SUNSCREEN ACTIVITY OF SUGAR PALM (*Arenga pinnata* (Wurmb.) Merr.) LEAF STALK ASHES EXTRACT

[1]Esti Rachmawati Sadiyah, [1]Endah Rismawati Eka Sakti and [1]Indah Ratnasari

[1] Department of Pharmacy, Faculty of Mathematics and Natural Sciences, Universitas Islam Bandung, Bandung, Indonesia

Corresponding author: esti_sadiyah@ymail.com

ABSTRACT

Sugar palm leaf stalk (petioles) ashes traditionally used as a daily cosmetic by Sundanese women to keep their skin smooth. Sugar palm leaf stalk ashes also used to treat acne, smallpox, and burns. The study was aimed to test the sunscreen activity of ashes extracts from sugar palm leaf stalk. The ashes were extracted using soxhlet and 96% ethanol as solvent. The sunscreen activity test was performed on the extract using UV-Vis spectrophotometer. Determination of Sun Protection Factor (SPF) value was done at 290-320 nm (UV-B wavelength) with 5 nm interval. The ashes extract of sugar palm leaf stalk showed the effectiveness of sunscreen activity at 10,000 ppm (SPF value = 9) as maximum protection. The SPF value was determined using Mansur mathematical equation. The determination of pigmentation transmittant was done at 322.5 – 372.5 nm, with 2.5 nm interval. Based on the result of pigmentation transmittance percentages, the sunscreen profile of sugar palm leaf stalk ashes extract (2000-10.000 ppm) showed the category of extra protection up to sunblock, according to classification from Balsam & Sagarin (1972). To be concluded, the ashes extract of sugar palm leaf stalk was a potential sunscreen. Further in vivo analysis should be done to confirm this potency.

Keywords: ashes, sugar palm, sunscreen, pigmentation.

1. INTRODUCTION

Sugar palm (*Arenga pinnata* (Wurmb.) Merr.) grows naturally in South East Asia to East Papua, and in Indonesia known as "aren", "enau" or "kawung" (Smits, 1996 : 53). The leaves of sugar palm are pinnates and its leaf stalk (petioles) have sheath at the base (Smits, 1996: 55). All parts of sugar palm from the root, stem, leaves, inflorescence and fruit are useful. The main product is "nira", or the sweet and aromatic fresh juice collected from tapping the stalk of inflorescence. Fermentation of the juice can be made into vinegar and brown sugar. Stem extraction can produce starch, and the white endosperm of immature seed are boiled with sugar to produce sweetmeat ("kolang-kaling"). Long black-grey fibres ("ijuk") can be collected from the trunk, the roots, the pith of the trunk, and leaf stalks (Smits, 1996: 54).

"Sarerang kawung" is the ashes resulted from the leaf stalk of sugar palm which is used for traditional cosmetics ingredient. Sundanese women in the past used sarerang kawung for facial powder to keep their skin smooth (Suwartapradja, 2003: 4). Sarerang kawung also used to treat acne, smallpox, and burns (Hidayati, 2009).

Lestari (2013: 3-4) had done the tyrosinase inhibition activity test of sugar palm leaf stalk ashes water extract and resulted IC_{50} value of 1,458.98 μg/mL, while the value resulted from ethanol extract was 1,960.91 μg/mL. The ashes contained five minerals that may have a role in tyrosinase inhibition, such as Al (344.56 mg/kg), Mg (82.6 mg/kg), Fe (26.76 mg/kg), Zn (6.10 mg/kg), and Cu (3.77 mg/kg) (Lestari, 2013: 5).

Zn contained in sugar palm leaf stalk ashes was one of inorganic substances that can be used as physical sunscreen. Physical blocker or particulate sunblock or inorganic sunscreen is the kind of powder that reflects or distorts ultra violet (UV) radiation. Physical sunscreen contain inert mineral particles such as titanium dioxide (TiO2), zinc oxide (ZnO), talk (silicate magnesium), magnesium oxide, kaolin, fero or ferioxide, barium sulfic, silicate, mica, and red petrolatum (Benson, *et al*., 2008 *in* Subchan, *et al*.,2011:145).

According to these information, sugar palm leaf stalk ashes contained the inorganic substances that can be used as physical blocker, but there was no explanation about the sample's sunscreen activities concerning Sun Protection Factor (SPF) values or percentages of Erythema and Pigmentation Transmittance (% Te and % Tp). For this reason, the research was conducted to test the sunscreen activity of sarerang kawung based on SPF, %Te and %Tp.

2. RESEARCH METHODS

Sugar palm leaf stalk was collected from Cisewu village, Garut, West Java. Plant species determination was done in Herbarium Jatinangor, Laboratory of Plant Taxonomy, Department of Biology, Mathematics and Natural Sciences, Universitas Padjajaran.

The leaf stalk that were used were the ones that already old, solid, dry, with brownish-yellow to brown colored sheath.

The leaf stalk were cut into pieces with 25-30 cm length, and burned for 1-2 hours to produce the greyish-white ashes. After the fire goes off, the ashes were left to cold for one night.

Sugar palm leaf stalk ashes were extracted using soxhlet and 96% ethanol as solvent with 1:8 ratios. The extract collected was then concentrated using waterbath in 50^{o}C.

Sunscreen activity test was done *in vitro* by determination of Sun Protecting Factor (SPF) value, erythema and pigmentation transmittance percentages using UV-Vis Spectrophotometry. The extract was tested on 2,000; 4,000; 6,000; 8,000 and 10,000 ppm and ethanol was used as blank sample. The absorbance measured showed the substance's activity in absorbing or reflecting UV light in the sample. For SPF value determination, absorbance was measured in UV-B radiation wavelength (290-320 nm) with 5 nm interval. Triple measurement was done for each wavelength. SPF value calculated from the absorbance measured, based on Mansur mathematical equation (Donglikar & Deore, 2016: 172):

$$\text{SPF spectrophotometric} = CF\ x\ \sum_{290}^{320} \text{EE}(\lambda)\ \text{x}\ \text{I}(\lambda)\ \text{x}\ \text{Abs}(\lambda)$$

With: EE (I)–erythemal effect spectrum; I (l)–solar intensity spectrum; Abs (l)–absorbance of sunscreen product; CF-correction factor (=10). The value of EE (λ) x I (λ) is constant and normalized as stated in **Table 1** (Donglikar & Deore, 2016: 172). **Table 2** showed the categories of sunscreen based on the value of SPF (Schalka & Reis, 2011: 514).

The percentages of erythema and pigmentation transmittance measurement were done on the samples using the same concentration as SPF measurement. Erythema transmittance was measured at 292.5-317.5 nm, and pigmentation transmittance at 322.5-372.5 nm, with 2.5 nm interval. Triple measurement was done for each wavelength.

Table 1. Normalized product function in the calculation of SPF

Wavelength (λ) in 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
	Total 1

Table 2. Categories of sunscreens based on the SPF value

Protection Level	SPF Value
Maximum	> 50
High	30-50
Medium	15-30
Low	42036

The determination of sunscreen category was based on Balsam & Sagarin (1972, *in* Athiyah *et al.*, 2015: 183, Yasin, 2017: 17, and Whenny *et al*., 2015: 155) as stated in Table 5, using the formula as follow:

$$\%\text{Te (Erythema Transmittance)} = \frac{\Sigma Ee}{\Sigma Fe} = \frac{\Sigma(TxFe)}{\Sigma Fe}$$

$$\%\text{Tp (Pigmentation Transmittance)} = \frac{\Sigma Ep}{\Sigma Fp} = \frac{\Sigma(TxFp)}{\Sigma Fp}$$

With: Ee-Ertyhema energy, Ep-Pigmentation energy, T-Transmission, Fe-Erythema Flux, and Fp-Pigmentation Flux. The value of Erythema Flux for each wavelength is showed in Table 3, and Pigmentation Flux is showed in Table 4.

Table 3. Erythema Flux

Wavelength (nm)	Erythema Flux (Fe)
290-295	0.1105
295-300	0.672
300-305	1
305-310	0.2008
310-315	0.1364
315-320	0.1125

Table 4. Pigmentation Flux

Wavelength (nm)	Pigmentation Flux (Fp)
320-325	0.1079
325-330	0.102
330-335	0.0936
335-340	0.0798
340-345	0.0669
345-350	0.057
350-355	0.0448
355-360	0.0456
360-365	0.0356
365-370	0.031
370-375	0.026

3. RESULT AND DISCUSSION

The sugar palm leaf stalk burning process yielded 0.95% of greyish-white ashes, while the extract was yellowish-white. Based on previous work by Ratnasari *et al.*

(2018), the same sample of sugar palm leaf stalk ashes contained Zn (1,132.0567 mg/kg ashes), which was one of inorganic substances that can be used as physical sunscreen. The sample also contained manganese (Mn) 548.5737 mg/kg, and selenium (Se) 109.4405 mg/kg.

Table 5. Sunscreen Activity Categories

Category	Transmittance	
	Erythema	Pigmentation
Sunblock	< 1%	3-40%
Extra protection	1-6%	42-86%
Standard suntan	6-12%	45-86%
Fast tanning	10-18%	45-86%

In SPF value determination, sample absorbance were measured in UV-B radiation wavelength (290-320 nm). UV-B radiation is the main cause of sunburn (erythema) and also in charge for photo aging and photo carcinogenesis (Larsen, 1994 *in* Rai and Srinivas, 2007).

SPF value is accepted globally to estimate a sunscreen protection, especially for UV-B radiation (More, 2007). Based on the result showed in Table 6, the sample SPF value increased in higher concentration and the highest was 9.005 (10,000 ppm). Although, according to sunscreen categories described by Schalka & Reis (2011: 514), the value showed low protection level.

Table 6. The sample SPF Value and Protection Level

Concentration (ppm)	SPF Value	Protection Level
2	2377	Low
4	4284	Low
6	6234	Low
8	7333	Low
10	9005	Low

Beside of SPF value, the percentages of erythema and pigmentation transmittance may also describe the sample sunscreen protection level. According to Cumpelik (1972, *in* Yasin, 2017: 20), the percentages of erythema or pigmentation transmission are the accumulation of UV energy that is transmitted by sunscreen on erythema or pigmentation spectrum, compared to erythema efficiency factor in each wave length between 292.5-372.5 nm.

Table 7 showed that based on percentages of erythema transmittance, the sample with concentration 8,000 and 10,000 ppm had fast tanning sunscreen category. On the other hand, based on percentages of

pigmentation transmittance, the same concentration showed sunblock activity.

Athiyah *et al.* (2015: 184) mentioned that a chemical substance has sunblock activity when it can totally protect the skin from sunrays that may cause erythema and pigmentation, specifically UV-A (322.5-372.5 nm) and UV-B (292.5-337.5 nm). On the contrary, substance with fast tanning activity absorb the least of UV-A and UV-B compared to the other sunscreen categories (Athiyah *et al.*, 2015: 186).

Fast tanning activity also showed by the sample with concentration 2,000 and 4,000 ppm, based on the percentages of pigmentation transmittance, but the resulted percentages of erythema transmittance did not showed any sunscreen activities. This result appeared to describe the sample potency in skin protection from pigmentation, but may not prevent erythema.

Table 7 The sample percentages of erythema, pigmentation transmittances and sunscreen category

Concentration (ppm)	%Te	Sunscreen Category	%Tp	Sunscreen Category
2	59,372	-	74,660	Fast tanning
4	46,860	-	58,771	Fast tanning
6	28,706	-	41,743	Extra protection
8	18,196	**Fast tanning**	30,182	Sunblock
10	14,592	**Fast tanning**	26,622	Sunblock

Higher sample concentration (6,000 ppm) showed better activity in skin pretection from pigmentation (extra protection category), but also did not prevent erythema because the resulted percentage transmittance was not included in the activity range. Sunscreen with extra protection category may absorb 95% or more UV light with 290-320 nm wave length (Wilkinson & Moore, 1982, in Athiyah *et al.*, 2015:185).

Based on the result of erythema and pigmentation transmittance percentages, the sample of sugar palm leaf stalk ashes extract might have more activity in protecting the skin

from UV-A radiation that cause pigmentation. The inorganic particles that contained in the ashes such as zinc, selenium, and manganese might have a contribution to this activity.

Smijs & Pavel (2011: 96, 99) mentioned that ZnO is more efficient in UV-A absorption, compared to TiO_2. Zinc oxide (ZnO) and titanium dioxide (TiO_2) are frequently used inorganic physical sun blockers. Both particles have UV attenuation properties from UV absorption, reflection and scattering of UV radiation and visible light. Antoniou *et al.* (2011: 1112) explained that ZnO and TiO_2 as physical sunscreens are very efficient, photostable, and offer protection extending into the UVA and visible ranges with almost negligible irritation and sensitization potential.

ZnO and TiO2 have opaque characteristic when applied to sunscreen formula, although the whitening effect of ZnO is lower than TiO2. The opaqueness of these sunscreen formulations results from the ability to reflect and scatter UV radiation and visible light (Smijs & Pavel, 2011).

To overcome the whitening effect from the big sized particles, titanium dioxide and zinc oxide are now frequently processed as microfine or nanoparticles (10–50 nm compared with 200–500 nm of the non-micronized form). These nanoparticles reflect/scatter and absorb UV, and they are transparent on the skin, thus enhancing the cosmetic acceptability of the product. Microfine TiO_2 has an absorption profile greater in the UVB but extends in the long UV-A. Microfine ZnO has a flat absorption profile that spans UV-B and UV-A (Antoniou *et al.*, 2011).

In other hand, selenium is one of natural products have been reported to enhance levels of antioxidant enzymes. Alpha-tocopherol (vitamin E), phloretin, ferulic acid, flavangenol, lipoic acid, uric acid, and a variety of flavonoids derived from plants are also known to have this activity (Amaro-Ortiz *et al*., 2014: 6210). Although the activity of this element did not directly interact with UV-rays, the content of selenium in the sample of sugar palm leaf stalk ashes might add a value to its potency as sunscreen.

The content of manganese in sugar palm leaf stalk ashes might also contribute to increase UV-A radiation absorption of the sample. Manganese doping has been shown to increase the UV-A : UV-B absorption ratio of titania, reduce free radical generation rates by over 90%, and provide free radical scavenging behavior (Wakefield *et al.*, 2004).

UV-A radiation comprises 90-95% UV-rays to reach the earth surface. UV-A radiation can cause tanning because of its ability to penetrate the skin deeper into the mid-dermis. UV-A radiation also can cause DNA damage, induce photo-carcinogenesis, photo-immunosuppression, photodermatosis, and photoaging (Barnetson, 2003 *in* Subchan, dkk., 2011:).

4. CONCLUSION

The ashes extract of sugar palm (*Arenga pinnata* (Wurmb.) Merr.) leaf stalk showed the potency to be developed as sunscreen, especially for protecting the skin from UV-A radiation, based on Zn and Mn content. The ashes content of selenium may also increase the level of antioxidant enzymes and improve its sunscreen activity. Further *in vivo* analysis should be done to confirm this potency.

Refferences

Amaro-Ortiz A., Yan B., and D'Orazio JA., 2014. Ultraviolet Radiation, Aging and the Skin: Prevention of Damage by Topical cAMP Manipulation, *Molecules*, **19**: 6202-6219.

Antoniou C., Kosmadaki MG., Stratigos AJ., Katsambas AD., 2011. Sunscreens – what's important to know, *J Eur Acad Dermatol Venereol*., **22**:1110–1118.

Athiyah M., Islamudin A., Rijai L., 2015. Aktivitas Tabir Surya Ekstrak Akar Bandotan (*Ageratum Conyzoides* L.) *Jurnal Sains dan Kesehatan*, **1**(4). p-ISSN: 2303-0267, e-ISSN: 2407-6082.

Donglikar MM., and Deore S., 2016. Sunscreens: A review, *Pharmagocnosy Journal*, **8**(3): 171-179.

Hidayati N., 2009. Manfaat Pohon Aren, http://www.niahidayati.net/manfaat-pohon-aren.html#more-6

Lestari MES., 2013. Potensi Abu dan Simplisia Pelepah Aren *(Arenga pinnata*.Merr) sebagai Inhibitor Tirosinase. *Skripsi* Departemen Biokimia, Fakultas Matematika dan Ilmu Pengetahuan Alam Institut Pertanian Bogor. Bogor. https://repository.ipb.ac.id/bitstream/handle/123456789/67797/G13mes.pdf?sequence=1&isAllowed=y

More BD., 2007. Physical sunscreens: On the comeback trail, *Indian J Dermatol Venereol Leprol*, **73**:80-5. Available from: http://www.ijdvl.com/text.asp?2007/73/2/80/31890

Rai and Srinivas, 2007. Photoprotection, *Indian J Dermatol Venereol Leprol*. **73**: 73-9. Available from https://tspace.library.utoronto.ca/bitstream/1807/47876/1/dv07028.pdf

Ratnasari I., Sakti ERE., dan Sadiyah ER., 2018. Uji Aktivitas Antioksidan Abu Pelepah Aren (*Arenga pinnata* (Wurmb) Merr.), http://karyailmiah.unisba.ac.id/index.php/farmasi/search/titles?searchPage=21

Schalka S. and dos Reis VM., 2011. Sun Protection Factor: Meaning and Controversies, *An. Bras. Dermatol,* **86**(3): 507-515.

Smits WTM., 1996. *Arenga pinnata,* (Wurmb) Merrill, in *Plants Resources of South-East Asia*. *No. 9. Plants yielding non-seed carbohydrates*, Editor: Flach, M. and Rumawas, F., Prosea Foundation, Bogor, Indonesia: 237.

Subchan P., Malik DA., Nahason WT., 2011. Fotoproteksi. *MDVI,* **38(**3).

Suwartapradja OS., 2003. *Arenga pinnata: A Case Study of Indigenous Knowledge on the Utilization of A Wild Food Plant in West Java*, [online at: http://arenindonesia.wordpress.com /makalah-aren/opan-s-suwartapradja/]

Smijs TG., and Pavel S., 2011), Titanium dioxide and zinc oxide nanoparticles in sunscreens: focus on their safety and effectiveness, *Nanotechnology, Science and Applications*, **4**: 95–112

Wakefield G., Lipscomb S., Hollanda E., and Knowland J., 2004. The effects of manganese doping on UVA absorption and free radical generation of micronised titanium dioxide and its consequences for the photostability of UVA absorbing organic sunscreen components, *Photochem. Photobiol. Sci*., **3**: 648-652

Whenny, Rusli R., Rijai L., 2015. Aktivitas Tabir Surya Ekstrak Daun Cempedak (*Artocarpus champeden* spreng), *Jurnal Sains dan Kesehatan*. **1(**4)

Yasin RA., 2017. Uji Potensi Tabir Surya Ekstrak Kulit Buah Jeruk Nipis (*Citrus aurantifolia*) Secara *In Vitro,* [Skripsi], Fakultas Kedokteran dan Ilmu Kesehatan, Universitas Islam Negeri Alauddin, Makassar