

SUNSCREEN PRODUCT CONTAINING PANDAN LEAF EXTRACT AND METHOD OF PREPARATION

Cross-Reference to Related Application

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This application claims priority to Singapore Patent Application No. 10202105617T filed 27 May 2021, the entire contents of which are hereby incorporated by reference.

Field of the Invention

10 The present invention relates to a sunscreen product containing a pandan leaf extract and method of preparation. In particular, the present invention relates to a sunscreen product containing a pandan leaf extract and an organic solvent-free method of preparing a pandan leaf extract for use in sunscreen product.

15 Background

Long-time exposure to the Sun's ultraviolet (UV) radiation can cause skin aging (e.g., wrinkles), sunburn, and even skin cancer. Consumers are advised to apply sunscreens other than wearing adequate clothing to avoid suffering from these health problems.

20 Commercial sunscreen products can be divided into two categories according to the active ingredients used, i.e., physical and chemical sunscreens. Physical sunscreens use zinc oxide and/or titanium dioxide as the active ingredients to absorb/deflect UV rays. Physical sunscreens are considered healthy but are not very comfortable for topical application, especially for people with dry skins as pure physical sunscreens

25 usually require use of high percentage (of up to 25%) of titanium dioxide or zinc oxide to provide sufficient protection.

On the other hand, chemical sunscreens use synthetic chemicals (for example, avobenzone, oxybenzone, aminobenzoic acid, and octocrylene, etc.) as active

30 ingredients. Such sunscreens are very effective in absorbing UV rays and easy to use. However, consumers' concern has never stopped regarding their unexpected side effects on skin. In addition, the disintegration of chemical UV filters induced by chlorinated water and UV rays leads to persistent environment-harmful by-products. As

a result, natural sunscreens have become more and more appealing recently as alternatives for the synthetic and physical UV filters in sunscreens.

It is therefore desirable to provide a product and a method that seek to address at least one of the problems described hereinabove, or at least to provide an alternative.

Summary of Invention

In accordance with a first aspect of this invention, an organic solvent-free method for preparing a pandan leaf extract for use in sunscreen product is provided. The method comprises (a) grinding pandan leaves into powder form; (b) soaking pandan leaf powder in an aqueous solution of sodium bicarbonate at an elevated temperature of 65°C to 85°C; (c) filtering the solution to collect the filtrate; (d) adding more aqueous solution of sodium bicarbonate to the pandan leaf powder remaining after the filtration; (e) repeating steps (b) to (d) at least once to obtain an extract solution; and (f) lyophilizing the extract solution to form lyophilized pandan leaf extract in powder form; and (g) blending the lyophilized pandan leaf extract with a cosmetic base to form a sunscreen product.

In accordance with an embodiment of this invention, the method further comprises blending the cosmetic base with titanium dioxide prior to blending the lyophilized pandan leaf extract with the cosmetic base.

In accordance with a second aspect of this invention, a sunscreen product comprising a lyophilized pandan leaf extract as an active ingredient is provided. In accordance with an embodiment of this invention, the sunscreen product further comprises titanium dioxide in an amount of less than 10% by weight based on the weight of the cosmetic base used to produce the sunscreen product.

Brief Description of the Drawings

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The above advantages and features of a product and a method in accordance with this invention are described in the following detailed description and are shown in the drawings:

Figure 1 is a graph showing a UV-Vis absorption of pandan leaf extract solutions (dash line: shows the readings for 20 times diluted solution of the as-extracted pandan leaf; solid line: shows the readings for lyophilized pandan leaf extract resuspended in deionized water at 1 mg/mL). The figure also shows pandan leaf extract in liquid form (1) and lyophilized pandan leaf extract in powder form (2).

Figure 2 is an FTIR spectrum of lyophilized pandan leaf extract.

Figure 3 is a graph showing the sun protection factor (SPF) values of the pandan leaf extract at different concentrations.

Figure 4 shows the results obtained for determining total phenolic content in the pandan leaf extract as gallic acid equivalent. Figure 4(a) shows images of assay solutions containing gallic acid/pandan leaf extract at different concentrations. Figure 4(b) shows a calibration curve of gallic acid solution. The square marker indicates the absorbance of pandan leaf extract at 2 mg/mL.

Figure 5 shows DPPH assay of the pandan leaf extract. Figure 5(a) shows images of DPPH solution in the presence of pandan leaf extract at various different concentrations. Figure 5(b) shows a plot of scavenging efficiency against the concentration of pandan leaf extract.

Figure 6(a) is a chart showing the absorbance of the reaction mixture at 470 nm as a function of time. Figure 6(b) is a photo of the liposome solutions after 2 hours of thermal autoxidation.

Figure 7(a) are photographs of cream blended with different amount of pandan leaf extract. Figure 7(b) shows typical UV transmittance curves of cream blended with different amount of pandan leaf extract.

Figure 8(a) are photographs of cream with 5wt% titanium dioxide blended with different amount of pandan leaf extract. Figure 8(b) shows typical UV transmittance curves of cream with 5wt% titanium dioxide blended with different amount of pandan leaf extract.

Figure 9 is a chart showing the *in vitro* SPF values of cream only and titanium dioxide included (5wt%) cream blended with different amount of pandan leaf extract.

Detailed Description

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The method disclosed in the present invention provides a promising application of Pandan (*Pandanus amaryllifolius* Roxb.) in sunscreen products. *Pandanus amaryllifolius* Roxb. is a tropical plant belonging to Pandanaceae family. It has fragrantly-scented leaves and the leaves are long, slender and spiky.

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Pandan leaves are known to have many uses such as for use as natural colorants, natural flavour and herbal medicine. In the present invention, it was found that pandan leaf extract prepared from pandan leaves can also be used in sunscreen products. The UV absorbing property of Pandan was studied. It was found that pandan leaf extract shows intrinsic UV blocking and antioxidant properties, and the pandan leaf extract is capable of boosting SPF of sunscreen products containing physical UV filters.

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In accordance with a first aspect of the present invention, an organic solvent-free method for preparing a pandan leaf extract from pandan leaves for use in sunscreen product is provided. The method comprises grinding pandan leaves into powder form and soaking the pandan leaf powder in an aqueous solution containing sodium bicarbonate at an elevated temperature of 65°C to 85°C. The solution is filtered, and the filtrate is collected. More aqueous solution of sodium bicarbonate is then added to the pandan leaf powder that remains after the filtration process. The steps of soaking the pandan leaf powder, filtering the solution and adding more aqueous solution of sodium bicarbonate are repeated at least once to obtain an extract solution. The extract solution is lyophilized to form a lyophilized pandan leaf extract in powder form prior to blending the lyophilized pandan leaf extract with a cosmetic base to form a sunscreen product.

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The pandan leaves can be ground using any suitable grinder or milling method. Milling method such as industrial available ball milling methods, including but not limited to ball mills, planetary mills, cutting mills, rotor and beater mills and mortar grinders, can be used to process the pandan leaves into powder form.

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The pandan leaf powder has an average particle size of 5-200 µm.

The pandan leaf powder obtained from the grinding process should be reasonably dry before the powder is added to the aqueous solution containing sodium bicarbonate for extraction. Any suitable drying method can be used to dry the pandan leaf powder if the
5 pandan leaf powder requires to be further processed to achieve a desired state of dryness.

The pandan leaf extract is obtained by soaking the pandan leaf powder in the aqueous solution containing 0.01 to 1 M sodium bicarbonate at an elevated temperature of 65°C
10 to 85°C, preferably 70°C to 80°C, more preferably about 75°C. The pandan leaf powder is soaked in the aqueous solution for a duration that is sufficient for effective extraction to take place. In one embodiment, the pandan leaf powder may be soaked for 30 to 60 min or longer.

15 The solution containing the sodium bicarbonate and the pandan leaf powder undergoes filtration and the filtrate containing the pandan leaf extract is collected. Any suitable method of filtration can be employed without departing from the scope of the present invention. In one embodiment, the solution is filtered through a membrane with a mesh or pore size of 0.45 μm , preferably 0.22-0.45 μm .

20 The steps of soaking the pandan leaf powder in the aqueous solution of sodium bicarbonate at an elevated temperature, filtering the solution and adding more aqueous solution of sodium bicarbonate to the pandan leaf powder remaining after the filtration process are repeated at least once, preferably twice, or more times to ensure effective
25 extraction of the pandan leaves.

The extract solution obtained from the method is then lyophilized to form a lyophilized pandan leaf extract in powder form prior to blending the lyophilized pandan leaf extract with the cosmetic base to form the sunscreen product. Lyophilization or freeze drying
30 is a process in which water is removed from a product after the product is frozen and placed under a vacuum. In the present invention, lyophilization is carried out by leaving the frozen Pandan extract in a Martin Christ freeze-drier for 1-3 days.

Cosmetic base is used as a base to formulate the lyophilized pandan leaf extract into
35 the sunscreen product. The cosmetic base can be a cream or lotion prepared from any

natural ingredients including, but not limited to, rose extract, cucumber extract, soya extract, lemon extract, beeswax and the like so long as the lyophilized pandan leaf extract can be mixed homogeneously with the cosmetic base and is stabilized. The lyophilized pandan leaf extract can be blended with the cosmetic base in any suitable proportion depending on the type of cosmetic base that is used and the sunscreen product to be produced. In one embodiment, the lyophilized pandan leaf extract is blended with the cosmetic base in an amount of 1-8% by weight based on the weight of the cosmetic base used.

10 In one embodiment, the method involves blending the lyophilized pandan leaf extract with the cosmetic base to form the sunscreen product. In another embodiment, the method involves blending the cosmetic base with titanium dioxide prior to blending the lyophilized pandan leaf extract with the cosmetic base. In one embodiment, the cosmetic base is blended with less than 10% by weight, preferably less than 5% by weight of titanium dioxide based on the weight of the cosmetic base used.

The lyophilized pandan leaf extract obtained from the method of the present invention is a nature derived cosmetic ingredient with remarkable SPF boosting effect. It is found to absorb intensely in the UVA and UVB regions and shows strong antioxidant property.

20 By blending the pandan leaf extract with the cosmetic base into a plant-based cream, the SPF is increased by up to five times with about 8% of pandan leaf extract loaded. The SPF boosting effect is further increased up to 138 times when an additional physical UV filter titanium dioxide is included. These surprising results are shown in Figure 9 and in Example 4 described hereinbelow. Sunscreen samples with SPF35 was obtained with a low loading of physical UV filter of about 5%. The strong SPF boosting effect can be attributed to the intrinsic UV blocking and antioxidant properties of the pandan leaf extract, which complement well with the physical UV filter to show good synergistic effect.

In accordance with a second aspect of the present invention, a sunscreen product comprising a cosmetic base and a lyophilized pandan leaf extract as an active ingredient is provided. In one embodiment, the sunscreen product comprises the cosmetic base and the lyophilized pandan leaf extract as an active ingredient. In another embodiment, the sunscreen product comprises the cosmetic base, the lyophilized pandan leaf extract, and titanium dioxide in an amount of less than 10%, preferably less than 5% by weight based on the weight of the cosmetic base used to produce the sunscreen product.

The cosmetic base can be a cream or lotion prepared from any natural ingredients including, but not limited to, rose extract, cucumber extract, soya extract, lemon extract, beeswax and the like. The lyophilized pandan leaf extract can be blended with the cosmetic base in any suitable proportion. Preferably, up to 1% by weight based on the weight of the cosmetic base, more preferably, up to 8% by weight based on the weight of the cosmetic base.

The method and product of the present invention have several advantageous. The pandan leaf extract obtained by the method of the present invention shows intrinsic UV blocking and antioxidant properties. The pandan leaf extract is capable of boosting SPF of sunscreen product containing physical UV filter. The sunscreen product containing the lyophilized pandan leaf extract of the present invention does not contain any synthetic chemical UV filters and the ingredient used as the active ingredient is a natural ingredient. The sunscreen product is environmentally friendly, and it can protect skin from free radical damage due to strong antioxidant property of Pandan. The lyophilized pandan leaf extract obtained by the method of the present invention can be added to other products including, but are not limited to, skin and face care products (for example, moisturizer, day cream, etc.), hair care products (for example, shampoos, hair mist, leave-in conditioners and styling agents) and baby care products (for example, lotions, oils, creams, etc.), as ingredient for protecting the skin or scalp from UV rays.

To facilitate a better understanding of the present invention, the following examples of specific embodiments are given. In no way should the following examples be read to limit or define the entire scope of the invention. One skilled in the art will recognize that the examples set out below are not an exhaustive list of the embodiments of this invention.

EXAMPLES

Example 1

- Organic solvent-free extraction of pandan leaf

Prior to extraction, dry pandan leaves were ground into powders using a vibrational mill (PULVERISETTE 0 from Fritsch) with a single stainless-steel ball of 50 mm in diameter.

The vibration amplitude (1-1.5 mm) and the duration of grinding (15-60 min) were varied to control the size and morphology of the final powders. To get the extract of pandan leaf, 7.223g of pandan leaf powder was soaked in 50 mL of 0.1M sodium bicarbonate solution at 75°C for 1 hr. Upon cooling down, the solution was filtered with 0.22 μ m
 5 membrane. The filtrate was then topped up with a new portion of fresh sodium bicarbonate solution (50 mL, 0.1 M), heated at 75°C for another 1 hr and subjected to filtration. The whole process of heating and filtration was repeated twice to ensure maximal extraction efficiency. The three portions of filtered solution were then combined and concentrated to 100 mL. The obtained pandan leaf extract solution has a brown
 10 colour and gives off a unique pandan aroma (Figure 1, item 1). In this Example, the pandan leaf extract solution was frozen first before it was placed in a Martin Christ freeze-drier for 1-3 days to obtain the lyophilized pandan extract in powder form (Figure 1, item 2). The frozen state of pandan leaf extract can be obtained by placing the extract solution at -20°C, or -80°C, or in liquid nitrogen (-196°C) for a sufficient period. The
 15 extraction efficiency is calculated as 18% based on mass.

Characterization

The lyophilized pandan leaf extract was characterized by UV-visible (UV-Vis) and FTIR
 20 spectroscopy. UV-Vis absorbance was measured for both as-extracted solution and the lyophilized pandan leaf powder resuspended in deionized water at 1 mg/mL.

As shown in Figure 1, both solutions show absorption in the UV-Vis region with an onset at approximately 580 nm. The intense absorption at the UVA (320-400 nm) and UVB
 25 (290-320 nm) regions implies the pandan leaf extract may be used as a UV filter for sun care purpose. Figure 2 shows the FTIR spectrum of lyophilized pandan leaf extract. The FTIR spectroscopy study of the lyophilized pandan leaf extract (see also the assignment of characteristic peaks in Table 1 below) suggests that pandan leaf extract is abundant in unsaturated alcohols, carboxylic acids, ketones, esters, aldehydes, and phenols. This
 30 finding is consistent with the literature that pandan leaf is rich in piperidine-type alkaloids (for example, pandamarine), quercetin, carotenoids, tocopherols, tocotrienols, and fragrant species (for example, 2-acetyl-1-pyrroline). (A. Jimtaisong, P. Krisdaphong, *Trop. J. Pharm. Res.*, 2013, 12, 425-431).

Table 1: Characteristic FTIR transmittance peaks and their assignments.

Wavenumber (cm ⁻¹)	Function group	Compound class
3421	O-H (stretching)	phenol, alcohol
2923	C-H (stretching)	alkane
2556	C-H (stretching)	aldehyde
1928	C-H (bending)	aromatic compound
1665	C=C (stretching)	alkene
1624	C=C (stretching)	α,β -unsaturated ketone
1452	C-H (bending)	alkane
1400	O-H (bending)	carboxylic acid
1359	O-H (bending)	phenol, alcohol
1047, 1033	C-O (stretching)	ester
999	C=C (bending)	alkene, monosubstituted
834	C=C (bending)	alkene, trisubstituted
706	C=C (bending)	alkene, disubstituted

Example 2

- 5 - Sun protection factor of pandan leaf extract

Lyophilized powder of the pandan leaf extract was resuspended in deionized water at different concentrations to measure UV-Vis absorption spectra in the range of 290-320 nm. SPF was calculated according to the Mansur method (G. Netto, J. Jose, J. Cosmet. Dermatol., 2018, 17, 1073-1083) using Equation 1 below:

$$SPF = CF \times \sum_{290}^{320} (EE(\lambda) \times I(\lambda) \times Abs(\lambda)) \quad (\text{Equation 1})$$

where CF = 10 and values of $EE(\lambda) \times I(\lambda)$ for specific wavelengths are listed in Table 2.

Table 2: Empirical values of $EE \times I$ at each specific wavelength.

Wavelength (λ , nm)	$EE \times I$ (normalized)
290	0.0150
295	0.0817
300	0.2874
305	0.3278
310	0.1864
315	0.0839
320	0.0180
Total	1

The calculated SPF values are 1.48, 2.96, 7.50, and 15.47 for lyophilized pandan leaf exact at concentrations of 0.1, 0.2, 0.5 and 1 mg/mL, respectively (see Figure 3).

Example 3

- Antioxidant property of pandan leaf extract

5 The antioxidant property of lyophilized pandan leaf extract was investigated by three separate methods.

First, the total phenolic content of lyophilized pandan leaf extract was determined using Folin-Ciocalteu reagent with gallic acid as a reference. (G.F. Deng, X. Lim, X.R. Xu, L.L. Gao, J.F. Xie, H.B. Li, *J. Funct. Foods*, 2013, 5, 260-266).

Briefly, 100 μL of lyophilized pandan leaf extract with different concentrations were dissolved in 1500 μL of Folin-Ciocalteu reagent (10x dilution). 1 minute later, an aqueous solution of sodium carbonate (1500 μL , 60 mg/mL) was added, and the mixture was incubated for 1.5 hr while shaking in the dark at room temperature. The absorbance of all samples was measured at 725 nm using UV-Vis spectrometer.

To compare the total phenolic content of pandan leaf extract with gallic acid, standard solutions of gallic acid were prepared at concentration of 0-100 $\mu\text{g/mL}$ in 80% methanol solutions and were subjected to the same procedure as described above to measure absorbance at 725 nm. A calibration curve was constructed by plotting absorbance as a function of gallic acid concentration. The absorbance of pandan leaf extract was then compared with that of the gallic acid standard solution and expressed as gallic acid equivalent (GAE). The results obtained are shown in Figure 4.

As shown in Figure 4, when the concentration of gallic acid increases, the reaction mixture becomes bluer (or darker in the black and white picture). Similarly, the reaction mixture with lyophilized pandan leaf extract also shows blue colour (or darker colour), implying that the pandan leaf extract is rich in phenolic compounds. The lyophilized pandan leaf extract at the lowest concentration (2 mg/mL) shows a blue colour (or a shade) similar to that of gallic acid at 80 $\mu\text{g/mL}$. By fitting the absorbance of reaction mixture back into the standard curve, the GAE value of 2 mg/mL, lyophilized pandan leaf extract was calculated to be 85.2 $\mu\text{g/mL}$, or 42.6 mg/g in dry mass.

The scavenging efficiency of lyophilized pandan leaf extract was then measured by the DPPH (2,2-diphenyl-1-picrylhydrazyl) assay. (J. Xie, K. M. Schaich, *J. Agric. Food Chem.* 2014, 62, 4251-4260). The lyophilized pandan leaf extract powder were re-suspended in Tris-HCl buffer (100 uM, 1 mL, pH7.4) at different concentrations, and further mixed
 5 with DPPH (1 mL, 500 µM in methanol) and incubated in the dark for 15 min. The absorbance of all samples was measured at 517 nm using UV-Vis spectrometer. As shown in Figure 5, when the concentration of lyophilized pandan leaf extract increases, the colour of the mixture solutions changes from purple to brown (from right to left of Figure 5a). The purple colour comes from the DPPH radical, which disappears in the
 10 presence of antioxidants. The result clearly suggests that the lyophilized pandan leaf extract indeed shows good antioxidant property.

The DPPH radical scavenging efficiency of the pandan leaf extract was calculated using Equation 2 below:

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$$\text{Scavenging efficiency} = (A_{\text{control}} - A_{\text{sample}})/A_{\text{control}} \times 100 \text{ (Equation 2)}$$

where A_{control} is the absorbance of control sample in the absence of lyophilized pandan leaf extract at 517 nm; A_{sample} is the absorbance of the sample in the presence of
 20 lyophilized pandan leaf extract at 517 nm.

The DPPH radical scavenging efficiency was further plotted against the concentration of lyophilized pandan leaf extract. See Figure 5. From the curve in Figure 5, the concentration for 50% scavenging efficiency is determined as 6.17 mg/mL.

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The antioxidant activity of the lyophilized pandan leaf extract was determined by the β-carotene bleaching method. (M.A. Prieto, I. Rodriguez-Amado, J.A. Vazquez, M.A. Murado, *J. Agric. Food Chem.* 2012, 60, 8983-8993). Briefly, one milliliter of β-carotene solution (0.2 mg/mL in chloroform) was mixed with 20 µL of linoleic acid and 200 µL of
 30 Tween 40. 40 µL of this solution was mixed with 40 µL of samples (40 mg/mL).

For control, the sample was replaced by 40 µL 80% methanol whereas for standard, the sample was replaced by 40 µL 40 mg/mL BHA (Butylated hydroxyanisole). After evaporation to dryness under vacuum at 40°C for 30 minutes, 20 ml of distilled water
 35 was added, and the mixture was shaken to form a liposome solution. The samples were

then subjected to thermal autoxidation using water bath at 45°C. The absorbance of the solution at 470 nm was measured using UV-Vis spectrometer every 20 minutes for a duration of 120 minutes. in dark room to avoid β -carotene oxidation. Antioxidant activity (AA) was calculated as percent inhibition relative to control using Equation 3:

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$$AA (\%) = (R_{\text{control}} - R_{\text{sample}}) / R_{\text{control}} \times 100 \quad (\text{Equation 3})$$

where R_{control} is bleaching rates of β -carotene in the absence of antioxidant, R_{sample} is bleaching rates of β -carotene in the presence of antioxidant. R is calculated by Equation 4:

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$$R = \ln(A_0/A_t)/t \quad (\text{Equation 4})$$

where A_0 is absorbance at $t = 0$ min and A_t is absorbance at $t = 120$ minutes

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As shown in Figure 6, the control remains colourless (Figure 6(b)(i)) while both samples with BHA or lyophilized pandan leaf extract show yellow colour (Figure 6(b)(ii) and Figure 6(b)(iii)) after 2 hours of oxidation, indicating lyophilized pandan leaf extract exhibits antioxidant activity similarly as BHA. Antioxidant activities of the lyophilized pandan leaf extract and BHA were calculated using Equation 3 and the results were 79% and 99%, respectively.

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Example 4

- SPF boosting effect of pandan leaf extract in sunscreen

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Due to intense absorption in the UVA and UVB regions as well as its good antioxidant property, it was found that the extract of pandan leaf can be used for suncare products. To study the SPF value of pandan leaf extract, a cream base formulation comprising plant extract and beeswax as the main ingredients was prepared. The formulation was blended with different amount of lyophilized pandan leaf extract powder to study its UV blocking property. The samples were then spread on a clean glass slide stickered with a 3M surgical tape at a density of 2 mg/cm² and dried in the dark for 15 minutes. The transmission spectrum of the sample was measured thrice in 280-400 nm range and used to calculate the SPF value according to Equation 5. (Y. Qian, X. Qiu, S. Zhu, *Green Chem.*, 2015, 17, 320-324).

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$$SPF = \sum_{290}^{400} E_{\lambda} S_{\lambda} / \sum_{290}^{400} E_{\lambda} S_{\lambda} T_{\lambda} \quad (\text{Equation 5})$$

where E_{λ} = CIE erythral spectral effectiveness, S_{λ} = solar spectral irradiance, and T_{λ}
 5 = spectral transmittance of the sample.

Figure 7 shows the appearance and transmittance spectra of the samples blended with lyophilized pandan leaf extract at different concentrations. It can be seen that as the concentration of lyophilized pandan leaf extract increases from 0 to 8%, the sample colour changes from yellow to brown (from left to right of Figure 7(a)) and the UV blocking effect is greatly increased. The calculated SPF values of the samples with 1%, 2%, 4% and 8% lyophilized pandan leaf extract are 0.66 ± 0.01 , 0.61 ± 0.02 , 1.09 ± 0.04 , and 1.27 ± 0.09 , respectively. As a comparison, the SPF of the cream alone is 0.25 ± 0.00 only (Figure 9). It is evident that lyophilized pandan leaf extract has certain SPF values.

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To further improve the sun blocking property, the cream was blended with 5% titanium dioxide first and then with different amount of lyophilized pandan leaf extract powder. The blended cream was then subjected to SPF measurement using the method as described hereinabove. As shown in Figure 8, introduction of titanium dioxide greatly improves the UV-blocking property in the UVB region and only whitens the samples containing lyophilized pandan leaf extract slightly. As expected, the SPF values are further increased to 1.64 ± 0.18 , 3.87 ± 0.79 , 14.94 ± 1.32 , and 34.67 ± 2.33 for the samples with 1%, 2%, 4% and 8% lyophilized pandan leaf extract, respectively (Figure 9). The excellent sun blocking property can be attributed to the synergistic effect of titanium dioxide and lyophilized pandan leaf extract, which combines the strong UVB blocking property of the physical UV filter and the strong antioxidant property of the Pandan leaf extract.

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Note that the concentration of titanium dioxide or zinc oxide is usually very high (>10%) in order to achieve high SPF values for sunscreens using physical UV filters only. The technology of the present invention is promising as it requires the use of only a small amount of physical UV filters and use of all natural ingredients in sunscreen products.

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Although several embodiments of the present invention have been shown and described, the present invention is not limited to the described embodiments. Instead, it would be appreciated by those skilled in the art that changes may be made to the embodiments without departing from the scope of the invention, the scope of which is set forth in the
5 following claims.

CLAIMS

1. An organic solvent-free method of preparing a pandan leaf extract for use in sunscreen product, the method comprising:
 - 5 (a) grinding pandan leaves into powder form;
 - (b) soaking the pandan leaf powder in an aqueous solution of sodium bicarbonate at an elevated temperature of 65°C to 85°C;
 - (c) filtering the solution to collect the filtrate;
 - (d) adding more aqueous solution of sodium bicarbonate to the pandan leaf
10 powder remaining after the filtration;
 - (e) repeating steps (b) to (d) at least once to obtain an extract solution;
 - (f) lyophilizing the extract solution to form a lyophilized pandan leaf extract; and
 - (g) blending the lyophilized pandan leaf extract with a cosmetic base to form a
15 sunscreen product.
2. The organic solvent-free method according to claim 1, wherein the pandan leaf powder is soaked in the aqueous solution of sodium bicarbonate at the elevated temperature for 45 to 90 min.
- 20 3. The organic solvent-free method according to claim 2, wherein the pandan leaf powder is soaked in the aqueous solution of sodium bicarbonate at 75°C for 60 min.
4. The organic solvent-free method according to claim 1, wherein the step of lyophilizing the extract solution comprises freeze drying the extract solution for 1 to 3
25 days.
5. The organic solvent-free method according to claim 1, wherein the lyophilized pandan leaf extract is blended with the cosmetic base in an amount of 1 to 8% by weight based on the weight of the cosmetic base used to form the sunscreen product.
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6. The organic solvent-free method according to claim 1, further comprising:
blending the cosmetic base with titanium dioxide prior to blending the lyophilized pandan leaf extract with the cosmetic base.

7. The organic solvent-free method according to claim 6, wherein the titanium dioxide is in an amount of less than 10% by weight based on the weight of the cosmetic base.
- 5 8. A sunscreen product comprising a cosmetic base and a lyophilized pandan leaf extract as an active ingredient.
9. The sunscreen product according to claim 8, wherein the lyophilized pandan leaf extract is in an amount of 1 to 8% by weight based on the weight of the cosmetic base.
- 10 10. The sunscreen product according to claim 8 or 9, further comprising titanium dioxide in an amount of less than 10% by weight based on the weight of the cosmetic base.
- 15 11. The sunscreen product according to any one of claims 8 to 10, wherein the cosmetic base is a cream or lotion prepared from natural ingredient selected from the group consisting of rose extract, cucumber extract, soya extract, lemon extract and beeswax.