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Review Article

Nutraceutical value of sesame oil – An update

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ABSTRACT

Sesame oil is one of the cooking oil used in the human diet since ancient times. Sesame oil is obtained from seeds of *Sesamum indicum* cultivated throughout the world. Sesamin and sesamol are antioxidant lignans present as rich concentration in sesame oil. Beneficial effect of sesame oil and its antioxidant lignans reported by researchers in various experimental animals and human models. The aim of this review to discuss the accumulating evidence that suggests that sesame oil possess a diverse range of biological action and may be beneficial for human to deviate from various diseases.

Keywords: Antioxidants; cardio protection; human diet; oxidative stress; sesame lignans; *Sesamum indicum*

INTRODUCTION

Sesame oil, derived from the seeds of plant species of *Sesamum indicum* Family *Pedaliaceae*, consists of various fatty acids and nonfat antioxidants, including tocopherol, sesamin, sesamol, and sesamol (Fukuda, 1990). Sesame oil has been part of the human diet since ancient times. Sesame oil is one of the major dietary oils in Asian countries. Antioxidant lignan present in the sesame oil may contribute to improve human health (Saleem & Gauthaman, 2009). Sesamin and sesamol are the most abundant lignans of sesame oil and the major fat soluble lignans (Liu et al., 2006). Sesamin and sesamol are comprised of benzene and furfuran rings. The structural difference between them is that sesamol contains oxygen between its benzene and furfuran rings (Marchand et al., 1997). Sesamin and sesaminol are the major phenolic constituents of sesame oil, which have been reported to possess a broad spectrum of pharmacological effects, including anti-mutagenic, antioxidant, antihypertensive, anti-inflammatory antithrombotic and cardio protective effects (Gauthaman & Mohamed Saleem, 2009). In this review, various pharmacological effects of sesame oil were documented by both animal and human study to support the nutraceutical value of sesame oil. Different kinds of pharmacological activity of sesame oil are presented in Figure 1.

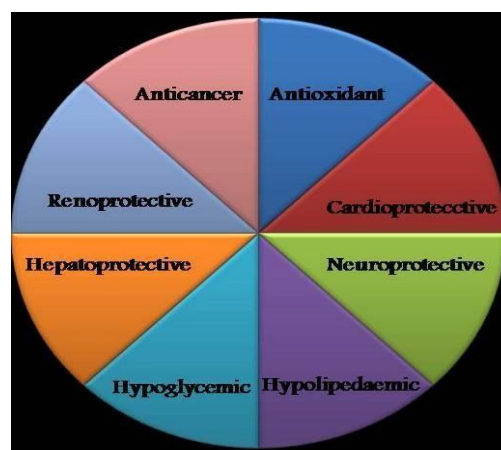


Figure 1: Pleiotropic effects of sesame oil

Antioxidants effect of sesame oil

Hsu et al. reported the antioxidative effect of sesame oil in animal models. They reported that a single dose of sesame oil decrease the oxidative stress and also protect the liver from oxidative injury by enhancing the antioxidant parameters. The protective effect might be due to inhibition of xanthine oxidase enzyme (Hsu & Liu, 2002; 2004; Hsu et al., 2004; Hsu et al., 2006). In another study, it has been reported that sesame oil decreasing the lipid peroxidation (LPO) by scavenging the reactive oxygen species (ROS) triggered by endotoxin lipopolysaccharide in rats (Kang et al., 1998; Nakai et al., 2003; Hsu & Liu, 2002; 2004). Many studies supported the antioxidant properties of sesame oil due to presence of sesamin and sesamol, sesaminol in rich level. Furthermore, the scavenging property of sesame oil is more effective than either α -tocopherol or probucol in reducing the peroxy radicals derived from 2,2'-azobis (2-amidinopropane) dihydrochloride

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(Kang et al., 2000). Researchers reported that administration of sesame oil during stress enhancing the antioxidative enzymes like glutathione peroxidase (GPx), superoxide dismutase (SOD), and catalase in rodents (Hemalatha et al., 2004; Hsu et al., 2004; 2005; 2006).

Hypoglycemic effect

Dietary supplementation of sesame oil for type II diabetic patients in combination with glibenclamide significantly altered the lipid parameters and serum sugar level when compared with glibenclamide alone treated patients. Sesame oil also enhanced the enzymatic and non-enzymatic antioxidants in diabetic patients. This study suggested that inclusion of sesame oil in the diet improve the hyperglycemic condition in type II diabetic patients (Sankar et al., 2011).

Wound healing effect

Shenoy et al. (2011) evaluated the wound healing effect of sesamol in an experimental animal model. Sesamol treatment significantly increased the tensile strength and hydroxyl proline level. These results indicate that sesamol could be a promising drug in normal as well as delayed wound healing processes.

Cardioprotective effect

Sesamin is one of the antioxidative lignin presents in the sesame oil, as per literature it is found that sesamin is a useful prophylactic treatment in hypertension and cardiovascular hypertrophy (Matsumara et al., 1995; Kang et al., 2000; Nakano et al., 2002). Kaneez et al. (2007) studied the cardioprotective effect of sesame oil against doxorubicin (DOX) induced myocardial injury. They found that sesame oil at a dose of 5 ml/Kg ameliorates the cardiotoxicity via endogenous antioxidant mechanism. Sankar et al. (2005) reported the protective role of sesame oil in hypertensive patients. They observed that consumption of sesame oil remarkably reduced the oxidative stress by increasing the antioxidant enzymes. The effect of sesame oil compared with nifedipine as known antihypertensive drugs. Sesame oil produced significant reduction in blood pressure when compared to nifedipine alone treated patients. The antihypertensive property of sesame oil might be due to presence of one or more antioxidative principle. In another study, sesame oil is mixed with sun flower oil and administered to the hypertensive patients. Nifedipine and oil mix significantly reduced the blood pressure and normalized the lipid level, electrolytes and enzymatic parameters (Sudhakar et al., 2011). Nakano et al. (2006) reported that administration of sesamin produced significant antihypertensive activity via endothelial nitric oxide-dependent vasorelaxation. It has been suggested that sesamin metabolites modulate the vascular tone and contribute to the *in vivo* antihypertensive effect of sesamin by inducing an endothelial nitric oxide-dependent vasorelaxation.

We have reported the cardioprotective properties of chronic oral administration of sesame oil in in-vitro

model of myocardial ischemic reperfusion injury in rats. In this study, we observed that sesame oil administration at a dose 5 & 10 ml/kg produced significant protection via enhancing the endogenous antioxidant enzymes (Saleem et al., 2012). Sesamol is one of the antioxidative principle presents in the sesame oil protected the myocardium against isoproterenol induced myocardial toxicity via antihyperlipidemic action (Vennila & Pugalendi, 2012).

Karatzi et al. (2012a) studied the hemodynamic effects of sesame oil consumption against hypertensive patients. They observed that fifteen days treatment of sesame oil at a dose of 36 g significantly reduced the systolic blood pressure; heart rate was normalized and increased to the level of total antioxidant capacity. In another study, they found sesame oil consumption exerts a beneficial effect on endothelial function, and this effect is sustained with a long-term daily use (Karatzi et al., 2012b).

Anti-inflammatory activity

Sesame oil and its lignans interfere with an inflammatory pathways. Sesamin decreases the synthesis of arachidonic acid via inhibition of $\Delta 5$ desaturase activity. It also reduces the formation of pro-inflammatory mediators, including prostaglandin PGE₂, Tumor Necrosis Factor- α (TNF- α), Interleukin-6 and Interleukin-10 in mice (Chavali et al., 1998; Umeda-Sawada et al., 2003). Chronic oral administration of sesame oil significantly altered the oxidative stress induced biochemical changes occurring in adjuvant arthritis; moreover, it improves endothelium-dependent relaxation of the aorta and tends to decrease hind paw edema (Sotnikova et al., 2009). Analgesic, antipyretic and anti-inflammatory activity of sesame oil at a dose of 5 and 10 ml/kg was evaluated in an experimental animal model. Sesame oil shows significant protective action in these models with the dose dependent activity (Mohamed Saleem et al., 2011).

Hypolipidemic action

Sesame oil reduced the accumulation of cholesterol by inhibition of absorption and decreasing synthesis of cholesterol (Hirose et al., 1991; Ide et al., 2001). It is found that administration of sesamin reduced the serum cholesterol in animal model and in another study, it is observed that sesamin inhibits the activity of liver microsomal 3-hydroxy-3-methylglutaryl Coenzyme A reductase (HMG-CoA reductase), the rate limiting enzyme of cholesterol synthesis in liver (Hirose et al., 1991). Satchithanandam et al. (1993; 1996) reported the hypocholesterolemic effect of sesame oil in an animal model. Supplementation of sesame oil reduced the serum cholesterol and LDL level in rats via inhibition of lymphatic absorption of cholesterol and fatty acids and also reduced synthesis of cholesterol in liver. In another animal model, it is found that sesame oil consumption decrease the triacylglycerols (TG) and cholesterol level in blood and liver (Ide et al., 2001). Sesame

oil consumption reduced the level of cholesterol and triglyceride and enhances the level of HDL in hypertensive patients (Sankar *et al.*, 2005). Oral administration of sesame oil and N-acetylcysteine significantly restored the lipid level and hepatic steatosis on diet-induced hypercholesterolemic mice also enhanced the serum level of antioxidant enzyme (Korou *et al.*, 2010).

Sharma *et al.* (2012) studied the potential role of sesamol in a chronic high-cholesterol/high-fat diet (HFD)-induced cardiometabolic syndrome (CMetS) in rats and also explored the molecular mechanism driving this activity. The results suggest that sesamol attenuates oxidative stress, inflammation, IR, hepatic steatosis and hypertension in HFD-fed rats via modulating PPAR γ , NF- κ B, P-JNK, PPAR α , LXR α , SREBP-1c and e-NOS protein expressions, thereby preventing CMetS.

Gastro protective action

Hsu *et al.* (2009) reported the gastro protective action of sesame oil on ethanol-induced gastric mucosal lesions. Administration of sesame oil significantly decreased the ulcer induced by ethanol. They found that the protective action of sesame oil via reduced mucosal lipid peroxidation, as well as glutathione and nitric oxide production in acidified ethanol-treated stomachs. Ji *et al.* (2010) studied the therapeutic value of sesame oil in the treatment of small bowel obstruction. The study showed that sesame oil was a safe and effective adjunct to the standard treatment of partial adhesive small bowel obstruction.

Effect on experimental septic rats

Sepsis is one of the major problems to cause high mortality for hospitalized patients. Sesame oil administration to septic rats reduced the free-radical generation and also decreases the hepatic lipid peroxidation by inhibiting superoxide anion and nitric oxide (Hsu *et al.*, 2008a, b; Hsu *et al.*, 2006b).

Effect on liver and kidney

Effect of sesame oil on liver injury caused by acetaminophen (APAP) & lead-plus-lipopolysaccharide (Pb + LPS) overdose has been documented. Sesame oil at a dose of 8 ml/kg significantly regressed to all the parameters altered by these two agents and protected the rats against acute liver injury. In acetaminophen, induced model sesame oil increased the glutathione and inhibited lipid peroxidation via inhibition of ROS. In Pb + LPS model sesame oil inhibited the tumor necrosis factor- α , interleukin-1 β , and nitric oxide production in serum and liver tissue. The inhibition of proinflammatory cytokines and nitric oxide might be involved in sesame oil associated protection against Pb + LPS-induced acute hepatic injury in mice (Chiang *et al.*, 2005; Hsu *et al.*, 2007a; Chandrasekaran *et al.*, 2008). Sesame oil at a dose of 8 ml/kg significantly reversed the altered biochemical and antioxidative parameters induced by cumulative over dose of APAP. The protective action of sesame oil against APAP induced oxida-

tive liver injury via stabilization of glutathione and inhibition of ROS (Chandrasekaran *et al.*, 2010).

Hsu *et al.* (2007b) reported the protective action of sesame oil against cisplatin induced hepatic and renal damage. They observed that sesame oil offered the therapeutic effect against cisplatin induced organ damage via inhibiting nitric oxide-associated LPO in mice. Li *et al.* (2012) reported that sesame oil significantly decreased the blood urea nitrogen (BUN) and creatinine in acute iron intoxicated rats. Sesame oil showed both prophylactic and therapeutic effect against iron induced renal injury. Li *et al.* (2011) reported that subcutaneous injection of sesame oil protected the kidney from ferric-nitrosylacetate injected mice. In this study, they observed that sesame oil produced both prophylactic and therapeutic effect against acute renal injury in mice.

Protective role of sesame oil at a dose of 0.5 ml/kg against acute kidney injury induced by the synergistic action of aminoglycoside and iodinated contrast in rats has been reported. Sesame oil significantly altered the kidney function by inhibiting renal oxidative stress in rats (Hsu *et al.*, 2011).

Goksu Erol *et al.* (2012) studied the nephroprotective action of sesame oil against cyclosporine induced nephrotoxicity. They observed that sesame oil and omega-3 fatty acid acid treatments produced significant protection against cyclosporine induced nephrotoxicity. However, impaired renal function not altered by these treatments. Cypermethrin is one of the pyrethroid pesticides producing liver and kidney toxicity. Chronic oral administration of sesame oil at a dose of 5 ml/kg significantly altered the biochemical parameters and histological changes produced by cypermethrin (Abdou *et al.*, 2012). Sesame oil also protected the kidney from gentamicin induced nephrotoxicity at single oral dose administration (Periasamy *et al.*, 2010; Hsu *et al.*, 2010).

Neuroprotective action

Ahmad *et al.* (2012) reported that incorporation of sesame oil in diet enhancing the antioxidant enzyme. They evaluated the antioxidant potential of sesame oil in 6-Hydroxydopamine (6-OHDA)-induced neurotoxicity in mice. The mice pretreated with sesame oil diet showed the protective role via increasing the antioxidant enzyme and also inhibit activation of NADPH oxidase dependent inflammatory mechanism due to 6-OHDA induced neurotoxicity in mice. Hussien *et al.* (2011) reported that chronic administration of sesame oil in female rat decreased the oxidative stress induced by cypermethrin via enhanced antioxidant enzymes in rat brain. In this study, they observed that administration of sesame oil also preserved the histopathological damage induced by cypermethrin in rat brain. Sesamin at a dose of 30 mg/kg protecting the brain from middle cerebral artery occlusion in experimental rat. The results suggested that sesamin reduced the brain cell

death and generation of free radicals in rat brain (Khan et al., 2010).

Effect on multiple sclerosis

Ghazavi & Mosayebi, (2012) studied the protective role of sesame oil at a dose of 4 ml/kg against multiple sclerosis (MS). MS is induced in an animal model by experimental autoimmune encephalomyelitis (EAE) is a Th1 cell mediated autoimmune disease of the CNS. The results observed in this study indicated that sesame oil significantly lowered the clinical symptoms of EAE and also delayed the onset of disease. Thus, inclusion of sesame oil in the diet may be effective for MS patients.

Anticancer effects

Sesamin found to be shows anti-proliferative and antiangiogenic activity. Akl et al. (2012) studied the antiproliferative action sesamin in combination with α -tocotrienol. The results of this study revealed that the anti-proliferative effect of sesamin in combination with α -tocotrienol associated with inhibition of endothelial growth factor dependent mitogenic signaling in mammary tumor cells. Tanabe et al. (2011) studied the possible link between EphB2 and autophagy in presence of sesamin. The present study reveals a novel function for EphA1 and EphB2 in the induction of autophagy by sesamin, suggesting a tumor suppressor role for these proteins in colorectal cancer. In another study, it has been reported that sesamin may have been potential against cancer and other chronic diseases through the suppression of a pathway linked to the NF-kappaB signaling (Harkumar et al., 2010).

Miscellaneous

Endotoxin is a potent inducer of lipid peroxidation (LPO), which is associated in the development of endotoxemia. 3, 4-Methylenedioxyphenol (sesamol) is one of the sesame oil lignans with a high anti-LPO effect. Sesamol dose dependently reduced serum LPO in endotoxin-challenged rats, decreased hydroxyl radical and peroxy nitrite, but not superoxide anion counts, increased the activities of superoxide dismutase, catalase, and glutathione peroxidase in endotoxin-treated rats, reduced nitric oxide (NO) production and inducible NO synthase expression, and attenuated hepatic and renal injuries induced by endotoxin in rats. We concluded that sesamol might protect against organ injury by decreasing NO-associated LPO in endotoxemic rats (Hsu et al., 2006c).

Jiang et al. (2011) reported that sesamin an active lignan from sesame oil could stimulate melanogenesis in B16 cells via the up-regulation of MITF and tyrosinase, which was, in turn, due to the activation of cAMP signaling.

Oil pulling therapy is effective and has been used in the Indian traditional system for strengthening the teeth and to prevent the decay, bleeding gums. Asokan et al. (2011a) reported that oil pulling by using sesame oil

prevent the halitosis and organism equal to chlorhexidine. The myth that the effect of oil-pulling therapy on oral health was just a placebo effect has been broken and there are clear indications of possible saponification and emulsification process, which enhances its mechanical cleaning action (Asokan et al., 2011b). The oil pulling therapy showed a reduction in the plaque index, modified gingival scores, and total colony count of aerobic microorganisms in the plaque of adolescents with plaque-induced gingivitis (Asokan et al., 2009).

Periasamy et al. (2012a) investigated the protective effect of prophylactic sesame oil against monocrotaline-induced sinusoidal obstruction syndrome (SOS) in rats. A single prophylactic dose of sesame oil protects against SOS by downregulating MMP-9 expression, upregulating TIMP-1 expression, and inhibiting oxidative stress. However, in another study, they found that oral administration of sesame oil does not protect the rats against monocrotaline-induced SOS (Periasamy et al., 2012b). Srinivasan & Liu, (2012) studied the comparative effect of sesame oil and peanut oil against monocrotaline induced toxicity in rats. The results indicated that sesame oil is more efficacious than peanut oil against acute monocrotaline poisoning in rats.

Arumugam & Ramesh (2011) studied the protective role of sesame oil against 4-Nitroquinoline-1-oxide (4-NQO) -induced oxidative DNA damage and lipid peroxidation (LPO) in rats. Oral administrations of sesame oil prevent the DNA damage in a dose-dependent fashion. This study indicates that the antioxidant, sesame oil, effectively protected DNA damage and LPO induced by 4-NQO. Kanimozhi & Prasad (2009) reported the protective effect of sesamol against radiation-induced DNA damage in mice. The results suggested that sesamol protect γ -radiation-induced DNA damage in mice lymphocytes, which may be attributed to its antioxidant property.

CONCLUSION

Protective roles of sesame oil in various disease conditions are well documented. From the literature, it has been found that sesame oil and its antioxidant lignans sesamin and sesamol shows different pharmacological activity like cardioprotective, hypoglycemic, anticancer, anti-inflammatory, renoprotective, hepatoprotective, gastro protective and neuroprotective action. These all pharmacological effect offered by sesame oil via antioxidative mechanism. So, incorporation of sesame oil in the human diet may be alleviates all the life-threatening diseases.

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