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Chemical Constituents and Functional Phytochemistry of Pumpkin: A Nutraceutical Perspective

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Abstract

The pumpkin (Cucurbita maxima), a member of the Cucurbitaceae family, is a popular edible plant that is grown and widely used as a functional food and herbal remedy. The purpose of this review was to examine the nutritional and functional components of pumpkin as well as the advantages these nutrients have for health. Fractions of pumpkin are a great source of minerals, proteins, carbs, and oils. Phenolics, flavonoids, tocopherols, carotenoids, terpenoids, cucurbitacin, moschatin, and phytosterols are among the families of phytochemical substances that have been identified from pumpkin fractions. Numerous epidemiological investigations on animals and human trials have provided substantial information regarding the pharmacological activities of pumpkin bioactives. The history of the pumpkin diet shows that there is a negative correlation between its use and the incidence of cancer. The seeds, peel, and meat of pumpkins contain active compounds that function as powerful antimicrobials and antioxidants. During processing, no portion of the pumpkin fruit should be thrown away because it has good phytochemistry that can have positive health effects. The food and pharmaceutical sectors can use all of these pumpkin parts as medicinal agents by isolating and characterizing the bioactives in the form of powders or extracts.

Keywords: Phytochemicals, Bioactive compounds, Pharmacological activities, Antioxidant activity, Cancer prevention, Waste utilization, pharmaceutical applications

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Introduction

Pumpkin is classified under the genus Cucurbita and the family Cucurbitaceae, comprising three economically significant species: Cucurbita maxima, Cucurbita pepo, and Cucurbita moschata. Major global producers are the United States, China, Russia, and India. Carotenoids, phenolics, vitamins, minerals, polysaccharides, pectens, fibers, tocopherols, phytosterols, essential oils, proteins, peptides, and amino acids are the most prevalent natural phytochemicals found in enough amounts in pumpkin. Pumpkin's diverse array of bioactives has been linked to a number of biological and pharmacological properties, including as prebiotic, antibacterial, anticancer, antioxidant, cardioprotective, antiaging, and anti-inflammatory properties [1]. The use of pumpkin also improves the nutritional content of produced foods. Pumpkin's nutraceutical and functional food qualities make it a food that may be used in a variety of ways [2]. Antioxidant components like vitamin C, vitamin A, vitamin E, zinc, and beta-carotene are abundant in vegetables like pumpkin. These kinds of vegetables strengthen the body's innate and adaptive immune systems in place of fast food, which is high in saturated fats and harmful cholesterol [3]. Plants have long been used to treat cancer and other illnesses. Plants were used to extract anticancer chemicals and therapeutic elements over time. The discovery of vinca alkaloids "Vinblastine and Vincristine" and the isolation of cytotoxic podophyllotoxins in the 1950s marked the beginning of the hunt for anticancer drugs [4]. Pumpkin is one of these plants that has been used medicinally. Nutrients such as lipids, proteins, carbs, and minerals are abundant in pumpkin fractions. Phenolics, flavonoids, tocopherols, carotenoids, terpenoids, cucurbitacin, moschatin, and phytosterols are among the families of phytochemical substances that have been identified from pumpkin fractions. Numerous epidemiological investigations on animals and human trials have provided substantial information regarding the pharmacological activities of pumpkin bioactives. The skin, flesh, and seeds of pumpkins contain active compounds that have antibacterial and antioxidant properties. During processing, no portion of the pumpkin fruit should be thrown away because it has good phytochemistry and can have beneficial effects on health. All of these pumpkin components can be used as extracts or powders to separate and describe bioactives and employ them as medicinal agents in the food and pharmaceutical

industries. Rather than being eaten raw, technologies should be used to create new and creative pharmaceutical foods and nutraceuticals using the healthful components of pumpkin.

Phytochemistry

The phytochemicals found in pumpkin have a wide range of therapeutic properties that cause different physiological effects on human bodies. Tocopherol, cucurbitacin, alkaloids, flavonoids, phenolics, phytosterols, and tannins are the main bioactive components of plants. Along with their various biologically active ingredients, including proteins, sterols, fixed oils, polysaccharides, and para-aminobenzoic acid, pumpkin seeds also provide a host of health advantages. According to [5], the phytosterol content of pumpkin seed kernels was the highest at 265-289 mg/100 g. and the hypocholesterolemic effect of these phytochemicals is remarkable [6] The electron-donating properties of phenols enable them to scavenge reactive oxygen, which is essential for preventing diseases including cancer, Parkinson's disease, and Alzheimer's in both plants and animals [7]. The presence of tocopherol isomers (a, b, g, and d) in raw pumpkin seeds has been shown to confer antioxidant capacity, potentially reducing the incidence of diabetes mellitus [8]. Since alkaloids (180 mg/100 g) in pumpkin are therapeutic molecules that scavenge free radicals or bind with catalysts of certain metal ions (oxidative reactions) to slow the growth of microorganisms (bacteria, fungi, protozoans, etc.) and thereby prevent the onset of various diseases, they are highly sought after in pharmaceutical formulations. Astringent qualities of tannins include the ability to heal wounds and irritated mucous membranes. The methanol extraction of Cucurbitacin derivatives from Cucurbita pepo seeds was found to have anti-ulcerative properties by preventing ulcers on the stomach mucosa. Pumpkin seeds had a squalene content ranging from 583.2 to 747 mg/100 g. Many cancers have been discovered to respond well to squalene, a triterpene that is a precursor to the body's manufacture of steroid hormones, cholesterol, and vitamin D [9]. Pumpkin seeds are utilized all over the world due to their nutritional value and health advantages, and they are high in unsaturated oil. They are phospholipids, which are significant constituents of lipids and cell membranes. Numerous illnesses, including diabetes, heart disease, and several cancers, especially breast cancer, can be avoided with linolenic acid [10]. Properties of nutraceuticals, which are products generated from food that provide health advantages, are a combination of the words "nutrition" and "pharmaceuticals." Since they are thought to be safe and may have nutritional benefit, they have recently been investigated as viable substitutes for the management and prevention of numerous illnesses. Abundant phytochemicals in fruit and vegetables make them wonderful source for functional foods as these feature vast health benefits likewise. Cucurbita maxima has antirheumatic properties (it suppresses rheumatic disease symptoms), demulcent properties (it creates a calming film over a mucous membrane), diuretic properties (it increases urine production), nervine properties (it calms agitated nerves), and taeniafuge properties (it removes tapeworms from the body) [11]. Additionally, the fibers in pumpkin help to buffer the stomach's pH by binding the excess acids that the digestive system produces. As a support for benign prostatic hyperplasia (BPH), it is used to treat gastrointestinal parasites, urinary dysfunctions, dysuria, cardiovascular diseases, and blood glucose control [12].

Antioxidant activity

Antioxidants are compounds that prevent oxidative chain reactions from starting or continuing, which delays the oxidation of other molecules. Exogenous substances are required by biology to prevent harmful oxidation of bodily cells and tissues and to maintain the body's appropriate health and function [13]. Several in-vitro tests, including metal chelating activity, reducing power, and radical scavenging activity, are typically used to assess the antioxidant activity of Cucurbitaceae seed protein. Depending on the degree of hydrolysis (DH) and molecular weight distribution of the peptides in the hydrolysates, it has been observed that the antioxidant activity increases with hydrolysis. Cucurbitaceae seed protein hydrolysates generally exhibit stronger antioxidant activity when the DH is higher and the peptides are smaller [14]. The isomeric combination of beta and delta tocopherol is present in pumpkin seed oil. Vegetable oils contain non-glycoside compounds called tocopherols, which function as organic antioxidants. According to Chen and Huang [15], pumpkin polysaccharide isolated using the hot water extraction method exhibits strong antioxidant qualities in both its native and sulfated forms.

Anticancer activity

It has been reported that the antioxidants and polyphenolic chemicals included in food help regulate abnormal inflammatory signals and signaling pathways linked to cancer stem cells [16]. Cucurbita pepo extract may be created as a novel chemotherapeutic drug to stop or slow the growth of cancer and tumors. Pumpkin seed diet carotenoids have been linked to prostate cancer in addition to reducing the incidence of colon, lung, breast, and stomach cancer.

According to a study, some fundamental proteins called microtubule-associated proteins (MAP)2 and MAP4 found in seeds stop leukemia K-562 cells from growing. However, there have also been reports of other proteins preventing the growth of melanoma. Cucurmosin from the sarcocarp of Cucurbita moschata has recently demonstrated high cytotoxicity against three cancer cell lines of both human and murine origin identified from Type1 ribosome-inactivating proteins, in addition to providing rRNA and N-glycosidase activity [17]. Pumpkin polysaccharides exhibit good anticancer benefits by eliminating numerous free radicals formed in the body during metabolism, including superoxide anions, hydroxyl radicals and other reactive oxygen species. According to reports, a moderate amount of fatty oil found in pumpkin seeds is safe for both humans and animals, and it also protects against genotoxicity brought on by azathioprine disorders [18]. Crude pumpkin extracts and their many purified fractions, such as proteins and polysaccharides, have been used in numerous in vitro and in vivo studies that demonstrate anticancer activity against malignant tumors linked to leukemia and skin cancer. In addition, the rate at which tumor cells divided was also inhibited by boiling pumpkin juice [19].

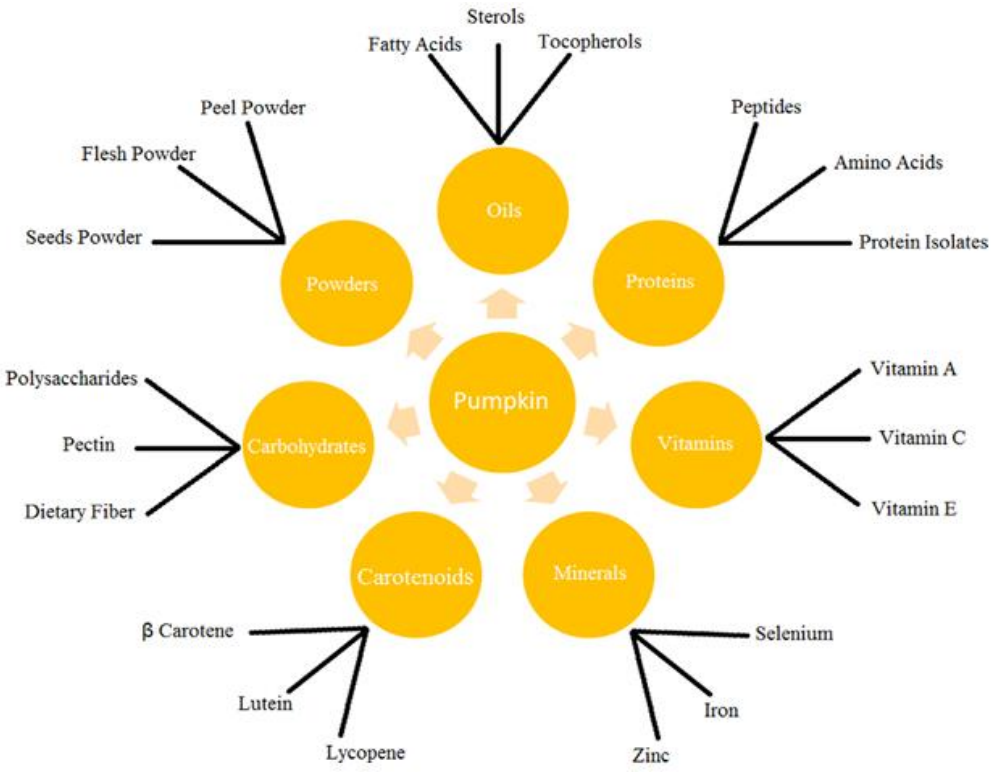

Figure 1 phytochemicals present in pumpkin. (Sehar *et al*., 2022)

Pumpkin based pharma and functional food products

The aesthetic value and antioxidant potential of food products made from pumpkin are enhanced by natural pigments like carotenoids. Using various technologies, pumpkin peel and pulp were examined for the content of carotenoids and polyphenols, the compounds that give pumps their antioxidant capabilities. The findings were comprehensive [20]. Porridge, biscuits, and sponge cake were among the cereal-based foods enhanced by pumpkin powder, which is high in carotenoids. Using in vitro study models, the bio accessibility and cell uptake of carotenoids from various bakery goods were examined. It was found that lutein, beta-carotene, and beta-carotene had notably high bio accessibility. In order to increase the antioxidant activity of the created product, pumpkin flour was employed as a functional ingredient in flat noodles. Noodles with pumpkin powder added showed improvements in flavor, texture, fragrance, and accessibility [21].

Food applications

Pumpkin is grown all over the world for its medicinal and culinary uses, as well as to make syrups, jams, jellies, purees, and other food products. Pumpkin seeds are used to make a variety of baked goods, including cereal bars, chikki, bread, crackers, cookies, cakes, muffins, and snacks. In addition to adding taste to baked goods, soups, and gravies, pumpkin seed powder also improves the nutritional value of the final product. Through pumpkin fermentation, certain flavors

and aromas have been added to soups and condiments. Nigeria is the source of the edible fluted pumpkin seeds, which are used to make ogiri. This fermented substance is added to soups and other dishes as a condiment.

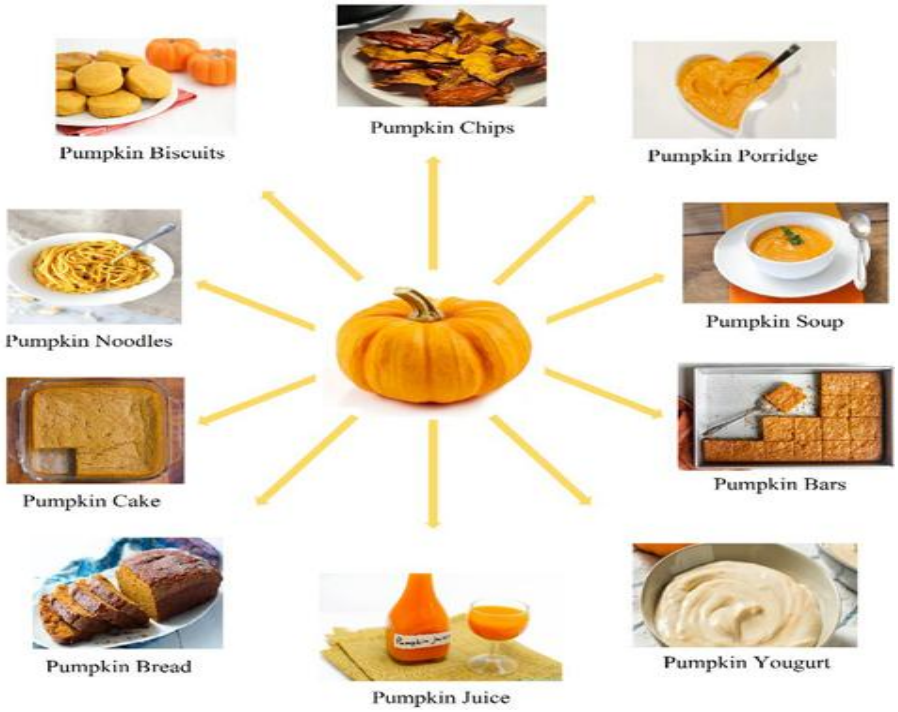

Figure 2 Pumpkin derived healthy and functional food products. (Sehar *et al*., 2022)

Conclusion

Cucurbita's nutritional and phytochemical components make it a popular vegetable and medicinal plant. Tocopherol (e.g., α- and γ-tocopherol), carotenoid (e.g., β-carotene, β-cryptoxanthin, lutein, and zeaxanthin), and β-sitosterol are among the phytocompounds found in pumpkin that have anti-inflammatory, antioxidative, anticarcinogenic, and anti angiogenesis properties. Fruit pericarp, leaves, petals, and seeds have all been utilized as building blocks for novel pharmacological, nutraceutical, and functional food formulations. In poor nations, all parts of the pumpkin are readily available and reasonably priced. In order to maximize the plant's utilization and provide consumers with health advantages through culinary products made with pumpkin, cucurbita can be used to create a variety of valuable products.

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