The Effects of Defatted Organic Red Jasmine Rice Bran Extract on Sun Protection Products**

Jiraporn Thongtan*
Faculty of Science and Technology, Suan Dusit University

Abstract

The effects of defatted organic red jasmine rice bran extract (DRBE) on sun protection properties were evaluated. Three formulations of sun protection products were studied as followed; two formulations consisted of oil in water emulsion and another formulation was gel emulsion and stability test was applied in all formulations. The results showed that DRBE at 1 µg/mL had antioxidant activity of 91.64% and IC_{50} of 64.02 µg/mL. The extract had the highest antioxidant stability of 88.12% when stored at 4° C. Furthermore, the effects of DRBE on sun protection factor (SPF) was found to have an effect on enhancing the sunscreen values on all three formulations, in which SPF values increased from 2.86 to 4.39. The highest SPF value of 4.39 was obtained for gel emulsion. Hence, the SPF values of these three formulations were claimed for medium protection and water resistance properties for 2 hour maximum. The gel emulsion showed the lowest reduction of SPF value at 0.08 and 0.2, respectively, after stored at room temperature for 30 and 60 days. These results demonstrated that DRBE boosted the SPF value and it can be potentially used as SPF stabilizer.

Keywords: Organic Red Jasmine Rice Bran, Sun Protection Factor, Sunscreen Products

* Corresponding Author
e-mail: Jiraporn_tho@dusit.ac.th
**Acknowledgment: Office of the Higher Education Commission. (OHEC)

Introduction

Rice bran oil is a side product of rice milling processes, it is a natural source of antioxidant which can be used in cosmetic skin care. Muntana & Prasong (2010) studied total phenolic contents and their antioxidant activities of Thai white, red and black rice bran extracts. The result showed the antioxidant activity of all rice bran extracts had following high antioxidant efficacy, red>black>white rice bran, respectively. Jun et al. (2012) reported the investigation of antioxidant activities and phenolic compounds of pigmented rice bran. Red rice bran showed the highest antioxidant activity at 500 µg/mL, it also had the highest total phenolic and total flavonoid. These results showed that red rice bran is a potential source of antioxidants.

Defatted rice bran is a waste after rice bran oil production which contains antioxidant activity. From the preliminary test of the ethanolic defatted red jasmine rice bran, antioxidant activity (DPPH method) of the extract showed the inhibition activity of 91.64% and IC_{50} of 64.02 µg/mL.

Sun light is the main source of ultraviolet radiation (UVR), in which UVA (320 - 400 nm) and UVB (290-320 nm) are common UVR that can damage skin molecules and structures. UVA causes skin aging and UVB causes sunburn. Photoprotection from UV damage are found to be by clothing, glasses and sunscreen products. The sunscreen products consist of physical sunscreen and chemical sunscreen which act to reflect, scatter and absorb UV photons. The sunscreen product was evaluated for the efficacy of Sun Protection Factor (SPF) (Cadet, Sage & Douki, 2005).

Athikomkulchai et al. (2007) studied the development of sunscreen products from a volatile oil which isolated from dry rhizome of *Kaempeferia galanga.* The sun protection factor (SPF) of the 7% volatile oil containing sunscreen product was 4.69, which SPF value of basic cream was not included.

Rice bran oil and rice bran extract are the sources of antioxidant which have been applied in cosmetic. However, the use of defatted organic red jasmine rice bran extract in sunscreen application was rarely found.

Objective

The aim of this study is to investigate the effect of using defatted organic red jasmine rice bran extracts (DRBE) on the sun protection value of sunscreen in order to reduce the use of sunscreen chemicals in the formulation.

Materials

Defatted organic red jasmine rice bran was collected from Prasat District, Surin Province, Thailand, in October 2014. 2,2-Diphenyl-1-picrylhydrazyl(DPPH) and absolute ethanol were from Sigma-Aldrich (Steinheim, Germany). Cetyl Alcohol (and) Glyceryl Stearate (and) PEG-75 Stearate (and) Ceteth-20 (and) Steareth-2, Octocrylene,Butyl Methoxydibenzoylmethane, C12-15 Alkyl Benzoatewere from PC Intertrade co., ltd. (Thailand)Polyacrylamide (and) C13-14 Isoparaffin (and) Laureth-7, Propanediol, Xanthan gum, Stearate 21, Stearate 2 were from Brenntag co., ltd. (Thailand). Ethanol (95%), 2NaEDTA, Cetyl alcohol, Propylene Glycol, Diazolidinyl Urea, Methylparaben, Propylparaben, Cyclopentasiloxane, Dimethiconeand Triethanolamine were from Namseng co.,ltd. (Thailand). Bis-Ethylhexyloxyphenol Methoxyphenyl Triazine was from BASF co., ltd. (Thailand). Dicaprylyl Carbonate and Decyl cocoate were from Evonik co., ltd. (Thailand).

Methods

1. Defatted organic red jasmine rice bran extract

After organic red jasmine rice bran was compressed for 48 hours, defatted rice bran was sieved and then kept in hot air oven at a temperature of 100°C for 10 min. Defatted rice bran was macerated with 95% ethanol (1:5 w/v) for 3 day and then filtered (Whatman No.1). The filtrate was then applied to a rotary evaporation for volume reduction and the extracts were stored at 4°C until used (Azwanida, 2015).

2. Determination of DPPH radical scavenging assay

DPPH radical scavenging assay is common antioxidant assay. Five difference concentrations ranging between 0-1 mg/mL of each DRBE (1 mL) was mix with 1 mL of 0.02mM DPPH (ethanol), the mixture was vigorously mixed for 20 times. After incubation for 30 minutes in darkness at room temperature, the absorbance was recorded at 517 nm

by UV visible spectrophotometer. The percentage of radical scavenging activity was showed as IC_{50} value that represent the concentration of DRBE required to scavenging 50% of DPPH radical. The method was modified from Heinonen el al. (1998).

3. Stability test of DRBE

DRBE was stored at 4° C for 180 days and then all samples were analyzed for antioxidant activity using the above mentioned method.

4. Preparation of cream-based and cream with DRBE (Oil in Water)

The composition of the cream-based and cream-based with DRBE is shown in Table 1. Premix of 2NaEDTA and propanediol with xanthan gum were then added into deionized water and stirred until homogeneous and then the temperature was increased to 70-75° C. Another mixture B was heated to 70-75° C and then added to the former mixture A. The formulation was then homogenized until homogeneous solution was achieved. It was cool down to 40° C and mixture C, D and E were added to the mixtures, homogenized until homogeneous.

Table 1 The ingredients in the formulation (oil in water)

Part	Ingredients	%w/w			
		CF1*	F1**	CF2***	F2****
	Deionized water	q.s. to 100	q.s. to 100	q.s. to 100	q.s. to 100
A	2NaEDTA	0.1	0.1	0.1	0.1
	Propanediol	2.0	2.0	2.0	2.0
	Xanthan gum	0.5	0.5	0.5	0.5
	Octocrylene	3.0	3.0	3.0	3.0
	Butyl Methoxydibenzoylmethane	5.0	5.0	5.0	5.0
	Ethylhexyl Methoxycinnamate	3.0	3.0	3.0	3.0
	Bis-Ethylhexyloxyphenol Methoxyphenyl Triazine	2.0	2.0	2.0	2.0
B	Cetyl alcohol	1.0	1.0	1.0	1.0
	Stearate 2	3.0	3.0	-	-
	Stearate 21	2.5	2.5	-	-
	Cetyl Alcohol (and) Glyceryl Stearate (and) PEG-75 Stearate (and) Ceteth-20 (and) Steareth-2	-	-	5	5
	Dicaprylyl Carbonate	6.5	6.5	-	-
	Decyl cocoate	6.5	6.5	-	-
	Cyclopentasiloxane	2.0	2.0	-	-
	C12-15 Alkyl Benzoate	-	-	6	6
C	Propylene Glycol, Diazolidinyl Urea, Methylparaben, Propylparaben	1.0	1.0	1.0	1.0
D	Triethanolamine	0.23	0.23	-	-
E	DRBE	-	0.1		0.1

Remark: *CF1=control formulation 1 (Chatelain & Gabard, 2001), **F1= formulation 1, ***CF2= control formulation 2, ****F2= formulation 2

5. Preparation of gel-based and gel with DRBE (Gel emulsifier)

The compositions of the gel-based and gel-based with DRBE are shown in Table 2. Mixture A was slowly added which contained the following; Polyacrylamide (and) C13-14 Isoparaffin (and) Laureth-7 in Deionized water, 2NaEDTA and Propanediol. The mixture was then homogenized until homogeneous and heated up to 70-75° C. Mixture B was heated up to 70-75° C and then added into mixture A homogenized until homogeneous, cooled down to 40° C and then mixture C and D were added.

Table 2 The ingredients in the formulation (Gel emulsifier)

Part	Ingredients	%w/w	
		CF3*	F3**
A	Deionized water	q.s. to 100	q.s. to 100
	2NaEDTA	0.1	0.1
	Propanediol	2.0	2.0
	Polyacrylamide (and) C13-14 Isoparaffin (and) Laureth-7	2.0	2.0
B	Octocrylene	3.0	3.0
	Butyl Methoxydibenzoylmethane	5.0	5.0
	Ethylhexyl Methoxycinnamate	3.0	3.0
	Bis-Ethylhexyloxyphenol Methoxyphenyl Triazine	2.0	2.0
	C12-15 Alkyl Benzoate	5.0	5.0
	Dimethicone	3.0	3.0
C	Propylene Glycol, Diazolidinyl Urea, Methylparaben, Propylparaben	1.0	1.0
D	DRBE	-	0.1

Remark: *CF3 = control formulation 3, **F3 = formulation 3

6. Accelerated stability testing

The stabilities of all products were evaluated after six heating and cooling cycles. One cycle of all products was stored at 45° C for 48 hours and then cooled down to 4° C for 48 hours (Leelapornpisit, 1997).

7. Microbiological analysis

The total plate count method (TPC) of the microorganism was analyzed using a spread plate technique on the aerobic plate count (APC) medium. Yeast and mold were counted according to the American Society for testing Material (1991) (Detmer et al, 2010; Kaushik, 2008).

8. Determination of Sun Protection Factor (SPF)

The SPF value was evaluated after storage for 30 and 60 days using Labsphere UV-2000S Analyzer (CTFA South Afica; COLIPA; JCIA, 2006).

Results and Discussion

The maceration with ethanol was used in this study for cosmetic safety process. The DRBE was a dark brown and sticky compound, 16.38% yield was obtained. The antioxidant activity of DRBE was determined by DPPH method, the result obtained showed a strong antioxidant potential with scavenging of 91.64% at the concentration of 1 mg/mL and IC_{50} value of 64.02 µg/mL (n=3) (the result show in Fig. 1). DRBE was added in F1, F2 and F3 at 0.1%. After DRBE was stored for 180 days, the antioxidant activities were determined. The results showed a radical scavenging value of 88.12% for DRBE stored at 4° C, DRBE kept at room temperature gave a value of 72.19%, (show in Table 3). This demonstrated that DRBE stored at 4° C showed higher antioxidant than at room temperature. This result of antioxidant activity was lower than the study of Suhery & Husni (2017), in which red rice bran extract had the higher antioxidant activity of IC_{50} 43.23 µg/mL and the inhibition of 96.997% at the concentration of 1 mg/mL were observed (Suhery & Husni, 2017). Thus, the differences of this study compared with the results of Suhery & Husni (2017) were that the defatted organic jasmine red rice bran was used instead of whole red rice bran. Furthermore, the defatted jasmine red rice bran used in this study was from organic source but not with the study compared using the same extraction method.

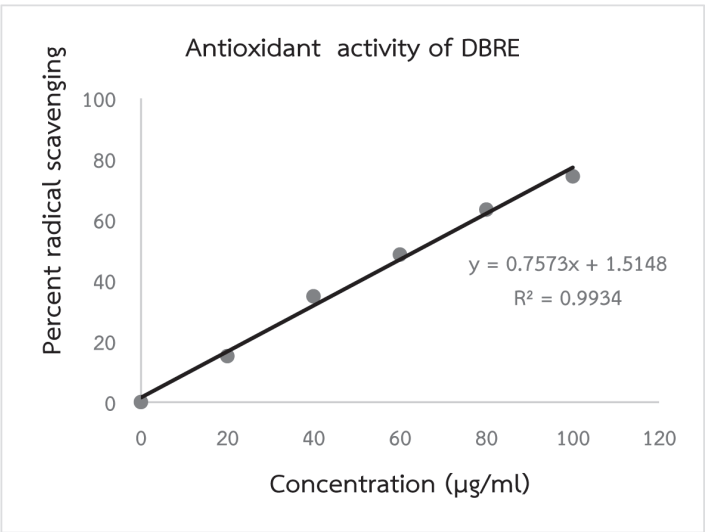

Fig. 1 DPPH radical scavenging assay of DBRE

Table 3 Radical scavenging values of DBRE stored at 4° C and at room temperature

Temperature	% radical scavenging	
	Day 0	Day 180
4°C	91.64±0.23	88.12±0.18
Room temperature	91.64±0.23	72.19±0.15

The stability of all formulations are shown in Table 4, all formulations were passed significantly of all parameter determined except for F2 which yeast and mold were detected at $1x10^2$ CFU/g. This might be due to the contamination during the production processes. However, this value meets the criteria announced by the Ministry of Public Health (No. 40) BE 2548 (Total number of microorganisms allowed to be detected for not over $1x10^3$ CFU/g).

Table 4 The results of product evaluation

Parameter		Formulation					
		CF1	F1	CF2	F2	CF3	F3
Homogeneous (H*)	C_0[a]	H	H	H	H	H	H
	C_6[b]	H	H	H	H	H	H
Color	C_0	White	Ivory	White	Ivory	White	Ivory
	C_6	White	Ivory	White	Ivory	white	Ivory
Creaming**	C_0	No	No	No	No	No	No
	C_6	No	No	No	No	No	No
Cracking***	C_0	No	No	No	No	No	No
	C_6	No	No	No	No	No	No
Total plate count	C_0	0	0	0	0	0	0
(CFU/g)	C_6	0	0	0	0	0	0
Yeast and mold	C_0	0	0	0	0	0	0
(CFU/g)	C_6	0	0	0	$1x10^2$	0	0
pH****	C_0	6.34±0.11	6.51±0.15	6.24±0.08	6.37±0.07	6.12±0.07	6.29±0.08
	C_6	6.39±0.03	6.63±0.08	6.33±0.02	6.42±0.17	6.07±0.05	6.11±0.25

Remark: *H = Homogeneous, **Creaming = Separate products floating on the floor or hanging down when shaken are restored, ***Cracking = Products separated from each other clearly cannot be returned in the original, C_0[a] = Heating cooling cycle (0), C_6[b] = Heating cooling cycle (sixth cycle), ****N = 3

The results of sun protection factor (SPF) are shown in Table 5, F1, F2 and F3, which showed increased of SPF values of 3.71, 2.96 and 4.39, respectively compared with control formulations. Samples stored at room temperature for 30 days, the SPF value of the non DRBE formulation (CF1, CF2 and CF3) decreased to 0.51, 0.10 and 0.75 while the SPF values of the formulation contained DRBE (F1, F2 and F3) decreased to 0.27, 0.22 and 0.10 in comparison with control formulations. After 60 days, the SPF value of CF1, CF2 and CF3 decreased to 0.85, 0.28 and 0.81 while the formulation contained DRBE (F1, F2 and F3) decreased to 1.20, 0.76 and 0.21. The SPF values decreased because the chemical composition of DRBE deteriorates might be due to the reaction with light while the antioxidants in the DRBE help to inhibit the damage, resulting in the composition of sunscreen does not change or change less. These results clearly demonstrated that DRBE increased SPF value compared with all control formulations.

Table 5 The SPF values of the formulated products*

Formulation	SPF value		
	Day 0	Day 30	Day 60
CF1	18.58±0.21	18.02±0.69	17.68±0.38
F1	22.24±0.79	21.97±1.18	21.04±0.36
CF2	12.33±0.23	12.13±0.13	11.95±0.43
F2	15.19±0.14	14.97±0.07	14.33±0.13
CF3	13.11±0.13	12.36±0.21	12.20±0.08
F3	17.50±0.43	17.42±0.07	17.29±0.26

Remark: *N=3

Protection levels were determined by SPF value for 4 levels, 6 and 10 represented low protection, 15, 20 and 25 represented medium protection, 30 and 40 represented high protection and 50^{+} represented very high protection (European Commission, 2006; Lionetti & Rigano, 2017). The possible water resistance were claimed to report on the label by SPF value from 4 to 7 represented of there was no water resistance properties, 8 to 14 represented water resistance properties of 40 min maximum, 15 to 29 represented water resistance properties of 2 hours maximum and more than 30 represent water resistance properties of maximum 4 hours (Australian/New Zealand Sunscreen Standard AS/NZS

2604, 2012). The SPF of F1, F2 and F3 were 22.24, 15.19 and 17.50, respectively, showed medium protection and water resistance properties of maximum 2 hours.

Conclusion

The effect of DRBE on sun protection factor (SPF) was found to have an effect on the sunscreen efficacy of all formulations, in which the gel emulsion formula gave the highest SPF value. The SPF values of these three formulations were claimed for medium protection and water resistance properties of 2 hours maximum. All formula stored at room temperature for 30 and 60 days, the gel emulsion showed the SPF values of 0.08 and 0.21 respectively. This demonstrated that DRBE boosted the SPF value, SPF stabilizer and water resistance properties. Thus, DRBE can be used potentially as SPF booster, SPF stabilizer and water resistance.

References

Athikomkulchai, S., Vayumhasuwan, P., Tunvichien, S., Piyapong, S., Malaipuang, S., & Ruangrungsri, N. (2007). Yhe development of sunscreen products from *Kaempferia galangal. Journal of Health Reaearch;* 21(4), 253-256.

Australian/New Zealand Standard AS/NZS 2604. (2012). *Sunscreen products-Evaluation and Classification* (6th ed.). Standards Australia Limited/Standards New Zealand. Retried May 30, 2017 from http://infostore.saiglobal.com/store/.

Azwanida, N. N. (2015). A review on the extraction method use in medicinal plants, principle, strength and limitation. *Medicinal & Aromatic plants,* 4(3), 1-6.

Cadet, J., Sage, E., & Douki, T. (2005). Ultraviolet radiation-mediated damage to cellular DNA. *Mutation Research,* 571(1-2), 3-17.

Chatelain, E., & Gabard, B. 2001. Photosatabilization of butyl methoxydibenzoylmethane (Avobenzone) and ethylhexyl methoxycinnamate by bis-ethylhexyloxyphenol methoxyphenyl triazine (Tinosorb S), a new UV broadband filter. *Photochemistry and Photobiology,* 74(3), 401-406.

CTFA South Afica; COLIPA; JCIA. (2006). *International sun protection factor (SPF) test method.* Bruxelles, Belgium: COLIPA.

Detmer, A., Jørgensen, C., & Nylén, D. (2010). *A guidance document on microbiological control of cosmetic products.* Danish Ministry of the Environment, Environmental Protection Agency. Retried May 30, 2017 from http://www2.mst.dk/udgiv/publications/2010/978-87-92668-66-0/pdf/978-87-92668-67-7.pdf

European Commission. (2006). Commission Recommendation of 22 September 2006 on efficacy of sunscreen products and the claims made relating thereto. *Office Journal of the European Union,* 265, 39-43.

Heinonen, I.M., Lehtonen, P.J., & Hopia A.I. (1998). Antioxidant activity and berry and fruit wines and liquors. *Journal of Agricultureal and Food Chemistry,* 46, 25-31.

Jun, H. I., Song, G. S., Yang, E. I., Young, Y., & Kim, Y. O. (2012). Antioxidant activities and phenolic compounds of pigmented rice bran oil. *Journal of Food Science,* 77(7), 759-764.

Kaushik, P., Goyal, P., Chauhanm A., & Chauhan, G. (2008). In vitro evaluation of antibacterial potential of dry fruit extracts of *Elettaria cardamomum* Maton (Chhoti Elaichi). *Iranian Journal of Pharmaceutical Research,* 9(3), 287-292.

Leelapornpisit, P. (1997). *Cosmetic Emulsion.* Bangkok: O.S. printing house.

Lionetti, N., & Rigano, L. (2017). The new sunscreens among formulation strategy, stability issues, changing norms, safety and efficacy evaluations. *Cosmetics,* 4(15), 1-11.

Muntana, N., & Prasong, S. (2101). Study on total phenolic contents and their antioxidant activities of Thai white, red and black rice bran extract. *Pakistan Journal of Biological Sciences,* 13(4), 170-174.

Suhery, W. N., & Husni, D. N. (2017). Effect of cream base types on the antioxidant activity of the cream preparation of red rice bran extract. *Research Journal of Pharmaceutical, Biological and Chemical Science,* 8(1) (Suppl.), 255-262.

Author

Dr. Jiraporn Thongtan

Cosmetic Science Program, Faculty of Science and Technology,
Suan Dusit University
e-mail: Jiraporn_tho@dusit.ac.th