Review Article

Health Benefits of Sesame Oil on Hypertension and Atherosclerosis

Lawrance C. Chandra* and Solo Kuvibidila

Department of Nutritional Sciences, College of Human Sciences, Oklahoma State University (OSU), Stillwater, OK 74078.

Address: Division of Comparative Pathology, Tulane National Primate Research Center, 18703 Three Rivers Road, Covington, LA 70433-8915

E-mail: lachandra@tulane.edu, Tele Phone: +1-985-871-6561, Fax: +1-985-871-6510

*Corresponding author

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ABSTRACT

Hypertension and atherosclerosis are the major contributors of cardiovascular disease worldwide. Drug therapy alone may not be sufficient enough to treat either the hypertension or atherosclerosis without the involvement of any dietary management. Dietary intervention thus becomes an integral part in course of the cardiovascular disease therapy. Moreover, the long term treatment with medications for these chronic diseases results in several adversarial side effects. Therefore it is wise to look for any alternative measure using dietary components with least side effects as a complimentary to minimize the therapeutic costs and other undesired effects. In that course the dietary management by using several foods enriched with natural antioxidants and polyunsaturated fatty acids are gaining much importance in preventing as well as treating the hypertension or atherosclerosis. Olive oil from the "Mediterranean diet" has already gained much attraction due to its cardiovascular health benefits. In this mini review, we extended the focus on the benefits of Sesame oil which is also known as Gingelly or Til oil in India and frequently used for daily uses.

INTRODUCTION

Hypertension and atherosclerosis are the major causes behind any cardiovascular diseases [1]. Identifiably, diet plays a major role in their development [2]. On the other hand pharmacological therapy alone is proven to be insufficient therefore a dietary intervention is felt very necessary for complete treatment [2 & 3]. The chronic nature of this ailment requires continuation of the therapy which would result in a higher costs as well as

providing unwanted side effects. Thus, to reduce the cost and side effects it is often advisable to look for an alternative path of therapy. To its assistance, in recent days foods enriched with natural antioxidants or polyunsaturated fatty acids are gaining the importance [4]. As an example, olive oil has been historically selected for its beneficial role in Mediterranean diet. It attracts much attention due to its high monounsaturated fatty acids and natural antioxidants content [5, 6].

Oil from sesame seeds used in Southern Indian cooking bears the similar comparison with olive regarding the polyunsaturated acids and antioxidant content [7]. Advantageously, in addition to its high degree (41%) of unsaturation it is also least prone to the rancidity [8]. This unique property makes it an ideal cooking medium throughout the ages in Indian subcontinent. Besides its use in Southern Indian cooking, sesame oil has been used also as a flavor enhancer in many Asian Nations' cuisine. Table-1 shows the exact composition of the Indian sesame oil.

Ingredients	Amount
Palmitic acid	7.0 - 12.0%
Stearic acid	3.5 - 6.0%
Oleic acid (Omega 9)	35.0 - 50.0%
Linoleic acid (Omega 6)	35.0 - 50.0%
Phytosterols	117.64 mg/tbsp
Vitamin E	4% or .556 mg/tbsp

Table-1: Sesame oil composition (According to National Agriculture Library's USDA Nutrient Database).

Several beneficial effects of the sesame oil were already recorded in ancient Indian medical literature, Ayurveda [9]. In those days, sesame oil was also used as a topical antibacterial, antifungal and antiviral agent by the traditional medical practitioners. Although the use of oil is known from the ancient past, however, the scientific literatures regarding its health benefits are considerably limited. In limited doses the oil is seen to be harmless but its effect after prolong uses especially towards any pregnant or lactating women, under aged children and even within the people suffering either with liver or kidney diseases are questionable and not been fully verified [7]. Obviously, those allergic to peanuts should be forbidden to use because of the sinister anaphylactic shock [7]. Apart from this rarity, we sincerely believe that its large beneficial effect can overshadow the above adversarial concern, which are mostly confined to a limited population, particularly when considering the broad preventive measures in hypertension or atherosclerosis.

Sesame oil and Hypertension

Hypertension is essentially classified as primary and secondary. About 90% of the hypertension cases are categorized as being primary which unfortunately bears no clear single identifiable etiology [10]. A large number of physiological facts are known to involve in maintaining the normal blood pressure. Any derangement in one of them may help developing the primary hypertension. On the contrary, secondary one result mostly from the kidney disease or else could be due to any tumor formation like, pheo-chromocytoma or para-ganglioma [10].

Understanding of the pathophysiology of hypertension is highly critical for treating the high blood pressure sufferers. Its pathophysiology is complex therefore not well understood also. The alterations of plasma membrane among the cells of a pressure-regulating center of the brain stem and its associated vascular changes could be one such proposed mechanism behind the etiopathogenesis of primary hypertension [11]. Although admittedly, other interrelated factors including salt intake and the problems regarding obesity, resistance to

Insulin, Renin-Angiotensin system or sympathetic nervous system also contributes differentially in regulating the blood pressure [10]. Therefore, a complementary blood pressure lowering agent needs to be added to control the chronic hypertension. In that context, dietary intake of sesame oil could be a logical approach owing to the availability of several active ingredients like sesamin, episesamin, sesaminol, vitamin E and MUFA. It has been already noted that in both experimental animals and humans, the oil provides an antihypertensive role lowering the hypertension either primary or secondary [12-16]. In humans, it also synergistically modulates the effects of several antihypertensive medications thereby reducing their doses [16]. Admittedly, a limited number of data were available to examine or reconfirm many of those effects. One such study showed that substituting sesame oil as a cooking agent (35 grams /day) for 45 days among fifty hypertensive patients using diuretics and β-blockers significantly lowered the blood pressure. Interestingly, in the event of withdrawing the oil afterward resulted in the pressure elevation [14].

In another study, among the hypertensive patients using nifedipine (calcium channel blocker) was compared along with other edible oils. In that impressive trial, five hundred and thirty patients using nifedipine were randomly divided in 3 groups (356 patients-sesame oil; 87 patients-sunflower oil; 47 patients-groundnut oil) whereas the control ones (n=40) are receiving only the drug, nifedipine. The oils were supplied to the patients and instructed to use only for edible purposes for exact 60 days. Each person received 35 g of oil/day. Blood pressure, lipid and antioxidant profiles were measured before at baseline and after 60 days of oil substitution. Among the groups, sesame appeared to be promising against the blood pressure rise, lipid peroxidation and also the lipid profile [16].

In another preliminary pilot study, among the diabetic hypertensive subjects substitution of sesame oil (35 g / day / person) was seen to reduce the blood pressure also [15]. It has been conjectured that the beneficial role of sesame oil is due to the presence of several of its natural components sesamin, vitamin E or oleic acid.

Effect of Sesamin

Reportedly, the sesamin and its active metabolites (Fig – 1) can induce antihypertensive effects in experimental animal models [17-20]. The feeding of sesamin for five weeks inhibited the generation of reactive oxygen species (ROS) during deoxycorticosterone induced hypertensive rats [17]. It also ameliorated endothelial dysfunction through the enhancement of vascular antioxidant defense. Its antioxidant effect is very comparable to Tempol, a Super-Oxide Dismutase (SOD) mimetic [18]. Contrarily, sesamin increases endothelial nitric oxide (NO) production during isolated cell and organ studies whereas it failed to produce endothelial NO in case of in-vivo experiments [19 & 21]. The antihypertensive effects of sesamin feeding were neither observed in chronically N^G-Nitro-L-arginine (NOARG)-treated rats nor in deoxycorticosterone acetate treated endothelial nitric oxide synthase-deficient mice. This indicates that mechanisms behind anti-hypertensive action might not follow the NO generating pathways [19]. Additionally, the recent study also confirms that feeding of sesamin can abolish the increase of NADPH oxidase activity while elevating the aortic mRNA expression of p22phox, gp91phox, Nox1 and Nox4 which is usually induced by the deoxycorticosterone acetate. As an overall estimate, the enhancement of vascular antioxidant defense is the major mechanism behind the action of-sesamin [20].

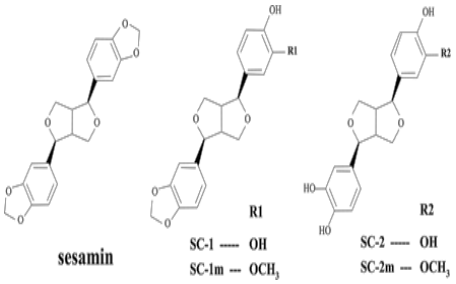

Figure-1: Chemical structures of sesamin and its metabolites.

Further, sesamin can inhibit Δ-5 desaturase activity of N-6 fatty acids that results in the accumulation of dihomo-γ-linolenic acid (DGLA) in the plasma membrane in place of archidonic acid thereby decreasing the production of pro-inflammatory mediators [32]. It also increases the accumulation of eicosapentaneoic acid (EPA) and docosahexaneoic acid (DHA) into the cell membrane including vascular endotheliums. In that way it decreases the in-vivo PGE_2 production [32] thereby reduces the possibility of any pro-inflammatory conditions. Incidentally, the effects are observed only in case of rats and humans but not in mice [33, 34 & 35]. Further, sesamin synergizes eicosapentaneoic acid (EPA) and docosahexaneoic acid induced hepatic fatty oxidation in rats [36].

Effect of Vitamin E

The sesame oil is widely known to be a rich source of vitamin E. It has been reported that the component sesamin in oil improves the bioavailability of vitamin E by inhibiting the α-tocopherol degrading enzymes [22]. In that maneuver the dietary intake of sesame oil helps to raise the vitamin E level which is a known antioxidant and beneficial for the cardiovascular health. As per further addition, vitamin E also exerts mild antihypertensive effects [23&24]. Therefore a part of the antihypertensive action of sesame oil may be due to the resultant effect of sesamin and vitamin E.

Effect of Oleic acid

It has been already recorded that oleic acid (monounsaturated omega-9 fatty acid) in sesame oil exerts antihypertensive effect [25]. It was known that human hypertensive subjects have the altered levels of membrane lipids and G proteins suggesting a possible role of G protein-coupled adrenoreceptor being differently engaged in modulating the hypertension. Various studies also confirmed that the hypotensive effect of olive oil could be due to the incorporation of oleic acid in the plasma membranes, which regulates the membrane lipid structure in a way to control the G protein-mediated signaling thereby subsequently lowering the high blood pressure [25]. The incorporation of oleic acid and its modulation of α- and β-adrenoreceptors offers convincing proves in this regard [26]. Thus all the evidences may help hypothesize that the use of sesame oil in making food may effectively control the hypertension via the same mechanism. But other fatty acids like elaidic (trans-18:1n-9) or stearic (18:0) have failed in that respect indicating an important role of stereo-specificity in the process [27].

Sesame oil and Atherosclerosis

Atherosclerosis is a slowly progressive disease of the arteries. It is a fatty intimal plaque, formed by lipid deposition, smooth muscle cell proliferation combining with the synthesis of extracellular matrix in the arterial intima which is considered as the hallmark of atherosclerosis [28]. It imposes major health problem in both developed and developing nations. Development of “fatty streak" is thought to be the first step in developing the atherosclerosis [28]. Many etiological factors are proposed for its development for example, involvement of oxidized

LDL, turbulent blood flow, endothelial injury or dysfunction, oxidative stress, pro-inflammatory cytokines, smoking, hypertension, diabetes, infection and inflammation. But the exact mechanism(s) for its development remains unknown [28]. Until now, the hypothesis of "response-to-injury" has been widely accepted. A growing body of evidence supports, that in addition to the vascular endothelial injury, oxidized LDL and subsequent inflammation and fibrosis is the primarily the initiating steps. Along that process, the macrophage colony stimulating factor (MCSF) produced by inflamed vascular intima attracts the monocytes and help differentiate into macrophage. Later, the uptake of oxidized LDL by macrophages and its subsequent transformation into lipid laden foam cell is the key event in developing of atherosclerosis [29]. The elevated postprandial lipemia overpowers the antioxidant properties of healthy endothelium and resulting in more oxidation of LDL causing further endothelial dysfunction. The event raises the levels of cytokines and adhesion molecules namely IL-6, TNF-α and ICAM-1 in circulation [30]. The prevalence of fatty streaks in young adults and children with apparent good health strongly suggests that atherosclerosis is caused mainly due to the postprandial lipemia [28]. Over a long period, these chronic postprandial lipids overload results in atheroma and acute coronary events. Hence in that concern, nutritional intervention aiming to control the postprandial lipemia and lipid oxidation could be effective to prevent the development of atherosclerosis.

Considering the chemical composition, the dietary intake of sesame oil is expected to improve the condition preventing any postprandial lipemia or lipid oxidation. Although many reports are available concerning the effect of sesamin on lipid metabolism and atherosclerosis but only a few studies using the intact sesame oil as a diet are available. Bhaskaran et.al., convincingly showed that three months feeding of the oil prevent in developing atherosclerosis in Low-Density Lipoprotein receptor deficient mice in comparison with their cohort atherogenic diet group. Additionally, sesame oil also improved the lipid profile in these deficient mice. [31]. As already stated that the substitution of sesame oil as a cooking media (35 grams /day) showed improvement of lipid profiles and antioxidant status in hypertensive patients with or without the diabetes [15&16].

Obviously, the oil in diet provides dietary antioxidants like, vitamin E, sesamin, episesamin, sesaminol etc. These nutrients along with other phytochemicals help reduce the postprandial lipemia by lowering any oxidative stress arises due to the oxidization of LDL, while preventing vascular inflammation and later the incidence of atherosclerosis.

Thus sesame oil has a good potential to prevent the occurrence of atherosclerosis by acting through multiple ways.

CONCLUSION

The multitude of existing data regarding beneficial effects of sesame oil shows a great promise. But according to American Heart Association the caloric intake concerning this oil use should not be exceeded more than 10 % of the total value. So far, any data regarding the controlled double blind clinical trials are unavailable which should be the major attention in future. As a precautionary measure, due to the insufficient safety evaluation, sesame oil should be used with added caution within children and pregnant or lactating women and also for the patients with existing liver or kidney diseases. Additionally, in case of diarrhea the use of this oil should be avoided

because of the laxative effect. While considering these factors the judicious daily use of sesame oil will definitely help reduce the occurrence of hypertension or atherosclerosis. So the oil from sesame plant seed (Sesamum indicum) belonging to Pedaliaceae family is certainly a nature's gift to mankind.

Conflict of interest: None

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