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Review Article

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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

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'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-κB 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-arthritic, anti-inflammatory, and antidepressant qualities [14]. Pumpkin seeds contain zinc, phosphorus, magnesium, potassium, and selenium, which help combat arthritis, inflammation, and prostate cancer [15].

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

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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

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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

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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 decreasein 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 (C16H18O9)	Artichoke, Avocado, Broccoli, Green tea, Kiwi	Treats CVDs	[57]
	Ferulic Acid (C10H10O4)	Broccoli, Cabbage, Lettuce, Spinach	Regulates NO/ET-1, protects endothelium, angiogenic	[58]
	p-Coumaric Acid (C9H8O3)	Avocado, Basil, Spinach	Antioxidant, anti-inflammatory, heart-protective	[59]
	Gallic Acid (C7H6O5)	Avocado, Green tea	Antioxidant, anti-inflammatory, antimicrobial, cardioprotective	[60]
Flavonoids	Kaempferol (C15H10O7)	Avocado, Broccoli, Cabbages, Fennel leaves	Antioxidant, antihypertensive, cardioprotective	[61]
	Quercetin (C15H10O7)	Broccoli, Kale, Spinach, Watercress	Anti-inflammatory, obesity, CVDs	[62]
	Rutin (C27H30O16)	Avocado, Green tea	Antioxidant, CVD protection	[17]
	EGCG (C22H18O11)	Green tea	Lowers BP, improves HDL, protects heart and brain	[13]
	Luteolin (C15H10O6)	Broccoli, Cabbages, Celery, Green peas	Antioxidant, anti-inflammatory, cardioprotective	[63]
Terpenoids	Cryptoxanthin (C40H56O)	Broccoli, Green grapes, Lettuce	Reduces myocardial ischemia injury	[64]
	Lutein (C40H56O2)	Avocado, Kale, Spinach, Zucchini	Lowers CVD and coronary artery disease risk	[65]
Glucosinolates	Indole-3-carbinol (C9H9NO)	Broccoli, Kale, Mustard greens	Anti-inflammatory, antihypertensive	[66]
	DIM (C17H14N2)	Broccoli, Cabbages, Watercress	CVD therapeutic effect	[67]
	Sulforaphane (C6H11NOS2)	Cruciferous vegetables, Cabbages	Cardioprotective, reduces ROS, improves cell survival	[57]
	Caffeic Acid (C9H8O4)	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

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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].

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, review and editing: MA, FJ, IYM, CN, MJI

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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REFERENCES

[1] Roth GA, Johnson C, Abajobir A, Abd-Allah F, Abera SF, Abyu G *et al*. Global, regional, and national burden of cardiovascular diseases for 10 causes, 1990 to 2015. Journal of the American College of Cardiology.2017 Jul;70(1):1-25.doi:10.1016/j.jacc.2017.04.052.

[2] Ceclu L, Mocanu DG, Nistor OV. Pumpkin-health benefits. Journal of Agroalimentary Processes and Technologies. 2020; 26(3): 241-6.Singh A and Kumar V.

[3] Phyto-chemical and bioactive compounds of pumpkin seed oil as affected by different extraction methods. Food Chemistry Advances.2023Oct;2:100211.doi: 10.1016/j.focha.2023.100211.

[4] Patel K, Soni A, Tripathi R. Pumpkin seed: Nutritional composition, health benefits.Magnesium.2023July; 3(12):190-2.

[5] Kaur S, Panghal A, Garg MK, Mann S, Khatkar SK, Sharma P *et al*. Functional and nutraceutical properties of pumpkin-a review.Nutrition & Food Science.2020Mar;50(2):384-401.doi:10.1108/NFS-05-2019-0143.

[6] Hussain A, Kausar T, Sehar S, Sarwar A, Ashraf AH, Jamil MA *et al*. A Comprehensive review of functional ingredients, especially bioactive compounds present in pumpkin peel, flesh and seeds, and their health benefits.Food Chemistry Advances.2022Oct;1: 100067.doi.org/10.1016/j.focha.2022.100067.

[7] Gibbons SM, Gurry T, Lampe JW, Chakrabarti A, Dam V, Everard A *et al*. Perspective: leveraging the gut microbiota to predict personalized responses to dietary, prebiotic, and probiotic interventions. Advances in Nutrition.2022Sep;13(5):1450-61.doi:10.1093/advances/nmac075.

[8] Agrawal K and Shahani L. Pumpkin seeds and oil as sources of bioactive compounds and their therapeutic uses: A review.Bulletin of Environment, Pharmacology and Life Sciences.2021Jul;10: 01-8.

[9] de Jesus Silva AJ, Contreras MM, Nascimento CR, da Costa MF.Kinetics of thermal degradation and lifetime study of poly (vinylidene fluoride) (PVDF) subjected to bioethanol fuel accelerated aging.Heliyon.2020Jul; 6(7).doi:10.1016/j.heliyon.2020.e04573.

[10] El-Mosallamy AE, Sleem AA, Abdel-Salam OM, Shaffie N, Kenawy SA. Antihypertensive and cardioprotective effects of pumpkin seed oil.Journal of Medicinal Food. 2012Feb;15(2):180-9.doi:10.1089/jmf.2010.0299.

[11] Baran MF and Gökdoğan O. Determination of energy balance in pumpkin seed (Cucurbita pepo L.) production.Avrupa Bilim ve Teknoloji Dergisi.2020 Aug;(19):43-7.doi:10.31590/ejosat.715740.

DOI: https://doi.org/10.54393/pjhs.v6i4.2913

[12] Dowidar M, Ahmed A, Mohamed H. The critical nutraceutical role of pumpkin seeds in human and animal health: An updated review.Zagazig Veterinary Journal. 2020 Jun; 48(2): 199-212. doi: 10.21608/zvjz.2020.22530.1097.
[13] Wang Z, Ding Z, Li Z, Ding Y, Jiang F, Liu J. Antioxidant and antibacterial study of 10 flavonoids revealed rutin as a potential antibiofilm agent in Klebsiella pneumoniae strains isolated from hospitalized patients.Microbial Pathogenesis.20210ct;159:105121. doi:10.1016/j.micpath.2021.105121.
[14] Cwiek-Ludwicka K.In memoriam-Professor Halina Mazur (1929-2021).Roczniki Państwowego Zakładu Higieny. 2021 Mar; 72(1). doi: 10.32394/rpzh.2021.0155.
[15] Batool M, Ranjha MM, Roobab U, Manzoor MF, Farooq U, Nadeem HR *et al.* Nutritional value, phytochemical potential, and therapeutic benefits of pumpkin (Cucurbita sp.). Plants.2022May;11(11):1394.doi:10.3390/plants11111394.
[16] Syed QA, Akram M, Shukat R. Nutritional and therapeutic importance of the pumpkin seeds. Seed. 2019;21(2):15798-803.doi:10.26717/BJSTR.2019.21.003586.
[17] Din SR, Saeed S, Khan SU, Kiani FA, Alsuhaibani AM, Zhong M. Bioactive compounds (BACs): A novel approach to treat and prevent cardiovascular diseases.Current Problems in Cardiology.2023Jul;48(7):101664.doi:10.1016/j.cpcardiol.2023.101664.
[18] Bellinger BJ, Cook MI, Hagerthey SE, Newman S, Kobza RM. Lipid Composition Differences of Periphyton, Crustaceans, and Small Fishes in Response to Eutrophication and Management in the Florida Everglades, USA.Lipids.2021Jan;56(1):31-47.doi:10.1002/lipd.12272.
[19] Di Stefano E, Oliviero T, Udenigwe CC. Functional significance and structure-activity relationship of food-derived α-glucosidase inhibitors.Current Opinion in Food Science.2018Apr;20:7-12.doi:10.1016/j.cofs.2018.02.008.
[20] Shaban A and Sahu RP.Pumpkin seed oil: An alternative medicine.International Journal of Pharmacognosy and Phytochemical Research.2017 Feb;9(2):11.doi:10.25258/phyto.v9i2.8066.
[21] Rolnik A and Olas B. Vegetables from the Cucurbitaceae family and their products: Positive effect on human health.Nutrition.20200ct;78:110788. doi:10.1016/j.nut.2020.110788.
[22] Perez Gutierrez RM. Review of Cucurbita pepo (pumpkin) its phytochemistry and pharmacology. Journal of Medicinal Chemistry.2016;6(1):12-21.doi:10.4172/2161-0444.1000316.
[23] Kumar K, Mounika SJ, Sudhakar P, Sandeep BV. Evaluation of biochemical and phytochemical parameters in germinating and nongerminating seeds of Cucurbita maxima. International Journal of Applied Science and Engineering Research.2016Jan;5(4):341-53.doi:10.6088/ijaser.05034.
[24] Zhang F, Shi D, Wang X, Zhang Y, Duan W, Li Y. β-cryptoxanthin alleviates myocardial ischaemia /reperfusion injury by inhibiting NF-κB-mediated inflammatory signalling in rats.Archives of Physiology and Biochemistry.2022Jul;128(4):1128-35.doi:10.1080/13813455.2020.1760302.
[25] Mantzouranis E, Kakargia E, Kakargias F, Lazaros G, Tsioufis K. The impact of high protein diets on cardiovascular outcomes: a systematic review and meta-analysis of prospective cohort studies. Nutrients.2023Mar;15(6):1372.doi:10.3390/nu15061372.
[26] Sert D, Rohm H, Struck S. Ultrasound-assisted extraction of protein from pumpkin seed press cake: impact on protein yield and techno-functionality. Foods.2022Jan;11(24):4029.doi:10.3390/foods11244029.
[27] Landrigan PJ. Lead and the heart: an ancient metal's contribution to modern disease.The Lancet Public Health.2018Apr;3(4):e156-7.doi:10.1016 /S2468-2667(18)30043-4.
[28] Miteu G and Ezeh B. Effects of roasting periods on the nutritive value of Telfaira occidentalis (fluted pumpkin) seeds.IPS Journal of Nutrition and Food Science. 2022 Apr; 1(1): 6-10. doi: 10.54117/ijnfs.v1i1.2.
[29] Shamsi TN, Parveen R, Fatima S. Trypsin inhibitors demonstrate antioxidant activities, inhibit A549 cell proliferation, and increase activities of reactive oxygen species scavenging enzymes.Indian Journal of Pharmacology.2017Mar;49(2):155-60.doi:10.4103/ijp.IJP_553_16.
[30] Hussain A, Kausar T, Sehar S, Sarwar A, Quddoos MY, Aslam J *et al.* A review on biochemical constituents of pumpkin and their role as pharma foods; a key strategy to improve health in post COVID 19 period.Food Production, Processing and Nutrition.2023Mar;5(1):22.doi:10.1186/s43014-023-00138-z.
[31] Lestari B and Meiyanto E. A review: The emerging nutraceutical potential of pumpkin seeds.Indonesian Journal of Cancer Chemoprevention.2018Jul;9(2):92-101.doi:0.14499/indonesianjcanchemoprev9iss2pp92-101.
[32] Blekkenhorst LC, Sim M, Bondonno CP, Bondonno NP, Ward NC, Prince RL *et al.* Cardiovascular health benefits of specific vegetable types: a narrative review.Nutrients.2018 May;10(5):595.doi:10.3390/nu10050595.
[33] Nameni RO, Woumbo CY, Kengne AP, Zokou R, Tekou FA, Nguekouo PT *et al.* Effects of stifled cooking on the quality and lipid-lowering potential of oils extracted from two species of pumpkin seeds (Citrullus lanatus and Cucumeropsis mannii). Pharmacology.2021;4(1):47. doi: 10.31183/imcp.2020.00047.

DOI: https://doi.org/10.54393/pjhs.v6i4.2913

[34] Hussain A, Kausar T, Sehar S, Sarwar A, Ashraf AH, Jamil MA *et al.* Utilization of pumpkin, pumpkin powders, extracts, isolates, purified bioactives and pumpkin based functional food products:A key strategy to improve health in current post COVID 19 period: An updated review. Applied Food Research. 2022Dec;2(2):100241.doi:10.1016/j.afres.2022.100241.

[35] Adsul S and Madkaikar V. Pumpkin (Cucurbita pepo) seed.Oilseeds:health attributes and food applications .2021Oct:473-506.doi:10.1007/978-981-15-4194-0_19.

[36] Amin MZ, Rity TI, Uddin MR, Rahman MM, Uddin MJ. A comparative assessment of anti-inflammatory, anti-oxidant and anti-bacterial activities of hybrid and indigenous varieties of pumpkin (Cucurbita maxima Linn.) seed oil.Biocatalysis and Agricultural Biotechnology.2020Sep;28:101767.doi:10.1016/j.bcab.2020.101767.

[37] Jin R, Guo Y, Xu B, Wang H, Yuan C. Physicochemical properties of polysaccharides separated from Camellia oleifera Abel seed cake and its hypoglycemic activity on streptozotocin-induced diabetic mice. International Journal of Biological Macromolecules. 2019Mar;125:1075-83.doi:10.1016/j.ijbiomac.2018.12.059.

[38] Barnabe M, Blanc N, Chabin T, Delenne JY, Duri A, Frank X *et al.* Multiscale modeling for bioresources and bioproducts.Innovative Food Science & Emerging Technologies.2018Apr;46:41-53.doi:10.1016/j.ifset.2017.09.015.

[39] Kulczyński B, Gramza-Michałowska A, Kobus-Cisowska J, Kmiecik D. The role of carotenoids in the prevention and treatment of cardiovascular disease-Current state of knowledge.Journal of Functional Foods.2017Nov;38:45-65.doi:10.1016/j.jff.2017.09.001.

[40] Vorobyova OA, Bolshakova AE, Pegova RA, Kol'chik OV, Klabukova IN, Krasilnikova E *et al.* Analysis of the components of pumpkin seed oil in suppositories and the possibility of its use in pharmaceuticals.Journal of Chemical and Pharmaceutical Research.2014Jul;6(5):1106-16.

[41] Griffin M, Nicolaides A, Tyllis T, Georgiou N, Martin RM, Bond D *et al.* Carotid and femoral arterial wall changes and the prevalence of clinical cardiovascular disease. Vascular Medicine.2009Aug;14(3):227-32.doi:10.1177/1358863X08101542.

[42] Diwan AD, Ninawe AS, Harke SN. Gene editing(CRISPR-Cas) technology and fisheries sector.Canadian Journal of Biotechnology.2017;1(2):65-72.doi:10.24870/cjb.2017-000108.

[43] Mahajan UB, Chandrayan G, Patil CR, Arya DS, Suchal K, Agrawal YO *et al.* The protective effect of apigenin on myocardial injury in diabetic rats mediating activation of the PPAR-γ pathway.International Journal of Molecular Sciences.2017Apr;18(4):756.doi:10.3390/ijms18040756.

[44] Hazaveh MB, Abedi B, Rahmati-Ahmadabad S. Effects of aerobic training and pumpkin seed extract consumption on the heart and aorta oxidative stress biomarkers:A case of rats exposed with arsenic. Journal of Cardio-Thoracic Medicine.2021Jan;9(1).doi:10.22038/jctm.2021.55557.1315.

[45] Chesak SS, Khalsa TK, Bhagra A, Jenkins SM, Bauer BA, Sood A. Stress Management and Resiliency Training for public school teachers and staff: A novel intervention to enhance resilience and positively impact student interactions.Complementary Therapies in Clinical Practice.2019Nov;37:32-8.doi:10.1016/j.ctcp.2019.08.001.

[46] Sharma P, Kaur G, Kehinde BA, Chhikara N, Panghal A, Kaur H. Pharmacological and biomedical uses of extracts of pumpkin and its relatives and applications in the food industry: a review. International Journal of Vegetable Science.2020Jan;26(1):79-95.doi:10.1080/19315260.2019.1606130.

[47] Rajasree RS, Sibi PI, Francis F, William H. Phytochemicals of Cucurbitaceae family-A review. International Journal of Pharmacognosy and Phytochemical Research.2016Jan;8(1):113-23.

[48] Batool M, Ranjha MM, Roobab U, Manzoor MF, Farooq U, Nadeem HR *et al.* Nutritional value, phytochemical potential, and therapeutic benefits of pumpkin (Cucurbita sp.).Plants.2022May;11(11):1394.doi:10.3390/plants11111394.

[49] Djuricic I and Calder PC. Beneficial outcomes of omega-6 and omega-3 polyunsaturated fatty acids on human health:An update for 2021. Nutrients.202 Jul;13(7):2421.doi:10.3390/nu13072421.

[50] Herkeľ R, Gálik B, Arpášová H, Bíro D, Juráček M, Šimko M *et al.* Fatty acid profile and nutritional composition of table eggs after supplementation by pumpkin and flaxseed oils.Acta Veterinaria Brno.2016Oct;85(3):277-83.doi:10.2754/avb201685030277.

[51] Ali WS. Nutrition with pumpkin(Cucrbita pepo)cake as lowering cholesterol in rats.Middle East Journal of Applied Sciences. 2015 Jan; 5(1): 10-.

[52] Abuelgassim AO and Al-Showayman SI. The effect of pumpkin (Cucurbita Pepo L) seeds and L-arginine supplementation on serum lipid concentrations in atherogenic rats.African Journal of Traditional, Complementary and Alternative Medicines.2012Oct;9(1):131-7.doi:10.4314/ajtcam.v9i1.18.

[53] Zdarilova A, Vrublova E, Vostalova J, Klejdus B, Stejskal D, Proskova J *et al.* Natural feed additive of Macleaya cordata: safety assessment in rats a 90-day feeding experiment. Food and Chemical Toxicology. 2008 Dec; 46(12): 3721-6. doi: 10.1016/j.fct.2008.09.054.

[54] Barakat LA and Mahmoud RH.The antiatherogenic, renal protective and immunomodulatory effects of purslane, pumpkin and flax seeds on hypercholesterolemic rats. North American Journal

DOI: https://doi.org/10.54393/pjhs.v6i4.2913

of Medical Sciences.2011Sep;3(9):411.doi:10.4297/najms.2011.3411.

Glew RH and Glew RS, Chuang LT, Huang YS, Millson M, [55] Constans D, Vanderjagt DJ. Amino acid, mineral and fatty acid content of pumpkin seeds (Cucurbita spp) and Cyperus esculentus nuts in the Republic of Niger. Plant Foods for Human Nutrition.2006Jun;61:49-54. doi:10.1007/s11130-006-0010-z.

[56] Proboningsih J, Wirjatmadi B, Kuntoro K, Adriani M. Expression of VCAM in Male Wistar Rats (Rattus norvegicus) with Hypercholesterolemia Supplemented with Pumpkin Seeds (Cucurbita moschata Duch) Extract.Health Notions.2018Jun;2(6):648-54.doi:10.33846/hn.v2i6.214.

[57] Dong H, Zhao Y, Zhao L, Lu F. The effects of berberine on blood lipids: a systemic review and meta-analysis of randomized controlled trials. Planta Medica.2013Apr;79(06):437-46. doi: 10.1055/s-0032-1328321.

[58] Pei J, Gao S, Sarp S, Wang H, Chen X, Yu J *et al.* Emerging forward osmosis and membrane distillation for liquid food concentration:A review. Comprehensive Reviews in Food Science and Food Safety.2021Mar;20(2):1910-36.doi:10.1111/1541-4337.12691.

[59] Ma C, Dastmalchi K, Whitaker BD, Kennelly EJ. Two new antioxidant malonated caffeoylquinic acid isomers in fruits of wild eggplant relatives. Journal of Agricultural and Food Chemistry.2011Sep;59(17):9645-51. doi: 10.1021/jf202028y.

[60] Kumar N and Pruthi V. Potential applications of ferulic acid from natural sources. Biotechnology Reports. 2014 Dec; 4: 86-93. doi: 10.1016/j.btre.2014.09.002.

[61] Soler-Rivas C, Espín JC, Wichers HJ. Oleuropein and related compounds.Journal of the Science of Food and Agriculture.2000May;80(7):1013-23.doi:10.1002/(SICI)1097-0010(20000515)80:7<1013::AID-JSFA571>3.0.CO;2-C.

[62] Marzocchella L, Fantini M, Benvenuto M, Masuelli L, Tresoldi I, Modesti A *et al*.Dietary flavonoids: molecular mechanisms of action as anti-inflammatory agents.Recent Patents on Inflammation & Allergy Drug Discovery.2011Sep;5(3):200-20.doi:10.2174/187221311797264937.

[63] Shah SM, Akram M, Riaz M, Munir N, Rasool G. Cardioprotective potential of plant-derived molecules: a scientific and medicinal approach. Dose-Response.2019May;17(2):1559325819852243.doi:10.1177/1559325819852243.

[64] Parveen A, Babbar R, Agarwal S, Kotwani A, Fahim M. Mechanistic clues in the cardioprotective effect of Terminalia arjuna bark extract in isoproterenol-induced chronic heart failure in rats.Cardiovascular Toxicology.2011Mar;11:48-57.doi:10.1007/s12012-010-9099-2.

[65] Luo Y, Shang P, Li D. Luteolin: a flavonoid that has multiple cardio-protective effects and its molecular mechanisms.Frontiers in Pharmacology.2017Oct;8:692.doi:10.3389/fphar.2017.00692.

[66] Fernández-Sanlés A, Sayols-Baixeras S, Subirana I, Degano IR, Elosua R. Association between DNA methylation and coronary heart disease or other atherosclerotic events:a systematic review. Atherosclerosis.2017Aug;263:325-33.doi:10.1016/j.atherosclerosis.2017.05.022.

[67] Licznerska B and Baer-Dubowska W. Indole-3-carbinol and its role in chronic diseases.Anti-inflammatory Nutraceuticals and Chronic Diseases.2016:131-54.doi:10.1007/978-3-319-41334-1_6.

[68] Li H, Ming X, Xu D, Mo H, Liu Z, Hu L *et al*. Transcriptome analysis and weighted gene co-expression network reveal multitarget-directed antibacterial mechanisms of benzyl isothiocyanate against Staphylococcus aureus.Journal of Agricultural and Food Chemistry.2021Sep;69(39):11733-41.doi:10.1021/acs.jafc.1c03979.

[69] Mohammadi S, Memarian A, Sedighi S, Behnampour N, Yazdani Y. Immunoregulatory effects of indole-3-carbinol on monocyte-derived macrophages in systemic lupus erythematosus: a crucial role for aryl hydrocarbon receptor.Autoimmunity.2018Jul;51(5):199-209.doi:10.1080/08916934.2018.1494161.

[70] Benaniba MT, Belhaneche-Bensemra N, Gelbard G. Kinetics of tungsten-catalyzed sunflower oil epoxidation studied by 1h nmr. European Journal of Lipid Science and Technology.2007 Dec;109(12):1186-93.doi:10.1002/ejlt.200700114.

[71] Kwon YI, Apostolidis E, Kim YC, Shetty K. Health benefits of traditional corn, beans, and pumpkin: in vitro studies for hyperglycemia and hypertension management.Journal of Medicinal Food.2007Jun;10(2):266-75.doi:10.1089/jmf.2006.234.