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Bipsa Banerjee
Department of Home Science, University of Calcutta, Kolkata, West Bengal, India

Santa Datta De
Professor, Department of Home Science, University of Calcutta, Kolkata, West Bengal, India

Corresponding Author:
Bipsa Banerjee
Department of Home Science, University of Calcutta, Kolkata, West Bengal, India

Seeds of *Syzygium cumini* (Jamun): A Review on its Health Promoting Aspects

Bipsa Banerjee and Santa Datta De

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Abstract
Commercial cultivation of Jamun fruit (*Syzygium cumini L.*), a member of the Myrtaceae family, is practised in tropical and subtropical regions of the world. Its fruits have delectable flesh that is sweet, sour, and astringent. During the industrial processing of fruit pulp into beverages, jellies, jam, vinegar, wine, and squash, jamun fruit seeds are thrown away as waste. The chosen papers that were potentially relevant about jamun seed were reviewed after searching specific literature. Jamun seeds are a potential source of bioactive substances like hydrolysable tannins, phenolic acids, flavonoids, other phenolics, terpenoids, phloroglucinol derivatives, and saponins. These substances have been linked to a number of biological activities, including antimicrobial, antioxidant, gastroprotective, antidiabetic, hypolipidemic, cardio protective, immunomodulatory, anti-inflammatory, anti-pyretic, chemo preventive, anti-anemic, Neuropsychopharmacological, and anti-allergic as well. However, to validate the safe consumption limit and establish further therapeutic roles of jamun seeds for their widespread use as a nutraceutical or pharmaceutical component, thorough and methodical *in vivo* clinical research involving human subjects must be carried out. Research is also needed to determine the precise processes underlying the bioactivities displayed by jamun seeds.

Keywords: Antioxidant, bioactive, consumption, jamun, seed

Introduction
Nature has consistently served as a great example of the remarkable phenomenon of symbiosis. There is a growing interest in natural product therapies with a fundamental approach to nature as people become more conscious of the efficacy and negative effects of synthetic pharmaceuticals. *Syzygium cumini L.* (family Myrtaceae) (Chase *et al*, 2009) [8]. commonly known as Jamun, Jaman, Duhat in Hindi and Black Plum, Indian Blackberry, Jambolana, Java plum, Malabar plum, Portugese plum in English. Jamun is an important traditional medicinal plant, a huge native to India and its bordering countries like Nepal, Pakistan etc. All parts of the jamun or Jambul tree find a wide variety of uses. The ripe jamun fruits are mostly used but other parts like bark, leaves and importantly the seeds are also used to treat a range of ailments. Jamun seeds are usually not consumed raw by people. Each jamun fruits has a single weed
which comprises almost 25% of the total fruit weight (Sehwag *et al*, 2014) [44]. The seeds are of great benefit because it lowers blood glucose level. It also contains Vitamin C and Vitamin A, riboflavin, nicotinic acid, choline, folic acid, calcium, phosphorus etc (Janick *et al*, 2008) [20] Jamun seed powder is used to treat diabetes by several traditional practitioners. Scientifically it has a low glycemic index making it a good option for treatment of diabetes mellitus. Antidiabetic effects of jamun seed suggesting it holds significant potential to produce safer drugs for diabetes treatment, another study showed that jamun seeds can lower blood glucose by 30%. Studies also show that consumption of jamun seed powder may also provide benefits during chemotherapy and radiation (Jagetia *et al*, 2005) [18].

Table 1: Scientific classification of *Syzygium cumini*, (Bhowmik *et al*, 2005) [7]

Kingdom	**Plantae**
Order	Myrtales
Family	Myrtaceae
Genus	Syzygium
Species	S. cumini

Fig 1: Image of Jamun seeds

Geographical Distribution

The evergreen jamun tree is found all over India, particularly in the tropical regions, in the upper Gangetic plains. Typically, they are grown in the banks of rivers, lakes, and other wet areas for the purpose of providing shade along roadside. In the seventeenth century, Miller was grown in England. It was exported to Thailand, Madagascar, the Philippines, Israel, Algeria, California, Ceylon, Malaya, and Australia, among other nations. (Katiyar *et al*, 2016) [24] The evergreen tree is grown throughout the entire south Indian forested region. It is grown in Thailand, the Deccan, Bengal, the Philippines, Madagascar, the Philippines, Thailand, as well as by streams and in wet areas of evergreen forests. (Aqil *et al*, 2014) [2].

Jamun Cultivation

When growing on deep loam soil, plants and trees have a tremendous potential for growth. In order to flourish at its best, the tree can resist salt in the soil and waterlogging. According to research, jamun trees perform best in dry conditions for fruit setting and good growth. Various methods exist for polyembryony and seed propagation of the jamun/naval fruit. The typical propagation strategy produces good economic outcomes for growing jamun trees. The Jamun seeds can be quickly sown and do not require a period of dormancy for optimum germination. 15 to 20 days is possible.

The farming of the jamun tree begins with the excavation of a pit that is 75% soil and 25% composted manure. Pit with a 1*1*1 m suggested size. The Jamun trees need to be watered about 8 to 10 times each year. The jamun tree is anticipated to grow in three stages. Gibberellic acid GA3 is applied or sprayed at a ppm of 60 to stimulate fruiting. The Jamun tree's flower, which has a higher pollen fertility efficiency.

As is customary for other plants, honey bees, houseflies, and other pollinators help the jamun tree flower. In the absence of this pollination, the traditional method of hand pollination can be used to increase pollination rates, albeit occasionally fruit set production may suffer. Usually, the ripe fruits are carefully hand-picked. On average, a yield of the Jamun fruits is between 80 and 100 kg. Fruits can be stored at ambient temperature for almost 4-5 days and in the refrigerator for many days. (Rehaman *et al*, 2021) [41].

Plant Description

A big, 30-meter-tall evergreen tree, the jamun. Most often found on ancient stems, bark has a rough texture and is pale brown in hue. The leaves are leathery, obovate-elliptic, and 6 to 12 centimeters long. They may vary in shape, are smooth and shining, and have many nerves that converge at the margin. The tip of the leaf is broad and less acuminate. Most panicles, measuring 4 to 6 cm, are produced by branchlets that are located beneath the leaves. Flowers are fragrant, greenish-white, 7.5–13 mm across, in branched clusters at the tips of the stems. The calyx is cup-shaped, and the four petals are fused into a cap. The calyx has teeth, is funnel-shaped, and is 4 mm in length. (Swami *et al*, 2012) [50] (Kirtikar *et al*, 2003) [26]

Jamun Seed Description

The colour of jamun seed is white to pink with an oblong shape. The seed has length of approx. 18.2mm and width 11. 05mm.The average weight of jamun seed is 1. 62g.The texture is coarse. (Kshirsagar *et al*, 2019) [25].

Methods

For various studies published, the key words 'Jamun seed', or '*Syzygium cumini*', 'nutrition', 'medicinal properties', 'anti-oxidant', 'antimicrobial', 'gastroprotective', 'antidiabetic', 'hypolipidemic', 'cardioprotective', 'immunomodulatory', 'chemo preventive', 'antipyretic' and 'antiallergic' were searched in the databases PubMed, Embase, Scopus, Lilacs, and Google Scholar. Studies and research, and that discussed the advantages of consuming jamun seeds were included in this review and thereafter the conclusive results were assessed.

Review of Literature

Phytochemistry

Of the total weight of the jamun fruit, almost 75% of the fruit is from pulp (including skin) and the rest 25% is contributed by the seeds which are generally neglected but have good nutritive value. Jamun seeds also contains the following phytochemicals the alkaloid jambosine, a glycoside jambolin or antimallin, chlorophyll, resin, albumen, phenolics such as ellagic acid, gallic acid, caffeic acid, ferulic acid and their derivatives. It has been reported that jamun seed oil contains many important saturated and unsaturated fatty acids (Sah *et al*, 2011) [43]. The seeds are moderately rich in protein and calcium. In separate studies Modi *et al* and Kumar *et al* also asserted the presence of saponins, tannins, phytosterol, monoterpenoids, glycosides, alkaloids, triterpenoids, flavonoids such as rutin and quercetin, β-sitosterol (Modi *et al*, 2010) [33]

Nutritional Property

Carbohydrates, protein, fats, minerals, vitamins, and bioactive phytochemicals are among the nutrients found in Jamun Seed. Gallic acid, corilagin, ellagic acid, 3-galloylglucose, 3, 6-hexahydroxy diphenoylglucose, 1-galloylglucose, -sitosterol, quercetin, and 4, 6-hexahydroxydiphenoylglucose are the main phytochemicals of JS, and they are all significant for medicine. (Tak *et al*, 2022) [51] Because jamun is high in fiber. It can maintain digestive system healthy, ensuring appropriate digestion and the removal of dangerous poisons from the body. The anthocyanins, chlorophyll, phytosterols, amino acids, vitamin C, vitamin B complexes (thiamine, riboflavin, folic acid), essential minerals and trace elements (calcium, iron, sodium, magnesium, zinc, phosphorus, chromium,

vanadium, and potassium), essential oil, albumin, and fats are present in significant amounts in the seeds. According to the seeds' fatty acid profiles, lauric, myristic, palmitic, stearic, oleic, linolenic, malvalic, and sterculic acids are the most prevalent fatty acids, and -sitosterol is the major phytosterol. (Dangour *et al*, 2009) [11]

Table 2: Nutritional property of *Syzygium cumini* (Ghosh *et al*, 2017) [14]

Property	Amount	Property	Amount
Carbohydrate (%)	89.68±0.29	Sodium (mg)	43.86±12.09
Sugar (%)	5.54±0.69	Potassium (mg)	606.46±69.37
Fat (%)	1.28±0.11	Calcium (mg)	135.86±26.81
Protein (%)	4.68±0.35	Zinc(mg)	0.46±0.17
Ascorbic acid (mg/100g)	1.84±0.14	Iron(mg)	4.2±0.80
Polyphenol (mg GAE/g)	386.51±10.25	Magnesium (mg)	111.6±18.06
Antioxidant (%)	48.23±2.98	Copper (mg)	2.13±0.86
Tannin (mg/100g)	388.99±7.34	Manganese (mg)	0.4±0.11
Fiber (%)	1.21±0.06	Chromium (mg)	1.4±0.61
Anthocyanin (mg/100g)	18.47±1.99	Lead(mg)	0.66±0.06

Antimicrobial Activity

Bhuiyan *et al*. reported that a jamun seed extract was effective as an antibacterial agent against *Bacillus cereus, Bacillus subtilis, Bacillus megaterium, Streptococcus betahaemolyticus, Staphylococcus aureus, and Shigella dysenteries, Shiga, Sh. boydii, Sh. flexneriae, Sh. Sonnei, Escherichia coli, Salmonella typhi B, Sal. Typhi B-56* and *Klebsiella* species. According to Jadhav *et al*, the methanolic extract of the seeds possess broad antimicrobial spectrum against *Vibrio cholera*, *Aeromonas hydrophila* and *B. subtilis* with minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) ranging from 1.5-12.0 and 1.5-16.0 mg/ml (Jadhav *et al*, 2009) [17]. Banerjee *et al*, 2011[4] reported antibacterial effect of ethanolic extract against two gram positive *(S. aureous* and *E. faecalis)* and three Gram negative bacteria (*E, coli, K. pneumonia* and *P. aeroginosa*). Due to the presence of monoterpene aldehydes, which block protease action and have a bactericidal impact on oral pathogens, S. cumini has antibacterial properties.

The phyto-chemical analysis and investigation of the spasmolytic activity of the hydro alcoholic extract derived from S. cumini seeds were done in a study by Monteiro *et al*, 2020 [35]. The seeds' spasmolytic, antibacterial, and anti-ant diarrheal properties were combined, demonstrating that they share the same secondary metabolites, indicating their therapeutic potential for the treatment of colic and/or diarrhea.

Antioxidant Activity

Antioxidant 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-1-1-picrylhydrazyl (DPPH) and nitric oxide and by chelating transition metal catalyst like ferric ions.

In support of trapping mechanism, inhibition of auto-oxidation in β-carotene and linoleic acid has been reported by Bhajpai *et al*. It was revealed that the antioxidant potential of the seed extract against superoxide radical is six times higher than Trolox and is concentration dependent. (Bajpai *et al*, 2005) [3] In-vitro antioxidant profiling was examined using the 50% acetone extract of jamun seeds. Maximum DPPH radical scavenging activity was shown in the extract, followed by 2, 2′-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid) ABTS radical scavenging activity. Nitric oxide scavenging and heavy metal chelation were observed, but lipid peroxidation, H2O2, and OH-Scavenging were moderate (Yadav *et al*, 2020) [54].

Gastroprotective Activity

According to Chaturvedi *et al*., jamun seed ethanolic extract can prevent stomach ulcers in rats brought on by cold restraint stress, aspirin, 95% ethanol, and pylorus ligation. Reduced acid-pepsis secretion, cell shedding, lipid peroxidation, and increased mucin and mucosal glycoprotein were used to identify the mechanism of action. According to them, the extract's positive benefits on diabetic rats with co-existing stomach ulcers may be attributable to its direct promotion of gastric mucosal defense and anti-diabetic actions (Chaturvedi *et al*, 2009) [9]. It was observed that there was a significant decrease in the gastric ulcer index after the administration SC extract alone and as well as in combination with Acarbose (5mg/kg), (Joshi *et al*, 2019) [22]

Antidiabetic Activity

A significant portion of the population who suffer from lifestyle disorders like diabetes is showing signs of interest in alternative medical practices including Unani, Ayurveda, and others. Jamun seeds are prescribed widely in such medicine systems for controlling diabetes (Chitnis *et al*, 2012) [10]. Effectiveness of the extracts using different solvents has been explored by different scientist on different animal models. Rat studies has been successfully carried on alloxan induced diabetes (Prince *et al*, 2004) [38]. streptozotoc induced diabetes (Sridhar *et al*, 2005) [48] and fructose induced model. (Vikrant *et al*, 2001) [53]. Sharma *et al* studied diabetes ameliorative effect of ethanolic extract of jamun seeds on alloxan induced diabetes on rabbits. Study has also been extended to clinical trials on human subjects. (Sahana *et al*, 2010) [42].

Pharmacological studies revealed that the administration of powder form of jamun seeds, its ethanolic, methanolic, ethyl acetate (Purohit *et al*, 2000) [40] and aqueous extracts either orally or injected intraperitoneally were capable of ameliorating diabetes (Prince *et al*, 1998) [39]. When used in the above-mentioned alternative medicine systems, the seeds offer no toxicity on subjects. This has been evidenced from the toxicological studies performed on rats using aqueous extract and ethyl acetate and methanol extracts which rallied no mortality with sub-acute and acute oral toxicities. In clinical studies on human subjects with diabetes Type I and Type 2 successful results with no side effects have been reported on oral administration of jamun seed powder. (Srivastava *et al*, 1983) [49] Singh *et al*, 2007 speculated the increment in serum insulin level towards its effect on repairing of β-cells of pancreas, the later in damaged state reduces the insulin secretion. In support of β-cells regeneration, Dusane *et al*, 2011 [13] reported potentiality of

chloroform extract to induce islet neogenesis *in vivo* as well as *in vitro* studies. The antidiabetic effect of seed extracts has also been observed in regard with lowering efficacy of starch hydrolyzing enzymes including a-amylase, pancreatic amylase and a-glucoamylase (Karthic *et al*, 2008) [23].

Sharma *et al*, 2011 described the mechanism towards maintaining carbohydrate homeostasis by increasing and decreasing the activity of key enzymes for glycolysis and gluconeogenesis. The extract also activates glucose transport in a phosphatidylinositol 3 kinase-dependent fashion in cell culture manner. Studies by Grover *et al*, 2002 [16] and Tanwar *et al*, 2010 [52] have shown that jamun seeds also prevent diabetic induced secondary pathogenesis like kidney damage, neuropathy and gastropathy. The seed also reduces hyperglycemia induced oxidative stress by restoring levels of glutathione, increasing activities of superoxide dismutase, catalase and consequently decreasing the levels of lipid peroxidase (Prince *et al*, 1998) [39]. When taken three times daily with water as a 25gm powder, seed extract decreases blood sugar and diabetes. Thus, jamun seed could be considered as novel therapeutic armamentarium for treatment of diabetes. (Bashir *et al*, 2022) [5]

Hypolipidemic Activity

One of the most frequent consequences of diabetes mellitus is an alteration in lipid profile, and in this respect, the hypolipidemic effect of jamun seed on both alloxan and streptozotocin-induced diabetic rats has been comprehensively investigated. The ratio of total serum cholesterol to high density lipoprotein cholesterol, Low Density Lipoproteins (LDL), and triglycerides can all be decreased by ethanolic extract of seeds. According to Ravi *et al*., oral treatment of the ethanolic extract of jamun kernel caused the high levels of cholesterol, phospholipids, triglycerides, and free fatty acids in the plasma, liver, and kidney tissues of streptozotocin-induced diabetic rats to return to normal. They claimed that the reducing effect was comparable to that of regular medication therapy (glibenclamide). It has been hypothesized by Modi *et al* that antihyperlipidemic effect of jamun seeds may be due to presence of alkaloids, tannins, saponins, phenols, flavonoids and triterpenes. (Modi *et al*, 2010) [33]

Cardioprotective Activity

In albino rats, Mastan *et al*, 2009 [31] found that a methanolic extract of jamun seeds provided cardiac protection against isoproterenol-induced myocardial infarction. The phytochemicals present in the extract, such as alkaloids, amino acids, flavonoids, glycosides, phytosterols, saponins, steroids, tannins, and triterpenoids, likely contributed to the impact by reinforcing the cardiac membrane.

Immunomodulatory Activity

Immunomodulatory refers to the control of the immune system through stimulation and inhibition of immune system cells and organs. Immunomodulatory therapy is now understood to be a viable alternative to traditional chemotherapy for a range of sick diseases. The methanolic extract of jamun seeds, according to Mastan *et al*., appears to have promising immunomodulatory effects. They reported a significant increase in total white blood cell, neutrophils, and lymphocytes count in a dose-dependent manner while studying humoral and cellular immunity in mice by injecting carbon ink suspension, hemagglutination reaction, and delayed type hypersensitivity response in rats induced by sheep red blood cell. (Mastan *et al*, 2008) [32].

Neuropsychopharmacological Activity

Neuropsychopharmacology is an approach to study the effect of functional component on the central nervous system (CNS) with respect to biochemical and behavioral changes in subject. Depressants for CNS are often prescribed by doctors for people suffering from anxiety. Chakraborty *et al* studied neuropsychopharmacology effect with chloroform extract of jamun seed on rats. The study observed alteration in general behavior pattern, reduction in exploratory behavior pattern, muscle relaxation and suppression of aggressive behaviour, suggesting that organic extract of jamun seed possess CNS depressant action (Parmar *et al*, 2010) [36].

The methanol extract also caused suppression of conditioned avoidance response and exhibited antagonism to amphetamine group toxicity (Lim *et al*, 2012) [29]. Oral treatment with hydroalcoholic extract showed an anticonvulsant activity in pentylenetetrazol and maximal electroshock induced convulsions, besides a hypothermic effect (De Lima *et al*, 1998) [12]. The results suggested that some active principles of jamun with central depressant properties exhibit an anticonvulsant action, although the polyphenols do not seem to be the main constituents responsible for this effect.

Chemo preventive Activity

According to Parmar *et al*, 2010 [36] DMBA-induced and croton oil-promoted skin carcinogenesis in Swiss albino mice can both be prevented by a hydro alcoholic extract of jamun seed. They claim that when compared to the control group, feeding 125 mg extract/kg body weight/day during pre-initiation (i.e., 7 days before and 7 days after application of DMBA) or post-initiation (i.e., starting on the day of the start of croton oil treatment and continuing until the day of the experiment) phases decreased the cumulative numbers of papilloma, increased the average latency period, and decreased tumor incidence (carcinogen alone). The control group was the study's final segment, according to Parmar *et al*, 2011 [37] (carcinogen alone). Jamun seed has the capacity to modify the biochemical and histological status during skin carcinogenesis, according to the findings of this study by Parmar *et al*, 2011 [37] Researchers have shown that the jamun seed's antioxidant capability is the most likely mechanism for its chemo preventive action. Additionally, Goyal *et al*, 2010 [36] found that pre, post, and post-treatment administration of the aqueous extract of jamun seed (25 mg/kg body weight/day) was effective in preventing benzo-a-pyrene (BaP)-induced for stomach carcinogenesis in Swiss albino mice; it decreased the tumor incidence, tumor burden, and cumulative number of gastric carcinomas.

Anti-inflammatory Activity

In order to treat paw oedema in wister rats, Kumar *et al*. reported employing ethyl acetate and methanol extracts as an anti-inflammatory (Kumar *et al*, 2008) [28]. According to Modi *et al*., oral administration of the methanolic and aqueous extracts @250mg/kg body weight reduced the oedema by 48.29% and 68.85%, respectively, when compared to the untreated control group, while diclofenac sodium, the standard medication, at 100mg/kg body weight reduced it by 75.08%. A persistent kind of inflammatory disease in the joints is arthritis. Arya *et al*, 2011 [1] also observed that methanolic extract has an anti-arthritis effect on adjuvant-induced arthritis in rats.

Antipyretic Activity
Mahapatra *et al*, 1986 [30] investigated the antipyretic effect of dried seed methanol extracts given intraperitoneally to rats at doses of 50 mg/kg body weight.

Anti-anemic Activity
Aqueous extract of seeds exhibits anti-anemic effect by increasing total hemoglobin, preventing weight loss, and reducing the production of free radicals in tissue. (Prince *et al*, 1998) [39].

Anti-allergic Activity
Mahapatra *et al*, 1986 [30] showed that Flavonoids, which have been isolated from Myrtaceae species, including jamun seed, are thought to be responsible for the extract's antiallergic properties. These compounds have been shown to have strong inhibitory effects on a number of enzymes involved in cell activation and the production of inflammatory mediators. Jamun seeds can therefore be used to treat allergic illnesses. (Jayashree *et al*, 2022) [21]

Results and Conclusion
Jamun seeds have a broad spectrum of field of research. Reviewing a number of different publications and literature it may be concluded that the jamun seeds have many beneficial effects. The seeds are rich source of phytochemicals including phenolic as well as non-phenolic bio actives. Pharmacological studies relate the phytochemicals to provide diversified therapeutic effects like anti-oxidative, anticancerous, anti-diabetic, antimicrobial, radio protective and others, the most widely investigated one being the ameliorating action against diabetes mellitus. Other studies have also revealed that the seeds also contain many alkaloids, these alkaloids have an ability toward the hyperglycemic effect. As a result, it has a variety of advantages. The other important product derived from jamun is the seed powder. The powder which is been extracted from the seed and especially developed for diabetes cure which is often prescribed to diabetes patient. Very often people suffer from urine problems or kidney infection and these jamun seed in the form of powder has been proved to be effective in much cases. Hence it is seen that it helps in solving the problem related to urine infection. Sometime this powder is extracted from the other parts of the plant and consists majorly of the properties like anti-oxidant. In other words, the jamun fruit's entire body is rich in therapeutic potential and has a very promising future. The pharmacological activities of the seeds are mainly attributed to the presence of various flavonoids and alkaloids which are readily absorbed in humans. Thus, it can be speculated that the beneficial effect of the jamun seeds reported in rodents will also be observed in humans. Composition analysis indicates that there are low fat contents in seeds of jamun. The seeds are rich in protein and calcium and also some important minerals like potassium, magnesium. Amount of zinc, iron, copper, manganese and chromium contents of jamun seed are found to be very low. High amount of polyphenols are present in the seed. The seeds also have adequate amount of Vitamin C and Iron. A significant overall effect of jamun seed powder supplementation was found in improvement of lipid profile in the patients of diabetes mellitus. However, this result is seen in small number of subjects. Seed powder supplementation also prevents oxidative stress and shows anti-inflammatory and antifibrotic activity in liver of high carbohydrate high fat diet fed rats. This review, covering comprehensive information on the nutritional, chemical and therapeutic aspects, would help to bring the jamun seed in the lime light of the therapeutic and functional food sector. New steps must be taken to undergo research about various forms of jamun seed like seed powder, seed oil to introduce it to all community.

Recommendations
Taking all the above discussed points into consideration, it could be recommended that jamun seed may be a part of daily diet. Fresh seed extraction is always better for health. It is a easily available fruit in tropical countries. It would add a variety in monotonous fruit choice.

Future Research
Proper investigation needed to know the recommended daily safe dose of jamun seed. The interference of jamun seed in any nutrient absorption could be investigated in future.

References

1. Arya V, Gupta VK, Kaur R. A Review on plants having anti-arthritic potential. Int J Pharm Sci Rev Res. 2011;7(2):131-136.
2. Aqil F, Munagala R, Jeyabalan J, Joshi T, Gupta RC, Singh IP, *et al*. The Indian Blackberry (Jamun), Antioxidant Capacity, and Cancer Protection. Cancer. Academic Press; 2014. p. 101-113.
3. Bajpai M, Pande A, Tewari SK, Prakash D. Phenolic compounds and antioxidant activity of some food and medicinal plants. Int J Food Sci Nutr. 2005;56:287-291.
4. Banerjee J, Narendhirakannan RT. Phytochemical analysis, antibacterial, *in vitro* antioxidant and cytotoxic activities of ethanolic extract of *Syzygium cumini* (L.) seed extract. Int J Pharma Sci Res. 2011;2:1799-1806.
5. Bashir H, Hussain A, Kumhar SH, Rasheed U. Ethnomedical Survey of Andi-diabetic Plants of Jammu & Kashmir; c2022.
6. Benherlal PS, Arumughan C. Chemical composition and *in vitro* antioxidant studies on *Syzygium cumini* fruit. J Sci Food Agric. 2007;87:2560-256.
7. Bhowmik D, Gopinath H, Kumar PB. Traditional and Medicinal Uses of Indian Blackberry. J Pharmacogn Phytochem. 2005;1(5):2278-4136.
8. Chase MW, Reveal JL. A phylogenetic classification of land plants to accompany APG III. Botanical Journal of Linnean Society. 2009;161:122-127.
9. Chaturvedi A, Bhawani G, Agarwal PK, Goel S, Singh A, Goel RK. Ulcer healing properties of ethanolic extract of Eugenia jambolana seed in Diabetic Rats: Study on Gastric Mucosal Defensive Factors. Indian J Physiol. 2009;53(1):16-24.
10. Chitnis KS, Palekar SB, Koppar DR, Mestry DY. Evaluation of *Syzygium cumini* Linn. seed formulations available in market using spectrophometric and chromatographic techniques. Int J Pharm Sci Res. 2012;3:556-560.
11. Dangour AD, Dodhia SK, Hayter A, Allen E, Lock K, Uauy R. Nutritional quality of organic foods: A systematic review. Am J Clin Nutr. 2009;90(3):680-685.
12. De Lima TCM, Klüeger PA, Pereira PA, Neto MWP, Morato GS, Farias MR. Behavioral effects of crude and semi-purified extracts of *Syzygium cumini*i linn. skeels. Phytotherapy Research. 1998;12(7):488-493.
13. Dusane MB, Joshi BN. Seeds of *Syzygium cumini* Skeel potential for islet regeneration in experimental diabetes. J Chinese Integ Med. 2011;9:1380-1387.

14. Ghosh P, Pradhan R, Mishra S, Patel A, Kar A. Physicochemical and Nutritional Characterization of Jamun (*Syzygium cumini*). Curr Res Nutr Food Sci. 2017;5:25-35.
15. Goyal PK, Verma P, Sharma P, Parmar J, Agarwal A. Evaluation of anticancer and anti-oxidative potential of *Syzygium cumini* against benzo[a]pyrene (BaP)induced gastric carcinogenesis in mice. Asia Pac J Cancer Prevent. 2010;11:753-758.
16. Grover JK, Rathi SS, Vats V. Amelioration of experimental diabetic neuropathy and gastropathy in rats following oral administration of plant (Eugenia jambolana, *Mucuna pruriens* and *Tinospora cordifolia* extracts. Indian J Exp Biol. 2002;40:273-276.
17. Jadhav VM, Kamble SS, Kadam VJ. Herbal medicine: *Syzygium cumini*: A review. J Pharm Res. 2009;2:1212-1219.
18. Jagetia GC, Baliga MS, Venkatesh P. Influence of seed extract of *Syzygium cumini* (Jamun) on mice exposed to different doses of gamma-radiation. J Radiat Res. 2005;46(1):59-65.
19. Jananippriya V, Elanchezhiyan S, Rajkumar Daniel G, Vennila K, Gayathri E. Evaluation of antimicrobial activity of *Syzygium cumini* (Jamun) *in vitro*: A pilot study. J Indian Acad Dent Spec Res. 2019.
20. Janick J, Paull RE. The encyclopedia of fruit and nuts. CABI. 2008.
21. Jayashree TV, Ravali T, Kumar NS, Rao TR, Pavani B. To compare and evaluate the antioxidant activity of *Syzygium cumini* seeds by different extracts (Ethanol, Ethyl Acetate, Water). Int J Res Eng Sci. 2022.
22. Joshi M, Paudel M, Upreti S. Therapeutic influence of Jamun (*Syzygium cumini*): A review. J Pharmacogn Phytochem. 2019;8(3):1056-1059.
23. Karthic K, Kirthiram KS, Sadasivam S, Palvannan T, Thayumanavan B. Identification of alpha-amylase inhibitors from *Syzygium cumini* Linn. Seeds. Indian J Exp Biol. 2008;46:677-680.
24. Katiyar D, Singh V, Ali M. Recent advances in pharmacological potential of *Syzygium cumini*: A review. Adv Appl Sci Res. 2016;7(3):1-2.
25. Kshirsagar RB, Desai GB, Sawate AR, Deshmukh NM. Physico-chemical and nutritional properties of jamun (*Syzygium cumini*) seed. J Pharmacogn Phytochem. 2019;8(2):211-213.
26. Kirtikar KR, Basu BD. Indian medicinal plants with illustrations. International Book Distributer Dehradun, Oriental Enterprises; 2003. p. 1538-1539.
27. Kirtikar KR, Basu BD. Indian Medicinal Plants. Periodical Experts. 1975;2:1052-53.
28. Kumar A, Ilavarasan R, Jayachandran T, Deecaraman M, Kumar RM, Aravindan P, *et al*. Anti-inflammatory activity of *Syzygium cumini* seed. Afr J Biotech. 2008;7:941-943.
29. Lim TK. *Syzygium cumini* in: Edible med non-med plants. 2012;3:745-759.
30. Mahapatra PK, Chakraborty D, Chaudhuri AK. Anti-inflammatory and antipyretic activities of *Syzygium cumini*. Planta Med. 1986;52:540.
31. Mastan SK, Chaitanya G, Bhavya LT, Srikanth A, Sumalatha G, Eswar K. Cardioprotective effect of methanolic extract of *Syzygium cumini* seeds on isoproterenol-induced myocardial infarction in rats. Der Pharmacia Letter. 2009;1:143-149.
32. Mastan SK, Saraseeruha A, Gourishankar V, Chaitanya G, Raghunandan N, Reddy GA, *et al*. Immuno-modulatory activity of methanolic extract of *Syzygium cumini* seeds. Pharmacology online. 2008;3:895-903.
33. Modi DC, Patel JK, Shah BN, Nayak BS. Anti-inflammatory activity of seeds of *Syzygium cumini* Linn. J Pharm Edu Res. 2010;1:68-70.
34. Modi DC, Patel JK, Shah BN, Nayak BS. Pharmacognostic studies of the seed of *Syzygium cumini* L. Pharm Sci Monitor. 2010;1:20-26.
35. Monteiro FS, Carvalho AFS, Ribeiro RM, Borges ACR, Borges MOR. Phytochemical profile and investigation of the spasmolytic activity of hydroalcoholic extract of *Syzygium cumini* (L.) Skeels Seeds. Eur J Med Plants. 2020;3:27-38.
36. Parmar J, Sharma P, Verma P, Goyal PK. Chemopreventive action of *Syzygium cumini* on DMBA-induced skin papillomagenesis in mice. Asia Pac J Cancer Prevent. 2010;11:261-265.
37. Parmar J, Sharma P, Verma P, Sharma P, Goyal PK. Modulation of DMBA-induced biochemical and histopathological changes by *Syzygium cumini* seed extract during skin carcinogenesis. Int J Curr Biomed Pharm Res. 2011;1(2):24-30.
38. Prince PS, Kamalakkannan N, Menon VP. Antidiabetic and antihyperlipidemic effect of alcoholic Syzigium cumini seeds in alloxan induced diabetic albino rats. J Ethnopharmacol. 2004;91:209-213.
39. Prince PS, Menon VP, Pari L. Hypoglycemic activity of Syzigium cumini seeds: Effect on lipid peroxidation in alloxan diabetic rats. J Ethnopharmacol. 1998;61:1-7.
40. Purohit A, Daradak HM. Antidiabetic activity of *Syzygium cumini* Seeds extract in alloxan diabetic mice. Hamdard Med. 2000;43:33-34.
41. Rehaman S. Therapeutic traits of jamun tree: *Syzygium cumini* (Linn.) to combat against covid-19. Researchgate. Net. 2021;6:248-253.
42. Sahana DA, Shivaprakash G, Raghavendra B, Prabha MRA, Jyothi G, Pai MRSM. Effect of Eugenia jambolana on plasma glucose, insulin sensitivity and HDL-C levels: preliminary results of a randomized clinical trial. J Pharm Res. 2010;3(6):1268-1270.
43. Sah AK, Verma VK. *Syzygium cumini*: An Overview. J Chem Pharm Res. 2011;3(3):108-113.
44. Sehwag S, Das M. Nutritive, therapeutic and processing aspects of Jamun, *Syzygium cumini* (L.) Skeels: An overview. Indian J Nat Prod Resour. 2014;5(4):295-307.
45. Sharma SB, Rajpoot R, Nasir A, Prabhu KM, Murthy PS. Ameliorative effect of active principle isolated from seeds of Eugenia Jambolana on carbohydrate metabolism in experimental diabetes. Evid Based Complement Alternat Med. 2011;789871.
46. Sharma SB, Nasir A, Prabhu KM, Murthy PS, Dev G. Hypoglycemic and hypolipidemic effect of ethanolic extract of seeds of Eugenia jambolana in alloxan-induced diabetic rabbits. J Ethnopharmacol. 2003;85:201-206.
47. Singh N, Gupta M. Effects of ethanolic extract of *Syzygium cumini* (Linn.) seed powder on pancreatic islets of alloxan diabetic rats. Indian J Exp Biol. 2007;45:861-867.
48. Sridhar SB, Sheetal UD, Pai MR, Shastri MS. Preclinical evaluation of the antidiabetic effect of Eugenia jambolana seed powder in streptozotocin-diabetic rats. Braz J Med Biol Res. 2005;38:463-468.

49. Srivastava Y, Bhatt VH, Gupta OP, Gupta PS. Hypoglycemia induced by *Syzygium cumini* Linn. seeds in diabetes mellitus. Asian Med J. 1983;26:489-491.
50. Swami SB, Thakor NS, Patil MM, Haldanka PM. Jamun (*Syzygium cumini* (L.): A Review of Its Food and Medicinal Uses. Food Nutr Sci. 2012;3:1100-1117.
51. Tak Y, Kaur M, Jain MC, Samota MK, Meena NK, Kaur G, Amarowicz R. Jamun seed: A review on bioactive constituents, nutritional value and health benefits. Pol J Food Nutr Sci. 2022;72:211-228.
52. Tanwar RS, Sharma SB, Singh UR, Prabhu KM. Attenuation of renal dysfunction by anti-hyperglycemic compound isolated from fruit pulp of Eugenia jambolana in streptozotocin-induced diabetic rats. Indian J Biochem Biophys. 2010;47:83-89.
53. Vikrant V, Grover JK, Tandon N, Rathi SS, Gupta N. Treatment with extracts of Momordica charantia and Eugenia jambolana prevents hyperglycemia and hyperinsulinemia in fructose fed rats. J Ethnopharmacol. 2001;76:139-143.
54. Yadav N, Pal A, Sihag S, CR N. Antioxidant activity profiling of acetonic extract of Jamun (L.) seeds in different models. Open Food Sci J. 2020;12(1).