Review Article

From Ancient Wisdom to Modern Health: 'Let Food Be Thy Medicine' – Examining the Cardiovascular Impact of Ghee and Seed Oils"

FNU Anamika[1], Sidharth Mahajan[2], Parth Munjal[3], Kanishk Aggarwal[4], Rohit Jain[5]

From, [1]University College of Medical Sciences, New Delhi, India, [2]Government Medical College, Amritsar, India, [3]Rohilkhand Medical College and Hospital, Bareilly, India, [4]Dayanand Medical College and Hospital, [5]Penn State Milton S. Hershey Medical Center, PA, USA

ABSTRACT

Diet and eating habits are closely linked to overall health, particularly cardiovascular well-being. In recent years, there has been a growing trend in the consumption of ghee (clarified butter) and seed oils (vegetable oils derived from plant seeds such as corn, soybeans, sunflower, and peanuts). While concerns have been raised due to their high-fat content, both ghee and seed oils contain bioactive compounds with potential health benefits. Ghee is a rich source of fat-soluble vitamins—A, D, E, and K—and also contains short-chain and medium-chain fatty acids that may have anti-inflammatory and lipid-modulating effects. Some studies suggest that moderate ghee consumption may improve HDL levels and reduce LDL oxidation, potentially lowering the risk of atherosclerosis. Conversely, seed oils are high in Omega-6 and Omega-3 polyunsaturated fatty acids (PUFAs), which are known to support endothelial function and reduce systemic inflammation when consumed in appropriate ratios. This narrative review aims to assess and compare the effects of ghee and seed oil intake on cardiovascular disease risk, drawing on current scientific literature to clarify their respective roles in cardiovascular health and disease prevention.

Key words: Seed oil, ghee, vegetable oil, cardiovascular disease, omega-3 polyunsaturated fatty acids, refined oil

Diet plays a significant role in well-being and susceptibility to illness throughout human life, with the distinction between beneficial and detrimental eating habits continually evolving to adapt to various factors, including nutritional requirements, population changes, and advancement in research [1]. In recent years, significant attention has been directed towards understanding how specific dietary patterns influence the development and prevention of diseases, particularly the consumption of oil and clarified butter (ghee), which contain fats that often warrant thorough examination due to their potential impact on health [2].

Clarified butter, also known as ghee, is derived from the milk of animals such as cows, buffaloes, camels, goats, and other animals and is prepared by heating butter or cream to just over 100°C to remove water content by boiling and evaporation, then filtering out the precipitated milk solids [3]. Ghee is mainly composed of 99.5% fat and less than 0.5% moisture and is a rich source of fat-soluble vitamins such as vitamin A (28.21 ± 0.142 IU/g), vitamin D (11.42 ± 0.425 IU/g), vitamin E (31.55 ± 1.109 IU/g), vitamin K, and phospholipids with providing about 110 calories/day/person or 5.5 % of the daily energy on a 2000-calorie diet [3, 4].

India is the largest consumer of ghee, where the per capita consumption of ghee and butter increased to 4.48 kg per year (12.3 grams per person per day) in 2020 from 2.7 kilograms per year (7.4 grams per person per day) in 2007 [4]. Studies analyzing the fatty acid composition of ghee have revealed that it typically contains approximately 47.8% saturated fat, around 62% monounsaturated fatty acids (MUFA), mainly conjugated linoleic acid, and is recognized for its anti-carcinogenic, anti-atherogenic, anti-adipogenic, and anti-diabetic properties [5]. Though ghee is considered a culturally and commercially vital food entity, it remains a controversial food ingredient among modern nutritionists and codified traditional medicinal knowledge systems with differing views. Conventional knowledge systems like Ayurveda perceive ghee as a healthy food with therapeutic value. At the same time, modern nutritionists consider that consuming dairy fat should be limited due to saturated fatty acids, which raise the risk of cardiovascular diseases (CVD) [6].

In addition, various studies studying the effect of supplemented diets on cardiovascular health have yielded

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Correspondence to: FNU Anamika, University College of Medical Sciences, New Delhi, India.
Email: anamikapilaniya@gmail.com

mixed results, with some studies showing that diets containing 5% to 10% ghee consumed over periods ranging from 2 weeks to 2 months did not significantly alter serum total cholesterol and triglyceride levels and affect cardiovascular health [5]. However, other experimental studies analyzing the effect of a ghee supplementation diet have reported increased serum total cholesterol and triglycerides after feeding a 10% ghee-supplemented diet for two months [5].

Seed oil is derived from various plants' seeds, such as corn, soybeans, peanuts, castor, canola, sunflower, cottonseed, etc [7]. The increasing global demand for vegetable oils highlights their importance as healthier alternatives, as they contain more unsaturated fatty acids than animal fats like ghee. In 2022/23, sunflower seed oil amounted to maximum consumption worldwide with about 20.5 million metric tons. In contrast, soybean oil had the highest level of edible oil consumption in the United States in 2023, with Americans consuming about 12.25 million metric tons of soybean oil [7]. Over the years, they have been identified to replace the high saturated content of ghee and other hydrogenated oil as they are rich in omega-6 polyunsaturated fats, particularly linoleic acid (LA) and omega-3 fats like alpha-linolenic acid (ALA), with exact composition varies based on plant species, strain, environmental conditions, and extraction methods [8].

The MUFAs are significantly found in sources like: olive, canola, peanut, sunflower, and sesame seeds. In contrast, polyunsaturated fatty acids (PUFAs) are predominantly found in soybeans, corn, sunflower, and certain nuts and seeds, such as walnuts and sunflower seeds. Another omega-3 fatty acid, alpha-linolenic acid (ALA), is mainly found in nuts and seeds like walnuts, flaxseed, and vegetable oils such as soybean and canola [9]. While seed oils provide a protective effect on the body, especially the cardiovascular system, due to the presence of omega-3 fatty acids, however their processing and refining chemical methods like degumming, neutralization, bleaching, and dewaxing lead to the formation of refined oil often pose a significant risk to the body [10].

In addition to the chemical processes, high temperatures involved in refining, reaching up to 270°C during deodorization and oil extraction, can compromise the oil's quality by depleting antioxidants like tocopherols and sterols, generating free radicals and trans fats, triggering inflammatory responses, causing tissue damage, and forming polymeric compounds with potential atherogenic and mutagenic effects. In addition, repeated frying exacerbates this degradation, accumulating harmful compounds detrimental to the cardiovascular system [11].

It is crucial to consider that the data suggesting a link between high fat and CVD may not address the involvement of other risk factors, such as a sedentary lifestyle, cigarette smoking, primary hyperlipidemia, obesity, hypertension, and diabetes mellitus in CVD development, instead of oil and ghee consumption alone. This highlights the need for comprehensive knowledge about the complex mechanisms driving ghee and seed oil consumption and their impact on cardiovascular health. Communities, especially those who consume large amounts of seed oil and ghee, can benefit from a scientific understanding of these biochemical and cellular mechanisms for better cardiovascular health. This article reviews the effects of seed oil and ghee consumption on the risk of cardiovascular diseases.

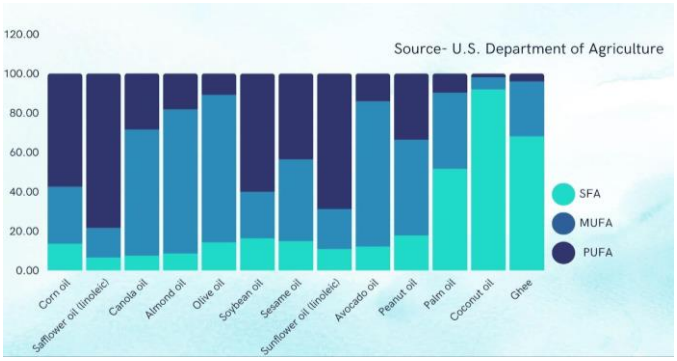

Figure 1: Fat composition of various fats in oils and ghee

SFA: Saturated fatty acids; MUFA: monosaturated fatty acids; PUFA: polyunsaturated fatty acids

Pathophysiology

Dietary fats play a crucial role in our nutrition, providing essential energy and nutrients for our well-being. The sources from which we obtain fats are of paramount importance, as they directly influence our energy levels, nutrient intake, and overall health [12]. Understanding the intricate relationship between dietary fats and cardiovascular health is crucial in promoting optimal well-being. We must incorporate options like seed oil or clarified butter into our diets when considering nutritional fats [13].

Seed oils are rich in polyunsaturated fatty acids (PUFAs), which have been associated with numerous cardiovascular benefits, including reduced blood pressure and improved cholesterol levels [14]. The advantages of seed oils come from how they're made up chemically and affect various metabolic processes in the human body. Omega-6 and omega-3 PUFAs present in seed oils are essential as they play a crucial role in the production of eicosanoids such as prostaglandins (PGs), prostacyclin (PGI), and lipoxins. These eicosanoids have an essential function in vasodilation and antiplatelet aggregatory action. PUFAs also increase the endogenous production of nitric oxide (NO), which is a potent vasodilator and, in turn, causes a reduction in blood pressure.

Studies have demonstrated that seed oils, specifically canola oil, can benefit high-density lipoprotein (HDL) cholesterol and triglyceride levels. This is mainly because they contain a significant amount of ALA, an omega-3 fatty acid. Canola oil is not a substantial source of docosahexaenoic acid (DHA), but it is abundant in ALA, which can be metabolized by the body into DHA. This conversion process is associated

with increasing the functionality of HDL cholesterol, the "good" cholesterol, and increases levels of HDL and triglyceride metabolism [15, 16]. The impact of seed oils on metabolic processes suggests a promising potential for reducing the risk of cardiovascular disease.

While seed oil offers numerous positive effects, addressing its potential drawbacks is essential, primarily originating from the presence of Trans Fatty Acids (TFA). Trans-fats are formed through hydrogenation, which converts liquid oils into solid fats [17]. Structurally, trans fats have a unique configuration of carbon-carbon double bonds in their fatty acid chains. Unlike cis fats, where hydrogen atoms are on the same side of the double bond, trans fats have hydrogen atoms positioned on opposite sides. This trans configuration alters the shape of the fatty acid chain, resulting in a more linear structure, and contributing to their harmful effects on health. They have been strongly associated with an increased risk of cardiovascular disease by raising LDL (low-density lipoprotein) cholesterol, also known as "bad" cholesterol, while simultaneously lowering levels of HDL [18]. TFAs induce systemic inflammation by influencing prostaglandin activity. They elevate inflammatory markers such as IL-6, plasminogen activator inhibitor-1 (PAI-1), Tumour necrosis factor (TNF-α), TNF receptors, and monocyte chemoattractant protein-1 [19].

They hinder the synthesis of crucial fatty acids like arachidonic acid by inhibiting the desaturase enzyme, altering the metabolic balance, and contributing to hypercholesterolemia and coronary artery disease (CAD) [19, 20]. Another commonly used cooking oil is clarified butter, known as ghee. It is a source of saturated fats and contains antioxidants that may support heart health when consumed in moderation [20]. Consuming ghee in moderation has demonstrated various health benefits, including cognitive improvement, gastrointestinal tract health, immunomodulation, and cardiovascular benefits. Ghee consumption at 2.5% of total energy levels has shown a dose-dependent decrease in LDL, very low-density lipoprotein) VLDL, cholesterol, and triglyceride levels, while also reducing fatty streak formation in the coronary arteries of rabbits. The cholesterol-lowering effect of ghee may be attributed to increased secretion of cholesterol in bile [21]. Ghee's capacity to reduce the levels of arachidonic acid metabolites, including thromboxane and prostaglandin, and inhibit the release of leukotrienes may also be advantageous in preventing cardiovascular disease [5].

Ghee is a rich source of fats, specifically saturated fatty acids (SFAs). SFAs are a diverse group of fatty acids that consist solely of carbon-to-carbon single bonds. About 62% of ghee's SFA content comes from palmitic acid, which is associated with an increase in LDL and total cholesterol [22]. Elevated levels of LDL are a significant contributing factor to the development of CAD [23]. The primary cell membrane receptor for LDL is LDLR(LDL receptor), which is produced by the LDLR gene. LDL in circulation binds to the LDLR and is internalized through endocytosis, resulting in the formation of vesicles called endosomes. Upon entering the cytoplasm, LDL separates from the LDLR, and the LDLR is subsequently returned to the plasma membrane by recycling. LDL is transported to lysosomes, where it is broken down by acid hydrolase, resulting in the release of small-molecule cholesterol that can be used by cells [24].

Without LDLR on the plasma membrane or insufficient LDL receptors, LDL cannot enter the cell for destruction. This leads to elevated cholesterol levels in the bloodstream. The LDLR gene is downregulated in response to increased intracellular cholesterol levels. Consequently, dietary fat intake significantly determines lipid levels in the bloodstream, affecting the risk of developing CAD. Elevated levels of lipids in the blood can lead to the deposition of adipocytes within arteries, contributing to the progression of atherosclerosis, a key factor in the development of CAD [25]. Understanding the diverse effects of dietary fats on cardiovascular health underscores the importance of informed nutritional choices for promoting overall well-being and reducing the risk of coronary artery disease.

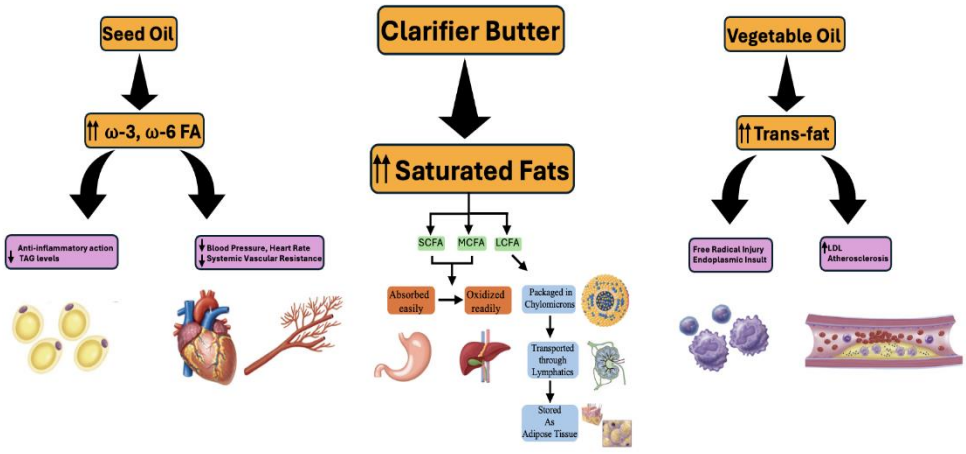

Figure 2: Comparative Pathways and Atherosclerosis Risk: Seed & Vegetable Oil vs. Clarified Butter. "This figure is an original creation by the authors."

DISCUSSION

Cardiovascular health is influenced by various factors, such as diet, exercise, medical comorbidities, and genetic predisposition. Among dietary components, fats play a crucial role, and one debated aspect is choosing between two widely consumed options: clarified butter (ghee) or seed oil.

Ghee consumption has been associated with lower incidence and lower prevalence of cardiovascular diseases [26]. A cross-sectional study conducted by Vyas et al., which included 200 individuals above 40 years of age with no prior health comorbidities, revealed that a history of ghee consumption correlated with a lower incidence of coronary heart disease (CHD) compared to oil consumption [27]. However, this study had limitations such as reliance on less objective measurements and a small sample size. Similarly, in a cross-sectional study by Gupta et al., which included a large sample size of 1982 males aged above 20 years, a lower prevalence of CHD was found among a rural population that consumed more than 1 kg of ghee per month {Odd's Ratio (OR): 0.23, 95% Confidence Interval(CI): 0.18-0.30} [28].

In a randomized controlled trial that compared the effects of different cooking fats on blood lipid levels, it was seen that the consumption of ghee resulted in a decrease in triglyceride levels by 6.3 mg/dl (95% CI: -10.7 to -2.0) and a significant increase in apolipoprotein A (ApoA) levels by 3.5 mg/dl(95% CI: 2.4 to 9.4) [29]. There was also a substantial reduction in triglyceride levels by an average of 9.6 mg/dl in the blended oil group, with the most significant decreases in total cholesterol by 8.4 mg/dl and triglycerides by 11.2 mg/dl in the soft margarine oil. Besides these positive impacts of ghee, a few studies have reported the negative consequences. In a case-control study by Ismail et al., which recruited 388 individuals (194 cases and 194 controls) aged 15-45 years, ghee consumption was identified as an independent risk factor for acute myocardial infarction in the cases (OR: 3.91, CI: 1.52 - 10.03) [30].

Table 1: Summary of Studies Highlighting Positive Effects of Ghee on Cardiovascular Health

Study Name	Study Design	Study Results
Gupta et al. [13]	Cross-sectional Survey	Lower CHD, lower cholesterol/triglycerides, improved psoriatic symptoms in ghee consumers.
Mohammadi Hosseinabadi et al. [14]	Crossover RCT	Ghee increased apo-B and non-HDL cholesterol but LDL and cholesterol: HDL ratio were comparable.
Mohammadifard et al. [15]	RCT	Triglycerides reduced by 6.3 mg/dl, and ApoA increased by 3.5 mg/dl.

Table 2: Summary of Studies Highlighting Detrimental Effects of Ghee on Cardiovascular Health

Study Name	Study Design	Study Results
Ismail et al. [11]	Case-Control Study	Ghee was an independent risk factor for AMI in South Asian adults (OR: 3.91).
Shankar et al. [12]	RCT	Ghee increased total and HDL cholesterol vs. mustard oil.

Seed oils, derived from seeds like corn, soybeans, and cottonseed, contain high levels of omega-6 polyunsaturated fats, particularly linoleic acid (LA), and some omega-3 fats like alpha-linolenic acid (ALA) [31]. Consuming seed oils, particularly those rich in omega-6 fatty acids like oxidized linoleic acid, notably escalates the risk of atherosclerosis and, consequently, heart diseases [32]. While omega-3 fats have anti-inflammatory properties, excess linoleic acid can lead to inflammatory responses and tissue damage [33]. Modern diets in the U.S. and some other regions have shifted dramatically towards higher omega-6 to omega-3 ratios, mainly due to increased consumption of seed oils. Some studies describe the neutral impact of seed oils.

In a 3-month controlled-feeding trial, Wu et al. compared the effects of n-6 PUFA-rich soybean oil, MUFA-rich olive oil, and MUFA-rich camellia seed oil on body weight and cardiometabolic profiles among Chinese women, finding no significant difference in body weight changes but observing favorable effects on cardiometabolic profiles with olive oil and camellia seed oil consumption, such as a slight increase in HDL levels [34]. Nicol et al. conducted a randomized controlled trial comparing the effects of sunflower and rapeseed oil consumption on coronary artery disease biomarkers, revealing no differential impact on biomarkers [35]. Some other studies showed positive effects of seed oils, like Chardonnay seed oil supplements, which have demonstrated improvement in peripheral endothelial function due to polyphenols [36].

Studies also showed an effect on lipid profile and hypertension control, like seabuckthorn seed oil, which has also demonstrated reductions in dyslipidemia and blood pressure in hypertensive patients [37]. Baru almond oil supplementation in hemodialysis patients reduced dyslipidemia and cardiovascular risk factors [38]. Alwosais et al. investigated the effects of chia seed supplementation in adults with type 2 diabetes, finding improved systolic blood pressure [39]. In a study by Akrami et al., there was a reduction in blood pressure, total cholesterol, LDL, and triglyceride levels, and no significant change in fasting glucose levels, with the consumption of Flaxseed oil and sunflower seed oil in 60 patients aged 30-60 and diagnosed with metabolic syndrome [40]. Kuhnt et al. assessed the effects of echium oil supplementation on cardiovascular risk factors,

observing increases in long-chain n-3 PUFAs and reductions in cardiovascular disease markers [41].

The literature collectively highlights the potential of dietary oils, such as olive oil, chia seed oil, and echium oil, in improving cardiovascular health markers, including blood pressure, lipid profiles, and endothelial function, offering promising strategies for cardiovascular risk reduction. Given the complexity of the relationship between dietary fats and cardiovascular health, further research is necessary to identify ghee and diverse seed oils' specific impacts on different populations and better understand the mechanisms underlying these effects. Additionally, considering individual variations in response to dietary fats and oils, personalized nutritional approaches may be crucial in optimizing cardiovascular health outcomes.

Table 3: Summary of Studies Highlighting Positive Effects of Seed Oil on Cardiovascular Health

Study Name	Study Design	Study Results
Shoaei-Hagh et al. [2]	Double-blinded RCT	Reductions in BP, total cholesterol, and LDL.
Wu et al. [3]	Double-blinded RCT	Olive and camellia seed oils improved cardiometabolic profiles.
Nicol et al. [4]	RCT	No differential impact on CAD biomarkers from sunflower vs. rapeseed oil.
Alwosais et al. [5]	RCT	Chia seed improved systolic BP in T2DM patients.
Schincaglia et al. [6]	RCT	Baru almond oil reduced dyslipidemia and CV risk.
Corban et al. [7]	Double-blinded RCT	Chardonnay seed polyphenols improved endothelial function.
Akrami et al. [8]	RCT	Both flaxseed and sunflower oil reduced BP and lipid peroxidation.
Vashishtha et al. [9]	Double-blinded RCT	Seabuckthorn seed oil reduced dyslipidemia and BP.
Kuhnt et al. [10]	Double-blind RCT	Echium oil increased n-3 PUFAs and improved CV markers.

Table 4: Summary of Studies Highlighting Detrimental Effects of Seed Oil on Cardiovascular Health

Study Name	Study Design	Study Results
DiNicolantonio et al. [1]	Hypothesis Study	Oxidized linoleic acid in omega-6 vegetable oils is a driver of atherosclerosis and heart disease in Western populations.

Future Directions

While current evidence provides important insights into the cardiovascular implications of ghee and seed oil consumption, several gaps remain that warrant further investigation. Future research should explore the differential effects of various types of ghee—such as cow ghee, buffalo ghee, and commercially processed ghee—on lipid metabolism, endothelial function, and inflammatory markers. Comparative studies evaluating traditionally prepared versus industrially processed ghee could help clarify whether the method of preparation alters its cardiovascular risk profile.

Similarly, seed oils differ significantly in their fatty acid composition; thus, randomized controlled trials assessing individual oils like sunflower, canola, soybean, flaxseed, and mustard oil are needed to delineate their specific impacts on atherosclerosis, hypertension, and cardiac function. Moreover, the influence of the Omega-6 to Omega-3 ratio in these oils on cardiovascular outcomes remains a key area of interest. Longitudinal cohort studies that account for confounding dietary and lifestyle factors would further enhance understanding. Lastly, the molecular mechanisms by which these fats influence lipid oxidation, nitric oxide bioavailability, and endothelial integrity should be explored through mechanistic and translational studies.

CONCLUSION

Dietary fats play a crucial role in our nutrition by influencing energy levels, nutrient intake, and overall well-being; thus, it becomes essential to recognize this vital relationship between dietary fats and cardiovascular health. Seed oils as well as clarified butter can be discerned as a double-edged sword, hence it is of paramount importance to balance the consumption, while minimizing trans fats and saturated fats in the former and latter, respectively is crucial. Informed dietary choices that consider the complex effects of different fats on cardiovascular health can help reduce the risk of coronary artery diseases and enhance quality of life.

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