Research article

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The Effect of Hemp Seed Oil on Skin and Soap Performance

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ABSTRACT

The cannabis plant is essentially a variety of the Cannabis Sativa L. plant. It is used in the textile, energy, automotive and cosmetics. The use of oil derived from hemp seeds has become widespread in cosmetics. Hemp seed oil does not contain Δ9-tetrahydrocannabinol (Δ9-THC) and it is used in the production of food, biodiesel and polymers as well as cosmetics. In this study, different concentrations of hemp seed oil were used in cream and soap formulations, which are among the cosmetic products, and effect on skin hydration, sebum and transepidermal water loss (TEWL) on the skin was investigated. At the same time, the foaming test was applied to soaps containing different concentrations of hemp seed oil to see effects of soap foam performance. To analyse these, a rinse-off and leave-on product were selected. In soap formulations, there is positive effect on skin hydration and TEWL with sebum decrease. The most important change in cream formulations with respect to bar soap formulations is the increases in sebum. The effects of hemp seed oil on soap foam performance were examined. As a result of the study, its effect on the foam of the soap base which is used in this study is positive.

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Introduction

The seeds of cannabis plant are used in cosmetics. Hemp seeds contain 20-25% protein, 20-30% carbohydrates, 25-35% fat, and 10-15% insoluble fibers and a rich range of minerals [1]. Hemp seeds are completely free of Δ 9-THC and can be used in the production of food, cosmetics, biodiesel and polymers [2].

The use of oil derived from hemp seeds has recently become widespread in the cosmetics industry. It has been suggested that hemp seed oil is perfectly balanced in terms of the ratio of two essential polyunsaturated fatty acids (linoleic and linolenic acid (3: 1)). Due to this property and the presence of γ-linolenic acid, oil is used as an ideal ingredient for light body oils and lipid-enriched creams known for their high penetration into the skin [3]. Table 1. shows the percentage presence of fatty acids in hemp seed oil.

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Table 1 Hemp Seed Oil Fatty Acid Ratio [4]

Hempseed Oil Fatty Acid		**Percentage (%)**
C16:0	Palmitic	5,98 ± 0,02
C18:0	Stearic	2,41 ± 0,09
C18:1n9 *cis*	Oleic	9,15 ± 0,17
C18:2n6 *trans*	Linolelaidic	0,86 ± 0,15
C18:2n6 *cis*	Linoleic	55,64 ± 1,21
C18:3n6	gamma-Linolenic	5,30 ± 0,12
C18:3n3	a-Linolenic (cis 9)	18,02 ± 0,19
C20:0	Arachidic	0,93 ± 0,01
C20:1n9	Eicosenoic	1,71 ± 0,17
unsaturated fatty acids		90,68 ± 0,51

Hemp seed oil has been reported to be effective as a sunscreen, skin repairment, anti-allergy and anti-aging, which is high-quality raw material for skin care products [5] and some of its characteristics and properties have been studied. As far as the cosmetic properties are concerned, some of the studies did not provide any particularly interesting result. There have been studies related to the formulations, characterization and antibacterial properties of hemp seed oil. One study evaluated the degree of oxidation of hot pressed and cold pressed hemp seed oil stored in five different environments. The results showed that long chain unsaturated fatty acids were oxidized. The oxidation products of hemp seed oil were analysed by headspace solid phase micro-extraction gas chromatography-mass spectrometry (HS-SPME-GC / MS) and high performance liquid chromatography (HPLC).

It has been found that seed oils stored at low temperature, protected from light and the external environment, contain aldehydes, ketones and alcohols, which have a negative impact on the health of consumers [5].

Hemp seed oil and its emulsions were tested against the growth of selected bacteria (*Micrococcus luteus and Staphylococcus aureus subsp.*) using disk diffusion and broth microdilution methods. It has been suggested that the formulation in the study does not exhibit antibacterial activity due to hemp seed oil addition [6]. On the other hand, cannabis seed emulsions were prepared with different HLB values. After 2 months 25 ˚C and 4 ˚C, it

was observed that the hemp seed oil emulsion showed good stability without phase seperation [6].

In spite of the not promising results quoted above, it might be considered that hemp seed oil can have some positive effects on skin properties. Cannabidiol (CBD), a non-psychoactive compound from the cannabis plant, has garnered significant attention in recent years for its anecdotal therapeutic potential for various pathologies, including skin and cosmetic disorders. Though a body of preclinical evidence suggests topical application of CBD may be efficacious for some skin disorders, such as eczema, psoriasis, pruritis, and inflammatory conditions, confirmed clinical efficacy and elucidation of underlying molecular mechanisms have yet to be fully identified. [7].

One of these is transepidermal water loss (TEWL), one of the most reliable indicators of epidermal barrier function; TEWL refers to the amount of water loss from a specific skin area in a given time period [8]. The use of soap and harsh detergents causes xerosis and exacerbates atopic dermatitis (AD) by a mechanism involving skin barrier breakdown [9]. Occlusive agents serve to reduce transepidermal water loss (TEWL) by forming a hydrophobic barrier film over the skin surface to prevent evaporation of water from the SC, trapping water in the skin's uppermost layers [10]. Creams can have a delaying effect on transepidermal water loss thanks to the occlusive oils they contain. Another effect of creams is to increase skin hydration.

And another reason for using skin products such as soaps and creams is to reduce sebum. Most people think that excess facial sebum causes a shiny or oily looking face and want to reduce facial sebum using cosmetics. Also, oxidized sebum or free fatty acids derived from sebum can irritate the skin and cause skin problems such as seborrheic dermatitis and acne [11].

Materials And Methods

Hemp seed oil was supplied from a local market in Tuzla, Istanbul, Turkey and used in the moment of purchase without any pretreatment. GC and FTIR tests of the supplied hemp seed oil have been completed by the Evyap® laboratories. 0.50, 1.00 and 1.50 w/w% of hemp

seed oil was added to the soap and cream. Formulation of the products are formed by Evyap Sabun Yağ Gliserin San. ve Tic. A.S.®

Skin base measurement

20 volunteers with different genders and age groups and with different skin types were kept in conditional room at 18 ˚C with 8% relative humidity for 15 minutes. The samples were applied on a 25 cm^2 square on the forehead of the volunteers. Before the soaps and creams were applied, the hydration value of the skin was taken from 3 points with Courage + Khazaka electronic GmbH Corneometer® CM 825 and the averages were recorded. Transepidermal water loss was recorded by averaging 10 values with Courage + Khazaka electronic GmbH Tewameter® TM 300 in the same 25 cm^2 square area. Finally, with the Courage + Khazaka electronic GmbH Sebumeter® SM 815, the sebum value was measured 3 times from the same area and the averages were calculated.

Soap measurement on skin

After having measured the base values on the untreated skin, 5 mg soap foam which is including hemp seed oil was applied to the same 25 cm^2 area in forehead of the same volunteers. After 30 seconds later, soap foam was rinsed from the skin using tap water.

After the soap was rinsed from the skin, there was no drying process and the skin was allowed to dry naturally in the conditioned environment. TEWL and hydration and sebum were measured 15 minutes, 30 minutes and 60 minutes after removal of the foam. The steps were exactly the same for soaps containing 0.00%, 0.50%, 1.00% and 1.50% by weight. Results are recorded as a negative expression indicates a decrease in the specified time interval, while a positive expression indicates an increase.

Cream measurement on skin

1.00 gram of the cream containing hemp seed oil was taken and applied to the forehead in a 25 cm^2 square of the same volunteers. The hydration value of the skin was taken from 3 points with Courage + Khazaka electronic GmbH Corneometer® CM 825 respectively, from the applied area and the averages were recorded. Transepidermal water loss was recorded by averaging 10 values with Courage + Khazaka electronic GmbH Tewameter® TM 300 from the applied area. Finally, the sebum value was measured 3 times with Sebumeter® SM 815 from Courage + Khazaka electronic GmbH, and their average was recorded. Corneometer

and tewameter measurements were repeated for cream formulations of 0.00%, 0.50 %, 1.00%, 1.50% w/w hemp seed oil concentrations. After the application of the creams, the same measurements were performed as 15 minutes, 30 minutes and 60 minutes, respectively, and the results were recorded. Results are recorded as a negative expression indicates a decrease in the specified time interval, while a positive expression indicates an increase.

Measurement of soap foaming performance

To determine the foaming performance of soaps, foam test method was applied to soap samples. The 0.40 g soap sample was weighed and placed in a beaker. It was homogenized for 5 minutes at 3600 rpm by adding 1000 mL of deionized water on it. After 5 minutes, samples were poured into 3 measuring cylinders of 50 mL. Each of the metering cylinders was rotated for 30 seconds on the spinner to determine the amount of foam per unit volume. After 30 seconds the initial volume value of the foam was recorded. After 15 minutes and 30 minutes, foam volumes were measured and recorded as well. ,

Results

Characterization of hemp seed oil

When the GC results graphed in Figure 1. are compared with the hemp seed oil content in Figure 2, the results largely overlap. The difference in the ratio of fatty acids in hemp seed oil is due to the different structure of each plant. Detailed results of the graph in Figure 2 are shown in Table 2. FT-IR analysis results are shown in Figure 2.

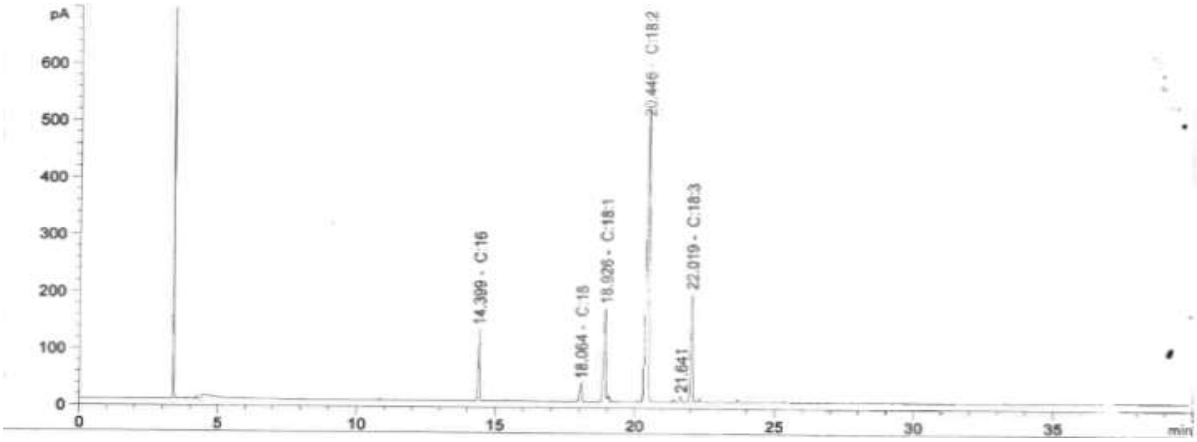

Fig 1 GC Analysis Result of Hemp Seed Oil

Table 2 Hemp Seed Oil GC Analysis Results

Peak	Retime [Min]	Width [Min]	Area [pA*s]	Area %	Name
1	5.3	0.0	0.0	0.0	C:8
2	6.0	0.0	0.0	0.0	C:10
3	8.0	0.0	0.0	0.0	C:12
4	11.0	0.0	0.0	0.0	C:14
5	14.4	0.0	487.1	8.8	C:16
6	18.1	0.1	170.2	3.1	C:18
7	18.9	0.1	1020.4	18.4	C:18:1
8	20.4	0.1	3106.6	56.1	C:18:2
9	22.0	0.0	756.5	13.7	C:18:3

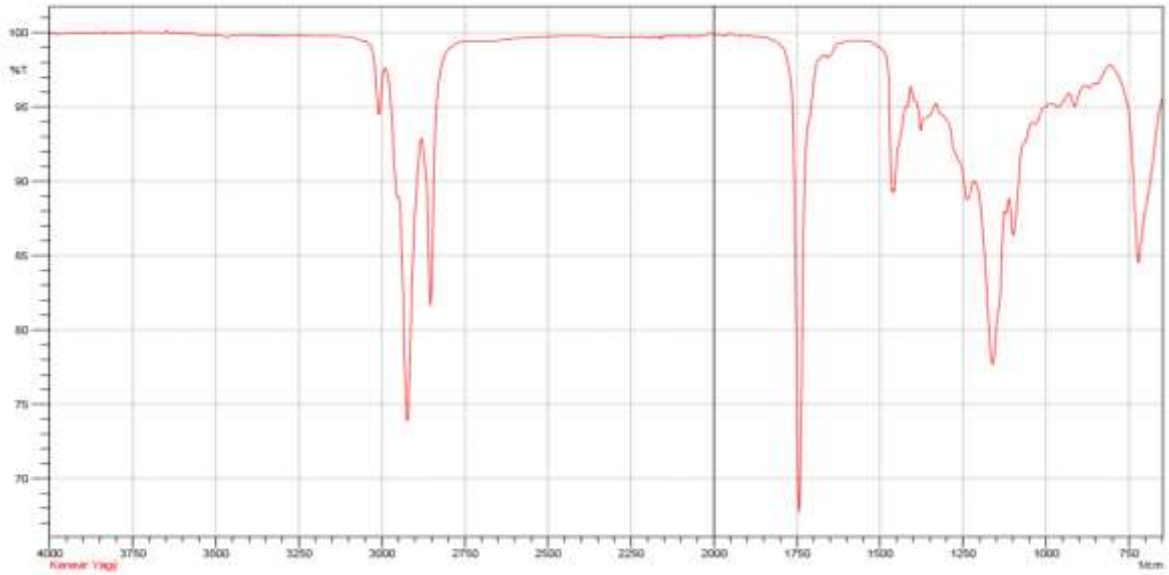

Fig 2. FT-IR Result of Hemp Seed Oil

Chemical analysis

Heavy metal ion analysis of the water used at this stage was performed by SGS Istanbul - Food Control & Agriculture® using EPA 200.8 analysis method. The pH, conductivity and hardness analysis of the same water sample was carried out. Heavy metal values were given in Table 3. The pH analysis result of the same water is 8,001; conductivity analysis result is 767.1. The water hardness analysis result is stated as 21 dH (hard).

Table 3 Heavy Metal Ions Analysis Results of Soap Rinse Water

Analysis	**Result / Uncertainty**	**LOQ**	**Unit**
Antimony (Sb)	Not Detected	1	µg/L
Cadmium (Cd)	Not Detected	1	µg/L
Chromium (Cr)	Not Detected	1	µg/L
Cobalt (Co)	Not Detected	1	µg/L
Nickel (Ni)	Not Detected	1	µg/L
Copper (Cu)	Not Detected	1	µg/L
Arsenic (As)	Not Detected	1	µg/L
Mercury (Hg)	Not Detected	1	µg/L
Lead (Pb)	Not Detected	1	µg/L

Soap measurements

Soap removes lipids in the skin's barrier and modifies trans-epidermal water loss and skin hydration. The results for the control without hemp oil are reported in Table 4. A negative expression indicates a decrease in the specified time interval, while a positive expression indicates an increase.

Table 4 Skin hydration, TEWL, Sebum Measurement Values of Soap Containing 0.00 % Hemp Seed Oil

Hemp Seed Oil (%)	**Volunteers**	**Skin Hydration [g/min]**			**TEWL (g/ hm^2)**			**Sebum**
		0-15 Min	**15-30 Min**	**30-60 Min**	**0-15 Min**	**15-30 Min**	**30-60 Min**	**0-60 Min**
0.00	**1**	-18.2	-19.1	-15.7	-14.1	-12.6	-1.5	33.0
	2	-3.2	-11.7	-2.6	-6.7	-9.2	-3.2	-97.0
	3	-4.1	-0.8	0.0	-0.9	-9.1	-5.3	-21.0
	4	-22.2	-20.5	-18.3	-3.2	-7.9	-5.3	-28.0
	5	-0.4	-15.7	-4.5	-7.1	-5.6	-4.1	7.0
	6	-10.2	-15.9	-5.5	-9.1	-11.1	-10.5	-18.0
	7	-19.9	-17.3	-14.7	-0.8	-8.2	-4.2	-34.0
	8	-9.0	-5.4	-5.3	-12.3	-10.2	-7.7	18.0
	9	-21.2	-2.8	-1.2	-2.4	-13.4	-11.2	-45.0
	10	-12.3	-7.6	-5.4	-18.6	-20.6	-13.4	22.0
	11	-15.8	-3.9	-2.5	-15.3	-12.5	-3.4	38.0
	12	-17.1	-5.2	-4.3	-2.8	-3.3	-0.2	-2.0
	13	-0.8	-0.1	-0.2	-4.7	-5.8	-4.2	-45.0

	14	-4.2	-9.4	-9.8	-0.2	-2.9	-1.1	-31.0
	15	-13.6	-7.4	-3.6	-0.6	-7.8	-6.9	-54.0
	16	-5.7	-12.2	-10.4	-3.5	-12.4	-5.3	-94.0
	17	-7.4	-8.1	-14.3	-0.7	-2.2	-0.2	43.0
	18	-20.3	-19.5	-18.4	-11.4	-14.3	-9.9	-65.0
	19	-2.1	-2.6	-2.2	-3.3	-8.3	-2.7	-67.0
	20	-3.3	-0.3	-0.4	-1.4	-10.6	-3.8	-32.0
	Average	-10.5	-9.3	-7.0	-6.0	-9.4	-5.2	-23.6

Table 5 shows the skin hydration, TEWL and sebum data of soap with 0.50% hemp seed oil content for 20 people in detail. Data were taken as the average change between specified minutes. Based on the mean values of 7 volunteers, the use of hemp seed oil appears to have a positive effect on skin hydration. Although there was a decrease of -6.2 in skin hydration between 0 and 15 minutes, an increase in hydration was seen in the following measurements. When the same results were evaluated for TEWL, soap containing 0.50% hemp seed oil was not shown significant results during 60 minutes. The value of TEWL was quite small. 0.50% concentration will not cause a change for TEWL.

The change in sebum values were evaluated for the first 60 minutes and are reflected in Table 5. It has been observed that hemp seed oil reduces sebum with a value of -31.8.

Table 5 Skin hydration, TEWL, Sebum Measurement Values of skin treated with foam from Soap Containing 0.50 % Hemp Seed Oil

Hemp Seed Oil (%)	**Volunteers**	**Skin Hydration [g/min]**			**TEWL (g/ hm^2)**			**Sebum**
		0-15 Min	**15-30 Min**	**30-60 Min**	**0-15 Min**	**15-30 Min**	**30-60 Min**	**0-60 Min**
0.50	**1**	-8.3	3.1	12.7	-4.1	2.0	-1.5	18.0
	2	-0.4	-14.7	8.9	-0.4	5.0	-1.7	-70.0
	3	-0.5	-1.9	4.0	2.9	-0.1	-1.6	-31.0
	4	-16.7	2.0	3.3	-0.2	-2.5	-2.5	-32.0
	5	4.8	-13.7	-1.5	-0.2	1.7	-2.2	-3.0
	6	-6.1	-5.4	2.9	0.0	-1.4	-0.8	-36.0
	7	-17.9	10.3	11.4	-0.8	4.4	-2.4	-65.0
	8	-6.4	-2.3	4.4	-0.1	2.3	-3.5	-21.0
	9	-18.2	-9.2	2.7	-4.4	1.2	-2.4	-18.0
	10	-4.3	-2.3	7.6	-2.1	-2.5	-1.6	-34.0

	11	-12.5	-8.8	-2.4	2.3	-1.2	-3.2	-42.0
	12	-11.7	-4.9	6.3	-4.9	3.4	-1.9	12.0
	13	-0.3	0.0	7.7	3.6	4.2	-2.6	-27.0
	14	-3.2	-2.7	4.6	-2.7	1.9	-0.2	-39.0
	15	-9.8	-2.6	5.0	-0.1	-2.6	-1.2	-43.0
	16	-2.9	-2.3	5.1	-2.5	3.6	-2.1	-56.0
	17	-5.6	-1.4	2.9	-3.1	0.8	-4.2	-28.0
	18	0.0	0.0	6.6	-2.6	-1.3	-0.1	-19.0
	19	-1.9	-1.1	13.5	3.5	-0.3	-2.5	-34.0
	20	-2.8	-1.2	18.9	0.0	3.9	-0.7	-67.0
	Average	-6.2	-3.0	6.2	-0.8	1.1	-1.9	-31.8

Table 6. shows the data of soap with 1.00% hemp seed oil content as hydration, TEWL and sebum. Considering the data as the mean change between the specified minutes, it is seen that the mean values of 20 subjects showed an incredible effect when soap containing hemp seed oil increased from 0.50% to 1.00%. Although there was a decrease in skin hydration in the first 15 minutes, it was increased dramatically between 15-30 minutes. Skin hydration tended to return to its original state after 30 minutes. At the end of 60 minutes, there was almost no change in skin moisture with respect to initial values. There was a steady decrease in TEWL. Although the soap increased TEWL when first applied to the skin, there was a decrease in water loss with the effect of hemp seed oil.

The change in sebum have been evaluated for the first 60 minutes and are reflected in Table 6. It has been observed that hemp seed oil reduces sebum with a value of -36.7 with respect to 0.50% hemp seed oil. There was 17% decrease in sebum after 60 minutes.

Table 6 Skin hydration, TEWL, Sebum Measurement Values of Soap Containing 1.00 % Hemp Seed Oil

Hemp Seed	**Volunteers**	**Skin Hydration [g/min]**			**TEWL (g/ hm^2)**			**Sebum**
		0-15 Min	**15-30 Min**	**30-60 Min**	**0-15 Min**	**15-30 Min**	**30-60 Min**	**0-60 Min**

Oil (%)								
1.00	**1**	-16.9	12.2	5.4	-1.7	2.3	-3.0	-97.0
	2	2.6	-3.1	-5.9	3.7	2.0	2.4	-125.0
	3	-2.2	-6.9	-3.3	2.0	0.3	-1.3	65.0
	4	-21.7	2.7	3.8	-0.2	6.3	12.5	-39.0
	5	-10.0	13.8	-9.5	3.1	0.1	-0.4	-16.0
	6	3.4	0.7	3.0	2.6	-2.9	-0.4	-28.0
	7	19.9	8.4	0.1	1.9	1.6	-3.3	-16.0
	8	-8.7	5.7	6.3	3.2	2.5	11.5	-23.0
	9	2.3	6.4	4.2	5.7	1.8	-0.2	-53.0
	10	-1.2	2.5	3.1	0.4	1.5	-0.8	-61.0
	11	-10.9	-5.2	-2.4	1.2	4.4	-11.2	-38.0
	12	-7.4	-3.3	-15.7	-3.7	0.0	-1.1	-78.0
	13	2.4	5.9	4.8	-2.9	1.1	3.6	-18.0
	14	-1.7	2.1	1.2	2.2	1.3	3.7	-43.0
	15	-5.4	-2.4	-7.1	6.1	2.6	0.0	-27.0
	16	-1.7	3.9	-4.4	3.9	-3.1	-0.2	-19.0
	17	-3.3	7.9	3.2	8.2	0.5	3.1	-27.0
	18	-5.6	4.8	6.1	-5.1	0.3	2.9	-30.0
	19	-1.1	12.3	-11.3	3.9	1.5	2.2	-21.0
	20	-1.4	9.9	2.2	1.1	1.6	-1.2	-39.0
	Average	-3.4	3.9	-0.8	1.8	1.3	0.9	-36.7

Table 7. shows the data of soap with 1.50% hemp seed oil content as moisture, TEWL and sebum. The data were interpreted as the average change between the specified minutes, and by looking at the average values of 20 volunteers, it can be said that by increasing the ratio of hemp seed oil to 1.50%, the skin moisture decreased considerably in the first 15 minutes, but then it started to increase rapidly until 60 minutes.

When the same results were evaluated for TEWL, although it was observed that it increased based on the value of 2.4 in the first 15 minutes, there was a significant decrease between 15 and 30 minutes. Within 30-60 minutes the skin tended to return to its initial state.

The change in sebum were evaluated for the first 60 minutes and were reflected in the Table 7. It has been observed that hemp seed oil significantly reduces sebum with a value of -44.29.

Table 7 Skin hydration, TEWL, Sebum Measurement Values of Soap Containing 1.50 % Hemp Seed Oil

Hemp Seed Oil (%)	Volunteers	Skin Hydration [g/min]			TEWL (g/ hm^2)			Sebum
		0-15 Min	15-30 Min	30-60 Min	0-15 Min	15-30 Min	30-60 Min	0-60 Min
1.50	**1**	-11.1	-6.7	4.8	-1.3	-0.2	-2.2	-59.0
	2	-1.2	-7.6	-1.7	9.4	-2.0	2.4	-85.0
	3	-10.7	-2.3	7.1	0.6	1.4	-0.5	-10.0
	4	12.6	-2.4	-6.6	2.0	-3.9	-2.0	-7.0
	5	-2.1	-2.7	2.0	2.5	-0.9	-2.5	-6.0
	6	-26.7	-1.6	5.9	0.4	-5.7	4.1	-35.0
	7	-17.2	3.3	7.9	4.0	-3.4	0.4	-108.0
	8	-9.5	-2.5	1.4	2.3	1.2	1.9	-34.0
	9	-13.7	-4.7	-2.4	3.1	1.6	1.5	-67.0
	10	-24.1	-12.8	-6.3	3.5	-2.4	-3.4	-73.0
	11	-13.1	-3.6	2.1	5.2	3.1	1.2	-32.0
	12	-1.4	4.4	3.7	2.3	-3.6	-6.2	-96.0
	13	-2.1	2.6	2.9	1.7	-2.8	2.3	-54.0
	14	-7.9	1.1	3.5	-1.9	-3.4	1.1	-41.0
	15	-4.4	-2.9	2.4	2.5	-5.8	1.5	-35.0
	16	-11.1	-5.6	-1.9	3.1	-1.4	2.7	-28.0
	17	-1.6	4.8	5.2	4.7	4.4	-1.6	-29.0
	18	-2.1	-1.3	3.6	-3.2	-7.1	-5.1	-24.0
	19	-3.2	-2.8	4.6	3.6	-1.5	3.4	-49.0
	20	-5.6	-4.5	7.8	3.8	-6.8	2.5	-51.0
	Average	-7.8	-2.4	2.3	2.4	-2.0	0.1	-46.2

It has seen 0.50%, 1.00% and 1.50% hemp seed oil content data in Table 8. As can be seen, the highest level was observed at 0 minutes. Subsequently, it has gradually decreased and reached the minimum level in 30 minutes.

Table 8 Soap Foaming Test Results with Hemp Seed Oil Ratio Variation

Hemp Seed Oil (%)	0. Min	15. Min	30. Min
0.00	2.28	1.35	1.12
0.50	2.24	1.65	1.28
1.00	1.88	1.57	1.28

1.50	2.43	2.08	1.48

Hemp seed oil has been observed to yield only 1.50% effective results at minute 0, based on the soap base measurement according to Table 8. However, considering the 15th and 30th minutes, it was observed that the amount of soap foam increased with the increase in the concentration of hemp seed oil.

Cream measurements

Cream formulation is contained emollients and humectants. Emollients are created a barrier on the skin. Hydration, TEWL and sebum for the skin treated with cream without hemp oil are reported in table 9.

Table 9 Skin hydration, TEWL, Sebum Measurement Values of Cream Containing 0.00 % Hemp Seed Oil

Hemp Seed Oil (%)	**Volunteers**	**Skin Hydration [g/min]**			**TEWL (g/ hm^2)**			**Sebum**
		0-15 Min	**15-30 Min**	**30-60 Min**	**0-15 Min**	**15-30 Min**	**30-60 Min**	**0-60 Min**
0.00	**1**	-3.5	-2.2	13.9	3.5	1.5	-2.3	120.0
	2	-28.9	-23.3	-13.7	9.0	-6.8	4.5	87.0
	3	-4.5	0.2	2.3	-2.3	-5.4	3.9	34.0
	4	-23.8	-12.4	0.1	-11.2	-12.1	-9.5	27.0
	5	-2.3	3.5	3.0	0.8	-2.3	2.0	45.0
	6	-29.5	-21.5	-8.1	3.8	-1.7	1.2	129.0
	7	-23.2	-12.0	-1.9	4.6	-2.5	2.7	134.0
	8	-27.3	-22.3	-18.4	3.1	-2.5	4.8	137.0
	9	-31.6	-18.4	7.1	2.6	-3.1	2.5	32.0
	10	-17.3	-12.8	-8.2	4.2	-5.7	6.5	76.0
	11	-19.3	-11.5	0.5	6.8	-2.5	0.1	98.0
	12	-8.2	-6.6	-2.1	11.3	2.9	0.4	79.0
	13	-2.1	3.5	0.1	4.2	-4.4	3.7	73.0
	14	-5.9	0.4	6.5	-8.9	-5.1	-4.1	44.0
	15	-29.4	-17.3	2.5	-2.1	0.3	1.1	60.0
	16	-32.9	-3.6	-1.9	3.6	-3.5	0.9	45.0
	17	-11.1	-8.8	-2.6	-1.5	-2.1	5.7	54.0
	18	-7.2	-1.4	11.7	-5.1	-8.9	-2.6	111.0
	19	-3.7	-5.3	2.4	2.8	-1.2	-5.5	134.0

	20	-18.5	-13.9	-1.5	0.4	-9.4	-2.1	76.0
	Average	**-16.5**	**-9.3**	**-0.4**	**1.5**	**-3.7**	**0.7**	**79.8**

Table 10. contains skin hydration, TEWL and sebum data of the cream with a 0.50% hemp seed oil content. There was a significant reduction in skin hydration in the first 15 minutes. However, as the absorption level increased, the hydration level increased over time.

There was an increase in water loss in the first 15 minutes for cream with a 0.50% hemp seed oil content. The water loss decreased significantly in the following minutes because the moisture was too much at the beginning and the rate of water loss was very fast. As the absorption occurred on the skin, the moisturization level increased. Transepidermal water loss in 30-60 minutes increased slightly compared to 15-30 minutes and reached -3.3.

Sebum values were evaluated for the first 60 minutes and reflected in Table 10. Hemp seed oil was found to increase sebum with a value of 114.7.

Table 10 Skin hydration, TEWL, Sebum Measurement Values of Cream Containing 0.50 % Hemp Seed Oil

Hemp Seed Oil (%)	**Volunteers**	**Skin Hydration [g/min]**			**TEWL (g/ hm^2)**			**Sebum**
		0-15 Min	**15-30 Min**	**30-60 Min**	**0-15 Min**	**15-30 Min**	**30-60 Min**	**0-60 Min**
0.50	**1**	-5.6	-4.2	5.4	-2.4	-5.6	-3.4	134.0
	2	-3.6	1.1	2.7	5.6	2.5	5.1	89.0
	3	-12.8	-3.1	6.8	-4.2	1.5	-2.8	45.0
	4	-18.9	-11.1	1.0	-7.9	-9.6	-4.6	76.0
	5	-21.4	-8.9	-3.7	0.4	-3.1	-1.1	82.0
	6	-12.5	-12.4	-1.1	3.7	-6.4	-6.7	187.0
	7	-6.8	-6.3	-2.3	1.1	-7.2	-2.5	145.0
	8	-21.6	-12.1	-4.9	3.6	1.1	4.9	165.0
	9	-2.1	-6.6	0.9	2.1	2.8	4.4	56.0
	10	-6.1	2.5	7.7	6.9	-3.9	3.4	85.0
	11	-21.5	-12.4	-3.0	2.7	4.6	5.1	101.0
	12	-17.4	-9.8	-2.9	-2.9	-9.1	-7.8	132.0
	13	-20.6	-2.5	0.1	0.8	-3.6	-2.1	108.0
	14	-7.7	-3.2	-1.3	-15.9	-13.4	-11.4	112.0

	15	-19.4	-11.6	-7.4	-9.0	0.4	0.2	134.0
	16	-18.1	-12.5	-10.2	2.6	-0.1	-4.9	126.0
	17	-16.3	-8.4	8.5	3.1	-4.4	-7.3	103.0
	18	-11.1	-10.9	5.2	0.3	-7.5	-4.2	176.0
	19	-21.9	-13.5	3.3	-1.9	-1.2	-0.9	102.0
	20	-20.1	-16.2	0.1	2.5	-3.2	-9.1	136.0
	Average	**-14.3**	**-8.1**	**0.2**	**-0.4**	**-3.3**	**-2.3**	**114.7**

Table 11. contains the skin hydration, TEWL and sebum data of the cream with 1.00% hemp seed oil content. The cream containing 0.50% hemp seed oil had the same effect on skin hydration as the cream containing 1.00% hemp seed oil. While there was a significant decrease in the first 15 minutes, the penetration of the oil into the skin increased the skin hydration as 2.7 at the end.

Considering cream containing 1.00% hemp seed oil. During 60 minutes, there is no significant change in TEWL. It does not affect the water loss on the skin.

Sebum values were evaluated for the first 60 minutes and are reflected in Table 11. as the average value per minute. Hemp seed oil was found to increase sebum by 123.8.

Table 11 Skin hydration, TEWL, Sebum Measurement Values of Cream Containing 1.00 % Hemp Seed Oil

Hemp Seed Oil (%)	**Volunteers**	**Skin Hydration [g/min]**			**TEWL (g/ hm2)**			**Sebum**
		0-15 Min	**15-30 Min**	**30-60 Min**	**0-15 Min**	**15-30 Min**	**30-60 Min**	**0-60 Min**
1.00	**1**	**-1.6**	**-1.3**	**-1.4**	**1.1**	**5.0**	**-8.9**	**204.0**
	2	**-19.2**	**5.2**	**-9.5**	**5.2**	**-10.0**	**0.4**	**145.0**
	3	**-1.8**	**-4.6**	**-2.0**	**-7.6**	**-0.5**	**1.6**	**71.0**
	4	**-16.2**	**-8.1**	**12.7**	**-16.2**	**-13.6**	**-11.1**	**125.0**
	5	**1.7**	**-15.4**	**12.0**	**5.6**	**-7.1**	**5.2**	**45.0**
	6	**-22.1**	**-2.3**	**9.8**	**2.9**	**-6.1**	**0.7**	**175.0**
	7	**-17.9**	**2.3**	**-2.8**	**7.7**	**-1.8**	**3.9**	**174.0**
	8	**-12.2**	**-8.7**	**4.3**	**4.6**	**-2.5**	**1.7**	**68.0**
	9	**-8.9**	**-2.5**	**3.8**	**2.7**	**-3.1**	**1.8**	**87.0**
	10	**-16.5**	**-11.4**	**1.7**	**-2.6**	**-5.9**	**-3.6**	**99.0**

	11	**-2.7**	**3.7**	**6.9**	**-1.2**	**-3.3**	**1.7**	**112.0**
	12	**-13.7**	**1.6**	**3.5**	**6.8**	**2.6**	**5.1**	**153.0**
	13	**-16.9**	**-6.2**	**-4.5**	**-8.9**	**-11.8**	**-6.9**	**89.0**
	14	-4.7	0.5	3.1	-1.5	-9.6	-4.7	93.0
	15	-21.7	-3.8	8.6	0.4	1.7	3.1	79.0
	16	-19.7	-11.4	1.9	5.2	3.9	5.9	110.0
	17	-3.1	4.6	11.6	4.8	2.1	2.2	121.0
	18	-2.6	0.9	-2.3	-1.5	-8.3	-7.2	142.0
	19	-4.7	-1.8	0.2	-4.8	-12.8	-5.3	197.0
	20	-11.1	-5.4	-3.9	-6.2	-7.1	-11.0	187.0
	Average	**-10.8**	**-3.2**	**2.7**	**-0.2**	**-4.4**	**-1.3**	**123.8**

Table 12. contains the skin hydration, TEWL and sebum data of the cream with 1.50% hemp seed oil content. As 0.50% and 1.00% hemp seed oil content; 1.50% hemp seed oil the same effect on skin hydration in cream formulation. It decreased in first 15 minutes. When the data are considered as the average change between the determined minutes, it is possible to say that the hydration is not different from the other dosages and decreases in the first 15 minutes, but increased over time. It reached the 5.8 in the 30-60 minutes range.

An increase of 2.5 was observed in the first 15 minutes, the transepidermal water loss decreased significantly in 15-30 minutes and reached -3.00 However, it increased a slightly more in 30-60 minutes and the value was recorded as -7.5.

Sebum values were evaluated for the first 60 minutes and reflected in Table 12. Hemp seed oil was found to increase sebum by 155.0.

Table 12 Skin hydration, TEWL, Sebum Measurement Values of Cream Containing 1.50 % Hemp Seed Oil

Hemp Seed Oil (%)	**Volunteers**	**Skin Hydration [g/min]**			**TEWL (g/ hm^2)**			**Sebum**
		0-15 Min	**15-30 Min**	**30-60 Min**	**0-15 Min**	**15-30 Min**	**30-60 Min**	**0-60 Min**
1.50	**1**	-13.8	12.0	0.9	-1.9	4.6	-2.8	199.0
	2	1.1	-4.6	3.4	28.2	-27.8	-3.3	146.0

	3	-2.9	-8.6	5.8	1.1	-4.1	6.8	76.0
	4	-31.1	-4.0	13.3	-4.2	-28.6	-11.4	160.0
	5	-7.4	-4.9	10.8	2.5	-3.6	3.4	148.0
	6	-20.3	-1.7	7.5	-1.3	-3.0	-1.4	196.0
	7	-6.7	1.3	0.3	-4.8	1.5	-0.3	192.0
	8	-8.5	-6.2	3.6	-3.6	-9.7	-4.9	78.0
	9	-12.5	-3.7	2.1	2.5	-12.4	-9.7	98.0
	10	-11.6	-1.8	4.8	-1.8	-6.3	-3.1	112.0
	11	-21.7	-3.9	6.6	-6.7	-16.9	-11.1	143.0
	12	-8.9	-2.4	11.4	-2.1	-2.2	0.4	211.0
	13	-1.5	3.7	2.2	-3.4	-4.1	0.8	98.0
	14	-9.6	-1.1	15.0	1.9	-3.6	3.6	102.0
	15	-3.6	-4.6	1.1	5.3	-9.4	-1.7	167.0
	16	-6.4	-1.7	2.2	2.8	2.1	7.9	175.0
	17	-10.9	-4.4	6.8	7.7	-3.8	9.2	198.0
	18	-11.1	-2.3	1.5	8.1	-5.7	-2.6	174.0
	19	-13.7	1.8	8.9	5.5	-14.9	-2.8	226.0
	20	-21.7	-5.2	7.2	14.9	-1.5	0.1	201.0
	Average	**-11.1**	**-2.1**	**5.8**	**2.5**	**-7.5**	**-1.1**	**155.0**

Discussion

As can be seen from the results of the analysis in Table 2., palmitic acid in hemp seed oil is 8.8%. When the values compared to the literature values in Table 1., hemp seed oil which was used in this study is greater than literature value. The same applies to stearic acid, oleic acid, linoleic acid. However linolenic acid is less in hemp seed oil which was used in this experiment. Contrary to literature, arachidic and eicosenoic acid were not found in the hemp seed oil which was used.

FT-IR analysis results are shown in Figure 2. The peak in the range of 2500-3300 refers to carboxylic acids [12]. As can be seen from the results of the analysis, between 2500 and 3300 peaks were found. Likewise, FT-IR results prove the presence of fatty acids. Also, no heavy metals were found in the tap water used for rinsing.

By using hemp seed oil at different rates of 0.00, 0.50, 1.00 and 1.50 %, the effect on the subjects was examined and the change in skin hydration was compared in Table 4, 5, 6 and 7. It was clearly demonstrated that soap containing hemp seed oil significantly reduced skin

hydration in the first 15 minutes, increased skin hydration in the next 15 minutes, and continued to increase skin hydration except soap containing 1.00% hemp seed oil between 30-60 minutes. Therefore, soap containing 1.00% hemp seed oil had a quick effect, but it lost its effect quickly. It has been observed that hemp seed oil increases skin hydration.

The effect of hemp seed oil in terms of transepidermal water loss is given in Table 4,5,6 and 7. Looking at the average data of the volunteers, there was an increase in transepidermal water loss in the first 15 minutes, except for soap containing 0.50% hemp seed oil. While increasing hemp seed oil in the same minute interval caused an increase in transepidermal water loss, the same result was not valid for the other minute intervals. Soap with 1.50% hemp seed oil was most effective at intervals of 15-30 minutes. The skin tended to return to its normal state at 30-60 minute intervals.

The reduction of sebum is generally considered a good factor for skin health. The sebum must be in balance. As can be seen in Table 4,5,6 and 7; the rate of sebum decreased significantly in the first 60 minutes with the increase in the ratio of hemp seed oil. The recorded value of -31.8 at 0.50% was recorded as -36.7 at 1.00%, and finally the least sebum was provided with a value of –46.2 at 1.50%. The effect of hemp seed oil on soap foam has been studied. Table 8. shows the results of the study conducted with a base that does not contain hemp seed oil. The volume of soap foam in 1 mL was read as 2.28 at 0 minutes. Afterwards, it gradually decreased to 1.12 in the 30th minute.

When the effect of hemp seed oil used in cream in different proportions on the subjects was examined. Skin hydration decreased for the first 15 minutes, but then increased depending on time. After 15 minutes skin moisture increased significantly compared to the first 15 minutes. It can be said that the dosage of hemp seed oil used on a general basis is proportional to the skin hydration according to Table 9, 10, 11 and 12.

Hemp oil 0.50% and 1.50% increased transepidermal water loss, but the cream containing 1.00% hemp seed oil reduced it negligibly. The cream worked between 15-30 minutes and reduced transepidermal water loss. After 30 minutes, the skin tended to return to normal, but it had a positive effect on the skin by reducing transepidermal water loss at three dosages of the initial level. 0.50% hemp seed oil increased the TEWL at 0-15 min. The decrease of TEWL was seen at 15-30 and 30-60 min. However the most effective skin barrier function

was seen at 15-30 minutes measurement. Therefore, depending on the hemp oil concentration and formulation, the duration of hemp seed oil efficacy may chance.

When the proportion of sebum with hemp seed oil is examined, it increases with increasing hemp seed oil concentration. Depending on the cream formulation, these sebum values may change. For instance, for lower sebum values, cream formulations with lower oil phase can be prepared.

Conclusions

Hemp seed oil has effect on skin hydration, TEWL and sebum. To analyse these, a rinse-off and leave-on product were selected. In soap formulations, there is positive effect on skin hydration and TEWL with sebum decrease. The most important change in cream formulations with respect to bar soap formulations is the increases in sebum.

The effects of hemp seed oil on soap foam performance were examined. As a result of the study, its effect on the foam of the soap base which is used in this study is positive.

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