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REVIEW PAPER

Pumpkin (*Cucurbita pepo* L.) seed oil – cosmetic, food and medical raw material

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Summary

Pumpkin (*Cucurbita pepo* L.) seed oil, as a non-drying oil, is a raw material used in cosmetics, food and medical industries due to its biological and nutritional properties. It is a rich source of phytosterols, protein, polyunsaturated fatty acids and vitamins. This oil exhibits antibacterial, antioxidant and anti-inflammatory properties. The oil is used by the cosmetics industry in anti-aging, protective and hair care products due to its bioactive compounds such as tocopherols, phytosterols and phenolic acids, which act as antioxidants. It also has a sunscreen effect, absorbing about 20% of harmful UVB rays.

Key words: *vegetables in cosmetology, cosmetics industry, healing properties, natural ingredients, superfoods*

Słowa kluczowe: *warzywa w kosmologii, przemysł kosmetyczny, właściwości lecznicze, składniki naturalne, superfoods*

INTRODUCTION

The consumption and use of Pumpkin (*Cucurbita pepo* L.) in various forms is beneficial to human health, as it contains various biologically active ingredients such as phenolic acids, protocatechic acid, syringic acid, caffeic acid, *p*-coumaric acid, vanillic acid and ferulic acid.

Phytosterols contained in pumpkin seed oil, including β -sitosterol, inhibit the conversion of testosterone into dihydrotestosterone, which is responsible for the weakening of hair follicles. Pumpkin has healing properties, in cases of high blood pressure and cancer, among others. Pumpkin seed oil has antibacterial, antioxidant and anti-inflammatory properties. Its consumption counteracts diabetes. This review aims to discuss these beneficial properties, their qualitative and quantitative composition and potential cosmetic, food and medicinal uses, based on current literature.

Description of pumpkin (*Cucurbita pepo* L.)

Pumpkin belongs to the genus *Cucurbita* L. [1], family *Cucurbitaceae*. It comes from Mexico but is grown in many countries around the world, including Serbia and Poland [2-4]. It grows in rich and moist-soil, and grows best in sunny locations [5].

C. pepo is an annual climber with pentagonal shoots that can reach up to 15 m in length. The leaves are large, alternate, 5-lobed, with blunt sinuses. The root system is shallow, branched, and grows from a well-developed tap root. Pumpkin is a monoecious plant with actinomorphic, odourless flowers about 10 cm in diameter. Male flowers have a long, bell-shaped calyx, 6 to 12 cm long, ranging in colour from yellow to light orange. Female flowers have a bell-shaped, 5-tooth calyx. This plant blooms from July to September [6, 4]. Pumpkin fruits differ in shape (oval, spherical, cylindrical, flattened, elongated), colour (white, yellow, green, cream, orange) and size [7, 4]. In the processing industry, orange flesh pumpkins are most valued due to their high carotenoid content [8]. The long flowering period of pumpkins makes them of great beekeeping value [9]. Pumpkin seeds are harvested using combine harvesters [10].

Two types of pumpkins are grown in Poland: winter squash (*C. maxima* Duchesne) and pumpkin (*C. pepo* L.) [11]. In temperate regions, the pumpkin is grown mainly for the ripe pulp. In Argentina, unripe fruit is also eaten, and in Europe it is often grown for seeds [1].

Pumpkin is very popular in food and cosmetic industries [12]. Pumpkin seeds, commonly regarded

as agro-industrial waste, are an extremely rich source of bioactive compounds with interesting nutraceutical properties. The seeds have an oval, flat shape and a light green interior under the white scales. They are rich in dark green-red oil, obtained by cold pressing at temperatures of up to 50°C. For the production of pumpkin seed oil, supercritical carbon dioxide extraction is also used [13]. The solvent extraction method is the most efficient, extracting 98% of seed oils [14]. Pumpkin seeds contain about 500 g/kg of oil [12].

Pumpkin seed oil is thick and absorbs into the skin slowly, therefore it is classified as a non-drying oil [15]. It is an important part of the diet and is added to salads, for example. Fresh, cold-pressed pumpkin seed oil has a colour ranging from green-red to dark red, its taste is mild and nutty [13]. It is highly dichromatic and sticky. Its strong antioxidant effect and the prevention of hypertension and cancer have been documented. However, the composition and physicochemical properties of pumpkin seed oil remain fairly unexplored, especially for North African varieties. Determining both the physicochemical properties and oxidative stability would significantly contribute to the valorisation of the potential of pumpkin seed oil in the cosmetics, pharmaceutical and food industries [16]. In recent years, special attention has been paid to the health properties of pumpkin seed oil in the fight against many diseases and its antibacterial, antioxidant and anti-inflammatory effects [17]. Pumpkin seeds and the oil produced from them are a rich, natural source of phytosterols, protein, polyunsaturated fatty acids and vitamins [4].

Pumpkin seeds are also used in culinary practices, mainly in Slovenia, Hungary and the southern parts of Austria. Roasted pumpkin seeds are a popular snack in many African countries, especially Tunisia [16]. Pumpkin fruits are also used in the production of purees, biofuels and alcohol [18, 19].

The composition of pumpkin seed oil

Pumpkin seed oil is rich in highly unsaturated fatty acids (80.7%) and saturated fatty acids (19.3%). The dominant fatty acids are: oleic, linoleic, palmitic and stearic acids. The oil is rich in squalene, tocopherols, phytosterols and carotenoids (lutein and zeaxanthin) [14].

Triacylglycerols (94.5%) constitute a large part of the lipid fraction of pumpkin seed oil, and there are also monoacylglycerols, diacylglycerols and free fatty acids. The composition of the non-glycerol fraction includes sterols, phospholipids, tocopherols, triterpene alcohols, squalene, chlorophylls and caro-

tenoids [13]. Among fatty acids, oleic acid (42.5%) and linoleic acid (37%) have the highest share, while palmitic acid (12.3%) and stearic acid (5.2%) are found in smaller amounts [20]. An important component of the lipid fraction of pumpkin seed oil is a hydrocarbon with strong antioxidant properties, such as squalene, its percentage content is 0.89% [21].

Among the phytosterols in pumpkin seed oil are, inter alia, beta-sitosterol, desmosterol, campesterol, stigmaterol, β -sitosterol, spinasterol, D7,22,25-stigmastatrienol, D7-stigmastenol, D7,25-stigmastadienol and D7-avenasterol, fatty acids, squalene, tocopherols and zinc [22, 14]. The composition of this oil also includes tocopherols, and their content is presented in Table 1. Vitamin E compounds are strong antioxidants of polyunsaturated fatty acids and phospholipids, which are part of cell membranes, and are also involved in metabolic processes. Vitamin E compounds have antioxidant properties due to the presence of a hydroxyl group in the chromanol ring [23].

Table 1.

Tocopherol content in pumpkin seed oil [21]

Type of tocopherol	Contents [mg/kg]
α -tocopherol	71.4
β -tocopherol	–
γ -tocopherol	423.1
δ -tocopherol	13.6
Totality	508.1

The oil also contains phenolic acids such as protocatechuic acid, syringic acid, caffeic acid, p-coumaric acid, vanillic acid and ferulic acid [14]. These compounds protect the lipids present in the seeds against oxidation and are also precursors of substances that shape the taste and aroma [13]. It has been shown that roasting pumpkin seeds causes changes in the chemical composition and oxidative stability of the obtained oils. During the roasting process, there are changes in the content of phospholipids, phenolic compounds and tocopherols. The increased content of these components significantly improves the chemical composition of the oil [24].

The compounds that determine the colour of the oil are carotenoids and chlorophylls. Carotenoids

present in the oil protect the skin against the harmful effects of external factors, but their content in pumpkin seed oil is relatively low and amounts to about 260 $\mu\text{g/g}$ [12]. The content of chlorophyll pigments is six times higher than that of carotenoids. Their presence is important due to their participation in photochemical reactions [25].

Table 2 lists the elements that are present in pumpkin seed oil, but not all are desirable as they may contribute to reducing the durability of the oil. The amount of undesirable elements is usually low and does not exceed the acceptable standards, except for copper (Cu) [25].

Table 2.

Content of selected elements in cold-pressed pumpkin seed oil [12]

Element	Contents [mg/kg]
Fe	1.3
Cu	1.1
Cd	0.005
Pb	0.1
As	<0.005
Hg	<0.005
Zn	0.33

Pumpkin seed oil in cosmetology

Vegetable oils used in cosmetics can be divided into, among others, popular oils, special oils (including pumpkin seed oil) and medicinal oils. Popular oils are often refined (chemically and physically) during production, while special and therapeutic oils are produced under individual conditions, e.g. cold, without access to light and air, which make it possible to maintain the nutritional properties of the oil [26].

Pumpkin seed oil (INCI: Cucurbita Pepo Seed Oil) is a greasy emollient that leaves an occlusive layer (film) on the surface, which prevents excessive water evaporation. It is used to treat dry, flaky, damaged and mature skin [12]. In the cosmetics industry, it is typically used in anti-aging, protective and hair care products [27].

The 5α -reductase enzyme is involved in conversion of the hormone testosterone into hormone dihydrotestosterone (DHT) [28]. A large

amount of DHT is responsible for the weakening of hair follicles and the symptom of the conversion of these compounds is androgenic alopecia. The phytosterols contained in the pumpkin seed oil, including β -sitosterol, inhibit the conversion of testosterone into DHT [22]. Research conducted by Teeranachaideekul *et al.* [28] shows that pumpkin seed oil-loaded niosomes are an effective delivery for the treatment of hair loss because they inhibit the mRNA expression of genes involved in the synthesis of 5α -reductase. According da Cruz *et al.* [29] oral administration of pumpkin seed oil is effective in increasing the number and length of hair follicles and remodelling of skin collagen. After 24 weeks of pumpkin seed oil treatment in male patients with mild to moderate androgenic alopecia the mean hair number increased by 40% [30]. Topical application of pumpkin seed oil to the scalp was also shown to stimulate hair growth [31]. Three months of pumpkin seed oil topical application have resulted in a significant decrease in the diversity of vellus hair, hair shafts and straight regrowth hair in the treatment of baldness in women [32]. For these reasons pumpkin seed oil is recommended for hair loss, dryness and skin inflammation [22].

In addition, this oil can be an important component of cosmetic creams and emulsions due to the content of bioactive compounds such as tocopherols, phytosterols and phenolic acids, which act as an antioxidant [33]. The phenol content of pumpkin seed oil has been found to range from 25 to 51 mg GAE/kg of oil [27].

C. pepo seed oil also has a sunscreen effect. This oil absorbs up to 22% of harmful UVB rays, which is why it is becoming an increasingly popular component of sunscreen products [34]. In contrast, pumpkin seed oil's strong anti-inflammatory, antibacterial and antioxidant properties result from the presence of bioactive compounds and make it a desired ingredient in products that accelerate wound healing [12].

Food properties of pumpkin seed oil

Pumpkin seed oil is intended for direct consumption, as a marinade or salad dressing [35]. Due to its colour and foaming, the oil is not suitable for cooking [36]. It is used as an ingredient in chocolates, cereal bars, bread, cakes, soups, pesto, muffins and as a pasta garnish. Pumpkin seeds butter is an alternative to peanut butter [37]. Pumpkin seeds can produce similar amounts of oil to those of the most popular cooking oil plants such as cotton, soybeans, and olives

[27]. The by-product of pumpkin oil production is pomace, otherwise known as expeller. The pomace is used, in food processing and elsewhere [38]. In France, pumpkin expeller is used as a feed additive for pigs and poultry [39].

The skimmed pumpkin seeds left over from oil production are used to produce flour [40]. Roasted, fermented or even germinated seeds can also be used to make flour [41]. Such flour is known as alternative or unconventional flour, and producers use it as a substitute for ordinary wheat flour, because it contains many minerals, vitamins, essential fatty acids and antioxidants, all of which are beneficial for human health [42].

Pumpkin seed oil in medicine

A moderate dose of fatty oil in pumpkin seeds is not toxic to animals and humans, and also has a protective effect against genotoxicity caused by azathioprine. The recommended dose of pumpkin seed oil is the equivalent of 10–30 g [14]. Pumpkin has healing properties, including in cases of high blood pressure or cancer. El-Mosallamy *et al.* [43] proved that pumpkin seeds can play an important role in blood vessel relaxation and lowering blood pressure. They observed that oral administration of L-nitroarginine (L-NAME)-induced hypertension to rats with methylester hypertension, 40 or 100 mg/kg of pumpkin seed oil daily for 6 weeks slowed the increase in blood pressure in the test animals. Moreover, blood levels of malondialdehyde (MDA) decreased – a marker of lipid peroxidation mechanisms responsible for increasing the concentration of nitric oxide [44].

Pumpkin seed supplementation in rats has been shown to have antiatherosclerotic and hepatoprotective effects in hypercholesterolaemic rats. Subsequent studies have shown that the seeds exhibit estrogen-like effects, such as regulating lipid metabolism, bone remodelling, and the development of epithelial, mammary and uterine cells [33].

Consuming pumpkin seed oil counteracts diabetes, has antibacterial, antioxidant and anti-inflammatory properties [6]. It has been found to inhibit the activity of *Actinetobacter baumannii*, *Aeromonas veronii* biogroup *sobria*, *Candida albicans*, *Enterococcus faecalis*, *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Salmonella enterica* subsp. *enterica* serotype *typhimurium*, *Serratia marcescens* and *Staphylococcus aureus* at a concentration of 2% (v/v) [4]. Bardaa *et al.* [6] proved that skin wound healing in rats treated with

pumpkin oil extract was better than in untreated or reference groups based on macroscopic, morphometric and histological data. Pumpkin seed oil and pumpkin seed extract are increasingly appreciated for their excellent nutritional quality and medicinal value, especially in the prevention and treatment of benign prostatic hyperplasia (BPH) [45]. Both pumpkin seed oil and tamsulosin (TM) significantly reduced symptoms of BPH, however, the advantage of pumpkin seed oil was its lesser side effects [46]. Bakhaidar *et al.* [47] proved that raw palmetto oil and pumpkin seed oil combined with a fabricated nanostructured lipid carrier (NLC) improved the bioavailability of tamsulosin and its therapeutic activity against BPH.

Pumpkin seeds are rich in potassium and phosphorus, and pumpkin puree is rich in potassium, which can be used to activate kidney function and treat kidney disease [48]. Pumpkin seed oil has a strong effect against nocturia and urinary incontinence and reduces the frequency of urination [49]. It may also have a protective effect on the liver by scavenging free radicals, mitigating their harmful effects and treating liver damage [48].

CONCLUSIONS

Pumpkin is a vegetable that is gaining popularity because of its biological and nutritional properties are equal to or even better than that of commonly grown vegetables and fruits. Pumpkin is rich in ingredients valuable for the health of the entire body. The active compounds contained in the flesh, peel and seeds are valuable in diet, as well as, skin and hair care. Pumpkin is a rich source of β -carotene and can also be used in conjunction with other vegetables and fruits to enhance the nutritional properties of these foods.

New discoveries and research lead to more ideas for the extensive use of pumpkin seeds in the production of nutraceuticals, cosmetics or pharmaceutical products. Pumpkin seed oil has many uses, and the presence of numerous antioxidant compounds helps to combat stress caused by UV radiation. It is most often used in cosmetics for mature and dry skin, as well as in anti-aging products and hair conditioners. Pumpkin oil has a sunscreen effect. This oil absorbs up to 22% of harmful UVB rays, which is why it is becoming an increasingly popular ingredient in sunscreen products.

Ethical approval: The research conducted is not related to either human or animal use.

Conflict of interest: Authors declare no conflict of interest.

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