

REVIEW ARTICLE

The Nutritive and Medicinal Properties of Tahini: A Review

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ABSTRACT

Tahini is an oily paste made from mechanically hulled and ground sesame seeds. Tahini is considered a condiment in many regions of the world primarily in the Middle Eastern countries from the Levant region including Syria, Lebanon, Palestine, and Jordan. Sesame seeds contain about 25-35% protein, as well as at least 55% oil, predominantly unsaturated fat from oleic acid (35.9-47%), linoleic acid (35.6-47.6), palmitic acid (8.7-13.8%), stearic acid (2.1-6.4%), and arachidic acid (0.1-0.7%). Tahini is widely known as one of the natural health promoting foods that has the potential to prevent various health problems such as hypertension, hypercholesterolemia, cancer and aging. Additionally, it may be useful in managing oxidative stress-associated diseases, such as atherosclerosis, diabetes mellitus, obesity, chronic renal failure, rheumatoid arthritis, and neurodegenerative diseases including Alzheimer's disease. Moreover, sesame oil has multiple physiological functions, such as decreasing blood lipids, increasing antioxidative ability and γ -tocopherol bioavailability, and providing anti-inflammatory function and a potential estrogenic activity. Many health promoting effects are attributed to its lignans that are consisted of sesamin and sesamol. In *sesame oils*, the ranges of *sesamin* and *sesamol* are 0.93-2.89 and 0.30-0.74 mg/g oil, respectively, with tocopherol contents of 304-647 μ g/g oil. Lignans may increase antioxidant potential of diets and provide stability. Hence, this review will highlight and discuss the potential nutritional and health promoting effects of Tahini.

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Introduction

Tahini or Tahina is a thick beige colored oily paste made from mechanically hulled, toasted and ground sesame seeds (*Sesamum indicum L.*) (1). Its name derived from the Arabic language of ṭahīna, from ṭahīn, flour, from ṭahana, to grind. Sometimes it is referred as sesame paste, Tahini butter, Tahini dressing depending on the type of sesame seeds used. It can also be prepared with untoasted seeds and called "raw tahini". Tahini is considered a condiment in many regions of the

world mainly in the Middle Eastern region from the Levant countries including Syria, Lebanon, Palestine, and Jordan. Tahini also features in South-East Asian, Central Asian, and African cooking. It has boosted its popularity across the globe. In the past 3 decades, it became very popular ingredient, especially in vegetarian recipes as it adds rich flavor, when used (2).

Tahini has gotten its beneficial properties from sesame seeds, which are not only being used for culinary purposes, but also in traditional medicines

for their nutritive, preventive and curative properties. They are high in energy due to high fat content and contain many health benefiting nutrients, minerals, antioxidants and vitamins that are essential for wellness that have positive effects on human health (3). There is not enough data to trace the origin and the period when Tahini was introduced in the region. But it has been suggested that Tahini was made for the first time, when sesame seeds were planted in the ancient Middle East. The original area of first plantation of sesame is obscure, but it seems likely to have first been brought into cultivation in Asia or India. Archeological records indicate that it has been known and used as a crop in Babylon and Assyria some 4,000 years ago. It was probably exported to Mesopotamia around 2500 BCE and was known in Akkadian and Sumerian. Prior to 600 BC, the Assyrians used sesame oil as a food, lotion, and medication, primarily by the rich, as the difficulty of obtaining it made it expensive. Hindus used it in votive lamps and considered the oil sacred (4).

Nowadays, Tahini is considered as a major ingredient in very famous Middle Eastern dishes such as hummus and baba ghanoush and many other hors d'oeuvre dishes. The purpose of this review was to explore the possible health and medicinal properties of Tahini despite the scarcity of such published studies. To our knowledge, this article will shed some light on this magical condiment (Figure 1).

Benefits of Tahini

The nutritional and medicinal importance of Tahini comes from its content of lignans. Sesame seed contains very high levels (up to 2.5%) of furofuran lignans with beneficial physiological activities, mainly sesamin, sesamol, and sesaminol glucosides. Lignans play an important role in intermodulation of fatty acid metabolism, inhibition of cholesterol absorption and biosynthesis, antioxidant and vitamin E-sparing effects, hypotensive and



Figure 1: Tahini or sesame paste.

antiaging effects, and improvement of liver functions. Lignans may also increase antioxidant potential of diets and provide stability. *In vitro* and *in vivo* studies revealed vitamin E sparing effects (5). The major components of lignans were shown in Figure 2.

Sesame seeds contain about 25-35% protein, as well as 55% fatty acids, mainly unsaturated fats. The sesame oil also contains oleic acid (35.9-47%), linoleic acid (35.6-47.6), palmitic acid (8.7-13.8%), stearic acid (2.1-6.4%), and arachidonic acid (0.1-0.7%) (6). Chemical analysis values of Tahini differ from one sesame cultivar to another, and processing of the seeds may play a role in getting different values. The sesame seeds contain approximately a quarter of soluble fibers out of the total fiber present in sesame. The main part of soluble fiber is mucilaginous gum and its composition ranges from 8 to 11g per 100 g. As an average, Tahini has the following nutrients values which are demonstrated in Table 1.

Lipids in Tahini are the major part of the paste and regarding the sesame seeds, their percentage may range from 55% to 85%. Unfortunately, Tahini is poor in omega 3 fatty acids or ALA, but the good news is that Tahini does not have cholesterol. Tahini seems to contain large amounts of fat mainly the MUFA and PUFA fats, known to be beneficial to

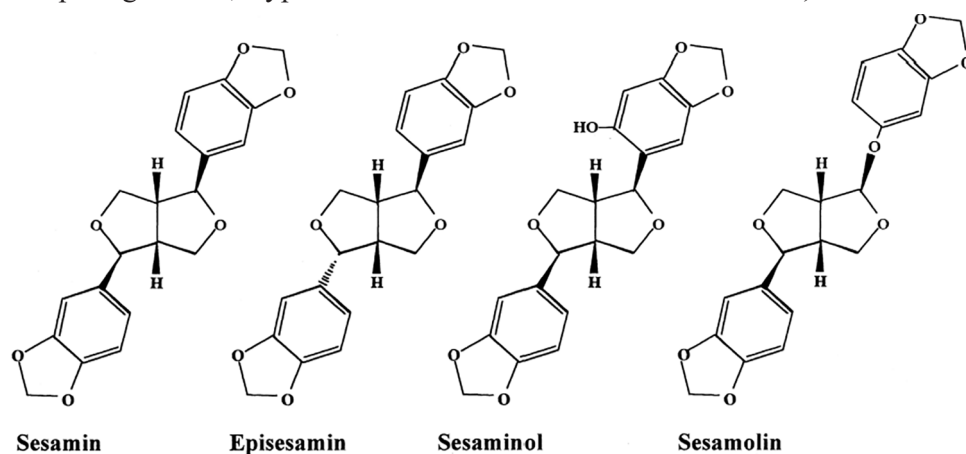


Figure 2: Lignan's functional components in Tahini.

Table 1: Proximate analysis of Tahini (100 g).

Nutrient	Amount	Unit
Water	3.05	g
Energy	595	Kcal
Protein	17	g
Total lipids (fats)	53.76	g
Carbohydrates, by difference	21.19	g
Total dietary fibers	9.3	g
Total sugars including NLEA	0.49	g

Food Composition Databases Seeds, sesame butter, tahini, type of kernels unspecified". United States Department of Agriculture 2019.

Table 2: Lipids content and types in Tahini (100 g).

Types of fatty acids	Fatty Acids	Percentage
Unsaturated fatty acids	Oleic acid	35.9-47
	Linoleic acid	35.6-47.6
Saturated fatty acids	Palmitic acid	8.7- 13.8
	Stearic acid	2.1-6.4
	Arachidonic acid	0.1-0.7

Food Composition Databases Seeds, sesame butter, tahini, type of kernels unspecified". United States Department of Agriculture 2019.

the heart and overall health (7). Although linolenic acid is one of the most important unsaturated fatty acids, the linolenic acid content was very low in all sesame accessions varying from 0.28 to 0.40%. Sesame has more unsaturated fatty acids than many other vegetable oils, and its higher proportion of unsaturated to saturated fatty acids makes it a potentially important dietary source of essential fatty acids (8). Linoleic acid is required for cell membranes, for transportation of cholesterol in the bloodstream, and for blood clotting. Lipids in Tahini were shown in Table 2.

With regard to minerals content, the major mineral in Tahini is calcium followed by potassium, magnesium and phosphorus. All other elements are present in comparatively low concentrations (6). All minerals that present in Tahini are very important for growth and development and in maintaining good health (3). They play different roles such as in synthesis of amino acids and proteins, photosynthesis, carbohydrate metabolism, nucleic acids, teeth development, and regulating the acid-alkaline balance in the body (3, 6). The presence of these minerals also confirms the fact that Tahini is of high nutritional benefits. The minerals present in Tahini are listed in Table 3.

Tahini is also considered a good source of many vitamins such as B-complex vitamins, mainly niacin (B3), folic acid, thiamin (vitamin B1), pyridoxine (vitamin B6) and riboflavin (B2). Unfortunately, Tahini does not contain all necessary vitamins and therefore, it is poor in vitamin C, B12, retinol, vitamin D2, D3 and vitamin K as shown in Table 4.

Antioxidants in Tahini

The phenolic compounds in Tahini appear to be responsible for the antioxidant activity. Phenolic components serve as important antioxidants and they tend to prevent the oxidation of different biological molecules (9). The highly antioxidant activity of sesame oil in Tahini was clarified and found to involve lignans with tocopherols, and these activities can have many positive health benefits such as lowering fatty acid concentration in liver and serum due to acceleration of fatty acid oxidation and suppression of fatty acid synthesis, and the controlling influence on the ratio of n-6/n-3 polyunsaturated fatty acids under excess intake of either n-6 or n-3 fatty acids in the diet. Sesame lignans lower the cholesterol concentration in serum, especially in combination with tocopherol, due to the inhibition of absorption from the intestine and suppression of synthesis in the liver (10). Sesame lignans also showed other useful functions such as acceleration of alcohol decomposition in the liver, antihypertensive activity, immunoregulatory activities, and anticarcinogenic activity. Also, sesame oil in Tahini was an effective and potent anti-inflammatory and antioxidant compound and may serve as a valuable nonpharmacological agent in atherosclerosis and other inflammatory diseases. It was shown that activities of enzymes involved in hepatic fatty acid oxidation and synthesis among rats fed sesame (*Sesamum indicum L.*) differ in lignan content (sesamin and sesamol). Sesame can increase both the hepatic mitochondrial and the peroxisomal fatty acid oxidation rate (11).

Table 3: Mineral contents of Tahini (100 g).

Mineral	Amount	Unit	DV%
Calcium (Ca)	141	mg	14
Iron (Fe)	4.42	mg	34
Magnesium (Mg)	95	mg	27
Phosphorus (P)	790	mg	113
Potassium (K)	459	mg	10
Sodium (Na)	35	mg	2
Zinc (Zn)	4.62	mg	49
Copper (Cu)	1.61	mg	170
Selenium (Se)	34.4	µg	35

Food Composition Databases Seeds, sesame butter, tahini, type of kernels unspecified". United States Department of Agriculture 2019.

Table 4: Vitamins content of Tahini (100 g).

Vitamin	Amount	Unit	DV%
B1 (Thiamin)	1.590	mg	138
B2 (Riboflavin)	0.120	mg	10
B3 (Niacin)	5.640	mg	38
B6 (pyridoxine)	0.150	mg	12
Folate, Total	98	µg	25
Vitamin A	67	µg	-
Choline	25.8	µg	-
Alpha tocopherol, Vitamin E	0.25	mg	1.6

Food Composition Databases Seeds, sesame butter, tahini, type of kernels unspecified". United States Department of Agriculture 2019.

Anti-inflammatory Properties in Tahini

Sesame oil has anti-inflammatory, anti-atherosclerotic and lipid lowering properties *in vivo*. An aqueous extract of sesame oil has also anti-inflammatory and anti-atherosclerotic properties. The methoxyphenol derivatives showed potent anti-inflammatory properties. The anti-inflammatory molecules associated with sesame oil may contribute the anti-inflammatory and anti-atherosclerotic properties (12). Sesame oil was shown to be effective in inhibiting atherosclerosis in low-density lipoprotein-receptor negative mice. Aqueous extract of sesame oil significantly can reduce inflammatory markers in both macrophages and endothelial cells in a concentration-dependent manner. Aqueous extract of sesame oil has suppressed transcription and translocation of NF-kappaB. Aqueous extract of sesame oil was also demonstrated to be effective in inhibiting oxidation of lipoproteins *in vitro*. Furthermore, aqueous extract of sesame oil differentially regulated expression of scavenger receptors and increased ATP-binding cassette A1 (ABCA1) mRNA expression by activating liver X receptors (LXRs), that suggest additional effects on lipid metabolism (13).

Antiaging properties of Tahini

Sesaminol has been identified as a new

antioxidative principle in sesame oil which is also present in Tahini. Sesame lignans has a synergistic effect on vitamin E activities, when added to tocopherols. The presence of sesaminol markedly enhances vitamin E activity of γ -tocopherol to the same level of α -tocopherol, and also significantly enhances the vitamin E activity of α -tocopherol. These effects were accompanied by a marked increase in the concentrations of these tocopherols in blood and liver, including hypocholesterolemic activity, and suppressive activity of chemically induced cancer (14).

Inhibition of Atherosclerosis

Sesame oil of Tahini has both mono- and poly-unsaturated fatty acid constituents in equal proportions. In addition, it also has high levels of numerous antioxidants and inducers of peroxisome proliferator-activated receptor. Sesame oil could inhibit atherosclerosis lesion formation effectively, perhaps because of the synergistic actions of fatty acid and nonsaponifiable components (15, 16). It was shown that a sesame oil-enriched diet could be an effective nonpharmacological treatment for atherosclerosis by controlling inflammation and regulating lipid metabolism (17). Sesame oil has been known to have anti-inflammatory and antioxidant properties, which makes it effective

for reducing atherosclerosis and the risk of cardiovascular diseases. It has shown that sesame oil can decrease low-density lipoprotein (LDL) levels, while maintaining high-density lipoprotein (HDL) levels (18). Tahini also has high levels of numerous antioxidants and inducers of peroxisome proliferator-activated receptor. Sesame oil-containing diet was shown to significantly reduce the atherosclerotic lesion formation and plasma cholesterol, triglyceride, and LDL cholesterol levels in LDLR ^{-/-} mice. These findings suggest that sesame oil could inhibit atherosclerosis lesions formation effectively, perhaps because of the synergistic actions of fatty acid and non-saponifiable components (19).

Tahini Improves Lipid Profile

Various researchers showed a positive effect of sesame seed in improving lipid profile and oxidative stress in patients with knee osteoarthritis (OA) and indicated the fact that sesame seed might be of help to reduce oxidative stress in OA patients (20). Lignans induce beneficial changes on risk factors related to cardiovascular diseases. The findings indicated that the diet with sesame significantly decreased the levels of serum total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C) and TC/HDL-C ratio. Lipid peroxidation (TBARS) decreased while the activities of Glutathione peroxidase (GPx) and superoxide dismutase (SOD) increased. There were no significant changes in anthropometric indexes such as weight and body mass index (BMI) after consumption of sesame. Sesame seed supplementation decreased serum TC, LDL-C, and lipid peroxidation, and increased antioxidant status in hyperlipidemic patients (21).

Health Benefits of Sesamin in Tahini on Cardiovascular Disease

Sesamin can reduce CVDs' risk and can be potentially useful as an adjuvant therapeutic agent to combat CVDs' risk factors. The effect of sesamin on CVDs and their risk factors is principally due to its antioxidant properties. The data indicates that RAS/MAPK, PI3K/AKT, ERK1/2, p38, p53, IL-6, TNF α , and NF- κ B signaling networks are all involved in moderating the various effects of sesamin on cardiovascular diseases (CVDs) and the risk factors (22). Sesame oil as a potent antioxidant can attenuate hypertension-dependent Left ventricular hypertrophy (LVH). Sesame oil significantly decreases the size of cardiomyocytes and the levels of cardiac renin, angiotensin-converting enzyme and angiotensin II (23).

Tahini May Lower Blood Pressure

It was shown that sesame oil as an edible oil lowers

blood pressure, decreases lipid peroxidation, and increases antioxidant status in hypertensive patients. Plasma levels of sodium reduced, while potassium after substitution of sesame oil increased (24).

Anti-hyperglycemic and Hypertensive Effects of Sesame Oil of Tahini

Sesame oil consumption influences beneficially the blood glucose, glycosylated hemoglobin, lipid peroxidation, and antioxidant levels in diabetic patients consuming sesame oil were compared showing a significant reduction in levels of blood glucose, and glycosylated hemoglobin (25). Anti-diabetics as a functional food may play an important role in glucose regulation and against deleterious effects of diabetes in humans with type 2 diabetes (T2DM) (26). These results indicate that substitution of sesame oil as the sole edible oil has an additive effect in further lowering blood pressure (BP) and plasma glucose in hypertensive diabetics. Regarding the effect of sesame oil in hypertensive diabetics, a decrease in plasma glucose, HbA1c, TC, LDL-C, and TG were observed. TBARS level was reduced, while the activities of enzymatic and the levels of non-enzymatic antioxidants increased. Plasma sodium levels decreased, while potassium levels increased (27).

Sesame Oil of Tahini and Anti-oxidative Stress

It is apparent that sesame seeds are rich in lignans, irrespective of lignan composition, and more profoundly affect hepatic fatty acid oxidation and serum triacylglycerol levels and possibly can attenuate oxidative stress. Therefore, consumption of sesame seeds rich in lignans may hopefully result in physiological activities to promote health status (28).

Sesame Oil in Tahini May Have Hepato-protective Role

Many researchers suggested a hepato-protective role for *Sesamum indicum* extract against liver injury from vanadium toxicity. Vanadium induces mitochondrial/lysosomal toxic interaction and vanadium reductive activation is mediated by glutathione in vanadium toxicity and is ameliorated by *S. indicum* extract (25).

Anti-cancer Properties

Lignans have a similar structure to estrogen. The sesamin and sesamol lignans in Tahini can bind to estrogen receptors, which may protect against hormone-related cancers. The therapeutic potential of sesamol was investigated intensively, and there is compelling evidence that sesamol acts as a metabolic regulator that possesses antioxidant, anti-mutagenic,

anti-hepatotoxic, anti-inflammatory, anti-aging, and chemopreventive properties (29). Various studies have reported that sesamol exerts potent anti-cancer effects. The signaling pathways that sesamol targets include the p53, MAPK, JNK, PI3K/AKT, TNF α , NF- κ B, PPAR γ , caspase-3, Nrf2, eNOS, and LOX pathways. A thorough understanding of the molecular targets of sesamol and the mechanisms of action underlying its anti-cancer effects is necessary for possible employment of sesamol as a chemotherapeutic agent in cancer prevention and therapy (30).

The anticancer effects and molecular mechanisms underlying its apoptosis-inducing effect were investigated in human lung adenocarcinoma (SK-LU-1) cells. Sesamol inhibited SK-LU-1 cell growth with an IC₅₀ value of 2.7 mM and exhibited less toxicity toward normal Vero cells after 48 h of treatment (Selective index=3). Sesamol increased the activity of caspase 8, 9, and 3/7, indicating that apoptotic cell death occurred through both extrinsic and intrinsic pathways. Sesamol caused the loss of mitochondrial transmembrane potential signifying intrinsic apoptosis induction. Decreasing bid expression revealed crosstalk between the intrinsic and extrinsic apoptotic pathways; demonstrating clearly that sesamol induces apoptosis through both pathways in human lung adenocarcinoma (SK-LU-1) cells (31).

In addition, sesame oil has down-regulated the expression of angiotensin type 1 receptor, JNK and p38 MAPK and apoptosis signal regulating kinase 1, c-Fos and c-Jun in rats receiving DOCA/salt. Furthermore, the induction of nicotinamide adenine dinucleotide phosphate oxidase, superoxide anion and hydroxyl radical and lipid peroxidation by DOCA/salt were inhibited by sesame oil. Sesame oil modulates cardiac RAS to ameliorate LVH by inhibiting MAPK activation and lowering oxidative stress (32). The anti-cancer effects of sesamin have been mainly attributed to its anti-proliferative, pro-apoptotic, anti-inflammatory, anti-metastatic, anti- and pro-angiogenic, and pro-autophagocytic activities. Therefore, it could be used in the prevention and/or treatment of various types of cancer (33).

Tahini Has Protective and Curative Role In Kidney

Sesame oil significantly decreased creatinine clearance rate and nuclear Nrf2 expression. Sesame oil significantly decreased hydroxyl radical, peroxynitrite level, lipid peroxidation, osteopontin, and renal collagen deposition, but increased creatinine clearance rate and nuclear Nrf2 expression. Supplementation of sesame oil mitigates DOCA/salt induced chronic kidney diseases in rats

by activating Nrf2 and attenuating osteopontin expression and inhibiting renal fibrosis in rats (34). Histopathological and histochemical staining showed that renal tubules had recovered and regenerated in the sesame oil-treated rats. Sesame oil was shown to inhibit oxidative stress and shorten the recovery period and allow the regeneration of renal tubules after the onset of gentamicin-induced renal injury in rats (35).

Tahini and Bone Health

PUFAs intake may help to prevent osteoporosis associated with estrogens deficiency. Present results showed that ovariectomized (OVX) increased significantly alkaline phosphatase (ALP) and tartrate-resistant acid phosphatase (TRAP) activity and the examination of bone tissue showed disruptive and lytic bone trabeculae. Sesamin concentration promoted Wnt/ β -catenin activity and enhanced more expressions of ALP, OSX, SOX9, RUNX2, and OCN, gradually. Silencing Wnt/ β -catenin weakened the enhancement on RUNX2 and OCN expression. Sesamin promoted bone structure in OVX rats, and significantly enhanced osteocalcin and collagen type I expression. Sesamin promoted osteoblastic differentiation of rat bone marrow mesenchymal stem cells (BMSCs) by regulating the Wnt/ β -catenin pathway, and improved rat bone structure. Sesamin could have therapeutic and preventive effects on osteoporosis too (36).

Anti-nutrients in Tahini

Although sesame seeds have a wide range of health and medicinal benefits, they have some anti-nutritional properties too. Raw sesame seed meal contains the highest level of anti-nutrients with respect to Trypsin Inhibitor (TIA), lectin, tannin, phytin, saponin and oxalate. Cooking and toasting can reduce anti-nutrient contents of sesame seed meal at lower cooking and toasting time (37). Another disadvantage of the seed is that it may cause allergic reactions in some people. The allergy may be mild to severe and lead to severe physical symptoms like vomiting, abdominal pain, swelling of lips and throat leading to breathing difficulty, chest congestion and death. The laxative effect of sesame also indicates that sesame oil should not be used by people who have diarrhea.

Conclusion

There are ample evidences suggesting that sesamol possesses potent anti-cancer properties *in vitro* and *in vivo*. Sesamol acts as a metabolic regulator that possesses antioxidant, anti-mutagenic, anti-hepatotoxic, anti-inflammatory, anti-aging, and

chemo-preventive properties. The ability of sesamol to regulate apoptosis and various stages of the cell cycle is also outlined. Further studies are suggested for the future to explore other benefits of Tahini for the human health.

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Conflict of Interest

None declared.

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