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Determination of sun protection potential of *Hibiscus rosa-sinensis* as natural additive for cosmetic industry

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Abstract: Harmful rays coming from the sun cause negative effects on the human body. Sunscreens and UV protective products are used to reduce and prevent these negative effects. Plants have been used in medicine and cosmetics for centuries, and have the potential to treat skin diseases. Consumers tend to use sunscreens that contain natural ingredients instead of synthetic sunscreens. In this study, the in vitro solar protection factor (SPF) values of water extracts from flowers and leaves of *Hibiscus rosa-sinensis* were investigated. The SPF values of the water extracts and commercially available cream mixtures were also examined. The SPF values of the extracts were measured at the wavelengths of 290-320 nm of UV-B ultraviolet rays reaching the earth from the sun. SPF values of *H. rosa-sinensis* flower and leaf extracts were determined as 11.77 and 22.10. The leaf extract has the highest SPF value (21.70) in 10 mL concentration among the prepared extract and cream mixtures. Therefore, *H. rosa-sinensis* extracts with high SPF values may have the potential to be used as natural additives in the cosmetic industries.

Keywords: Camellia; sun protection factor (SPF); extracts; cream.

1 Introduction

Nowadays, there is a significant increase in skin cancer caused by the harmful effects of the sun and environmental factors (Dorj et al. 2018). With the thinning of the ozone layer, harmful sun rays come directly to the earth and cause harm to people. Therefore, an increase in the incidence of skin cancer is observed (McMichael 1993; McKenzie et al. 2003). It is necessary to use sunscreens to prevent abnormalities that occur on the skin surface in varying forms and structures. Sunscreens are substances that can be applied to the skin in different ways, interfering with the sun's rays and reducing their harmful effects (Osterwalder and Lim 2007).

All rays of different wavelengths emitted from the sun are called the "electromagnetic spectrum of the sun" (Petrazzuoli 2000). UV radiation forms a specific part of the electromagnetic spectrum that has a shorter wavelength and higher energy than visible light. There are 3 types of UV of sunlight falling on the earth's surface; UVC (200-290 nm), UVB (290-320 nm), and UVA (320-400 nm). UV rays constitute 5% of the rays reaching the earth. UVA wavelength is in the range of 320-400 nm and it constitutes about 90% of UV rays. UVA rays can damage human cells by penetrating up to 100 µm deep to the skin surface. It causes sagging and wrinkles by causing loss of elasticity in human skin. Thus, it causes premature aging of the skin. UVA rays cause enzyme inactivation, protein denaturation, cell organelles and cell membrane damage (Azevedo et al. 1999). UVB is one of the ultraviolet rays reaching the surface of earth, although the majority of it is filtered by the atmosphere, with a wavelength of 290-320 nm. UVB rays are the type of rays that have the most effect on the formation of melanin pigment in the skin and sunburns (Azevedo et al. 1999). UVC is UV rays with the highest energy and lowest wavelength (200-290 nm) (Dutra et al. 2004).

Plants have historically been an important source of a wide variety of secondary metabolites used as pharmaceuticals, food additives, colours, agrochemicals, etc.(Al-Snafi 2015). *Hibiscus rosa-sinensis*, known as the Camellia, is a hairless shrub commonly grown in the tropics (Nadkarni 1996). Camellia has been used in traditional medicine to regulate menstruation and stimulate blood circulation. The flower has been used in diabetes, leprosy, regulating the menstrual cycle, liver ailments, stomachaches, cough suppressant, eye problems, miscarriage problems, and as an aphrodisiac. The leaves are used in the treatment of headache, dysentery, diarrhea, arthritis, boils and cough (Chopra and Rashid 1969; Jadhav et al. 2009; Pekamwar et al. 2013; Nath and Yaday 2015). Phytochemical analysis showed that *H. rosa-sinensis* leaf extract is rich in protein, free amino acids, carbohydrates, steroids and essential oils as well as phenolic compounds (Divya et al. 2013). The main cause of antioxidant effects in herbal products is phenolic compounds, which filter UV rays (Del Valle et al. 2020).

In the field of cosmetics, products with natural ingredients developed using plants are at the forefront. In our study, the sun protection factor (SPF) of water extracts from *H. rosa-sinensis* and commercial cream and the extract mixtures were investigated in vitro and their potential to be used as natural sunscreen additives in the cosmetic industry was determined.

2 Materials and Method

2.1 Plant Material

H. rosa-sinensis flower and leaf samples were collected from Alata Horticultural Research Institute (Mersin-Turkey) (Figure 1A.).

2.2 Preparation of Extracts

H. rosa-sinensis flower and leaf samples were dried in an airy environment and ground with a Waring-blender. For extraction, 10 g of powdered fruit sample was extracted in a hot water bath with 30 mL of water for 6 hours each day for 2 days (Figure 1B). After extraction, the solvents were evaporated. The extracts were then stored at 4°C in dry conditions until use (Figure 1C).

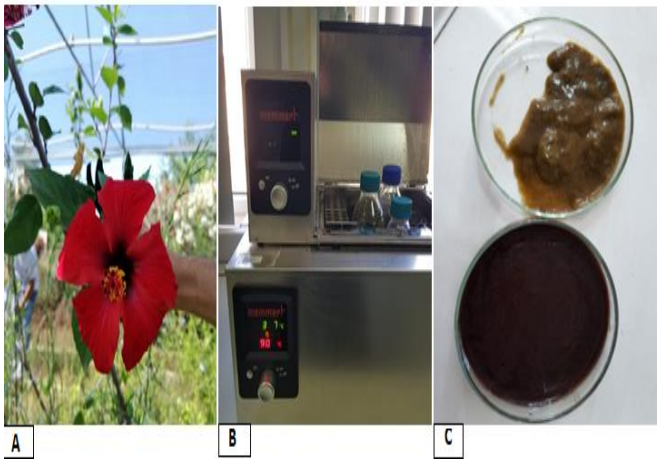

Fig. 1 *H. rosa-sinensis* (A) and Preparation of the Extracts (B-C)

2.3 Determination of SPF

H. rosa-sinensis flower and leaf water extracts (2 µg/µL) were weighed and mixed in ethanol (96%) with a vortex device until homogeneous. Then, the mixture was read in a spectrophotometer (Beckman Coulter) in the wavelength range of 290-320 nm with 3 repetitions at 5 nm intervals. The obtained values were calculated using the Mansur equation (1) (Mansur et al. 1986).

Equation 1

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

2.4 Determination of SPF of Extract and Cream Mixtures

In addition to determining the SPF values of the extracts, the SPF values of the extract and cream mixture were also examined. For this purpose, the modified method was used according to Asan-Ozusaglam and Celik (2023). Commercial cream and *H. rosa-sinensis* flower or leaf extracts were mixed and the mixture was made up to final volume (10 mL) with distilled water. The prepared mixtures were diluted with ethanol (40%) to the final volume of 2.5 mL, 5 mL and 10 mL concentrations and measured in 3 replications at 5 nm intervals using a spectrophotometer (Beckman Coulter) in the wavelength range of 290 nm-320 nm. SPF values of cream and extract mixtures were calculated using the Mansur equation (1) as mentioned above.

2.3 Statistical Analysis

The SPF data of *H. rosa-sinensis* flower and leaf extracts and cream mixtures were analyzed using GNU SPSS version software. Statistical significance was confirmed by one-way analysis of variance (ANOVA) with Tukey's post-hoc test. The difference between the data was considered statistically significant at the $p<0.05$ level.

3 Results and Discussion

SPF values of *H. rosa-sinensis* flower and leaf extracts were determined in vitro spectrophotometrically. The SPF value of the leaf water extract (22.10) was found to be higher than the SPF value of the flower extract (11.77) (Table 1 and 2).

Table 1 SPF Values of Camellia Flower Water Extract

	SPF Values		
λ (nm)	**CFx EE(λ)xI(λ)x Ab (λ)1**	**CFx EE(λ)xI(λ)x Ab (λ)2**	**CFx EE(λ)xI(λ)x Ab (λ)3**
290	0.28	0.23	0.24
295	1.18	1.08	1.23
300	3.71	3.51	3.70
305	3.74	3.53	3.82
310	2.01	1.90	2.02
315	0.88	0.83	0.88
320	0.18	0.17	0.19
Total SPF	**11.98**	**11.25**	**12.08**
Mean±SD	**11.77±0.46**		

Table 2 SPF Values of Camellia Leaf Water Extract

	SPF Values		
λ (nm)	**CFx EE(λ)xI(λ)x Ab (λ)1**	**CFx EE(λ)xI(λ)x Ab (λ)2**	**CFx EE(λ)xI(λ)x Ab (λ)3**
290	0.34	0.36	0.35
295	1.83	1.85	1.83
300	6.36	6.43	6.46
305	7.11	7.17	7.21
310	4.05	4.09	4.11
315	1.85	1.86	1.86
320	0.40	0.40	0.40
Total SPF	**21.94**	**22.16**	**22.22**
Mean±SD	**22.10±0.15**		

After determining the SPF values of the extracts alone, they were mixed with commercial cream and then the SPF values of the cream-mixture were evaluated. The results are given in Figure 2. The SPF value of the commercial cream as a control was also determined. Cream mixtures with *H. rosa-sinensis* flower and leaf water extracts showed higher SPF values at 10 mL concentration (20.67 and 21.70) compared to the control group (1.26).

Lokapure et al. (2014) determined the SPF value of the extracts from *H. rosa-sinensis* flower with 90% ethanol and the SPF value of the extract gel mixtures. They determined the SPF value of *H. rosa-sinensis* flower extract as 3.88±0.01 and the SPF value of flower extract-gel mixtures as 12.54±0.05. In another study using the extract of *H. rosa-sinensis* flower obtained with 90% ethanol, the UV absorption value of the extract was determined in the range of 200 nm – 400 nm. The results indicated that it has very high absorption (1.26) at 200 nm, high absorption at 280 nm (0.3), and moderate absorption (0.2-0.1) ability above 300 nm (Sidram et al. 2011). Dwivedi (2022) determined the SPF value of 40 µg/mL – 50 µg/mL – 60 µg/mL concentrations of *H. rosa-sinensis* flower extract obtained with 80% ethanol. The SPF values were found as 0.565, 0.691, 0.974, respectively. The differences between the results obtained in the current study and those of the literature may be due to many factors such as the solvent used in the extraction, the extraction method or the growing conditions of plant (Osorio-Tobón 2020).

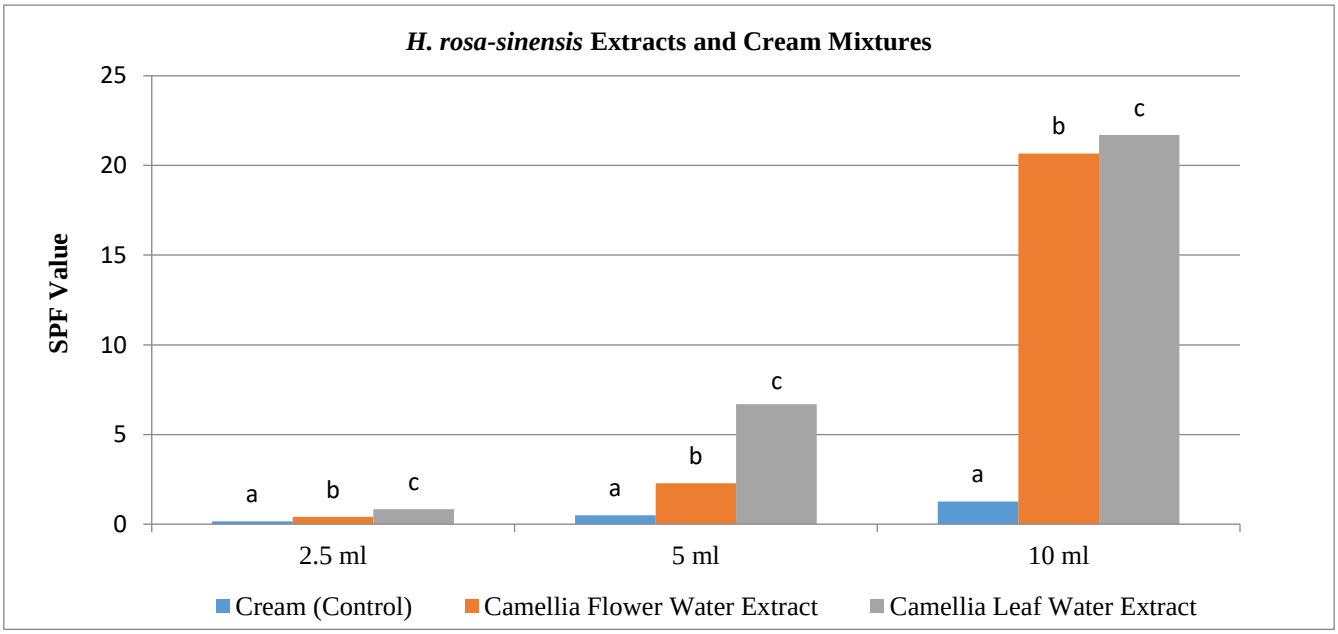

Fig. 2 SPF Values of *H. rosa-sinensis* Flower and Leaf Extracts and Cream Mixture
Different letters indicate significant difference at $p<0.05$ between samples.

5 Conclusion

Recent studies have shown that most synthetic sunscreens have adverse effects on the skin. Using the sun protection properties of plant extracts, cost-effective and readily available natural preservatives can be obtained. In the current study, UV absorption capacities and sun protection properties of water extracts obtained from *H. rosa-sinensis* flowers and leaves were determined. *H. rosa-sinensis* water extracts with high SPF values may have the potential to be used as natural sunscreen additives in the cosmetic industry. Therefore, the Camellia water extracts may be safer and cheaper alternative sources for the cosmetic industry after further in vivo studies.

Authors' contributions: The authors were equally contributed in writing the manuscript and are equally responsible for plagiarism.

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