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PHARMACOLOGICAL PROPERTIES AND THERAPEUTIC POTENTIAL OF SYZYGIUM CUMINI (JAMUN): A REVIEW

Meenakshi Kumawat*[1], Jyoti Damor[1], Jaya Kachchhwaha[1], Ayush Kumar Garg[1] and Chandan Singh[2]

*[1]PG Scholar and [2](H.O.D.) Associate Professor

PG Department of Dravyaguna, Dr. Sarvapalli Radhakrishanan Rajasthan Ayurved University, Jodhpur, Rajasthan, India.

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***Corresponding Author**
Dr. Meenakshi Kumawat
PG Scholar, PG Department of Dravyaguna, Dr. Sarvapalli Radhakrishanan Rajasthan Ayurved University, Jodhpur, Rajasthan, India.

ABSTRACT

JAMUN *(Syzygium cumini)* commonly known as Black berry, Black plum, Jambul or Java Plum, is large evergreen, glabrous tree, it is distributed throughout India, Sri Lanka, Malaya, and Australia. Annually the trees produce oblong or ellipsoid fruits (berries). They are green when raw and purplish black when fully ripe. The ripe fruits are sweetish sour to taste. Studies have shown that the berries contain carbohydrates, minerals and the pharmacologically active phytochemicals like flavonoids, terpenes, and anthocyanins. The plant is rich in compounds containing anthocyanins, glucoside, ellagic acid, isoquercetin, kaemferol and myrecetin. The seeds are claimed to contain alkaloid, jambosine and glycoside jambolin or antimellin, which halts the diastatic conversion of starch into sugar. The vast number of literatures found in the database revealed that the extracts of different parts of jamun showed significant pharmacological actions. Jamun is a plant with known ethnomedicinal uses. Scientific studies have shown that the various extracts of Jamun possess a range of pharmacological properties such as antibacterial, antifungal, antiviral, anti-genotoxic, anti-inflammatory, anti-ulcerogenic, cardioprotective, anti-allergic, anticancer, chemopreventive, radioprotective, free radical scavenging, antioxidant, hepatoprotective, anti-diarrheal, hypoglycemic and antidiabetic effects. Several dietary phytochemicals have been reported to have growth inhibitory and apoptotic effect on HeLa and other cervical cell lines.[1]

KEYWORDS: JAMUN *(Syzygium cumini)* cardioprotective, cervical cell lines.

INTRODUCTION

Plants are highly valuable and used since thousands of years by the people as the medicine to cure many diseases. Man has always searched for that gift of nature that heals the body and soothes the mind. Jamun is known to be an indigenous and important minor crop in India. It is an evergreen tropical tree native to Bangladesh, India, Nepal, Pakistan, Sri Lanka, the Philippines and Indonesia. It is a hardy fruit crop. Its tree is very tall and evergreen and partially deciduous under drought conditions. The original home of jamun is India. It is found growing wild throughout the country. Jamun is a large evergreen tree attaining a height of 2530 m and a stem girth 3-4 m. It is a beautifully shaped tree and is grown for its delicious fruits, shade and windbreak on the bunds road side avenues. Jamun is a cross-pollinated crop. This long-lived tree bears fruits up to 60-70 years. Traditionally the fruits, leaves, seeds and bark are all used in ayurvedic medicine. Its bark contains tannins, carbohydrates and other nutritional micronutrients that help to combat with many diseases. The bark of the plant is astringent, sweet, refrigerant, carminative, diuretic, digestive, anthelminthic, febrifuge, constipating, stomachic and antibacterial. The fruits and seeds are used to treat diabetes, pharyngitis, spleenopathy, urethrorrhea and ringworm infection. The leaves have been extensively used to treat diabetes, constipation, leucorrhoea and to inhibit blood discharges in the faeces.[2]

Morphological Characteristics of *Syzygium cumini* (jamun)

Jamun is a large evergreen and densely foliaceous tree with greyish-brown thick bark, exfoliating in woody scales. The wood is whitish, close grained and durable; affords brown dyes and a kind of a gum *Kino*. The leaves are leathery, oblong-ovate to elliptic or obovate-elliptic with 6 to 12 centimeters long (extremely variable in shape, smooth and shining with numerous nerves uniting within the margin), the tip being broad and less acuminate. The panicles are borne mostly from the branchlets below the leaves, often being axillary or terminal and are 4 to 6 centimeters long. Flowers are scented, greenish-white, in clusters of just a few or 10 to 40 and are round or oblong in shape and found in dichotomous paniculate cymes. The calyx is funnel-shaped, about 4 millimeters long, and toothed. The petals cohere and fall all together as a small disk. The stamens are numerous and about as long as the calyx. Several types, which differ in colour and size of fruits, including some improved races bearing purple to violet or white coloured flesh and seedless fruits have been developed. The fruits are berries and are often obviously oblong, 1.5 to 3.5 centimeters long, dark-purple or nearly black, luscious, fleshy and edible; it contains a single large seed.[3,4] The plant

produces small purple plums, which have a very sweet flavor, turning slightly astringent on the edges of the pulp as the fruit becomes mature. The dark violet colored ripe fruits give the impression the fruit of the olive tree both in weight and shape and have an astringent taste.[5] The fruit has a combination of sweet, mildly sour and astringent flavour and tends to colour the tongue purple.

Parts are used

Leaves, Stem bark, Flowers, Fruit, Seeds.

Phytochemical constituents

Leaves

The leaves are rich in acylated flavonol glycosides[6], quercetin, myricetin, myricitin, myricetin 3-O-4-acetyl-L-rhamnopyranoside[8], triterpenoids, esterase, galloyl carboxylase[9], and tannin.[7]

Stem bark

The stem bark is rich in betulinic acid, friedelin, epi-friedelanol, β-sitosterol, eugenin and fatty acid ester of epi-friedelanol, β-sitosterol, quercetin kaempferol, myricetin, gallic acid and ellagic acid[10], bergenins, flavonoids and tannins.[11] The presence of gallo- and ellagi-tannins may be responsible for the astringent property of stem bark.

Flowers

The flowers are rich in kaempferol, quercetin, myricetin, isoquercetin (quercetin-3-glucoside), myricetin-3-L-arabinoside, quercetin-3-D-galactoside, dihydromyricetin[12], oleanolic acid, acetyl oleanolic acid, eugenol-triterpenoid A and eugenol-triterpenoid B.[12]

Fruits

The fruits are rich in raffinose, glucose, fructose, citric acid, mallic acid, gallic acid, anthocyanins[13]; delphinidin-3-gentiobioside, malvidin-3-laminaribioside, petunidin-3-gentiobioside[14], cyanidin diglycoside, petunidin and malvidin.[15] The sourness of fruits may be due to presence of gallic acid. The color of the fruits might be due to the presence of anthocyanins.[14] The fruit contains 83.70–85.80 g moisture, 0.70–0.13 g protein, 0.15–0.30 g fat, 0.30–0.90 g crude fiber, 14.00 g carbohydrate, 0.32–0.40 g ash, 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, 55.00 mg potassium, 0.23 mg copper, 13.00 mg sulfur, 8.00 mg chlorine, 80 I.U. vitamin A,

0.01–0.03 mg thiamine, 0.009–0.01 mg riboflavin, 0.20–0.29 mg niacin, 5.70–18.00 mg ascorbic acid, 7.00 mg choline and 3.00 mcg folic acid per 100 g of edible portion.[16] One of the variety of jamun found in the Brazil possesses malvidin-3-glucoside and petunidin-3-glucoside.[17] The peel powder of jamun also can be employed as a colorant for foods and pharmaceuticals and anthocyanin pigments from fruit peels were studied for their antioxidant efficacy stability as extract and in formulations.[18]

Seeds

gallic acid, ellagic acid, corilagin, 3, 6-hexahydroxy diphenoylglucose, 1-galloylglucose, 3-galloylglucose, quercetin, β-sitoterol, 4,6-hexahydroxydiphenoylglucose.

Therapeutic use of jamun

Entire plant of jamun (seeds, fruit pulp, leaves, flower and bark) is renowned for its medicinal value. Jamun encompasses its use in various traditional medicinal systems like Ayurveda, Unani, Siddha and Homeopathic. History of medicinal usage of jamun is marked by its prescribed usance by Charkha and Sushruta for curing many diseases like diarrhoea, obesity, vaginal discharge, menstrual disorders, haemorrhage, etc.[19] Recent studies have demonstrated its several pharmacological effects like antibacterial[20-22], antifungal[23], antiviral[24], antioxidant potential[25-27], anti-inflammatory[28], hepatoprotective[29,30], anti-diabetic[31,32], hypolipidemic[33], cardioprotective[34], anti-diarrhoeal[35], anti-allergic[36], anti-pyretic[37], anti-neoplastic[38], chemopreventive.[39,40] Among all these therapeutic properties, antidiabetic effect is most vividly studied.

Antimicrobial- Effectiveness of jamun seed extract as antibacterial agent as against Bacillus cereus, B. subtilis, B. megateriun, Steptococcus betahaemolyticus, Staphylococcus aureus, Shigella dysenteriae, Sh. shiga, Sh. boydii, Sh. flexneriae, Sh. sonnei, Escherichia coli, Salmonella typhi B, Sal. typhi B-56 and Klebsiella species.[41]

Antioxidant- Antioxidants control free-radicals which lead to several diseases and accelerate ageing. Several in vitro studies have demonstrated such potentiality using alcoholic extracts of the seed. The extracts could act in various ways by trapping free radical like superoxide, hydroxyl, lipid-peroxide and 2,2-diphenyl-1-picrylhydrazyl (DPPH) and nitric oxide and by chelating transition metal catalyst like ferric ions.

Antidiabetic- Jamun seeds are prescribed widely in many medicine systems for controlling diabetes. Anti-diabetic effect of jamun seed has also been substantiated by many pharmacological studies. The studies carried out by Helmstadter and Kumar et al revealed considerable reduction in blood glucose level of induced diabetic animals when treated with jamun seed.[42,43] Effectiveness of the extracts using different solvents has been explored by different scientists on different animal models.

Hepatoprotective- Effectuality of jamun peel extract as hepatoprotective agent against carbon tetrachloride (CCl4) induced oxidative damage on rat hepatocytes. In vivo studies by Das and Sarma on paracetamol induced toxicity in rats has also supported the hepatoprotective effect.[44] Based on oral administration of ethanolic extract of pulp in dose dependent manner, they reported decrement in rise of serum enzymes, level of total protein and albumin owing towards hepatoprotection. The study also asserted no acute oral toxicity and intact histological structure of liver.

Immunomodulatory- The term immunomodulatory means regulation of the immune system by suppression and stimulation of cells and organs of the immune system. It is now being recognized that immunomodulatory therapy could be practiced as an alternative to conventional chemotherapy towards variety of diseased conditions. the methanolic extract of jamun seeds possesses promising immunomodulatory activity.[45] While working on humoral and cellular immunity in mice by injecting carbon ink suspension and hemagglutination reaction and delayed type hypersensitivity response in rats induced by Sheep Red Blood Cell, they reported a significant increase in total white blood cell, neutrophils and lymphocytes count in dose-dependent manner.[45]

Hypolipidemic- Alteration in lipid profile is one of the most common complications in diabetic mellitus and in that context hypolipidemic effect of jamun seed has been thoroughly studied on both alloxan and streptozotocin induced diabetic rats. Ethanolic extract of seeds is able to reduce the level of total serum cholesterol/high density lipoprotein cholesterol ratio, low density lipoproteins (LDL) and triglycerides.[46,47] Elevated levels of cholesterol, phospholipids, triglycerides and free fatty acids in the plasma, liver and kidney tissues of streptozotocin induced diabetic rats were reverted back to normalcy on oral administration of ethanolic extract of jamun kerne.[33] According to them, the lowering effect was comparable to that of the treatment with standard drug (glibenclamide).

Anticancerous- Anticancerous effect of jamun pulp has been successfully studied on human cervical carcinoma cell lines i.e. HeLa and SiHa using crude methanolic extract[45] and breast cancer cells using hexane: acetone: methanolic extract.[38] The study revealed that the extracts induced apoptosis in tumorous cells and the antiproliferative effect was proportional to dose and exposure time. the extract exerted no apoptotic effect on non-tumorous breast cells.[38] These in vitro oncological studies profess the potentiality of jamun pulp extracts towards inhibition and death of cancerous cells.

Chemopreventive- study have reported that hydro-alcoholic extract of jamun seed possesses chemopreventive properties in the DMBA-induced and croton oil promoted skin carcinogenesis in Swiss albino mice.[40] According to them, feeding of 125 mg extract/kg body weight/day during phases of, either pre-initiation (i.e 7 days before and 7 days after application of DMBA) or post initiation (i.e. from the day of start of croton oil treatment and continued till the day of experiment), reduced the cumulative numbers of papillomas, the tumour incidence and increased the average latency period when compared with the control group (carcinogen alone). In continuation to this study concluded that jamun seed has the potential to modulate biochemical and histopathological status during skin carcinogenesis.[49] Researchers have identified antioxidant capacity of jamun seed as the probable mechanism of chemopreventive effect.[40,48] In addition and also have observed that administration of the aqueous extract of jamun seed (25 mg/kg body weight/day) was effective in preventing benzo-a-pyrene (BaP)-induced forestomach carcinogenesis in Swiss albino mice, when applied as pre-, post- and pre-post treatment; it reduced the tumour incidence, tumour burden and cumulative number of gastric carcinomas.[39]

Antibacterial- Recently study reported antibacterial action of jamun pulp.[50] The study was performed with extracts using different solvent systems (ethyl acetate, acetone, methanol, aqueous and diethyl ether) and different maturity index of the fruit pulp (young, premature, mature, preripened and ripened). The extracts asserted more effectiveness on Gram positive bacteria than Gram negative. Among different stages of maturity and the solvents used, the diethyl ether extract from preripened pulp was the most potential antimicrobial agent.

Cardioprotective- study reported beneficial effects of methanolic extract of jamun seeds on cardioprotection against isoproterenol-induced myocardial infarction in albino rats.[34] The effect was probably related to strengthening of the myocardial membrane, induced by the

phytochemicals like alkaloids, amino acids, flavonoids, glycosides, phytosterols, saponins, steroids, tannins and triterpenoids in the extract.

CONCLUSION

Whole contour of jamun comprising peel, pulp and seed is a rich source of phytochemicals including phenolic as well as non-phenolic bioactives. Pharmacological studies relate the phytochemicals to provide diversified therapeutic effects like antioxidative, anticancerous, antidiabetic, antimicrobial, radioprotective and others, the most widely investigated one being the ameliorating action against Type 1 and Type 2 diabetes. Further studies are required to identify the principal functional component responsible for such functions. Jamun which possesses attractive colour, astringent taste and appreciable mineral and vitamin content is seasonal, perishable and underutilized fruit. Jamun is widely used by the traditional healers for the treatment of various diseases especially diabetes and related complications. Most pharmacological works on diabetes were carried out with seeds but the pharmacological potential of the other parts of the plant is required to explore in detail. Similarly, not many works are there with pharmacological actions of phytochemical constituents of jamun. Based on these facts, the authors hope that this review highlights the role of jamun in various treatments and recommend that further phytochemical and clinical research should be done on this traditional medicinal plant for the discovery of safer drugs. Jamun carries a great potential to be taken up as a raw material for post-harvest processing and development of functional food carrying disease prevention ability besides the basic function of supplying nutrients. This review covering comprehensive information on the nutritional, therapeutic and processing aspects of jamun.

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