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Research Article

Tahini: The Magical Condiment In-Depth Look at its Nutritional and Health Benefits

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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% of protein as well as at least 55% of 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%), as well as 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 -tocopherol bioavailability, and providing anti-inflammatory function and potential estrogenic activity. Many health promoting effects are attributed to its lignans. Lignans consists of sesamin and sesamolin. In sesame oils, the ranges of sesamin and sesamolin were 0.93 mg/g-2.89 mg/g oil and 0.30 mg/g-0.74 mg/g oil, respectively, and tocopherol contents were 304 μg/g-647 μg/g oil. Lignans may increase antioxidant potential of diets and it is providing stability. Hence, this article will highlight and discusses the potential nutritional and health promoting effects of Tahini.

Keywords: Tahini; Sesamin; Sesamolin; MUFA; PUFA; Anti-inflammatory; Anti-oxidents; Lignin

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 ṭaḥīna, from ṭaḥīn, flour, from ṭaḥana, to grind. Sometimes it's referred to 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 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 it contains many health benefiting nutrients, minerals, antioxidants and vitamins that are essential for wellness and have positive effects on human health [3].

There is no 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

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published studies. To our knowledge, this article will be the first to shed some light on this magical condiment.

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, sesamolin, and sesaminol glucosides. Lignans plays an important role in inter modulation of fatty acid metabolism, inhibition of cholesterol absorption and biosynthesis, antioxidant and vitamin E-sparing effects, hypotensive and antiaging effects, improvement of liver functions. Lignans may also increase antioxidant potential of diets and it is providing stability. *In vitro* and *in vivo* studies reveals vitamin E sparing effect has been demonstrated [5]. The major components of lignans are shown in Figure 1.

Sesame seeds contain about 25%-35% of protein as well as 55% of fatty acids mainly unsaturated fat. 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%), as well as 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 g-11 g 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. According to 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 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 [8,9]. Linoleic acid is required for cell membranes, for transportation of cholesterol in the bloodstream, and for blood clotting. Lipids in Tahini are 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

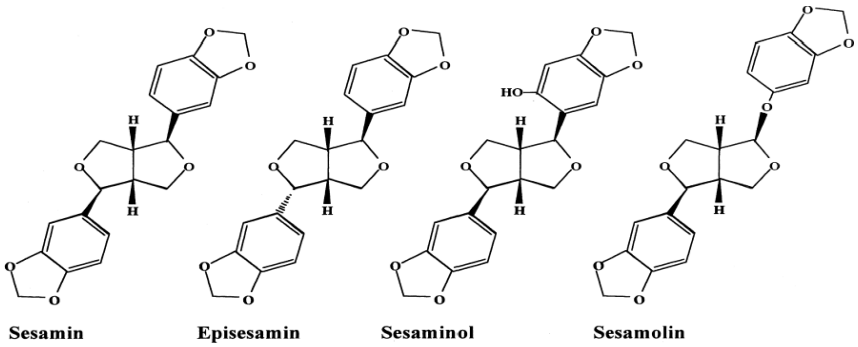

Figure 1: Lignan's functional components in Tahini.

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

Source: 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%
	Arachido nic acids	0.1%-0.7%

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

different roles such as in synthesis of amino acids and proteins, photosynthesis, carbohydrate metabolism, nucleic acids, teeth development, regulating the acid-alkaline balance in the body. The presence of these minerals also confirms the fat 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 unfortunately does not contain all necessary vitamins and therefore it's 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 antioxidative 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 lowered 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 [10,11]. Sesame lignans also showed other useful functions such as acceleration of alcohol decomposition in the liver, antihypertensive activity, immunoregulatory activities, anticarcinogenic activity. Also, sesame oil in Tahini was effective of potent anti-inflammatory and antioxidant compounds and may serve as a valuable nonpharmacological agent in atherosclerosis and other inflammatory diseases.

In another study, activities of enzymes involved in hepatic fatty acid oxidation and synthesis among rats fed sesame (*Sesamum indicum* L.) differing in lignan content (sesamin and sesamolin) were compared. Sesame increased both the hepatic mitochondrial and the peroxisomal fatty acid oxidation rate [11].

Anti-inflammatory and antioxidant activities

Sesame Oil (SO) has anti-inflammatory, anti-atherosclerotic and lipid lowering properties in vivo. An aqueous extract of sesame oil (SOAE) has also anti-inflammatory and anti-atherosclerotic properties. The methoxyphenol derivatives showed potent anti-inflammatory properties. The anti-inflammatory molecules associated with SO may contribute the anti-inflammatory and anti-atherosclerotic properties [12]. Sesame Oil (SO) was effective in inhibiting atherosclerosis in low-density lipoprotein-receptor negative mice. SOAE significantly reduced inflammatory markers in both macrophages and endothelial cells in a concentration-dependent manner. SOAE, transcription and translocation of NF-kappa B was suppressed. SOAE was also effective in inhibiting oxidation of lipoproteins in vitro. Furthermore, SOAE differentially regulated expression of scavenger receptors and increased ATP-binding cassette A1 (ABCA1) mRNA expression by activating Liver X Receptors (LXRs), suggesting additional effects on lipid metabolism [13].

Antiaging properties of tahini

Sesaminol has been identified as a new antioxidative principle in sesame oil which is present in Tahini. Sesame lignans had a synergistic effect on vitamin E activities when added to tocopherols. The presence of sesaminol markedly enhanced vitamin E activity of γ-tocopherol to the same level of α-tocopherol, and also significantly

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

Mineral	Amount	Unit	D
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, n	4.62	mg	49
Copper, Cu	1.61	mg	170
Selenium, Se	34.4	µg	35

Source: 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
B, pyridoxine	0.150	mg	12
Folate, Total	98	µg	25
Vitamin A	67	µg	-
Choline	25.8	µg	-
AlphaTocopherol, vitamin E	0.25	mg	1.6

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

enhanced 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. hypocholesterolemia activity, suppressive activity of chemically induced cancer [14].

Inhibition of atherosclerosis: Sesame oil in Tahini has both mono- and polyunsaturated 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].

Other studies suggested 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 disease. It has shown that SO 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 significantly reduced the atherosclerotic lesion formation and plasma cholesterol, triglyceride, and LDL cholesterol levels in LDLR/mice. These findings suggest that sesame oil could inhibit atherosclerosis lesion formation effectively, perhaps because of the synergistic actions of fatty acid and nonsaponifiable components [19].

Anti-cancer properties

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 [20].

There is sufficient evidence 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 chemopreventive properties. The ability of sesamol to regulate apoptosis and various stages of the cell cycle is also outlined. The signaling pathways that sesamol targets include the p53, MAPK, JNK, PI3K/AKT, TNFα, NF-κB, PPARγ, caspase-3, Nrf2, eNOS, and LOX pathways. Sesamin inhibited the proliferation of a wide variety of tumor cells including leukemia, multiple myeloma, and cancers of the colon, prostate, breast, pancreas, and lung [21]. Sesamin also potentiated tumor necrosis factor-alpha-induced apoptosis and this correlated with the suppression of gene products linked to cell survival (e.g., Bcl-2 and survivin), proliferation, inflammation (e.g., cyclooxygenase-2), invasion (e.g., matrix metalloproteinase-9, intercellular adhesion molecule 1), and angiogenesis (e.g., vascular endothelial growth factor). Sesamin manifests chemopreventive effects through the suppression of NF-kappa B-regulated cell survival, proliferation, invasion, and angiogenic gene products [22].

Tahini improves lipid profile

Various studies showed a positive effect of sesame seed in improving lipid profile and oxidative stress in patients with knee OA and indicated the fact that sesame seed might be of help to reduce oxidative stress in OA patients [23]. Lignans induce beneficial changes in risk factors related to cardiovascular disease. The results showed that the diet with sesame significantly decreased the levels of serum Total Cholesterol (TC) and Low-Density Lipoprotein Cholesterol (LDL-C) and TC/HDL-C ratio. Lipid peroxidation (TBARS) decreased while the activities of GPX and SOD were increased. There were no significant changes in anthropometric indexes such as weight and BMI after consumption of sesame. Sesame seed supplementation decreased serum TC, LDL-C and lipid peroxidation, and increased antioxidant status in hyperlipidemic patients [24].

Health benefits of sesamin in tahini on cardiovascular disease

Sesamin can reduce CVD risk sesamin can be potentially useful as an adjuvant therapeutic agent to combat CVD and its multitude of risk factors. The effects of sesamin on CVD and its risk factors, principally due to its antioxidant properties. The data indicates that RAS/MAPK, PI3K/AKT, ERK1/2, p38, p53, IL-6, TNFα, and NF-κB signaling networks are all involved in moderating the various effects of sesamin on CVD and its risk factors [25].

Sesame oil, a potent antioxidant, attenuates hypertension-dependent LVH. Sesame oil significantly decreased the size of cardiomyocytes and the levels of cardiac renin, angiotensin-converting enzyme and angiotensin II [26].

Tahini may lower blood pressure

The results suggested that sesame oil as edible oil lowered blood pressure, decreased lipid peroxidation, and increased antioxidant status in hypertensive patients. Plasma levels of sodium reduced while potassium elevated upon the substitution of sesame oil [27].

Anti-hyperglycemic and hypertensive effect of sesame oil in tahini

Sesame oil consumption influences beneficially the blood glucose, glycosylated hemoglobin, lipid peroxidation, and antioxidant levels in diabetic consuming sesame oil were compared with resulted in a significant reduction in levels of blood glucose glycosylated hemoglobin [28]. Anti-diabetic as a functional food may play an important role in GLU regulation and against deleterious effects of diabetes in humans with type 2 diabetes [29].

These results indicate that substitution of sesame oil as the sole edible oil has an additive effect in further lowering BP and plasma glucose in hypertensive diabetics. The effect of sesame oil in hypertensive diabetics. Plasma glucose, HbA1c, TC, LDL-C, and TG were decreased. TBARS level was reduced, while the activities of enzymic and the levels of nonenzymic antioxidants were increased. Plasma sodium levels were reduced, while potassium levels were elevated [30].

Sesame oil in Tahini and Anti-oxidative stress: It is apparent that sesame seeds rich in lignans, irrespective of lignan composition, more profoundly affect hepatic fatty acid oxidation and serum triacylglycerol levels and possibly attenuate oxidative stress. Therefore, consumption of sesame seeds rich in lignans hopefully results in physiological activity to promote health [31].

Sesame oil in Tahini may have hepato- protective role: Many studies suggested a hepato-protective role for extracts against liver injury resulted from vanadium toxicity. Vanadium induced mitochondrial/lysosomal toxic interaction and vanadium reductive activation mediated by glutathione in vanadium toxicity ameliorated by Sesamum indicum extracts [32].

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 [33]. Various studies have reported that sesamol exerts potent anti-cancer effects. The signaling pathways that sesamol targets include the p53, MAPK, JNK, PI3K/AKT, TNFα, NF-κB, PPARγ, 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 [34].

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 [35].

In addition, sesame oil 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 [36].

Tahini has protective and curative role of kidney

Sesame oil significantly decreased creatinine clearance rate and nuclear Nrf2 expression were 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 disease in rats by activating Nrf2 and attenuating osteopontin expression and inhibiting renal fibrosis in rats [37]. Histopathological and histochemical staining showed that renal tubules had recovered and regenerated in the sesame oil-treated rats.sesame oil inhibits oxidative stress to shorten the recovery period and allow the regeneration of renal tubules after the onset of gentamicin-induced renal injury in rats [38].

Tahini and bone health

PUFAs intake may help to prevent osteoporosis associated with estrogens deficiency. Present results showed that OVX increased significantly ALP and TRAP activity and the examination of bone tissue showed disruptive and lytic bone trabeculae. Sesamin concentration promoted Wnt/ß-catenin activity and enhanced more expressions of ALP, OSX, SOX9, RUNX2, and OCN, gradually. Silencing Wnt/ß-catenin weakened the enhancement on RUNX2 and OCN expression. Sesamin promoted bone structure in ovariectomized rats, and significantly enhanced osteocalcin and collage type I expression. Sesamin promoted osteoblastic differentiation of rat BMSCs by regulating the Wnt/ß-catenin pathway, and improved rat bone structure. Sesamin could have therapeutic and preventive effects on osteoporosis [39].

Antinutreints in tahini

Although sesame seeds have a wide range of health and medicinal benefits, they have some anti-nutritional properties. 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 seedmeal at lower cooking and toasting time [40]. 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, pain abdomen, 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 is ample evidence 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 chemopreventive properties. The ability of sesamol to regulate apoptosis and various stages of the cell cycle is also outlined

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