

Development of Sunscreen Emulgel Containing *Cinnamomum Burmannii* Stem Bark Extract

Sani Ega Priani¹, Haniva Humanisya², Fitrianti Darusman³

^{1,2,3}, Bandung Islamic University (UNISBA), Pharmacy Department, Taman Sari, Bandung 40116, Indonesia

Abstract: Ultraviolet B (UVB) rays are the major cause of sunburns. Sunscreens are used to protect the skin against harmful UV radiation. The objective of this research is to determine the sunscreen activity of *Cinnamomum burmannii* stem bark extract and finally to develop and characterize the sunscreen emulgel formulation. Cinnamon stem bark was extracted using ethanol by maceration process. Ethanol extract was formulated to topical emulgel preparation and submit to physical and sunscreen activity test. Determination of SPF values of the extract and emulgel were conducted *in vitro* using spectrophotometer. The result showed that both of the extract and formulated emulgel have potency to protect against UV-B radiation. The emulgel formulated was stabil base on physical stability test.

Keywords: Cinnamon bark, extract, emulgel, sunscreen, spectrophotometer

1. Introduction

Ultraviolet radiation (UVR) is defined as that electromagnetic radiation with wavelengths between x rays and visible light (100 and 400 nm) and is divided into UVA (320-400 nm), UVB (290-320 nm), and UVC (100-290 nm). UVB is largely responsible for erythema of sunburn and suntan of the skin [1]. Excessive exposure to UV carries profound health risks, including atrophy, pigmentary changes, wrinkling and malignancy [2]. UVR induced reactive oxygen species (ROS) production and generating photobiological reactions on the skin [3].

Topical application of sunscreens, containing ultraviolet-filters (UV-filters), is preferred protection against adverse effects of ultraviolet radiation (4). The main goals of sunscreens are to protect against UVB radiation and long wavelength UVA radiation, scavenge ROS, activate cellular repair systems, including DNA repair. Antioxidants are commonly added in commercial sunscreen preparations in order to reduce the photo-oxidative damage that results from UV-induced ROS production. [5] [6]

Cinnamomum burmannii Nees ex. Bl. is a shrub or a small tree commonly known as Indonesian cassia, Batavia cassia, and Padang Cassia that distributed in Southeast Asia and is cultivated in parts of Indonesia and Philippines [7]. *Cinnamomum burmannii* stem bark (cinnamon bark) is one of the plant that known have antioxidant and UV absorption property [8]. Our previous study was evaluated antioxidant activity of cinnamon bark extract. The study show that the extract have very high antioxidant activity, with the IC₅₀ value is 10.398 µg/mL ± 0.075. The major compound of *Cinnamomum burmannii* oil is cinnamaldehyde that known have antibacterial [9] and antioxidant activity [10]. Besides cinnamaldehyde, cinnamon bark also containing of cinnamic acid, that known to have sunscreen activity [11][12]. The natural sunscreen activity of the cinnamon bark need further investigated. Combination of sunscreen and antioxidant activity of cinnamon bark, give an advantage in sunscreen formulation.

Most common types of sunscreens presently in use are the topical preparations. Emulgel is one such topical drug delivery system that incorporates properties of both gel and emulsion [13]. Emulgels show good spreadability and ease of compliance [14]. Emulgel having physical stability better than cream and ointments [15].

There are some *in vitro* assays methods to determine sun protecting factor (SPF) of the samples, one of them is with measurement of the absorption characteristics of the sunscreens product on the basis of spectrophotometric analysis of dilute solutions. UV spectrophotometric method for SPF determination is easy, rapid, cost effective, and can be used for *in vitro* determination of SPF value in many cosmetic formulations [16].

The objective of this research is to determine the sunscreen activities of cinnamon bark extract and the formulated emulgel. The ultimate goal of this research is to develop an effective herbal sunscreen emulgel.

2. Methodology

2.1 Plant Material

Stem barks of *Cinnamomum burmannii* Nees ex. Bl. were collected from manoko, West Java, Indonesia, and determined at herbarium Bandung Institute of Technology (ITB), Indonesia. The stem bark after collection were dried and powdered to get a coarse powder.

2.2 Extraction Process

The dried powder of cinnamon bark was extracted by maceration with ethanol (EtOH) for 24 hours at room temperature for three times, and evaporated using a vacuum rotary evaporator.

2.3 Phytochemical screening

Preliminary screening of secondary metabolites such as alkaloids, flavonoids, saponins, quinones, polyphenol, tannin, terpenoids and steroid were carried out according to the common phytochemical methods [17].

2.4 Sun protection activity test of the extract

The test was done in vitro using spectrophotometric analysis (UV-Visible spectrophotometer/Shimadzu type UV mini-1240, Japan). Sample as much as 10.0 mg was weighed individually, transferred to 100 ml volumetric flask and finally diluted to volume with ethanol (100 ppm). Then, the solution was diluted to get sample concentration 10 and 50 ppm. The absorbance of samples in solution was measured in the wavelength range of 290 to 320 nm with every 5 nm interval. Each measurement was performed in triplicates. SPF value was calculated according to the Mansur equation.

$$SPF_{\text{spectrophotometric}} = CF \times \sum_{290}^{230} EE(\lambda) \times I(\lambda) \times Abs(\lambda)$$

Where EE (λ) - erythemal effect spectrum; I (λ) - solar intensity spectrum; Abs-Absorbance of sunscreen product; CF-correction factor (=10). The value of EE x I are constant and predetermined

Table 1: The Value of EE x I

Wave length (λ /nm)	EE x I (normalized)
290	0.0150
295	0.0817
300	0.2874
305	0.3278
310	0.1864
315	0.0839
320	0.0180

EE- Erythemal effect spectrum; I- solar intensity spectrum

2.5 Formulation Emulgel Containing Cinnamon Stem Bark Extract

Table 2: Formulation of Cinnamomum bark emulgel

Ingredients	Emulgel (%)
Cinnamon stem bark extract	1
Olive oil	20
Sodium lauryl sulfate	0.75
Cetostearyl alcohol	6.75
Methyl paraben	0.18
Propyl paraben	0.02
Alfa-tocopherol	0.03
Gel carbopol 934 2% (+TEA)	12.5
Purified water until	100

The composition of emulgel formulations is shown in table 2. First, the stock gel was prepared by dispersing Carbopol 934 in heated purified water (80 °C) and the gel pH was adjusted by triethanolamine (TEA), and the dispersion was cooled and left overnight. The oil phase of the emulsion was prepared by dissolving cetostearyl alcohol in olive oil while the aqueous phase was prepared by dissolving sodium lauryl sulfate in purified water. Both the oily and aqueous phases were separately heated to 60 to 70 °C then the oily phase was added to the aqueous phase with continuous stirring. Cinnamon bark extract, methyl paraben, propyl paraben, and tocopherol were dissolved in propylene glycol and then added to the emulsion. The obtained emulsion was mixed with the carbopol gel to obtain the emulgel.

2.6 Physical Stability Evaluation of Emulgel

Physical Appearance

The emulgel was inspected visually for their color, homogeneity and consistency

Centrifugal Test

Centrifugal test was performed at room temperature and at 3750 rpm for 5 hours by placing the 10 g of sample in centrifugal tubes.

Freeze thawing test

At one cycle of this test, emulgel was stored at the refrigerator (4°C) for 48 hours and then stored at the oven (40°C) for 48 hours. The test was conducted in 5 cycle. Observation about organoleptic and phase separation of the emulgel was done at the end of each cycle.

Rheological Study

The viscosity of the emulgel formulations was determined by using viscometer brookfield RV (DV-I Prime). Using spindle No 15. The maximum shear rate was 100 RPM while minimum shear rate was 10 RPM [18].

Accelerated stability test

The emulgel was stored at 40°C for 4 weeks. Physical appearance, pH, and viscosity of the emulgel was determined at every week.

2.7 Sun protection activity test of the emulgel

Determination SPF value of the cinnamon bark emulgel and emulgel base, were done use the same method with the extract, using spectrophotometer at the sample concentration equivalent with 100 ppm of extract. (dilution 1:100)

3. Result and Discussion

Coarse powder of cinnamon bark was extracted by maceration process using universal solvent (ethanol). From 300 g cinnamon powder, it was yield 50.08 g ethanol extract (16,7 %).

Table 3: Phytochemical screening on the plant and extract

Class of compounds	Powder of stem bark	Ethanol extract
Alkaloids	-	-
Flavonoids	+	+
Saponins	+	+
Tannins	+	+
Quinones	+	+
Polyphenol	+	+
Steroids & Triterpenoids	+	+
Monoterpenes & sesquiterpenes	+	+

(+) = Presence of constituents; (-) = Absence of constituents.

The phytochemical analysis of the coarse powder and ethanol extract of the cinnamon bark showed the presence of different groups of secondary metabolites such as flavonoids, saponins, tannins, quinones, terpenoids, and steroid which are medicinally importance.

The SPF value was determined to the ethanol extract. The extract was dissolved in ethanol to get 3 concentration of solution (10, 50, 100 ppm). The absorbance of the solutions were then measured at 290-320 nm with the range of measurement 5 nm, that appropriate with the waveleght of UV B radiation. EExI value was as described in table 1, while the CF value used in this measurement was 10 as recommended [19]. Below is an example of the SPF value calculation from the extract at concentration 100 ppm.

Table 4: SPF value calculation of ethanol extract at 100 ppm.

Wave lenght(nm)	EE x I	Abs (Avarage)	(EE x I) x abs x CF
290	0.0150	0.611	0.092
295	0.0817	0.429	0.350
300	0.2874	0.369	1.061
305	0.3278	0.331	1.085
310	0.1864	0.308	0.574
315	0.0839	0.298	0.249
320	0.0180	0.277	0.049
SPF Value			3.462

The SPF value was determined to three concentration of extract (10, 50, 100 ppm). Increase in SPF value in proportion to the increase in the extract concentration (Table 5).

Table 5: SPF value of cinnamon bark extract

Extract concentration	SPF value
10 ppm	0.184 ± 0.018
50 ppm	1.066 ± 0.085
100 ppm	3.462 ± 0.253

Cinnamon bark extract was formulate to emulgel preparation. Olive oil was used as oil phase in the formulation. Oily vehicles are more effective for producing a uniform and long-lasting film of sunscreen on the skin, and their emollient properties protect the skin against the drying effects of exposure to wind and sun. Olive oil have photoprotective activity and give the best SPF values compared with another herbal oil that usually used in topical formulation [20].

Emulgel formulation was found to be homogenous of semisolid consistency, creamy white in colour with having the little odor of cinnamon. The pH values of all prepared formulation ranged from 5.1-5.3.

Centrifugation and freeze thaw tests were done to evaluate emulgel physical stability. One of instability case of an emulsion is creaming, i.e. the appearance of an oil phase at the surface of the system or by the sedimentation of components having a higher density. It is thus obvious to use centrifugation methods in order to speed up the potential destabilization process [21]. Freeze-thaw has been widely used as an accelerated path to judge emulsion stability. In emulgel stability test that have been done, no phase separation after centrifugation and freeze thaw tests was seen in the cinnamon bark emulgel. Knowledge of rheological properties of the formulation, has importance, and may lead to optimize topical drug delivery from topical formulation. The formulated emulgel revealed the non-Newtonian shear thinning, pseudoplastic (Fig 1). In pseudoplastic flow behavior, the molecules at rest entangled together with the association of

immobilized solvent. Under the influence of shear, the molecules tend to become disentangled and align themselves in the direction of flow thus offering less resistance to flow and this together with the release of the entrapped inner phase accounts for the lower viscosity. Shear thinning behavior is a desirable property of topical semisolid preparation since it should thin during application and thicken otherwise [22].

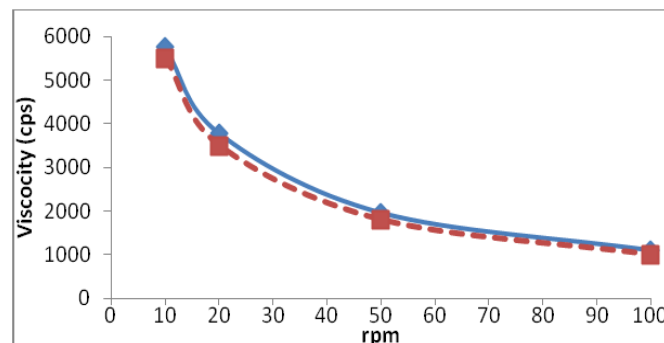


Figure 1: Rheogram of emulgel (upward/backward curve)

The pH and viscosity values of the emulgel were stablil for 4 weeks, during storage at 40°C. There were not statistically different ($p < 0.05$) between the pH and viscosity value before and after accelerated stability testing.

Table 6: pH and Viscosity of Emulgel (40°C)

Parameter	Time (weeks)				
	0	1	2	3	4
pH	5.23± 0.07	5.19± 0.08	5.21± 0.08	5.19± 0.09	5.18± 0.03
Viscosity (cps)	2155 ± 22.9	2101± 62.5	2161 ± 36.9	2140± 102	2116± 80

SPF value was determined to cinnamon bark emulgel and emulgel base using spectrophotometer method (Table 7). The result show that cinnamomon bark emulgel having an SPF value higher than emulgel base ($p < 0.05$). The result informed, cinnamon bark extract give significant effect for sunscreen activity of the formulated emulgel.

Table 7: SPF value of emulgel

Samples	SPF value
Cinnamon emulgel*	4.383 ± 0.063
Emulgel base	1.092 ± 0.141

*Statistically different with the emulgel base ($p < 0.05$)

4. Conclusion

Extract and formulated emulgel have potency to protect against UV-B radiation. The ethanol extract of cinnamon bark has sunscreen activity with the SPF value (100 ppm) 3.462±0.253. Cinnamon bark emulgel was physically stablil and has sunscreen activity with SPF value 4.383±0.141.

5. Future scope

To get more information about sunscreen activity of cinnamon bark, further research must be conducted to determined sunscreen activities of the fraction or isolates of cinnamon bark.

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Author Profile



Sani Ega Priani, received the B.S and M.S. degrees in Pharmacy from Bandung, Institute of Technology (ITB), Indonesia in 2005 and 2012, respectively. During 2007 until now, she stayed as a lectured in pharmacy department, Bandung Islamic University, Indonesia.