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Poppy (*Papaver somniferum* L.) Seed Oil: A Comprehensive Phytochemical and Pharmacological Evaluation for Health and Cosmetic Applications

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Abstract

The focus of research in the fields of dermocosmetics and biomedicine is increasingly on natural oils in relation to criteria such as biocompatibility. Poppy seed oil (*Papaver somniferum* L.) is notable for its high content of unsaturated fatty acids, particularly linoleic acid, antioxidant components and biologically active phytochemicals. A plethora of studies have been conducted on the oil's lipid profile, pharmacological effects, and potential health benefits. These studies have reported findings on a range of topics, including cholesterol level regulation, the prevention of cardiovascular diseases, and anti-inflammatory and immunomodulatory activities. In addition, its capacity to reinforce skin barrier function has led to the proposition of its utilisation as a complementary agent in the management of various dermatological conditions, including eczema, dermatitis, and pressure sores. This review appraises the phytochemical components, pharmacological activities, and contemporary applications of poppy seed oil in the domains of health and cosmetics. As demonstrated by extant literature, poppy seed oil has been utilised not only as a traditional food and oil source, but also as a noteworthy natural raw material for dermocosmetic and biomedical applications.

Key Words: *Papaver somniferum*, linoleic acid, eczema, cold press, wound healing, poppy seed oil, antioxidant, antimicrobial, dermatological application

1. Introduction

The utilization of oils and plant extracts has gained significant traction in the domains of cosmetics and health care, owing to their bioactive constituents. These natural components play important roles in various applications, such as protecting skin health and accelerating wound healing, thanks to their antioxidant potential, tissue regeneration promoting effects, and antimicrobial properties (Gunal et al., 2021; Ozcan et al., 2015).

The incorporation of vegetable oils into topical formulations has been demonstrated to enhance dermocosmetic efficacy by amplifying the soothing, nourishing, and protective properties of the products. In this context, poppy seed oil (Papaver somniferum L.) has garnered attention as a natural raw material due to its high content of unsaturated fatty acids, particularly linoleic acid, as well as phenolic compounds, tocopherols, and other biologically active phytochemicals. These components support the skin's barrier integrity, reduce transepidermal water loss, and suppress inflammatory processes, offering a valuable dermatological profile (Aslan ve Kurt, 2021; Aslan et al., 2024).

The poppy plant is a versatile species that has been utilized in various industries, including food, pharmaceuticals, cosmetics, and dye production. The oil, protein, minerals, and antioxidant components in the seeds provide nutritional and functional qualities, while the alkaloids in the capsules constitute an important pharmaceutical source (Erinç et al., 2009; Gültepe, 2013). According to data from the Food and Agriculture Organization (FAO) of the United Nations, Türkiye has the largest poppy cultivation area in the world as of 2018, with the P. somniferum subsp. anatolicum var. nigrum species being particularly prominent (FAOSTAT, 2020; Hao et al., 2015).

Figure 1. Various images of the green and dry form of the *P. somniferum* L. plant

According to extensive chemical analysis by Ghafoor et al.(2019) the oil content of poppy seeds varies between 28% and 53% depending on the variety and growing conditions. When the composition of the oil was analyzed, it was determined that the most dominant fatty acid was linoleic acid with a range of 53-74%, followed by oleic acid ranging from 13-24% and palmitic acid with 8-19%. This high proportion of unsaturated fatty acids increases the nutritional value of the oil and provides a functional quality for skin health. In addition to tocopherols, carotenoids, phytosterols, and phenolic compounds have been shown to enhance the antioxidant capacity of the oil, thereby exerting biological effects such as reducing oxidative stress, suppressing inflammation, and promoting tissue repair (Ghafoor et al., 2019; Muhammad et al., 2021; Yücel Şengün et al., 2020).

Recent studies have demonstrated the increased use of poppy seed oil in dermocosmetic products, including creams, serums, hair care oils, and barrier creams. This trend is attributed to the oil's recognized benefits, such as its capacity to moisturize and emollient properties, as well as its ability to strengthen skin barriers. Additionally, poppy seed oil possesses notable antioxidant

capacity, further highlighting its potential benefits for skin health and wellness. Furthermore, its potential application in topical formulations that promote wound healing is notable, owing to its anti-inflammatory and antimicrobial properties (Dilek et al., 2018; Emir et al., 2014).

In this review, the phytochemical composition, pharmacological properties, dermatological and cosmetic uses, and health effects of poppy seed oil are discussed with a systematic approach, as based on current scientific literature. Furthermore, an evaluation was conducted to ascertain the relationship between the functional properties of the oil and the production methods. Additionally, the available data concerning the safety profile was discussed.

2. Material and Methods

In this review study, the extant literature on the chemical composition, functional properties, pharmacological effects, and dermatological and cosmetic uses of poppy seed oil was systematically evaluated. A comprehensive search was conducted in major national and international databases, including PubMed, Scopus, Web of Science, and Google Scholar. The search was conducted using a combination of keywords, including "Papaver somniferum," "poppy seed oil," "linoleic acid," "cold press oil," "dermocosmetic," and "pharmacological activity." The search was limited to studies published between the years 2000 and 2025.

The publications included in this compendium encompass a wide array of scholarly works, such as research articles subjected to rigorous peer review, reviews that offer critical assessments of existing literature, theses that present novel research hypotheses, dissertations that provide comprehensive studies of a particular subject, official reports that document the findings of government-funded research, and chemical analysis studies that employ scientific methods to examine the composition of substances.

2.1. The Acquisition of Poppy Seed Oil and its Associated Properties

Poppy seed oil is primarily obtained through the application of two primary methods: cold pressing and solvent extraction. The cold-pressing method is a process that preserves phenolic compounds, tocopherols, and volatile components because it does not involve thermal treatment. This makes it a preferred method for food and cosmetic applications. In methods involving elevated temperatures or chemical solvents, oxidative stability may be compromised, potentially leading to the loss of biologically significant components. Consequently, the cold pressing technique is regarded as a suitable method for preserving the functional profile of the oil (Dąbrowski et al., 2020).

The oil obtained by cold pressing has a light yellow color, a runny consistency, and a characteristic aroma. These characteristics are advantageous for use in dermatological and cosmetic products. Oils obtained by high temperature or sequential pressing processes for industrial purposes are used in technical fields due to their distinct physicochemical properties.

2.2. Chemical Composition: Fatty Acids, Phytosterols, Antioxidants and Other Ingredients

Poppy oil is a nutritional and dermocosmetic product with a high content of unsaturated fatty acids, tocopherols, phenolic compounds, phytosterols, and carotenoids. The fatty acid profile of the oil is subject to variation due to factors such as variety, geographical location, and processing methods. The analysis revealed that linoleic acid is the most predominant fatty acid, comprising between 55% and 65% of the total fatty acid composition. Oleic acid was found to be present at a percentage ranging from 15% to 20%, while palmitic acid was

identified as comprising between 8% and 12% of the total fatty acid profile (Erinç et al., 2009; Özkan & Baydar, 2006).

Stearic acid and other fatty acids account for 2-5% of the total composition. The distribution of fatty acids has been demonstrated to enhance the functional properties of the oil, including the reinforcement of the skin barrier, the provision of moisture, the mitigation of inflammation, and the exertion of a protective effect against oxidative stress (Asil & Konuşkan, 2021; Kalender, 2002).

The phytosterols present in the oil, particularly β-sitosterol, are notable for their anti-inflammatory properties and beneficial effects on the skin barrier. (Aksoylu Özbek & Günç Ergönül, 2020; Çopuroğlu, 2004). Phenolic compounds and tocopherols have been demonstrated to enhance the antioxidant activity of the oil, thereby augmenting its capacity for free radical scavenging (Buran et al., 2022; Öztaşan et al., 2017; Saeed et al., 2022; Özkan & Baydar, 2006; Yücel Şengün et al., 2020). Furthermore, the presence of carotenoids and squalene in the oil has been demonstrated to enhance its stability and confer photoprotective properties (Varga et al., 2025; Dedebas, 2024; Türkavcı, 2021; Güngör, 2022).

The major phytochemical constituents of the oil are summarized in Table 1. The table is organized according to the average amounts reported in the literature in milligrams per kilogram, and it is referred to in the text for the sake of comprehensiveness within the scope of the review.

2.3. Functional Properties and Effects of Extraction Methods

The functional qualities of poppy seed oil are contingent upon the preservation of its chemical composition. The application of the cold press method has been demonstrated to enhance the antioxidant capacity of the oil. This effect is attributed to the stabilization of the components that are susceptible to heat treatment, including phenolic compounds, tocopherols, and volatiles. This supports the use of the oil in dermatological and cosmetic products for moisturizing, barrier strengthening, soothing, and wound healing. The extraction method also affects the sensory properties of the oil. The light texture and aromatic profile of cold-pressed oils make them particularly suitable for use in hair care products, moisturizers, and formulations that support the skin barrier (Muhammad et al., 2021; Yücel Şengün et al., 2020; Emir et al., 2014; Dąbrowski et al., 2020; Gupcsó & Németh, 2025; Aksoylu Özbek & Günç Ergönül, 2020; Türkavcı, 2021).

Table 1. The primary phytochemical components of poppy seed oil

Components	Reported range (mg/kg)	References
α- tocopherol	150–300	Yücel Şengün et al., 2020
γ- tocopherol	50–120	Yücel Şengün et al., 2020
total tocopherols	200–420	Yücel Şengün et al., 2020
β- carotene	1.5–3.2	Varga et al., 2025
total carotenoids	2.0–4.5	Varga et al., 2025
β-sitosterol	1000–1500	Aksoylu Özbek & Günç Ergönül, 2020

(Values may vary depending on genotype, climate, and extraction method)

3. Pharmacological Activities of Poppy Seed Oil

Poppy seed oil exerts a variety of pharmacological effects, attributable to its polyunsaturated fatty acids, phenolic compounds, tocopherols, phytosterols, and other biologically active components. These components contribute to antioxidant, anti-inflammatory, antimicrobial, and tissue healing properties, thus increasing the potential of the oil for use in health and

dermocosmetic fields (Saeed et al., 2022; Yücel Şengün et al., 2020).

3.1. Anti-inflammatory, Antioxidant, Antimicrobial, and Antifungal Effects

Linoleic and oleic acid, which are present in high concentrations in poppy seed oil, have been shown to suppress inflammation in tissues by reducing the production of inflammatory mediators such as prostaglandins and leukotrienes (Asil & Konuşkan, 2021; Erinç et al., 2009). Phenolic compounds have been reported to inhibit cyclooxygenase (COX) enzymes and alleviate chronic inflammatory processes (Öztaşan et al., 2017). These properties suggest that the oil can be used in a supportive manner to address inflammatory skin conditions, such as atopic dermatitis and eczema. Tocopherols and phenolic compounds have been demonstrated to reduce oxidative damage in cells by neutralizing reactive oxygen species (ROS). A multitude of studies have documented the high DPPH radical scavenging capacity of poppy seed oil and its protective effects against free radical-induced cellular damage (Saeed et al., 2022; Yücel Şengün et al., 2020). These effects are significant in terms of delaying skin aging and reducing UV-induced damage. Phenolic compounds and fatty acids in poppy seed oil have been shown to exhibit antimicrobial properties by disrupting the permeability of bacterial cell membranes (Dilek et al., 2018). A multitude of studies have demonstrated that the oil exerts an inhibitory effect on gram-positive and gram-negative bacteria, including Staphylococcus aureus and Escherichia coli. In addition, preliminary studies have indicated the potential for antifungal activity against certain fungal species (Yücel Şengün et al., 2020). These properties support the use of the oil in topical products for wound healing and maintaining barrier function.

3.2. Cardiovascular and Neuroprotective Effects

Poppy seed oil has been shown to contribute to the reduction of low-density lipoprotein (LDL) cholesterol levels by reducing cholesterol absorption in the intestine, a property attributable to the phytosterols it contains (Erinç et al., 2009; Aksoylu Özbek & Günç Ergönül, 2020). The presence of high unsaturated fatty acid content has been demonstrated to enhance vascular elasticity and reduce the risk of atherosclerosis (Kalender, 2002).

While there are reports in the extant literature suggesting a mild sedative effect of poppy seed oil, this effect is predominantly associated with other parts of the plant containing alkaloids. This phenomenon has yet to be scientifically substantiated in oils with low alkaloid content utilized for edible or cosmetic applications. Consequently, it is unwarranted to ascribe the sedative effect to routine utilization of the oil (Gürkök et al., 2010; Yazdani et al., 2003). This matter necessitates further investigation.

3.3. Anticancer Potential Effects

Research has indicated that phenolic compounds and alkaloids present in poppy plants may impede tumor cell proliferation and encourage apoptosis (Frary et al., 2013). However, a paucity of findings exists in the extant literature, particularly concerning the anticancer effect of seed oil. The antioxidant and anti-inflammatory properties of phenolic compounds in the oil may theoretically have a slowing effect on cancer development processes; however, extensive research at both cellular and clinical levels is needed to confirm this potential.

4. Dermatological and Cosmetic Uses of Poppy Seed Oil

Poppy seed oil has gained prominence in dermatological and cosmetic applications due to its abundant phytochemical content. The oil exhibits skin barrier supporting, moisturizing, antioxidant and antimicrobial properties due to its high linoleic acid

content, tocopherols, phytosterols, phospholipids and phenolic compounds. The synergistic effect of these components increases the potential of the oil for use in both daily care products and topical formulations for therapeutic purposes (Muhammad et al., 2021; Yücel Şengün et al., 2020).

4.1. The Effects of Moisturizing and Supporting the Integrity of the Barrier

A significant application of poppy seed oil in dermatology is its capacity to fortify the skin barrier. The linoleic acid present in the formulation contributes to ceramide synthesis in the stratum corneum, thereby reducing transepidermal water loss and supporting skin integrity (Erinç et al., 2009). In the context of compromised barrier function, a property of particular significance is demonstrated by this property. Such compromised barrier function may be exemplified by conditions such as eczema, atopic dermatitis, and chronic dryness. Conversely, oleic acid has been demonstrated to enhance moisture retention by increasing skin penetration and reducing scaling, itching, and redness caused by dryness (Asil & Konuşkan, 2021). Phytosterols and phospholipids have been shown to enhance skin barrier function by protecting against environmental stress factors (Aksoylu Özbek & Günç Ergönül, 2020). Consequently, the oil is particularly well-suited for use in formulations designed for sensitive and atopic skin.

4.2. Wound Healing and Tissue Repair

In addition to its anti-inflammatory and antimicrobial properties, poppy seed oil facilitates tissue repair through the presence of tocopherols. Tocopherols have been demonstrated to expedite wound closure by augmenting collagen synthesis and mitigating the deleterious effects of oxidative stress on tissue regeneration (Yücel Şengün et al., 2020). Phenolic compounds have been demonstrated to promote healing by mitigating the inflammatory response. For this reason, the oil is used as an auxiliary component in topical formulas developed for pressure sores, minor dermatological lesions, and barrier products that support wound healing (Dilek et al., 2018; Gültepe, 2013).

4.3. Anti-aging Effects

Phenolic components and tocopherols present in poppy seed oil have been shown to neutralize free radicals and decelerate collagen degradation. This feature offers a range of effects, including the reduction of fine lines, the maintenance of skin elasticity, and the mitigation of UV-induced photoaging (Öztaşan et al., 2017; Saeed et al., 2022). Consequently, the oil is regarded as a precious ingredient in antioxidant-containing serums, moisturizers, and anti-aging care products.

4.4. Effects on the Hair and Scalp

Linoleic acid and tocopherols have been demonstrated to promote hair follicle nutrition by enhancing circulation within the scalp. These effects may result in alleviating hair loss, strengthening hair strands, and increasing shine (Türkavcı, 2021; Yücel Şengün et al., 2020). The lightweight nature of poppy seed oil renders it well-suited for incorporation into hair care masks and oils (Emir et al., 2014).

4.5. Usage in Cosmetic Product Formulations

Poppy seed oil is regarded as a functional ingredient in a variety of cosmetic product categories, as evidenced by the extant scientific literature. The following is a summary of the functions, categorized by product type: The following substances are considered to be moisturizers and serums: The efficacy of long-lasting hydration and antioxidant protection is well-documented. The use of barrier creams is also a recommended practice. The following section will discuss the methods of

strengthening the barrier of atopic and sensitive skin. These methods include hair masks and treatment oils. It is imperative to nourish hair follicles and reduce breakage. The use of bath and body oils is also recommended. Softening, reduction of irritation, natural soaps: The cleaning effect is supported by antimicrobial activity. These product categories are no longer merely lists; rather, they are placed in a function-based scientific context.

5. Safety Assessment of Poppy Seed Oil and Its Derivatives

Poppy seed oil is widely regarded as safe for both food and cosmetic applications due to its low alkaloid content when obtained using appropriate production and refining methods. However, assessments of product safety are contingent on factors such as the preservation of composition, the implementation of quality control processes, and the development of formulations suitable for intended use (Casado-Hidalgo et al., 2023; Türkavcı, 2021).

5.1. Safety for Topical Use

Dermatological evaluations indicate that poppy seed oil possesses a low potential for irritancy. Phenolic compounds and unsaturated fatty acids have been demonstrated to provide a supportive effect on the skin barrier. However, it is recommended that patch testing be conducted prior to use, as sensitization may occur in some individuals (Gültepe, 2013; Yücel Şengün et al., 2020). The light structure and oxidative stability of the oil support its safe use in topical products formulated for sensitive and dry skin. However, its use in children, in cases of atopic skin, or in cases of impaired barrier integrity should be evaluated depending on the concentration of the formulation and other adjuvants.

5.2. Safety for Oral Use

A review of the extant literature on the nutritional use of refined poppy seed oil reveals no adverse safety findings. Nevertheless, recommended oral doses are derived from general dietary guidelines, and a clear clinical dose standard is not established. Zio et al. (2020) state that some refined oils can generally be considered safe at low doses. Although the literature generally indicates amounts such as 5-10 mL/day, it should be noted that these values are not a clinical dose recommendation, but rather a reflection of the ranges for food use (Erinç et al., 2009). Therefore, for oral use, it is recommended that the product be refined, contain low alkaloids, and that medical counseling be sought in individuals with chronic diseases.

5.3. Use with Special Groups

A paucity of clinical safety data exists in the extant literature regarding the use of poppy seed oil during pregnancy, lactation, and old age, whether topically or orally administered. The extant literature predominantly concentrates on the chemical stability or dermatological implications of the oil. In contrast, systemic toxicity assessments are deficient. Therefore: The following topics will be discussed in the context of pregnancy and breastfeeding: The safety of low concentrations of topical use in cosmetic products can be reasonably inferred; nevertheless, it is imperative to exercise caution in the absence of clinical data concerning high doses or oral use (Öztaşan et al., 2017). Pediatric Use: In cosmetic products, low concentrations (e.g., 2-5%) are preferable; direct application of pure oil is not recommended (Güngör, 2022). This study focuses on the experiences of elderly individuals. The potential benefits of the oil's moisturizing and barrier-supporting properties, particularly for individuals with weaker skin barriers, cannot be determined with certainty due to the absence of clinical studies. Consequently, the utilization of these products in specific groups should be

assessed in accordance with the formulation of the product and the individual health status.

5.4. Stability and Storage Conditions

Poppy seed oil is susceptible to oxidation due to the presence of unsaturated fatty acids. Although tocopherols and phenolic compounds have been shown to delay oxidation to a certain extent, maintaining the stability of the oil requires more comprehensive considerations. Specifically, the oil should be stored in conditions that prevent light exposure, maintain low temperatures, and minimize contact with air (Dedebas, 2024). Maintaining stability is imperative for ensuring pharmacological efficacy and product safety.

6. Conclusion

This review study evaluated the chemical composition, biological activities, and dermatological and cosmetic potential of poppy seed oil in accordance with current literature. Poppy seed oil is characterized by elevated concentrations of linoleic and oleic acids, tocopherols, phytosterols, and phenolic compounds. These constituents possess a variety of biological functions, including antioxidant, anti-inflammatory, antimicrobial, and barrier-strengthening properties. These biological properties suggest that the oil can be used as a supportive ingredient in both food and topical products.

From a dermatological perspective, the fact that the oil supports the integrity of the stratum corneum, reduces transepidermal water loss, and limits oxidative stress-induced skin damage provides a scientific basis for its use in moisturizing and barrier repair products. Furthermore, the oil's inherent anti-inflammatory and antioxidant properties, which are known to facilitate wound healing, support its use as an auxiliary ingredient in formulations designed for tissue repair. The documented positive effects on hair and scalp suggest that the oil may also be a functional ingredient in cosmetic hair care products.

In regard to safety, the low alkaloid content and minimal irritation potential of refined poppy seed oil suggest that it offers a generally safe profile for topical use. However, clinical data concerning specific conditions, including pregnancy, pediatric use, and long-term oral consumption, remains limited and necessitates meticulous, product-specific evaluation in these domains. The oxidation-sensitive nature of the oil underscores the necessity of maintaining optimal storage conditions.

A comprehensive review of the extant literature reveals that poppy seed oil possesses the potential to serve as a natural ingredient in various applications, including dermatological support, moisturization, antioxidant protection, and tissue repair. However, data concerning its anticancer potential, neuroprotective effects, and systemic pharmacological effects are very limited. Consequently, it is recommended that subsequent studies prioritize the following domains: The mechanisms of action of poppy seed oil at the cellular and molecular levels must be elucidated. Clinical evaluations of long-term use on human skin are necessary. Safety data must be expanded for pediatric, pregnancy, and chronic disease groups.

The interaction and stability of the oil with different cosmetic formulations must be investigated. The anticancer and neuroprotective potential of the oil in vitro and in vivo models must be verified. In light of these evaluations, it is concluded that poppy seed oil is a natural ingredient of high biological value; however, the need for scientific evidence remains in some areas. This finding indicates that the oil may warrant further investigation in the domains of food technology and dermocosmetic product development.

Author Contribution

All authors declare equal contribution to the design, interpretation of the review, and editing of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest during the accomplishment of this research. None of the authors has any financial and/or personal relationships with other people or organizations that could inappropriately influence (bias) their work.

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