Conference Paper

Formulation and Physical Characterization of Sunflower Oil Nano Emulsion Containing Cinnamon Bark Extract

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Abstract.
This research developed a sunflower oil nano emulsion containing cinnamon bark extract. Cinnamon bark contains many bioactive compounds that provide various pharmacological benefits, including antioxidant properties. The bark extract, when developed into a nano emulsion system using sunflower oil, improves the antioxidant property. The maceration method using ethanol 95% was used to extract the cinnamon bark and then further developed into the nano emulsion system using between 80 as surfactant and PEG 400 as cosurfactant. The optimum nano emulsion formula contains 4% sunflower oil, and 30% PEG 400. The sunflower oil nano emulsion is transparent, with a globule size of 102 ± 32 nm. The optimum formula of cinnamon bark nano emulsion was achieved with 0.25% extract. This shows good physical characteristics and stability.

Keywords: nanoemulsion, cinnamon bark, sunflower oil

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1. INTRODUCTION

Cinnamomum bark is traditionally used for flavoring food and is also used for medical purposes due to its various pharmacological activities. There are four main economically important cinnamon species, *Cinnamomum verum* (Sri Lankan or Ceylon cinnamon), *Cinnamomum cassia* (Chinese cinnamon), *Cinnamomum loureiroi* (Vietnamese cinnamon), and *Cinnamomum burmannii* (Java or Indonesian cinnamon) [1]. Cinnamon bark contains many bioactive compounds such as cinnamyl alcohol, coumarin, cinnamic acid, cinnamaldehyde, and anthocyanins. Those compounds cause some pharmacological activity of cinnamon bark: analgesic, antibacterial, anti-diabetic, anti-fungal, antioxidant, antirheumatic, anti-thrombotic, and anti-tumor activities [2].

Our previous research showed that cinnamon bark extract (*Cinnamomum burmannii*) has very strong antioxidant activity, according to IC50 10.398 ± 0.075 ppm (<50 ppm)

[3]. The antioxidant activity of cinnamon bark extract can be applied for many purposes, including topical application. Using exogenous antioxidants topically in cosmetic and dermo pharmaceutical preparations decreases free radicals' action [4]. Topical antioxidants protect skin from sunburns and photoaging, inhibit pigmentation, stimulate skin repair, and increase skin hydration [5].

In order to increase the effectiveness of topical application, it is necessary to select an appropriate delivery system for cinnamon bark extract. That extract contains various compounds, and some of them possess hydrophobic properties. Nano emulsions have been considered a promissory delivery system for drugs with poor water solubility by increasing their permeation through the skin. They present kinetic stability compared to macroemulsions with higher surface area and optimal for topical applications [6,7]. Nano emulsions is a stable, isotopically clear dispersion of two immiscible liquids, stabilized by surfactant and cosurfactant molecules, and has a small droplet size in the range of 20-200 nm. [8]. The main components of nano emulsion are the oil phase, water phase, surfactant, and co-surfactant. In this research, sunflower oil was used as an oil phase. Sunflower oil has good antioxidant activity, which can enhance

the activity of the preparation [9]. Another study shows that sunflower oil could improve hydration of the adult skin without inducing erythema. Bioactive compounds of sunflower oil include alpha-tocopherol, phenolic compounds, oleic acid, and linoleic acids related to those activities [10].

This research aimed to develop the nano emulsion sunflower oil nano emulsion containing cinnamon bark extract.

Physical characterizations were conducted for nano emulsion preparation.

2. MATERIALS AND METHODS

2.1. Preparation of Cinnamon Bark Extract

Cinnamon bark that has been determined as *Cinnamomun burmannii* spesies was collected from Manoko, Lembang, West Java, Indonesia. The coarse powder of cinnamon bark was extracted by the maceration using ethanol 95% (1:3) with two additional steps of re-maceration. Extract than concentrated by vacuum rotary evaporator. Cinnamon bark extract the further evaluated by phytochemical screening, using standard procedure [11].

2.2. Formulation of Sunflower Oil Nano Emulsion

Sunflower oil nano emulsion was formulated using Tween 80 as surfactant and PEG400 as co-surfactant. Six formulas of nanoemulsions were prepared at variation in concentration surfactant dan cosurfactant (Table 1). Sunflower oil, tween 80, and PEG 400 were mixed and heated at 40^0C. Distilled water was heated at 40^0C and added to the oil phase. Mix the system using a magnetic stirrer at 1000 rpm for 20 minutes, then sonicated using a sonicator bath for 10 minutes [12].

TABLE 1: Formulation sunflower oil nano emulsion.

Ingredients (%)	F1	F2	F3	F4	F5	F6
Sunflower oil	4	4	4	4	4	4
Tween 80	20	22	24	26	28	30
PEG 400	20	22	24	26	28	30
Distilled water ad	100	100	100	100	100	100

2.3. Physical Evaluation Sunflower Oil Nano Emulsion

The optimum formula of sunflower oil nano emulsion was selected organoleptic, % transmittance evaluation, and globule size determination. % transmittances were determined using spectrophotometer UV/Vis (Shimadzu UV-1800) at a wavelength of 650 nm. The globule diameter of nano emulsion was determined using a particle size analyzer (Beckman Coulter LS 13 320) [13].

2.4. Formulation of Sunflower Oil Nano Emulsion Containing Cinnamon Bark Extract

Cinnamon bark extract was added to the optimum formulation of sunflower oil nano emulsion at concentrations 0.25; 0.5; 0.75; 1 %. Six formulas of nano emulsions were prepared at variation in concentration surfactant dan cosurfactant. Sunflower oil, tween 80, and PEG 400 were mixed and heated at 40^0C. The cinnamon bark extract was added to the oil phase using sonication to enhance solubility. Distilled water was heated at 40^0C and added to the oil phase. Mix the system using a magnetic stirrer at 1000 rpm for 20 minutes, then sonicated using a sonicator bath for 10 minutes [12].

2.5. Characterization of Sunflower Oil Nano Emulsion Containing Cinnamon Bark Extract

The optimum formula of sunflower oil nano emulsion containing cinnamon bark extract was selected by organoleptic and % transmittance determination. Further evaluation, including pH, viscosity, and stability study also conducted to the optimum formulation. The pH of nano emulsions was determined using calibrated pH meter (Metler

Toledo, Seven Compact^{TM} S220). The viscosity of preparations was assessed by viscometer Brookfield (RV D 220). The viscosity of preparation was measured at varying rotational speeds of the spindle (10; 20; 50; 100; 50; 20; 10 rpm) to determine the rheological behavior of nano emulsion [13]. Thermodynamic stability tests were performed by centrifugation, heating cooling, and freeze-thaw tests. Nano emulsion gel was centrifuged at 3750 rpm for 30 minutes. At heating cooling tests, the nano emulsion was stored at temperatures 4^0C and 40^0C for a minimum of 24 hours for each temperature and carried out for three-cycle. In the freeze-thaw test, the nano emulsion was stored at temperatures 4^0C and 40^0C, minimum of 24 hours at each temperature (three-cycle). Physical instabilities such as creaming, phase separation, and sedimentation were assessed at the end of each cycle [14].

3. RESULTS AND DISCUSSION

Cinnamon bark extract, containing many secondary metabolites based on phytochemical screening, including alkaloids, flavonoids, saponins, quinones, terpenoids, steroids, tannins, and polyphenols. Phenolic compounds of cinnamon bark give the antioxidant activity of the extract [15]. Other bioactive compounds such as cinnamaldehyde and eugenol also possess antioxidant activity [16]. This study developed cinnamon bark extract for a nano emulsion system to enhance skin penetration. Sunflower oil was used as an oil phase due to its antioxidant and other beneficial activities on the skin. The result of the optimization formula of sunflower oil nano emulsion showed in Table 2. The result showed that the optimum formula of sunflower oil is F6 that produces a transparent yellowish nano emulsion, with a transmittance value of 99.80 $\pm$0.07 %. Percent transmittance above 90% indicates the formation of nano globules. A particle size analyzer determined the globule size of nano emulsion F6 (Fig. 1). The globule size of nano emulsion F6 is 102 $\pm$ 32 nm, appropriate with nano emulsion globule size requirements (<200 nm). Therefore, F6 was used as the base formula for the sunflower nano emulsion to add cinnamon bark extract [17].

Table 2: The physical evaluation result of sunflower oil nano emulsion.

Formulation	Organoleptic	% Transmittance
F1	Tranparent, yellowish	75.15 ±0.02
F2	Transparent, yellowish	88.86 ±0.05
F3	Transparent, yellowish	77.97 ±0.03
F4	Cloudy, yellowish	22.60 ±0.02
F5	Cloudy, yellowish	15.71 ±0.23
F6	Transparent, yellowish	99.80 ±0.07

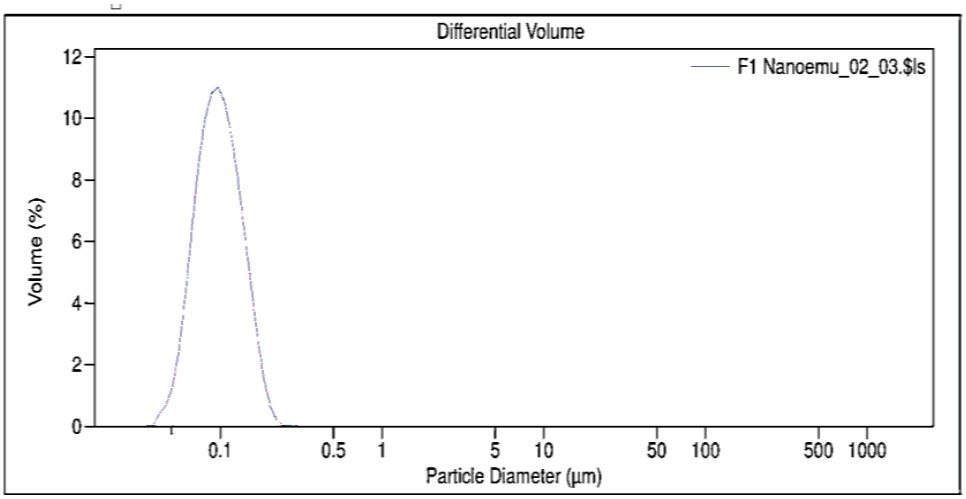

Figure 1: Globule size determination of nano emulsion F6.

Cinnamon bark extract was added to sunflower oil nano emulsion (F6) at various concentration 0.25; 0.5; 0.75; 1

% (Table 3). Organoleptic and % transmittance testing were used as an initial screening of to selected optimum formula. The optimum formula is F6A, based on the % transmittance value (>90%). However, if we want to increase the antioxidant activity of the nano emulsion, another formula (F6B, F6C, F6D) can be further developed (Table 4).

Table 3: Formulation of cinnamon bark nano emulsion.

Ingredients (%)	F6A	F6B	F6C	F6D
Cinnamon bark extract	0.25	0.5	0.75	1
Sunflower oil	4	4	4	4
Tween 80	20	22	24	26
PEG 400	20	22	24	26
Distilled water ad	100	100	100	100

Table 4: Initial screening of cinnamon bark nano emulsion.

Formulation	Organoleptic	% transmittance
F6A	Transparent, yellowish brown	91.82 ±0.06
F6B	Transparent brown	73.99 ±0.14
F6C	Transparent, brown	68.60 ±0.07
F6D	Cloudy, brown	58.31 ± 0.10

The final formula of F6A shows in Table 5. Phenoxy ethanol was added to the formulation to maintain biological stability. Alpha-tocopherol and ascorbic acid were added as antioxidants for sunflower oil and the extract. According to Tables 5 and 6, cinnamon bark nano emulsion F6A has good physical characteristics and stability. Cinnamon bark nano emulsions (F6A) show a transparent appearance. The pH of nano emulsion is appropriate with skin pH (4.5-6,5). Cinnamon bark nano emulsion shows Newtonian behavior due to its low viscosity and good homogeneity. The nano emulsion also has good physical stability due to centrifugation, heating cooling, freeze-thaw tests indicated by no creaming, phase separation, and sedimentation after each stability testing.

Table 5: Final formula of sunflower oil containing cinnamon bark extract.

Ingredients (%)	F6A
Cinnamon bark extract	0.25
Sunflower oil	4
Tween 80	20
PEG 400	20
Phenoxy ethanol	0.5
Ascorbic acid	0.1
Alpha-tocopherol	0.1
Distilled water ad	100

Table 6: Physical evaluation of nano emulsion F6A.

Parameter		Results
Organoleptic		Transparent, brown
pH		4.83 ±0.01
Viscosity (100 rpm)		349.33 ±0.58 cps
Rheology		Newtonian
	Centrifugation	Stable
Satbility	Heating-cooling	Stable
	Freeze-thaw	Stable

4. CONCLUSIONS

Sunflower oil nano emulsion containing cinnamon bark extract has been developed. The nano emulsion was prepared at oil concentration 4%, using tween 80 (30%) as surfactant and PEG400 (30%) as cosurfactant. The sunflower nano emulsion shows a transparent appearance with a globule size is 102 $\pm$ 32 nm. The optimum formula of cinnamon bark nano emulsion was achieved in addition extract 0.25%. The final formula of sunflower nano emulsion containing cinnamon bark extract has good physical characteristics and stability based on centrifugation, heating cooling, and freeze-thaw tests.

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