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REVIEW PAPER

Oils from fruit seeds and their dietetic and cosmetic significance

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Summary

Plant-origin oils are an essential element of the diet, affecting the preservation of health, but also of significant importance for the care of skin and its appendages. Among fats of plant origin, oils from fruit seeds are an important group. They are a rich source of fatty acids, tocopherols, tocotrienols, carotenoids, flavonoids, phytosterols and other bioactive compounds that have positive effect in relation to specific functions of the human body. Fruit seed oils play an important role in health prophylaxis, because they prevent the development of diseases of civilisation, alleviate the effects of stress and slow down the ageing process of the body. Due to the beneficial effects on the skin, they are also used in cosmetology. In formulations of cosmetic preparations, plant oils are the basis for the administration of other active ingredients, but they are also used due to their biological properties. The article discusses in detail the composition, dietary and cosmetic importance of oil from the seeds of raspberries, blackcurrants, rose hips and grapes.

Key words: ***Rubus idaeus, Ribes nigrum, Rosa canina, Vitis vinifera, fatty acids, health prophylaxis***

Słowa kluczowe: ***Rubus idaeus, Ribes nigrum, Rosa canina, Vitis vinifera, kwasy tłuszczowe, profilaktyka zdrowotna***

INTRODUCTION

Plant oils are liquid fats obtained from various parts of plants, including fruits (e.g. olives, sea-buckthorn), seeds (e.g. borage, flaxseed, sea-buckthorn), fruit stones (e.g. grapes, blackcurrants, raspberries, plums), nuts (e.g. walnut, hazel) or sprouts (e.g. wheat) [1, 2]. A special group of plant oils, which are very popular in terms of production and consumption, are cold-pressed oils [3]. Due to the various biologically active compounds they contain, they can be included in functional foods. The presence of polyunsaturated fatty acids, fat-soluble vitamins and antioxidants, including polyphenolic compounds, carotenoids or tocochromanols (tocopherols and tocotrienols), is associated with beneficial health effects on the human body (improved well-being, health status, reduced risk of disease) [2, 4-6]. Plant oils are a natural source of fatty acids, including unsaturated fatty acids that play an important role in the proper functioning of the human body [7, 8]. The group of unsaturated fatty acids includes omega-9 (ω-9) monounsaturated fatty acids and omega-3 (ω-3) and omega-6 (ω-6) polyunsaturated fatty acids (PUFA) [1, 8] (fig. 1). Polyunsaturated fatty acids are not synthesised in the human body; hence, they must be supplied in the diet [9].

Plant-origin fatty acids, which are the source of essential fatty acids, are characterised by high biological activity [9]. Significant dietary and cosmetic importance is demonstrated by the omega-3 and omega-6 acids, including alpha-linolenic (ALA, 18:3, ω-3), linoleic (LA, 18:2, ω-6) and gamma-linolenic acid (GLA, 18:3, ω-6), classified as *essential fatty acids* (EFA) [7, 10]. EFAs are assigned an important role in health prophylaxis, especially in relation to allergic, inflammatory and cardiovascular diseases [11]. The ω-3 and ω-6 fatty acids are precursors of eicosanoids (prostaglandins (PG), prostacyclins (PGI), thromboxanes (TXA), leukotrienes (LT) and lipoxins (LX) – broad-spectrum tissue hormones (e.g. anticoagulants, reduction of triacylglycerol concentration, regulation of cardiovascular function, blood pressure or inflammatory processes) [7, 12]. Uauy and Dangour [13] also emphasise the importance of omega-3 acids, particularly docosahexaenoic acid (DHA), in brain development and its role in the prevention of old-age diseases, such as dementia and Alzheimer's disease. Acids from the omega-3 family: docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) are also attributed to the reduction of cancer risk [14]. Acids from the omega-3 and omega-6 families are metabolised in the human body by the same enzymes, indicating functional links between the metabolic pathways of both families, consisting of substrate competition and regulation of a given stage of changes on the principle of negative feedback. The excess of fatty acids from one family in the diet (usually ω-6) automatically causes a reduction in the intensity of changes in the second series,

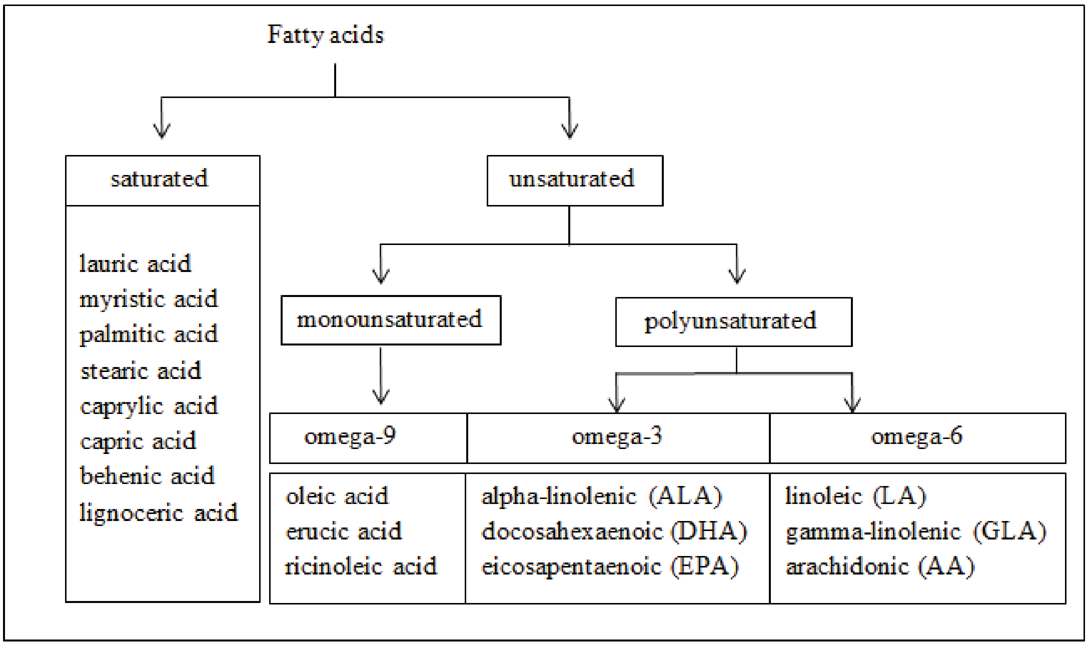

Figure 1.
Division of fatty acids [developed based on: 1, 8]

and consequently a deficiency in the body of these acids (ω-3). Therefore, the proper ratio of ω-6 to ω-3 acids is important in the human diet, which should be from 2.5:1 to 4:1 [10, 15]. Modern diets, due to the consumption of fats containing large amounts of ω-6 acids, disturb the balance between ω-3 and ω-6 acids; in European countries this ratio is 20:1 and in the American diet it is 30:1. In Poland, the ratio of ω-6 to ω-3 fatty acids is, on average, 7:1, mainly due to the low intake of ω-3 acids [15]. Therefore, care should be taken to ensure a high supply of ω-3 fatty acids in the diet, while avoiding consumption of oils rich in ω-6 acids.

Sterols present in plant oils help to lower LDL cholesterol in the blood, and thus reduce the risk of heart disease [16]. Tocochromanols, in addition to phytosterols, a significant group of unsaponifiable components of plant oils, are characterised by the ability to neutralise lipid peroxide radicals formed during the oxidation of polyunsaturated fatty acids (PUFA) [6]. Slightly higher antioxidant activity among the tocochromanols of oily plants is shown by tocotrienols compared to the corresponding tocopherols [3].

Plant oils, rich in polyunsaturated fatty acids, as components of lipids in cell membranes, also have a significant impact on the proper appearance and function of the skin [17]. Plant-derived fats reinforce the barrier of skin protection, affect the reconstruction of the stratum corneum, prevent transepidermal water loss (TEWL), normalise the sebaceous glands, reduce the negative effects of UV radiation on the skin, and, as UV filters, prevent skin photo-ageing processes [7, 17-19]. The symptom of fatty acid deficiency is dryness of the epidermis, exfoliation, flaccidity of the skin, inflammation, dermatitis, increased tendency to irritation and slowed healing process [7, 10].

Plant oils are widely used as biologically active compounds, but also as substrates for many cosmetic products, including creams, emulsions, lotions, hair conditioners, brilliantine, beauty masks and protective lipsticks [1]. In cosmetics, i.e. preparations for external application to the skin, oils with a high content of essential unsaturated omega-6 fatty acids, which are the main component of the skin's lipid mantle, are of the greatest importance due to the possibility of their incorporation into intercellular cement ceramides [1, 20].

An interesting group of plant oils are oils from fruit seeds. It is worth mentioning not only oils that are well-known and used in the past but also those that are newly discovered as raw materials of dietetic and cosmetic importance.

Raspberry seed oil

The oil is obtained from raspberry seeds (*Rubus idaeus* L.) from the *Rosaceae* family. The Latin name of this plant refers to the red colour (*Rubus*) and the *Ida* mountain in Crete, where raspberries come from and where they grow nowadays too [21]. Raspberry seeds contain about 23% oil, which is a source of saturated (palmitic (2.1%), stearic (0.9%)) and unsaturated (alpha-linolenic (23.9%), linoleic (57.5%), oleic (13.3%), eicosenic (0.4%)) fatty acids [1, 9, 24]. Among the mentioned bioactive components, there are polyphenol compounds (2.65 $mg \cdot 100\ g^{-1}$), phytosterols (5.38 $mg \cdot g^{-1}$) including campesterol, stigmasterol, sitosterol, avenasterol, cytrostadienol, and carotenoids including zeaxanthin, β-carotene, lutein and cryptoxanthin [9, 22]. Raspberry seed oil also contains large amounts of vitamin E (301.9 $mg \cdot 100g^{-1}$); tocopherols (295.19 $mg \cdot 100\ g^{-1}$), including α-tocopherol (71 $mg \cdot 100\ g^{-1}$), γ-tocopherol (272 $mg \cdot 100g^{-1}$), Δ- tocopherol (17.4 $mg \cdot 100\ g^{-1}$); and tocotrienols (6.73 $mg \cdot 100\ g^{-1}$) [9, 23]. Consumption of raspberry fruit has been associated with a decrease in the risk of developing many chronic diseases, such as obesity and cardiovascular diseases [24]. Due to the content of active substances and specific biological properties, raspberry seed oil can be used as a nutraceutical. This oil is appreciated as a component of the diet, being a source of essential fatty acids and preventing the development of diseases of civilisation [9, 24]. It has been shown that raspberry seed oil can affect the improvement of liver function [24]. Pieszka *et al.* [9] prove that raspberry seed oil used as a food supplement has strong antioxidant properties.

Raspberry seed oil (according to INCI: *Rubus Idaeus (Raspberry) Seed Oil*) is used in cosmetology as a component of face care, eye contour, cleavage and body preparations. It absorbs well, moisturises, oils and firms the skin, strengthens the lipid barrier of the epidermis and improves sebaceous glands. It is also a natural preservative and absorption promoter, because it promotes the penetration of other cosmetic preparation ingredients [21]. It was confirmed that raspberry seed oil can be a well-tolerated base for cosmetics and dermocosmetics, not causing skin irritation. Research by Pereira *et al.* [25] shows that the nano-emulsion based in plant oils (raspberry, passion fruit and peach oil) positively influences the condition of the skin, improves hydration and lubrication, without changing the pH value of the skin [24]. Oomah *et al.* [23] report that raspberry seed oil has the ability to absorb UV radiation, thus it can be used as a protective ingredient with a broad spectrum of activity. Niculae *et al.* [26] state that this oil can be used to prepare modern forms of cosmetics. It proved to be a valuable component, improving the antioxidative and photoprotective activity of the product [25]. Due to its anti-inflammatory properties, raspberry seed oil has also found applications in cosmetic and pharmaceutical preparations used to prevent gingivitis, eczema and other skin disorders [22].

Blackcurrant seed oil

The oil obtained from blackcurrant seeds (*Ribes nigrum* L.; the *Grossulariaceae* family) is a source of saturated (8.8%), monounsaturated (12%) and polyunsaturated fatty acids (78.6%) of the ω-6 (62.1%) and ω-3 families (16.5%) [2]. Among saturated fatty acids, in the highest amounts, there are palmitic (6.2%) and stearic acids (1.5%), while in the group of unsaturated fatty acids there are linoleic (49.1%), alpha-linolenic (13.0%), oleic (12.9%), gamma-linolenic acids (12.7%) and, rarely found in plant oils, stearidonic acid (SDA) (2.4%). There is an optimal ratio (4:1) between the n-6 and n-3 family acids in the blackccurrant seed oil [27]. Among the characteristic bioactive components of oil from blackcurrant seeds, there are tocopherols (1231.6 mg·kg^{-1}), including α-tocopherol (453.3 mg·kg^{-1}), γ-tocopherol (711.1 mg·kg^{-1}) and Δ-tocopherol (67.2 mg·kg^{-1}), polyphenolic compounds, mainly quercetin-3-O-glucoside and p-coumaric acid, as well as sterols (562.1 mg·100g^{-1}), including β-sitosterol (463.4 mg·100 g^{-1}), campesterol (48.9 mg·100g^{-1}), stigmasterol (5.6 mg·100 g^{-1}), Δ5 avenasterol (13.1 mg·100 g^{-1}), Δ7 stigmasterol (23.0 mg·100 g^{-1}), Δ7 avenasterol (8.1 mg·100 g^{-1}) and, in small amounts, pigments(carotenoids (7.2 mg·kg^{-1}) and chlorophylls (0.2 mg·kg^{-1}) [28, 29].

Research by Vecera *et al.* [30] indicates that blackcurrant seed oil positively affects the modification of risk factors associated with the development of coronary heart disease, such as hypertension, inflammatory processes or platelet aggregation. It has also been shown that replacing hard fats, such as lard, with blackcurrant seed oil rich in unsaturated fatty acids, has a positive effect on metabolism and lowering the concentration of lipids [30]. Research by Wu *et al.* [31] confirms the effect of strengthening the immune system in healthy elderly people due to blackcurrant seed oil.

Blackcurrant seed oil (according to INCI: *Ribes Nigrum (Blackcurrant) Seed Oil*), characterised by a high content of γ-linolenic acid (GLA), has a beneficial effect on the condition of the skin [1, 11]. GLA, along with α-linolenic acid, plays an important role in the repair and regeneration of the skin's protective barrier. Applied externally in the form of creams, it penetrates the stratum corneum of the epidermis, whereas applied internally it passes into the dermis, strengthening its coherence and preventing transepidermal water loss (TEWL) [32]. Deficiency of γ-linolenic acid, arising from linoleic acid by enzymatic reaction involving Δ-6-desaturase, is the cause of many skin problems, including excessive exfoliation of the epidermis. Therefore, blackcurrant seed oil is recommended for the care of dry and sensitive skin, but also in the case of psoriasis or atopic dermatitis [7, 17].

Wild rose seed oil

Oil is obtained from wild rose (*Rosa canina* L.) belonging to the *Rosaceae* family. The seeds of this plant contain from 4.9% to 17.82% of oil, which is a source of phytosterols (5891.6-6485.4 mg·kg^{-1}), including β-sitosterol (4753.3–5297.3 mg·kg^{-1}), campesterol (192.3–205.4 mg·kg^{-1}), stigmasterol (60.2–77.9 mg·kg^{-1}), Δ5 avenasterol (242.4–379.1 mg·kg^{-1}), Δ7 avenasterol (37.2–55.8 mg·kg^{-1}), tocopherols (1124.7 mg·kg^{-1}), including α-tocopherol (116.6–147.3 mg·kg^{-1}), γ-tocopherol (630.4–777.1 mg·kg^{-1}), Δ-tocopherol (230.4–259.9 mg·kg^{-1}), carotenoids (107.7 mg·kg^{-1}) and polyphenolic compounds (783.55 g·kg^{-1}), predominantly p-coumaric acid methyl ester (108.32–391.77 μg·kg^{-1}), ferulic acid methyl ester (113.98 μg·kg^{-1}), vanillic acid (92.67–247.69 μg·kg^{-1}) and 4-hydroxybenzoic acid (78.71 μg·kg^{-1}) [33]. Wild rose seed oil contains 6.6% saturated, 15.3% monounsaturated and 78.1% polyunsaturated fatty acids [32, 33]. In the group of saturated fatty acids, palmitic (3–5%), stearic (1.5–2.5%) and myristic acid (less than 0.5%) can be mentioned, while alpha-linolenic (ω-3; 16.6–26.5%), linoleic (ω-6, 35.9–54.8%), oleic acid (ω-9, 14.7–22.1%) are among the unsaturated fatty acids, and there is also a small amount of palmitoleic acid (ω-7, less than 0.5%) [1, 33–35]. The research results of Grazjer *et al.* [33] indicate that the wild rose seed oil is a valuable source of PUFA in the human diet [33].

Rose hips have multidirectional applications, including health-promoting, such as in the treatment of influenza, infections, inflammatory diseases and chronic pain [36]. Szentmihályi *et al.* [37], comparing methods of extracting oil from wild rose seeds (including traditional solvent extraction with ultrasound-, microwave-, sub- and supercritical fuid extraction), report that extraction with carbon dioxide in the supercritical state proved to be the most beneficial, providing a natural composition and does not cause degradation of the product components that can be used for medicinal purposes [37]. Wild rose seed oil, due to its high content of unsaturated fatty acids, can be used as a dietetic, health-promoting and cosmetic ingredient [33, 35]. It shows a possible anti-cancer effect as well as antioxidant, anti-inflammatory properties and improves lipid metabolism [33, 38]. In addition, beneficial effects of wild rose seed oil have been demonstrated in the case of dermatoses, ulcers and other skin diseases [38].

Wild rose seed oil (according to INCI: *Rosa Canina (Rose hip) Seed Oil*) is characterised by good cosmetic and dermatoprotective properties. It is recommended by cosmetologists as an emollient and revitalising agent. Patel [39] and Fujii *et al.* [40] emphasise the importance of caring, including the softening, antioxidant and anti-wrinkle effects of this oil. It has been shown that it reduces skin pigmentation, reduces discolouration, acne lesions, scars and stretch marks, as well as retaining the moisture of the skin and delaying the appearance of wrinkles. Cosmetologists recommend wild rose seed oil as a natural skin-vitaliser [39, 40].

Grape seed oil

The oil is obtained from the grape-vine (*Vitis vinifera* L.) belonging to the *Vitaceae* family. Grape seeds are a raw material for obtaining the oil, but are also a source of biologically active compounds important for the human body [41]. Grape seed contains fibre (40%), protein (11%), phenolic compounds (7%), including resveratrol (up to 20 $\mu g \cdot 100\ g^{-1}$), as well as lipids, sugars, minerals and other active substances [42-44]. In the group of polyphenols present in grape seeds, there are catechins (epicatechin, gallocatechin, epigallocatechin, epicatechin 3-O-gallate), procyanidins and phenolic acids (gallic, coffee, ferulic, *p*-coumaric acid) [45]. Grape oil, cold pressed from seeds, is a source of EFA, as well as tocopherols, phytosterols and phospholipids [2, 46]. Among the saturated fatty acids, palmitic and stearic are mentioned, whereas in the group of unsaturated fatty acids there are omega-3 (α-linolenic (0.5%), omega-6 (linoleic (72–85%) and omega-9 (oleic (10%) fatty acids [1, 47]. Grape seed oil can be one of the main sources of vitamin E. The total tocopherol content is 142.6 $mg \cdot kg^{-1}$, including the predominant quantities of α-tocopherol (139.2 $mg \cdot kg^{-1}$) and γ-tocopherol (3.2 $mg \cdot kg^{-1}$) [4, 41]. Cold pressed, light green grape oil is characterised by good sensory quality and, according to consumer research of Wroniak *et al.* [5], it is even the most desirable of the all tested oils. Due to its high content of omega-6 acids, it is an important component of a diet with health-promoting effects used in the prevention of cardiovascular diseases, but also for diabetes or obesity [34, 48]. Bazán-Salinas *et al.* [46] and Kołodziejczyk and Olas [41] show that the consumption of grape seed oil reduces platelet aggregation and is important in the prevention and treatment of atherosclerosis. The research results of Nayak *et al.* [47] indicate that grape seed oil accelerates the wound healing process, which is related to the antibacterial, anti-inflammatory and antioxidant activity of the biologically active compounds in grape seeds, including fatty acids and polyphenols. This oil can be used in the therapy of psoriasis, decubitus and skin chafes [48].

Grape seed oil (according to INCI: *Vitis Vinifera (Grape) Seed Oil*) is also used in cosmetology as a raw material with softening, soothing, antioxidant and normalising effects [48, 49]. As an oil containing high amounts of omega-6 acids, it is important in the care of dry skin, because it regenerates the lipid barrier of epidermis and prevents from excessive loss of water, but also for oily and seborrheic skin, because it has no comedogenic properties and normalises sebaceous glands [1, 48]. Due to the content of vitamin E and resveratrol, which have antioxidant and anti-ageing effects, grape oil is also recommended for mature skin [44, 48, 49].

CONCLUSIONS

The discussed oils from fruit seeds (raspberries, blackcurrants, rose hips and grapes) are valuable dietary and cosmetic raw materials. As a source of polyunsaturated fatty acids and bioactive compounds, they play an important role in the prevention of many diseases, including in the cardiovascular system, obesity and diabetes. Numerous scientific studies also confirm the beneficial effect of plant-origin oils on maintaining the proper structure and functioning of the skin and its appendages. For this reason, they are particularly important in cosmetology as skin care products, bases for cosmetics or potential ingredients for cosmetic preparations.

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

Conflict of interest: Authors declare no conflict of interest.

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