

## THE EFFECT OF ESSENTIAL OIL CONCENTRATIONS ON PARTICLE SIZE OF KENCUR (*Kaempferia galanga L.*) NANOEMULSIONS WITH MALTODEXTRIN AND TWEEN 80 AS EMULGATORS

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**Abstract:** Kencur (*Kaempferia galanga L.*) essential oil nanoemulsion was proposed to replace baby powder which has been banned in several countries. This study aimed to determine the effect of various kencur essential oil concentrations on particle size and to measure their stability during storage. This research was initiated by examining essential oil quality and followed by the formulation of nanoemulsion with maltodextrin and tween 80. PSA characterized it, and stability was observed for six weeks. The results showed that the essential oil of kencur was of good quality with a clear yellow color oil, a distinctive odor of kencur, 0.933 g/mL of density, and a 1.480 refractive index value. This value is considered standard in Indonesia's National standards (SNI) of essential oil. The L1, L2, L3, and L4 nanoemulsion formulas have particle sizes: 20.4 nm, 20.3 nm, 21.7 nm, and 26.2 nm, respectively. L1 (0.475) is chosen as the best formula based on the PI value. The formulas showed good stability and homogeneity for six weeks of storage. Its pH is also persistent at room temperature (30 °C) or in refrigerator storage (7 °C).

**Keywords:** *Kaempferia Galanga, L.*, Nanoparticles, Emulsion, Essential Oil.

### INTRODUCTION

Lack of education about the dangers of using powder in infants (0-12 months) is the leading cause of the high rate of upper respiratory tract infections in infants. 58% of infants and toddlers in Indonesia still use powder, while 85.7% of baby powder users are exposed to upper respiratory tract infections [1]. This data might be larger if the study was conducted in rural areas with minimal education about baby powder use. Many parents even use the powder as a remedy for all skin disorders in babies. Not all skin problems are solved with baby powder. There is even a possibility that the use of powder will aggravate the skin disorder. An investigation of the relationship between the use of baby powder and the incidence of atopic dermatitis has been carried out [2]. The results concluded that giving baby powder is related to the incidence of atopic dermatitis. At the same time, the treatment of dispensary dermatitis must be done by improving the skin's hydration and applying moisturizers. In addition, pediatricians in various countries have recommended no longer using talcum powder on babies because the fine particles are insoluble in water and harmful to the lungs. If it settles on the mucous membranes, the powder particles will interfere with the cilia, bronchi, and alveoli function and make it harder to clean the lungs [3].

A new formula is needed that can overcome skin problems that often appear in babies, such as itching due to prickly heat or dry skin. Moisturizer softens the skin and reduces itching, creating a layer of oil on top of the skin that can trap water underneath, to prevent the penetration of irritants, allergens, and bacteria. Moisturizers can be in the form of lotions, creams, and ointments. Using moisturizers or gels in dealing with disorders of the baby's skin is safer than using powder.

The formulation should not be in powder but in the form of a lotion or gel. In addition, products for babies must be of safe ingredients if absorbed by the body or swallowed. The nanoencapsulation of kencur dregs powder has been used as a prickly heat treatment [4]. Kencur was chosen as the main active ingredient in manufacturing nanoemulsions because it is safe for consumption and is safe when absorbed into the body. In addition, kencur is also easy to obtain because of its abundance in Indonesia.

Kencur effectively treats various diseases including cough, nausea, swelling, ulcers, and antitoxin [5]. Kencur has also been reported to have medicinal potential for hypoglycaemics and antituberculosa [6], antioxidant, anti-inflammatory [7-8], and anti-cancer [9]. Kencur is used to mix in herbal drinks, so it is safe to be absorbed into the body.

Nanoemulsions are transparent dispersion preparations of oil and water, which are stabilized by the molecular film interface of surfactants and co-surfactants. They are thermodynamically stable and have droplet sizes of less than 100 nm. The type of nanoemulsion depends on the composition or materials used, namely: oil in water nanoemulsion, in the form of oil droplets dispersed in the water phase. Water-in-oil type, in which water droplets are dispersed in the oil phase as an emulsion [10]. The nano-sized particles (nanoparticles) allow for better distribution of products and can expand the surface contact of the material particles. Nanoparticles prolong and regulate drug release during the delivery process to the target. Natural polymer is often used as a drug carrier system.

This research was conducted by applying a natural maltodextrin polymer as a coating agent with the addition of kencur (*Kaempferia galanga L.*)

essential oil as the active ingredient. The purpose of this study was to determine the effect of adding various concentrations of kencur essential oil to the nanoparticle's size and the characteristics of the solution during storage.

## RESEARCH METHOD

### Materials and instrumentation

The materials used in this research include kencur essential oil, distilled water, maltodextrin, and tween 80. The tools used in this research include a magnetic stirrer ST-2B, analytical balance, 300 V/T Ultrasonic Homogenizer, Ultrasonic Bath Homogenizer Leela Sonic, Particle Size Analyzer Horiba Scientific SZ-100, pH meter, and thermometer.

### Procedures

#### Nanoemulsion synthesis

The coating solution was prepared by dissolving 3 g of maltodextrin in 100 mL of distilled water and then adding 2 mL of Tween 80. This mixture was stirred for 30 minutes. The next stage is the oil coating process. The essential oil is added to the coating solution in various ratios (Table 1).

Table 1. The ratio of Coating Solution and Galanga Essential Oil

Sample	Coating (mL)	Galanga EO (mL)
L1	100	0.5
L2	100	1
L3	100	1.5
L4	100	2

Each solution was stirred for 30 minutes. After that, the solution was homogenized with an ultrasonic wave for 5 minutes. Repeat the homogenization of the solution with the Ultrasonic Bath Homogenizer for 20 minutes.

#### Nanoemulsion Characterization

Nanoemulsion characterization was carried out on the L1, L2, L3, and L4 solution formulations using Particle Size Analyzer (PSA) instrumentation. The instrument works by the Dynamic Light Scattering (DLS) technique. Particle size and Polydispersity Index are the focus of the measured parameters.

### Nanoemulsion Stability Test

The nanoemulsion stability test was carried out on 2 solution formulations that produced significantly different particle sizes. The solution was placed in a closed container at 2 different temperatures, namely at room temperature and 7°C. Tests were carried out at 0-6 weeks of storage with pH, odor, and homogeneity as observation parameters.

## RESULTS AND DISCUSSIONS

### Nanoemulsion synthesis

Nanoparticles with emulsion form allow the oil phase to be dispersed in the water phase. This technique can also be used for other products with the same principle of increasing the solubility of oil in water. The essential oil of Kaempferia galanga has a clear yellow appearance, a characteristic odor of galanga. The density is 0.933 g/mL, and the refractive index is 1.480. The standard refractive index value of a kencur essential oil is 1.3-1.7[11]. Based on SNI 06-1312-1998, the essential oil is in the standard range. Coating material or the carrier will help the oil phase or active ingredients to distribute easier [12-13]. Maltodextrin was chosen as the carrier because it is commonly used in various food and pharmaceutical products [14-15]. Samples 1 and 2 are preliminary experiments to find the right formulation (Table 2). Observation of sample 1 showed a mixture with a cloudy appearance with a gel-like precipitate. It indicates that the solution has not yet formed an emulsion in nano size. On the third day, the solution was separated into each component, which indicates that a stable emulsion has not been formed. Preparation 2 showed more inhomogeneity of the mixture from the beginning. It shows that maltodextrin cannot stand alone to coat galanga essential oil. Samples L1-L4 were prepared by adding tween 80 as an emulsifier or surfactant. The results showed that a more stable emulsion solution was successfully formed. It shows that maltodextrin cannot be a coating to form nanoemulsions. It takes tween 80 as an emulsifier to make nanoemulsion formulations stable [16]. An illustration of the interaction of materials during the formation of nanoemulsions can be seen in Figure 1.

Table 2. preliminary observations of the emulsion process

No.	Maltodextrin (g)	Tween (mL)	EO (mL)	Day-1	Day-3
1	5	0	1	Cloudy solution and small gel-like precipitate.	Clear solution with white gel precipitate.
2	5	0	0.5	White granules precipitate and do not completely dissolve	White granules precipitate and do not completely dissolve
L1	3	2	0.5	Yellowish clear solution	Yellowish clear solution
L2	3	2	1	Yellowish clear solution	Yellowish clear solution
L3	3	2	1.5	Yellowish clear solution	Yellowish clear solution
L4	3	2	2	Yellowish clear solution	Yellowish clear solution

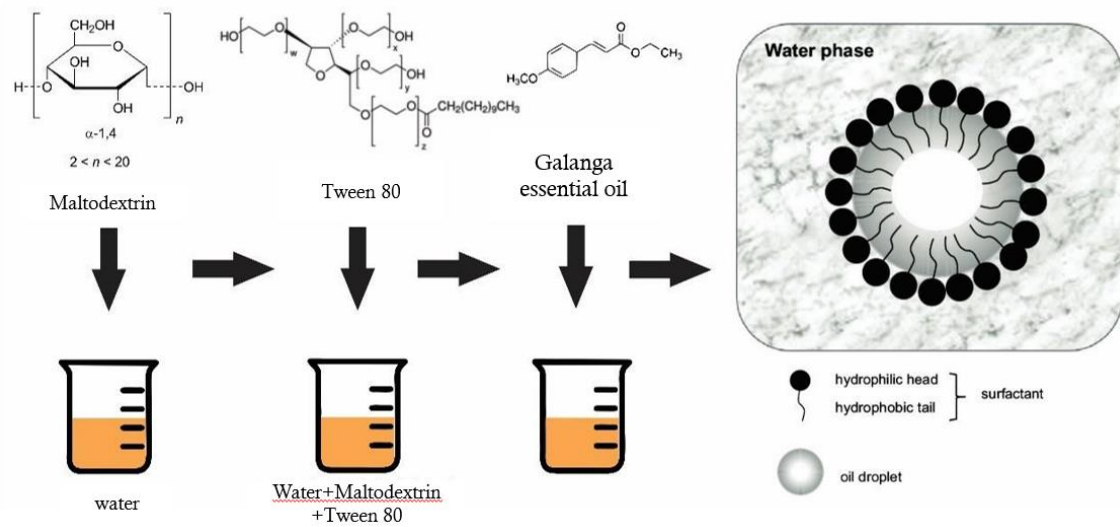


Figure 1. Emulsion formation process

Maltodextrin is soluble in distilled water because its structure has a hydroxy group. Solutions of maltodextrin and tween 80 are soluble because tween 80 is amphoteric, whereas tween 80 can act and react with acids and bases. Tween 80 can bind polar and non-polar solutions at the same time. The interaction between maltodextrin and tween 80 is a polar-polar interaction or hydrogen bonding, where the hydroxy group on maltodextrin binds to the oxide in tween 80 and vice versa. Meanwhile, galanga essential oil itself is non-polar. Therefore, adding essential oils will dissolve completely in the mixture because of the non-polar bond that occurred with the tween 80 carbon chain.

The uniformity of the emulsion particle size was optimized with ultrasonic waves. Ultrasonic waves can also reduce particle size. Homogenizer prevents particles from settling so that non-polar compounds are well dispersed. Both processes are needed to avoid agglomeration between the particles.

### Effect of Essential Oil Levels on Particle Size

Table 2 shows the results of the measurement of particle size and PI of L1-L4 solutions. Particle size observations showed that the emulsion obtained was nanometres in size ( $0 < 100$  nm). Measurements were carried out using the DLS method and resulted in particle sizes of 20.4 nm (L1), 20.3 nm (L2), 21.7 nm (L3), and 26.2 nm (L4), respectively, with the homogeneous distribution. Based on the nanoemulsion particle size, the more essential oils, the larger the particle size formed. It is concluded that nanoemulsion of Kencur essential oil with maltodextrin as coating material and tween 80 as a surfactant at this ratio tends to be effective in producing small particle sizes. In contrast to the ratios in other formulas which produce larger particle sizes, namely 110-120 nm [17], 147 nm [18] and 220 nm [19].

Table 3. Measurement results with PSA instrument

No. sample	Galanga EO (mL)	Distribution pattern	Particle size (nm)	PI
L1	0.5	Monodisperse	20.4	0.475
L2	1	Monodisperse	20.3	0.536
L3	1.5	Monodisperse	21.7	0.522
L4	2	Monodisperse	26.2	0.548

Another data we get is the PI value. This value indicates the quality of the uniformity of dispersion. Based on the results obtained, the PI values are 0.475 (L1), 0.536 (L2), 0.532 (L3), and 0.548 (L4). It shows that the L4 formulation with a particle size of 26.2 nm is more uniform than L2 and L3, which has particle size of 20.3 nm and 21.7 nm. The L1 formula achieves the smallest PI value with a particle size of 20.4 nm and 0.475 nm. Particle size distribution and polydispersity

index were used as size uniformity parameters. The polydispersity index value ranges from 0 to 1. The polydispersity index value close to zero indicates a homogeneous particle distribution. While the PI value exceeding 0.5 indicates high heterogeneity, it can increase the occurrence of agglomeration due to collisions between particles [20].

**Nanoemulsion Stability Test**

The stability test was carried out by observing the physical parameters. Nanoemulsion stability is one of the important factors for characterization related to product quality and efficacy. One of the ways to evaluate the stability of nanoemulsions is by the presence or absence of deposits in the product. Observations at L1 and L4 included the appearance of the product's homogeneity, odor, and pH for 6 weeks at

room temperature and refrigerator (7°C). The two formulas chosen were due to differences in essential oil content and particle size, which had significantly different ranges. The pH value that is safe to be applied to the skin surface is 4.5 to 6.5. Therefore the pH should be in the pH range of the product made in a stable state and maintained within that range [21].

Table 4. Nanoemulsion Stability Test at Room Temperature

Observation time (weeks)	Room temperature					
	L1			L4		
	pH	Smell	Homogeneity	pH	Smell	Homogeneity
0	4	Galanga	Homogeny	4	Galanga	Homogeny
1	4	Galanga	Homogeny	4	Galanga	Homogeny
2	4	Galanga	Homogeny	4	Galanga	Homogeny
3	4	Galanga	Homogeny	4	Galanga	Homogeny
4	4	Galanga	Homogeny	4	Galanga	Homogeny
5	4	Galanga	Homogeny	4	Galanga	Homogeny
6	4	Galanga	Homogeny	4	Galanga	Homogeny

Table 5. Nanoemulsion Stability Test at 7°C

Observation time (weeks)	Refrigerator temperature (7°C)					
	L1			L4		
	pH	Smell	Homogeneity	pH	Smell	Homogeneity
0	4	Galanga	Homogeny	4	Galanga	Homogeny
1	4	Galanga	Homogeny	4	Galanga	Homogeny
2	4	Galanga	Homogeny	4	Galanga	Homogeny
3	4	Galanga	Homogeny	4	Galanga	Homogeny
4	4	Galanga	Homogeny	4	Galanga	Homogeny
5	4	Galanga	Homogeny	4	Galanga	Homogeny
6	4	Galanga	Homogeny	4	Galanga	Homogeny

The results showed that despite having a range in particle size and essential oil content, the results obtained did not change significantly during 6 weeks of storage, both at room temperature and at 7°C. The galanga essential oil nanoemulsion formulations L1 and L4 had good physical stability. The observation of homogeneous transparent homogeneity indicated it, no separation of the coating and oil phases, the characteristic odor of galangal, and constant pH for 6 weeks storage at room temperature and refrigerator.

**CONCLUSIONS**

The essential oil used in the manufacture of nanoemulsions has good quality. This oil complies with the standard coverage of the test parameters in the form of a clear yellow color of the oil, a characteristic odor of kencur, an oil density of 0.933 g/mL, and a refractive index of 1.480. Characterization using PSA (Particle Size Analyzer) showed that nanoemulsions were successfully formed with particle sizes value of L1 to L4, respectively, 20.4 nm, 20.3 nm, 21.7 nm, and

26.2 nm. The best nanoemulsion formulation is the L1 formulation, with a particle size of 20.4 nm and a PI value of 0.475. The stability test on the two nanoemulsion formulations showed good stability, with good homogeneity properties and a stable pH of both formulations was 4.

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