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Analysis of the effect of camelina oil on the skin after a single use

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Original article

Abstract

The aim of this study was to evaluate the effect of a single application of *Camelina sativa* oil (also known as false flax oil) on selected skin properties of the medial forearm, including skin hydration, transepidermal water loss (TEWL), and elasticity. The study involved 20 healthy women aged 22–26 years. Skin parameters were assessed four times: at baseline, after inducing a model disruption of the skin barrier using the tape stripping method, and then 1 hour after application of the tested oil on both disrupted and intact skin. Specialized, scientifically certified devices were used, including a corneometer, tewameter, cutometer, and indentometer.

A significant increase in skin hydration was observed following oil application, both on disrupted and intact skin. No effect of *Camelina sativa* oil on skin barrier function (TEWL) or on elasticity parameters measured with cutometry and indentometry was observed.

The results confirm that camelina oil exhibits rapid moisturizing effects. No reduction in TEWL was observed, suggesting that the tested oil behaves similarly to drying oils. The lack of effect on other biomechanical skin properties after a single application does not rule out potential effects during prolonged use, which would require empirical confirmation in further studies.

Keywords

- vegetable oils
- assessment of skin characteristics
- corneometry
- tevametry
- cutanometry
- identometry

Contribution

A – Preparation of the research project
B – Assembly of data
C – Conducting of statistical analysis
D – Interpretation of results
E – Manuscript preparation
F – Literature review
G – Revising the manuscript

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Introduction

Due to its location and primary role, the epidermis functions as a barrier, protecting the body from harmful external factors while simultaneously preventing the loss of essential substances from within the body and skin. The epidermal barrier limits transepidermal water loss (TEWL), thereby preventing skin dehydration and maintaining its elasticity.[1] The *stratum corneum*, composed of keratinized cells, safeguards deeper tissues from desiccation and serves as a barrier against xenobiotics, toxins, and bacteria. The epidermal barrier plays a role in maintaining homeostasis and supporting regeneration. However, even minor epidermal damage can compromise skin barrier function. Upon barrier disruption, regenerative mechanisms are activated, leading to increased production of ceramides and lipids, as well as regulation of keratinocyte proliferation and differentiation.[2]

The epidermal surface is covered by the hydrolipidic mantle, a mixture of water, low-molecular-weight components, and lipids, which protects the skin from water loss. The hydrolipidic barrier is formed by secretions from the sweat and sebaceous glands. Under the influence of the skin microbiota, sebum components are metabolized into free fatty acids and other compounds, resulting in acidification of the skin surface, which constitutes an additional defensive mechanism protecting the skin against pathogens.[1]

The epidermal barrier also serves a sensory function, allowing the perception of stimuli from the external environment.[3] Conversely, its condition influences the sensory characteristics of the skin, both subjectively and objectively, as assessed using rating scales and a range of research tools.[4–7]

A variety of cosmetic ingredients have been shown to exert beneficial effects on epidermal barrier function. These ingredients consist of chemical compounds that, through different mechanisms, can replenish and regenerate the hydrolipidic mantle or stimulate the skin to express components that enhance its function.[8,9] Most commonly, compounds classified as emollients, humectants, and ingredients with secondary moisturizing mechanisms are indicated in this context. Fatty acids, primarily sourced from plant oils in cosmetics, in addition to their emollient effects, can facilitate the penetration of active substances by fluidizing lipids in the *stratum corneum*, making this group of ingredients a key component of cosmetic formulations.[10]

Vegetable oils were among the earliest used emollients, providing smoothing and soothing effects for the skin as well as care benefits for skin appendages, including nails and hair.[11] Currently, vegetable oils constitute a group of natural raw materials valued primarily for their moisturizing properties. Many chemical components of these oils have a structure similar to that of the intercellular cement of human epidermis. Triglycerides, the main constituents of oils, form a film on the skin surface, while ceramides, sterols, phospholipids, and free fatty acids modify the protective barrier of the epidermis, penetrate its deeper layers to replenish missing elements of the intercellular cement, and, over time, alter the metabolism of the viable layers of the skin as well as the composition and amount of sebum.[12–14]

The cosmetic effect of a vegetable oil depends on its chemical composition, which is primarily determined by the plant species and the specific part of the plant from which the oil is obtained. Additional factors influencing chemical composition include the location and conditions of cultivation as well as the method of oil extraction.[15,16] Oils such as almond, castor, flaxseed, sunflower, coconut, raspberry seed, avocado, and grape seed oils are popular examples in cosmetics.[17,18]

Cold-pressed oils are considered the highest quality, as this method preserves bioactive compounds beneficial to the body. Consequently, they are used as raw materials for cosmetic products intended for skin and hair care.[19]

The greatest cosmetic activity is associated with the unsaturated fatty acids present in triglycerides, particularly essential fatty acids (EFAs) of the omega-6 (ω-6) and omega-3 (ω-3) families. In skincare, oils rich in linoleic acid (ω-6) and α-linolenic acid (ω-3) are especially valued, as they are the least comedogenic.[17] Moreover, these fatty acids can be incorporated into cell membrane lipids, supporting the reconstruction of damaged epidermal barriers and preventing water loss. Their presence is important for the treatment of skin disorders, such as atopic dermatitis, as well as in daily skincare routines. These oils are utilized as bases for a variety of cosmetic products, including creams, emulsions, milks, ointments, masks, hair conditioners, protective lip balms, and bath and nail care products.[20]

Camelina oil

Camelina sativa L. (false flax), also known as camelina or gold-of-pleasure, is an annual oilseed plant from the Brassicaceae family, native to Southern Europe and Southwestern Asia. Initially regarded as a weed in flax and cereal crops, it was eventually cultivated for oil production.[21] The plant reaches a height of 65–110 cm and has a smooth or pubescent, branched stem that lignifies with age. The leaves are lanceolate, 5–8 cm long, with smooth or wavy margins. The flowers, 5–7 mm in

diameter, are typically self-pollinating, and the very small seeds are contained within siliques.[22]

Camelina has a short life cycle of 85–100 days and occurs in both spring and winter varieties, with the former being more widely cultivated globally. The plant adapts well to diverse climatic and soil conditions and demonstrates high resistance to diseases and pests. Among Brassicaceae species, it is the least sensitive to temporary soil water deficits, making its cultivation relatively simple and environmentally sustainable.[21] Currently, camelina is grown in various regions worldwide, including North Africa (Tunisia), Australia (Tasmania, South Australia, Victoria, Western Australia), North America (USA, Canada), and South America (Argentina, Uruguay).[21]

Camelina seeds are used for oil production, which has applications in medicine as well as in biofuels and biochar production.[23] Camelina oil is one of the richest plant sources of ω-3 fatty acids.[21] Due to its low content of glucosinolates, natural sulfur-containing compounds predominantly found in Brassicaceae plants, camelina seeds can also be used directly as animal feed. In feeds with high glucosinolate content, the goitrogenic and toxic effects on the thyroid, liver, and kidneys can reduce feed intake and lower production efficiency.[24]

Common methods for extracting camelina oil include mechanical extraction (cold-pressing or hot-pressing), solvent extraction, and enzyme-assisted extraction. Mechanical extraction typically employs screw or frame presses, and the resulting oil requires further processing, such as filtration and degumming.[22] Solvent extraction may be used to recover residual material following mechanical extraction, offering high efficiency suitable for large-scale oil production. Enzyme-assisted extraction avoids the use of organic solvents, which is a significant advantage, though the process is time-consuming. Supercritical CO_2 extraction is also possible, but it is costly and not used in conventional oil mills.[23,26]

Camelina oil has attracted attention for its potential health-promoting properties.[27,28] Studies have shown beneficial effects on body weight and plasma lipoprotein profiles in animals fed this oil.[29] However, the primary contemporary application of camelina oil is in biofuel production, primarily biodiesel and aviation fuel.[30,31] A significant advantage of camelina is that the entire plant can be utilized.[32] By-products of cold-pressing (cake and meal) are mainly used as animal feed. Additionally, camelina oil is valuable in the biopolymer industry, and waste from its production can be used as compost to improve soil quality.

Chemical composition of camelina oil

Camelina oil consists of two fractions: a non-saponifiable fraction, which includes tocopherols and sterols, and a saponifiable fraction, comprising fatty acids and their derivatives. The fatty acid composition is dominated by unsaturated acids, both monounsaturated and, predominantly, polyunsaturated (>55%), alongside saturated acids (9.1–10.8%).[22,25,26] The principal components of the oil are linoleic acid and α-linolenic acid, making camelina oil a valuable source of ω-3 fatty acids.[21,33]

A distinctive feature of camelina oil is its high content of eicosanoic (arachidic) acid, which is rarely found in other vegetable oils. Camelina is also one of the few sources of medium-chain fatty acids (MCFAs), which are considered beneficial for maintaining a healthy body composition due to their effects on thermogenesis.[34] The oil is characterized by a low erucic acid content, which is advantageous, as this acid can increase levels of triglycerides and free fatty acids, negatively affecting cardiovascular health.[35,36]

Camelina oil contains sterol compounds such as brassicasterol, campesterol, sitosterol, and Δ5-avenasterol, with brassicasterol being characteristic of this oil.[36] Additionally, camelina seeds contain carbohydrates, including monosaccharides and polysaccharides, as well as compounds such as phytic acid, sulfur-containing glucosinolates, and condensed tannins.[37]

Camelina sativa seed oil is utilized across various domains. Owing to its unique fatty acid profile, this oil can be classified as a specialty oil suitable for direct consumption.[33] It can be used in cooking, in the production of ω-3-enriched margarine, or as an ingredient in salad dressings, mayonnaise, ice cream, and other food products.

Another application of camelina oil is in the cosmetic industry, as noted by Arshad et al.[23] Currently, on the Polish cosmetic market, primarily pure oils obtained through various extraction methods are available, intended for skin and hair oiling treatments. The number of cosmetic products in which camelina oil is one of the ingredients in the complete formula remains very limited. Despite the availability of both pure camelina oil for cosmetic purposes and products containing it as an ingredient, no studies have been conducted to date on how this oil interacts with the skin. The proposed research project aimed to fill this gap. The aim of the study was to analyze the effects of a single application of camelina oil on the basic biophysical properties of the forearm skin in young, healthy women.

Table 1. Chemical composition of camelina oil (Camelina sativa)[33,38–43]

Group of components	Subgroup of components	Components	Percentage content	Ingredient notes / functions
Fatty acids	Polyunsaturated, omega-3	Alpha-linolenic acid (C18:3)	25.1–31.9%	Demonstrates anti-inflammatory activity; supports cardiovascular, skin, and nervous system health; mitigates skin-aging processes
	Polyunsaturated, omega-6	Linoleic acid (C18:2)	18.6–26.3%	Supports epidermal barrier integrity; exhibits anti-inflammatory activity; facilitates skin regeneration and the maintenance of hydration and elasticity
	Monounsaturated, omega-9	Oleic acid (C18:1)	14.3–18.9%	Emollient; enhances the penetration of active substances into the skin; exhibits anti-inflammatory activity; exerts a beneficial effect on the circulatory system
		Gondoic acid (C20:1)	12.4–15.3%	Forms a protective layer on the skin; softens and smooths the epidermis
		Erucic acid (C22:1)	2.4–3.4%	At higher concentrations, may be harmful to health (dietary exposure); in cosmetics, used as a softening agent and emollient
	Saturated	Palmitic acid (C16:0)	6.1–7.6%	Supports skin lipid barrier function; exerts smoothing effects; commonly used in protective products
		Stearic acid (C18:0)	2.3–3.0%	Improves cosmetic texture; functions as an emollient and emulsion stabilizer; gentle on the skin
Polyphenols	Phenolic acids	Ellagic acid, protocatechuic acid, p-hydroxybenzoic acid, chlorogenic acid, caffeic acid, synapic acid	~128 mg/kg	Exhibits antioxidant activity; contributes to oil stability
Vitamins	Tocopherols	γ-tocopherol (dominant), α-tocopherol	52.4–72.3 mg/100 g	Natural antioxidants; enhance the oxidative stability of the oil
Sterol compounds	Phytosterols	β-sitosterol, campesterol, stigmasterol, brassicasterol	167–262 mg/100 g	Reduce LDL cholesterol levels; exert health-promoting effects
Mineral ingredients		K, Mg, Ca, Fe, Zn	<1ppm	Minerals primarily present in whole seeds, absent in refined oil

Materials and methods

Study group

The research project received a positive opinion from the Bioethics Committee at the Tarnów Academy (No. 12/2025, dated March 12, 2025). Prior to the study, each participant provided written informed consent and completed a screening form, allowing for the assessment of eligibility criteria. Participants were thoroughly informed about the study objectives, methods employed, and the procedure. All individuals participated voluntarily, with the option to withdraw at any stage.

Inclusion criteria were: age between 20 and 28 years, absence of skin lesions in the study area, no history of chronic dermatological conditions, and no complications following wax hair removal. Exclusion criteria were: pregnancy, lactation, and presence of skin lesions on the forearms.

A total of 20 young women participated in the study. The mean age was 23.45 years, with a median age of 23 years.

Study protocol

On the inner side of the non-dominant forearm of each participant, a 5 cm × 5 cm study area was delineated (Figure 1). Baseline measurements of skin characteristics were performed on the designated area (I). Subsequently, a model barrier disruption procedure (tape stripping) was performed on half of the delineated area, and measurements were repeated (II).

Following this, 0.5 mL of camelina oil was applied and gently massaged into the skin within the designated area. The study employed unrefined, cold-pressed camelina seed oil (Olini, Poland). One hour after oil application, skin assessments were conducted again on both the intact area (III) and the barrier-disrupted area (IV).

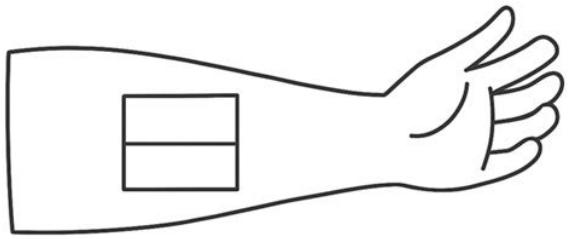

Figure 1. Determination of the test area on the forearm of the non-dominant hand of a project participant

Methods

Model barrier disruption procedure

Tape stripping is a method developed for assessing the quality and efficacy of cosmetic and dermatological preparations.[44] The procedure was performed on half of the designated study area using adhesive tape, which was applied to the target area, pressed, and then removed with a decisive motion. This process was repeated 20 times.

Assessment of skin biophysical properties

Skin biophysical properties were evaluated using the Multi Probe Adapter MPA (Courage + Khazaka GmbH, Germany), to which appropriate probes from the same manufacturer were connected. Environmental conditions (temperature and humidity) were simultaneously monitored to meet the manufacturer's criteria, ensuring measurement stability and repeatability.

Stratum corneum hydration was measured using corneometry with the Corneometer® CM 825 probe, which assesses dielectric capacitance, allowing estimation of water content in the *stratum corneum* at a depth of 10-20 μm. Measurements were performed using a one-second method, with three readings taken on non-overlapping areas; the mean of these readings was recorded.

Transepidermal water loss (TEWL), used to evaluate the barrier function of the skin, was assessed with the Tewameter® TM 300. This open-chamber tewameter features two sets of sensors: humidity and temperature, measuring directly at the skin surface and at a small distance, assessing the thermal gradient and changes in humidity due to water evaporation from the skin. Measurements were performed by placing the probe perpendicularly to the study area, with each measurement lasting 30 seconds.

Skin elasticity and firmness were evaluated using the Cutometer® dual MPA 580. During measurement, the probe was held perpendicular to the skin surface. The device generated controlled negative pressure (1 mBar) to draw the skin into the probe for a defined period (2 seconds), after which the vacuum was released. The degree of skin displacement and the time required for the skin to return to its original state were assessed, recorded as parameters R0 and R2. Measurements were repeated three times, and the mean value was calculated.

The Indentometer IDM 800 was used in biomechanical skin assessments to evaluate firmness. Its operation is based on observing the effect of precise pin indentation on the skin. The probe was applied three times per measurement, and the mean value was calculated.

Statistical analysis

Data were collected and analyzed using Microsoft Excel (USA) and JASP 0.19.3 (Netherlands). The distribution of variables was assessed using the Shapiro-Wilk test. Depending on the results, either the paired Student's t-test or the Wilcoxon test was applied. For statistically significant differences, effect size was evaluated using Cohen's d for the t-test or an appropriate nonparametric test. Correlations were analyzed using Spearman's rho. Correlation strength was interpreted as follows: $|r| < 0.2$, no linear relationship; 0.2-0.4, weak correlation; 0.4-0.7, moderate correlation; 0.7-0.9, strong correlation; >0.9, very strong correlation. Results were considered statistically significant at $\alpha < 0.05$.

Results

Corneometry measurements

The mean stratum corneum hydration at baseline (Measurement I) was 36.20 ± 6.57 CU (Corneometer Units). Following tape stripping, the value increased to 38.48 ± 8.05 CU (Measurement II). One hour after camelina oil application, the hydration on the intact skin area averaged 45.18 ± 11.67 CU (Measurement III), while in the barrier-disrupted area it reached 53.90 ± 13.44 CU (Measurement IV). The variables demonstrated a normal distribution ($p > 0.05$) (Table 2). Significant differences were observed between Measurements I and III ($p = 0.003$) and between Measurements II and IV ($p < 0.001$) (Table 3). Graphical interpretation of the results is presented in Figures 2 and 3.

Table 2. Corneometric measurement results

	I	II	III	IV
M	36.20	38.48	44.46	50.06
Me	35.55	36.68	45.18	53.90
SD	6.57	8.05	11.67	13.44
Min	23.93	27.00	23.60	15.97
Max	45.23	52.27	64.80	66.57
p (Shapiro-Wilk)	0.219	0.118	0.739	0.009

Note: M—arithmetic mean; SD—standard deviation; Me—median; MIN—minimum value; MAX—maximum value; I -measurement of baseline skin characteristics; II—skin characteristics after tape stripping; III—measurements of undamaged skin characteristics one hour after oil application; IV—measurements of damaged skin characteristics one hour after oil application.

Table 3. Comparison of corneometric measurements

Comparison	I vs II	I vs III	II vs IV
Test t	−1.89	−3.44	−4.07
p (t)	0.074	0.003	<0.001
Effect (d)	−0.423	−0.768	−0.910
Wilcoxon Test	Z = −1.46	Z = − 2.95	Z = −2.99
p (w)	0.154	0.002	0.002
Effect	−0.371	−0.752	−0.762

Note: I—baseline measurement, II—after tape stripping, III—1 hour after applying oil to undamaged skin, IV—1 hour after applying oil to skin after tape stripping, *t*-test—*t*-test statistic value for normally distributed data, *p*(*t*)—*p*-value for the *t*-test, Effect (d)—measure of the effect size of the difference between measurements, Wilcoxon test—z statistic for the Wilcoxon test, *p*(w)—*p*-value for the Wilcoxon test, Effect—effect size for the Wilcoxon test.

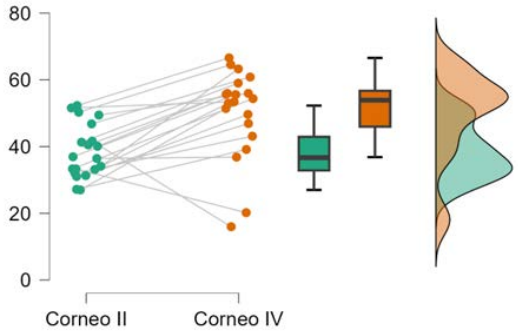

Figure 2. Comparison of corneometer measurements [CU]

Note: Corneo II—corneometer test results on skin damaged by tape stripping; Corneo IV—corneometer test results 1 hour after applying oil to skin after tape stripping.

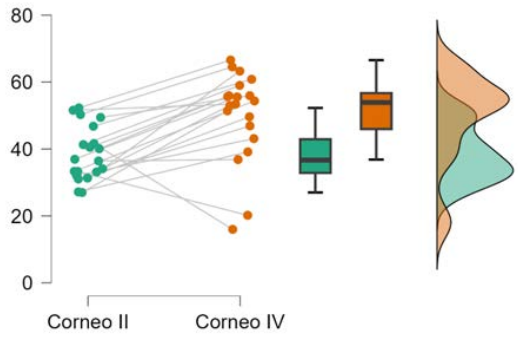

Figure 3. Comparison of corneometer measurements [CU]

Note: Corneo I—corneometer test results on undamaged skin; Corneo III—corneometer test results 1 hour after applying oil to undamaged skin.

Tewametry measurements

Baseline TEWL in the study participants averaged 9.85 ± 3.21 g/h/m^2. Following tape stripping, TEWL increased to 12.87 ± 3.87 g/h/m^2. One hour after oil application on intact skin, TEWL measured 10.87 ± 3.24 g/h/m^2, whereas in the previously tape-stripped area it reached 14.26 ± 5.81 g/h/m^2 (Table 4). Analysis of TEWL revealed a significant increase between Measurements I and II ($p < 0.001$). No significant differences were observed between Measurements I and III, or between II and IV (Table 5).

Table 4. Tewametric measurement results

	I	II	III	IV
M	9.85	12.87	10.87	14.26
Me	8.77	11.90	9.75	14.76
SD	3.21	3.87	3.24	5.81
Min	5.80	6.99	6.70	7.20
Max	19.70	23.10	16.36	30.26
p (Shapiro-Wilk)	0.001	0.010	0.083	0.011

Note: M—arithmetic mean; SD—standard deviation; Me—median; MIN—minimum value; MAX—maximum value; I -measurement of baseline skin characteristics; II—skin characteristics after tape stripping; III—measurements of undamaged skin characteristics one hour after oil application; IV—measurements of damaged skin characteristics one hour after oil application.

Table 5. Comparison of tewametric measurements

Comparison	I vs II	I vs III	II vs IV
Test *t*	−3.40	−1.33	−1.58
p (t)	0.003	0.201	0.132
Effect (d)	−0.761	−0.296	−0.352
Wilcoxon Test	Z=−3.21	Z=−1.42	Z=−1.33
p (w)	<0.001	0.165	0.191
Effect	−0.819	−0.362	−0.338

Note: I—baseline measurement, II—after tape stripping, III—1 hour after applying oil to undamaged skin, IV—1 hour after applying oil to skin after tape stripping, *t*-test—*t*-test statistic value for normally distributed data, *p*(*t*)—*p*-value for the *t*-test, Effect (d)—measure of the effect size of the difference between measurements, Wilcoxon test—z statistic for the Wilcoxon test, *p*(w)—*p*-value for the Wilcoxon test, Effect—effect size for the Wilcoxon test

Indentometry measurements

The mean baseline skin firmness measured with the Indentometer was 1.475 ± 0.803 mm. After tape stripping, the value increased to 1.758 ± 0.855 mm. One hour after oil application on intact skin, it measured 1.512 ± 0.821 mm, and in the tape-stripped area after one hour, it was 1.522 ± 0.693 mm (Table 6). These differences did not reach statistical significance (Table 7).

Table 6. Indentometer measurement results

	I	II	III	IV
M	1.475	1.758	1.512	1.522
Me	1.220	1.895	1.250	1.275
SD	0.803	0.855	0.821	0.693
Min	0.540	0.420	0.500	0.490
Max	2.700	2.700	2.700	2.700
p (Shapiro-Wilk)	0.008	0.010	0.005	0.064

Note: M—arithmetic mean; SD—standard deviation; Me—median; MIN—minimum value; MAX—maximum value; I -measurement of baseline skin characteristics; II—skin characteristics after tape stripping; III—measurements of undamaged skin characteristics one hour after oil application; IV—measurements of damaged skin characteristics one hour after oil application.

Table 7. Comparison of indentometer measurements

Comparison	I vs II	I vs III	II vs IV
Test *t*	−2.12	−0.52	1.4
p (t)	0.048	0.610	0.177
Effect (d)	−0.474	−0.116	0.313
Wilcoxon Test	Z = −1.81	Z = −0.81	Z = 1.42
p (w)	0.074	0.433	0.163
Effect	−0.485	−0.211	0.380

Note: I—baseline measurement, II—after tape stripping, III—1 hour after applying oil to undamaged skin, IV—1 hour after applying oil to skin after tape stripping, *t*-test—*t*-test statistic value for normally distributed data, *p*(*t*)—*p*-value for the *t*-test, Effect (d)—measure of the effect size of the difference between measurements, Wilcoxon test—z statistic for the Wilcoxon test, *p*(w)—*p*-value for the Wilcoxon test, Effect—effect size for the Wilcoxon test

Cutometry measurements

Results for the R0 parameter and their statistical analysis are presented in Tables 8 and 9, with no statistically significant differences observed.

Table 8. Results of cutometer measurements (parameter R0)

	I	II	III	IV
M	0.308	0.271	0.284	0.253
Me	0.295	0.280	0.245	0.225
SD	0.176	0.093	0.144	0.066
Min	0.180	0.110	0.170	0.140
Max	1.000	0.450	0.850	0.360
p (Shapiro-Wilk)	<0.001	0.246	<0.001	0.104

Note: M—arithmetic mean; SD—standard deviation; Me—median; MIN—minimum value; MAX—maximum value; I -measurement of baseline skin characteristics; II—skin characteristics after tape stripping; III—measurements of undamaged skin characteristics one hour after oil application; IV—measurements of damaged skin characteristics one hour after oil application.

Table 9. Comparison of cutometer measurements (parameter R0)

Comparison	I vs II	I vs III	II vs IV
Test *t*	−1.10	−0.64	−1.09
p (t)	0.284	0.53	0.289
Effect (d)	−0.245	−0.143	−0.243
Wilcoxon Test	Z=−1.25	Z=−0.66	Z=−1.31
p (w)	0.211	0.51	0.191
Effect	−0.318	−0.168	−0.34

Note: I—baseline measurement, II—after tape stripping, III—1 hour after applying oil to undamaged skin, IV—1 hour after applying oil to skin after tape stripping, *t*-test—*t*-test statistic value for normally distributed data, *p*(*t*)—*p*-value for the *t*-test, Effect (d)—measure of the effect size of the difference between measurements, Wilcoxon test—z statistic for the Wilcoxon test, *p*(w)—*p*-value for the Wilcoxon test, Effect—effect size for the Wilcoxon test

Skin elasticity, assessed using the R2 parameter, also showed no significant changes among the participants (Tables 10 and 11).

Table 10. Results of cutometer measurements (parameter R2)

	I	II	III	IV
M	76.33	76.89	74.43	73.50
Me	77.47	78.03	75.63	76.13
SD	4.96	5.19	6.05	7.58
Min	64.20	65.86	52.53	44.90
Max	85.10	84.21	81.06	80.00
p (Shapiro-Wilk)	0.328	0.476	<0.001	<0.001

Note: M—arithmetic mean; SD—standard deviation; Me—median; MIN—minimum value; MAX—maximum value; I -measurement of baseline skin characteristics; II—skin characteristics after tape stripping; III—measurements of undamaged skin characteristics one hour after oil application; IV—measurements of damaged skin characteristics one hour after oil application.

Table 11. Comparison of cutometer measurements (parameter R2)

Comparison	I vs II	I vs III	II vs IV
Test *t*	0.53	1.54	1.02
p (t)	0.602	0.142	0.322
Effect (d)	0.118	0.343	0.228
Wilcoxon Test	Z = 0.56	Z = 1.40	Z = 1.17
p (w)	0.575	0.162	0.242
Effect	0.142	0.375	0.313

Note: I—baseline measurement, II—after tape stripping, III—1 hour after applying oil to undamaged skin, IV—1 hour after applying oil to skin after tape stripping, *t*-test—*t*-test statistic value for normally distributed data, *p*(*t*)—*p*-value for the *t*-test, Effect (d)—measure of the effect size of the difference between measurements, Wilcoxon test—z statistic for the Wilcoxon test, *p*(w)—*p*-value for the Wilcoxon test, Effect—effect size for the Wilcoxon test

Disscusion

This study is the first to investigate the effects of a single application of camelina oil on skin properties such as hydration, TEWL, elasticity and firmness. The research provides a significant contribution to the understanding of camelina oil applications in cosmetology. Until now, this oil has primarily been evaluated for its nutritional value and industrial uses, while its effects on human skin had not been previously analyzed. The obtained results allow for a preliminary assessment of the short-term effects of the oil on skin properties, providing a foundation for future, more detailed studies.

The study demonstrated that even a single application of camelina oil can significantly improve skin hydration. This increase can be attributed to the presence of biologically active compounds in the oil, such as ω-3 and ω-6 fatty acids, as well as tocopherols and phytosterols, which play important roles in maintaining

adequate stratum corneum hydration. Notably, the improvement in hydration was observed in both barrier-disrupted and intact skin areas.

The observed increase in TEWL following tape stripping confirmed the efficacy of this procedure and its correct execution. These data confirm that the model procedure effectively disrupted the skin barrier, allowing for simultaneous observation of the oil's effects on both healthy and partially barrier-compromised skin. This model was designed to highlight the oil's potential regenerative and occlusive effects. However, camelina oil did not significantly reduce TEWL within one hour of application, suggesting that full restoration of barrier function may require longer exposure or repeated use of the active substance. TEWL assessments are typically performed at various time points depending on study objectives. Measurements 15–30 minutes after product application indicate the initial skin response, with rapid barrier improvement observed for occlusive ingredients (e.g., paraffin). Observations after 1–2 hours, as in the present study, allow assessment of short-term efficacy, while measurements at 4–6 hours indicate sustained effects. The longest protocols (24 hours or more) reveal long-term effects.[45–47]

As expected, no statistically significant changes were observed in biomechanical skin parameters, including elasticity (R0) and firmness (R2), following a single application of camelina oil, either on intact or barrier-disrupted skin. These skin properties are likely to improve only with regular and long-term application of the product.[48] The absence of significant changes, however, also indirectly indicates no adverse rapid inflammatory or immunological responses (e.g., swelling or other reactions associated with activation of inflammatory cascades), which requires confirmation in further analyses.

Despite the lack of significant changes in skin firmness and elasticity, the components of camelina oil, particularly vitamin E isomers, phytosterols, and polyunsaturated fatty acids, may exert protective and regenerative effects. They are expected to mitigate oxidative stress and inflammatory conditions in the skin.[1,36] Their presence may therefore positively influence skin condition with prolonged use.[22,33]

In a study by Dzidek et al. (2022), the effects of three different oils: raspberry seed oil, coconut oil, and sesame oil on young women's skin were evaluated.[49] Each oil represented one of the categories: drying, semi-drying, and non-drying oils. Typically, oil properties within these groups are used to indicate their suitability for various skin types, though detailed studies were previously lacking. Interestingly, raspberry seed oil, a drying oil rich in ω-3 and ω-6 fatty acids, showed the greatest improvement in hydration and reduction of TEWL. This suggests that the hydrating effect of plant oils is not solely due to occlusion but results from a cumulative action of various mechanisms determined by chemical composition. This concept may also explain the findings of the present study: improved hydration without increased barrier function following camelina oil application.

Similar effects have been observed for flaxseed oil, another drying oil alongside camelina and raspberry seed oils. In a study by Lina et al. (2010), daily use of flaxseed oil over four weeks in individuals with dry skin led to significant improvements in elasticity and reductions in TEWL.[50] These data suggest that camelina oil may also prove beneficial for skin barrier function and skin firmness when used over extended periods. Conversely, in a study by Kieć-Świerczyńska et al. (2015), almond oil (a non-drying oil) showed moisturizing and softening effects but did not significantly impact skin firmness.[51] Boucetta et al. (2014) observed that argan oil improved skin elasticity and reduced TEWL. Similar to camelina oil, it contains substantial amounts of tocopherols and phytosterols.[52] These studies indicate that barrier and firming effects are likely associated with specific phytochemical groups present in plant oils.

Study limitations include a small sample size, inclusion of only young women, a single oil application, and the absence of a control group. Strengths include a comprehensive evaluation of the effects of a single application and controlled measurement conditions. Further studies are recommended to assess regular use of the oil, its effects under varying environmental conditions, and its impact on different skin types.

Conclusions

1. A single application of camelina oil on the skin leads to a significant increase in hydration, observable on both intact and barrier-compromised skin.
2. A single use of this oil does not alter the skin barrier function, suggesting that it does not exhibit strong occlusive properties. This characteristic may be valuable for skin types where additional occlusion is unnecessary or undesirable.
3. No statistically significant changes were observed in the biomechanical properties of the skin, such as elasticity and firmness, following single application.

References

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