



Review Article



Pumpkin Seeds and Heart Health: A Comprehensive Review of Their Role in Cardiovascular Disease Prevention and Management

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ABSTRACT

Cardiovascular Diseases (CVDs) remain a major global health concern, with an increasing prevalence requiring urgent preventive strategies. Diet and lifestyle play a crucial role in CVD development, emphasizing the need for healthy food interventions. To explore the potential cardioprotective benefits of pumpkin seeds (*Cucurbita spp.*) and their bioactive compounds in promoting cardiovascular health. Relevant literature was reviewed to evaluate the macronutrient and micronutrient profile of pumpkin seeds, as well as their bioactive compounds. Study Design: A comprehensive review of the nutritional composition and functional properties of pumpkin seeds was conducted, focusing on their role in cardiovascular disease prevention. Key components, including linolenic acid, phytosterols, antioxidants, and pumpkin seed oil, were analyzed for their potential impact on cardiovascular health. Pumpkin seeds are rich in proteins, carbohydrates, and unsaturated fatty acids, along with essential micronutrients such as zinc, phosphorus, magnesium, potassium, and selenium. Linolenic acid in pumpkin seeds offers protective effects against CVDs, diabetes, and certain cancers. Phytosterols contribute to lowering LDL cholesterol levels, while their strong antioxidant properties help reduce oxidative stress, lower blood pressure, and prevent arteriosclerosis. Pumpkin seed oil, rich in magnesium, enhances Nitric Oxide (NO) production, supporting vascular function and aortic protection. Given the increasing focus on plant-based diets for chronic disease prevention, regular consumption of pumpkin seeds may provide significant benefits in improving cardiovascular health. Further research and clinical trials are recommended to establish optimal dietary intake guidelines for maximizing their protective effects.

INTRODUCTION

Cardiovascular Diseases (CVD) are considered among the main diseases in the world. In the developed countries the prevalence of CVDs have become greater at an alarming rate than the past [1]. In almost every country, CVD issues are continuing their long-term rising trend. Major causes of CVD are Cardio metabolic, behavioral, environmental, and social risk factors. CVDs are common, have an increased persistence rate, and are growing in prevalence. Intervention strategies for improving health in countries should be specifically considered such as diabetes

prevention and management, weight management and increased physical activity, healthy diet, tobacco and alcohol prevention and activities for increased endurance and alcohol reduction [1]. To reduce the prevalence of these heart diseases, there is a need to include the plant-based products in the human diet owing to their significant antioxidant and bioactive properties. One such plant product is pumpkin [2]. Pumpkin is taken from the Greek word pepon, meaning a big melon. In the South Asian region, it is commonly regarded as 'Kashiphal', 'Sitaphal' or



'Kaddu' [3]. Cucurbitaceous family consists of gourds, squashes, melons and pumpkin [2]. Kingdom Plantae consists of a number of families; the greatest percentage of edible plant species is in Cucurbitaceae family [4]. The five genera; *Cucurbita*, *Sechium (chayotte)*, *Lagenaria (gourds)*, *Cucumis (cucumbers, gherkins and melons)* and *Citrullus (watermelons and wild colocynths)*, include pumpkins which may be added to the human diet in the fresh or processed form [5]. *Cucurbita maxima*, *Cucurbita moschata*, and *Cucurbita pepo* are the three most popular species among the 12 distinct species of the genus *Cucurbita* [6]. Pumpkin seeds (*Cucurbita spp.*) contain several bioactive compounds that contribute to cardiovascular health by lowering cholesterol, reducing blood pressure, and combating inflammation [7]. Phytosterols, such as β -sitosterol, campesterol, and stigmasterol, structurally resemble cholesterol and compete for absorption in the intestines, leading to a reduction in LDL cholesterol levels and improved lipid metabolism. Linolenic acid (omega-3 fatty acid) plays a crucial role in cardiovascular protection by inhibiting hepatic triglyceride synthesis, upregulating LDL receptor expression, and promoting cholesterol excretion through bile acids. Additionally, it enhances nitric oxide (NO) production, leading to vasodilation and improved vascular function while also reducing pro-inflammatory cytokines like TNF- α and IL-6. Magnesium, another key component, acts as a calcium antagonist, preventing vascular smooth muscle contraction and promoting vasodilation, ultimately lowering blood pressure [8]. It also supports endothelial function by stimulating NO synthesis and reducing oxidative stress. Potassium in pumpkin seeds further contributes to blood pressure regulation by maintaining electrolyte balance and counteracting sodium-induced hypertension. The antioxidants present, including vitamin E, polyphenols, and carotenoids, help scavenge Reactive Oxygen Species (ROS), inhibiting lipid peroxidation and reducing arterial plaque formation. Moreover, cucurbitacins, a group of triterpenoids found in pumpkin seeds, suppress NF- κ B and COX-2 pathways, reducing inflammation and preventing atherosclerosis. Additionally, the presence of tryptophan, a serotonin precursor, may indirectly lower stress-related hypertension. Collectively, these bioactive compounds contribute to cardiovascular protection by improving lipid metabolism, enhancing vascular function, lowering blood pressure, and reducing systemic inflammation. Regular consumption of pumpkin seeds as part of a balanced diet may thus offer significant cardioprotective benefits [9]. Historically, the pumpkin seeds have frequently been used as a soil fertilizer in agriculture, as animal feed, and in treating the problems of kidneys, prostate and bladder [2]. Moreover, pumpkin seeds contain fiber, sterols, and omega-3 fatty acids that

provide cholesterol lowering effects in blood. The predominant oils extracted from the pumpkin seeds contain high amount of oleic and linoleic acids, which are unsaturated [4]. A study showed that the death rate from coronary artery disease was significantly lower in humans who consumed diets high in linoleic acid [10]. The oil extracted from pumpkin seeds has anti-inflammatory effects and lowers blood pressure and cholesterol [11]. Triacylglycerol concentrations are lowered and multiple CVD risk factors are mitigated by pumpkin seeds oil ingestion [12, 13]. For a long time researches have been conducted on the active components of the pumpkin skin flesh and seeds, providing a brief overview of their health-related effects. These studies have shown that pumpkin peel has anti-inflammatory effects, antibiotic properties, anticarcinogenic, antidiabetic, and antihypertensive effects, making it a potential diabetes climber. The health benefits exhibited by pumpkin seed oil include its antimicrobial, antihypertensive, anti-arthritis, anti-inflammatory, and antidepressant qualities [14]. Pumpkin seeds contain zinc, phosphorus, magnesium, potassium, and selenium, which help combat arthritis, inflammation, and prostate cancer [15].

Despite growing evidence that pumpkin seeds contain bioactive compounds with cardioprotective potential, cardiovascular diseases (CVDs) remain highly prevalent worldwide, indicating that dietary interventions are still underutilized in prevention strategies. Existing literature largely focuses on general nutritional profiling and in vitro or animal-based studies, with limited standardized clinical evidence in human populations. Moreover, inconsistencies exist regarding optimal intake levels, bioavailability, and long-term cardiovascular outcomes of pumpkin seed consumption. Therefore, the study aims to comprehensively review the nutritional, phytochemical, and functional properties of pumpkin seeds and evaluate their potential role in the prevention and management of cardiovascular diseases, highlighting mechanistic pathways such as lipid regulation, antioxidant activity, and vascular protection.

Nutritional Composition of Pumpkin Seeds

Pumpkin seeds are principally regarded as functional constituents of foods, which are known to remarkably increase the nutritional status of human beings [3]. Table 1 showed the constituents of pumpkin seeds. They are considered as a nutritional powerhouse because of the abundant quantities of nutrients present in them [6].

Table 1: Nutritional Profile and Bioactive Composition of Pumpkin (*Cucurbita spp.*)Seeds

Nutrient	Pumpkin Seeds (Value/100g)	RDA (Percentage)	References
Energy	559 Kcal	28%	[16]
Lipids	49.05 g	164%	[16]

Protein	30.23 g	54%	[12]
Fiber	6 g	16%	[16]
Carbohydrates	10.7 g	8%	[12]
Cholesterol	0 g	0%	[16]

Furthermore, the seed flesh has a nutty flavor and is high in protein, carotenoids, β -carotene, g-tocopherol, nitrogen-containing compounds (Cucurbitacin B and E, cucurbitin), glucosides (saponins) and minerals (potassium, phosphorus, magnesium, calcium, sodium, manganese, iron, zinc, and copper), which make the pumpkin seeds a premium food supplement (Table 2).

Table 2: Quantitative Analysis of Essential and Non-Essential Amino Acid Composition in Pumpkin (*Cucurbita spp.*) Seeds [12]

Amino acids	Pumpkin Seeds (Value/100g)
Glutamic Acid	4.315g
Arginine	4.033g
Aspartic Acid	2.477g
Leucine	2.079g
Lysine	1.833g
Isoleucine	1.264g
Threonine	0.903g
Tryptophan	0.431g
Methionine	0.551g
Cysteine	0.301g
Phenylalanine	1.222g
Tyrosine	1.019g
Valine	1.972g
Histidine	0.681g
Alanine	1.158g
Glycine	1.796g
Proline	1.01g
Serine	1.148g

Potassium supports homeostasis, magnesium maintains cell membrane potential, and sodium regulates blood pressure and fluids [3]. Table 3 shows their vitamin and mineral content.

Table 3: Vitamin and Mineral Composition in Pumpkin (*Cucurbita spp.*) Seeds [12][16][4]

Vitamins	Pumpkin Seeds (Value/100g)	RDA (Percentage)
A	16 IU	0.50%
B ₁ (Thiamin)	0.27 mg	23%
B ₂ (Riboflavin)	0.15 mg	12%
B ₃ (Niacin)	4.98 mg	31.0%
B ₅ (Pantothenic Acid)	0.75 mg	15%
B ₆ (Pyridoxine)	0.14 mg	11%
B ₉ (Folate)	58 mcg	15%
C	1.9 mcg	3%
E	35.1 mg	272%
K	0.007 mg	-
Minerals		
Calcium	46 mg	4.5 %

Sodium	7 mg	0.5 %
Potassium	809 mg	17%
Copper	1.3 mg	148%
Iron	8.82 mg	110%
Magnesium	592 mg	148%
Manganese	4.54 mg	195%
Phosphorus	1233 mg	175%
Selenium	9.4 mcg	17%
Zinc	7.81 mg	17%

Anti-Nutritional Elements

Pumpkin seeds contain antinutritional elements, including phytate (35.06 mg/100 g), oxalate (0.02 mg/100 g), hydrocyanic acid (0.22 mg/100 g), and nitrate (2.27 mg/100 g) [6]. Their chemical composition varies by species, diversity, maturity, and environmental conditions [2]. Compared to *Cucurbita maxima*, *Cucurbita pepo* has higher moisture, ash, protein, total nitrogen, and carbohydrate levels [6]. *Cucurbita pepo* and *Cucurbita moschata* contain more γ -tocopherol, while *Cucurbita pepo* is richest in β -sitosterol and *Cucurbita maxima* in β -carotene. Pumpkin seeds also have the highest iron content (95.85 ± 33.01 ppm) among 11 types of nuts and seeds [8].

Pumpkin Seed Phytochemistry

Pumpkin seeds derive their nutritional value from phytochemicals, including phenolic glycosides, tocopherols, triterpenes, saponins, phytosterols, lignans, and carotenoids [12]. These compounds promote gut health, support metabolism, and provide cardioprotective benefits by reducing cholesterol absorption and inflammation [16]. Pumpkin seeds rank third in phytosterol content among nuts and seeds, reducing atherosclerotic lesions and inflammatory cytokines (IL-6, TNF- α) while lowering LDL-C by ~10% with a daily intake of 2g [17]. β -sitosterol, the primary phytosterol, is present at 24.9 mg/100 g [18]. Pumpkin seeds also contain phytoestrogens (lignans, isoflavones) and phytosterols (β -sitosterol, secoisolariciresinol, genistein, daidzein). They are rich in oil (42.3% w/w) and squalene (89 mg/100 g) [19]. Bioactive compounds such as triterpenoids, carotenoids, polyphenols, and cucurbitacins contribute to cardiovascular health [20]. *Cucurbita maxima* seeds contain unique triterpenes with potential heart benefits. The Cucurbitaceae family provides saponins and glycosides that aid cardiovascular function and blood clotting, while cucurbitacin enhances autophagy in cardiomyocytes, preventing cardiac heteropathy [21]. Tocopherol isomers (α , β , γ , δ) reduce CVD risk, while phenolics, quercetin, and flavanols prevent LDL oxidation and inflammatory cytokine synthesis [22]. Luteolin and cryptoxanthin provide additional cardiovascular protection by mitigating inflammatory signals [23]. Among postmenopausal women, pumpkin seed oil improved blood pressure and lipid profiles by raising HDL-C, reducing cardiovascular complications [24].

Standardized Methods for Evaluating Pumpkin Seed Oil

Standardized methods are used to evaluate Pumpkin Seed Oil (PSO) for its composition, antioxidant capacity, and bioavailability. GC-MS identifies fatty acids, while HPLC analyzes tocopherols, carotenoids, and phytosterols. ICP-OES measures mineral content, and antioxidant activity is assessed using DPPH, FRAP, and ORAC assays. Bioavailability studies include in vitro digestion models and human or animal trials to determine nutrient absorption and metabolic effects [15]. Compared to other plant-based oils, PSO offers a unique blend of phytosterols, tocopherols, and essential minerals for cardiovascular health. While olive oil is high in oleic acid, PSO provides superior cholesterol-lowering compounds. Flaxseed oil has more omega-3s, but PSO supports blood pressure regulation and vascular health through its diverse bioactive profile. Sunflower oil, though rich in vitamin E, lacks significant omega-3s and phytosterols. Overall, PSO aids lipid regulation, blood pressure control, and oxidative stress reduction, making it a valuable heart-healthy option [12].

Processing and Utilization of Pumpkin Seed in Preventing CVDs

Drying is a widely used commercial preservation method that extends shelf life, reduces weight, and facilitates storage and transport [6]. Roasting pumpkin seeds (100°C–130°C) enhances their nutty flavor by synthesizing pyrazines but decreases α -tocopherol by up to 15% and reduces phospholipids [5]. Protein content slightly declines after roasting for 30 and 60 minutes (21.46% and 22.96%, respectively) compared to raw seeds, along with slight reductions in palmitic, stearic, oleic, and linoleic acids [25]. Sert et al., (2022) investigated ultrasound-assisted extraction from pumpkin seed press cake, enhancing protein yield and functional properties [26]. Roasting for 60 minutes significantly lowers lead content (0.007 mg/100 g vs. 1.070 mg/100 g in raw seeds), reducing risks of hypertension, stroke, and heart disease [3]. Tannin levels in raw, boiled, fermented, germinated, and roasted seeds are 19.1, 7.5, 9.8, 14.0, and 9.9 g/kg, respectively. Tannins help protect cardiac tissue, prevent elastin degradation, and reduce arterial calcium buildup, thereby preventing CVDs [27]. Fermentation increases protein content from 28% to 39.4% while reducing fat from 48% to 25.5% [28]. Boiling lowers phytic acid to 4.3 g/kg, with fermentation reducing it further to 2.8 g/kg, though germination increases its levels [3]. Phytic acid aids heart health by reducing lipase activity, total cholesterol, and HDL [29]. Trypsin inhibitor content drops from 23.18 TIU/mg in raw seeds to 2.13 TIU/mg after processing [5]. Seed processing enhances carotene bioavailability, benefiting nutraceutical formulation [12]. Cold-pressed or steam-distilled pumpkin seed oil, known for its deep green color, effectively reduces CVD prevalence [30]. Pumpkin seeds are used in various forms, including fresh, boiled, cooked,

powdered, and in bioactive and pharmaceutical applications [31]. Pumpkin-derived oils and proteins have antimicrobial and pharmacological benefits [32]. *Cucurbita maxima* extracts (leaves, fruit, flowers) have antioxidant, anticancer, cardioprotective, and estrogenic effects [5]. Pumpkin-based foods exhibit preventive and therapeutic effects on CVDs [33]. Rich in bioactive compounds, pumpkin seed oil supports prostate, bladder, and heart health, lowering triglycerides, total cholesterol, LDL, uric acid, creatinine, and serum transaminases while increasing HDL [34]. The high fat content in pumpkin seeds contributes to reduced CVD risk [12].

Cardiovascular Health Benefits of Pumpkin Seeds:

Anti-hypertensive Effects

Pumpkin seeds have shown anti-hypertensive effects due to their bioactive compounds, which reduce oxidative stress and inflammation [21]. Adsul and Madkaikar (2021) provided a comprehensive overview of the nutritional and functional attributes of *Cucurbita pepo* (pumpkin) seeds in health and food applications [35]. Pumpkin seed oil, rich in vitamins, carotenes, and fibers, helps regulate diabetes and cardiovascular health [36]. Jin et al., (2019) evaluated polysaccharides from *Camellia oleifera* seed cake, highlighting their physicochemical properties and hypoglycemic effects in diabetic mice [37]. Barnabe et al., (2018) explored multiscale modeling approaches to optimize the use of bioresources and development of innovative bioproducts [38]. Polysaccharides in pumpkin seeds act as antioxidants, while their high tryptophan content aids in reducing depression [15].

Regulation of Blood Lipid Profile

Pumpkin seeds help manage heart diseases by reducing oxidative stress and preventing plasma lipoprotein oxidation [39]. Their oil, rich in unsaturated fatty acids and phytosterols, lowers LDL and increases HDL, limiting cholesterol absorption [40]. In postmenopausal women, pumpkin seed oil improves lipid profiles, enhances HDL-C, and reduces LDL-C, especially when combined with simvastatin [12].

Anti-inflammatory Effects

Pumpkin seeds exhibit anti-inflammatory properties superior to pharmaceuticals [4]. Their phytochemicals help reduce atherosclerosis, and roasting increases polyphenols, enhancing cardiovascular benefits [42]. Kaempferol in pumpkin seeds protects against cardiovascular diseases through its anti-inflammatory and antioxidant effects [43]. Hazaveh et al., (2021) examined the combined effects of aerobic training and pumpkin seed extract on oxidative stress markers in the heart and aorta of arsenic-exposed rats [44].

Anti-oxidative Effects

Pumpkin seeds reduce arteriosclerosis, hypertension, and cardiovascular diseases through their antioxidant activity [20]. Their oil significantly lowers serum triglycerides while increasing HDL [33]. Regular consumption helps regulate

blood pressure, and phytosterols in pumpkin seeds aid in cholesterol reduction [45]. Sharma *et al.*, (2020) reviewed the pharmacological, biomedical, and food industry applications of extracts from pumpkin and its related species [46]. Rajasree *et al.*, (2016) reviewed the diverse phytochemicals present in the Cucurbitaceae family and their potential pharmacological benefits [47]. Tocopherols, selenium, and zinc contribute to their strong antioxidant properties [10].

Improvement of Endothelial function

Pumpkin seed oil, rich in unsaturated fatty acids, prevents atherosclerosis by improving blood vessel elasticity [48]. Omega-6 and omega-3 PUFAs help lower LDL-C, reduce triglycerides, and support vascular function [49]. Their phytoestrogens and trigonelline compounds further aid in reducing blood pressure and cardiovascular risks [12].

In Vivo and Ex Vivo Studies

Pumpkin has both a direct and an indirect impact on serum lipid levels. A diet consisting of flaxseed and pumpkin oil was provided to Lohmann Brown Lite hens as part of a research experiment. According to this study, eggs produced by hens with a myristic acid, other saturated fatty acids including PUFA, and MUFA [50]. A comparable study using extract of pumpkin (5, 10, and 15%) and 72% wheat flour was carried out in 2015. When pumpkin cake was contrasted with control cake made of wheat, it was evaluated that pumpkin cake had more fiber (8%), carotenoids (41 mg/100 g), and ash (6.45%). Based on

biological investigation, it was found that pumpkin meal boosts HDL level and decreases bad cholesterol and cholesterol in a dose-dependent way [51]. Additional studies that used pumpkin seeds as a supplement to hypercholesterolemic rats support similar results. According to reports, PS reduced LDL while rise in HDL level reduced cholesterol level [52, 53]. Pumpkin has a positive effect on renal function in addition to its effects on blood lipid profile and atherogenicity [54]. Arginine, the precursor of Nitric Oxide (NO) and a factor in maintenance of blood pressure, apoptosis, cardiac health, and inflammatory response, is present in 2.6% of pumpkin seed powder [55]. Rats with hyperlipidemia were given the supplement of pumpkin seed extract showed increased expression of NO generation because of the presence of arginine, according to an in vivo study intended to examine the impact of seed extract of pumpkin (mostly arginine). Furthermore, the formation of NO reduces the LDL oxidation, resulting causing a decrease in the impact of Vascular Cell Adhesion Molecule (VCAM) [56]. Thus, adopting a lifestyle modification that includes daily consumption of pumpkins can be considered an effective dietary approach for managing hypercholesterolemia. In a research by Mosallamy *et al.*, (2012), it was noted that administering 40-100 mg/kg dose of pumpkin seed oil to rats with chemically induced hypertension for 6 weeks led to a reduction in abnormal blood pressure increase, lowered levels of Malondialdehyde (MDA) [10].

Table 4: Bioactive Compounds from Natural Sources: Their Therapeutic Potential in Cardiovascular Health and Disease Prevention

Class	Compound (Formula)	Sources	Therapeutic Potential	Ref
Phenolic Acids	Chlorogenic Acid (C ₁₆ H ₁₈ O ₉)	Artichoke, Avocado, Broccoli, Green tea, Kiwi	Treats CVDs	[57]
	Ferulic Acid (C ₁₀ H ₁₀ O ₄)	Broccoli, Cabbage, Lettuce, Spinach	Regulates NO/ET-1, protects endothelium, angiogenic	[58]
	p-Coumaric Acid (C ₉ H ₈ O ₃)	Avocado, Basil, Spinach	Antioxidant, anti-inflammatory, heart-protective	[59]
	Gallic Acid (C ₇ H ₆ O ₅)	Avocado, Green tea	Antioxidant, anti-inflammatory, antimicrobial, cardioprotective	[60]
Flavonoids	Kaempferol (C ₁₅ H ₁₀ O ₇)	Avocado, Broccoli, Cabbages, Fennel leaves	Antioxidant, antihypertensive, cardioprotective	[61]
	Quercetin (C ₁₅ H ₁₀ O ₇)	Broccoli, Kale, Spinach, Watercress	Anti-inflammatory, obesity, CVDs	[62]
	Rutin (C ₂₇ H ₃₀ O ₁₆)	Avocado, Green tea	Antioxidant, CVD protection	[17]
	EGCG (C ₂₂ H ₁₈ O ₁₁)	Green tea	Lowers BP, improves HDL, protects heart and brain	[13]
	Luteolin (C ₁₅ H ₁₀ O ₆)	Broccoli, Cabbages, Celery, Green peas	Antioxidant, anti-inflammatory, cardioprotective	[63]
Terpenoids	Cryptoxanthin (C ₄₀ H ₅₆ O)	Broccoli, Green grapes, Lettuce	Reduces myocardial ischemia injury	[64]
	Lutein (C ₄₀ H ₅₆ O ₂)	Avocado, Kale, Spinach, Zucchini	Lowers CVD and coronary artery disease risk	[65]
Glucosinolates	Indole-3-carbinol (C ₉ H ₉ N _O)	Broccoli, Kale, Mustard greens	Anti-inflammatory, antihypertensive	[66]
	DIM (C ₁₇ H ₁₄ N ₂)	Broccoli, Cabbages, Watercress	CVD therapeutic effect	[67]

	Sulforaphane (C ₆ H ₁₁ NOS ₂)	Cruciferous vegetables, Cabbages	Cardioprotective, reduces ROS, improves cell survival	[57]
	Caffeic Acid (C ₉ H ₈ O ₄)	Celery, Olives/Olive oil	Lowers BP, prevents atherosclerosis	[58]

Pumpkin seed oil helps to protect the heart and aorta from damage by boosting the production of nitric oxide (NO), thereby minimizing the risk of heart attacks due to its elevated magnesium content. Additionally, Pumpkin seed supplements have been found to be particularly effective at blocking calcium channels, which can help support heart health and improve circulation compared to drug amlodipine [10]. Li et al., (2021) used transcriptome analysis and gene co-expression networks to uncover the multitarget antibacterial actions of benzyl isothiocyanate against *Staphylococcus aureus* [68]. Mohammadi et al., (2018) demonstrated the immunoregulatory effects of indole-3-carbinol on macrophages in systemic lupus erythematosus via the aryl hydrocarbon receptor pathway [69]. The researcher Fruhwirth and Hermetter (2007) highlighted that pumpkin seed oil is rich in oleic acid, which helps lower blood pressure by improving the vasodilator pathway. This happens because oleic acid blocks calcium-mediated cell signaling by inhibiting the production of inositol 1, 4, 5-triphosphate and diacylglycerol [70]. As for pumpkin extracts, varieties like P5 (round orange) and P6 (spotted orange-green) have a high total phenolic content and moderate antioxidant activity. They also show moderate to high abilities to inhibit enzymes like -glucosidase and Angiotensin-Converting Enzyme (ACE). This suggests that incorporating antioxidant-rich dietary strategies using specific traditional plant based food combinations, such as those in pumpkin extracts, could help manage hyperglycemia and its related complications, such as oxidative stress and high blood pressure [71].

However, this review is limited by its reliance on previously published studies, many of which are preclinical or observational in nature, reducing the strength of clinical applicability. Variations in study design, extraction methods, and processing techniques across the literature also create inconsistencies in reported outcomes. Additionally, a lack of large-scale randomized controlled trials limits the ability to establish definitive dosage and long-term safety profiles. Future research should focus on well-designed human clinical trials to determine standardized intake guidelines, investigate dose-response relationships, and evaluate long-term cardiovascular outcomes. Further studies should also explore bioavailability enhancement techniques and compare pumpkin seed-based interventions with established pharmacological treatments for cardiovascular risk management.

CONCLUSIONS

Pumpkin seeds are nutrient-dense component of plant-based diets, offer significant Cardioprotective benefits due to their rich composition of bioactive compounds, including linolenic acid, phytosterols, antioxidants, and essential minerals. These compounds contribute to cardiovascular health by improving lipid profiles, reducing oxidative stress, lowering blood pressure, and enhancing vascular function. The presence of magnesium in pumpkin seed oil further supports nitric oxide production, aiding in arterial relaxation and aortic protection. Regular consumption of pumpkin seeds may help in the management of key risk factors associated with cardiovascular diseases, such as dyslipidemia, hypertension, and arterial stiffness. Given the growing emphasis on natural dietary interventions for chronic disease prevention, pumpkin seeds hold promise as a functional food for promoting heart health. However, further clinical studies and human trials are necessary to establish optimal dietary recommendations and fully elucidate their long-term effects on cardiovascular outcomes.

Authors' Contribution

Conceptualization: IYM

Methodology: AA, TN, MRK, YRK, TZ

Formal analysis: FJ, MJI

Writing and Drafting: MA, FJ, IYM, CN, MJI

Review and Editing: MA, FJ, IYM, CN, MJI

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

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