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***EUGENIA JAMBOLANA* LAM. (BLACK PLUM): A FUTURE SOURCE OF AN ANTIDIABETIC DRUG**

J. A. Sindhu Rani

Department of Biochemistry, NSS College, Nilamel, Kollam - 691535, Kerala, India.

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Correspondence to Author:

Dr. Sindhu Rani J. A.

Associate Professor,
Department of Biochemistry,
NSS College, Nilamel, Kollam -
691535, Kerala, India.

E-mail: sindhurani77@gmail.com

ABSTRACT: Traditional medicine has been aware about and made use of "medicinal herbs," for millennia. Numerous chemical compounds are produced by plants to serve a variety of purposes, including defence and protection against diseases and disorders. Type 1 diabetes mellitus (T1DM) and Type 2 diabetes mellitus (T2DM) are prevalent forms of DM, characterised by deficient insulin secretion (in T1DM) or impaired insulin action (in T2DM). Type 1 diabetes mellitus (T1DM) is typically identified in the paediatric and adolescent population, whereas type 2 diabetes mellitus (T2DM) is more prevalent among middle-aged and elderly individuals. The latter group often exhibits chronically elevated blood glucose levels due to lifestyle and dietary choices that are deemed detrimental to health. The black plum, or *Eugenia jambolana* Lam. (syn) *Syzigium cumini* (L.) skeels, is a medicinal plant widely used in various alternative Indian medical systems such as Ayurveda, Unani, and Homoeopathy. The utilisation of this plant has demonstrated efficacy in managing diabetes mellitus, mitigating inflammation, healing ulcers, and alleviating symptoms of diarrhoea. Preclinical studies have demonstrated the presence of antineoplastic, chemopreventive, radioprotective, antioxidant, antimicrobial properties. This review article summarises the therapeutic potential of *Eugenia jambolana* Lam for the prevention and treatment of diabetes mellitus based on recently published experimental studies.

INTRODUCTION: A remarkable effort has been made in finding novel lead molecules free of side effects in light of the rekindled interest in therapeutics around the world¹. Thus, herbal plants gained importance and became essential ingredients in the various traditional Indian medical systems such as Ayurveda, Unani, and Homoeopathy.

It is widely acknowledged that the bioactive compounds that are present in those plants are used in the production of pharmaceuticals as anti-cancer, anti-hypertension, anti-hypoglycaemic, antioxidant, and antimicrobial agents. Natural remedies are safer in comparison with synthetic pharmaceuticals which are toxic and have many side effects.

The World Health Organisation estimates that between 70-80% of the global population relies on alternative medicine, most commonly herbal remedies, as their primary source of healthcare². Diabetes mellitus (DM) refers to a group of related hyperglycaemic metabolic disorders that affect a large percentage of the world's population. The

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incidence of diabetes mellitus has skyrocketed in low-income countries like India due to changes in people's diet and exercise habits. The prevalence of diabetes mellitus among Indian adults was 4% in 2000 and is projected to rise to 6% by 2025, per a national survey³. Both type I and type II Diabetes can be managed with a variety of modern medical treatments. Despite their popularity, the use of synthetic drugs is associated with many side effects. Traditional plants with antihyperglycemic properties are increasingly being used to manage diabetes mellitus⁴.

Eugenia jambolana Lam. (Syn. *Syzygium cumini* Skeels) is a large tropical evergreen tree that is native to the Indian subcontinent and is a member of the family Myrtaceae. It is widely distributed across the Asian subcontinent, Eastern Africa, South America, Madagascar, and the United States. Many different names are used interchangeably for this tree, including two common synonyms *Syzygium jambolana* D.C. and *Eugenia cuminii* D. R⁵. It is also called an English black plum, an Indian blackberry, a Java plum, and Jambava in Hindi. There are two main morphotypes of jamun on the Indian subcontinent: the small, round Kaatha Jamun, with its acidic flavour, and the oblong, narrow Ras Jaman, with its dark purple or bluish skin, pink, sweet fleshy pulp, and small seeds^{6,7}. This large tree has densely foliated bark that is thick, greyish brown, and exfoliates in the form of scales.

The tree bears fruit once a year, and its fruits are both sour and sweet. The fruit is an oblong, deep purple berry that is large and situated in the centre, much like purple grapes. Fruits can be a wide range of elliptical shapes; they all share a pink, juicy pulp and truncated calyx limbs. The clusters of up to twenty fruits each are not all ripe at the same time. The fruits are edible, and their juicy flesh surrounds a large seed. Plums have a very sweet taste, but when they are fully mature, the edges of the pulp take on a subtle bitter flavour. During the course of the two-month fruit development process, significant proximal compositional and phytochemical changes occur. Unripe fruits are green, but they turn magenta, purple, and finally black as they ripen. When ripe, the fruit turns a deep purple and has a sweet, slightly sour, slightly astringent flavour^{8,9}. A combination of the sweet,

mildly sour, and astringent flavours found in ripe dark purple fruits. The tasty and nutritious fruits are used for making drinks, squashes, juices, and jellies¹⁰. In association to its dietary use, all parts of the tree mainly the seeds are used to treat a range of ailments, the most important being diabetes mellitus⁵. It is effective in treating a wide range of conditions, from cancer and allergies to stomach ulcers and infectious diseases.

Scientific Name: *Eugenia jambolana*: *Eugenia cumini*: *Syzygium cumini*,

The botanical classification of plant is described in table below¹¹.

TABLE 1: TAXONOMIC POSITION OF *EUGENIA JAMBOLANA* LAM

Scientific classification	
Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Sub- class	Rosidae
Order	Myrtales
Family	Myrtaceae
Genus	<i>Eugenia</i>
Species	<i>jambolana</i>

Phytochemistry of *Eugenia jambolana*: The leaves of *Syzygium cumini* contains various chemicals which have medicinal value. The chemical includes β -sitosterol, betulinic acid, mycaminose, crategolic (maslinic) acid, n-hepatcosane, n-nonacosane, n-hentriacontane, noctacosanol, n-triacontanol, n-dotricontanol, quercetin, myricetin, myricitrin and the flavonol glycosides myricetin 3-O-(4"-acetyl)- α Lrhamnopyranosides **Table 1**. Jamun plant is known to possess diverse phytochemicals, most of which are observed to be of health benefits¹². Phytoconstituents of seed kernels are mainly gallic acid, corilagin, 1-galloyl glucose, 33-galloyl glucose, 6-hexahydroxy diphenoyl glucose, ellagic acid, β -sitosterol, quercetin, 4,6 hexahydroxydiphenoyl glucose^{13,14}, with significant amounts of vitamin-C, B complex, iron, potassium and relatively low volumes of fat and cholesterol¹⁵.

The ethanol extract from *Eugenia jambolana* seeds were GC-MS-analyzed and found 17 compounds. Galactosan, Alpha-Cadinol, Tau-Murol, Diglycerol, Hexadecanoic acid, Dotriacontane,

Oleic acid, Cyclohexane, 1-(1,5-Dimethylhexyl)-4-(4-Methylpentyl), Ethyl ester, T-Butyl Cyclopentane peroxy carboxylate, 2,3-Anhydro-D-Mannosan, Alpha-Cadinol, Tau-Murol, Diglycerol¹⁶. The extracts contain a lot of phytoconstituents, which are the bioactive constituents responsible for the plant's therapeutic properties¹⁷. These chemicals have been widely used in pharmacology industry for the treatment of various diseases. Vitamins, minerals, and phytochemicals with powerful antioxidant properties can all be found in

abundance in jamun fruits. Some of these phytochemicals include phenolic compounds, flavonoids, gallic acid, anthocyanins, and tannins. The disaccharides sucrose, maltose, and galactose are found in high concentrations in jamun fruit, along with the monosaccharide's glucose, fructose, and mannose. They also contain a variety of essential amino acids, including asparagine, glutamine, alanine, cysteine, and tyrosine, and the fat-soluble vitamins ascorbic acid, thiamine, and niacin¹⁸.

TABLE 2: PHYTOCHEMICALS PRESENT IN EUGENA JAMBOLANA (*SYZIGIUM CUMINI*)

Plant part	Name of the Chemical constituent	Reference
Seed	Jambosine, Gallic acid, Ellagic acid, Corilagin, 3,6-hexahydroxy diphenylglucose, 1 galloylglucose, 3-galloylglucose, Quercetin, β sitosterol, 4,6 hexa hydroxy diphenyl glucose	12,19
Leaves	β -sitosterol, Betulinic acid, Mycaminose, Crategolic (maslinic) acid, n-hepatcosane, nnonacosane, nhentriacontane, Noctacosanol, ntriacontanol, ndotricontanol, Quercetin, Myricetin, Myricitrin and the flavonol glycosides myricetin 3-O-(4"-acetyl)- α -L-rhamnopyranosides	5,12,20
Stem bark	friedelin, friedelan-3- α -ol, betulinic acid, β sitosterol, kaempferol, β -sitosterol-D-glucoside, gallic acid, ellagic acid, gallotannin and ellagitannin and myricetine	19,12
Seed oils & essential oil from the leaves	α -terpeneol, Myrtenol, Eucarvone, Muurolol, α -myrtenal, 1, 8-cineole, Geranyl acetone, α -cadinol and Pinocarvone.	21
Flowers	Oleanolic acid, Ellagic acids, Isoquercetin, Quercetin, Kampferol and Myricetin	12
Fruit pulp	Anthocyanins, Delphinidin, Petunidin, Malvidin-diglucosides	22
Root	Root extract contains alkaloids and steroids and that of seed extract alkaloids, carbohydrates, phenols, proteins and tannins,	23

Medicinal Benefits of *Eugena jambolana* (*Syzigium cumini*):

Traditional uses: All parts of the jambolana can be used medicinally and it has a long tradition in alternative medicine. The leaves, seeds, and bark of these plants have therapeutic properties⁵. The leaf ash is used to whiten teeth and make the gums and teeth stronger. In the bark, it was also known to be able to heal wounds. According to the Unani system of medicine, they are supposed to be a liver tonic, to enrich blood, strengthen teeth and gums. The decoction is supposed to be a good lotion for removing ringworm infection of the head⁵. Traditional medical systems, particularly Unani literature documented a variety of pharmacological actions²⁴. Diabetes, ringworm, dysentery, cough, and inflammation are the conditions that have traditionally been treated with fruits. Ayurvedic medicine, a branch of traditional Indian medicine, used the fruits to treat diabetes mellitus. Traditional Indian medicine practitioners have employed the plant's many components to treat a wide range of ailments, including diabetes, mouth sores, cancer, colic, diarrhoea, digestive complaints, dysentery,

piles, pimples, and stomach aches. According to Ayurveda barks are acrid, digestive, and astringent. They are supposed to be useful for treating sore throat, bronchitis, asthma, thirst, biliousness, dysentery, and ulcers. The bark sialo known to possess wound healing properties. In the Siddha system of medicine, Jamun is considered to be a haematinic, and to decrease excessive heat of the body⁹.

Therapeutic Role of *Eugena jambolana* (*Syzigium cumini*):

The jamun fruit is renowned for its therapeutic benefits **Table 3**. Through the recent recognition of the medicinal values of the *Jamun* fruits, its marketing has increased significantly. The richness of tannins gives astringency to the fruits with a slight aftertaste. After processing the pulp into various value-added products, the kernels are left behind as a waste by-product of the processing. Traditionally, these kernels have been the most versatile addition to traditional medicines due to their rich phytochemical profile. The kernels are very nutritious and have been reported to contain

carbohydrates (89.68%), protein (4.68%), fiber (1.21%), fat (1.28%), calcium (135.86%), iron (4.2%), and ash content (3.13%). However, this fruit is rarely served because of its astringent taste and the purple stain it leaves on the tongue. Antimicrobial, antiviral, anti-inflammatory, anti-genotoxic, anti-ulcerogenic, cardioprotective, anti-allergic, anti-cancer, chemo preventive, radioprotective, antioxidant, hepatoprotective, anti-diarrheal, hypoglycaemic, and anti-diabetic effects

are only some of the therapeutic advantages of plant parts²⁵. Antimicrobial study of *S. cumini* leaves found that ethyl acetate extract of *S. cumini* leaves showed maximum antimicrobial activity at a concentration of 200 mg per ml²⁶. Leaf gall extract of jamun contains various phytochemicals which have antioxidant properties and are used in the treatment of various metabolic diseases such as diabetes mellitus, arthritis, cancer, liver disorder etc²⁷.

TABLE 3: PHARMACOLOGICAL ACTIVITIES OF *EUGENIA JAMBOLANA*

Pharmacological Activity	Observation	Reported by	
Antidiabetic activity	Diabetic therapeutic effects of ethyl acetate fraction from the roots of <i>Eugenia jambolana</i> in streptozotocin-induced male diabetic rats	28	
Anti-inflammatory activity	The seeds have anti-hyperglycemic effects	29, 30, 31, 32,	
	<i>In-vitro</i> and <i>in-vivo</i> anti-inflammatory properties	33	
	Ethanol extract of the bark possess anti-inflammatory effects in both acute (carrageenan, kaolin-carrageenin, and formaldehyde-induced) and chronic (cotton pellet granuloma) models in rats	34	
Cardio-protective activity	Ethanol extract of <i>S. cumini</i> bark had significant anti-inflammatory activity	35	
	Hydro-alcoholic extract from the fruits of <i>S. cumini</i> was evaluated for its antihypertensive and vasorelaxant effect	32,36	
	The methanolic extract of the seeds is reported to possess cardioprotective effects	37	
Antibacterial activity	Ethyl acetate extracts of the seeds of <i>E. jambolana</i> at a concentration of 200 µg/disc showed antibacterial activity.	38	
	The aqueous, ethanolic and acetone extracts of the bark was studied for its antibacterial effects on twelve strains of <i>Vibrio cholerae</i> .	39	
	antibacterial potential against human pathogenic bacteria	40	
Anti-fungal activity	Antifungal activity of <i>Syzygium cumini</i> against <i>Ascochyta rabiei</i>	41	
	The aqueous, ethanol and n-hexane extracts from the leaves, fruit, root-bark and stem-bark possess growth inhibitory effects on <i>Ascochyta rabiei</i>	41	
Anti-viral activity	Antiviral activity of <i>Eugenia jambolana</i> plant extract on buffalopox virus:	42	
Anti-Cancer Activity	Presence of flavonoids in <i>Syzygium cumini</i> (L.) was mainly responsible for the reduction and stabilization of nanoparticles. The nanoparticles were observed to devastate Dalton lymphoma cell lines <i>in-vitro</i>	43	
Antioxidant	Various fractions (viz water, ethyl acetate, chloroform and n-hexane) of the methanolic extract were studied for their free radical scavenging.	44	
	Antioxidant activity of <i>S. cumini</i> leaf galls extracts;	45	
	Antioxidant tannins from <i>Syzygium cumini</i> fruit.	46	
	The anthocyanin-rich fruit peel extract shown to be a effective as a reducing agent and scavenger of DPPH free radicals	47	
	The hydromethanolic extract of the Jamun seed was effective in scavenging free radicals	48	
	<i>S. cumini</i> leaf extracts contained phenolic compounds, such as ferulic acid and catechin, responsible for their antioxidant activity. (50)	49	
	Hypolipidemic activity	Hypolipidemic effect ethanolic extract	50,51,52
		Ethanol extract of seeds is able to reduce the level of total serum cholesterol/high density lipoprotein cholesterol ratio, low density lipoproteins (LDL) and triglycerides	53
		Ethanol extract of <i>E. jambolana</i> -kernel (100mg/kg body weight) had antihyperlipidemic activity on streptozotocin induced diabetic rats.	9,51
	Hepatoprotective activity	Ethanol Extract of The Pulp of <i>Eugenia jambolana</i> Lam. Hepatoprotective activity in rats induced with hepatotoxic paracetamol.	54
In another study it was revealed that the methanolic extract of <i>Eugenia jambolana</i> Lam. hepatotoxicity which was caused by carbon tetrachloride (CCL4).		55	

Radio protective Effect	The leaves of <i>S. cumini</i> were tested as a radioprotectant using a micronucleus assay. <i>S. cumini</i> was found to reduce the formation of micronuclei in lymphocytes	56
	Also confirmed that seed extract of <i>S. cumini</i> inhibited the micronuclei formation in mouse bone marrow cells induced by genotoxic stress.	57
Antipyretic activity	5 Jamun possess significant anti-pyretic action against the yeast-induced pyrexia in mice	58
Immunomodulatory Activity	The plant had treatment potential in immune-deficient conditions arising during radiation therapy or chemotherapy	59
Anti-allergic effects	anti-allergic activity of <i>Syzygium cumini</i> (L.) Skeels	59
CNS Protective	Ethyl acetate and methanol extracts of the seeds of <i>S. cumini</i> exhibited significantly CNS protective activity.	60
Antiulcerogenic	Antiulcerogenic	61

Antidiabetic Activity of *Eugena jambolana* (*Syzygium cumini*): Diabetes is the most prominent biomarker of Metabolic syndrome. It is known as the “third killer” of humanity, roughly affecting 10% of the world’s natives today. It is one of the top ten causes of death in the world, killing around 1.6 million people each year due to oxidative stress and inflammation caused by hyperglycemia. The hyperglycemia-induced oxidative stress and inflammation are mainly linked with the onset and progression of T2DM. Several studies have found that persistent low-grade inflammation is linked to an elevated risk of T2DM, or this underlying inflammation causes insulin resistance that is linked with symptoms of MS including hyperglycemia²⁵.

Jamun also known as Indian blackberry have long been recognised as nutritious food with diverse medicinal properties. The purple-to-blue, oblong fruits have pink pulp are eaten as fresh or as value added products like Jams, jellies, nectars, squashes, and wine. Fruit averages 75% edible, 83.7% moisture, 0.3% fat, 0.9% crude fibre, 0.7% protein, 14% carbohydrate, and 0.4% ash^{64, 65}. This fruit has minerals, sugars, vitamin C, and antioxidant-rich phenolic compounds (flavonoids, gallic acid, anthocyanins tannins). Leaves of *Syzygium cumini* are rich in acylated flavonol, myricetin, glycosides, quercetin, galloyl carboxyl, tannins, and esterase. Fruits contain quercetin, myricetin, kaempferol, oleanolic acid, eugenol-triterpenoid, and quercetin-3-D-galactoside. The roots contain flavonoid glycosides, while the stem and bark contain betulinic acid, quercetin, myricetin, gallic acid, ellagic acid, kaempferol, *etc.* Bark powder treats sore throat, asthma, bronchitis, dysentery, thirst, ulcers, and blood purification global tropical and subtropical regions¹³. In the last decade, the potent

anti-diabetic properties of the Jamunkernels have had a significant impact on research, which has further directed the efforts of the scientific community towards the validation of traditional claims by the development of appropriate methods and protocols to utilize the berry kernel which otherwise is a waste generated from fresh consumption or the processing. The kernels have a curative role against diseases like diabetes due to their positive interaction with the pancreas. Traditionally, various plant parts, i.e., pulp, seeds, bark, and leaves, have been transformed into a variety of food products like juices, herbal drinks, powders, and extracts, and their regular consumption has been reported effective against different diseases thus, resulted in various health claims. Recently Jamun kernel has been reported to protect against radiation and have pharmacological properties¹³.

Due to the rich phytochemical profile of the seeds/kernels have higher medicinal uses than pulp, bark, and leaves⁶². The furthestmost application of the kernels is as potent anti-diabetic agents in various herbal formulations as the kernels are rich in alkaloids, especially, jambolin, antimellin, jambosins, and glycosides, which can effectively reduce or even can stop the diastatic of starch to sugars conversion and restrict the sugar volume in the urine⁵. Before the discovery of insulin, Jamun was useful in the treatment of diabetes and was used either alone or in combination with other hypoglycemic plants even in Europe⁸⁰. It is essential to control diabetes because it can lead to a lots of health complications including kidney failure, nerve damage, blindness, heart attacks, strokes, poor blood circulation, hearing loss and many more. A healthy lifestyle that includes a proper diet, exercise, proper sleep, less stress and

so on plays a major role in controlling blood. A diabetes diet plan should include foods that are high in nutrients, low in fat, moderate in calories and few sugary foods. As fruits are generally sweet, people often think that a diabetic person should avoid eating them. But there are several fruits that are particularly effective at managing blood sugar. Packed with vitamins, minerals, antioxidants and phytonutrients, fruits are a healthy addition to any diet. Some fruits are better than others for diabetics. Moreover, diabetics also need to consider factors like glycaemic index and glycaemic load as they offer information on how different foods affect blood sugar and insulin levels. Low glycaemic index foods are believed to have a beneficial effect on blood glucose control as they do not significantly impact blood sugar levels.

Diabetic individuals can gain benefits from its fruit and leaves. The fruit aids in the conversion of carbohydrates to energy and regulates blood sugar levels. Usually, foods with a glycemic index score of 55 and below are classified as low glycaemic index foods. Those with a glycaemic index score of 70 and above are considered high glycemic index foods. Because of its low glycemic index, diabetic patients should consume Jamun during the summer²⁵. In spite of being packed with glucose and fructose, it is a low-calorie fruit. It is a good source of many nutrients like potassium, iron, proteins, vitamin carbohydrates, and magnesium⁶³.

Jamun seed, pulp, and bark have strong anti-diabetic properties. The seed is the most studied and effective anti-hyperglycemic remedy in experimental models^{66, 17}. Jamun seeds reduce the risk of diabetes-related secondary complications like nephropathy, neuropathy, gastropathy, diabetic cataracts, and peptic ulceration⁶⁷. Jamun extract activated the peroxisome proliferator-activated receptor gamma and Glut-4 transporter⁶⁸. Aqueous and methanolic extracts inhibited glucose utilisation with neutral and basic media performing better than acidic media⁶⁹. In an experimental design examined the rat models' glycaemic changes over eight weeks to determine therapeutic potential. Blood glucose levels and HbA1c levels dropped significantly by the eighth week after receiving Jamun at 200 mg/kg alone or with metformin. In another study rats with streptozotocin-induced type 2 diabetes, herbal drug and petroleum ether seed

extract of Jamun were tested for antidiabetic and anti-lipidemic effects. Treatment reduced fasting blood glucose (FBG) levels significantly after 22 days⁷⁰. In hyperglycemic rats, seed and fruit extracts significantly lower blood sugar and regulate insulin. Jamun fruit extract lowered hyperglycemic blood sugar by 12.29% and 5.35%. In normal and hyperglycemic rats, jamun seed extract decreased sugar by 7.04 and 14.36 percent and increased insulin by 7.24 and 3.56 percent¹⁴. In a human study, a combination of four T2DM medications, including Jamun, reduced HbA1c and blood sugar to normal levels after 12 weeks of ayurvedic treatment without insulin⁷¹. A hydro-ethanolic Jamun extract showed statistically significant antidiabetic activity by improving beta cell function and lowering insulin resistance⁷².

Ethyl acetate seed extracts in streptozotocin-induced diabetes rats for a short-term and long-term treatments reduced hyperglycemia. The treated group recovered superior recovery in serum insulin and glycated haemoglobin levels than the untreated group. In situ end-labelling examined treated group pancreatic beta cell regeneration. The study found that fraction treatment corrected hepatic hexokinase-I gene expression in diabetic rats. Ethyl acetate fraction inhibited sucrase and intestinal maltase. This study found that fraction treatment corrected hepatic hexokinase-I gene expression in diabetic rats. Ethyl acetate fraction inhibited intestinal maltase and sucrase. The gene regulation is antihyperglycemic⁷³.

In alloxan induced diabetic rats, *E. jambolana* seed and pulp significantly lowered blood glucose levels and the hypoglycemic activity is due to flavonoids⁷⁴. *Eugenia jambolana* extract reduces sitagliptin systemic exposure and improves diabetes. Pancreatic histopathology shows that combination treatment improves cell protection and normal acinus recovery. The combination treatment reduced systemic Sitagliptin exposure without affecting diabetes outcomes or antihyperglycemic activity⁷⁵. The effects of jamun seeds, and jamun leaf are hypoglycemic and Jamboline, a substance found in jamun seed powder, which aids in regulating blood glucose levels⁷⁶. Aqueous extract of the jamun seeds for six weeks resulted in a significant reduction in blood glucose and an increase in total haemoglobin⁷⁷. Antidiabetic

effects are mediated by upregulation of Peroxisome proliferator-activated receptors PPAR α and PPAR γ , which had the ability to differentiate 3T3-L1 preadipocytes⁷⁸. Mycaminose (50 mg/kg) from Jamun seeds also reduces hyperglycemia in rats with streptozotocin-induced diabetes⁷⁹. Jamun also raises serum insulin levels in normoglycemic and diabetic rats. Phytochemicals present in Jamun can protect pancreatic β -cells, stimulate insulin synthesis from residual beta cells, inhibit insulinase in the liver and kidney, and promote insulin-positive cell development in the pancreatic duct epithelial cells^{29, 67, 80}. Research indicates that Jamun seed inhibits both pancreatic amylase⁸¹ α -amylase⁸² in vitro. In a cell culture model, Jamun seed extract fraction activates glucose transport *via* phosphatidylinositol 3'kinase⁸³.

Eugenia jambolana seed showed more significant than pulp in reduction of blood glucose induced by alloxan⁷⁴. Jamun seed and pulp extract released insulin from Langerhans cells in normal and diabetic rats. The effect was stronger in normal rat cells. The pulp and seed extracts inhibited hepatic and renal insulinase activity in a dose depended on manner⁸⁴. Clinical evaluation of *Eugenia jambolana* hypoglycemic effects in patients diagnosed with Type II Non-Insulin Independent Diabetes showed that blood glucose levels were reduced in the group of patients, who were not on any antidiabetic medication. Urinary glucose levels were also investigated, and glycosuria was found to be reduced and the glucose levels were dramatically reduced with high dose⁸⁵. Antidiabetic and hypolipidemic properties jamun, come from its phytochemicals⁸⁶. In diabetic conditions, Jamun mediates the hypoglycemic activity through the depletion in the activities of the enzymes, glucose 6-phosphatase, adenosine deaminase, 5'-nucleotidase, phosphoenol pyruvatecarboxykinase, and fatty acid synthase, via the regulation of gene expressions⁸⁷.

CONCLUSION: The field of herbal medicine has grown exponentially in recent years, and these drugs are becoming popular in both developing and developed countries due to their natural origin and lower side effects. Jamun, is an evergreen tree found throughout India. Antidiabetic, antihyperlipidaemic, antioxidant, antiulcer, hepatoprotective, anti-allergic, antiarthritic,

antimicrobial, anti-inflammatory, antifertility, antipyretic, antiplaque, radioprotective, neuropsychopharmacology, nephroprotective, and antidiarrhoeal properties are reported in the fruit. Antidiabetic effect of Jamun is its most promising nutraceutical effect. The plant has a long history of therapeutic use, but evidence is scarce. Consumption of jamun fruit has increased recently because health-conscious people demand a diet rich in natural substances with the highest functional properties. To increase Jamun consumption, its traditional medicinal use must be developed, established, and documented with strong scientific rationales. This review covers experimental evidence for pharmacological potential of Jamun. The fruit's phytochemicals such as tannins, alkaloids, steroids, flavonoids, terpenoids, fatty acids, phenols, minerals, carbohydrates, vitamins, and their bioactive components are responsible for the health benefits. Future research may isolate, purify, and characterise these bioactive compounds of *Eugenia jambolana* Lam to develop antidiabetic drugs.

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