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Review

Nut Oils and their Dietetic and Cosmetic Significance: a Review

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Abstract:

Vegetable oils, which are a rich source of unsaturated fatty acids, phytosterols, vitamins and antioxidants, have a significant effect on the functioning and development of the body and contribute to health maintenance. They can be obtained from seeds, fruit stones, fruit, nuts or sprouts. This study discusses various species of plants that are sources of nut oils consumed in the daily diet and also used in the pharmaceutical and cosmetics industries.

1 INTRODUCTION

Tree nuts rank third, behind spices and fruits, in terms of content of bioactive constituents[1]. Tree nuts, dry fruits with a single seed in which the ovary wall hardens at maturity, are a rich source of phytochemicals with multi-faceted effects[2),3)]. Nuts have played an important role in the diet of many cultures, due to their wealth of nutrients, high energy value, and vast variety of flavours. Nuts are used as an ingredient in many dishes, such as snacks (roasted and salted almonds, hazelnuts and pistachios), sauces, cold soups, cakes, pastries and biscuits. They are also used as a component of dietary supplements. Nuts are considered a food with a high energy density (providing 23.4 to 26.8 kJ/g)[4),5)]. They contain fats (mainly unsaturated fatty acids), vegetable proteins, carbohydrates, and fibre, as well as a number of phytochemicals (Fig. 1).

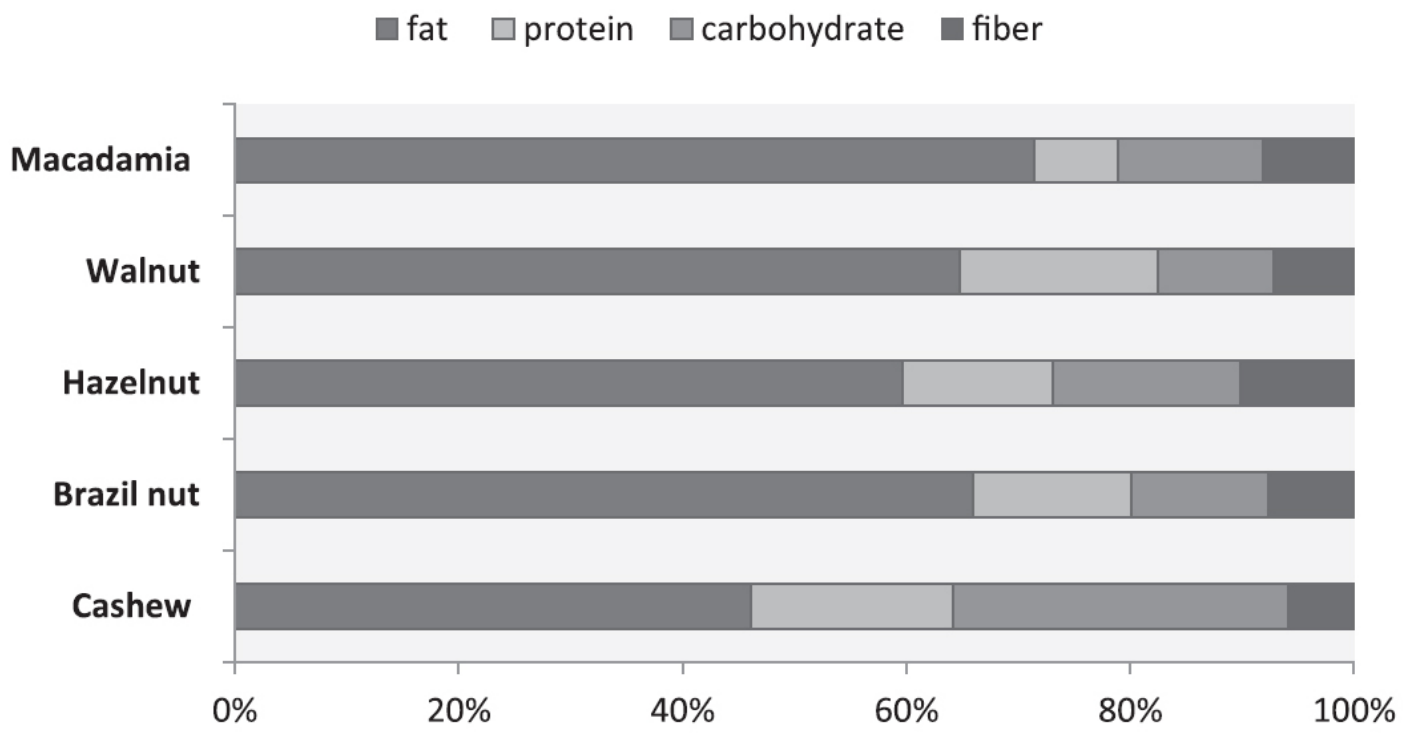

Fig. 1
Macronutrient contents of nuts[3),4),5)].

The type and content of phytonutrients in various nuts depends mainly on the species, as well as on agronomic, seasonal, and environmental conditions[7)]. Nuts contain nutrients with antioxidant properties, such as flavonoids (luteolin, quercetin, myricetin and kaempferol), phenolic acids, isoflavones (formononetin, daidzein and genistein), hydrolysable tannins, proanthocyanidins (condensed tannins), tocopherols, carotenoids and phytosterols. Nuts are also a valuable source of minerals (e.g. calcium, magnesium and potassium) and vitamins (vitamins E and B, folic acid and niacin)[2),4),6),8),9),10)] (Table 1).

Nut	Minerals (mg)[3]				Folate	PS	TPC	TFC	Tocopherol content (mg)[12]			Antioxidant activity
	Ca	Mg	Na	K	(μg)[3]	(mg)[3]	(mg GAE)[11]	(mg CA)[11]	α	β	γ	
Macadamia	85	130	5	368	11	116	497.8	137.9	0.54	0.00	0.00	13.4 μmolAAE/g[11] 4.1 μM[13]
Walnut	98	158	2	441	98	72	1580.5	744.8	0.70	0.15	20.83	458.1 μmolAAE/g[11] 83.46-93.08%[14]
Hazelnut	114	163	0	680	113	96	314.8	113.7	15.03	0.33	0.00	7.1 μmolAAE/g[11] 84.9-93.6%[15]
Brazil nut	160	376	3	659	22	47-148[16]	169.2	107.8	5.73	0.00	7.87	16.0 μmolAAE/g[11] 6.8 μM[13]
Cashew	37	292	12	660	25	158	316.4	63.7	0.90	0.03	5.31	29.5 μmolAAE/g[11] 2.2 μM[13]

PS-plant sterols; TPC-total phenolic content expressed as gallic acid equivalent (GAE), TFC-total flavonoid content expressed as catechin equivalent (CA), AAE- ascorbic acid equivalent. Source: [3, 11, 12]; [13]Inhibition of oxidation of LDL+VLDL-EC_{50}, DPPH inhibition percentage[14–16]

Table 1
Minerals, folate and phytochemical compounds with antioxidant effects in nuts (per 100 g).

The synergistic effect of many bioactive compounds contained in nuts determines their beneficial effects on human physiology[17]. As a natural source of antioxidants, nuts can potentially be used as ingredients in functional food[10]. Research indicates the multi-faceted health benefits of nuts, including inflammatory, prebiotic, anti-microbial, chemopreventive, and hypocholesterolaemic effects[2]. Research carried out by Estruch[18] has shown that including nuts in the diet may reduce the plasma level of pro-inflammatory cytokines (particularly IL-6, ICAM-1 and VCAM-1)[18]. Consumption of nuts as part of a balanced diet has been associated with a reduced risk of cardiovascular disease, as well as metabolic syndrome and diabetes[19),20),21]. In addition, nuts improve mental health, reduce stress and the risk of depression, and help to preserve cognitive functions[22),23),24]. Long-term consumption of nuts reduces total cholesterol and triglyceride levels and is associated with a reduced risk of weight gain and obesity[25),26]. Owing to their high content of protein and fibre, nuts provide a longer-lasting feeling of satiety. Although they contain high levels of fat, these are mainly poorly absorbed unsaturated fats, which induce energy expenditure by accelerating thermogenesis[8),26]. Moreover, oils derived from nuts, owing to their content of bioactive compounds, such as phenolics, tocopherols, sterols, or phospholipids, impart health benefits or desirable physiological effects[7]. For this reason, there has been an increase in interest in and nut oils and in their use in the food, pharmaceutical and cosmetics industries[2].

2 NUT OILS

Nut oils are obtained from various species of plants whose fruits are nuts. Sometimes, they are botanically drupes whose stones are called nuts. Nut 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[3),27] (Table 2).

Nut	Energy (kJ/100g)	Oil content (%)	Approximate fatty acid distributions (% of total fat) in nut oil										
			C14:0	C16:0	C16:1	C18:0	C18:1	C18:2	C18:3	C20:0	C20:1	C22:0	C22:1
Macadamia	3004	69-78	1.28	9.65	26.74	2.13	48.43	3.40	0.18	1.67	2.00	0.49	0.16
Walnut	2738	54-72	0.41	9.58	0.19	3.35	24.27	50.68	11.23	0.08	0.17	0.07	nd
Hazelnut	2629	60.4	0.13	5.82	0.29	2.74	79.30	10.39	0.46	0.16	nd	nd	nd
Brazil nut	2743	67.4	0.06	13.50	0.33	11.77	29.09	42.80	0.20	0.54	0.21	0.12	0.34
Cashew	2314	46.4	0.07	9.93	0.36	8.70	57.24	20.80	0.23	0.97	0.25	0.39	0.28

nd-not detected

Table 2

Total energy and oil content in nuts and fatty acid composition of nut oils - based on data from[3),11),28),29),30),31),32)]

Nut oils are characterized by low content of saturated fatty acids (SFAs) and high content of unsaturated fatty acids, among which monounsaturated fatty acids (MUFAs) predominate in most nuts (Fig. 2). Monounsaturated fatty acids of the omega-9 series (ω-9 or n-9), together with polyunsaturated fatty acids (PUFAs) of the omega-3 (ω-3 or n-3) and omega-6 (ω-6 or n-6) series, contribute about 91% of the energy from fat[28)].

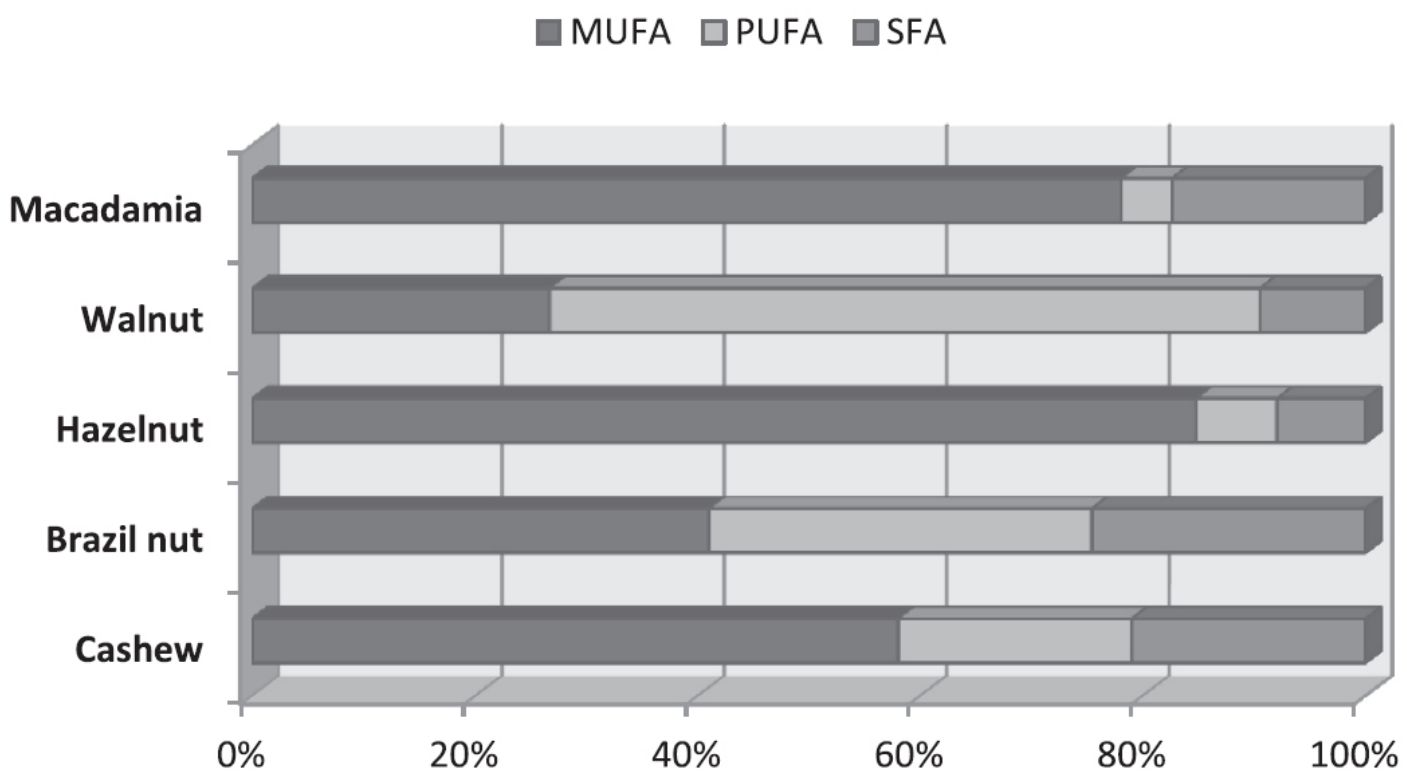

Fig. 2

Percentages of monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA) and saturated fatty acids (SFA) of nut oils[11),29),32),33)].

Polyunsaturated fatty acids are not synthesized in the human body, so they must be supplied in the diet. Rich sources include vegetable oils, nuts, seeds and products made from vegetable oils. PUFAs are significantly accumulated in specific tissues based on their selective need[27),34)]. Polyunsaturated fatty acids can undergo enzymatic transformation consisting in the introduction of successive double bonds (involving $\Delta 6$, $\Delta 5$ desaturases) and elongation of the carbon chain (mediated by elongase). Acids of the n-3 and n-6 series are metabolized in the human body by the same enzymes, indicating functional links between the metabolic pathways of both series. That is why the correct ratio of n-6 to n-3 acids in the human diet is so important[27),35)]. N-3 and n-6 fatty acids are precursors of eicosanoids (prostaglandins (PG), prostacyclins (PGI), thromboxanes (TXA), leukotrienes (LT) and lipoxins (LX) ? tissue hormones with a broad spectrum of activity (e.g. an anticoagulant effect, reduction in triacylglycerol concentration, and regulation of cardiovascular function, blood pressure or inflammatory processes)[34),36)] (Fig. 3). Essential unsaturated fatty acids have an important role in health prophylaxis, especially prevention of cardiovascular, allergic or inflammatory diseases[27),34),37)]. Proper intake of PUFAs, including ALA (18:3 n-3), a metabolic precursor of EPA and DHA, provides the functional effects and health benefits of EPA and DHA[38)]. Omega-3 acids, especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), exert cardioprotective effects and reduce platelet aggregation and vasoconstriction[19),36)]. Properties reducing the risk of cancer are ascribed to them as well[27)].

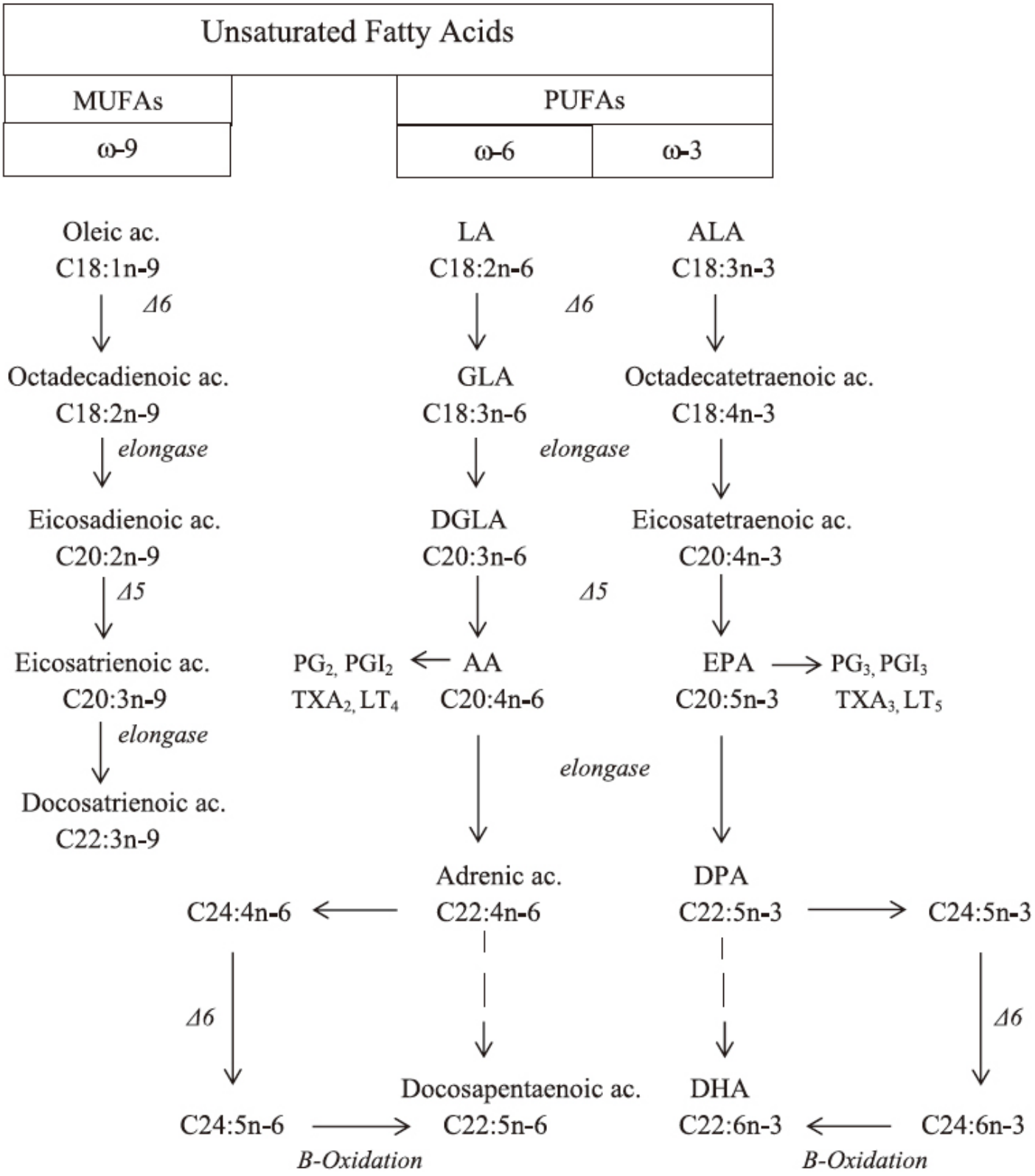

Fig. 3

Biosynthetic pathways of unsaturated fatty acids in human body[27),34),35),37)]. Abbreviations: MUFAs-monounsaturated fatty acids, PUFAs-polyunsaturated fatty acids, LA-linoleic acid, ALA-alphalinolenic acid, GLA-gammalinolenic acid, DGLA-dihomogammalinolenic acid, AA-arachidonic acid, EPA-eicosapentaenoic acid, DPA-docosapentaenoic acid, DHA-docosahexaenoic acid, Δ6-delta-6 desaturases, Δ5-delta-5 desaturases, PG-prostaglandins, PGI-prostacyclins, TXA-tromboxanes, LT-leukotrienes.

Nut oils together with the mono- and polyunsaturated fatty acids contained in them are not only an important component of the daily diet, but are also used in the care of the skin and its appendages (Fig. 4). Of particular cosmetic significance are omega-3 and omega-6 fatty acids, including alpha-linolenic acid (ALA, 18:3, n-3), linoleic acid (LA, 18:2, n-6) and gamma-linolenic acid (GLA, 18:3, n-6), classified as essential fatty acids (EFA). The cosmetic effect of vegetable oils primarily involves softening, hydration and regeneration of the epidermis. Owing to unsaturated fatty acids, which alongside ceramides and cholesterol are a component of intercellular cement, the skin acts as an effective barrier to transepidermal water loss (TEWL), which ensures an appropriate level of epidermal hydration and protection against external factors[39),40),41)].

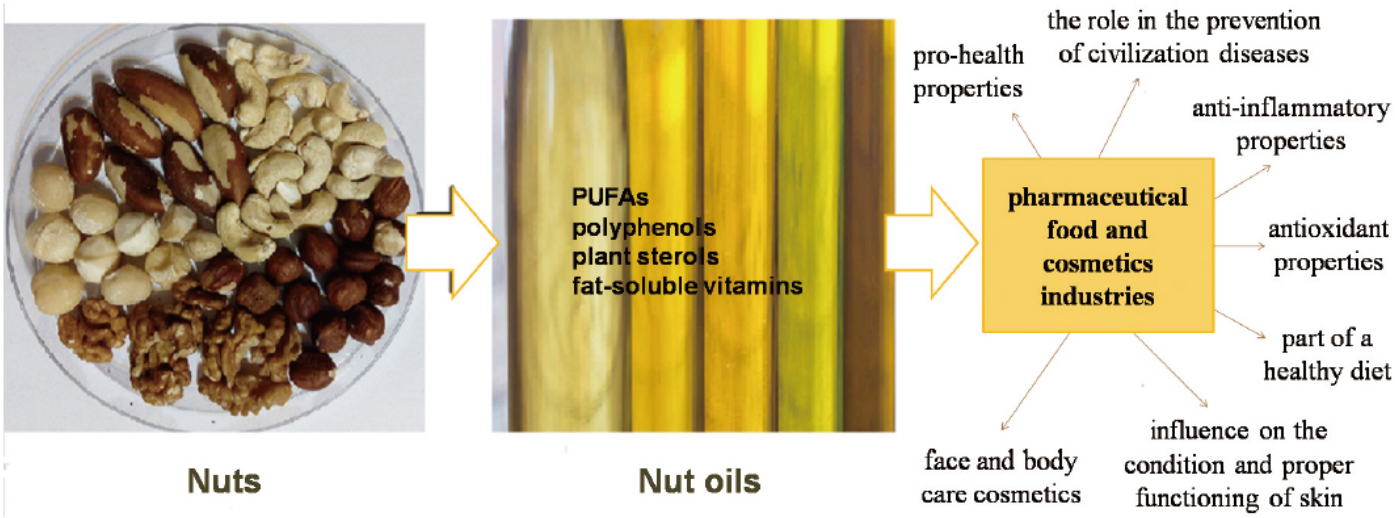

Fig. 4
Importance of nut oils for the health, food and cosmetics industry.

Common edible tree nuts include walnut, hazelnut, almond, Brazil nut, cashew, macadamia, pecan, pine nut and pistachio[2),4)]. The present study aims to draw attention to selected plant species that are sources of nut oils of importance in food, pharmaceuticals and cosmetics.

2.1 Macadamia nut oil

The macadamia (*Macadamia integrifolia* Maiden and Betche), of the Proteaceae family, is a tree found in Australia, South Africa, Brazil, Hawaii, Kenya and Costa Rica[42)]. Macadamia nuts are valued for their delicate taste, but also for their health benefits[29),43)]. They are a rich source of nutrients and bioactive compounds. Depending on the variety, seed maturity, location, and growth conditions, macadamia nuts vary in their content of lipids (33-65%), protein (8-20%), crude fibre (6-30%) and polyphenols (46-156 mg GAE/100 g)[2),44)]. Other bioactive components of the oil are tocopherols, including α-tocopherol (0.8-1.1 μg/g), δ-tocopherol (3.5-4.8

μg/g) and α-tocotrienol (17.2-48.4 μg/g) ; and sterols (1.117-1.549 μg/g), including sitosterol (901-1.354 μg/g), campesterol (61-112 μg/g), and δ-5-avenasterol (82-207 μg/g)[29]. The kernel, the edible part of macadamia, contains more than 60% oil[44]. The results of research carried out by Kaijser et al.[29] indicate varying oil content (69-78%) in different varieties of macadamia nut. Macadamia oil, in addition to saturated fatty acids (13.2-17.8%), contains polyunsaturated fatty acids (2.8-4.7%) and large amounts of monounsaturated fatty acids (80%), predominantly oleic and palmitoleic acid[29],[44]. The low content of polyunsaturated fatty acids makes the oil more stable and less susceptible to oxidation[29]. Due to the high content of monounsaturated fatty acids, consumption of macadamia nuts maintains health and reduces serum levels of low density lipoproteins (LDL) and cholesterol[43],[44]. These properties may be associated with high content of other bioactive compounds such as tocopherols, phytosterols and squalene[45]. Literature data confirm the benefits of including macadamia nuts in the diet to reduce the risk of coronary disease[46]. Macadamia oil is used in the food, pharmaceutical and cosmetics industries. It can be used to make gluten-free products, as ingredients for baked goods and beverages, or in the production of protein powder supplements. Macadamia oil capsules are used as a dietary supplement with nutritional and health-maintenance properties. In the production of cosmetics, oils with high content of essential fatty acids, which are the main component of the skin barrier, have the most important role. Macadamia oil quickly penetrates the skin, has a softening effect, and influences the condition and proper functioning of the skin. For this reason it is an important component of skin repair products, moisturizers, products preventing over-drying and irritation, and anti-ageing products. It can also be used in products intended for bleaching dark spots, regenerating the skin after excessive exposure to UV radiation, and reducing wrinkles. Macadamia oil is used in cosmetics for skin and hair care and other personal care products[44].

2.2 Walnut oil

The walnut (*Juglans regia* L.), of the *Juglandaceae* family, is the most common tree nut in the world. The walnut is a highly popular nut because of its good flavour. Due to its nutritional and therapeutic benefits, walnut has also been recognized as a functional food[47],[48]. Walnut seeds contain 54% to 72% oil (depending on the variety and cultivation conditions), 25% protein (including glutelin, prolamin, globulin and albumin) rich in essential amino acids, and 12-16% carbohydrates. In addition, it contains 1.5-2.0% cellulose; 1.7-2.0% minerals, e.g. sodium (0.30-0.41 mg/100 g), potassium (277-296 mg/100 g), calcium (68.15-75 mg/100 g), magnesium (71-94 mg/100 g), phosphorus (289-365 mg/100 g), iron (2.41?3.36 mg/100 g), zinc (1.92-3.02 mg/100 g), copper (0.65-1.11 mg/100 g) and manganese (2.21-2.43 mg/100 g) ; and polyphenols (1.558-1.625 mg GAE/100 g), including pedunculagin, ellagic acid, tellimagrandin I, casuarictin, tellimagranin II, casuarinin and gallic acid[2),30),49),50]. Walnut oil contains saturated fatty acids, i.e. palmitic acid C16:0 (3.9-11.4%) and stearic acid C18:0 (1.1-5.2%), and unsaturated fatty acids ? linoleic C18:2 (n-6, 46.9-68.6%), α-linolenic C18:3, n-3, 6.9-17.6%), and oleic 18:1 (n-9, 10.0-25.1%)[49]. The bioactive compounds in the oil include tocopherols (186.54 to 436.2 mg/kg), such as γ-tocopherol (81.58%), δ-tocopherol (6.19-15.79%), α-tocopherol (1.03-2.93%) and β-tocopherol (0.1-0.6%), carotenoids, mainly β-carotene (0.22-0.62 mg/kg), and phytosterols (144-1.679 mg/kg), including β-sitosterol (69.42-89.26%), campesterol (0.33-5.24%) and δ-5-avenasterol (0.1-7.34%). Due to its high nutritional value, walnut oil has not only dietetic importance but health-promoting value as well[51]. The mild-flavoured, yellowish oil of the walnut is recommended as an addition to foods prepared at low temperatures, such as

salads or cold desserts[30]. The polyphenols naturally occurring in walnut oil are responsible for the stability of the oil during storage. Moreover, polyphenolic compounds, including flavonoids, have a significant role in the treatment of a number of diseases due to their antioxidant and radical-scavenging abilities[48]. Consumption of walnuts and walnut oil, which is rich in natural antioxidants, may offer protection against certain cancers and also reduce the risk of cardiovascular disease and diabetes[11),30),52]. Research shows that walnuts improve the lipid profile and have a cardioprotective effect[8]. In addition to polyunsaturated fatty acids, walnuts contain a number of compounds with neuroprotective effects. Research on a rat model has shown that walnut consumption significantly contributes to maintenance of protein homeostasis in the brain, which was associated with improved cognitive and motor function[53]. Vadivel et al.[8] also emphasize the anti-inflammatory and antioxidant properties of walnuts. Walnut oil has been shown to be capable of scavenging DPPH radicals, which is linked to the presence of polyphenolic compounds and tocopherols[30]. Walnut oil can also be used in the cosmetics and pharmaceutical industries. The results of a study by Tsamouris et al.[54] indicate that walnut oil can be used for encapsulation and delivery of drugs and active ingredients in cosmetics. Other studies have shown that walnut oil can be a valuable base for pharmaceutical or cosmetic emulsions. As a component of an oil/water (O/W) emulsion, possibly through a humectant mechanism, it helps to improve skin hydration. For this reason, it can be a valuable component of natural skin care products, including those recommended especially for dry skin, as well as medicinal products, e.g. for the treatment of atopic dermatitis or psoriasis[55].

2.3 Hazelnut oil

The hazelnut (*Corylus avellana* L.) belongs to the Betulaceae family. Hazelnuts are often recommended as part of a healthy diet, but have also found application in cosmetics[56),57]. They are a valuable source of vitamins (including vitamin E, with 22.4 mg/100 g), minerals (magnesium, potassium, calcium, manganese, iron, zinc, phosphorus and copper) and polyphenols (291-835 mg GAE/100 g)[2),58]. They contain flavonoids (e.g. flavan-3-ols, catechin, epicatechin, myricetin-3-rhamnoside, and quercetin-3-rhamnoside)[59),60] ; phenolic acids (6.21-14.31 mg/100 g), including gallic, caffeic, ferulic, p-coumaric and sinapic acid; condensed tannin (941-3163 mg CE/100 g)[61),62] ; and stilbene (resveratrol)[9]. The seeds, containing from 54.6% to 63.2% oil, are an important source of saturated and unsaturated fatty acids, including oleic acid (39.5%), palmitoleic acid (37.0%), linoleic acid (6.9%), eicosaenoic acid (4.6%), docosenoic acid (3.4%), eicosanoic acid (2.3%), palmitic acid (2.3%), linolenic acid (1.1%), stearic acid (0.5%) and tetraeicosanoic acid (0.3%)[56),63]. Hazelnut oil has been found to contain 98.4% triacylglycerols and less than 0.2% phospholipids (phosphatidylcholine and phosphatidylinositol)[64]. It also contains tocopherols (462-508 mg/kg oil), predominantly α-tocopherol (382-472 mg/kg) and γ-tocopherol (61.2 mg/kg), and phytosterols (1.2-2.2 g/kg), including sitosterol (1416-1693 μg/g), campesterol (78-114 μg/g) and delta 5-avenasterol (110-170 μg/g)[63),65]. Hazelnuts are used in the food, pharmaceutical and cosmetics industries. The nuts and the oil obtained from them are often recommended as part of a healthy diet due to their strong antioxidant properties, which is linked to their high content of polyphenols and tocopherols[2),57]. Research results have shown that the inclusion of hazelnuts in the diet as a source of monounsaturated fatty acids is associated with favourable plasma lipid profiles and reduced risk of coronary heart disease (CHD)[66]. It has also been suggested that MUFA-rich nuts may moderately improve

oxidative status[12]. Hazelnut oil is used in cosmetic products as well, such as face and body cleansing and care cosmetics (day and night cream), bath oil, shampoo, personal care products, shaving products, and tanning products. It is used as a moisturizing, occlusive and regenerating agent for skin conditioning. Studies on hazelnuts as a cosmetic ingredient have dealt with concentration of use; methods of extraction/manufacture and quality control (chemical analyses) ; and contaminants and methods of their extraction (especially pesticides and heavy metals). The scientific literature on the safety of oils from various hazelnut species shows that the available data on the use of hazelnut oil as an ingredient in cosmetics are insufficient. Experts point out the need for research on questions such as dermal irritation and sensitization, UV absorption (if absorption is significant, then a photosensitization study is needed), 28-day dermal toxicity, reproductive and developmental toxicity, and genotoxicity[56].

2.4 Brazil nut oil

The Brazil nut tree (*Bertholletia excelsa* H.B.K.), of the Lecythidaceae family, grows throughout the Amazon Basin in South America. The Brazil nut, whose nutritional value is known all over the world, is one of the most important oleaginous seeds from the Amazon region[10),12]. The total content of oil in the seeds is 60.8 g/100 g[32]. On an industrial scale, oil is extracted by hot or cold pressing[68]. The pale yellow oil, with a characteristic pleasant aroma and flavour, contains 15% saturated fatty acids (SFAs), including large quantities of palmitic acid (13.50%) and stearic acid (11.77%), 5% MUFAs, including large quantities oleic acid (41.40%), and 21% PUFAs, predominantly linoleic acid (33.20%)[11),67),68]. The oil also contains tocopherols, including α-tocopherol (82.9 μg/g oil) and γ-tocopherol (116.29 μg/g oil), as well as phytosterols, including β-sitosterol (1325.4 μg/g oil), campesterol (26.9 μg/g oil), stigmasterol (577.5 μg/g oil) and brassicasterol (1.50 mg/100 g)[11),16]. Brazil nuts contain polyphenols (112-310 mg GAE/100 g), including flavonoids, as well as squalene[2),11]. They also contain magnesium (325 mg/100 g), calcium (180 mg/100 g), selenium (11.48 g/g), copper (1.4 mg/100 g), iron (2.98 mg/100 g), potassium (675.0 mg/100 g), zinc (3.51 mg/100 g), phosphorus (610.0 mg/100 g), niacin, and vitamins E, B_1 and B_6[11),69),70]. Due to their content of bioactive components, including those with antioxidant properties, Brazil nuts help to reduce the incidence of cardiovascular disease and eliminate risk factors such as oxidative stress, inflammation, high cholesterol or diabetes[6]. Their rich micronutrient composition can help to prevent heart disease and cancer[11]. Selenium, as an essential micronutrient which is present in large quantities in Brazil nuts and has good bioavailability, supports physiological processes such as immune system modulation and thyroid hormone regulation. As an antioxidant, it protects the body against the harmful effects of free radicals and also prevents the accumulation of heavy metals[6),69]. Due to their wealth of nutritional and functional compounds, Brazil nuts and the oil obtained from them can be used to produce pharmaceuticals, foods, and skin care products[70),71]. The dietary and health-promoting properties of Brazil nut oil are linked to the presence of unsaturated fatty acids from the ω-9 (oleic acid), ω-6 (linoleic acid) and ω-3 (linolenic acid) families[70]. Due to the high content of sitosterol in the oil, it can be used as a component of an anti-cholesterol diet. Owing to its favourable proportions of unsaturated fatty acids and the presence of sterols, tocopherols and tocotrienols, Brazil nut oil can be used in the health food industry and in some areas of medical science[70),71]. It is also a natural material valued by the pharmaceutical and cosmetics industries[68].

2.5 Cashew nut oil

Cashew (*Anacardium occidentale* L.) belongs to the family Anacardiaceae. It is generally grown in coastal regions, especially Brazil, and has spread to some tropical regions. *A. occidentale* was used for centuries for medicinal purposes, to treat headache and topical diseases such as dermatitis, and for its antidiarrheal properties. Today, cashew nuts, with their desirable flavour and significant content of proteins (20%), carbohydrates (23%), and fats (45%), are an important component of the human diet all over the world[72),73)]. Cashew nut consumption has been shown to have cardioprotective, anti-obesity, anticancer and antioxidant effects[11),72)]. Cashew nuts not only reduce the risk of cardiovascular disease, particularly stroke, but also lower the risk of metabolic syndrome[74)]. Attention has also been drawn to the nutritional and health benefits of cashew nut oil. As a chemically stable oil rich in phytonutrients, cashew nut oil can be consumed directly (served fresh, e.g. in salads) or for frying[75)]. Its high content of alkyl-phenols and naphthoquinones, which have antibacterial and antioxidant properties, helps to preserve the oil against oxidation[72)]. Cashew nut oil is recommended as part of a healthy diet due to its antioxidant properties, which are linked to its content of polyphenols (346.52 mg/kg oil), including quercetin (3.18 mg/100 g), kaempferol (4.24 mg/100 g), isorhamnetin (2.62 mg/100 g), naringenin (1.64 mg/100 g), resveratrol (1.41 mg/100 g), gentisic acid (104.04 mg/kg), benzoic acid (31.77 mg/kg), abscisic acid (22.71 mg/kg), ferulic acid (21.91 mg/kg), p-hydroxybenzoic acid (21.94 mg/kg) and naphthylacetic acid (10.38 mg/kg), as well as tocopherols (171.48 mg/100 g oil), including β-tocopherol (9.4 mg/100g), γ-tocopherol (30.03 mg/100g), α-tocopherol (8.5 mg/100g) and δ-tocopherol (0.63 mg/100 g)[33),72),73)]. The anacardic acids present in cashew nuts have been shown to exhibit greater antioxidant activity than well-known antioxidants such as 1-(+)-acetoxy pinoresinol, hydroxytyrosol, tyrosol, salicylic acid and caffeic acid[76)]. Scientific research demonstrates that tocopherols, as natural antioxidants present in vegetable fats, display stronger properties in combination with other antioxidants[77)]. Tocopherols are known to have numerous beneficial properties. They exhibit anti-inflammatory and antiproliferative properties, and also play a protective role against lipid peroxidation of membrane lipids and lipoproteins[2),78)]. The monounsaturated (oleic) and polyunsaturated (linoleic, linolenic) fatty acids in cashew nut oil reduce the level of low-density lipoprotein cholesterol and the risk of coronary heart disease[73)]. Phytosterols are used in the food industry (as anti-cholesterol additives in functional foods), pharmaceutical industry (in production of therapeutic steroids) and cosmetics industry (in creams and lipsticks)[79)]. The presence of potentially bioactive compounds in cashew nuts may be interesting for many branches of industry, where they can be used as a natural source of antioxidants[80)].

5 CONCLUSION

Nuts are complex plant foods, which, apart from vegetable protein, fibre, micronutrients, plant sterols and antioxidants, are a rich source of oil. Due to their favourable fatty acid profile, nut oils are an important element of the diet, contributing to health maintenance and playing an important role in the prevention of many diseases.

Numerous scientific studies have also confirmed the beneficial effect of vegetable oils in maintaining proper skin structure and function. For this reason, they are increasingly used as cosmetics or potential ingredients in cosmetic products.

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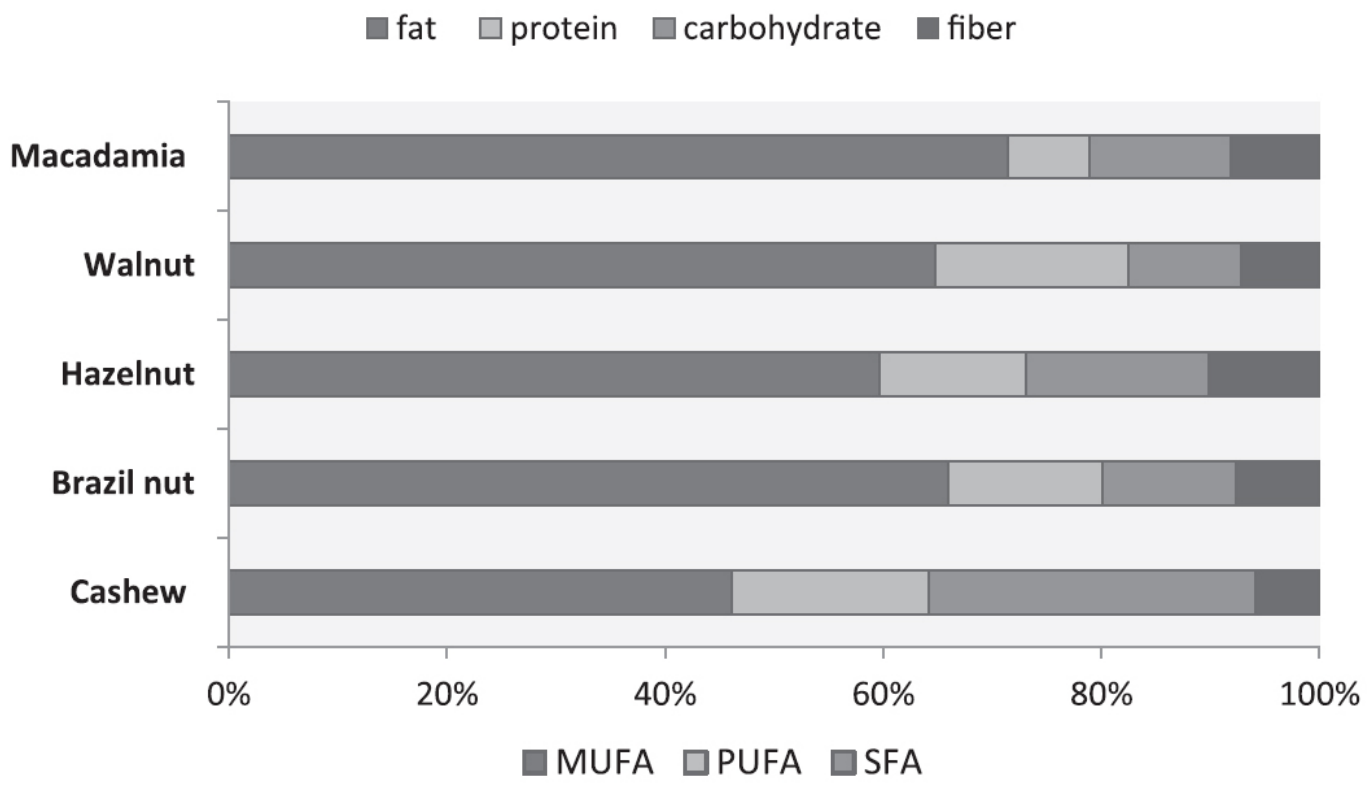
Figures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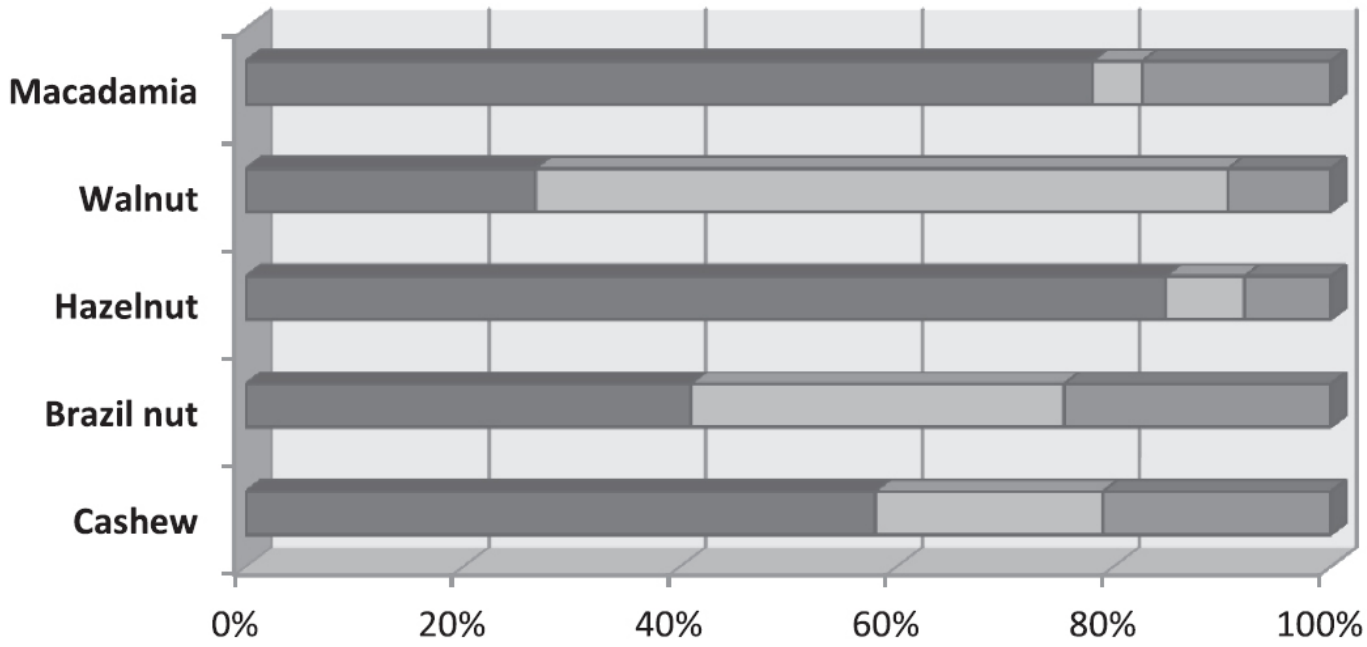
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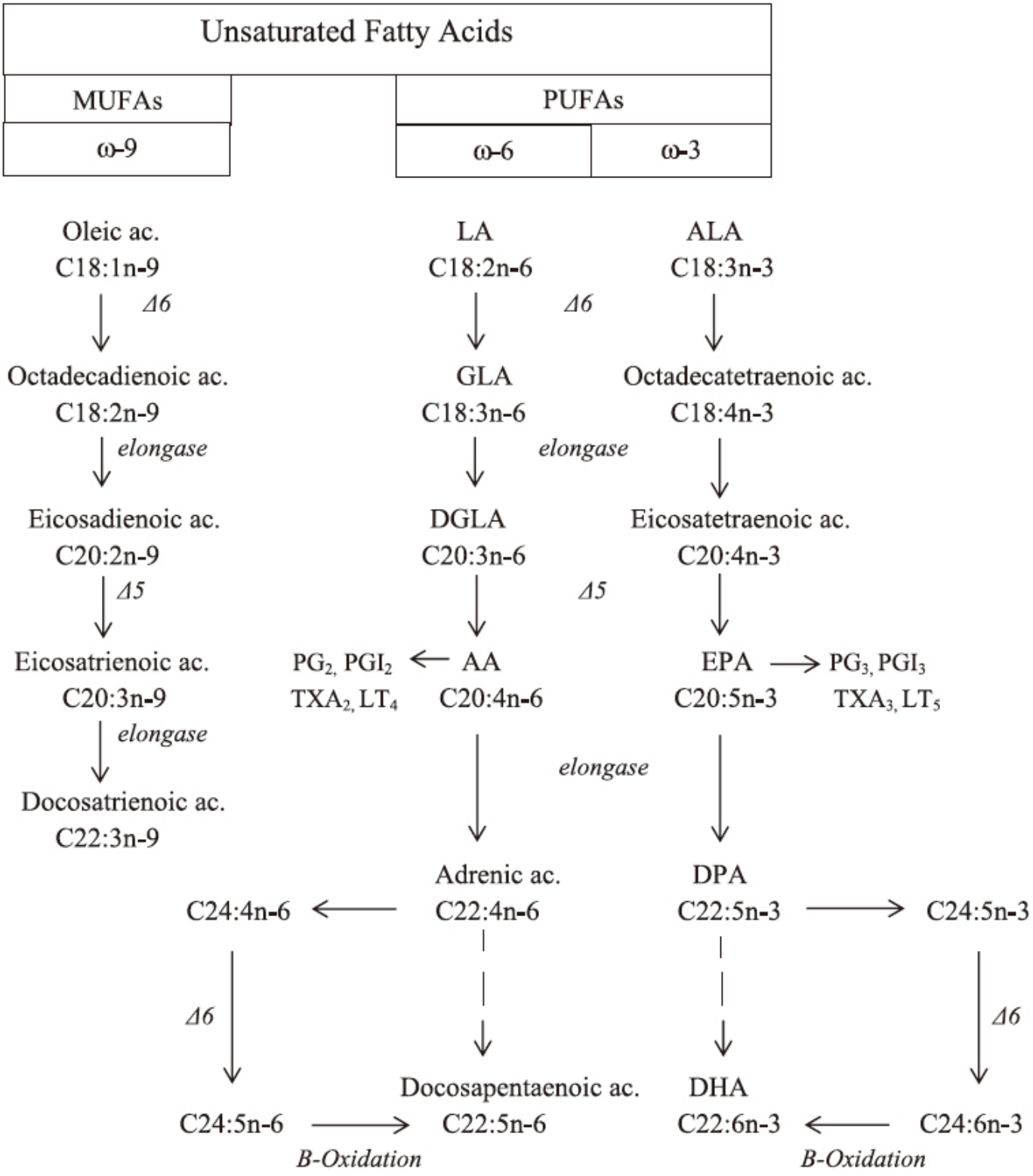
Unsaturated Fatty Acids
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PUFAs
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ω-6
ω-3
Oleic ac.
C18:1n-9
Δ6
Octadecadienoic ac.
C18:2n-9
elongase
Eicosadienoic ac.
C20:2n-9
Δ5
Eicosatrienoic ac.
C20:3n-9
elongase
Docosatrienoic ac.
C22:3n-9
LA
C18:2n-6
Δ6
GLA
C18:3n-6
elongase
DGLA
C20:3n-6
Δ5
PG2, PGI2
TXA2, LT4
AA
C20:4n-6
Adrenic ac.
C22:4n-6
ALA
C18:3n-3
Octadecatetraenoic ac.
C18:4n-3
Eicosatetraenoic ac.
C20:4n-3
EPA
C20:5n-3
PG3, PGI3
TXA3, LT5
elongase
DPA
C22:5n-3
C24:4n-6
C24:5n-3
Δ6
Δ6
Docosapentaenoic ac.
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DHA
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C24:5n-6
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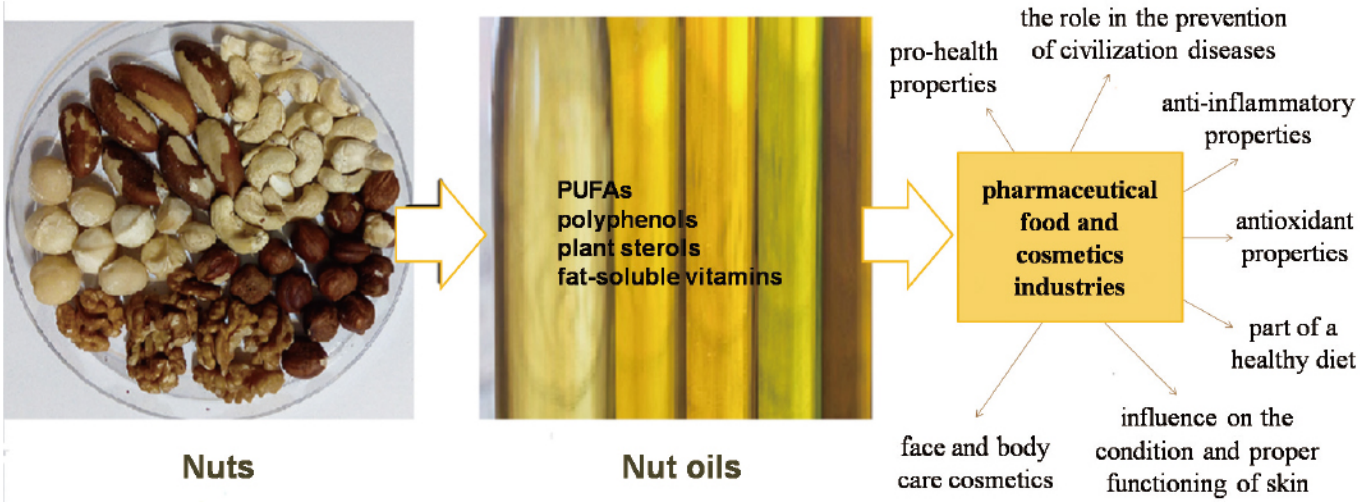
B-Oxidation



Nut	Minerals (mg)[3]				Folate	PS	TPC	TFC	Tocopherol content (mg)[12]			Antioxidant activity
	Ca	Mg	Na	K	(μg)[3]	(mg)[3]	(mg GAE)[11]	(mg CA)[11]	α	β	γ	
Macadamia	85	130	5	368	11	116	497.8	137.9	0.54	0.00	0.00	13.4 μmolAAE/g[11] 4.1 μM[13]
Walnut	98	158	2	441	98	72	1580.5	744.8	0.70	0.15	20.83	458.1 μmolAAE/g[11] 83.46-93.08%[14]
Hazelnut	114	163	0	680	113	96	314.8	113.7	15.03	0.33	0.00	7.1 μmolAAE/g[11] 84.9-93.6%[15]
Brazil nut	160	376	3	659	22	47-148[16]	169.2	107.8	5.73	0.00	7.87	16.0 μmolAAE/g[11] 6.8 μM[13]
Cashew	37	292	12	660	25	158	316.4	63.7	0.90	0.03	5.31	29.5 μmolAAE/g[11] 2.2 μM[13]

PS-plant sterols; TPC-total phenolic content expressed as gallic acid equivalent (GAE), TFC-total flavonoid content expressed as catechin equivalent (CA), AAE- ascorbic acid equivalent. Source: [3, 11, 12]; [13]Inhibition of oxidation of LDL+VLDL-EC_{50}, DPPH inhibition percentage[14–16]

Nut	Energy (kJ/100g)	Oil content (%)	Approximate fatty acid distributions (% of total fat) in nut oil										
			C14:0	C16:0	C16:1	C18:0	C18:1	C18:2	C18:3	C20:0	C20:1	C22:0	C22:1
Macadamia	3004	69-78	1.28	9.65	26.74	2.13	48.43	3.40	0.18	1.67	2.00	0.49	0.16
Walnut	2738	54-72	0.41	9.58	0.19	3.35	24.27	50.68	11.23	0.08	0.17	0.07	nd
Hazelnut	2629	60.4	0.13	5.82	0.29	2.74	79.30	10.39	0.46	0.16	nd	nd	nd
Brazil nut	2743	67.4	0.06	13.50	0.33	11.77	29.09	42.80	0.20	0.54	0.21	0.12	0.34
Cashew	2314	46.4	0.07	9.93	0.36	8.70	57.24	20.80	0.23	0.97	0.25	0.39	0.28

nd-not detected

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