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Investigation of Antimicrobial and Photoprotective Activity of *Hylocereus undatus* Methanol Extracts

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Abstract

Hylocereus spp, which is very rich in bioactive substances, is known to be protective against various metabolic disorders. Probiotics are known to be useful microorganisms and have potential use in the cure and prevention of some disorders. In this study, it was aimed to investigate the use potential of cream formulations containing *Hylocereus undatus* extracts in the pharmaceutical and cosmetic industries. Firstly, the antimicrobial activity of *H. undatus* extracts against some pathogenic microorganisms and probiotic candidate strains were determined. Inhibition zone diameters of the extracts against the tested pathogenic microorganisms were obtained in the range of 7.00-12.14 mm. Then, a cream formulation containing *H. undatus* fruit methanol extract and probiotic strain *L. fermentum* MA-7 against the pathogenic microorganisms was tested to determine its antimicrobial activity. Among the cream formulations, cream+ *H. undatus* fruit methanol extract + *L. fermentum* MA-7 (CEL) showed the highest inhibition zone diameter (17.59 mm) on *Escherichia coli* O157:H7. The solar protection factor (SPF) of the extracts and the extract-cream mixture was also determined in vitro. The peel extract exhibited the best SPF value of 25.92. The highest SPF values of peel and fruit extract cream mixtures were determined as 22.76 and 10.58 at 10 ml concentration. The result of the study indicated that *H. undatus* extracts and *L. fermentum* MA-7 cream formulation containing may have the potential to inhibit the growth of pathogenic microorganisms in the cosmetic and pharmaceutical industries as natural antimicrobial additives. In addition, *H. undatus* methanol extracts with high UV blocking capacity can be used as a natural protective additive in sunscreens for the cosmetic industry.

Keywords: White pitahaya, probiotic, cream formulation, antibacterial, antifungal, photoprotective activity

Research article
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INTRODUCTION

Hylocereus spp., known as pitahaya or dragon fruit, is a vine cactus species belonging to the cactus family Cactaceae. It is one of the tropical fruits newly introduced to the Mediterranean region of Turkey. It is generally known as dragon fruit in Turkey (Le Bellec et al., 2006; Attar et al., 2022).

Hylocereus spp. contains carbohydrates, steroids, proteins, tannins, alkaloids, flavonoids, and phenolic compounds. Pitahaya fruits are gaining popularity due to their exotic appearance and health benefits (Sushmitha et al., 2018; Mahdi et al., 2018). It has been reported that *Hylocereus* spp., which is very rich in bioactive materials, can be consumed as a preventative against obesity, type 2 diabetes, cancer, etc. (Attar et al., 2022). It has also been reported that both red and white dragon fruit peels are cytotoxic to cancer cell lines Bcap-37, MGC-803 and PC3 (Luo et al., 2014). Enhancement awareness of the benefits of plant products is becoming increasingly widespread in society in order to provide an adequate intake of macronutrients-micronutrients, vitamins, dietary fibers and phytochemicals, which are very important for human health (Attar et al., 2022).

The skin is an immunogenic organ that functions as a biological sensor for us and is the first defense against external allergens (Schmidt 2004). The skin is the largest organ of our body and is constantly exposed to chemical, physical, fungal, and bacterial threats. Probiotics are well known to be beneficial for skin conditions and have been clinically studies (Roudsari et al., 2015). The probiotics may have potential uses in the prevention and treatment of skin diseases in many areas such as skin hypersensitivity, allergic inflammation, UV-induced skin harm, wound protection.

Creams are semi-solid topical products designed to be applied to the mucous membrane or skin. Medicated creams are products containing active ingredients for therapeutic purposes in cases of inflammation, infection, etc. Non-medicated creams do not contain active components, they are used in cosmetics as a moisturizer, emollient, etc. in some skin conditions (Adeleye et al., 2019). There is an increment requisition for personal care products with natural ingredients, which are less hypo-allergenic compared to synthetic cosmetics and do not need to be hesitant about skin irritations. Natural cosmetic products provide the skin with nutrients such as vitamins A, C and E, which provide anti-inflammatory, antioxidant, anti-aging, anti-methanogenic effects and improve skin health (Lohani et al., 2019).

The intention of the study is to investigate the potential usage of the new cream formulations in the cosmetic and pharmaceutical industries. Firstly, the potential of using *H. undatus* extracts as a natural preservative instead of synthetic preservatives was investigated. New cream formulation containing *H. undatus* fruit extract was then developed, and its antimicrobial activity was evaluated. Afterwards, the solar protection factors (SPF) of *H. undatus* extracts were tested to obtain the potential use of *H. undatus* extracts as an additive in natural herbal sunscreens in the cosmetic industry. Finally, the SPF values of mercantile cream added *H. undatus* extracts was determined in vitro.

MATERIAL and METHOD

Plant Material and Preparation of Extracts

The *H. undatus* fruit was purchased from Antalya-Turkey. *H. undatus* fruits were washed and then fruit and peel were separated dried at room temperature (Figure 1). After grounding, the powder from *H. undatus* peel and fruit were separately extracted with methanol (99.7%) using a sonication device in 2 repetitions in 10 minutes every day (2 days) each. Then, the organic solvents were removed by a rotary evaporation. *H. undatus* peel and fruit extracts dissolved with dimethyl sulfoxide (DMSO) were sterilized by sterile filters (0.45 μm).

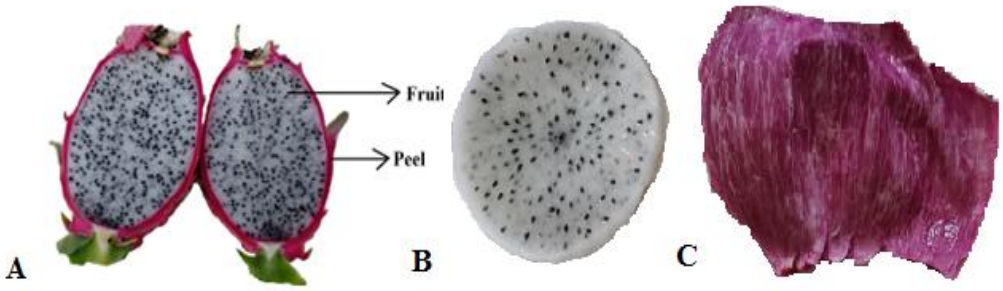

Figure 1. A: *H. undatus*, **B:** *H. undatus* fruit, **C:** *H. undatus* peel

Microorganisms

Food-borne and Clinical Pathogens

Enterococcus faecalis ATCC 29212 and *Listeria monocytogenes* ATCC 7644 were cultured at 37ºC in Tryptic Soy Broth (TSB) for 24 hours. *Salmonella enteritidis* RSKK 171, *Escherichia coli* O157:H7 and *Pseudomonas aeruginosa* ATCC 27853 were grown in Nutrient Broth (NB) for 24 hours.

Yeast

Candida albicans ATCC 10231 and *C. glabrata* RSKK 04019 were cultured at 30ºC in Yeast Peptone Dextrose (YPD) medium for 24 hours.

Probiotic Candidate Strains Originated from Breast Milk

Limosilactobacillus fermentum MA-7, *Lactobacillus gasseri* MA-1, *Lactobacillus delbrueckii* MA-9 were cultured at 37ºC in Man, Rogosa and Sharpe (MRS) media for 24 hours (Asan-Ozusaglam and Gunyakti, 2019; 2020; 2022).

Determination of Biological Activity

Disc Diffusion Method

The biological activity of peel and fruit methanol extracts obtained from *H. undatus* was determined using disc diffusion assay. The prepared bacterial suspension (0.5 Mcfarland) was inoculated on agar medium and sterile discs were placed on the agar**.** *H. undatus* peel and fruit extracts (4 mg/disc for pathogenic test microorganisms and 1, 2 and 4 mg/disc of for probiotic candidate strains) were then dropped onto the discs. Ampicillin (AM-10 µg/disc) antibiotics disc was used as controls for the pathogenic test microorganisms and Fluconazole (FCA-25 µg/disc) for the yeasts. The inoculated petri was incubated for 24 hours at suitable temperatures indicated previously. The experiment was carried out in duplicate.

Determination of Minimum Inhibition Concentration (MIC) and Minimum Bactericidal Concentration (MBC) or Minimum Fungicidal (MFC) Concentration

The micro-dilution assay was used to determine MIC and MBC or MFC values of the *H. undatus* extracts. The extracts were added to each tube containing growth medium to obtain a final concentration of 80 µg/µl and diluted to 40, 20, 10, 5 and 2.5 µg/µl. Microbial suspension (0.5 McFarland concentration) was added to each tube. The tubes were then incubated under the conditions required for each microorganism. After the incubation, the values in the tube without microbial growth were recorded as the MIC concentration of the extract. MBC and MFC concentrations were determined by inoculating samples from the tubes onto solid medium.

The petri dishes were incubated for 24 hours at the appropriate temperature for the test microorganisms. After incubations, the lowest concentration without growth was defined as MBC or MFC values.

Cream Formulation Containing *H. undatus* Fruit Extract and Probiotic

The antimicrobial activity of the cream formulations was obtained using the modified method used in our previous study (Asan-Ozusaglam and Celik, 2023). In the developed antimicrobial cream formulations, a mercantile cream, *H. undatus* fruit extract and/or a probiotic candidate strain *L. fermentum* MA-7 (Asan-Ozusaglam and Gunyakti, 2018) isolated from human milk were used. The antimicrobial activity of the developed cream groups was determined against the test microorganisms (*L. monocytogenes* ATCC 7644, *S. enteritidis* RSKK 171, *E. coli* O157:H7, *E. faecalis* ATCC 29212, *P. aeruginosa* ATCC 27853, *C. albicans* ATCC 10231 and *C. glabrata* RSKK 04019) using the well diffusion method. The experiment was performed in triplicate. The culture dishes were incubated in the conditions mentioned above for the test microorganisms.

Determination Photoprotective Activity of Extracts

The solar protection factor (SPF) of *H. undatus* peel and fruit extracts was determined by spectrophotometric method in vitro conditions. The extracts (0.002 g/ml) were mixed with 96% ethanol. The mixture was read in the UV-VIS spectrophotometer in the wavelength range of UV-B (290-320 nm). The Mansur equation was used to calculate the SPF value.

Mansur's equation (Mansur et al., 1986)**:**

$$\mathbf{SPF} = \mathrm{CF} \times \sum_{290}^{320} \mathrm{EE}(\lambda) \times \mathrm{I}(\lambda) \times \mathrm{Abs}(\lambda)$$

Determination of Photoprotective Activity of Cream Mixtures Containing Extract

The solar protection factor (SPF) of *H. undatus* peel and fruit methanol extracts and mercantile cream mixture was determined by spectrophotometric method under in vitro conditions. The cream and peel and fruit extract were mixed and then added distilled water to make up the final volume (10 g). The mixture was homogenized and diluted to three different concentrations (2.5-5-10 ml). The cream groups that did not contain the extract were used as the control group. The mixtures were measured in triplicate using UV-VIS spectrophotometer in the wavelength range of UV-B. The SPF values of the cream mixtures with containing the extract were calculate using the Mansur equation (Mansur et al., 1986).

Statistical Analysis

The data of antimicrobial activity of *H. undatus* extracts on lactic acid bacteria and the cream formulations on pathogenic test microorganisms were analyzed using GNU SPSS version software. The statistical significance was confirmed by One-Way analysis of variance (ANOVA) with Tukey's post-hoc test. *P* value below 0.05 ($P<0.05$) will be considered statistically significant.

RESULTS and DISCUSSION

Antibacterial and antifungal activities of *H. undatus* peel and fruit extracts were investigated on test microorganisms using disc diffusion and micro-dilution assays. The disc diffusion assay results against food-borne and clinical and yeast microorganisms are presented in Table 1. The inhibition zone diameters ranged from 7.00 mm to 11.85 mm for the peel extract and 7.55 mm to 12.14 mm for the fruit extract.

Among the test microorganisms, the highest inhibition zone diameters of *H. undatus* extracts were detected against yeasts. *H. undatus* peel and fruit extracts can be used to prevent and/or treat both bacterial and fungal infections.

Table 1. Disc diffusion assay results of *H. undatus* extracts.

Food-borne and Clinical Microorganisms	**Inhibition Zone Diameters (mm±SD)**		
	HPME	**HFME**	**AM**
***L. monocytogenes* ATCC 7644**	8.31±1.85	7.55±0.33	29.57 ±0.1
***S. enteritidis* RSKK 171**	9.43±0.11	9.08±0.94	-
***E. coli* O157:H7**	7.81±0.38	7.86±0.61	17.76 ±0
***E. faecalis* ATCC 29212**	7.00±0.72	8.14±1.82	24.02 ±0.3
***P. aeruginosa* ATCC 27853**	9.68±0.10	8.90±0.57	23.53 ±0.6
Yeast			**FCA**
***C. albicans* ATCC 10231**	11.85±0.44	10.64±0.06	-
***C. glabrata* RSKK 04019**	11.23±1.15	12.14±0.91	20.35 ± 0.10

*HPME: *H. undatus* Peel Methanol Extract, HPME: *H. undatus* Fruit Methanol Extract, -: resistant

In the study of Rohin et al. (2012), the inhibition zone diameter of white pitahaya (*H. undatus*) peel and fruit methanol extracts against *E. coli* (7.00 mm-ND) and *Enterococcus faecalis* (11.00 mm-8.00 mm) were determined using the disc diffusion assay. In the current study, the inhibition zone diameters of peel and fruit extracts against *E. coli* O157:H7 were found to be 7.81 mm and 7.86 mm. The zone of inhibition against *E. faecalis* ATCC 29212 was determined as 7.00 mm and 8.14 mm. In a recent study, the antimicrobial activity of peel and pulp methanol extracts from *H. undatus* against *Pseudomonas sp*. was investigated using the well diffusion method. The inhibition zone diameter was not observed in the peel extract against the *Pseudomonas* sp. test microorganism, while the inhibition zone diameter of 25 mm was detected in the pulp extract (Ishnava and Patel, 2019). The observation of various antimicrobial activity against the test microorganisms may be due to differences in the extraction method, extract concentrations, strains of test microorganisms and growing conditions of the fruit such as climate, soil conditions etc.

In our previous study, methanol extracts of *H. undatus* fruit and peel obtained by using different extraction method (with hot water bath) showed inhibition activity between 6.17 mm and 13.15 mm against test microorganisms (*L. monocytogenes* ATCC 7644, *S. enteritidis* RSKK 171, *E. coli* O157:H7, *E. faecalis* ATCC 29212, *P. aeruginosa* ATCC 27853, *C. glabrata* RSKK 04019 and *C. albicans* ATCC 10231). The difference in the inhibition zone between our previous work may be due to the difference in the extraction method used (Asan-Ozusaglam and Celik, 2023).

MIC is the lowest concentration that inhibits microorganism growth in vitro. The minimum bactericidal or fungicidal concentration is the lowest concentration that reduces the number of microorganisms in the medium containing the bacterial inoculum by 99.9 in vitro conditions (Kowalska and Dudek, 2021). Micro-dilution assay results are presented in Table 2. The results showed that MIC values of *H. undatus* peel extracts against test microorganisms were determined as 20-80 µg/ml and MBC values as 40-80 µg/µl.

The peel extract inhibited the *P. aeruginosa* ATCC 27853 and *C. glabrata* RSKK 04019 strains at the lowest concentration of MBC (40 µg/µl). The MIC values of the fruit extract against the test microorganisms were determined to be 40-80 µg/ml and the MBC values to be 40->80 µg/µl.

The lowest MFC value in fruit extract was determined against *C. glabrata* RSKK 04019 (40 µg/µl). Therefore, the *H. undatus* extracts may be used as a bactericidal or fungicidal agent in food and pharmaceutical industries.

Table 2. MIC, MBC or MFC values of *H. undatus* extracts.

Test Microorganisms	MIC (µg/µl)		MBC or MFC (µg/µl)	
	HPME	HFME	HPME	HFME
***L. monocytogenes* ATCC 7644**	40	80	80	>80
***S. enteritidis* RSKK 171**	80	40	80	80
***E. coli* O157:H7**	80	40	80	80
***E. faecalis* ATCC 29212**	80	80	80	>80
***P. aeruginosa* ATCC 27853**	40	40	40	80
***C. albicans* ATCC 10231**	40	40	80	80
***C. glabrata* RSKK 04019**	20	40	40	40

*HPME: *H. undatus* Peel Methanol Extract, HPME: *H. undatus* Fruit Methanol Extract

In a study conducted by Nurmahani et al. (2012), MIC and MBC values of hexane, chloroform and ethanol *H. undatus* fruit extracts against *S. aureus, Campylobacter jejuni, Bacillus cereus, L. monocytogenes, E. faecalis, Yersinia enterocolitica, E. coli, Salmonella typhimurium* and *K. pneumoniae* were determined in the range of 1.25-10 mg/ml and 2.5->80 mg/ml, respectively.

In the current study, the antimicrobial activity of *H. undatus* extracts against some probiotic candidate strains was also determined. Disc diffusion assay results are presented in Table 3. As the concentration of *H. undatus* extracts decreased, the inhibition zone diameters of the extracts on the probiotic candidate strains also decreased. The statistical analysis results showed that the difference between LAB in peel extract at 4 mg/disc concentration was not significant ($P>0.05$).

There was significant difference between *L. fermentum* MA-7 and other LAB tested ($P<0.05$) at 4 mg/disc concentration of fruit extract. The visual data indicates that the lowest inhibition zone diameter was obtained in *L. fermentum* MA-7 (9.62 mm) at the concentration 4 mg/disc in fruit extract. This means that *L. fermentum* MA-7 will be less affected by the *H. undatus* fruit extract and maintain its viability compared to other LAB tested.

In recent years, the studies on the development of mercantile products containing *H. undatus* fruit extract have been increasing. The appropriate concentrations of the *H. undatus* extracts and the probiotic candidate *L. fermentum* MA-7 strain may have the potential use in new cream formulations against infections.

Table 3. Antimicrobial activity of *H. undatus* extracts against some probiotic strains.

Test Microorganisms	Extracts Inhibition Zone Diameters (mm±SD)					
	1 mg/disc		2 mg/disc		4 mg/disc	
	HPME	HFME	HPME	HFME	HPME	HFME
***L. fermentum* MA-7**	6.40±0.47[a]	6.96±0.14[a]	7.66±0.12[a]	8.19±0.39[a, b]	10.31±0.34[a]	9.62±0.07[a]
***L. gasseri* MA-1**	6.36±0.10[a]	6.80±0.53[a]	8.99±0.48[b]	7.86±0.87[a]	10.33±0.52[a]	11.36±0.69[b]
***L. delbrueckii* MA-9**	6.56±0.02[b]	7.93±0.37[a]	7.59±0.25[a]	9.57±0.23[a, b]	9.61±0.04[a]	12.82±0.25[c]

*HPME: *H. undatus* Peel Methanol Extract, HPME: *H. undatus* Fruit Methanol Extract, the different letters in the same column shows statistically significance (P<0.05)

Thengi et al. (2019) isolated two *Leuconostoc* sp. strains from pitahaya fresh fruits. The strain showed antibacterial activity against *Staphylococcus aureus*. They also indicated that fruits are very important because they contain beneficial probiotic strains as well as their nutritional properties.

Micro-dilution assay results are presented in Table 4. The MIC values for all extracts were determined in the range of 20-40 µg/µl and MBC values were determined as 40 µg/µl. The results indicated that the tested probiotic strains were sensitive to *H. undatus* extracts, however, appropriate concentrations of the extracts can be used together with the probiotic strains.

Table 4. MIC and MBC values of *H. undatus* extracts against probiotic strains.

Test Microorganisms	MIC (µg/µl)		MBC (µg/µl)	
	HPME	HFME	HPME	HFME
***L. fermentum* MA-7**	40	20	40	40
***L. gasseri* MA-1**	20	40	40	40
***L. delbrueckii* MA-9**	40	20	40	40

*HPME: *H. undatus* Peel Methanol Extract, HPME: *H. undatus* Fruit Methanol Extract

The well diffusion test results of the cream formulations are presented in Table 5. Since *L. fermentum* is known to skin moisture and improve skin health (Lee et al.,2022), it has been used as a probiotic strain in the cream formulations in the current study. In the control (cream) group, inhibition zone was not observed against the tested microorganisms except for *P. aeruginosa* ATCC 27853 (6.44 mm) and *C. glabrata* RSKK 04019 (2.76 mm). In the CEL group, *H. undatus* fruit extract and probiotic candidate strain have been shown to increase the antimicrobial activity of commercial cream by creating a synergistic effect when compared to the control group.

The highest inhibition zone diameter was obtained to be 17.59 mm against *E. coli* O157:H7 in the CEL cream formulation group. *E. coli* O157:H7 is one of the food-borne pathogenic microorganisms that is important for public health. *E. coli* O157:H7 causes serious intestinal infections in humans (Turgut and Kaya, 2015). Another important feature of *E. coli* O157:H7 is that the minimal infection dose is very low (Özkuyumcu, 2009). The developed antimicrobial cream can be an alternative natural antimicrobial agent for protection from *E. coli* O157:H7 contaminations.

Unexpectedly, in *C. glabrata* RSKK 04019, the highest inhibition zone diameter was detected in the C (2.76 mm) and CL (8.73 mm) groups, while the lower inhibition zone diameter was found in the CEL (5.58 mm) group. This may be due to the fact that the extract may have a slight inhibitory effect on *L. fermentum* MA-7. The difference between CEL group and C group is significant in *C. glabrata* RSKK 04019 ($P<0.05$). The results of the presented study showed that the developed cream formulations may inhibit these pathogens when such pathogens infect to our skin. *Candida spp*. is one of the most common causes of colonization in burns and wounds. *Candida spp.* is associated with persistent infections that cause tissue loss on the surface of the skin and inhibit wound healing (Farjah et al., 2020). The high antimicrobial activity of the cream formulation prepared against *C. albicans* ATCC 10231 (8.52 mm) and *C. glabrata* RSKK 04019 (5.58 mm) test microorganisms indicated that it may has potential for use in the pharmaceutical and cosmetic industries. The high antimicrobial activity of the cream formulation prepared against test microorganisms showed that it has potential for use in the pharmaceutical and cosmetic industries.

Table 5. Well diffusion assay results of cream formulations.

Test Microorganisms	**Inhibition Zone Diameter (mm) of Cream Formulation Groups**			
	C	**CL**	**CE**	**CEL**
***L. monocytogenes* ATCC 7644**	ND[a]	ND[a]	ND[a]	2.78±0.19[b]
***S. enteritidis* RSKK 171**	ND[a]	1.62±0.82[b]	1.10±0.82[a]	3.03±0.49[c]
***E. coli* O157:H7**	ND[a]	6.40±0.24[b]	1.44±0.23[a]	17.59±1.39[c]
***E. faecalis* ATCC 29212**	ND[a]	ND[a]	1.46±0.36[b]	2.69±0.74[c]
***P. aeruginosa* ATCC 27853**	6.44±0.85[a]	3.28±0.30[b]	4.53±0.54[a,b]	7.62±1.16[a,c]
***C. albicans* ATCC 10231**	ND[a]	6.76±0.60 [b]	ND[a]	8.52±1.36[b]
***C. glabrata* RSKK 04019**	2.76±0.53[a]	8.73±0.62 [b]	4.57±0.14[c]	5.58±0.96[c]

*C: Cream (control), CL: Cream+ *L. fermentum* MA-7, CE: Cream+ fruit Extract, CEL: Cream+ fruit Extract+ *L. fermentum* MA-7, ND: Not Determined, the different letters on the same line indicate significance ($p<0.05$)

In a study, it was reported that topical applications of *H. undatus* aqueous extract showed improvement in excision (59%) and incision (52%) wound test in the treated group of diabetic rats (Perez et al., 2005). Sunscreens constitute an important part of the cosmetic industry. In our study, the SPF values of *H. undatus* peel and fruit extracts are given in Figure 2. The peel extract (25.92) has more solar protection potential than fruit extract (24.84).

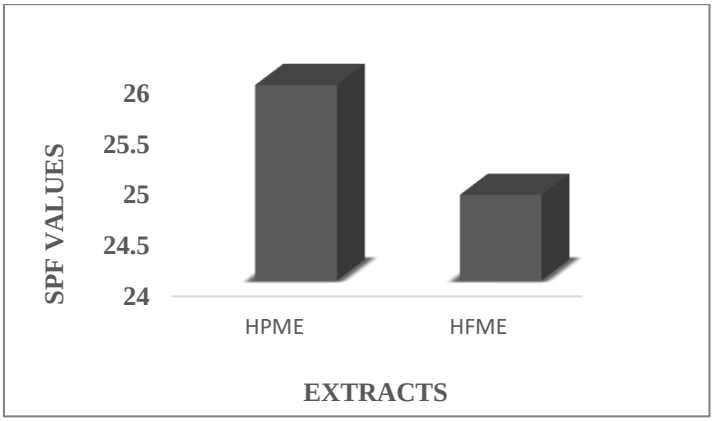

Figure 2. SPF values of *H. undatus* extracts (HPME: *H. undatus* Peel Methanol Extract, HPME: *H. undatus* Fruit Methanol Extract)

Vijayakumar et al. (2020) evaluated the solar protection factor of *Hylocereus polyrhizus* peel ethanol extract at different concentrations. In their studies, SPF values were determined as 15.38 - 35.02.

After determining the SPF values of *H. undatus* extracts, the extracts were mixed with mercantile cream and the SPF values of the extract and cream mixtures were determined at different concentrations. The SPF values of extract-cream mixtures are given in Figure 3. The extract and cream mixtures showed higher SPF values than the control group at all concentrations (2.5 ml, 5 ml and 10 ml). The peel extract exhibited the best SPF value of 22.76 at 10 ml concentration. This indicated that the peel extract had 93% UV blocking rate according to Imam et al. (2015). In our previous study, the SPF of white pitahaya fruit and peel methanol extracts (obtained by using a hot water bath) and cream mixtures was determined as 9.26 and 23.34 at a concentration of 10 ml (Asan-Ozusaglam and Celik, 2023).

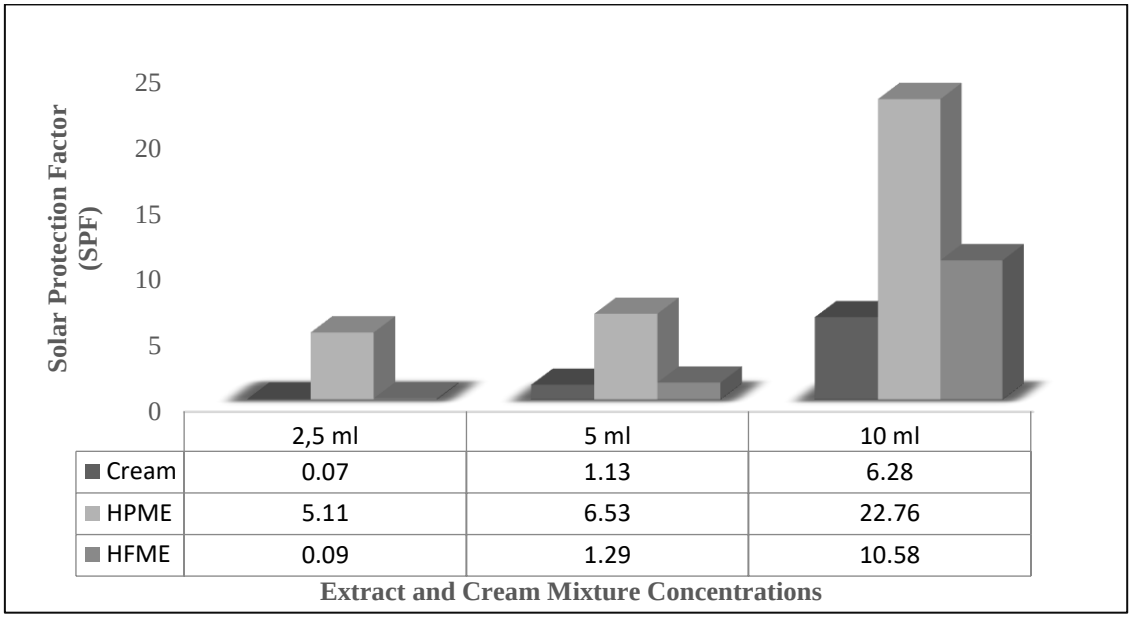

Figure 3. SPF values of cream-*H. undatus* extracts mixture (HPME: *H. undatus* Peel Methanol Extract, HPME: *H. undatus* Fruit Methanol Extract)

CONCLUSION

Biological activities of *H. undatus* peel and fruit extracts were investigated to evaluate the potential usage of *H. undatus* fruit in the pharmaceutical and cosmetic industry. The peel and fruit extracts of *H. undatus* have showed antimicrobial activity against tested microorganisms. The prepared cream formulation has a static/cidal effect against test microorganisms. Therefore, the use of *H. undatus* extracts can be an alternative solution to the prevention of various skin problems by reducing the use of synthetic preservatives. These cream formulations, they can be used in our daily life as an antibacterial moisturizing cream. Also, UV filtering capacities of *H. undatus* extracts were determined to be high. It was determined that when the extracts are mixed with the cream, the UV filtering capacity of the cream increases. Mercantile sunscreens raise various biosecurity and environmental pollution concerns, so these problems will be avoided when plant extracts are used. In our study, it was determined that *H. undatus* extracts have the potential to be used as a natural preservative in the cosmetic or pharmaceutical industry, instead of expensive topical cream formulations containing synthetic preservatives.

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