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The effect of avocado oil and sweet almond oil on basic biophysical characteristics of skin in healthy young women

Wpływ oleju z awokado i oleju ze słodkich migdałów na podstawowe cechy biofizyczne skóry u zdrowych, młodych kobiet

ABSTRACT

Introduction: Plant oils are widely used in cosmetology. Among the most commonly utilized are avocado oil and sweet almond oil. They are used both in their pure form and as carriers for essential oils. Despite their widespread use, evidence regarding their effects on selected skin biophysical properties remains limited.

Aim: This study aimed to evaluate the effects of topical application of avocado oil, sweet almond oil, and their mixtures on skin parameters. The effects were assessed on both intact skin and skin with experimentally impaired barrier function.

Materials and methods: The study included 20 healthy women aged 20–28 years. Skin parameters were assessed using non-invasive instrumental methods.

Results: Both the type of oil formulation and the measurement time significantly affected skin parameters. The greatest improvement in epidermal barrier function was observed after the application of sweet almond oil, whereas avocado oil tended to reduce reduce the moisture level of skin with impaired barrier function.

Conclusions: A single application of avocado oil did not improve skin hydration, and the results indicate that the efficacy of plant oils depends on both their chemical composition and the condition of the epidermal barrier.

Keywords: avocado oil, sweet almond oil, transepidermal water loss, skin hydration.

STRESZCZENIE

Wstęp: Oleje roślinne znajdują szerokie zastosowanie w kosmetologii. Wśród najczęściej wykorzystywanych surowców wyróżnia się olej z awokado oraz olej ze słodkich migdałów. Służą one zarówno w postaci czystej, jak i jako nośniki olejków eterycznych. Pomimo ich powszechnego zastosowania nadal brakuje danych dotyczących wpływu tych olejów na wybrane właściwości biofizyczne skóry.

Cel: Celem badania była ocena wpływu miejscowej aplikacji oleju z awokado, oleju ze słodkich migdałów oraz ich mieszanin na wybrane parametry skóry. Oceniano efekt działania preparatów zarówno na skórę nieuszkodzoną, jak i po zastosowaniu modelowej procedury naruszającej funkcję bariery naskórkowej.

Materiały i metody: Badaniem objęto 20 zdrowych kobiet w wieku 20-28 lat. Parametry skóry oceniano z wykorzystaniem nieinwazyjnych metod instrumentalnych.

Wyniki: Wykazano, że zarówno rodzaj preparatu olejowego, jak i czas pomiaru istotnie wpływały na parametry skóry. Największą poprawę funkcji bariery naskórkowej obserwowano po zastosowaniu oleju ze słodkich migdałów, natomiast olej z awokado wykazywał tendencję do obniżania poziomu nawilżenia skóry z zaburzoną funkcją bariery.

Wnioski: Jednorazowa aplikacja oleju z awokado nie poprawiła nawilżenia skóry, a uzyskane wyniki wskazują, że skuteczność olejów roślinnych zależy zarówno od ich składu chemicznego, jak i stanu bariery naskórkowej.

Słowa kluczowe: olej z awokado, olej ze słodkich migdałów, przeznaskórkowa utraty wody, nawilżenie skóry.

INTRODUCTION

In recent years, there has been growing interest in natural cosmetics and plant-based ingredients. Plant oils, have become particularly popular for their use in skin, hair, and nail care. This trend was influenced, among other things, by the COVID-19 pandemic, which increased interest in mindful skincare, simple cosmetic formulations, and natural and organic products [1].

The skin serves a protective function, and its proper functioning depends on adequate hydration and the condition of the hydrolipid barrier. Thanks to the content of unsaturated fatty acids, phytosterols, and antioxidants, they can support skin regeneration, reduce water loss, and improve its elasticity [2, 3]. Despite the growing popularity of natural ingredients, there is still a lack of studies confirming their actual impact on the biophysical properties of the skin. Therefore, this study focused on how avocado oil and sweet almond oil, two extremely commonly used raw materials, affect skin hydration and protective function. The assessment of skin hydration was based primarily on measurements of transepidermal water loss (TEWL) and the hydration level of the stratum corneum. TEWL measures the amount of water evaporating from the skin's surface and is an important indicator of the protective barrier function. High TEWL values suggest damage to the epidermal barrier, while low values indicate that it is functioning properly [4]. Non-invasive measurement methods are used, based primarily on the analysis of the skin's electrical properties [4, 5].

In cosmetology, cold-pressed and unrefined oils are particularly valued because they retain more than refined oils [6]. Vegetable oils can be classified as drying, semi-drying, and non-drying, depending on their content of polyunsaturated fatty acids, which affects their properties and use in skin care [7].

An example of a non-drying oil is avocado (*Persea gratissima*) oil. It is a valuable raw material used in cosmetology and nutrition due to its rich lipid content and the presence of a number of bioactive compounds [8, 9]. The predominant fatty acid is oleic acid, which accounts for approximately 50–60% of all fatty acids. The oil also contains linoleic, linolenic, and palmitic acids [8]. An important component of the oil is the unsaponifiable fraction, which includes phytosterols and tocopherols (vitamin E), which exhibit antioxidant activity and contribute to the stability of the raw material [8]. This oil also contains chlorophylls, carotenoids, and phenolic compounds, the presence of which determines its antioxidant and skin-care properties, as well as the raw material's fairly intense color [10, 11].

Sweet almond (*Prunus Amygdalus Dulcis*) oil is a valuable raw material used in cosmetology, pharmacy, and the food industry, classified as a semi-drying oil. Its main components are triacylglycerols rich in unsaturated fatty acids, primarily oleic acid (approx. 60-75%) and linoleic acid (approx. 15-30%), which are responsible for its beneficial [12, 13]. In addition to fatty acids, almond oil contains an unsaponifiable fraction, comprising tocopherols, phytosterols, phenolic compounds, squalene, and [14–16]. These components exhibit antioxidant, anti-inflammatory, and regenerative effects, helping to protect the skin against oxidative stress and strengthening its protective barrier. Their content depends, among other things, on the method used to extract the oil, with cold pressing helping to preserve a greater amount of bioactive compounds [16].

AIM

The study aimed to evaluate the effect of avocado oil and sweet almond oil on selected biophysical characteristics of the skin of young, healthy women, with particular emphasis on skin hydration and the function of the epidermal barrier, assessed TEWL values. The effects of both oils and their mixtures on the condition of undamaged skin and skin that had undergone a tape-stripping procedure were compared.

MATERIALS AND METHODS

The study included women who underwent a preliminary screening process, which included a medical history, an allergy test, and an assessment of the condition of the skin on the forearms. For qualified participants, measurement I was performed, consisting of a baseline assessment of skin hydration and epidermal barrier function in four designated areas of the forearm of the dominant hand (A–D), in accordance with the diagram shown (Fig. 1).

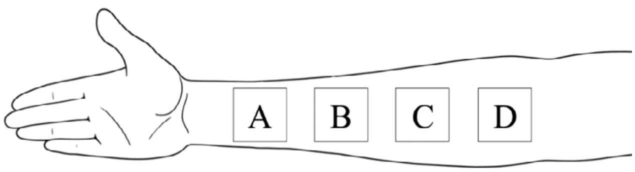

Fig. 1. Diagram of oil application. **Source:** Author's own work using publicly available AI-based tools.

On half of each of the tested areas, a stripping procedure was performed, involving the partial removal of the stratum corneum to temporarily weaken the skin barrier. Measurement II was performed after the procedure. Subsequently, the following were applied to the individual areas: 100% avocado oil (A), a mixture of 30% avocado oil and 70% almond oil (B), a mixture of 50% of both oils (C), and 100% almond oil (D). The preparations were applied to both damaged and undamaged skin in an amount of 0.5 ml per $5cm^2$. One hour after application of the preparations, measurement III (on stripped skin) and measurement IV (on undamaged skin) were taken.

Study group

Twenty women aged 20-28, students at the Tarnów Academy majoring in cosmetology. Only individuals with no history of allergies, dermatological diseases, or inflammatory lesions and skin damage in the areas were included in the study. Exclusion criteria also involved: pregnancy, breastfeeding, and a tendency to irritation following waxing and refusal to participate in the study.

The participants were informed about the purpose, methods, and course of the study and gave their informed, voluntary consent to participate. They could withdraw from the study at any stage without giving a reason. The study received a positive opinion from the Bioethics Committee at the Tarnów Academy (No. 12/2025 dated March 12, 2025).

Plant oils

The study used organic cold-pressed avocado oil with a characteristic aroma and an intense green color (manufacturer: Zrób Sobie Krem, Poland), according to the international nomenclature system for cosmetic ingredients (INCI) known as *Persea Gratissima* (*Avocado*) *Oil* [17] and organic sweet almond oil, cold-pressed, with a pale yellow color and a characteristic fatty scent, INCI: *Prunus Amygdalus Dulcis (Sweet Almond) Oil* from the same manufacturer [18]. The proportions of the components in oil blends were determined by weight, i.e., based on the percentage of each oil's mass relative to the total mass of the blend.

Instrumental skin studies

The TEWL test was conducted using a VapoMeter device manufactured by Delfin Technologies (Finland). The probe was applied to the skin of the forearm in designated areas. The duration of a single measurement was about 10 seconds [19].

The moisture content test, referred to in this study as MMM, was performed using the Multiprobe MoistureMeterD manufactured by Delfin Technologies (Finland), which measures

the biophysical properties of the skin noninvasively, using the tissue dielectric constant (TDC). The device operates on the principle of emitting an electromagnetic wave at a frequency of 265 MHz; the reflection of this wave from the tissue provides information about its hydration. The probe was applied perpendicular to the skin of the forearm, and constant, moderate pressure was maintained.

The XS5 probe was used, which provides insight into the characteristics of the skin at a depth of approximately 0.5 mm. The TDC result is proportional to the water content in the tissue. Measurements were performed under conditions consistent with the manufacturer's recommendations [20].

Controlled disruption of the epidermal barrier

The stripping procedure was performed on the skin of the forearm. Before beginning the procedure, it was ensured that the skin was clean, dry, and free of any cosmetics. The adhesive tape was applied to the skin surface with even pressure to ensure it adhered properly to the skin's surface.

The tape was then removed with a firm, quick motion. The entire procedure was repeated 20 times, each time using a new section of tape [21].

Statistical Analysis

The instrumental results were subjected to statistical analysis using the JASP 0.95.4 software (JASP Team, University Amsterdam, Netherlands). The distribution of the variables was tested using the Shapiro-Wilk test, and the homogeneity of variances was assessed using Levene's test. When the conditions were met, the results were analyzed using ANOVA for repeated measures (factor 1: measurement I-IV; factor 2: study area: A-D). For significant differences, post hoc tests were performed (Bonferroni test with the Holm correction). The presence of correlations between variables was examined using Pearson's r coefficient. For all tests, the significance level was set at $p < 0.05$.

RESULTS

The hydration level of individual skin areas at successive stages of the study is summarised in tab. 1 and the change in the hydration is presented on fig. 2. Analysis of the distribution of the variables showed that it conformed to a normal distribution.

To compare the skin hydration values obtained in successive measurements (I-IV) for the tested oil mixtures (A-D), a two-way analysis of variance for repeated measures (RM-ANOVA) was performed, taking into account the effect of measurement time, the type of mixture used, and the interaction between these factors. The analysis revealed a significant effect of measurement time and the type of mixture used (in both cases, $p < 0.001$). A significant interaction was also found between measurement time and the type of mixture ($p = 0.008$), indicating that changes in skin moisture over time depended on the formulation used.

A post hoc analysis of the interaction revealed that at the baseline measurement (I), skin hydration in the area where mixture A was applied was significantly higher than in the case of mixtures C ($p = 0.008$) and D ($p < 0.001$). Furthermore, in the area where mixture A was applied, a significant decrease in skin hydration 1 hour after application of the preparation was observed, both on damaged skin (A III; $p < 0.001$) and undamaged skin (A IV; $p = 0.003$), compared to the baseline measurement (A I). The remaining comparisons included in the interaction analysis did not reveal statistically significant differences.

Tab. 1. Skin moisture in the examined areas of the forearm.
Source: Author's own work.

Measurement	Mixture	Mean	SD
I	A	45.08	6.410
	B	39.94	5.304
	C	37.26	5.772
	D	35.41	5.676
II	A	42.07	8.813
	B	39.39	3.741
	C	36.86	6.838
	D	35.02	5.549
III	A	37.43	5.003
	B	37.45	4.823
	C	35.90	4.687
	D	35.22	2.902
IV	A	39.59	5.132
	B	38.75	4.538
	C	36.45	4.858
	D	35.85	3.302

SD – standard deviation, A – 100% avocado oil, B – 30% avocado oil and 70% almond oil, C – 50% avocado oil and 50% almond oil, D – 100% almond oil, I – baseline measurement, II – measurement after controlled epidermal damage, III – measurement 1 hour after applying the oils to damaged skin, IV – measurement 1 hour after applying the oils to undamaged skin.

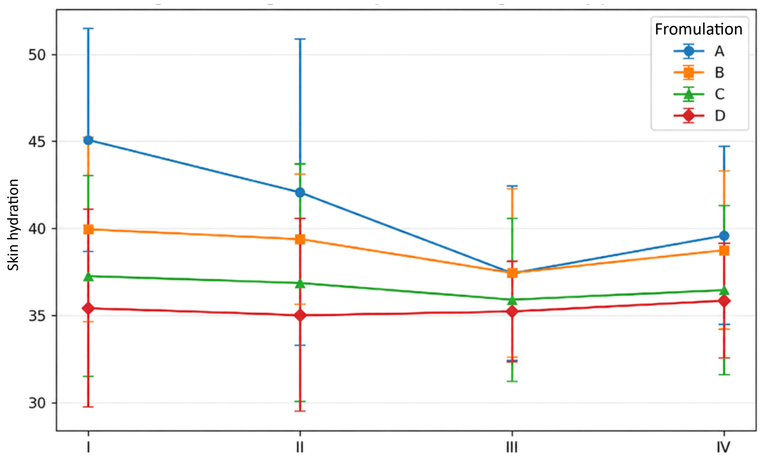

Fig. 2. Change in skin hydration at successive stages of the study. A – 100% avocado oil, B – 30% avocado oil and 70% almond oil, C – 50% avocado oil and 50% almond oil, D – 100% almond oil, I – baseline measurement, II – measurement after controlled damage to the epidermis, III – measurement 1 hour after applying the oils to damaged skin, IV – measurement 1 hour after application of the oils to undamaged skin. **Source:** Author's own work.

Tab. 2. Results of the post hoc analysis for measurements I-IV (MMM). **Source:** Author's own work.

		Mean difference	SE	df	t	p_{holm}
I	II	1.082	0.719	74	1.505	0.273
	III	2.920	0.644	74	4.535	< 0.001
	IV	1.761	0.608	74	2.894	0.020
II	III	1.839	0.683	74	2.691	0.026
	IV	0.679	0.774	74	0.877	0.383
III	IV	-1.159	0.357	74	-3.247	0.009

SE – standard error, df – degrees of freedom, t – t-test result, p_{holm} – Bonferroni test with the Holm correction, I – baseline measurement, II – measurement 1 hour after controlled epidermal damage, III – measurement 1 h after applying oils to damaged skin, IV – measurement 1 h after applying oils to undamaged skin.

Tab. 3. Results of the post hoc analysis of moisturization results for mixtures A-D. **Source:** Author's own work.

		Mean difference	SE	df	t	p_{holm}
A	B	2.159	1.329	74	1.625	0.265
	C	4.426	1.312	74	3.374	0.006
	D	5.671	1.312	74	4.323	< 0.001
B	C	2.267	1.312	74	1.728	0.265
	D	3.512	1.312	74	2.677	0.037
C	D	1.245	1.295	74	0.961	0.339

SE – standard error, df – degrees of freedom, t – t-test result, p_{holm} – Bonferroni test with the Holm correction, A – 100% avocado oil, B – 30% avocado oil and 70% almond oil, C – 50% and 50% almond oil, D – 100% almond oil.

Tab. 4 and fig. 3 present descriptive statistics for TEWL. It has been verified that the requirements for performing an ANOVA test have been fulfilled. The analysis revealed a significant effect of both the measurement time ($p = 0.026$) and the type of oil mixture used ($p < 0.001$). However, no significant interaction between the factors was observed, which indicates that changes in TEWL values over time proceeded similarly for all tested formulations.

Post hoc analysis of comparisons for successive measurement points revealed no statistically significant differences between any pair of measurements (all $p > 0.05$). The largest difference in means was observed between measurements II and III (difference in means = 0.665); however, even in this case, the result did not reach the level of statistical significance ($p = 0.076$).

A post hoc analysis of the tested formulations showed that the formulation containing 100% avocado oil (A) was characterised by significantly higher TEWL values compared to all other mixtures. Significant differences were observed between formulations A and B (mean difference = 1.762; $p = 0.007$), A and C (mean difference = 1.983; $p = 0.002$) and A and D (mean difference = 2.178; $p < 0.001$). No significant differences between mixtures B, C, and D were observed.

Tab. 4. Transepidermal water loss (TEWL) in the tested areas of the forearm. **Source:** Author's own work.

Measurement	Mixture	Mean	SD
I	A	8.735	2.767
	B	6.374	2.177
	C	6.150	2.256
	D	6.265	2.089
II	A	9.010	2.634
	B	7.021	2.004
	C	6.715	2.650
	D	6.235	2.130
III	A	8.075	2.571
	B	6.437	1.778
	C	6.060	1.699
	D	5.750	1.381
IV	A	7.455	2.329
	B	6.395	1.742
	C	6.420	1.475
	D	6.315	1.755

SD – standard deviation, A – 100% avocado oil, B – 30% and 70% almond oil, C – 50% avocado oil and 50% almond oil, D – 100% almond oil, I – baseline measurement , II – measurement after controlled damage to the epidermis, III – measurement 1 hour after applying the oils to damaged skin, IV – measurement 1 hour after applying the oils to undamaged skin.

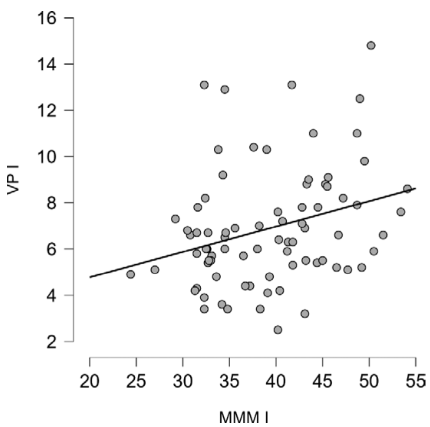

Fig. 4. Relationship between skin hydration level (0X axis) and transepidermal water loss (0Y axis); (r = 0.293; p < 0.01). **Source:** Author's own work.

Tab. 5 presents the results of the post hoc test for individual measurements (I-IV), and Table 6 shows the results for oil mixtures A-D, showing that oil A (pure avocado oil) differed significantly from all tested blends and pure almond oil.

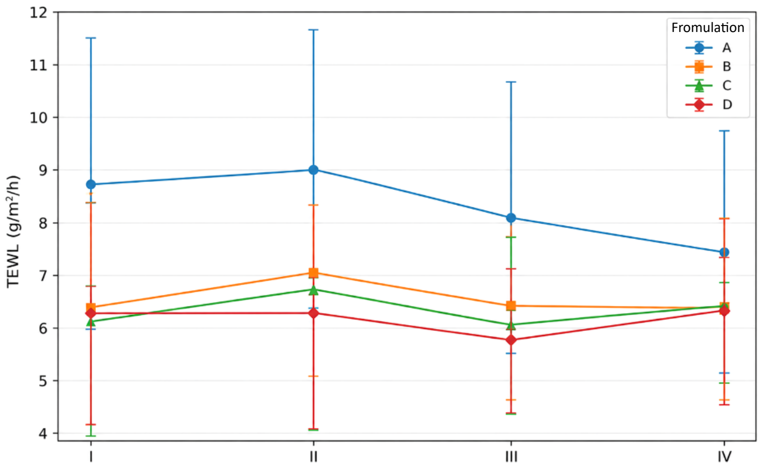

Fig. 3. Changes TEWL of the skin at successive stages of the study. A – 100% avocado oil, B – 30% avocado oil and 70% almond oil, C – 50% avocado oil and 50% almond oil, D – 100% almond oil, I – baseline measurement, II – measurement after controlled epidermal damage, III – measurement 1 hour after applying the oils to damaged skin, IV – measurement 1 hour after applying the oils to undamaged skin. **Source:** Author's own work.

Tab. 5. Results of the post hoc analysis for tewametry measurements I-IV. **Source:** Author's own work.

		Mean difference	SE	df	t	p_{holm}
I	II	-0.364	0.264	75	-1.382	0.684
	III	0.300	0.230	75	1.309	0.684
	IV	0.235	0.252	75	0.930	0.710
II	III	0.665	0.260	75	2.556	0.076
	IV	0.599	0.278	75	2.154	0.172
III	IV	-0.066	0.112	75	-0.587	0.710

SE – standard error, df – degrees of freedom, t – t-test result, p_{holm} – Bonferroni test with the Holm correction, I – baseline measurement, II – measurement 1 hour after controlled epidermal damage, III – measurement 1 h after applying oils to damaged skin, IV – measurement 1 h after applying oils to undamaged skin.

Tab. 6. Results of the post hoc analysis for mixtures A–D (tewametry). **Source:** Author's own work.

		Mean difference	SE	df	t	p_{holm}
A	B	1.762	0.541	75	3.255	0.007
	C	1.983	0.534	75	3.710	0.002
	D	2.178	0.534	75	4.075	< 0.001

SE – standard error, df – degrees of freedom, t – t-test result, p_{holm} – Bonferroni test with the Holm correction, A – 100% avocado oil, B – 30% avocado oil and 70% almond oil, C – 50% and 50% almond oil, D – 100% almond oil.

To investigate the relationships between the degree of skin hydration (MMM) and TEWL, a correlation analysis was performed using Pearson's r coefficient (Fig. 4). The results obtained indicated a weak, positive correlation between the tested formulations (r = 0.293; p < 0.01).

DISCUSSION

The results showed that a single application of the tested formulations affected skin hydration levels; however, the observed effects varied depending on the formulation. No significant improvement in skin hydration after applying 100% avocado oil, whereas whereas more favorable effects were observed after the application of sweet almond oil and mixtures of both oils. These differences may result from the different fatty acid compositions of the two oils. Avocado oil is characterized by a high content oleic acid, which may increase the permeability the stratum corneum and temporarily disrupt the organization of intercellular lipids, whereas sweet contains a higher proportion of linoleic acid, considered a component that helps maintain the integrity of the and its regeneration processes [8, 11-14].

The absence of significant changes in hydration levels immediately after the tape stripping procedure may result from the use of MoistureMeterD device, which allows for the assessment of the hydration of tissues located deeper than the stratum corneum of the epidermis. Unlike conventional corneometry, this method is less sensitive to superficial changes caused by mechanical damage to the stratum corneum, which may have limited the ability to detect short-term changes in hydration immediately after the procedure [5].

Despite the absence of significant changes immediately following damage the epidermal barrier, higher values of higher moisture levels were observed in undamaged skin than in skin subjected to the tape-stripping procedure. These results indicate that the preserved integrity of the epidermal barrier helps maintain the moisturizing effect. Similar observations were reported by Lin et al. and Poljšak et al., who demonstrated that the effectiveness of vegetable oils depends both on their composition and on the condition of the skin barrier [22, 23].

Plant-based emollients can act through both occlusion and by replenishing the lipids of the stratum corneum [3, 22, 23]. However, no significant effect of a single application of the tested preparations on TEWL values were observed. The absence of significant changes may result from the physiologically low TEWL in young, healthy study participants, which limited the extent of possible improvement. The literature emphasizes that the effects of emollients and vegetable oils in terms of reducing TEWL are more pronounced in populations with impaired epidermal barrier function [3, 6, 22, 23]. The participants of the study were young, healthy women who had low baseline TEWL values, indicating a properly functioning epidermal barrier and may have limited the possibility of observing significant changes. The obtained results are partially consistent with the study by Gogosz et al., who tested a drying oil (cameline oil) and also found no significant effect of a single application of vegetable oil on TEWL values, despite an improvement in skin hydration levels [24]. Other authors have also emphasized that the full effect of oils may only become apparent with regular, long-term use [25, 26]. In turn, Lin et al. pointed out that oils rich in linoleic acid had a more beneficial effect on the restoration of the epidermal barrier than oils with a high oleic acid content [22], which is consistent with this study: the greater efficacy of sweet almond oil and its mixtures compared pure avocado oil.

The results obtained may have practical significance in cosmetology. The results suggest that in the care of skin with a temporarily impaired epidermal barrier function, it may be more beneficial to use sweet almond oil or mixtures containing this oil than using avocado oil. It should be emphasized, however, that the presented observations pertain to the effects of a single application and require confirmation in studies involving long-term use of the formulations and an assessment of the mechanisms responsible for the restoration of the skin barrier.

A limitation of the study was the small size of the study group and the evaluation of only the effects of a single application of the formulations. In the future, it would be advisable to conduct studies involving a larger number of participants and an assessment of the impact of long-term use of the tested oils on the biophysical parameters of the skin. The observed higher values of hydration and TEWL in area A might result from local heterogeneity of the forearm skin, including differences in the structure of the stratum corneum, lipid content, and sweat gland activity. The lack of random assignment of the tested oils to skin areas is another limitation of the study. This approach was adopted to simplify the procedure and minimize the risk of errors during the application of the preparations and the performance of measurements.

Despite the results obtained, avocado oil and sweet almond oil remain valuable cosmetic raw materials. Their rich composition, which includes unsaturated fatty acids, phytosterols, and antioxidants, justifies further research into their use in skin care and in supporting the restoration of the epidermal barrier.

CONCLUSIONS

After a single application of 100% avocado oil, a significant decrease in moisture levels was observed both in skin that had undergone a tape-stripping procedure and in undamaged skin. These results indicate that the effect of plant oils may depend not only on their chemical properties, but also on the condition of the skin barrier and the manner of application. The results obtained suggest that the choice of oil used during cosmetological treatments, particularly massage using pure plant oils, should be tailored to the individual characteristics of the skin and the desired skincare effect. In the case of skin with a compromised skin barrier, it seems more appropriate to use oils richer in linoleic acid than oils with a high oleic acid content. In future studies, longer observation periods should be included, which will allow for determining how long the effect of a single treatment lasts and verifying the effects of repeated skin oiling.

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