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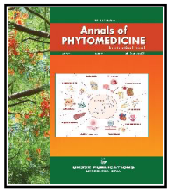

Review Article : Open Access

A comprehensive review on nutritional and antioxidant properties of Sesame (*Sesamum indicum* L.) seed oil with its therapeutic utilization as phytomedicine

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Abstract

Sesame (*Sesamum indicum* L.) is considered the queen of oilseed crops, which is one of the oldest oil crops used for human consumption. The crop is widely grown in the tropical regions of Asia and Africa. The demand for sesame seed oil has increased in the recent past due to high quality oil, antioxidant properties and phytochemical composition. The oil content of sesame seed is about 50-60%, which serves as reservoir of polyunsaturated fatty acids (PUFA). The health promoting properties in sesame oil are attributed to its content of lignans, tocopherols and tocotrienols. Sesame is known for the biological source of sesame furofuran lignans (sesamin, sesamol, sesamolin and sesaminol), which determines the oxidative stability and antioxidative activity. The balanced ratio of oleic and linoleic acids in sesame oil makes its more suitable for human health. In sesame oil, the polyunsaturated fatty acids (omega-3 and omega-6) constitute about 80 per cent and the remaining 20% is monosaturated fatty acids (palmitic and stearic acids). The omega 3 and omega 6 polyunsaturated fattyacids play a pivotal role in the immune system and pro inflammatory process by acting as a precursor of eicosanoids. Sesame seed oil lowers the blood sugar, blood pressure, LDL cholesterol, and triglycerides and increases HDL cholesterol and provides various health advantages such as neuroprotective, ahypocholesterolemia and antihypertensive activities. It also reduces the risk of cardiovascular disease, fatty liver diseases, atherosclerosis and obesity. In this review, nutritional and antioxidant properties of sesame seed oil and therapeutic value have been reviewed and presented here.

1. Introduction

Globally, Sesame (*Sesamum indicum* L.) is grown in an area of 11.7 m ha with a production of 7.70 m t and productivity of 512 kg/ha. About 97 per cent of the total world production is from Asian and African countries (Myint *et al*., 2020). In India, the production of sesame is 0.79 mt was obtained in an area of 1.7 m ha with a productivity of 431 kg/ha (Ezhilarasi *et al*., 2021). Though, the sesame seed production is highest in the world the per unit productivity is highest in China (1223 kg/ha) as compared to rest of the rest of the countries (Yadav *et al*., 2022). The total global vegetable oil production is 214 m t, out of which the contribution of sesame oil is less than 3 per cent (Yadav *et al*., 2022). Sesame is a versatile oilseed crop with the highest edible oil content of 52-55% among the oilseeds (Abdiani *et al*., 2024) with a protein content of 25% (Bunphan *et al*., 2021). Sesame is widely consumed either in the form of seeds, oil and flour and oil has been used in the diets from past 6000 years. Sesame is also consumed as alcoholic beverages, confectioneries, biscuits, seasons, nuts and pharmaceutical industries (Tarasiuk *et al*., 2023). Sesame oil is a staple oil for its pleasant flavour, aroma, taste and health benefits, which is deep to pale yellow in colour. The reason for the mellow aroma was reported to be C_5-C_9 straight-chain aldehydes or ketone derivatives (Twinkle and Kanav, 2017).

The healthiest oil contains the highest level of polyunsaturated fatty acids such as 46.26% of linoleic acid, 38.84% of oleic acid and 0.9% of arachidonic acid (Woo *et al*., 2019). The ALA (alpha-linolenic acid) is major source of antioxidant, which has anti-inflammatory properties (Singh *et al*., 2022). Adding antioxidant rich foods in dietary reduces the risk of many diseases (Aswany *et al*., 2023). The well-balanced content of polyunsaturated fatty acids (omega-3 and omega-6) and monosaturated fatty acids (omega-9 fatty acids) in sesame oil eventually reduces the risk of cardiovascular diseases (Wei *et al*., 2022). Use of sesame seed oil ameliorates the HFD-induced renal damage by its anti-inflammatory properties and reducing the oxidative stress (Woo *et al*., 2019). Sesame oil contains lignans (sesamin, sesamol, sesaminol and sesamolin), which have been reported to possess antioxidant, antiaging, anti-inflammatory, and anticancer properties (Hsu and Parthasarathy, 2017).

Although, the unsaturated fatty acid content of sesame seed oil was about 85 per cent, it is known to be highly resistant to oxidative rancidity and can be stored for a long time (De Vittori Gouveia *et al*., 2017). This specific thermal stability is not only attributed to the presence of tocopherols, but is also associated with lignans (Hashempour-Baltork *et al*., 2018; Thakur *et al*., 2018). The total sterol and tocopherol contents are higher with brown coloured seeds. While the lignan (sesamin and sesamolin) content was higher with the white seeded sesame (Muthulakshmi *et al*., 2017). Sesame seed oil by virtue of its higher vitamin E content (alpha-tocopherol) has a stronger antioxidant capacity and highly oxidatively stable properties

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(Mili *et al*., 2021). The oxidation of LDL (low-density lipoprotein) complex with cholesterol is prevented by sesame seed oil due to its antilipolytic effect, which simultaneously increases the HDL (high-density lipoprotein) as the reduction of LDL is associated with phytoestrogens (Oboulbiga *et al*., 2023).

Hot water floating method is the traditional method of oil extraction. Mechanical cold press (temperature less than 45°C) is the finest mode of oil extraction with high quality and more efficient. Heating at a temperature of 75°C with moisture of 6.3-6.5% resulting in high quality oil. Hot water floating method, poly press, Ram press, Ghani press, Soxhlet, fraction and enzymatic are the methods of oils extraction. The most extracted oil was related to poly press method with 70% efficiency (Kaviani *et al*., 2015).

Oils of plant origin applied topically can penetrate through lipid layers of the skin and enhances the skin health (Saxena *et al*., 2022). Refined sesame seed oil of pharmaceutical grade is used for oral and injectable medication which does not contain any protein, whereas unrefined oil is used in cuisines contains protein (Kelso and Gold, 2024). In some cases, consumption of unrefined sesame oil may result in in anaphylactic shock due to the presence of residual protein in susceptible cases (Hernandez *et al*., 2024). Sesame oil is a potential source of inhibiting proinflammatory mediators that attenuate lead- and iron-induced hepatic toxicity (Hasanein *et al*., 2019). Since sesame oil is an alternative fat source that pave the way for diversification of combined oils, sesame oil can be combined with frying oil and margarine (Ayouaz *et al*., 2022). This review summarises the research work related to the phytochemical properties, nutritional value, antioxidant properties and health benefits of sesame seed oil.

2. Oil quality and Sesame seed colour

Sesame which belongs to the Pedaliaceae family, is one of the ancient oilseed crops widely grown and domesticated over 5000 years (Zech-Matterne *et al*., 2015). The genus *Sesamum* comprises about 40 species, out of which 18 exclusively occur in Africa and five exclusively found in the India-Sri Lanka region for a total number of eight species. The colour of the cultivated sesame is classified into black sesame, yellow sesame and white sesame (Dar *et al*., 2019) and given in Figure 1. Sesame is postulated to have evolved from symmetric to asymmetric types in the sequence of black, brown, yellow and white colour seeded types (Wei *et al*., 2022). The seed colour of sesame varied from creamy white to charcoal black and white and black are the normal seed coat colours (Zhou *et al*., 2016). The preference of the consumer towards sesame oil is greatly influenced by the seed colour (Wang *et al*., 2020). Apart from culinary uses, white and black seeded sesame oil is treated as a medicinal food to treat chronic diseases of humans (Ölmez *et al*., 2022). However, the general belief is that black seeded sesame is more beneficial than white seeded sesame (Wang *et al*., 2018) and included in Traditional Chinese medicine as liver and kidney curing medicine. Black seeded sesame yields well whereas the oil content and quality are better with white seeded sesame (Wei *et al*., 2022). Mili *et al*., (2021) also reported that the oil content in black seeded sesame with thicker shells is lesser than light coloured sesame seeds (brown and white).

Figure 1: Pictures of Sesame plant, seed and oil.

The biochemical and antioxidant properties of sesame seed are related to seed colour (Dossou *et al*., 2023). Similarly, sesame seed content of oil, protein and lignans has a strong relationship with seed colour (Wang *et al*., 2020). Oil metabolism is also related to seed colour in sesame (Cui *et al*., 2021). Oil and protein contents were reported to be higher in dark coloured seeded sesame as compared to white seeded sesame. The total phenolic compounds are generally higher with black seeded sesame than the white seeded sesame, where the antioxidant activities are highly linked with the total phenolic and flavonoids content (Zhou *et al*., 2016). The sesamolin proportion to sesamin was more in black seeded sesame, while the sesamin proportion was more in the white seeded sesame (Andargie *et al*., 2021).

3. Physiochemical content of Sesame oil

The sesame seed oil colour may be yellow or black, which varies with the sesame varieties. Further, the colour of the oil is also related to the roasting of the seeds (Arab *et al*., 2022). The oil colour is yellow in the case of unroasted seeds, whereas the colour is brown and dark brown if the seeds are roasted (Arab *et al*., 2022). The saponification, acid, iodine, free fatty acid and peroxide values of sesame oil were reported as 176.15 ± 0.21 mg KOH/g, 2.5 ± 0.16 mg KOH/g, 98.6 ± 0.16 g I_2/100 g, 1.74 ± 0.15% weight by weight (w/w) and 9.4 ± 0 meq H_2O_2/g, respectively (Hassan and Wawata, 2018). The mean peroxide value, acid value, refractive index and conjugated diene value of sesame oil are 1.95 ± 1.24 meq/kg, 1.12 ± 0.58 mg KOH/g, 1.4,705 ± 0.0001 and 10.02 ± 1.43 ìmol/g respectively (Ramezani *et al*., 2022). Unsaponifiable index of H1.93% in sesame oil is attributed to the long shell-life during storage (Okandza *et al*., 2017). The low peroxide index and high iodine index observed in sesame oil indicate its nature of unsaturated fatty acids (Okandza *et al*., 2017). Zebib *et al*. (2015) observed that the values of phytic acid ranged from 307.61 to 324.91 mg/100 g, while total phenolic content and ferric iron reducing power ranged from 23.16 to 25.69 mg GAE/g and 32.33 to 34.53 µmol/g, respectively.

3.1 Nutritional profile of Sesame oil

Sesame is an important oil seed crop with a high protein content of 30-60% (Idowu *et al*., 2021) and the protein is rich in sulphur containing amino acids such as cysteine and methionine with a content of 6.1% (Abbas *et al*., 2022). Due to the presence of tocopherols and lignans in sesame seed oil, it is resistant to the oxidative rancidity and can be kept stable for a longer period (Chau *et al*., 2021). The major phenolic compounds of sesamolin and sesamin are found only in sesame seed oil (Liu *et al*., 2020). Certain amino acids like tryptophan and methionine are found only in sesame seed oil (Sharma *et al*., 2021). The ratio of polyunsaturated and monosaturated fatty acids was 0.79, which shows that sesame seed has balanced fatty acid content (Guimarães *et al*., 2018). The lipid level in sesame oil ranged from 35 to 62% (Arab *et al*., 2022). The higher content of lipids in sesame seed oil is linked with performing the physiological roles such as serving as a source of energy, constituents of cell membranes, chemical oxygen mediators and vital functions like blood coagulation, anti-inflammatory, antiageing and renal function. It also acts as a carrier of vitamins A, D, E and K, which are fat soluble (Oboulbiga *et al*., 2023). Sesame seed oil also contains about 40 mg/ 100 g of vitamin E, 43% of polyunsaturated fatty acids and 40% of monounsaturated fatty acids (Khalesi *et al*., 2016).

Sesame contains myristic acid (328-1728 ppm), which has anticancer properties (Wei *et al*., 2022). Sesame oil contains the essential fatty acids linoleic and oleic acids which cannot be synthesised by the human body system. The fat-soluble vitamin E is also found abundantly in sesame oil, in which gammatocopherol was the major constituent (Gharby *et al*., 2017). Though, the mean content of unsaturated fatty acids of linoleic and oleic acids (74.59%) is lesser than olive oil (80%), due to the presence of flavour substances and cost effectiveness, sesame oil is mostly used in the traditional dietary (Ma *et al*., 2019).

3.2 Phytochemical composition of Sesame oil

Sesame, the major oilseed crop is though well known for its nutritive value, it also contains phytochemical compounds such as lignans, phenols, polyphenols, aldehydes, phytosterols, naphthoquinones, anthraquinones and triterpenoids ((Mostashari and Mousavi Khaneghah, 2024). The higher level of sesamol and sesamolin in sesame seed oil, which are considered to be natural antioxidants, increases the anti-inflammatory, anticoagulant, antidepressant and antihypertensive activities (Langyan *et al*., 2022). The content of phytochemical compounds varied with the sesame varieties, soil, weather, environment, irrigation and nutrient management, time of harvest and oil extraction method (Xu *et al*., 2021). In addition, the oil extraction methods and hulling also play a major role in determining the lignan content. The lignan content was higher with the hot-pressed sesame oil than the refined and cold pressed oil (Khuimphukhieo *et al*., 2018).

3.3 Antioxidant properties of Sesame oil

Sesame oil possess antioxidant and anti-inflammatory properties, which effectively reduces the chances of cardiovascular diseases and atherosclerosis (Hsu and Parthasarathy, 2017). Sesame seed oil by virtue of its higher vitamin E content (alpha-tocopherol) has a stronger antioxidant capacity and highly oxidatively stable properties (Mili *et al*., 2021). The antioxidant activities of sesame oil are highly corelated with the total phenolic and flavonoids content (Zhou *et al*., 2016). The content of DPPH and ABTS radical scavenging potential and inhibition of degradation of β-carotene, the indicator of antioxidant potential was significantly higher than that of the reference antioxidant and α-tocopherol. Sesame oil contains higher total phenolic content of 26.00 ± 0.14 mg GAE/g of methanolic sesame oil which is higher than commonly available vegetable oil. Similarly, the antioxidant indicators namely DPPH and ABTS radical scavenging activity of sesame oil were 0.026 mg/ml and 58.0% at 2.0% (w/v), which was significantly higher than that of the reference antioxidant and α-tocopherol (Trad *et al*., 2023).

3.4 Fatty acids

The naturally occurring polyunsaturated fatty acids are classified into omega 3 (α-linolenic acid (ALA), eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA), omega-6 (arachidonic acid and linoleic acid), omega-7 (palmitoleic acid and vaccenic acid) and omega-9 (oleic acid and erucic acid) (Anna Stefanska, 2015). The fatty acid composition in sesame oil is abundantly made of polyunsaturated fatty acids (80%) and the remaining saturated fatty acids (Ozdemir *et al*., 2018). The saturated fatty acids in sesame oil are about 20 per cent of which 7.9-12% are palmitic acid and 4.8-6.1% are stearic acid (Wacal *et al*., 2019). The fatty oil profile indicates that the presence of linoleic and oleic acids ranges each up to 35 to 50% with a lesser percentage of 7-12 and 3.5-6% of palmitic and stearic acids respectively (Thakur *et al*., 2018). The functional compound tocopherols present in the sesame oil is attributed to the oxidative stability, in which γ-tocopherol is the major tocopherol (96% of the total γ-tocopherol), followed by δ-tocopherol and traces of β-tocopherol (Yuenyong *et al*., 2024). Out of the total sterols found in sesame oil, phytosterols contribute around 1.9 per cent. The β-sitosterol and campesterol are present abundantly in sesame oil, which constitutes around 80 per cent of total sterols (Pathak *et al*., 2019).

The thermal stability in sesame oil is ascribed to the presence of lignans and tocopherols (Andargie *et al*., 2021). Linoleic acid is the major polyunsaturated fatty acid (39.3-59%) and oleic acid is the monounsaturated fatty acid (32.7- 53.9%) found in sesame soil (Muthulakshmi *et al*., 2017). The major unsaturated fatty acid content in sesame oil is in the ratio of 18:1 and 18:2, respectively, for oleic and linoleic acids (Morris *et al*., 2021). The polyunsaturated fatty acids (omega-3 and omega-6) and monounsaturated fatty acid (omega-9) are present in a balanced proportion in sesame oil (Tahakur *et al*., 2018). Oleic, linoleic, stearic, palmitic, linolenic, arachidic, linolenic, lignoceric, behenic, caproic, margaric and myristic acids are the twelve unsaturated fatty acids found in sesame oil (Wei *et al*., 2022). The arachidonic acid (omega 6 series) and dihomo-gamma linolenic acid (omega 3 series) and eicosapentaenoic acid are the lipid mediators present in sesame seed oil (Oboulbiga *et al*., 2023).

3.5 Lignans

Lignans are secondary metabolites found in sesame which are chemically classified as dimers of phenyl propane (Dossou *et al*., 2023). Sesame seed oil is preferred and valued for its sensory and antioxidant properties. The antioxidant lignan content in sesame oil delays or prevents rancidity in sesame oil due to its strong radical-scavenging characteristics (Andargie *et al*., 2021). The sesame lignans have health beneficial effects such as blood lipids regulation, anticancer, antiaging, antidiabetic and anti-inflammatory

characteristics (Wei *et al*., 2022). Among the sixteen different types of lignans that have been isolated from sesame, most of the lignans were fat soluble aglycons and found in the sesame oil on extraction of oil from the seed. In the oil cake, glycosylated form of lignans has been reported (Andargie *et al*., 2021). The oil-soluble and water-soluble glycosylated lignans are the two types of lignans isolated from sesame seeds (Dar *et al*., 2019).

Sesamin and sesamolin are reported to be the major forms of fat soluble aglycons and the minor aglycons of sesame oil are sesamolinol, sesamol, pinoresinol, sesaminol, lariciresinol matairesinol and episesamin (Wan *et al*., 2023). The chemical structures of sesame lignans are given in the Figure 2 (Wei *et al*., 2022). Mono-di- and triglucosides of sesaminol, sesamolinol and pinoresinol are the major forms of lignan glycosides found in sesame oil (Andargie *et al*., 2021). Sesame oil contains lignan glycosides abundantly in the form of sesaminol monoglucoside, sesaminol diglucoside and sesaminol triglucoside (Ono *et al*., 2019). Sesaminol inhibits membrane lipid peroxidation and the rate of peroxisomal fatty acid oxidation is upregulated by sesamolin (Wu *et al*., 2019).

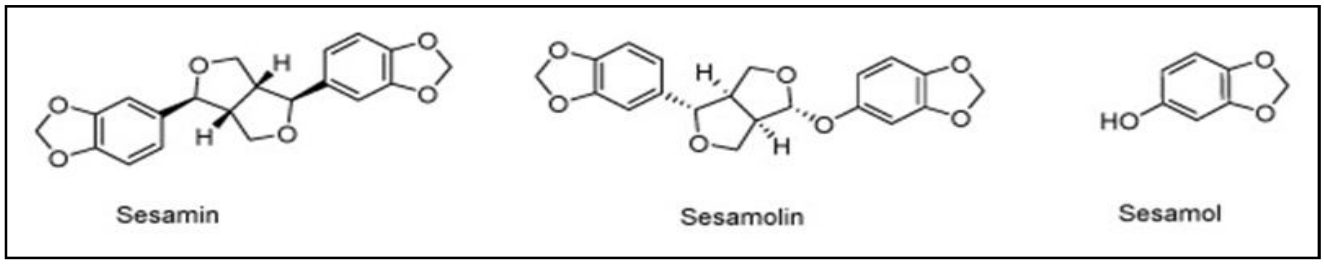

Figure 2: Chemical structures of Sesame lignans.

Sesamin and sesamolin are the major lignans of sesame and the content of sesamin and sesamolin exceeds 1.4% (Andargie *et al*., 2021). Sesamin is synthesised through the sequential formation of two methylenedioxy bridges from pinoresinol and sesamolin and sesaminol is obtained by the oxidative conversion of a portion of sesamin (Murata *et al*., 2017). The phenylpropanoid-derived plant specialized metabolites such as sesamin and sesamolin, are hydrophobic lignans abundantly found in sesame oil and sesaminol is majorly accumulated as a water-soluble sesaminol triglucoside (Ono *et al*., 2019). Sesamolin is the precursor of sesamol, plays a major role of antioxidant activity in sesame oil (Wan *et al*., 2015). Sesamolin, a sesaminol triglucoside which accumulates in the form of water-soluble glucosides inhibits β-amyloid oligomerisation and the formation of fibrils (Katayama *et al*., 2016) and is associated with Alzheimer's disease by inhibiting pathogenic β-amyloid accumulation (Ono *et al*., 2019).

3.6 Tocopherols

Tocopherol or alpha-tocopherol, the sub group collectively known as vitamin E is also a nutrient well-known for its health benefits, which improve the immune system in the body and guards PUFA against deterioration due to oxidation (Lee and Han, 2018). The colour of the pure tocopherols and tocotrienols is yellow viscous, which is easily oxidisable, photoliable and water insoluble (Singanusong and Garba, 2019). A set of molecules of 2-methyl-6-chromanol ring and phytyl chain (fully saturated) is referred as Tocopherols (Fritsche *et al*., 2017**)**. Besides the lignan content in sesame seed and oil, vitamin E, especially in the form of especially γ-tocopherol is present in sesame seed and oil. The tocopherol homologues, vitamin E occurred in four different forms of tocopherols and tocotrienols such as alpha, beta, gamma and delta (Vergallo, 2020). In sesame seed oil, gamma tocopherol is the abundant form of tocopherol (Wan *et al*., 2015).

The presence of endogenous antioxidants namely lignans and tocopherols abundantly in sesame oil enhanced the oxidative stability and thereby increased the keeping quality and shelf life (Matthäus and Özcan, 2018). Sesame seed oil is known for its resistance to rancidity, which is attributed to the content of tocopherols (33 mg/100 g to 101 mg/100 g) that inhibits oxidation (Oboulbiga *et al*., 2023). The tocopherols content is comparatively lesser in black seeded sesame than white or brown seeded sesame seeds (Wei *et al*., 2022). The total content of tocopherol in sesame oil varies between 530 and 1000 mg/kg, of which 521 mg - 990 mg/kg was γ tocopherol, the major tocopherol in sesame oil, 4-20 mg/kg of δ tocopherols and up to 3 mg/kg of α tocopherol (Mostashari and Mousavi Khaneghah, 2024). The major antioxidative composition in freshly extracted sesame oil is γ tocopherol. In sesame, the only tocopherol isomer identified in sesame was γ-tocopherol (Arab *et al*., 2022). Among the different forms of tocopherols, γ-tocopherol is abundantly found in sesame (23.18 to 25.93 mg/100 g) and 56.9-99.3 µg/g (Morris *et al*., 2021). The γ-tocopherol content in sesame oil is reported to be 490-680 mg/kg (Pathak *et al*., 2019). The total tocopherols in sesame seed and oil ranged from 50.9-211 ìg/g seed and 304-647 µg/g oil, respectively (Onsaard *et al*., 2018**).**

3.7 Phytosterols

The plant-derived sterols, also known as phytosterols, have similar structure and physiological functions to cholesterol and play vital roles similar to cholesterol in various physiological processes (Yang *et al*., 2019). Phytosterols belong to a group of steroid alcohols and esters that prevent the intestine form absorbing cholesterol (Abilasha *et al*., 2016). Phytosterols are one of the phytochemical compounds that possess the antioxidant and anticancerous properties and the LDL cholesterols can be lowered by consuming 1-2 g/day of sterols in yoghurt for the treatment of initial stages of hypercholesterolemia (Abilasha *et al*., 2016). Though there are about 200 different types of phytosterol in plants, the predominant phytosterol is β-sistosterol, stigmasterol and campesterol, which is abundantly present in sesame oil (Yang *et al*., 2019).

In sesame oil, the content of phytosterol is comparatively higher than other vegetable oils in which 58-62% was constituted by β-sitosterol, followed by 10-20% of campesterol and 3-6% of stigmasterol and the phytosterol content of the sesame oil ranges between 4500 and 18960 mg/kg of oil (Yang *et al*., 2019). Sesame oil contains phytosterols in the range of 740.2-896.4 mg/100 g (Arab *et al*., 2022). The largest proportion of fractions of unsaponifable matter

is phytosterols, which play a vital role in fluidity and permeability of membranes (Oboulbiga *et al*., 2023). The phytosterol content in sesame oil was reported to be 637.60 mg/100 g of sesame oil. Campesterol and β-sitosterol constitute 80 per cent of the total sterols in sesame oil. The phytosterol content in brown seeded sesame was comparatively higher than white seeded sesame (Miedes *et al*., 2024). The content of campesterol, another major phytosterol in sesame oil is around 17.8% of total sterols. Whereas the amount of delta 5-avenasterol and stigmasterol present in sesame oil was respectively about 10.2% and 6.4% (Deme *et al*., 2021).

4. Ethnobotanical properties

In Asian countries, sesame oil has been considered a very popular healthy food for several thousand years and its potential use as food in health benefits has been well documented (Langyan *et al*., 2022). Chinese used the sesame oil during the 4th Century as a traditional medicine for curing the oral and dental diseases, especially periodontal disorders such as toothaches and gum related problems (Naseem *et al*., 2017). In Taiwan, sesame oil is used as a traditional medicinal food, where chicken cooked with sesame oil is given to women in the first month of delivery (Wu *et al*., 2007). In India, sesame oil has been used in traditional medicine since Vedic times and sesame oil is known to cure Tridoshas, which improve the flow of energy and remove impurities (Amandeep *et al*., 2019). Sesame oil is considered an Indian and Chinese traditional medicine for increasing energy and preventing the ageing as well (Mahendra Kumar and Singh, 2015). Sesame oil was used to prepare medicines and perfumes in the empire of Babylon and it was used as medicine in ancient Egypt during 1500 BCE (Mili *et al*., 2021). In Uttranchal, sesame oil is used as ear drops to cure secretion and earache and commonly used by Gujarat tribals as hair oil to prevent hair fall and improve hair growth (Mili *et al*., 2021). Sesame oil is used as a substitute for olive oil by virtue of its nutraceutical benefits (Neeta *et al*., 2015). Sesame oil finds an important role in traditional Ayurvedic, Chinese and Tibetan medicinal practices. A sizeable global population still uses traditional medicines to cure many diseases (Sai *et al*., 2024).

5. Medicinal properties

The sesamin (0.5-1.1%) and sesamolin (0.2–0.6%) content in sesame oil is attributed to the possession of medicinal properties through the antioxidants and anti-inflammatory characteristics (Mahendra Kumar and Singh, 2015). The medicinal properties are summarised in Figure 3 (Oboulbiga *et al*., 2023).

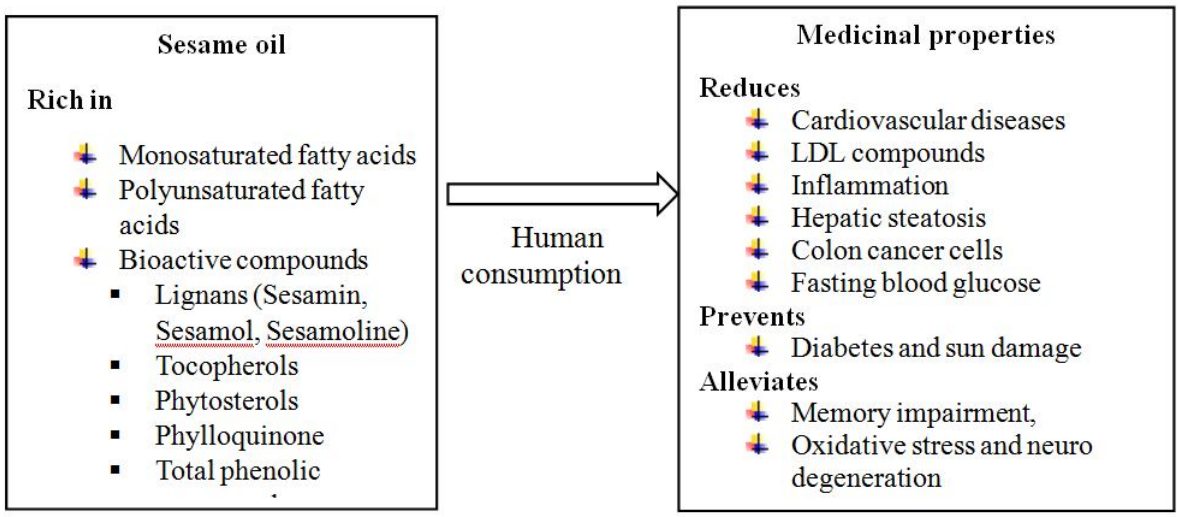

Figure 3: Summary of medicinal properties of Sesame oil.

Sesame oil reduces the lipid peroxidation due its antioxidant properties by protecting oral tissues from radical injury (Hadipour *et al*., 2023). Oil pulling with sesame oil has antibacterial activities against *Streptococcus mutans.* and *Lactobacilli* (Naseem *et al*., 2017). Hyperglycemia could be cured by regular consumption of sesame oil due to the presence of sesamin (Sharma *et al*., 2020). Including sesame oil in dietary sesame reduces the cerebrovascular ischaemia (Abbas *et al*., 2022). Sesame oil contains triglycerides largely in the form of linoleate, which selectively inhibits the growth of malignant melanoma (Amandeep *et al*., 2019). Sesame oil has antifungal and antibacterial properties which cure skin diseases caused by bacteria such as *Staphylococcus* and *Streptococcus*, strep throat and athlete's foot caused by fungi (Li *et al*., 2024). Rheumatoid arthritis affects many joints (Attri *et al*., 2023) and sesame oil could be used as a pain reliever against bursitis, tendonitis, colitis, arthritis, gastro-esophageal reflux disease and irritable bowel syndrome and reduces the degree of acidic mucin, fibrosis and inflammation (Zhou *et al*., 2023). Sesame oil, which contains more omega-3 fatty acids, the polyunsaturated fats is cardioprotective, reduces risk of diabetes and regulates blood pressure (Mostashari and Mousavi Khaneghah, 2024). Consumption of white seed sesame oil significantly controls hyperglycemia (Wei *et al*., 2022) and thereby regulates the functions of kidney and heart. Sesame oil improves the lipid profile by increasing the HDL cholesterol significantly (Aslam *et al*., 2017). Sesamin, which is present in sesame oil regulate the lipid metabolisms and reduces LDL cholesterol (Liang *et al*., 2015).

Sesame oil is reported to treat nasal mucosa dryness due to the dry winter climate (Younis *et al*., 2023). Sesame oil inhibits proinflammatory mediators and reduces the iron induced hepatic damage by inhibiting nitric oxide (Hasanein *et al*., 2019). Sesame oil inhibits free radical generation, proinflammatory mediators, lipid

peroxidation and oxidative stress (Hadipour *et al*., 2023). Sesamin, a lignan present in sesame oil reduces the lipid peroxidation and elevates the antioxidant enzymes of the liver and thereby protecting the liver from oxidative injury (Lv *et al*., 2015). Sesame seed oil is a natural protectant of UV rays, show upto 30 per cent resistance to UV rays and hence can be used to protect skin from sunburn (Chauhan *et al*., 2021). Sesame seed oil heals the sunburn injury and minor burns. It also acts as a natural protector against UV rays (Wei *et al*., 2022). Sesame oil enters into the skin easily and reaches the blood stream through capillaries and can also be utilised as a diluent for IM injections. It also serves as an oleaginous vehicle for drugs and intramuscular injection solvents (Oboulbiga *et al*., 2023). The anti-inflammatory potential of sesame oil on heavy metal poisoning and endotoxemia (Hsu and Parthasarathy, 2017) is documented. The pulmonary oedema bronchial neutrophilic inflammation is attenuated by sesame oil (Li *et al*., 2016).

Rinsing of mouth with sesame oil resulted in reduction of bacteria that causes gingivitis up to 85% ((Naseem *et al*., 2017). Gargling sesame oil arrests the growth of streptococcus and cold causing common bacteria (Harsh Priyank *et al*., 2017). Sesame oil is known for its hair care as it effectively controls dry scalp dandruff and also it reaches up to the follicle of hair on application and promotes hair growth (Mysore and Arghya, 2022). Sesame oil prevents premature hair growth and keeps the hair very dark (Twinkle and Kanav, 2017). Sesame oil is used as a hair growth promoter and to treat dental, bone and chronic inflammatory diseases (Neeta *et al*., 2015). Sesame oil penetrates into the bone marrow through immediate absorption and penetration through the tissues (Akinrinde *et al*., 2023). The sesamin content in sesame oil has antibacterial activities, especially against *Escherichia coli*, *Staphylococcus aureus*, *Staphylococcus aureus* and *Shigella flexneri*. Due to the presence of sesamin in sesame oil, it has a bactericidal effect (Li *et al*., 2024). Sesame oil heals cuts, abrasions and mild scrapes (Shamloo *et al*., 2015). Sesame oil is used as an ingredient in cosmetics, which has the power to destroy bacterial activities and remove the impurities (Wei *et al*., 2022). sesame oil is used as a base for cosmetics such as moisturisers, lipsticks and eye shadow creams (Haixia and Lu, 2015).

By virtue of higher oil content, the intestinal tract is lubricated by sesame oil besides the nourishment of internal organs (Adebisi *et al*., 2017). Sesame oil effectively soothes the phlebitis induced by chemotherapy (Shamloo *et al*., 2015) and also reduces acute traumatic limb pain (Nasiri and Farsi, 2017). Applying sesame oil in the abdominal region can cure premenstrual syndrome (Shamloo *et al*., 2015). Sesame oil and sesamin have a protective effect on hearing loss and also increase the hair cell damage activity (Wanachewin *et al*., 2017). The systolic and diastolic blood pressure is significantly lowered by sesame oil (Aslam *et al*., 2019). The presence of lecithin in sesame oil plays a major role in improving blood vessel elasticity and is considered to be a hindrance for buildup of cholesterol in the arteries and thereby prevents cardiovascular diseases (Aslam *et al*., 2021). Sesame oil also contains small amounts of copper, calcium, magnesium, zinc, iron and vitamin B6, where cardio vascular and pulmonary health is supported by magnesium, copper plays a major role in providing relief to rheumatoid arthritis. Calcium in sesame oil prevents osteoporosis, migraine and colon cancer (Twinkle and Kanav, 2017).

6. Conclusion

The review addresses mainly the therapeutic values of sesame oil besides its nutritional properties. Sesame oil is well known for its antioxidant and anti-inflammatory properties as it contains 80 per cent polyunsaturated fatty acids. This literature review indicates the oxidative stability and antioxidant activity of sesame oil due to the presence of lignans, tocopherols and tocotrienols. The oleic acid and the linoleic acid content in a balanced ratio is the major reason for the preference of sesame oil in huma health. Sesame seed oil lowers the cholesterol, risk of atherosclerosis, fatty liver and cardio vascular diseases, blood sugar level. Though many of the medicinal values are based on the indigenous traditional knowledge, future research should explore the science behind each pharmacological effects of sesame oil.

Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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