Chapter

Medicinal Utilization and Suitability of Pumpkin (*Cucurbita maxima*) Seeds for the Development of Value-Added Products

Adeyanmola Oluwaseyi Faturoti and Clement Olusola Ogidi

Abstract

Pumpkin (*Cucurbita maxima*) seeds have attracted significant interest due to their potential in developing f value-added products and their diverse medicinal purposes. These seeds are abundant in essential nutrients such as proteins, vitamins, minerals and unsaturated fatty acids, making them an excellent raw material for functional foods and dietary supplements. Additionally, their bioactive compounds, such as antioxidants and phytosterols, offer various health benefits, including anti-inflammatory, antimicrobial and anticancer properties. Their versatility in applications, such as oil extraction, protein supplements, beverages and snacks, position them as sustainable and cost-effective resources for product development in both food and health industries. This chapter explores the utilization of *Cucurbita maxima* seeds and underscores their potential to enhance human health.

Keywords: *Cucurbita maxima* seeds, value-added products, medicinal purposes, supplements, development

1. Introduction

Recently, fruits and vegetables have notably gained interest due to high nutraceutical and therapeutic values of bioactive compounds present in them, including pumpkin [1]. Pumpkins, as an oily seed, belong to the Cucurbitaceae of about 118 genera and 825 species and is collectively among the top 10 leading vegetable crops worldwide [2]. Although there are different species grown in the world, the most economically of them are *Cucurbita maxima, Cucurbita moschata Duch., Cucurbita ficifolia, Cucurbita pepo* L., *Cucurbita mixta* and *Telfairia occidentalis* [3]. *Cucurbita maxima* is an underutilized crop and a medium-sized plant grown for its fruits and seeds for human consumption [4]. The fruits vary in shape, color, sizes and weight of different

species [5, 6]. Despite *Cucurbita maxima* seeds being regarded as agro-industrial waste, the seeds have a unique flavor and nutty taste. They are consumed as salted or roasted snacks in various parts of the world, including Canada, the United States and Nigeria [4, 5]. *Cucurbita maxima* seeds serve as a powerhouse of nutrients with interesting nutraceutical properties [7]. *Cucurbita maxima* seeds are composed of proteins (25.2–37.0%), dietary fiber (3–6%), carbohydrates (18–25%), lipids (37.8–45.4%) and ash (3–5%) [3]. They serve as a potential source for edible oil extraction and rich in essential macro and micro elements such as potassium, calcium, sodium magnesium, iron, zinc and copper [8, 9]. Furthermore, *Cucurbita maxima* seeds are abundant in bioactive compounds like phenolic compounds, squalene, phytosterols, tocopherols (α, β, γ and δ), tocotrienols, carotenoids and flavonoids [9]. These natural bioactive constituents contribute significantly to disease prevention and overall health promotion. As a result, *Cucurbita maxima* seeds are classified as functional foods due to their high concentration of health-promoting bioactive components [10].

2. Characteristics of pumpkin (*Cucurbita maxima*) seeds

The characteristics of *Cucurbita maxima* seeds provide critical insights into their nutritional composition, facilitating their potential use in various culinary applications, food formulations and oil extraction. The seeds are often referred to as nutritional powerhouses and are an exceptional source of protein, fiber, lipids, minerals, phytochemicals, antioxidants and other bioactive compounds [10]. Owing to their remarkable nutraceutical properties, *Cucurbita maxima* seeds once considered agro-industrial waste, have gained recognition as miracle seeds [3, 11].

2.1 Nutritional components of pumpkin (*Cucurbita maxima*) seeds

Cucurbita maxima seeds are rich source of valuable nutritional components. These nutrients act as primary metabolites essential for sustaining life, while the bioactive compounds in the seeds play significant roles in disease prevention [10, 12, 13]. *Cucurbita maxima* seeds contain approximately 6.37–6.56% moisture content, 35–50% lipids, 25–37% proteins, 18–25% carbohydrate, 3–6% fiber and 3–5% ash [9]. They are particularly rich in fats and proteins, making them effective in addressing nutritional disorders such as malnutrition and in preventing from various ailments [8, 9]. *Cucurbita maxima* seeds also contain lipids which are composed of many essential and non-essential fatty acids including ω-3, ω-6 and ω-9 fatty acids, rendering them a favorable ingredient for edible oil extraction. The extracted oil can be utilized as a cooking oil or as a fat replacer in food industry [8]. Furthermore, the high protein content in the *Cucurbita maxima* seeds is suitable for the production of protein isolates and for use in flour formulations for baked goods such as biscuits and cookies [8, 9, 14, 15]. Protein isolates derived from *Cucurbita maxima* seeds have been shown to mitigate the adverse effects of low-protein and CCl4 intoxication [15]. Pumpkin seeds contain approximately 0.95–16.84% fiber, as documented by various researchers [include ref]. They also contain variable amount of carbohydrates, ranging from 1.00% to 26.43%, which makes them valuable ingredients in food formulation. The carbohydrate content of *Cucurbita maxima* seeds allows their use in the development of various bakery products, such as cake, cookies and bread [14]. Ash content of the seed was reported in the range of 1.60–7.20%. *Cucurbita maxima* seeds have

been extensively studied for their nutritional composition, with various researchers highlighting their significant protein, lipid and fiber content and their potential applications in food and nutrition industries [8, 9, 14].

2.2 Mineral composition of pumpkin (*Cucurbita maxima*) seeds

Cucurbita maxima seeds contain a substantial of essential minerals. They are particularly rich in potassium while being relatively lower and in sodium and provide significant levels of high levels of calcium, phosphorus, magnesium, iron and copper. Additionally, they are valuable sources of zinc, iron and copper [7]. Minerals such as zinc, copper and iron exhibit antioxidant properties, serving as cofactors for vital antioxidation-dependent enzymes [16, 17]. The low sodium and high potassium content in *Cucurbita maxima* seeds has notable clinical implications, particularly for enhancing cardiovascular health [18]. Zinc plays a crucial role in male reproductive health, the structural integrity of proteins and cellular protection [19]. These mineral concentrations highlight the potential of *Cucurbita maxima* seeds as a valuable ingredient for food fortification, particularly in bakery products.

2.3 Amino acids (g/100 g) profiles of pumpkin (*Cucurbita maxima*) seeds

Cucurbita maxima seeds are rich in protein, containing approximately 35%, which contributes to a diverse and significant amino acid profile [20]. Amino acids are essential as they serve as both the building blocks of proteins and as intermediates in various metabolism processes. An adequate dietary supply of essential amino acids, in both quantity and quality, is vital for maintaining physiological functions in human body [21, 22]. Research indicates that protein isolates derived from *Cucurbita maxima* seeds are comparable to those of soybeans exhibiting high bioavailability of amino acids [7, 22]. Notably, the globulin structure of *Cucurbita maxima* seeds closely resembles that of legume seeds [22, 23]. This similarity is significant, as it supports the potential of *Cucurbita maxima* seeds to serve as a reliable ingredient in the development of nutritious food products, thereby addressing the challenges of protein malnutrition in vulnerable populations. Additionally, *Cucurbita maxima* seeds protein isolates exhibit antioxidative and chelating properties, further enhancing the nutritional and functional applications [23–26].

2.4 Fatty acid (mg/100 g) profiles of pumpkin (*Cucurbita maxima*) seeds

The primary fatty acids in *Cucurbita maxima* seed oil are linoleic, oleic, stearic and palmitic, which collectively account for more than 95% of the total fatty acids content, with 75% unsaturated [27, 28]. Trace amounts of arachidic and linolenic acid have also been identified [29, 30]. The fatty acid profile of the *Cucurbita maxima* seed oil is presented in **Table 1**. Unsaturated fatty acids have been extensively studied due to their protective effect against cardiovascular diseases [42, 43]. They play a vital role in the healthy growth and development of brain and nervous system. Furthermore, they are associated with health benefits such as mitigating hypertension, arthritis, coronary heart diseases, cancer, inflammation and autoimmune disorders [42–45]. Importantly, only linoleic]and alpha-linolenic acids are considered essential for humans, as they cannot be synthesized by the body and must be obtained through dietary source [7].

Industry	Food product	Function	Reference
Meat	Beef meat ball	Fat replacement	[31]
	Chicken burgers	Enhanced stability during storage	[32]
	Beef patties	No change in textural property and decrease moisture content	[33]
Bakery	Biscuits	Decrease serum blood glucose level	[34]
	Cookies	Prevent constipation, diabetes, prolong intestinal transit time and lower cholesterol	[35]
	Muffins	Had a better sensory profile and improved nutritional value	[36]
	Cake	Increase in firmness and moisture retention	[37]
	Sausage	Improvement in the water holding capacity and cooking quality	[3]
Diary	Ice cream	An increase in the protein content improves the degree of satiety and enhances sensory characteristics	[38]
	Cereal milk	Improved the sensory and nutritional value Extended shelf life	[39]
Spice	Bouillon cube	Improved sensory and nutritional value	[5]
Vegetable oil	Vegetable oil	Functional food used as culinary and traditional medicine	[40]
	Vegetable fat	Improvement in the fatty acid profile of meat batters with no much difference in the textural profile.	[41]

Table 1.
Development of value-added products Cucurbita maxima *seeds.*

2.5 Phytochemical composition of pumpkin (*Cucurbita maxima*) seeds

Cucurbita maxima seeds are rich in phytochemical composition, serving as essential metabolites for functional foods. These nutrients play a crucial role in promoting health and prevent diseases [3]. Notably, *Cucurbita maxima* seeds are an excellent source of phenolic compounds, which have garnered significant attention from researchers due to their promising health benefits for humans [46]. Phenolic represent a diverse group of secondary metabolic products in plants and are known for their potent antioxidant properties [47, 48]. Their hydroxyl functional groups provide radical-scavenging abilities, making them effective in reducing the risk of oxidative stress-induced degenerative diseases [46]. The predominant phenolic compounds in *Cucurbita maxima* seeds include ferulic, vanillic acids, vanillin, tyrosol, p-hydroxybenzoic, caffeic and smaller amounts of trans-p-coumaric, syringic acids, luteolin and protocatechuic. These compounds contribute to the *Cucurbita maxima* seeds health-promoting potential. *Cucurbita maxima* are also an excellent source of vitamin E, which includes four tocopherol and tocotrienol isomers (α, β, γ and δ) [48, 49]. These isomers differ only in the number and position of the methyl groups on their chromanol ring [49, 50]. However, only one isomer (d-RRR-α-tocopherol) meets the criteria to be classified as true vitamin E [48]. While sunlight facilitates the synthesis of vitamin E in the human body, many plants, including *Cucurbita maxima* seeds, serve as rich dietary sources of this essential nutrient. Tocopherols and tocotrienols in *Cucurbita maxima* seeds are potent antioxidants capable of neutralizing highly reactive radicals by donating H + ion from their rings [7, 47]. Additionally, *Cucurbita maxima*

seeds are a valuable source of phytosterols. Phytosterols have been extensively studied for their cholesterol-lowering effects, particularly in reducing low-density lipoprotein (LDL) [51, 52], which translates to a decreased risk of cardiovascular diseases. Furthermore, numerous studies suggest that phytosterols may lower the risk of certain cancers [47, 53] and improve the management of prostate complications [54]. This high phytosterol content in *Cucurbita maxima* seeds makes them a promising and suitable nutraceutical option for managing various non-communicable diseases in humans [55].

3. Nutraceutical benefits of pumpkin (*Cucurbita maxima*) seeds

Cucurbita maxima is a well-known medicinal plant and is considered a functional food that promotes human health when consumed safely as shown in **Figure 1**. Its numerous biologically active components such as proteins, peptides, polysaccharides, sterols, fixed oils and para-aminobenzoic acid make it highly beneficial for human consumption [1]. The therapeutic potential of *Cucurbita maxima* seeds against various human diseases is attributed to their bioactive compounds, which produce distinct physiological effects in the human body.

3.1 Antihypertensive and cardio-protective activity

Blood pressure in the arteries remains persistently high due to a long-term health condition known as hypertension, which is a major risk factor for cardiovascular diseases. *Cucurbita maxima* seed oils are rich in bioactive medicinal component compounds, including monounsaturated and polyunsaturated fatty acids like omega 3, omega 6, oleic acid and linoleic acid, which play a significant role in reducing the risk of hypertension and cardiovascular illness [56]. Studies have shown that *Cucurbita maxima* seeds exhibit hypotensive effects and demonstrate favorable drug interaction outcomes when administered in animal models alongside commonly used antihypertensive medications, with commonly, such as felodipine [57].

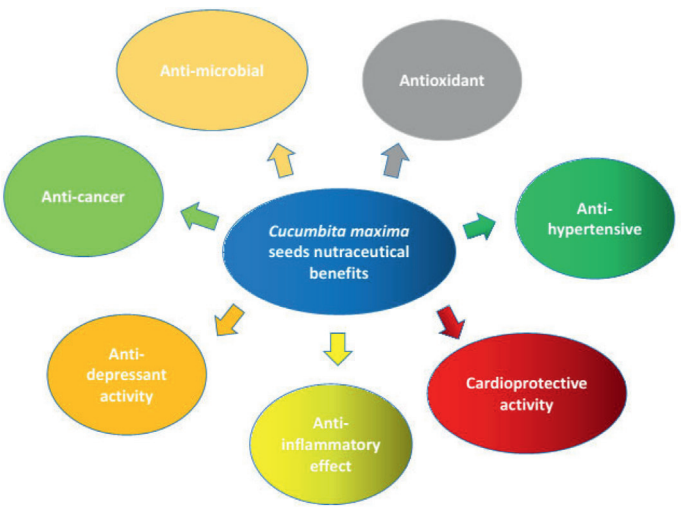


Figure 1.
Nutraceutical benefits of Cucurbita maxima *seeds.*

3.2 Anticancer activity

The phytoestrogenic compounds present in *Cucurbita maxima* seeds make them a promising candidate for preventing hormone-dependent cancer. The anticancer activity of the *Cucurbita maxima* seeds extract was evaluated on MCF7, Jeg3 and BeWo (chorionic carcinoma) cell lines, demonstrating significant cytotoxic activity and notable estradiol production. These results suggest that, like many phytoestrogenic substances, *Cucurbita maxima* seeds, rich in lignans and flavones, exhibit a biphasic effect through various pathways, possessing both estrogenic and antiestrogenic activities [58]. It is reported that consuming 20–40 mg/kg of pumpkin seed oil orally for 20 days can help reduce testosterone-induced prostate gland enlargement [59]. Additionally, the application of *Cucurbita maxima* seed oil has been shown to slow the progression of testosterone-induced hyperplasia. These findings highlight the potential of *Cucurbita maxima* seed oil in managing benign prostatic hyperplasia [60].

3.3 Anti-inflammatory effect

The management of numerous diseases can be supported by preventing inflammation, which is a significant risk factor for various pathological conditions such as cancer, cancer and other concerns. The anti-inflammatory effects of *Cucurbita maxima* seeds are primarily attributed to their rich content of polyphenols and other antioxidant compounds. These bioactive components help reduce inflammation by neutralizing free radicals and modulating inflammatory pathways [59].

3.4 Antidepressant activity

Depression is the most common brain disorder, characterized by disruptions in sleep, eating habits, interests and desires. *Cucurbita maxima* seeds have gained pharmacological importance as a natural source of antidepressant properties. They exhibit an antidepressant food score of 47%, primarily due to the presence of 5-hydroxytryptophan, a tryptophan intermediate that aids in serotonin (a neurotransmitter) formation [61]. Furthermore, *Cucurbita maxima* seeds are a remarkable source of zinc, which plays a crucial role in brain's conversion of tryptophan into serotonin, thereby promoting a sense of well-being.

3.5 Antioxidant activity

Cucurbita maxima seeds contain β-carotene, making them both nutritionally and pharmacologically balanced. β-Carotene, tocopherols and other carotenoid components in *Cucurbita maxim* seeds exhibit antioxidant activities, protecting cells from damage caused by reactive oxygen species and other free radicals [62]. Additionally, *Cucurbita maxima* seed extracts demonstrate antioxidant and geno-protective effects [63].

3.6 Antimicrobial activity

Cucurbita maxima seed oil, rich in linoleic and oleic acids, exhibits strong antibacterial properties against *Staphylococcus aureus*. It demonstrated a zone of inhibition of 15 mm. *Cucurbita maxima* seed extract in tests against *Bacillus subtilis*, *Staphylococcus aureus* and *Escherichia coli*, pumpkin seed extracts in petroleum ether and methanol, tested at concentrations of 10, 50, 100, 200, 500 and 1000 g/mL were

effective against *Pseudomonas aeruginosa*, *Candida albicans*, *Acinetobacter baumanii*, *Enterococcus faecalis*, *Klebsiella pneumonia*, *Escherichia coli* and *Staphylococcus aureus* are successful. Additionally, *Cucurbita maxima* seed oil has shown significant antibacterial activity against *Pseudomonas aeruginosa, Candida albicans, Acinetobacter baumanii, Enterococcus faecalis, Klebsiella pneumonia, E. coli and Staphylococcus aureus.* A polysaccharide derived from *Cucurbita maxima* seeds also display antibacterial properties, with a dosage of 0.5 mg/mL, significantly suppressing against *Escherichia* coli (12.8 ± 1.0 mm) and *Bacillus subtilis* (7.2 ± 0.3 mm), while showing a modest zone of inhibition against *Pichia fermentans* (2.3 ± 0.2 mm) and *Staphylococcus aureus* (2.3 ± 0.2 mm) [59].

3.7 Other nutraceutical benefits

In addition to the thematic nutraceutical benefits discussed above, the *Cucurbita maxima* seed exhibits ameliorative effects on hepato-inflammation, lipotoxicity and healing wounds [7, 64]. Furthermore, the seeds contribute to the prevention of Alzheimer's and Parkinson's diseases, anemia, benign prostate hyperplasia, hypercholesterolemia and hyperlipidemia [3].

4. Development of value-added products from *Cucurbita maxima* seeds

Food is a fundamental necessity of all living organisms. In everyday life, we consume food in both raw and processed forms. Nowadays, we mostly consume artificial foods that have some side effects [65]. *Cucurbita maxima* seeds are cultivated for their nutritional and medicinal benefits and are widely used in the production of various food items, including jellies, purees, jams, syrups, etc. In recent decades, utilizing *Cucurbita maxima* wastes, particularly the seeds as a functional food ingredient, have introduced new opportunities and challenges. These are incorporated into crackers, cookies, cakes, snacks, bread, muffins, cereal bars and other baked goods are all made with pumpkin seeds. The nutritional profile of these products is enhanced by the addition of *Cucurbita maxima* seeds, which also serve as a taste enhancer in dressings, soups and baked good [66–68]. Food producers are increasingly using *Cucurbita maxima* seed to create innovative and nutrient-rich products, as shown in **Table 1** and **Figure 2**. Its nutty flavor and appealing green hue make it a versatile ingredient in modern food applications [69]. Various studies have been conducted to develop value-added products including dietary supplements and food additives using *Cucurbita maxima* seeds.

4.1 Additional value-added products from *Cucurbita maxima* seeds

Cucurbita maxima seeds have significant potential for transformation into high-value products such as edible or biodegradable film. Defatted *Cucurbita maxima* seed meal has been effectively utilized in bio-based films, which not only provide an eco-friendly alternative but also help mitigate environmental issues relating to composting. These films are particularly suitable for applications in cakes, desserts and baked goods. The waste generated from *Cucurbita maxima* rich in carbon content, making it a desirable renewable substrate for producing added-value products [59]. The seed cake of *Cucurbita maxima,* a byproduct of oil extraction, can be used to develop edible coating materials with enhanced properties such as gas permeability, protein

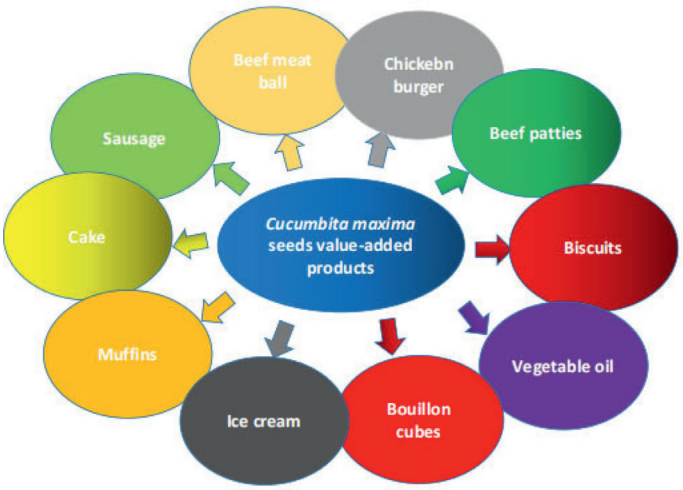


Figure 2.
Development of value-added products Cucurbita maxima *seeds.*

concentration, film thickness and mechanical barrier [70]. Using H_3PO_4 as a chemical agent, the pore structure of the activated carbon can be significantly influenced by adjusting the impregnation ratio and activation temperature [71]. This demonstrates that *Cucurbita maxima* seed shells are promising raw materials for producing commercially viable activated carbon.

5. Conclusion

Cucurbita maxima seeds are highly nutritious and categorized as super-food due to their exceptional properties. Their nutritional and bioactive components make them valuable nutraceutical foods. Once considered waste and underutilized, the nutraceutical potential of *Cucurbita maxima* seed is now widely recognized, leading to their incorporation into various applications. *Cucurbita maxima* seeds possess numerous – health promotion and are beneficial in managing ailments such as cancer, cardiovascular disease, benign prostate hyperplasia, Alzheimer's disease, Parkinson's disease, diabetes and hyperglycemia. They are a rich source of antioxidant compounds that enhance overall health and help prevent a range of diseases. The development of value-added products from *Cucurbita maxima* seeds has highlighted their suitability and utilization, creating market opportunities while promoting their beneficial nutritional and nutraceutical properties.

Conflicts of interest

The authors declare no conflict of interest.

DOI: http://dx.doi.org/10.5772/intechopen.1008975

Author details

Adeyanmola Oluwaseyi Faturoti* and Clement Olusola Ogidi
Department of Food Science and Technology, Olusegun Agagu University of Science and Technology, Okitipupa, Nigeria

*Address all correspondence to: oluwaseyiakintade@gmail.com

IntechOpen

© 2025 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. CC BY

References

[1] Hussain A, Kausar T, Sehar S, Sarwa 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. 2023;**5**:1-14. DOI: 10.1186/s43014-023-00138-z

[2] Jeffrey C. An outline classification of the cucurbitaceae. In: Biology and Utilization of the Cucurbitaceae. Ithaca, New York: Cornell University Press; 2019. pp. 449-464. DOI: 10.7591/9781501745447-039

[3] Singh A, Kumar V. Pumpkin seeds as nutraceutical and functional food ingredient for future: A review. Grain & Oil Science and Technology. 2024;**7**:12-29

[4] Ambi AA, Bashir M, Hasfat BM, Nura M, Abubakar H, Shatu M. Effect of processing on vitamin A and some mineral contents of pumpkin (*Cucurbita maxima*) seed. Bayero Journal of Pure and Applied Sciences. 2020;**13**(2):113-116. DOI: 10.4314/bajopas.v13i2.15

[5] Akintade AO, Ifesan BOT, Awolu OO, Olaleye MT. Evaluation of physicochemical properties and sensory attributes of pumpkin seed (*Cucurbita maxima*) bouillon cube. Journal of Culinary Science & Technology. 2022;**22**:1272-1294. DOI: 10.1080/15428052.2022.2123293

[6] Woldesenbent GK. Review on pumpkin production and nutritional value in Ethiopia. Journal of Biology, Agriculture and Healthcare. 2020;**10**(24):1-7

[7] Dotto JM, Chacha JS. The potential of pumpkin seeds as a functional food ingredient: A review. Scientific African. 2020;**10**(e00575):1-4

[8] Singh A, Kumar V. Phyto-chemical and bioactive compounds of pumpkin seed oil as affected by different extraction methods. Food Chemistry Advances. 2023;**3**:100211. DOI: 10.1016/j.focha.2023.100211

[9] Singh A, Kumar V. Nutritional, phytochemical and antimicrobial attributes of seeds and kernels of different pumpkin cultivars. Food Frontiers. 2022;**3**:182-193. DOI: 10.1002/fft2.117

[10] Pham TT, Tran TTT, Ton NMN, Le VVM. Effects of pH and salt concentration on functional properties of pumpkin seeds protein fractions. Journal of Food Processing and Preservation. 2017;**41**:e13073. DOI: 10.1111/jfpp.13073

[11] Achu MB, Fokou E, Kansci G, Fotso M. Chemical evaluation of protein quality and phenolic compound levels of some Cucurbitaceae oilseeds from Cameroom. African Journal of Biotechnology. 2013;**12**:735-743. DOI: 10.5897/AJB10.1728

[12] Adams AA, Imram S, Wang S, Mohammad A, Kok S, Gray DA, et al. The hypoglycaemic effect of pumpkins as anti-diabetic and functional medicines. Food Research International. 2011;**44**(4):862-867. DOI: /10.1016/j.foodres.2011.03.016

[13] Rodríguez-Miranda J, Hernández-Santos B, Herman-Lara E, Herman-Lara MA, Carmona-García R, Gómez-Aldapa CA, et al. Physicochemical and functional properties of whole and defatted

meals from Mexican (*Cucurbita pepo*) pumpkin seeds. International Journal of Food Science and Technology. 2012;**47**(11):2297-2303. DOI: 10.1111/j.1365-2621.2012.03102.x

[14] Akintade AO, Ifesan, Awolu OO, Ifesan BOT. Nutritional evaluation of fermented, germinated and roasted pumpkin (*Cucurbita maxima*) seed flour. Acta Universitatis Cibiniensis Series E: Food Technology. 2019;**23**(2):179-186

[15] Nkosi CZ, Opoku AR, Terblanche SE. Antioxidative effects of pumpkin seed *(Cucurbita pepo*) protein isolate in CCl_4- induced liver injury in low-protein fed rats. Phytotherapy Research. 2016;**20**:935-940. DOI: 10.1002/ptr.1977

[16] Datta S, Sinba B, Bhattacharjee S, Seal T. Nutritional composition, mineral content, antioxidant activity and quantitative estimation of water soluble vitamins and phenolics by RP-HPLC in some lesser used wild edible plants. Heliyon. 2019;**5**(3):e0143. DOI: 10.1016

[17] Seymen M, Uslu N, Türkmen O, Al Juhaimi F, Özcan OO. Chemical compositions and mineral contents of some hull-less pumpkin seed and oils. Journal of the American Oil Chemists' Society. 2016;**93**(8):1095-1099. DOI: 10.1007/s11746-016-2850-5

[18] Dotto J, Matemu AO, Ndakidemi PA. Nutrient composition and selected physicochemical properties of fifteen Mchare cooking bananas: A study conducted in Northern Tanzania. Scientific African. 2019;**6**:1-9. DOI: 10.1016/j.sciaf.2019.e00150

[19] Aghaei S, Nikzad H, Taghizadeh M, Tameh A, Taherian A, Moravveji A. Protective effect of pumpkin seed extract on sperm characteristics, biochemical parameters and epididymal histology in adult male rats treated with cyclophosphamide. Andrologia. 2014;**46**(8):927-935. DOI: 10.1111/and.12175

[20] Jafari M, Goli SAH, Rahimmalek M. The chemical composition of the seeds of Iranian pumpkin cultivars and physicochemical characteristics of the oil extract. European Journal of Lipid Science & Technology. 2012;**114**(2):161-167. DOI: 10.1002/ejlt.201100102

[21] Cai T, Li Q, Yan H, Li N. Study on the hypoglycemic action of pumpkin seed protein. Journal of Chinese Institute of Food Science and Technology. 2003;**3**(1):7-11

[22] Rezig L, Chibani F, Chouaibi M, Dalgalarrondo ML, Hessini K, Guéguen J, et al. Pumpkin (*Cucurbita maxima*) seed proteins: Sequential extraction processing and fraction characterization. Journal of Agricultural and Food Chemistry. 2013;**61**(32):7715-7721. DOI: 10.1021/jf402323

[23] Yang C, Wang B, Wang J, Xia S, Wu Y. Effect of pyrogallic acid (1, 2,3-benzenetriol) polyphenol-protein covalent conjugation reaction degree on structure and antioxidant properties of pumpkin (*Cucurbita* sp.) seed protein isolate. LWT. 2019;**109**:443-449. DOI: 10.1016/j.lwt.2019.04

[24] Nkosi C, Opoku A, Terblanche S. Effect of pumpkin seed (*Cucurbita pepo*) protein isolate on the activity levels of certain plasma enzymes in CCl_4-induced liver injury in low-protein fed rats. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives. 2005;**19**(4):341-345. DOI: 10.1002/ptr.1685

[25] Nkosi C, Opoku A, Terblanche S. In vitro antioxidative activity of pumpkin seed (*Cucurbita pepo*) protein

isolate and its In vivo effect on alanine transaminase and aspartate transaminase in acetaminophen-induced liver injury in low protein fed rats. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives. 2006;**20**(9):780-783. DOI: 10.1002/ptr.1958

[26] Sarkar SK, Hossain MT, Uddin MB, Absar N. Purification, characterization and physico-chemical properties of three galactose --specific lectins from pumpkin (*Cucurbita maxima*) seed kernels. Journal of the Chinese Chemical Society. 2007;**54**(6):1433-1442. DOI: 10.1002/jccs.200700203

[27] Meru G, Fu Y, Leyva D, Sarnoski P, Yagiz Y. Phenotypic relationships among oil, protein, fatty acid composition and seed size traits in *Cucurbita pepo*. Scientia Horticulturae. 2018;**233**:47-53. DOI: 10.1016/j.scienta.2018.01.030

[28] Bialek A, Bialek M, Jelinska M, Tokarz A. Fatty acid composition and oxidative characteristics of novel edible oils in Poland. CyTA – Journal of Food. 2017;**15**(1):1-8. DOI: 10.1080/19476337.2016.1190406

[29] Balbino S, Doric M, Vidakovic S, Kraljic K, Škevin D, Drakula S, et al. Application of cryogenic grinding pretreatment to enhance extractability of bioactive molecules from pumpkin seed cake. Journal of Food Process Engineering. 2019;**42**(8):e13300. DOI: 10.1111/ j f pe.1330

[30] Geranpour M, Emam-Djomeh Z, Asadi G. Investigating the effects of spray drying conditions on the microencapsulation efficiency of pumpkin seed oil. Journal of Food Processing and Preservation. 2019;**43**:e13947. DOI: 10.1111/jfpp.139.47

[31] Longato E, Lucas-González R, Peiretti PG, Meineri G, Pérez-Alvarez JA, Viuda-Martos M, et al. The effect of natural ingredients (*amaranth* and pumpkin seeds)on the quality properties of chicken burgers. Food and Bioprocess Technology. 2017;**10**(11):2060-2068

[32] Oztürk T, Turhan S. Physicochemical properties of pumpkin (*Cucurbita pepo* L.) seed kernel flour and its utilization in beef meat balls as a fat replacer and functional ingredient. Journal of Food Processing and Preservation. 2020;**44**(9):e14695

[33] Serdaroğlu M, Kavuşan HS, Ipek GAMZE, Öztürk B, U.R.C.U. Evaluation of the quality of beef patties formulated with dried pumpkin pulp and seed. Korean Journal for Food Science of Animal Resources. 2018;**38**(1):1-13

[34] Malkanthi HHA, Umadevi SH, Jamuna KV. Glycemic response and antioxidant activity of pumpkin seed powder (*Cucurbita maxima*) blended biscuits. Journal of Pharmacognosy and Phytochemistry. 2018;**7**(4):1877-1882

[35] Kumari N, Sindhu SC, Rani V, Kumari V. Shelf life evaluation of biscuits and cookies incorporating germinated pumpkin seed flour. International Journal of Current Microbiology and Applied Sciences. 2021;**10**:1436-1443

[36] Białek M, Rutkowska J, Adamska A, Bajdalow E. Partial replacement of wheat flour with pumpkin seed flour in muffins offered to children. CyTA – Journal of Food. 2016;**14**:391-398

[37] Bhat MA, Anju B. Study on physicochemical characteristics of pumpkin blended cake. Journal of Food Processing & Technology. 2013;**4**:262

[38] Soleimanian Y, Sanou I, Turgeon SL, Canizares D, Khalloufi S. Natural plant fibers obtained from agricultural residue

used as an ingredient in food matrixes or packaging materials: A review. Comprehensive Reviews in Food Science and Food Safety. 2022;**21**(1):371-415

[39] Shendge S, Patharkar S. Standardize the processing technology for preparation of cereal milk fortification with garden cress (*Lepidium sativum*) seed and pumpkin (*Cucurbita*) seed powder. Pharma Innovation. 2020;**9**:423-426

[40] Samec D, Loizzo MR, Gortzi O, Cankaya IT, Tundis R, Suntar I, et al. The potential of pumpkin seed oil as a functional food-a comprehensive review of chemical composition, health benefits, and safety. Comprehensive Reviews in Food Science and Food Safety. 2022;**21**(5):4422-4446

[41] Ferrer-Gonzalez BM, Garcia-Martinez I, Totosaus A. Textural properties, sensory acceptance and fatty acid profile of cooked meat batters employing pumpkin seed paste or soybean oil oleogel as fat replacers. Grasas y Aceites. 2019;**70**:e320. DOI: DOI.10.3989/gya.1055182

[42] Plat J, Baumgartner S, Vanmierlo T, Lütjohann D, Calkins KL, Burrin DG, et al. Plant-based sterols and stanols in health & disease: "Consequences of human development in a plant-based environment?". Progress in Lipid Research. 2019;**74**:87. DOI: 10.1016/j.plipres.2019.02.003

[43] Amin MZ, Islam T, Uddin MR, Uddin MJ, Rahman MM, Satter MA. Comparative study on nutrient contents in the different parts of indigenous and hybrid varieties of pumpkin (*Cucurbita maxima* Linn.). Heliyon. 2019;**5**(9):e024. DOI: 10.1016/j.heliyon.2019.e02462

[44] Chari KY, Polu PR, Shenoy RR. An appraisal of pumpkin seed extract in 1,2-dimethylhydrazine induced colon cancer in wistar rats. Journal of Toxicology. 2018:1-12. DOI: 10.1155/2018/6086490

[45] Li L, Leung PS. Use of herbal medicines and natural products: An alternative approach to overcoming the apoptotic resistance of pancreatic cancer. International Journal of Biochemistry & Cell Biology. 2014;**53**:224-223. DOI: 10.1016/j.biocel.2014.05.021

[46] Fawzy EI, ElMakawy AI, El-Bamby MM, Elhamalawy HO. Improved effect of pumpkin seed oil against the bisphenol-A adverse effects in male mice. Toxicology Reports. 2018;**5**:857-863. DOI: 10.1016/j.toxrep.2018.08.014

[47] Xiang J, Apea-Bah FB, Ndolo VU, Katundu MC, Beta T. Profile of phenolic compounds and antioxidant activity of finger millet varieties. Food Chemistry. 2019;**275**:361. DOI: 10.1016

[48] Azzi A. Tocopherols, tocotrienols and tocomonoenols: Many similar molecules but only one vitamin E. Redox Biology. 2019;**26**:1259. DOI: 10.1016/j.redox.2019.101259

[49] Rozanowska M, Edge R, Land EJ, Navaratnam S, Sarna T, Truscott TG. Scavenging of retinoid cation radicals by urate, trolox, and α-,β-,γ-,and δ-tocopherols. International Journal of Molecular Sciences. 2019;**20**(11):2799. DOI: 10.3390/ijms20112799

[50] Saito Y, Yoshida Y. Chemical reactivity and cellular uptake of tocopherols and tocotrienols. In: Vitamin E. United Kingdom: Royal Scociety of Chemistry; 2019. pp. 51-63

[51] Wang M, Zhang L, Wu X, Zhao Y, Wu L, Lu B. Quantitative determination of free and esterified phytosterol profile

in nuts and seeds commonly consumed in China by SPE/GC–MS. LWT. 2019;**100**:355-336. DOI: DOI. 10.1016/j.lwt.2018.10.077

[52] Nakano T, Inoue I, Murakoshi T. A newly integrated model for intestinal cholesterol absorption and efflux reappraises how plant sterol intake reduces circulating cholesterol levels. Nutrients. 2019;**11**(2):310. DOI: 10.3390/nu11020310

[53] Reaver A, Hewlings S, Westerman G, Blander K, Schmeller T, Heer M, et al. A randomized, placebo-controlled, double-blind crossover study to assess a unique phytosterol ester formulation in lowering LDL cholesterol utilizing a novel virtual tracking tool. Nutrients. 2019;**11**(9):2108. DOI: 10.3390/nu11092108

[54] Alhakamy NA, Fahmy UA, Ahmed OAA. Attenuation of benign prostatic hyperplasia by optimized tadalafil loaded pumpkin seed oil-based self nanoemulsion: In vitro and in vivo evaluation. Pharmaceutics. 2019;**11**(12):640. DOI: 10.3390/pharmaceutics11120640

[55] Hajhashemi V, Rajabi P, Mardani M. Beneficial effects of pumpkin seed oil as a topical. Phytomedicine. 2019;**9**(6):499-504. DOI: 10.22038/ajp.2019.13463

[56] Das UN. Essential fatty acids: Biochemistry, physiology and pathology. Biotechnology Journal. 2006;**1**:420-439

[57] Makni M, Sefi M, Fetoui H, Garoui EM, Gargouri NK, Boudawara T, et al. Flax and pumpkins seeds mixture ameliorates diabetic nephropathy in rats. Food and Chemical Toxicology. 2010;**48**:2407-2412

[58] Richter D, Abarzua S, Chrobak M, Vrekoussis T, Weissenbacher T, Kuhn C, et al. Effects of phytoestrogen extracts isolated from pumpkin seeds on estradiol production and ER/PR expression in breast cancer and trophoblast tumor cells. Nutrition and Cancer. 2013;**65**:739-745

[59] Gavril RN, Stoica F, Lipsa FD, Constantin OE, Stănciuc N, Aprodu I, et al. Pumpkin and pumpkin by-products: A comprehensive overview of phytochemicals, extraction, health benefits, and food applications. Food. 2024;**13**:2694. DOI: 10.3390/foods

[60] Gossell-Williams M, Lyttle K, Clarke T, Gardner M, Simon O. Supplementation with pumpkin seed oil improves plasma lipid profile and cardiovascular outcomes of female non-ovariectomized and ovariectomized Sprague-dawley rats. Phytotherapy Research. 2008;**2008**(22):873-877

[61] LaChance LR, Ramsey D. Antidepressant foods: An evidence-based nutrient profiling system for depression. World Journal of Psychiatry. 2018;**8**:97-104. DOI: 10.5498/wjp.v8.i3.97

[62] Ceclu L, Nistor OY. Red beetroot: Composition and health effects- a review. Journal of Nutritional Medicine and Diet Care. 2020:**6**. DOI: 10.23937/2572-3278.1510043

[63] Yasir M, Sultana B, Nigam PS, Oswusu-Apenten R. Antioxidant and genoprotective activity of selected cucurbitaceae seed extract and LC-ESIMS/MS. Food Chemistry. 2016;**199**:307-313. DOI: 10.1016/j.foodchem.2015.11.138

[64] Zhao XJ, Chen YL, Fu B, Zhang W, Liu Z, Zhuo H. Intervention of pumpkin seed oil on metabolic disease revealed by metabonomics and transcrip profile. Journal of the Science of Food and Agriculture. 2017;**97**(4):1158-1163

[65] Aziz A, Noreen S, Khalid W, Ejaz A, Faiz ul Rasool I, Maham, et al. Pumpkin and pumpkin byproducts: Phytochemical constitutes, food application and health benefits. ACSO Mega. 2023;**8**:23346-23357

[66] Noh NANM, Karim L, Omar SR. Value-added products from pumpkin wastes: A review. Malaysian Journal of Science, Health & Technology. 2022;**8**:77-84

[67] Sadeghi A, Ebrahimi M, Raeisi M, Ghods Mofidi SM. Improving the antioxidant capacity of bread rolls by controlled fermentation of rice bran and addition of pumpkin (*Cucurbita Pepo*) puree. Food Measurement. 2019;**13**:2837-2845

[68] Çiftçi S, Suna G. Functional components of peanuts (*Arachis hypogaea* L.) and health benefits: A review. Future Foods. 2022;**5**:100140

[69] Syed QA, Akram M, Shukat R. Nutritional and therapeutic importance of the pumpkin seeds. Biomedical Journal of Scientific & Technical Research. 2019;**21**:3586

[70] 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. 2019;**26**:1-17. DOI: 10.1080/19315260.2019.1606130

[71] Demiral I, and¸Samdan, C. Preparation and characterization of activated carbon from pumpkin seed shell using H_3PO_4. Anadolu University Journal of Science and Technology-A Applied Sciences and Engineering. 2016;**17**:125-138