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Pumpkin the functional and therapeutic ingredient: A review

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Abstract
Pumpkin is regarded as valuable vegetables primarily because of the high carotenoid content, the low energetic value, high in carbohydrates and minerals. Consumption of pumpkin helps to prevent skin diseases, eye disorders reducing cell damage in the body, cancer and improve immune function. Pumpkin contains biologically active components that include polysaccharides, para-aminobenzoic acid, fixed oils, sterol, proteins and peptides. Its popular medicinal uses are as antidiabetic, antihypertension, antitumor, immunomodulation, antibacterial, anti-hypercholesterolemia, intestinal antiparasitia and anti-inflammation as reported by different researchers. The Pumpkin seed is excellent source of protein and also has pharmacological activities such as anti-diabetic, antifungal, antibacterial, anti-inflammation activities and antioxidant effects. It has obtained considerable attention in recent years because of the nutritional and health protective values of the seeds. The antimicrobial activity of pumpkin has many applications, including preservation, pharmaceuticals, alternative medicine and natural therapies.

Keywords: pumpkin, therauptic, medicinal, antidiabetic

Introduction

The pumpkin is a vegetable crop belonging to the cucurbitaceae family. This family contains chemicals, including tetracyclic triterpenes, saponins, proteins, fibers, polysaccharides and minerals (iron, zinc, manganese, copper, etc) [1]. The family is one of the largest families in plant kingdom comprising of highest number of edible plant species. Seeds embedded in a bright-yellow fibrous endocarp are large, non endospermic and usually dark red in colour. It is needed to complement staples in food, supplying indispensable minerals and vitamins that may not be present in staple diets. They generally produce more nutrients per unit land area than staple foods. Pumpkin seed oil typically is a highly unsaturated oil, with predominantly oleic and linoleic acids present. Very low levels of linolenic acid or other highly unsaturated fatty acids are present, providing pumpkin seed oil with high oxidative stability for storage or industrial purposes and low free radical production in human diets. Studies of pumpkin seed oil triacylglycerol positional isomers found that oleic and linoleic acid distribution patterns are not random [2]. The highly unsaturated fatty acid composition of pumpkinseed oil makes it well-suited for improving nutritional benefits from foods. Pumpkin seed oil has been implicated in providing many health benefits [3]. The most critical health benefit attributed to pumpkin seed oil is preventing the growth and reducing the size of the prostate [4, 5]. There is also evidence that suggests pumpkin seed oil can retard the progression of hypertension [6] and mitigate hypercholesterolemia [7] and arthritis [8]. Reduced bladder and urethral pressure and improved bladder compliance have been linked to pumpkin seed lipid components [9-12]. Pumpkin seed oil has been foundto alleviate diabetes by promoting hypoglycemic activity [3]. Pumpkin seed oil has been found to provide a significant source of vitamin E (tocopherol) in Japanese diets [13]. Diets high in pumpkin seeds have also been associated with lower levels of gastric, breast, lung, and colorectal cancer [14].There are alsopotential health benefits to be gained from the various carotenoidpigments found in pumpkin seed oil [15], and carotenoids from all sources of pumpkin fruit have been linked to the prevention of prostate cancer [16, 17]. Despite the aforementioned health benefits, pumpkin seed oil has been shown to exhibit no antimicrobial activity [18]. The antioxidant properties of tocopherols could play a significant role Roasted pumpkin seed oil was found to contain higher levels of α- and γ-tocopherol than roasted sunflower oil [19]. Total tocopherol content was 20.1 mg/100 g, of which 87% was in the γ-form, and no β- or δ-tocopherol was detected. In addition to good health benefits, pumpkin seeds are less expensive and are widely distributed.

According to Food and Agriculture Organization of United Nation (FAO), production of pumpkins, squashes, and gourds in 2011 was estimated over 24.3 million tons harvested from 1.7 million hectares [20].Cultivation of *Cucurbita cultigens* (a variety of pumpkin) as a food source on aglobal scale attributed to their adaptability in varied climatic conditions provide great opportunities for increased diversity and market growth by introducing unexplored forms of existing species [21]. Pumpkin contains biologically active compounds like polysaccharides, para-aminobenzoic acid, fixed oils, sterol, proteins and peptides. The fruits are a good source of carotenoid and γ - aminobutyric acid [22]. Due to its popular medicinal uses, researchers have focused over pumpkin from the last few decades, using modern tools, and credited pumpkin with antidiabetic, antihypertensive, antitumor, immunomodulative, antibacterial, anti-hypercholesterolemia, intestinal antiparasitial, anti-inflammatory and antalgic [23].

Recently, functionality and composition of dietary fibre fractions obtained from pumpkin were investigated [24], showing the capability of these fibres to be used as food ingredients or additives to improve food quality. Pumpkin is a high-yield vegetable, easy to grow, and consequently inexpensive. Changes in colour, flavour and viscosity that occur in the course of thermal processing affect the palatibility of a pumkin pureed product [25].

Chemical composition and bioactive components

The chemical composition of pumpkin varies from one cultivar or species to other. According to Mi [26] proximate composition of the pumpkin pulp varied between 75.8 and 91.33% moisture, 0.2 and 2.7% crude protein, 0.47 and 2.1% crude ash and 3.1 and 13% carbohydrate content. Pumpkin fruits have many nutritional components including polysaccharides, proteins, essential amino acids, valuable antioxidants, carotenoids and minerals. Seeds of pumpkin are rich in oil and the variability in the oil content is due to its broad genetic diversity. Pumpkin seeds have a high nutritional value (table 1), provides good quality oil, and excellent source of protein. Due to the presence of highly unsaturated fatty acids, pumpkin seed oil is well-suited for enhancing nutritional benefits from foods.

Table 1: Bioactive components and their percentage in Pumpkin seed (nutritive value per 100 g).

Components	nutritive value	Percentage of RDA
Energy	559 kcal	28
Carbohydrates	10.71 g	8
Protein	30.23 g	54
Total fat	49.05 g	164
Cholesterol	0 mg	0
Dietary fibre	6 g	16
Vitamins		
Folate	58 µg	15
Niacin	4.987 mg	31
Pa ntothenic acid	0.750 mg	15
Pyridoxine	0.143 mg	11
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Riboflavin	0.153 mg	12
Thiamine	0.27 mg	23
Vitamin A	16 IU	0.5
Vitamin C	1.9µg	3
Electrolytes		
Sodium	7 mg	0.5
Potassium	809 mg	17
Minerals		
Calcium	46 mg	4.5
Copper	1.343 mg	159
Iron	8.82 mg	110
Magnesium	592 mg	148
Manganese	4.543 mg	19
Phosphorus	1,233 mg	176
Selenium	9.4 µg	17
Zinc	7.81 mg	71
Phytonutrients		
Carotene-b	9 µg	-
Cryptoxanthin-b	1 µg	-
Lutein–zeaxanthin	74 µg	-

USDA-National Nutrient Data base

Nutritionaland dietary uses of Pumpkin

Pumpkins are consumed as freshly boiled and steamed or in processed form like soup and curry. It is high in β-carotene, which gives it yellow or orange color. Beta-carotene in plants that have a pleasant yellow-orange color is a major source of vitamin A[27]. It is also high in carbohydrates and minerals. Consumption of carotene containing foods helps in the prevention of dermatological ailments, eye disorders and certain cancers [28]. Incorporation of β -carotene rich ingredients in the form of pumpkin powder or flour in food products is therefore considered a very effective approach to eradicate vitamin-A related health problems [29].

Nutritional and health protective value of pumpkin draws considerable attention of food scientists in recent years [30].Food is one of our most basic needs, which provides us energy and also nourishes all our internal organs of the body. Plants produce oil seeds, grains, fruits and vegetables [31]. Pumpkin has gained a considerable attention in recent years for its nutritional and health promoting values. Pumpkin is cost effective and a nutrient rich source; the pumpkin seed flour incorporated complementary food mix is highly nutritive and economical with highly acceptable sensory attributes [32].

Functional components and their properties

Pumpkin seed oil is rich in many antioxidants and essential nutritional componentslike essential fatty acids (FAs), vitamins, squalene, carotenoids, tocopherols, phytoestrogenes, phytosterols, polyphenols, hydrocarbon, triterpenoids andselenium [33]. Pumpkins are rich source of calcium, iron, vitamin A, oil (25 -55%), rich in unsaturated oleic and linoleic acids), protein (25 - 35%) with high amounts of arginine, aspartate andglutamic acid, but deficient in lysine and sulphurcontaining amino acids [34].Pumpkin seeds have been used as an anthelmintic agent and proved effective in the treatment of functional disorders of the bladder [35].The healing powers of plants have been reported fromcenturies; about 80% of the available therapeutic substances have their origin from medicinal plants [36]. Scientists proved that the plants have medicinal properties for their biological activities ranging from antimicrobial to antitumor. The antimicrobial activity of plants has many applications in food preservation, pharmaceuticals, alternative medicine and natural therapies [37]. While some of the oils used on the basis of efficient antimicrobial properties have well documented *in vitro* activity [38]. The seed of pumpkin has pharmacological activities such asanti-diabetic [39], antifungal, antibacterial and antiinflammation activities, and antioxidant effects [40]. The most critical health benefit attributed to pumpkin seed oil is stopping the growth and reducing the size of the prostate [41]. Fruits and vegetables are essential ingredients of a healthy diet, and their consumption as food could help to prevent wide range of diseases [42]. The positive health effects of fruit and vegetable have been credited to the relatively high antioxidant concentration of fruits and vegetables [43]. Antioxidants naturally occur in fruits and vegetables. They are micronutrients that posses ability to neutralize free radicals or their actions [44]. Free radical have been implicated in the etiology of several major humans ailments, including cancer, cardiovascular disease, neural disorders, diabetes and arthritis [45]. Utilization of fruits and vegetables has been increased rapidly due to their health benefits. However, the perishable nature of fruits and vegetables and over-dependency of human on fewer plant species generate immense pressure on the industries to supply bulk of fresh fruits and vegetables to the emerging population. Such increased demand can only be fulfilled by either using the technology to prevent the deterioration of commodity after harvest or to introduce underutilized fruits and vegetables for their commercial utilization. These less significant underutilized fruits remained unexplored for and remained confined mainly to natural wild, semi-wild and semi domesticated conditions albeit with large ever increasing variability. Besides their importance as potential horticulture species these plants are incidentally store houses of genes for adaptation to hostile climatic conditions, salt tolerance, diseases tolerance and several important nutritional values. Further, efforts to cultivate these plants have not been explored as their economic potential has either been not completely explored or such products are confined mostly limited to traditional usage [46]. Many of the indigenous tropical and temperate fruits and vegetables have still remained underexploited due to the unawareness of their potential uses and market demand. These species have many uses as fruits, vegetables and also have significant therapeutic and medicinal properties [47]. Pumpkin is a essential food ingredient as part of a diet and as a medicinal therapeutic [48]. It is believed that pumpkin is a healthy and functional vegetable as it is rich in phenolics, flavonoids, vitamins (including β-carotene, vitamin A, vitamin B_2, α-tocopherol, vitamin C, vitamin E), amino acids, carbohydrates and minerals (especially potassium) and has low energy content and a large amount of fiber. Pumpkin may prove to be an excellent source of provitamin a carotenoids for the prevention of vitamin A deficiency [49]. Besides the provitamin a activity the special physiological functionality of several carotenoids as well as the prevention of cancer made it mandatory to enhance the knowledge about the content of carotenoids in foods [50].

Therapeutic and Health Promoting Properties

Anti-carcinogenic effect

Cancer is a rapidly growing health problem; it presents the biggest challenge to researchers and medical professionals and has been selected for various prevention and therapeutic strategies. The dietary intake of many vegetables and fruits has been found to reduce the risk of occurrence of cancer [51]. Diets high in pumpkin seeds have also been associated with lower risk of gastric, breast, lung and colorectal cancers [52]. There are also potential health benefits, including anti-carcinogenic effects, to be gained from the various carotenoid pigments found in pumpkin seed oil [53]. The carotenoids from pumpkin fruits have been linked to the prevention of prostate cancer [54, 55]. There are still various controversies regarding the use of juices of pumpkin fruits in cancer situations; for example, boiled pumpkin juice significantly suppressed the incidence of aberrant cells while fresh pumpkin juice enhanced it [56].It was reported that pumpkin fruit extracts markedly reduced tumour weight in S-180-bearing mice [56]. Cheong *et al.*, [56]. Isolated some basic proteins from pumpkin seeds named MAP2 (MW 2249 Da) and MAP4 (MW 4650 Da), and reported inhibition of the growth of leukemia K-562 cells. Moreover, other proteins from pumpkin seeds were reported to inhibit melanoma proliferation [57]. Xia *et al.* [58]. Isolated a novel ribosome-inactivating protein (RIP) called moschatin from the mature seeds of pumpkin (C. moschata) and a novel immunotoxin moschatin-Ng76 was prepared successfully which efficiently inhibits the growth of targeted melanoma cells M21 with an IC50 (50 % inhibitory concentration) of 0·04 nM, 1500 times lower than that of free moschatin. Recently, Hou *et al.* [59] isolated a novel type 1 RIP designated cucurmosin from the sarcocarp of C. moschata that exhibits strong cytotoxicity to three cancer cell lines of both human and murine origin, besides rRNA N-glycosidase activity.

Anti-diabetic activity

With the rapidly increasing cases of diabetes and its high risk interms of economic perspective on world population, the research for safer and inexpensive medicines for the treatment of diabetes is new challenge and innovative aid to the era of medicine technology. The use of herbal sources with bioactive components such as pumpkin is one among them. Therefore, various studies for the anti-diabetic potential of pumpkin is one of them, which is a normally cultivated plant in farms and its fruits are used for human consumption in diabetic conditions [60]. Local healers recommend the ingestion of crude aqueous extract of pumpkin fruits for the treatment of type 2 diabetes or non-insulin-dependent diabetes mellitus [61]. In various other reports, the pumpkin exhibited acute hypoglycaemic activity (blood sugar lowering) in temporarily hyperglycaemic rabbits, in alloxan-induced diabetic rabbits, and in type 2 diabetic patients [62, 63, 64]. Xia & Wang [65] demonstrated that pumpkin has hypoglycaemic activity like a standard drug (tolbutamide) in healthy animals with temporary hyperglycaemia and in mild diabetic animals, but not in severe diabetic animals. They suggested that these effects might be due to either increased pancreatic insulin secretion from the existing b-cells or insulin release from the bound form. D-chiro-Inositol was identified in pumpkin (especially in *Cucurbita ficifolia*) and this compound has been considered as an insulin action mediator (insulin sensitiser) [66]. However, the detailed mechanism of antidiabetic action of this component remains to be clarified. Various other components have also been isolated from pumpkin and analysed for anti-diabetic potential. For example, Kwon *et al.* [61]. Reported that phenolic phytochemicals of pumpkin have anti-diabetic effects in terms of b-glucosidase and a-amylase inhibition. Pumpkin also has hypotensive effects in terms of angiotensin I-converting enzyme-inhibitory activities. Furthermore, Quanhong *et al.* [67]. Also investigated hypoglycaemic substances from pumpkin, and they isolated protein-bound polysaccharide by activity-guided isolation from water-soluble substances of the pumpkin fruits. When this protein-bound polysaccharide from pumpkin fruits (PBPP) was evaluated for hypoglycaemic activity and effects on serum insulin levels in alloxan diabetic rats, and it was found that PBPP can increase the levels of serum insulin, reduce the blood glucose levels and improve tolerance of glucose in alloxan-induced diabetic animals. By considering all these facts, it can be concluded that pumpkin has potential anti-diabetic properties, which may suggest the inclusion of this plant in anti-diabetic regimens to treat human diabetes. However, further studies in detail are warranted to explore the mechanistic and therapeutic potential of pumpkins for diabetes.

Antimicrobial and Antifungal effects

Despite the aforementioned health benefits, pumpkin seed oil has been shown to exhibit antimicrobial activity [68]. Pumpkin extracts showed a broad spectrum antimicrobial activity against several bacteria [69]. Un-irradiated pumpkin seeds were effective against *Rhodotorula rubra* and *Candida albicans* at 0.5 and 1.0 mg/ml concentrations [70].

Anti-inflammatory effects

Pumpkin-fortified foods are considered as a good source of anti-inflammatory substances, which can help in many diseases such as arthritis [71]. Pumpkin seed oil significantly inhibited adjuvant induced arthritis in rats, similar to a well-known anti-inflammatory substance called indomethacin [72]. The beta-carotene in pumpkin seeds has anti-inflammatory properties and regular consumption of pumpkin seeds can protect against joint inflammation [73].

Conclusion

Pumpkin provides valuable source of carotenoids that have a major role in the nutrition in the form of pro-vitamin A. Being rich source of carotenoids pumpkin-based food products can help in preventing skin diseases, eye disorders and cancer. Incorporation of β -carotene rich ingredients in the development of food products is considered a cost-effective approach to vitamin-A related health problems. Moreover, the anti-diabetic properties and anticancerousproperties of pumpkin have generated interest in consuming this fruit and utilizing it as a source of various bioactives for the development of value added products and nutraceuticals.

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