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Pumpkin: Horticultural Importance and Its Roles in Various Forms; a Review

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Abstract

Pumpkin (*Cucurbita moschata* Duch ex Poir) is one of the important among the vegetable crops and native of Mexico and extensively cultivated in India, Africa, Latin America, Southern Asia and the United States. Since past times it is in the diet of agronomic and some metropolitan areas throughout the world while today pumpkin is more analyzed crop mid-October horticulture, commercial, industrialization, and research. There are few of scientific studies on its physiological, chemical, physicochemical, nutritional, functional and technological characteristics. There is some scientific literature on pumpkin has been highlighting its importance as a source of α and β-carotene, lutein, vitamin C (Ascorbic acid), dietary fibers, minerals etc and these nutritional and bioactive components are very important for providing benefits to human health. Many of the researchers agree to indicate that more of the scientific investigations are needed to achieve greater and better utilization of this important pumpkin crop. This review will focus on nutritional, minerals, physical, phytochemical, medicinal, industrial and some technological approaches of the pumpkin.

Keywords: Diet; ethnomedicine; horticulture; nutrition; lphyto-chemical; pumpkin

Introduction

Among food crops, vegetables are important in the aspect of the diet and give an eloquent amount of nutrients especially carbohydrates, minerals, vitamins and fiber and always have an elite status among the health food crops. By integrated action of oxygen radical scavengers such calcium, fibre, β-carotene and ascorbic acid which is present in vegetables, reduce the risk of cancer, heart disease, premature aging etc. Among all of these, pumpkin is one of the important vegetable crops and because of the nutritional and medicinal values, it is considered as important vegetable crop nowadays [1]. In India pumpkin is also Commonly known as 'Sitaphal', 'Kashiphal' or 'kaddu' and belongs to the family Cucurbitaceae and the genus Cucurbita. Cucurbitaceae family consists of about 118 genera and 825 species, according to the last taxonomic treatment of Jeffrey [2]. It includes *C. moschata, C. Pepo, C. Maxima, C. Mixta, C. Ficifolia* and *Telfairia occidentalis* as vegetable crops. Three of these, like *C. pepo* L., *C. maxima Duch.* and *C. moschata Duch*. are economically important species, have high production and cultivated worldwide. [3,4]. *C. moschata* has a Central American origin, domesticated in Mexico at least c. 5000 B.C. and in Peru c. 3000 B.C., now widely distributed throughout the world. It is said to be the most commonly cultivated among Cucurbita in the American tropics. *C. moschata* is dicotyledonous, consists of a succulent soft hairy stem, an annual climber growing to 3 meters and at maturity, it gives rise to flowers and fruits, which have numerous seeds. Leaves are simple, alternate, and shallowly lobed, often with white spots along the veins. The peduncle (stem that holds the fruit) is five-angled and flares outward where attached to the fruit. Fruits (technically referred to as pepos) are relatively large, with shapes ranging from globose to oblong to flatten. Seeds are 16–20 mm long. Seed germinates in 5–7 days from sowing. The plants form an extensive fibrous root system. Flowering starts 35–60 days after emergence and is more or less continuous. Pumpkin fruits are picked when nearly or fully mature 4–6 weeks after flowering, and are harvested in several rounds until the crop ends, 90–180 days after planting. Some farmers leave the fruits lying in the fields for weeks for fully ripen to collect the seeds. The skin is also variable in thickness, but soft, smooth and durable. The skin color can be from light to dark green, light to dark orange, and the pulp can vary considerably from brown, to completely white, bright orange to greenish light. It can be sweet, smooth and usually nonfibrous, and the seeds can be numerous, ovate-elliptic, with a yellowish white surface. The main season for growing cucurbits is summer and rainy in most parts of India. The maturity of pumpkin fruit occurs in about 90-120 days [5] and the fruits are often allowed to ripen on the vine to ensure good shelf life. Nutritional plants and herbal preparations have been traditionally used in developing countries and, a revival of its use in the United States and Europe can be observed. It is popularly used in various systems of traditional medicine for treatment of several ailments like antidiabetic, antihypertensive, antitumor, antibacterial, antihypercholesterolemia, intestinal antiparasitic, and anti-inflammation [6]. Polysaccharides, para-aminobenzoic acid, oils, sterol, proteins and peptides like biological components are also present in pumpkin. [7-10].

Worldwide production of pumpkin, squashes, and gourds is 24.62 million metric tones from an area of 5,10,0000 ha [11] and in India, the total production is 49,00,000 tones from an area of

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45,000 ha [12]. The average fruit weight fluctuates between 8 to 10 kg, sometimes even up to 20 kg. Pumpkin is one of the rich sources of phytonutrients and they are the valuable source of functional components mainly carotenoids, zeaxanthin, vitamin E, ascorbic acids, phytosterols, selenium and linoleic acid, which acts as an antioxidant in human nutrition [13]. Pumpkin has vast scope of diversification for its application in the production of commercial products such as jam, jelly, marmalades, puree, sauces, chutney, pickle and halwa, cookies and weaning mix, pies and beverages [14-16]. Any drink other than water kills as beverage, is an important culinary prepared by pumpkin for human consumption and contributes mid-August to quench the thirst [17] and are marketed under a variety of names such as fruit drink, breakfast drink, ready-to-serve (RTS), nectar, squash, spiced squash etc. [18].

Cultivation

Climate

Pumpkin is very sensitive to frost that's why temperatures should be high (above 35 ºC), freezing-free period and humidity should also be low. Temperature ranging from 20ºC to 35 ºC for maximum production are ideal and till the emergence of plants for germination the soil temperature requirement should be above 16 ºC. The above temperatures are helps in high yield for pumpkin production [19].

Soil, sowing of seeds and irrigation

Well-drained soil is preferred for easy penetration of roots maximum up to a meter deep, fertile soils with pH water between 6.0 and 6.5. Except these the pumpkin root can tolerate both slightly acid and slightly alkaline soils. For better growth and risk of diseases which is especially soil born in pumpkin, a crop rotation has been used so that pumpkin crops do not follow the previous crop which was infected by diseases. For high yields good ground preparation through many times of plowing is essential and ripping is necessary if the soil has been compacted. Before planting the field should be plowed 20 to 25 cm deep for fine tilth. Before sowing and after this the seeds have been sown. Before sowing all organic matter should be incorporated into the soil well to allow complete decomposition otherwise there can be serious losses from damping-off diseases. Usually, pumpkin crop plantation has been happened by direct seed sowing but sometimes can be sown as transplants and this transplantation procedure are useful when trying to establish a very early season crop or when using permanent beds. The crop is sown in with the space of 1.0 to 1.5 m and the range of rows has been 2.0 to 3.0 m apart between plants. Before sowing seeds should be treated or dusted with a fungicide to manage the disease-causing organisms, such as bacterial spot, Fusarium root rot, and damping-off, which may be generally spread by the seed surface. The requirement of water for proper growth and development of pumpkin crop, about 4 to 8 megalitres per hectare of irrigation water for full cultivation started from sowing to harvest time. Due to the different type of soils, the quantity of water also varies with the soil type, irrigation method, and condition of weathers like hot, dry winds for a consistent maximum yield of high quality. Furrow irrigation requires an even, gentle slope and a soil type that allows water to spread laterally, without penetrating too deep into the soil. Irrigation plays a vital role during flowering time, for proper fruit setting and filling. If plants are stressed due to lack of water (osmotic stress) at these times, flowers and young fruit are fallen off. At the time of maturation of fruit, the crop needs less irrigation. When the conductivity of the irrigation water reaches to 2.5 dS/m, a yield loss of 20 to 30% may be expected. These values are a guide only and vary with soil type, leaching potential, irrigation method and age of the plant.

Harvesting

Harvesting of the crop is done four months after the time of sowing. Pumpkin are harvested September through October. Sometimes harvesting may start in mid August to early September which requires good handling and storage of the pumpkin fruit before selling to the customers in late October. The first frost occurs in early to mid October in northern parts of the state when the pumpkin fruits are still curing outside in the fields. It is important to note that pumpkin fruits can tolerate light frost that kills the vines only but more fruit loss can occur if the frost caused injury on the fruit surface as the damaged areas act as avenues for fungal and bacterial fruit rot pathogens. Remove pumpkins from the fields before the hard freeze (when the night temperatures are less than 27 degrees (F) or else you may risk losing 80-90 percent of the fruits.

Status of chemical substances

Pumpkin is a good source of vitamin C (ascorbic acid), minerals, carotenes (α and β), various dietary fibers and phenolic mixtures. Skin firmness which comes from the sunlight has decreased by β-carotene that's why it is known as an anti-inflammatory agent and on the other hand α-carotene basically accepted as to decrease the procedure of aging, decrease the danger of mounting cataracts in eyes and defend against the growth of a tumor. By the oxidation of unsaturated fatty acid then the oxidative damage occurs and the cell membrane is full of fatty acid that's why the tocopherols (Vitamin E) saves the cell from this damage [20]. The seeds of *C. moschata* are usually thrown away but they possess a great source of various nutrients and oils [14]. After the industrial processing, the seeds of *C. moschata* are commercially used as a savory appetizer and have been reported as a good alternative for nutritional embellishment of various products of food [21]. The seeds of *C. moschata* also have a high nutritious value, contain the good quality of oil and are a good source of protein. The fruits of pumpkin are usually sweet after ripe with a yellow and an orange flesh, rich in β-carotene and precursor of vitamin A. Various antioxidant components including vitamin A, vitamin E, C, K, B2, carotenes, xanthophylls and phenolic compounds have been reported from fruits of pumpkin [22]. Pumpkin seeds are also an important source of polyunsaturated fatty acids, phytosterols, and zinc, which can prevent chronic diseases [23]. In addition, pumpkin seed extract

significantly improved the histopathological parameters such as vacuolization in dermatopathology, disorganization, and separation of epididymal epithelium in CP-treated rats that's why pumpkin seed extract could be used to prevent CP-induced reproductive toxicity [24]. Similarly, Mohammadi et al [25-27] have shown that administration of ginger and pumpkin seed extract simultaneously increased the number of germ cells in seminiferous tubes and had positive effects on the recovery of spermatogenesis in adult rats.

Seeds as a source of oil and nutrients

Seeds of pumpkin are also known as Pepitas and are small, flat, green, having the taste likes nut flavor and mostly are covered by a white husk, however, some varieties may produce seeds without husk. Seeds representing 3.1% of total fruit weight of pumpkin and are rich in protein (33%), low in phytic acids and trypsin inhibitor and high in sulfur-containing amino acids, a major source of oil (47.3%) and added in the source of national oil production [28]. In addition to high levels of Zn, P, K, Se, Mn and Cu the seeds of the pumpkin are also contained Mg and Fe and has high amount of fatty acids content like palmitic, stearic, oleic and linoleic acids [29,30]. The linoleic acid is the major fatty acid in pumpkin seed oil reported by Kamel et al. [31] and is also a rich source of phytosterols and structurally similar to cholesterol. The oil of pumpkin seeds improve the nutrition of human diets having high unsaturation and tocopherol content and also has high oxidative stability, various applications in industries and suitable for food [32].

Minerals

For the importance of human health, pumpkin has a good source of minerals. Pumpkin is used as a food for mid-aged and aged peoples because having high calcium and potassium as well as sodium in its pulp. It is used for the prevention of osteoporosis and hypertension [33]. Having chromium (Cr) content, pumpkin is good for any other vegetable and is a component of glucose tolerant factor and improved blood glucose tolerance.

Amino acids and proteins

Besides less than 2.0% of protein content in pumpkin, there are various essential amino acids in pumpkin pulp eg; 0.508% of lysine, 0.493% of isoleucine, 0.609% of valine, 0.700% of leucine, 0.483% of phenylalanine and 0.381% of threonine are high in *C. moschata* [34]. Many immuno-component proteins have also been found in pumpkin [35]. From pumpkin leaves there is antifungal protein isolated and purified which can rapidly break down the hyphal tips of Neurospora crassa at a concentration of lesser than 200nM, and significantly inhibit the growth of *Fusarium oxysporum* and *Candida* albicans on agar disc plate at lesser than 2 nM [36].

Nutritional values

Pumpkin is cultivated in hot climate type of areas around the world as diet, fodder for the animals. Besides these, the flowers, young stems, ripe fruits are consumed as a vegetable and latter are also used to prepare the various type of sweets. Pumpkin seeds from different regions contain a protein, fat and carbohydrate content of 28-40%, 44- 53% and 7-10% and shows as a prominent source of oil and protein [37]. The seeds are eaten whole as roasted or toasted ground into different stews and are also consumed directly by humans as a snack food. [38] Pumpkins provide a number of beneficial nutrients and minerals like iron, magnesium, phosphorus, potassium, copper, and manganese [39]. They contain high levels of thiamin, niacin, vitamin B6, have even higher levels of vitamin C and vitamin E and are also dominant fatty acids present in the oil like oleic acid of 29% and linoleic acid of 47%. [40].

Ethnomedicinal purposes

Due to the wide range of biological activities in flora and fauna, the various species of cucurbits family have phytochemical of great interest and called cucurbitacins. As a result of this, cucurbitacins are better-known chemicals and are kept in the list various stock of drugs for the preparation of medicines [41]. Various parts of the plant species belong to family Cucurbitaceae is used in ethnomedicines like fruits have the sharp effect on the bowels, in the refinement of blood and in the medication of leprosy in human beings. Besides these, seeds have useful importance in the cure of pain chests, febrile disease, haemoptysis, bronchitis, applied in the case of bladder stone, chronic kidney problem and also used as anti-ulcer cucurbitane type triterpenoid [42,43] 3-amino-3-carboxypyrrolidine, a specific amino acid called as cucurbitin is present in different varieties of pumpkin and squash and their seeds are used for the elimination of tapeworms and roundworms which are intestinal parasites.

Medicinal properties

C. moschata Duch. commonly known as "pumpkin" and belongs to the Cucurbitaceae family and the plant widely deals for the use of its fruit and seeds in various pharmacological activities for example fruits is rich in nutrition due to γ-tocopherol and carotenoid and shows anti-fatigue activity in mice [6,44]. It has been found that the peel of pumpkin contains different amino acids including alanine, arginine, aspartic acid, glutamic acid, histidine, leucine, isoleucine, glycine, lysine, methionine, phenylalanine, serine, threonine, valine, and tyrosine. Both of mono and polyunsaturated fatty acids, as well as saturated ones like palmitic acid, stearic acid, oleic acid and linoleic acid, have been found in the oil which is extracted from the seeds of pumpkin [45]. On the other hand pumpkin has several pharmacological activities in its different parts like the powder which has been extracted from the fruit help in reducing the blood glucose with the increment of plasma insulin and showed antidiabetic activity in alloxan-induced diabetic mice [46-48]. Pumpkin peel was also used for the treatment of hepatic disorders, peptic ulcer, gastrointestinal bleeding and different types of wounds, including burn wound because of its cool and wet nature [49]. There is some other medicinal importance of pumpkin including here that it shows an antidiabetic effect and also protect the diabetic nephropathy [50]. Extensively pumpkin extracts have

antimicrobial activity antimicrobial activity like pumpkin oil inhibits *Acinetobacter baumanii, Candida albicans, Enterococcus faecalis, Escherichia coli, Klebsiella pneumonia, Pseudomonas aeruginosa,* and *Staphylococcus aureus* at the concentration of 2.0%. [51]. Several studies (in vitro as well as in vivo) with crude pumpkin extracts and its various purified fraction including proteins and polysaccharide shows anticancer activity against malignant tumor associated with skin cancer, Ehrlich-Lettre ascites carcinoma (EAC) and leukemia. Besides these, boiled pumpkin juice comparably suppressed the rate of the division of tumor cells [52]. Pumpkin seed was found to be an anthelmintic and was eaten fresh or roasted for the relief of abdominal muscles pain due to intestinal worms; reduce the incidence of bladder stones [53]. For the reduction of bladder pressure, increase the bladder compliance and reduce the urethral pressure the oil of pumpkin plays the significant role. [54]. The protein which is extracted by pumpkin seeds after CCl4 intoxication resulted in significantly reduced levels of various enzymatic activities like lactate dehydrogenase (LD) which is found in nearly all living cells of animals, plants, and prokaryotes and catalyzes the conversion of lactate to pyruvic acid and converts NAD+ to NADH and back, alanine transaminase (ALT) to maintain the blood level, aspartate transaminase (AST) to diagnose liver disorder [55]. Pumpkin showed urokinase inhibitory activity over 80% with water by different ways of processing [56]. Head of a pumpkin stem observed in the use of analgesia and anti-inflammation activities [57]. A dietetic formula made of pumpkin oils was found to beneficial for children with diarrhea [58]. According to Kim et al. [59] the presence of β-carotene in pumpkin help in the treatment of depression in Korea and the seeds of pumpkin also used in anti-hyperglycaemic activity because of containing globulins and developed the peptide-drugs or phytomedicines from these bioactive proteins used in therapy of Diabetes mellitus [60]. Aghaie et al. [61] show the reproductive toxicity of cyclophosphamide which has been found in pumpkin and used in the treatment of cancer. Sharma et al. [62] also gave the suggestion for a medicative importance of Cucurbita on colon or rectal cancer.

Technological aspects

From edible part of *C. moschata,* chloroform and ethyl acetate have been extracted by the studies and from the extracts of chloroform, the saturated fatty acid which contains 52% of C17, 49% of C19 and 4% of C15 have been isolated. Besides this, by the ethyl acetate, the 11.36% of phytosterols, 48.86% of stigmasterol and 39.77% of bsitosterol have also been isolated. Having above these substances the chloroform and ethyl acetate showed significant anti complementary activities of the complement system [63]. The polysaccharide like Alcohol Insoluble Polysaccharide (AIP) was finally fractioned into Water Soluble Pectic fraction (WSP), an Ethylene diaminetetra acetic acid Soluble Pectic fraction (ESP) and Alkali-Soluble Pectic fraction (ASP) were isolated from the peels of C. moschata. The above fractions were analyzed for their chemical composition and subjected to gel filtration and ion exchange chromatography. Beside this, AIP fraction promotes the activities of good intestinal bacteria, peel might be an attractive material for the development of functional foods [64].

According to several technological properties, the powder of pumpkin with different ratio was added to noodles and makes some noodle products. Four samples (2%, 3%, 4% and 5%) samples were evaluated for β-carotene content, physical dough properties, color, cooking properties, and sensory characteristics and among these four noodles with 5.0% pumpkin powder were the most favorable in appearance, taste, texture, and acceptability among the four samples. Raw material of peeled and unpeeled pumpkin pulp used for the production of flour mixed with wheat flour as a functional integrant in food products to evaluate of its physicochemical properties like color, proximate compositions includes moisture, ash, lipid, protein and carbohydrate contents, water activity and functional properties like water holding capacity and oil holding capacity. After the evaluation, it has been found that in comparison to the commercial wheat flour, the peeled pumpkin pulp flour (PPPF) and unpeeled pumpkin pulp flour (UPPF) were observed to be more attractive in terms of color. On the other hand, it was found in comparison to commercial wheat flour the peeled pumpkin pulp flour and unpeeled pumpkin pulp flour was superior in term of nutrients as indicated by the significantly higher ash and crude fiber content. There was no significant difference shown in the water holding capacity of PPPF and wheat flour but the oil holding capacity of PPPF and UPPF was shown to be significantly higher than the wheat flour. After exposure to air drying between 30ºC and 70ºC, the concentration of proximate like lipids, fibers, and proteins of C. moschata has been diminished with drying even at a temperature as low as 30°C and this the most ambient temperature in tropical countries. The protein content was not affected by drying and it was observed that increasing the drying temperature from 30°C to 70°C led to a reduction of 70% of the drying time [65].

Conclusion

From this review article, it is clear that members of Cucurbitaceae family show multifunctional uses in the living life of humans as well as animals. *Cucurbita moschata* has been used in the making of medicine to diagnose the various diseases in human being. They can be employed in the nutritional, ethnomedicinal purposes, technological aspects for the extraction of various chemicals. It is recommended that there should be increased in the production of these plants which will be profitable and will contribute to food security and livelihood sustainability in India and other parts of the world.

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