The Effects of Stirring Time at High Speed on Particle Size and Dispersion of Rice Bran γ-Oryzanol Nanocream

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Abstract. *γ-oryzanol* is a constituent of rice bran and contains trans-ferulic acid, which is a highly effective antioxidant. It is, therefore, very potential to be incorporated in skin-care products that can provide protections from the sun, pollution, wind, and temperature. Such products would inhibit aging in, reduce damage of, and brighten the skin. Nanocream is cream with particle size ranging from 40 to 91.8nm, and highly effective in delivering the active compounds. The study aimed to determine the effects of stirring time at high speed on the characteristics of *γ-oryzanol* nanocream, which were particle size and dispersion. This method employed high speed mixer, set at 15,000 rpm because the shear stress it provides can reduce droplet size. The time variables of mixing were 0, 5, 10.5, 20, and 25 minutes. Results showed that increased stirring time produced smaller particle size, with the smallest particle size of 48.1 ± 12.1 nm and the largest dispersion area was 5-7 cm at 20 minutes. However, there appeared to be a re-agglomeration at 25 minutes as the particle size increased to 54.1 ± 17.2 nm. It was determined that the optimal stirring time in nanocream preparation was 20 minutes. There were correlations between stirring time and particle size, and stirring time and dispersion.

Keywords: *γ-oryzanol*, antioxidant, nanocream, *Rice Bran* , stirring time.

1. Introduction

Rice is the main staple for the majority Indonesians. However, utilization of rice bran is still limited to mostly livestock feed. Added values can be gained from rice bran by extractions of active compounds contained in it.[1] For example, defatted rice bran extract contains proteins, fiber, and mineral that can be used as supplement in food products.[2] Rice bran also contains γ-oryzanol, which consists of trans-ferulic acid ester and phytosterol.[3] Ferulic acid is a phenolic acid that is an effective antioxidant. The addition of 0.5% ferulic acid to a solution containing 15% L-ascorbic acid and 1% α-tocopherol showed an increased protection to the factors of four to eight when applied to the facial skin.

Extracted γ-oryzanol from rice bran oil can be incorporated in cosmetic products, such as cream for skin care. Cream that contains antioxidant(s) can provide greater protection from negative effects of exposure to the Sun, pollution, wind, and temperature. [4] This protection can inhibit aging and damage of skin. [5] Extraction of γ-oryzanol can be achieved with the ultrasonic method using the most polar solution, which is n-hexane and isopropanol at the ratio of 1:3 (w/v), to achieve a large yield.

One of the bioactive compounds in γ-oryzanol from rice bran is an antioxidant that can be used in skin care cream. [6] However, a main issue in antioxidant utilization is decreased activity when it undergoes prolonged exposure to air and light. Nanocream or semi-solid emulsion is a pharmaceutical formulation for body care and cosmetic products. Nanocream is prepared with high speed mixing method, a high-pressure homogenizer or ultrasonicator. [9] Nanocream with nano droplets at 40-91.8 nm can easily be dispersed on skin and increase the amount of the active compound delivery.[7] The use of a homogenizer can produce droplets with diameters of less than 10 μ m, and at15,000 rpm macro and micro emulsions (2.9 – 0.08 μm) will form.

The objective of this study was to determine the effects of stirring time at 15.000 rpm on the application of γ-oryzanol as antioxidant on the particle size and dispersion nanocream.

2. Research Method

The materials used consisted of γ-oryzanol product of extraction from rice bran using n-hexane and isopropanol solvent at the ratio of 1:3 (w/v). The previous studies explained that if the ratio used is 1: 3 for n hexane and isopropanol, there will be a decrease in the yield of or-oryzanol produced from rice bran [8]. Base

cream made from stearic acid, cetyl alcohol, glycerol, triethanolamine, Methyl Paraben, Propyl Paraben, and distilled water. The equipment used included ultrasonic extraction equipment, a high-speed mixer (Getra Ks-10000), and a Particle Size Analyzer. The research steps are presented in a flow chart on Figure 1.

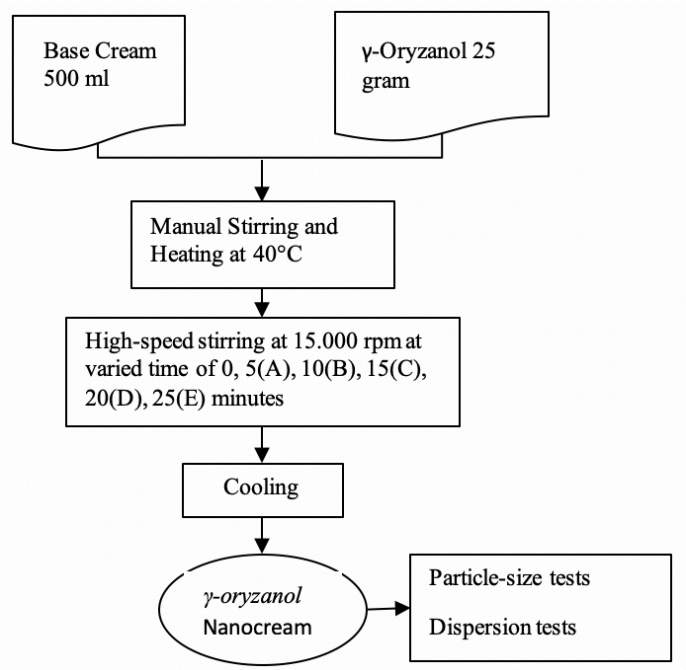

FIGURE 1. The flowchart of γ-oryzanol nanocream preparation

TABLE 1. Base Formulation O / A Cream

No.	Component	Quantity (%)	Function
1.	Stearic acid	25	Emulsifying agent and solubilizing agent
2.	Cetyl alcohol	1	*Stiffening agent*
3.	Glycerol	5	Emollient
4.	Triethanolamine	2	alkaline agents / pH regulators
5.	Methyl Paraben	0,1	Antimicrobial / Preservatives
6.	Propyl Paraben	0,05	Antimicrobial / Preservatives
7.	Aquadest	500	Solvent

(Source : ISFI (Ikatan Sarjana Farmasi Indonesia),1971)

Particle-size tests are carried out by preparing 1.5 mg of sample droplet size using a particle size analyzer (PSA) using dynamic light scattering technique [12]. Dispersion tests are carried out by means of this test carried out by emphasizing two glass slabs on 0.5 g of the preparation, measured for distribution on the surface of the glass for each additional load, which is 50, 100, 150, 200, and 250 grams [13]. The diameter of the distribution of the formula is calculated from the average length of the diameters from several sides using a circular formula.

3. Results and Discussion

3.1. Particle Size Analyses

The results from the analyses of particle size using a particle size analyser (PSA) are presented in Figure 2. As shown in Figure 2, stirring at 15,000 rpm produced particle sizes within the range of nano particle size of 40-91.8 nm. The difference in particle sized decreased with prolonged stirring time. However, particle sized

increased in 25 minutes because re-agglomeration occurred [9]. The results of previous studies with the ultrasonication stirring method with optimal stirring only up to 90 minutes while more than 90 minutes of particles agglomerated back so that the particle size becomes larger. Emulsion stability is the stability of a material where the emulsion contained in the material does not have the tendency to join with other particles and form separate particles. the stability of the nanocrim emulsion is higher because nonocrim particles are more homogeneous and fused. [10] As a comparison, a previous study showed that the stability of an emulsion increased from 88% to 97% from stirring at one and three hours, respectively.

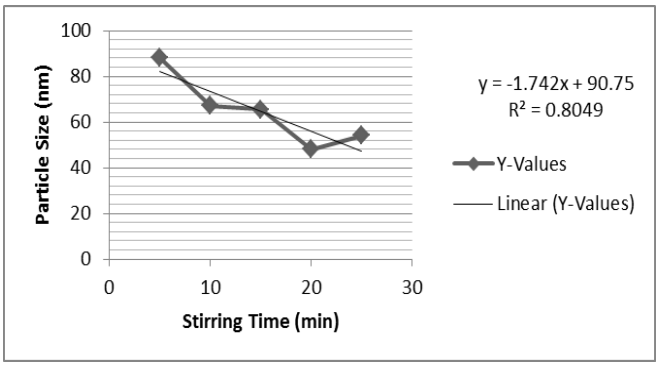

FIGURE 3. The results from particle size analyses using PSA

3.2. Dispersion Tests

These tests were conducted to determine the dispersion rate of the samples and evaluate the effects of stirring time at high speed on this characteristic. The results are shown in Figure 3.

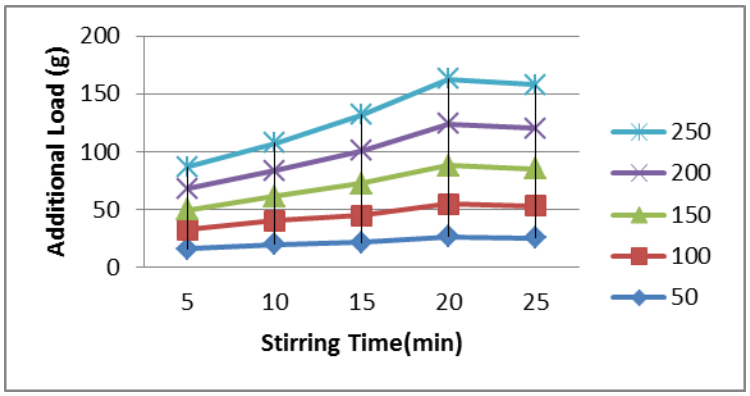

FIGURE 3 The results of dispersion tests

Based on the results in Figure 3, the dispersion values that met the 5-7 cm diameter requirement were achieved with nanocream samples of B, C, D, and E. [11] The value of good dispersion for the skin in the cream is 5-7cm. The A samples did not meet the requirement, which were the results of particle size. The particle size in A cream was larger than those of B, C, D, and E preparations. Furthermore, D nanocream produced the highest dispersion value because it also had the smallest particle size among the samples. There are significant differences in diameters and areas among the samples. Diameter forms a direct correlation with the area of a circle; the greater the diameter, the larger the area. It can be concluded that the optimal time of high-speed stirring in the preparation of nanocream was 20 minutes because at this time the sample with the smallest particle size and the largest dispersion area was produced. There was a re-agglomeration at 25 minutes of stirring and a reduction of dispersion capacity.

4. Conclusions

The increased of stirring time produced smaller particle size, with the smallest value of 48.1 $\pm$ 12.1 nm and the largest dispersion area was 5-7 cm at 20 minutes. There appeared to be a re-agglomeration at 25 minutes

as the particle size increased to 54.1 ± 17.2 nm. The optimal stirring time in nanocream preparation with the smallest particle size and the largest dispersion area was 20 minutes. There were significant correlations between stirring time and particle size, and stirring time and dispersion.

Acknowledgments

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