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Lipid Ameliorating and Anti-oxidative potential of *Sesamum indicum L.* in improving blood lipid profile: A comprehensive review

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Sesamum indicum L. is an excellent source of unsaturated fatty acids and secondary metabolites. Most commonly used in Eastern and African countries, easily available and cheap source of vital nutrients. The aim of this review was to identify scientific evidences regarding the hypolipidemic and ant oxidative potential of sesame seed and its derivatives. Electronic search of Google scholar, Medline and PubMed databases are conducted. Elevated levels of plasma lipids and cholesterol is known as hyperlipidemia, increased lipids levels are directly associated with vascular and metabolic disorders. Hyperlipidemia is the most common risk factor of cardiovascular diseases. Sesame seed is loaded with vitamin E, sesamin, sesamol, lignans and phytoestrogen, these constituents have potential to reduce hyperlipidemia, hypercholesterolemia and elevated triglycerides levels. They also act as antioxidants to prevent lipid peroxidation and oxidative stress. Mechanism behind hypolipidemic effect of sesame seed, is its ability to increase superoxide dismutase SOD and glutathione peroxidase (antioxidants) activity, reduction in triglycerides and Malondialdehyde (MDA) concentration. Previous studies suggested that *Sesamum indicum L.* is highly effective to manage hyperlipidemia and dislipidemia due to its lipid ameliorating and antioxidative effect.

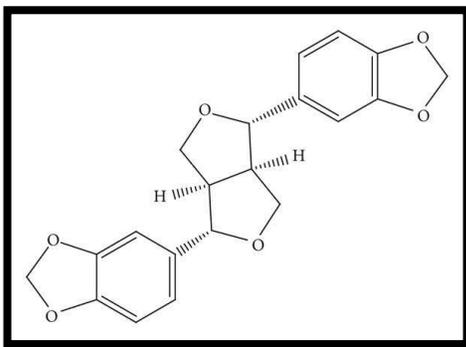
Keywords: *Sesamum indicum L.*, Blood Lipid Profile, Sesamol, Lipid Peroxidation

INTRODUCTION

Medicines made from traditional food sources have great impact on health and disease (Korou LM et al. 2014). Now a days natural foods are getting more attention due to their therapeutic effects on health. *Sesamum indicum* (sesame seed) is also considered as traditional food with potential health benefits and used as a therapeutic agent for the prevention of various diseases (Taha NM et al. 2014). *Sesamum indicum* is belonged to family *Pedaliaceae* and grown in both tropical and sub-tropical areas (Aly

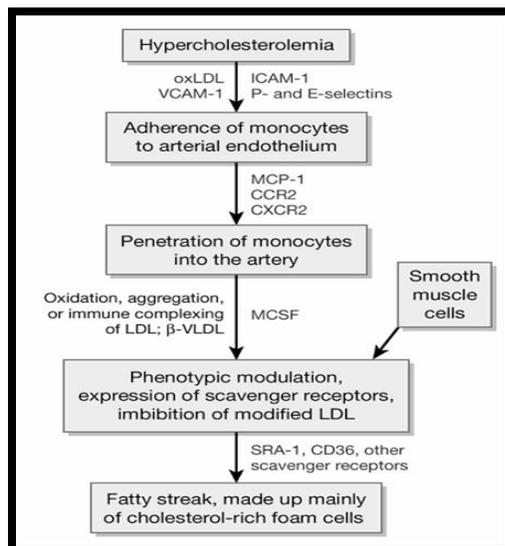
AA et al. 2020). Sesame seeds are largely used in south African and Middle Eastern countries for the purpose of cooking and baking (Sankar D et al. 2016). Industries are also used it widely for the production of pastes, bakery and vegetarian preparations (Mokhber et al. 2019). On the other hand sesame seeds are also used for medicinal purposes. *Sesamum Indicum* is a richest source of essential vitamins, minerals and other nutrients (Taha NM et al. 2014). Its major components are proteins and oils but seeds also provide sufficient amount of essential vitamins (A, E, B1, B2, B3)

and minerals (Ca, P). Whereas sesame seeds are also rich in phytochemicals, lignans, phytosterols and unsaturated fatty acids (Devarajan et al. 2016). Sesamin and sesamol (phytochemicals) are main active ingredients of sesame seeds that have potential to fight against different diseases. Diet may act as risk or protection for the progression of disease (Hernandez-Ortega \ et al. 2012), several clinical trials show that sesame seed and its products have potential to reduce the risk of cardiovascular diseases and its complications by modulating lipids levels and blood pressure as shown in table 1 (John et al. 2015). Polyunsaturated fatty acids, lignans and phytochemicals are directly associated with the reduction of CVD risk factors (Majdalawieh et al. 2020; Zhang et al. 2016).



(Yang Y et al. 2018)

Figure 1: Structure of Sesamin



Al-nuqali et al. 2016; Balakumar et al. 2016)

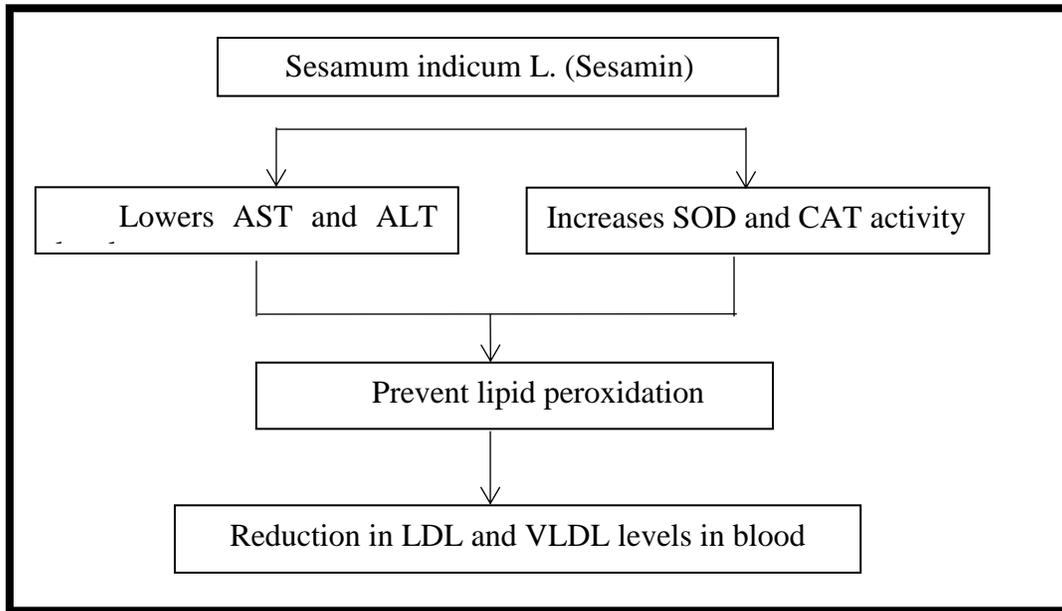
Figure2: Atherosclerosis caused by Hypercholesterolemia (Mechanism)

Hyperlipidemia is considered as one of the major risk factors of coronary heart diseases and its complications (Balakumar P et al. 2016). Hyperlipidemia and hypercholesterolemia (Vallejo-Vaz AJ et al. 2014) trigger lipid peroxidation which further leads toward atherosclerosis and clogging of arteries as shown in figure 2 (Al-nuqali E et al. 2016). It is believed that morbidity and motility rate because of cardiovascular diseases can be reduced by maintaining blood lipids levels (Cardoso et al. 2018).

Globally 80% population is affected by CVD, possible reasons behind cardiovascular diseases are hyperlipidemia, hypercholesterolemia, obesity and hypertension (Khan et al. 2018). It has been evaluated that one third of CVD is caused by elevated blood lipid levels (Shahid SU and Sarwar S, 2020). About 40-45% Pakistani population is suffering from hyperlipidemia and Pakistan ranked at seventeen (17) number with increase motility rate due to coronary heart diseases (Zaid M and Hasnain S, 2018) One third of ischemic heart disease is attributed to elevated cholesterol (Khan et al. 2019). Coronary heart disease is largely associated with hyperlipidemia that leads toward atherosclerosis, stroke and heart attacks (Lashari et al. 2019; Clebak et al. 2020).

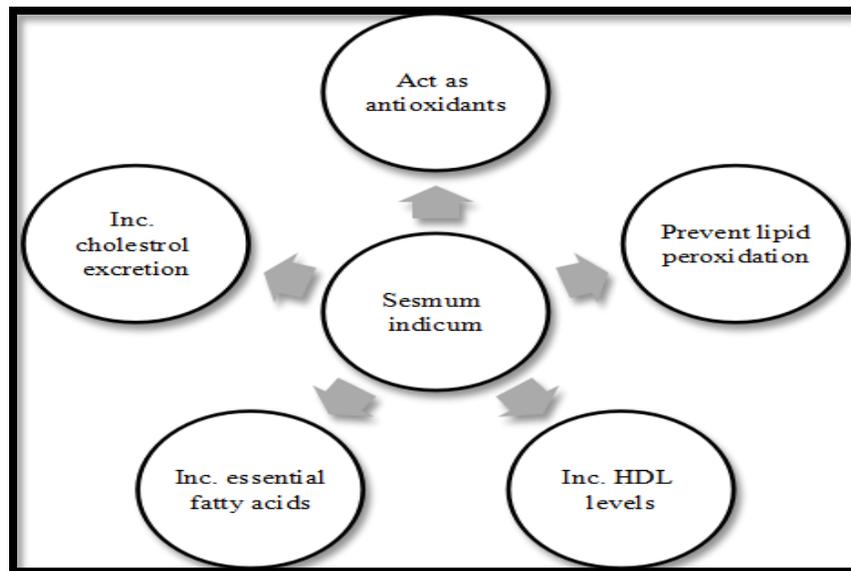
Despite the increased research on the impact of sesame seeds on several health aspects in last years, hypolipidemic effect of sesame seeds has been also observed (Ali poor et al. 2012). Sesamin (Fig 1) the active ingredient is able to reduce blood cholesterol levels by inhibiting its production in liver and reducing cholesterol absorption in intestine (Yang et al. 2018).

Sesame lignans (Qin et al. 2019) also increase the excretion of cholesterol and bile acids (Rasheed and Shakir, 2018). Several animal studies showed that *Sesamum indicum* has ability to reduce blood lipids levels by reducing the activity of acyl-CoA reductase, 3-hydroxy-3-methylglutaryl-CoA reductase inhibitors (Luijten et al. 2019) and lipid peroxidation (Ahmed AA et al. 2017; Yalagala et al. 2017). Antioxidant mechanism has been determined by increased production of Superoxide dismutase (Bigoniya et al. 2012) and Glutathione peroxidase (Annema et al. 2016). Sesame seeds and its products are also responsible for enzymatic and non-enzymatic antioxidants production (Khalesi et al. 2016).



(Wang et al. 2020)

Figure 3: Lipid lowering effect of *Sesamum indicum*



(Alipoor et al. 2012; Qin H et al. 2019)

Figure 4: Hypolipidemic potential of *Sesamum indicum*

Table 1: Summary of studies

Dietary Element	Studied participants	Sample size	Study Duration	Effect on Blood lipids levels and oxidative -stress	References
Sesame seeds (50g)	Osteoarthritic patients	25	8-weeks	Increased Antioxidants capacity	Eftekhar Sadat et al. 2013
Sesame seed Powder (50g)	Over weight and Obese women	46	6-weeks	Reduce lipid levels , reduction in fat percentage	Hojati et al. 2018
Black and white sesame seeds	Hyperlipidemic rats	100	4-weeks	Reduction in TG, TC, LDL levels Increased production of SOD and CAT	Li C et al. 2020
Sesame seed Powder (40g)	Hyperlipidemic patients	21	4-weeks	Reduced lipid profile and Improved total Antioxidant capacity	Chen \ et al. 2016
Sesame seed extract (25, 50,75mg)	Hyperlipidemic rats	30	60sdays	Improvement in lipid levels and antioxidant capacity	Sivakanthan et al. 2017
Sesame seeds (40g)	Hyperlipidemic patients	50	60days	Increase production of SOD and glutathione peroxidase enzymes Improvement of blood lipids levels	Haghighian et al. 2014
Sesame oil, rice bran oil and ground nut oil	Wistar Male rats	18	25	Anti-inflammatory effect	Yalagala et al. 2017
0.5g/kg sesame seed oil and 1.25g/kg sesame butter to diabetic rats for 6-months	Male albino rats	40	6weeks	Sesame butter has more antioxidant potential than oil	Haidari et al. 2016
Sesamol (100 mg/kg body weight)	Obese rats	50	4weeks	AST,ALT REDUCE	Qin et al. 2019
sesame seed cake	Wistar albino rats	25	4weeks	Low TG,TC	Bigoniya et al. 2012
Sesame seed oil 50 g	Male Balb/c mice	32	1month	antioxidative	Khorrami et al. 2018
Sesamin supplements	Sprague-Dawley rats	45	5weeks	Lipid lowering effect	Zhang et al. 2016

Lipid ameoliorating and anti-oxidative potential

Hyperlipidemia is characterized by elevated blood lipids levels and major risk factor of CVD (Hussein et al. 2017). Different nutraceuticals and pharmaceutical food products are used for prevention and management of cardiovascular diseases (Sarfraz et al. 2016). Several studies have been conducted to find out the therapeutic effect of sesame on lipids levels (Abdul-Lattif F, 2018) Phytosterols present in sesame help to reduce total cholesterol, triglycerides (Brooks \ & Schindler \ . 2019), adipose tissues and total fats

in rats. It has been reported that animals fed with sesame seeds supplements had more antioxidants levels than others (Mallick et al. 2016). Most of diseases are caused by oxidative-stress such as atherosclerosis and ischemic heart diseases. Sesame seeds and its derivatives are also responsible to increase total antioxidant capacity (TAC), which prevent further lipid peroxidation. Malondialdehyde is the end product of lipid peroxidation which has been reduced by consuming sesame seed supplementation (Haidari et al. 2016).

In a study hypolipidemic effect of *Sesamum indicum* was determined in hyperlipidemic rats. Thirty rats were divided into five groups, (1)

control group was fed on regular food and 1g multivitamins, (2) group two was provided 3.7ml coconut oil, normal food, water and 1g multivitamins whereas group 3,4,and 5 were provided 25, 50, 75mg sesame seed extract per kg body weight orally for 60 days. The findings showed that the level of total fats and adipose tissues were reduced while antioxidants enzymes were increased in rats, fed with sesame seed extract as compare to other intervention groups (Sivakanthan et al. 2017).

Haghighian et al. examined the antioxidative and hypolipidemic effect of *Sesamum indicum L*. supplementation in osteoarthritis patients. In this study intervention group was provided with 40g sesame seed supplement (powder) for 60 days of study. After the completion of study TAC, TC, LDL, HDL and triglycerides levels were measured. Findings showed a significant reduction in LDL, TC and triglycerides levels whereas HDL levels were improved. TAC (total antioxidant capacity) were also increased in intervention group. Thus, the findings revealed that sesame seed is a good source of antioxidants (Haghighian et al. 2014).

Rheumatoid arthritis (RA) is also an inflammatory disease and oxidative stress plays a significant role in its progression (Maleki et al. 2015). Different studies proved that Sesamin, the main lignin constituent of sesame seed, is an effective antioxidant and anti-inflammatory agent. This study was conducted to determine the effect of sesamin on RA, lipid profile and oxidative stress markers. Placebo-controlled clinical trial was conducted by randomly selecting 44 participants with RA and divided into two groups: intervention and control group. Patients were provided 200 mg/day of sesamin supplement and placebo, for 6 weeks in both groups. Anthropometric measurements and blood pressure were assessed at the start and end of the study. Results showed that sesamin supplementation significantly decreased MDA (malondialdehyde) levels and increased TAC levels. In the sesamin group, the mean of weight, body mass index, waist-to-hip, systolic blood pressure, LDL levels and total cholesterol levels were also reduced. There was no change in parameters in other group. So it has been concluded that sesame seed is beneficial for both CVD and RA (Gouveia et al. 2016).

Hypolipidemic and antioxidant effect of sesame seeds supplements were also determined in 21 hyperlipidemic patients. In this study subjects were instructed to consume 40g roasted sesame seed powder for 1month with regular diet.

Participant,s body weight and blood lipid levels were examined at the start and end of the study. After one-month, the findings revealed that there was a significant reduction in rthiobarbituric acid–reactive substances in LDL and cholesterol levels (Chen et al. 2005).

Sesamum indicum perform different biological effects in both animals and humans. Another study was performed in which hyperlipidemic rats were fed with sesame kernels and sesame seed. Finding of this study evaluated that sesame seeds have more beneficial impact on weight, hyperlipidemia and antioxidants levels as compared to kernel group. Body weight of rats fed with sesame seed was significantly reduced while antioxidants capacity, glutathione peroxidase (GSH-Px), superoxide dismutase (T-SOD) and HDL levels were increased. Due to increased antioxidants capacity malondialdehyde (MDA) levels were also reduced. Liver indexes revealed that sesame seeds and sesame kernel have potential to prevent the accumulation of fats on liver (Li figure et al. 2020). Sesame seeds contain more than 50% oils (MUFAs and PUFAs) (Raesi-Dehkordi H et al. 2018). These essential fatty acids are considered as lipids lowering agents and prevent the progression of coronary artery diseases (Narasimhulu et al. 2016). Similarly a study was conducted to find out hypolipidemic effect of sesame seeds in women with metabolic syndrome. Women were advised to consume 50g sesame seed powder for 6-weeks. After intervention period body fat percentage, BMI(body mass index), waist circumference and lipids levels were measured. Results indicated that body weight was comparatively reduced in sesame group and total body fats were also significantly reduced (Hojati \ et al. 2018).

Phytosterols (plant sterols) are naturally occurring components present in the cell wall of plants. Phytosterols have resemblance to cholesterol present in human body (Ide T et al. 2015). There phytosterols compete with cholesterol present in body and inhibit its absorption in small intestine. *Sesamum indicum L*. contains significant a mount of phytosterols that help to reduce blood cholesterol levels (Khatun et al. 2019). Hypolipidemic mechanism of *Sesamum indicum L*. is based upon its phytochemical's (Sasamin) ability to reduce Alkaline phosphatase (ALP), Aspartate aminotransferase (AST) and Alanineaminotransferase (ALT) levels as shown in figure 3 (Wang et al. 2020). These enzymes are involved in lipid peroxidation which increasse Melonaldehydes levels in blood (Dravie et al.

2020).

On the other hand sesamol is able to increase blood SOD and catalase (CAT) activity (Jahagirdar A et al. 2018).

Antioxidant potential of *Sesamum indicum* L. has been also observed in another study. In which patients with knee osteoarthritis were referred to consume 50g sesame seeds for 8 weeks. There was a significant improvement in clinical signs and symptoms of knee osteoarthritis (Eftekhar Sadat et al. 2013). Hyperlipidemia has become a leading cause of CVD and its complications.

CONCLUSION

This article finds out the potential benefits of *Sesamum indicum* and its active ingredient Sesamin. Depending upon previous studies *Sesamum indicum* has potential to improve blood lipids levels and antioxidants capacity, which is directly associated with prevention of cardiovascular diseases as shown in figure.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

Add contribution of each author (with abbreviated name) here. For example WEP designed and performed the experiments and also wrote the manuscript. EW, OA, and IDJ performed animal treatments, flow cytometry experiments, tissue collection, and data analysis. AS and MR designed experiments and reviewed the manuscript. All authors read and approved the final version.

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