysis products of PKO and Tween 80) which will be added to fresh coconut milk as much as 1% (w/v), consisting of 10 levels, namely with mixed HLB values = 3, 6, 7, 8, 9, 10, 11, 12, 15 and control. To obtain the HLB value for the mixture of 2 emulsifiers, a certain ratio is carried out. For example for the value of HLB = 6, use the equation: 15 (x) + 3 (100-x) = 6 (100), so that for a 100 mg mixed unit, we get 15x + 300 -3x = 600, then 15x - 3x = 600 - 300… 12x = 300… and x = 25 mg, or it takes a Tween 80 weight of 25 mg and an emulsifier from PKO ethanolysis of 100-25 = 75 mg. With the same calculation, a mixture of each emulsifier composition will be obtained for each of the HLB values 7, 8, 9, 10, 11, and 12. The treatment was repeated 3 times, analyzed with a complete randomized block design (RAKL). The experimental unit for the amount of coconut milk is 12 mL. The ingredients of four types of coconut milk, each of which was analyzed for moisture content, density, and viscosity [16]. To see whether there were differences between treatments, analysis of variance was carried out at the real level of 1 and 5% and further analysis with the Duncan New Multiple Range Test (DNMRT) at the 5% real level. Observations consisted of: testing the stability of coconut milk emulsion with a creaming index [17].

## 3. Results and Discussion

***Water Coconut.*** The water content value of coconut milk with the addition of water: 1:0; 1:1; 1:2; and 1:3 (v/v), respectively: 71.55% (± 0.63%); 85.85% (± 0.28%); 90.46% (± 0.30%) and 92.34% (± 0.26%). The water content of mother coconut milk is 71.55%, higher than the water content of coconut fruit, which is 42.2 [1] because in the manufacture of mother coconut milk in this study there was an addition of 500 mL of water to 1000 g. grated coconut flesh.

***Viscosity***. Viscosity is a value that indicates the viscosity unit of the dispersing medium of an emulsion system. The results of the greatest viscosity in this study were the mother coconut milk without further dilution (1:0, v/ v), namely, 8.80 $Mm^2/s$, while for coconut milk that has been diluted with the addition of water (1:1; 1:2; 1:3, v/v), the viscosity decreases, respectively to: 1.62; 1.40; 0.86 $Mm^2/s$. Increasing the viscosity of coconut milk prevents oil droplets from joining so that the stability of the emulsion increases [18].

***Density***. The average density or density of coconut milk with the addition of water: 1:0; 1:1; 1:2; and 1:3 (v/v), respectively: 0.979 (± 0.011); 0.987 (± 0.002); 0.988 (± 0.001); and 0.990 (± 0.002). The addition of water (dilution) to coconut milk causes an increase in the density value of thin coconut milk which is closer to the water density, which is around 1,000.

***Stability of Coconut Milk Emulsion***. During storage, for 18 hours at room temperature (25-28 $^oC$), coconut milk is separated into two parts, namely the cream layer on the top (oil-rich layer) and the transparent skim / serum layer at the bottom (water-rich layer). Coconut milk naturally contains coconut protein and phospholipids which can act as an emulsion emulator/stabilizer, but this is not effective enough in stabilizing the emulsion for a long time. Without the addition of an emulsion stability agent, coconut milk can only last for a few minutes [3]. The addition of the emulsifier mixture of PKO and TWEEN 80 ethanolysis products with a mixed HLB value of = 12, was able to maintain the emulsion stability from 44.84% (± 1.34%; coconut milk control) to 61.22% (± 2.18%). The addition of an emulsifier mixture with a value of HLB = 12 in coconut milk without dilution with the addition of water (1:0, v/v) had a significant effect on the stability of the coconut emulsion as shown in ‘figure 1’.

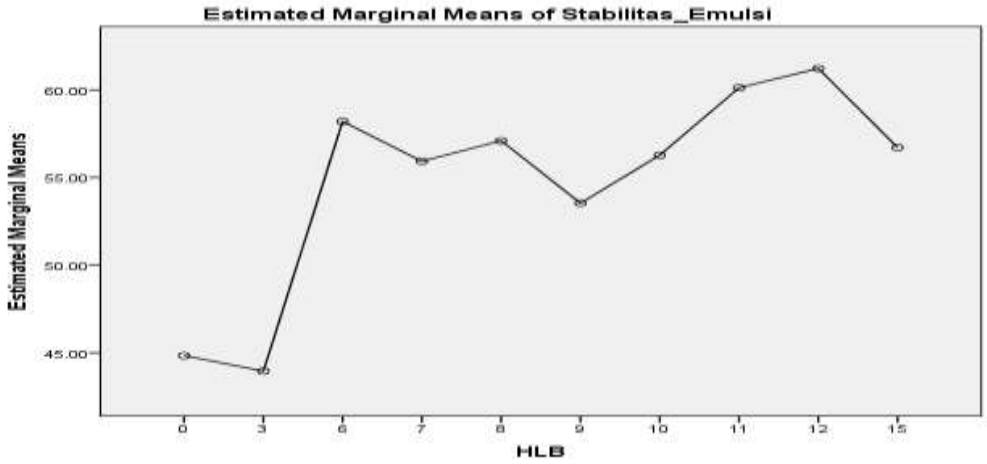
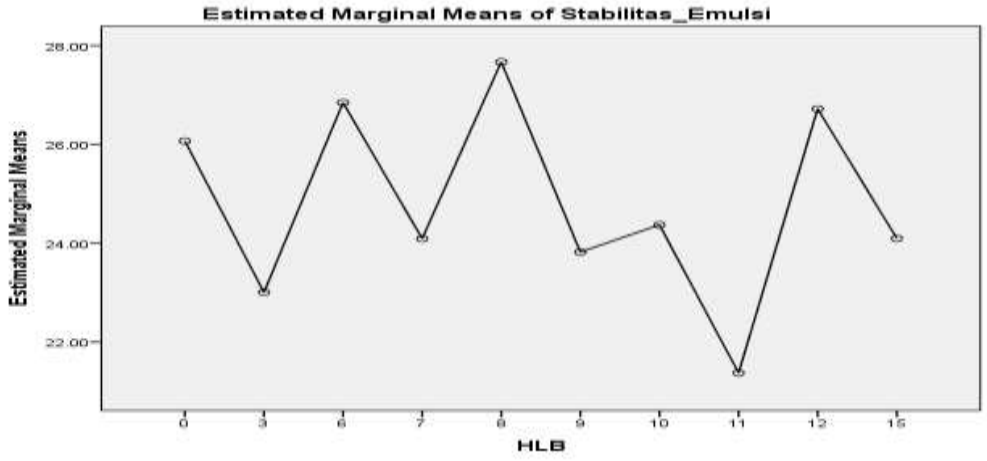
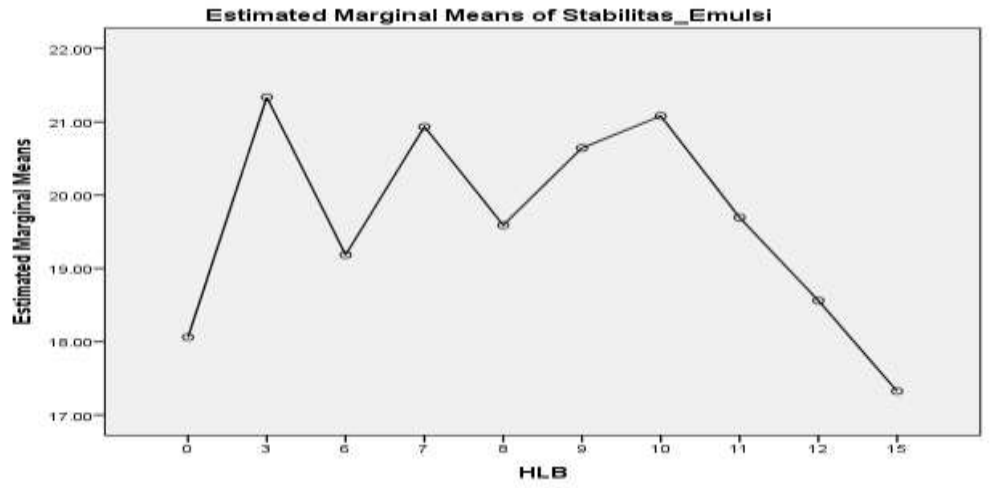



**Figure 1**. Emulsion stability values of coconut milk (without dilution of water) with the addition of the emulsifier mixture with HLB values of 3 up to 15 (HLB 0 is coconut milk control without the addition of an emulsifier)

It is known that the HLB value of Tween 80 is 15, while the HLB value of PKO ethanolysis products is around 3, referring to the value of the Mono-Diacylglycerol emulsifier from Fully Hydrogenated Palm Kernel Oil (MDAG) with an HLB value = 3 [19]. The mixing of the two causes a change in the HLB value of the emulsifier mixture, depending on the mixing composition. The stability value of coconut milk emulsion diluted with the addition of water at a ratio of 1:1; 1:2; and 1:3 (v/v) decreased drastically, respectively: 26.72% (± 1.32% for HLB = 12 treatment, control 26.07 ± 0.44%), 21.08% (± 0.46% for treatment HLB = 10, control 18.06 ± 3.33%); and 20.24% (± 2.38% for HLB = 9 treatment, control 13.92 ± 0.95%). details can be seen in ‘figure 2’.




A

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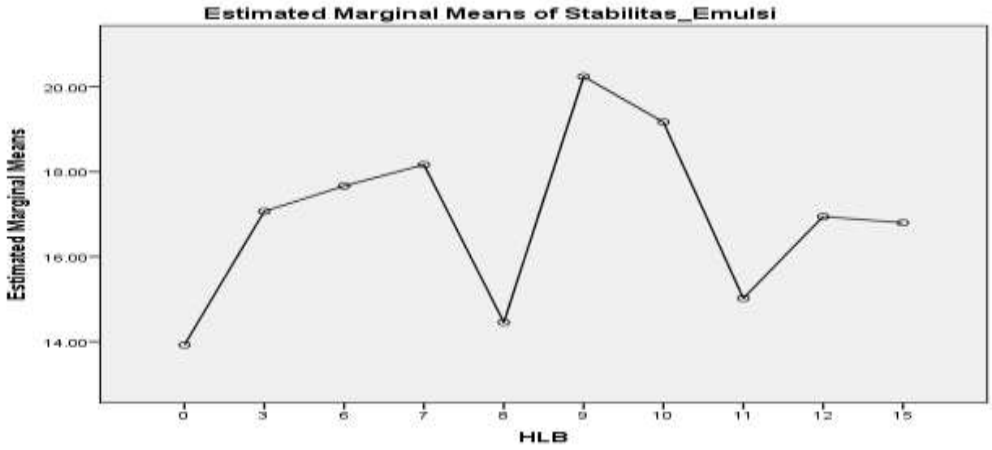


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**Figure 2.** The emulsion stability values of coconut milk diluted with the addition of water at the ratio: 1:1; 1:2; and 1:3 (v/v) and added the emulsifier mixture with HLB values from 3 up to 15 (HLB 0 is coconut milk control without the addition of emulsifier).

Coconut milk, if left for a few minutes will produce 2 layers, namely the top layer (called cream) with high oil content and skimmed with low oil content [20]. Based on 'figure 2', coconut milk is diluted with the addition of water at the ratio: 1:1; 1:2; 1:3 (v/v), then the treatment of adding the emulsifier mixture in the HLB values range of 3 up to 15 did not significantly affect the stability of coconut milk emulsion.

## 4. Conclusion

The best emulsion stability value was in the treatment of fresh coconut milk without the addition of water with a mixture of HLB 12 (61.22% ± 2.18%) and the lowest was in fresh coconut milk without the addition of water with a mixture of HLB 3 (43.95% ± 2.60%) with coconut milk emulsion stability. as control was 44.84% (± 1.34%). The addition of the emulsifier mixture at the value of HLB = 12 in fresh coconut milk without diluting with water (1:0, v/v) had a significant effect on the emulsion stability of the coconut milk. Furthermore, the emulsion stability value of coconut milk diluted with the addition of water (1:1; 1:2; 1:3, v/v) decreased drastically, so it can be concluded that the treatment has no significant effect on the stability of coconut milk emulsion in the addition of the emulsifier mixture with HLB values interval from 3 up to 15.

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