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Nutritional, Therapeutic and Food Applications of Jamum (*Syzygium cumini*)

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A B S T R A C T

Syzygium cumini commonly known as jamun, jambolan, black plum and jambol etc., is underutilized fruit in various parts of world. It has been known for its medicinal properties and is considered as one of the most important traditional medicines for the treatment of diabetes mellitus. Besides it, this fruit is used for the treatment of diseases like inflammation, ulcers and diarrhea. But it is rich source of nutrients, particularly phytochemicals such as anthocyanins, glucoside, ellagic acid, isoquercetin, kaemferol and myrecetin. The seeds are claimed to contain alkaloid, jambosine and glycoside jambolin or antimellin, which are effective for diabetic patients. Instead of medicinal properties it can also be used in food processing. But very less findings regarding its processing and food uses are available. Different products like jam, jelly, squash, juice, nectar can be prepared by this fruit which are rich source of antioxidants and nutrients. So, it is the need of time that instead of using the extracts for medicinal purposes, jamun should be used in the form of food products. In the current review, health benefits, medicinal and food uses of jamun have been briefly discussed.

Key words: Jamun, processing, medicinal properties, health benefits

INTRODUCTION

Fruits and vegetables belong to an important class of foods that supply human diet with nutritive requirements including vitamins and minerals which are essential for normal body health and function. Jamun (*Syzygium cumini*) is one of the members of the family Myrtaceae and is a large perennial tree inherent to the Indian subcontinent, but now a day these trees are very common throughout the Asian subcontinent, Eastern Africa, South America and Madagascar (Warrier *et al*., 1996; Li *et al*., 2009). The jamun fruits are produced once in a year and its availability is possible in the month of June-July (Shrivastava and Kumar, 2009) and the jamun fruits are characterized as berries that are sweetish sour to taste (Warrier *et al*., 1996). The common cultivars of jamun are Ra Jamun, Kaatha, Narendra Jamun-6 and Konkan bhar doli and the cultivar grown in Pakistan is Rajamun. The jamun fruit is a berry which is big sized, oblong in shape and deep purple or bluish black in color. Its pulp is purple pink and fruit is juicy and sweet (Achrekar *et al*., 1991). Jamun is perishable and underutilized fruit which is rich in nutrients like vitamins, minerals,

flavonoids, essential oils, anthocyanins, phenolic compounds and other antioxidants (Sharma *et al*., 2006; Reynertson *et al*., 2008). Due to oxidative stress inhibition ability, cell carcinogenesis and to induce apoptosis in malignant cells the anthocyanins and phenolics have gained supreme attention (Hou *et al*., 2005). Stability of anthocyanin is vital for bioactive roles and color for food products. Stability and color of anthocyanins and phenolics is dependent on many factors (structure, light intensity, pH, temperature, quality, enzymes, oxygen, ascorbic acid, presence of co-pigments, metallic ions, sugars and their degradation products (Bao *et al*., 2005).

Estimated world production of Jamun is 13.5 million tons per annum out of which 15.4% are contributed by India. India stands second in production of Jamun in the world (FAO, 2009). Total cultivated area under jamun in Pakistan is 1338 hectare and total production per annum is 7712 t (FAO, 2009). Being climacteric fruit ripening of jamun fruit is not possible after its harvesting. Harvesting of wholly ripe fruits is done by shuddering the branches of trees and hand picking. The typical produce of fully grown flowered and sprout trees are 50-70 kg and 80-100 kg plant^{-1} year^{-1} (Noomrio and Dahot, 1996). Jamun fruits are highly perishable so their expected storage stability is almost 2 days when kept at ambient temperature. Shelf life of fruit can be increased up to three weeks by precooling it and packing in perforated polythene bags and storing it at 8-10°C and 85-95% humidity (Morton, 1987). Typically losses of perishable fruits in developing countries are 10-25% due to inadequate handling, processing and transportation practices (Coursey, 1983). Jamun fruits come in underutilized fruit category which are neither cultivated nor commercially processed in Pakistan. The quality of jamun is greatly deteriorated between its harvesting and consumption so there is a considerable wastage of this fruit. To prevent this wastage and to make the jamun available round the year it is practicable to convert the fruit into value added products (Shahnawaz *et al*., 2012).

Ripe Jamun have almost 83% water with practically 14% solids containing a mixture of fermentable sugar. The Jamun pulp contains significant amounts of fermentable sugar, which may be used for alcoholic fermentation (Chowdhury and Ray, 2007). The jamun fruits are rich source of iron and are largely used as an effective medicine in the treatment of diabetes, heart and liver trouble (Shrivastava and Kumar, 2009). Jamun fruits are opulent in fructose, raffinose, glucose (Srivastava, 1953). Important phenolic compounds in fruit pulp are Ellagic Acid (0.03 mg g^{-1}), Quercetin (0.01 mg g^{-1}), Rutin (0.12 mg g^{-1}), Cyanidin 3-glcoside (0.14 mg g^{-1}), Delphinidin 3 glcoside (1.61 mg g^{-1}), Quercitrin (less than 0.1%) (Reynertson *et al*., 2008). Sourness of fruit is due to the presence of Gallic acid and color will be due to the anthocyanins (Venkateswarlu, 1952). One hundred grams Jamun fruit comprises almost 83.70-85.80 g moisture, 0.70-0.13 g protein, 0.15-0.30 g fat, 14.00 g carbohydrate, 0.32-0.40 g ash, 0.30-0.90 g crude fiber, 8.30-15.00 mg calcium, 35.00 mg magnesium, 15.00-16.20 mg phosphorus, 1.20-1.62 mg iron, 26.20 mg sodium, 0.23 mg copper, 13.00 mg sulfur, 8.00 mg chlorine, 0.01-0.03 mg thiamine, 55.00 mg potassium, 8 I.U vitamin A, 0.009-0.01 mg riboflavin, 0.20-0.29 mg niacin, 5.70-18.00 mg ascorbic acid, 7.00 mg chlorine and 3.00 mcg folic acid per 100 g of edible portion (Baliga *et al*., 2011). Constituents that are reported in the seeds of *Syzgium cumini* are protein (6.3-8.5%), 1.18% fat, 16.9% crude fiber, 21.72% ash, 0.41% calcium, 0.17% phosphorus, fatty acids (palmitic, stearic, oleic and linoleic), fatty oils (30 g kg^{-1}), including lauric (2.8%), myristic (31.7%), palmitic (4.7%), stearic (6.5%), oleic (32.2%), linoleic (16.1%), malvalic (1.2%), stercu-lic (1.8%) and vernolic acid (3%) 41% starch, 6.1% dextrin, a trace of phytosterol (β-sitosterol) and tannin (predominantly corilagin, ellagitannins, ellagic acid, gal-loyl-galactoside and gallic acid) (6-19%) (Lock *et al*., 2009; Ranjan *et al*., 2011). The seeds of jamun fruit contains oils which comprises of 33.2% 1-chlorooctadecane, 8.02% decahydro-8a-ethyl-1,1, 9.24% tetratet-racontane, 5.29% 4-(2-2-dimethyl-6-6-methylene- cyclohexyl) butanol, 4a,6-tetrame-thylnapahthalene, 5.15% Octadecane, 3.97% octacosane, 1.72% heptacosane and 1.71% eicosane (Kumar *et al*., 2009).

HEALTH BENEFITS OF JAMUN

Jamun fruit seeds and pulp have been testified to assist various tenacities in diabetic patients, such as depressing blood glucose levels and adjourning diabetic complications including neuropathy and cataracts and jamun fruit lessens the sugar in the blood and hence play important role in the control of diabetes (Helmstadter, 2008).

Administration of aqueous extract of jamun about 400 mg per day for 15 days noticeably prohibited hyperglycemia and hyper insulinemia, this dose is recommended in the treatment of non-insulin dependent diabetes (Vikrant *et al*., 2001). The seeds of jamun encompass Glucoside, Jamboline and Ellagic acid, which have the ability to check the conversion of starch into sugar when there is excess production of glucose in body (Giri *et al*., 1985). Jambolan and mango juice in equal amounts quench thirst in diabetics (Gordon and Jungfer, 2011). Jamun possess antineoplastic, (Barh and Viswanathan, 2008) Radio protective (Jagetia *et al*., 2005) and chemo preventive effects (Parmar *et al*., 2010), all these properties are used to treat the cancer disease. The ripe fruits are good diet in recuperation diarrhea and dysentery and syrup or vinegar prepared from ripe jamun is also useful in the treatment of spleen expansion and it is effective in long-lasting diarrhea (Nadkarni, 1954). The fruit juice is used in diarrhea and dysentery and it is greatly affected when the patient passes blood-mixed stool (Ranjan *et al*., 2011). Extract of the fruit pulp inhibits the lipid peroxidation (Benherlal and Arumughan, 2007). Like the fruit juice, powdered jambolan and mango seeds along with curds are used in treatment of enlarged spleen and retained urine (Gordon and Jungfer, 2011).The plants of jamun as a whole have antioxidant, free radical scavenging (Rekha *et al*., 2008; Zhang and Lin, 2009), antibacterial (Rajakaruna *et al*., 2002), Antifungal (Chandrasekaran and Venkatesalu, 2004), antidiabetic (Grover *et al*., 2000) and anti-inflammatory activities (Muruganandan *et al*., 2001).

FOOD USES

Being a perishable commodity the jamun fruits cannot be kept in fruit form for a long period of time so it is good practice to preserve the valuable fruits in the form of its processed products like juices, drinks, squashes, nectars, jam and jellies etc. Jambolan juice which is of good quality is admirable for the preparation of drinks, syrup and squash. Squash is a drink which is prepared by cooking of mashed fruits for 5-10 min at 140°F and is stored in the bottles. After that these mashed fruits are pressed to obtain juice and at last this juice is mixed with sugar, water, sodium benzoate and citric acid (as a preservative) (Lai *et al*., 1960). Jamun fruits which are of good size and quality, having a sweet or sour acid flavor and a slightest of astringency, are enjoyable as raw fruit and may be processed into tarts, sauces and jam. If the fruits are soaked in salt water then the palatability of astringent fruits is improved (Kennard and Winters, 1960). Another way to improve the palatability of fruit is that the fruits are rubbed with salts and give stay time of about one hour (Burkill, 1935). Jamun fruits are used for extraction of juices which is comparable in its nutrition to that of grape juice (Quisumbing, 1951). In order to reduce the astringency of juice extracted from cooked jamun fruits, it is recommended not to squeeze the fruits and allow draining without squeezing the. The white-fleshed jamun is an excellent source of pectin and is known for making the stiff jelly even at very brief cooking (Miller *et al.,* 1955). The most common type of jamun is purple fleshed which is also used for the preparation of jelly. The jellies made by the purple colored fruits are rich colored but are deficient in pectin and there is need to add pectin or commercial gelling agent. Another approach is to make jelly by combining the jamun with the fruits that are significant sources of pectin like guavas (unripe or sour) (Barret, 1928). In different parts of world (Goa and Philippines) the valuable source of wine is *Syzygium cumini*, resembling Port (Daster, 1943). Brandy and distilled liquor that are prepared from jamun are called "Jambava" that is made by using the fruits that have been subjected to fermentation. Vinegar is also made from the jamun which is popular in some countries like India. It has purple color, pleasant aroma and mild flavor, which is very attractive for consumers. Jamun fruits come in underutilized fruit category which are neither cultivated nor commercially processed in Pakistan. The quality of jamun is greatly deteriorated between its harvesting and consumption so there is a considerable wastage of this fruit. To prevent this wastage and to make the jamun available round the year it is practicable to convert the fruit into value added products (Shahnawaz *et al*., 2012). Fermented beverages i.e. as vinegar and cider and ready-to-serve beverages and squashes (non-fermented) are the processed products of jamun fruit. Fruits can also be preserved in the form of jelly. Jamun juice of good quality is excellent for making sherbets, squashes and syrups (Miller *et al*., 1955). Jamun pulp is significant source of minerals i.e. calcium, sodium, potassium, zinc, copper, chromium, manganese, magnesium and iron (Indrayan *et al*., 2005).

But when this pulp is used in the preparation of products like jam, jelly, ready to serve juice and squash then the amount of these minerals reduces which is due to their loss during processing (Shahnawaz *et al*., 2009). Jamun jelly prepared from artificial sweeteners (acesulfame-k, cyclamate, saccharin and sucralose) has less acidity and calorific value (50%) as compared to that prepared from sugar (Lago-Vanzela *et al*., 2011). Processing of jamun fruit into value added products like ready to serve juices, jams and squashes with better sensory, nutraceutical and nutritional properties is an important approach to preserve this valuable fruit. Therefore it is necessary to develop, optimize and popularize the value added products of jamun commercially in Pakistan (Shahnawaz *et al*., 2012).

MEDICINAL USES

In the folk medicines and in the pharmaceutical trade the jamun has gained more importance than in any other field. Medicinally, the fruit is stated to be astringent, stomachic, carminative, antiscorbutic and diuretic (Sarivastava *et al*., 1983). Besides these the jamun fruit extracts exhibit the cytotoxic and antimicrobial properties and can also found uses on topical antimicrobial products. In comparison to other non-traditional fruits jamun displayed considerable high antioxidant activity, which can constituent such as anthocyanins, tannins and flavonols (Gordon and Jungfur, 2011). The anthocyanin composition of the jamun is characterized by the presence of 3, 5-di-glucosides of five out of six aglycones commonly found in foods (Adelia *et al*., 2011). Fruits contain many different kinds of anti-oxidant compounds, including flavonoids, phenolics, carotenoids and vitamins, which are all considered beneficial to human health, for decreasing the risk of degenerative diseases by reduction of oxidative stress and for the inhibition of macromolecular oxidation (Kubola *et al*., 2011). There is a very high anthocyanin content in *Syzygium cumini* fruits which attributes to its antioxidant and free radical scavenging activity. These pigments can be a good source of natural food colorants for the food processing industries.

Fruit bark decoction for anti-plasmodial activity was performed, leading to the isolation of three known ellagic acid derivatives (ellagic acid, ellagic acid 4-O-alpha-L-2”-acetylrhamnopyranoside, 3-O-methylellagic acid 3’-O-alpha-L-rhamnopyranoside), as well as the new derivative 3-O-methylellagic acid 3’-O-beta-D-glucopyranoside (Simoes-Pires *et al*., 2009) 3-hydroxy androstane (Miller *et al*., 1955) (6’methyl, 2’-1- hydroxyl-isopropene-1-yl) 4,5,6 H pyran present in *Syzygium cumini* seed is one of the important marker compound (Sapana *et al*., 2009). Phytochemical investigation of the stem bark of (*Syzygium cumini* L.) Skeels (Myrtaceae) yielded four new lignin derivatives characterized as (7α,8α,2’α)-3,4, 5-trimethoxy-7,3’,1’,9’-diepoxylignan (cuminiresinol), (7α, 7’α,8α,8’α)-3,4-dioxymethylene-3’,4’-dimethoxy-7,9’,7’,9-diepoxylignan-5’-ol (5’-hydroxy-methyl-piperitol), (7α, 7’α,8α,8’α)-3’-methoxy-9-oxo-7,9’,7’,9-diepoxylignan-3,4, 4’-triol or 3-demethyl-9-oxo-pinoresinol (syzygiresinol A), (7α,7’α,8α,8’α)-9-oxo-7,9’,7’,9-diepoxylignan-3,4,3’,4’, 5’-pentaol or 3,3’-didemethyl-9-oxo-pinoresinol along with the known lignans di-demethyl-5-hydroxypinores- inol, dimethylpinoresinol, didemethoxypinoresinol, pi-noresinol and 4’-methyl-5’-hydroxypinoresinol (Qurat and Ali, 2009). The anthocyanins occur as 3, 5 but not 3-diglucosides, of delphinidin, cyanidin, petunidin, peonidin and malvidin. This is the report to use a combination of spectrometric and spectroscopic methods are used to identify unequivocally the structures of jamun fruit anthocyanins (Liya *et al*., 2009). Flavonoids have been referred to as nature’s biological response modifiers, because of their intrinsic capacity to transform the body’s reaction to allergies and virus and they showed their anti-allergic, anti-inflammatory, anti-microbial and anti-cancer activities. Plant steroids are known to be important for their cardio tonic activities and also possess insecticidal and antimicrobial properties. They are also used in nutrition, herbal medicine and cosmetics (Gowri *et al*., 2010). Seed extracts of *Syzygium cumini*, often used in Ayurvedic medicine and are reported to have high phenolic contents and anti-oxidant activity when measured by using the Trolox Equivalent Antioxidant Capacity (TEAC) and Ferric Reducing Antioxidant Power (FRAP) antioxidant assays (Reynerston *et al*., 2008).

The juice of the ripe fruit, or a decoction of the fruit, or jamun vinegar, may be administered in India in cases of enlargement of the spleen, chronic diarrhea and urine retention. Water-diluted juice is used as a gargle for sore throat and as a lotion for ringworm of the scalp. Jambolan juice and mango juice, half and half, quench thirst in diabetics (Gordon and Jungfur, 2011). The reasons for the myriad pharmacological effects are due to the presence of diverse phytochemicals like flavonoids, anthocyanins and terpenes.

Extracts of both, but especially the seeds, in liquid or powdered form (Steinmetz, 1965) are freely given orally, two or three times a day to patients with diabetes mellitus or glycosuria. In many cases, the blood sugar level reportedly is quickly reduced and there are no ill effects. Fresh seeds are considered superior to dried seeds. Reduction of blood sugar was obtained in alloxan diabetes in rabbits (Gordon and Jungfur, 2011). On the other hand, it was found that there is no physiological activity in the bark (Bhatnagar *et al*., 1961). Other reported constituents of the seeds are: tannin, fatty acids (palmitic, stearic, oleic and linoleic), trace of phytosterol (Quisumbing, 1951), gallic acid, 1-2%; chlorophyll, starch, 41%, dextrin, 6.1%; protein, 6.3% and a trace of phytosterol. The seeds are claimed by some to contain a glycoside, jambolin or antimellin, which halts the diastatic conversion of starch in to sugar also a resin yielding phenolic substances named jambidol and ellagic acid and an alkaloid, jambosine (Parmar *et al*., 2010). The bark contains 8% to 19% tannin, gallic acid, 1.67%, resin, small amounts of ellagic acid and myricetin. A decoction of the bark is taken internally for dyspepsia, dysentery and diarrhea and also serves as an enema. The dried and powdered seeds and root-bark are similarly employed. Powdered bark mixed with curds is given in menorrhagia. Powdered jambolan and mango seeds, with curds, are used, like the fruit juice, in treating enlarged spleen and retained urine. The leaf juice is effective in the treatment of dysentery, either alone or in combination with the juice of mango or embolic leaves (Gordon and Jaungfer, 2011). The leaves, steeped in alcohol, are prescribed in diabetes (Parmar *et al*., 2010). Jambolan leaves may be helpful as poultices for skin diseases. The leaves yield 12-13% tannin (by dry weight), also an essential oil containing limeonene and dipentene (20- 30%), about 40% of sesquiterpene and a little azulenic sesquiterpene. Bark decoctions are taken for asthma and bronchitis and are gargled or used as mouth wash for the astringent effect on mouth ulcerations, spongy gums and for stomatitis. Ashes of the bark, mixed with water, are spread over local inflammations or blended with oil, applied to burns (Gordon and Jaungfer, 2011).

In the year 2008, 12.7 million new cancer cases and 7.6 million cancer deaths occurred (Ferlay *et al*., 2010). More troublingly, prophecies are that, the worldwide prevalence of the cancer will increase by three times by the year 2020 with an unbalanced upsurge in cases from the developing world countries that have restricted resources to grab the problem (Are *et al*., 2010). The surgery, hormone therapy, radiotherapy and chemotherapy which are traditional methods for the treatment of cancer remain prohibitively expensive to the large number of population in the developing countries. The mortality and associated morbidity will be enormous due to the compromised financial condition of the patients with an expected rise in cancer incidence, (Ferlay *et al*., 2010). Since the emergence evolution, herbal drugs have been used in the ancient civilizations and their use in the treatment of cancer is on a rise especially in the developing and underdeveloped countries primarily due to its easy affordability, non-toxic nature, easy acceptability, less toxic or no toxic effects and easy availability. Plants have been the main ingredients of various medications of the traditional Indian system of medicine, the Ayurveda and one such plant of immense importance is *Eugenia jambolana* Lam (Syn. *Syzygium cumini* Skeels or *Syzygium jambolana* Dc or *Eugenia cuminii* Druce), colloquially known as Java plum, Portuguese plum, Malabar plum, black plum, Indian blackberry, jaman, jambu, jambul and jambool (Warrier *et al*., 1996).

CONCLUSION

Lot of research has been carried out on the use of jamun as the traditional medicine for the treatment of the diabetes. From pharmacology point of view, the seeds of the fruit have been used in the medicines of diabetes, but the work on the other parts of plant is not explored. Overall, it has been cleared that as a medicine jamun fruit has

large potential but very less work has been done from food processing point of view. So, it is the need of time that we should explore the nutrition of this fruit in the form of food products like jam, jelly, squashes, nectars, juices and candies etc. instead of medicines or extracts. Work should also be done on the methods of preservation of this fruit like other valuable fruits because it is full of nutrition particularly phytochemicals.

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