Indian Journal of Agriculture and Allied Sciences
A Refereed Research Journal

ISSN 2395-1109
e-ISSN 2455-9709
Volume: 3, No.: 3, Year: 2017

www.mrfsw.org
Received: 10.07.2017, Accepted: 25.08.2017
Publication Date: 30th September 2017

ANTI-DIABETIC HERBAL DRUG OF JAMUN (*Syzygium cumini*): A REVIEW

Satya Prakash Chaudhary[1], Ratnesh Kumar Rao[2] and Sanjeev Kumar[3]
[1]PhD Scholar, [2]Secretary, Mahaima Research Foundation and Social Welfare, 194, Karaundi, Banaras Hindu University, Varanasi, E-mail: mrfsw_kvns@yahoo.com, mahimafound@gamil.com and [3]Assistant Professor, Department of Dravyaguna, Faculty of Ayurveda, Institute of Medical Sciences, Banaras Hindu University, Varanasi, E-mail: sp1imsbhu@gmail.com,Corresponding Author: Satya Prakash Chaudhary

Abstract: *Jamun or Black plum is an important summer fruit, associated with many health and medicinal benefits. The black plum is known to relieve stomach pain, carminative, anti-scorbutic and diuretic. Jamun vinegar is good to reduce enlargement of spleen, diarrhea, and who has urine retention problems. Jamum's ployphenolic compounds are effective against cancer, heart diseases, diabetes, asthma and arthritis. Various digestive disorders i.e. flatulence, bowel spasm, stomach disorders, dysentery are cured by jamun. It is also eaten as tonic to increase sexual activity. Jamun is known by different names such as jambul, jambas, jamun, jambolan, rajaman, kala jamun, neredu, naval, nerale, jamali, java plum, black plum and black berry.*

The jamun fruit and jamun leaves are good for diabetes patient. The black plum has anti-diabetic features. Jamun helps to convert starch into energy and keep your blood sugar levels in check. In the summer season, the sugar patient should eat jamun regularly because of its low glycemic index. Jamun reduces the symptoms of diabetes like frequent urination and thrusting. The extract of bark, seeds, and leaves are too beneficial in the treatment of diabetes. Dried alcoholic extract of the seeds are good to reduce the level of blood sugar. The decoction of the bark and powdered seed is good in the treatment of diabetes. The extract of the bark, seeds and leaves are good in decreased of sugar in urine (glycouria). Jamun, jamun seeds and jamun leaf are hypoglycemic effects. Jamun seeds powder contains jamboline, a type of glucose, which helps to control the conversion of starch into sugar.

Keywords: *Jamun, Black plum, Diabetes, Glucose, Seed, Bark and Leaves.*

Introduction: The rising global epidemic of type 2 diabetes (T2D) places primary care at the frontier of an effective health-care response. Implementation of evidence-based treatments in primary care, where most patients receive almost all of their diabetes care, can for example help patients achieve glycemic targets early in their illness, which is important for improving long-term patient outcomes. Yet, most people in the community with T2D continue to have glycemic levels out of target.

Insulin is an evidence-based treatment for achieving normoglycemia in T2D. Use of long acting insulin analogs with patient-driven algorithms is feasible, safe, effective [1,2], and associated with improved patient satisfaction [3]. Early use of insulin for people with T2D is supported by international guidelines [4]. Yet, starting insulin is often delayed in clinical practice, particularly in general practice leading to prolonged hyperglycemic burden for patients [5]. This is an example of a "translational gap." Bridging such gaps to improve research impact in the real world of clinical care is a global issue. It is the focus of Clinical Translation Science Centres in the US [6], the National Institute of Health Research in the UK [7], and the Research Translation Faculty in the National Health and Medical Research Council [MRC] in Australia. All these initiatives aim to bridge the "valley of death" between research evidence and health policy and clinical practice.

The "T3 translational gap" covers "Translation to Practice" and is focused on ways to disseminate and implement recommendations from clinical efficacy studies into general clinical practice. T3 translational research is particularly important for primary care, where the "grand

challenge" [8] is to design studies that account for primary care's unique context, the uncertainty and the generalist approach that are at the heart of primary care practice.

One of the best medicinal benefits of jamun is its anti-diabetic properties. The black plum works against diabetes and convert sugar into energy. The Jamun fruit is good for digestive system because of its coolant features. Jambul is being having astringent properties, helps to prevent acne, blemishes, wrinkles and pimples. It is also good for blood due to more amount of iron. The presence of vitamin C is beneficial for fair skin complexion. Jamun is having many bio-chemical compounds, which includes flavonoids, essential oils, gallic acid, oxalic acid, malic acid, betulic acid, etc., which are beneficial in managing and treating of many diseases.

In association to its dietary use, all parts of the tree and, importantly the seeds are used to treat a range of ailments, the most important being diabetes mellitus [9]. Preclinical studies have shown that the various extracts of Jamun possess a range of pharmacological actions, such as antibacterial, antifungal, antiviral, anti-ulcerogenic, cardioprotective, anti-allergic, hepatoprotective and anti-diarrheal effects, thereby supporting its myriad traditional uses [9].

The observations suggest that the extract was an efficient preventer of lipid peroxidation in all organs but the degree of protection was variable. At the lowest concentration of 5 ppm the anti-lipid peroxidative effects were high in the rat brain 68.3%] followed by rat liver [83%], mitochondria [86%] testes [72%], and the erythrocyte ghost cells [48%] [10]. The extract was also observed to decrease the levels of CCl4-induced LPx in the primary rat hepatocytes in vitro [11]. Animal studies have also shown that administering Jamun decreased the levels of lipid peroxides in the stomachs of animals subjected to ulcerogenic treatments [12, 13, 14], in the brain, liver, kidneys and serums of diabetic animals [15, 16]. A similar mechanism may be operating towards prevention of carcinogenesis and radiation-induced ill effects and needs to be validated.

About Plant: *Syzygium cumini* [*S. cumini*] [L.] Skeels is one of the best known species and it is very often cultivated. The synonyms of *S. cumini* are *Eugenia jambolana* Lam., *Myrtus cumini* Linn., *Syzygium jambolana* DC., *Syzygium jambolanum* [Lam.] DC., *Eugenia djouant* Perr., *Calyptranthes jambolana* Willd., *Eugenia cumini* [Linn.] Druce and *Eugenia caryophyllifolia* Lam. It is commonly known as jambolan, black plum, jamun, java plum, Indian blackberry, Portuguese plum, Malabar plum, purple plum, Jamaica and damson plum. For long in the period of recorded history, the tree is known to have grown in the Indian sub-continent, and many others adjoin regions of South Asia such as India, Bangladesh, Burma, Nepal, Pakistan, Sri Lanka and Indonesia. It was long ago introduced into and became naturalized in Malaysia. In southern Asia, the tree is venerated by Buddhists, and it is commonly planted near Hindu temples because it is considered sacred to Lord Krishna [17]. The plant has also been introduced to many different places where it has been utilized as a fruit producer, as an ornamental and also for its timber. In India, the plant is available throughout the plains from the Himalayas to southern India.

A tree to 20 tall with scaly gray bark; leaves opposite, dark green, 5-15 cm long, 2.5-8 cm wide, acuminate, elliptic-oblong, narrow; petioles 1-2.5 cm long; flowers in cymose clusters, axillary or in axils of fallen leaves, white or pink, 12 mm wide; calyx 4-6 mm wide, up to 8 mm long; petals caducous; stamens many [c. 50], exserted, white or pinkish, to 7 mm long; fruit oblong, 2-2.5 cm long, deep purplish-black, juicy; seed 1, large, green".

Syzygium cumini, known as jambul, jambolan, jamblang or jamun, is an evergreen tropical tree in the flowering plant family Myrtaceae. It is native to the Indian Subcontinent, adjoining regions of Southeast Asia, China and Queensland. [18] The name of the fruit is sometimes mistranslated as blackberry, which is a different fruit in an unrelated family. *Syzygium cumini* has been spread overseas from India by Indian emigrants and at present is common in former tropical British colonies.

The leaves which have an aroma similar to turpentine, are pinkish when young, changing to a leathery, glossy dark green with a yellow midrib as they mature. The leaves are used as food for livestock, as they have good nutritional value.


Flower bud and open flowers

Syzygium cumini fruit color changing from green to pink to blood red to black as it matures.

Syzygium cumini trees start flowering from March to April. The flowers are fragrant and small, about 5 mm in diameter. The fruits develop by May or June and resemble large berries; the fruit of *Syzygium* species is described as "drupaceous". [19] The fruit is oblong, ovoid. Unripe fruit looks green. As it matures, its color changes to pink, then to shining crimson red and finally to black color. A variant of the tree produces white coloured fruit. The fruit has a combination of sweet, mildly sour and astringent flavour and tends to colour the tongue purple.

Common Name

Common name	**Language**
duhat	Chamorro
faux pistachier	French
guayabo pesgua	Spanish
jaman	Hindi
jamblon	French
jambolan plum	English
jambolanier	French
jambool	English
jambu	English
jamélongue	French
jamelongue	French
jamelonguier	French
jamelonier	French
jammun	Hindi
Java plum	English
ka‘ika	Maori [Cook Islands]
kaika	Maori [Cook Islands]
kavika ni India	Fijian
mesegerak	Palauan
mesekerrák	Palauan
mesekerrak	Palauan
mesigerak	Palauan
nonu fi‘afi‘a	Samoan
paramu	Maori [Cook Islands]
pisat	Maori [Cook Islands]
pistāita	Maori [Cook Islands]
pistas	Mangarevan
pistas	Tahitian
pistati	Maori [Cook Islands]
pītāti	Maori [Cook Islands]
prunier de java	French
wu mo	Chinese
yambolana	Spanish
Scientific Classification	
Kingdom:	Plantae
Clade:	Angiosperms
Clade:	Eudicots
Clade:	Rosids
Order:	Myrtales
Family:	Myrtaceae
Genus:	*Syzygium*
Species:	***S. cumini***
Binomial name: *Syzygium cumini*	
Nutrients and phytochemicals	
Java Plum Leaf	
Compound	**Percent**
Crude Protein	9.1
Fat	4.3
Crude Fiber	17.0

Ash	7
Calcium	1.3
Phosphorus	0.19
Source: http://www.hort.purdue.edu/newcrop/morton/jambolan.html	
Nutritional value per 100 g [3.5 oz]	
Energy	251 kJ [60 kcal]
Carbohydrates	14 g
Dietary fiber	0.6 g
Fat	0.23 g
Protein	0.995 g
Vitamins	
Thiamine [B1]	[2%] 0.019 mg
Riboflavin [B2]	[1%] 0.009 mg
Niacin [B3]	[2%] 0.245 mg
Vitamin B6	[3%] 0.038 mg
Vitamin C	[14%] 11.85 mg
Minerals	
Calcium	[1%] 11.65 mg
Iron	[11%] 1.41 mg
Magnesium	[10%] 35 mg
Phosphorus	[2%] 15.6 mg
Potassium	[1%] 55 mg
Sodium	[2%] 26.2 mg
Other constituents	
Water	84.75 g
Source: https://en.wikipedia.org/wiki/Syzygium_cumini	

Ayurvedic Properties

Hindi	**Sanskrit**	**English**	
Rasa	Kashay, Madhur, Amla	Taste	Astringent, Sweet, Sour
Guna	Laghu, Ruksha	Physical Property	Light, Dry
Virya	Sheet	Potency	Cold
Vipaka	Katu	Metabolic Property [After Digestion]	Pungent

Practical Uses of Syzygium cumini

- Jamun fruit works miraculously in diabetes. It is wonderful medicine for the sufferers of hyperglycemia. Because it's low glycemic index maintains proper sugar level in human body.
- This fruit is rich in iron and richness of iron makes it a natural blood purifier as it ensures proper blood supply of oxygenated blood throughout body.
- It is good source of vitamin A and C and it is very beneficial for overall health of eye and skin. Astringent property of this herb makes skin healthy, glowing and free from acne and pimple.
- It contains various chemical compounds like oxalic acid, gallic acid etc. which makes this fruit capable to fight against malaria and various other microbial and bacterial infections.
- It protects our body from the harmful effects of free radicals that are main cause of cardiovascular disorders and good for overall heart health.
- It is also used for the treatment of lung associated disorders such as cough, asthma and bronchitis.
- This fruit is used for digestive system related problems like flatulence, abdominal pain and dysentery.
- This herb is aphrodisiac in nature and it is used as tonic to generalize weakness, treating anemia and to improve sexual weakness.
- Jamun bark is very effective for the females suffering with leucorrhea.
- Jamun in combination with other herbs is used for the treatment of constipation and also helpful in pancreas related ailments.
- It is also very beneficial for depression, exhaustion and other nervous system related disorders.
- This herb is also beneficial to make strength of teeth and gums.
- This herb is also very beneficial in mouth ulcers and sore throat.

- It pacifies kapha and pitta dosha but it aggravates vata dosha.

hytochemical Constituents: Jambolan 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 and seed extract has lowered blood pressure by 34.6% and this action is attributed to the ellagic acid content [17]. The seeds have been reported to be rich in flavonoids, a well-known antioxidant, which accounts for the scavenging of free radicals and protective effect on antioxidant enzymes [20, 21] and also found to have high total phenolics with significant antioxidant activity [22] and are fairly rich in protein and calcium. Java plums are rich in sugar, mineral salts, vitamins C, PP which fortifies the beneficial effects of vitamin C, anthocyanins and flavonoids [23].

Leaves: The leaves are rich in acylated flavonol glycosides [9], quercetin, myricetin, myricitin, myricetin 3-O-4-acetyl-L-rhamnopyranoside [24], triterpenoids [25], esterase, galloyl carboxylase [26], and tannin [17].

Stem bark: The stem bark is rich in betulinic acid, friedelin, epi-friedelanol, β-sitosterol, eugenin and fatty acid ester of epi-friedelanol [27], β-sitosterol, quercetin kaempferol, myricetin, gallic acid and ellagic acid [28], bergenins [29], flavonoids and tannins [30]. 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 [31], oleanolic acid, acetyl oleanolic acid, eugenol-triterpenoid A and eugenol-triterpenoid B [31]**.**

Roots: The roots are rich in flavonoid glycosides [32] and isorhamnetin 3-O-rutinoside [33].

Fruits: The fruits are rich in raffinose, glucose, fructose [34], citric acid, mallic acid [35], gallic acid, anthocyanins [36]; delphinidin-3-gentiobioside, malvidin-3-laminaribioside, petunidin-3-gentiobioside [37], cyanidin diglycoside, petunidin and malvidin [38]. 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 [37]. 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 [39]. One of the varieties of jambolan found in the Brazil possesses malvidin-3-glucoside and petunidin-3-glucoside [40]. The peel powder of jambolan 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 [41].

Essential Oils: The essential oils isolated from the freshly collected leaf [accounting for 82% of the oil] [42], stem, seed, fruits contain α-Pinene, camphene, β-Pinene, myrcene, limonene, cis-Ocimene, trans-Ocimene, γ-Terpinene, terpinolene, bornyl acetate, α-Copaene, β-Caryophyllene, α-Humulene, γ-Cadinene and δ-Cadinene [43], trans-ocimene, cis-ocimene, β-myrcene, α-terpineol, dihydrocarvyl acetate, geranyl butyrate, terpinyl valerate [44], α-terpineol, β-caryophyllene, α-humulene, β-selinene, calacorene, α-muurolol, α-santalol, cis-farnesol: lauric, myristic, palmitic, stearic, oleic, linoleic, malvalic, sterculic and vernolic acids [45]. Unsaponifiable matter of the seed fat was also chemically investigated [46].

Medicinal Properties: The bark is acrid, sweet, digestive, astringent to the bowels, anthelmintic and used for the treatment of sore throat, bronchitis, asthma, thirst, biliousness, dysentery and ulcers. It is also a good blood purifier. The fruit is acrid, sweet, cooling and astringent to the bowels and removes bad smell form mouth, biliousness, stomachic, astringent, diuretic and antidiabetic [47]. The fruit has a very long history of use for various medicinal purposes and currently has a large market for the treatment of chronic diarrhea and other enteric disorders. The seed is sweet, astringent to the bowels and good for diabetes. The ash of the leaves is used for strengthening the teeth and gums. Vinegar prepared from the juice of the ripe fruit is an agreeable stomachic and carminative and used as diuretic [48] and it is also useful in spleen enlargement and an efficient astringent in chronic diarrhea.

Juice of tender leaves of this plant, leaves of mango and myrobalan are mixed and administered along with goat's milk and honey to treat dysentery with bloody discharge, whereas

juice of tender leaves alone or in combination with carminatives such as cardamom or cinnamon is given in goat's milk to treat diarrhoea in children [47]. Traditional medical healers in Madagascar have been using the seeds of jambolan for generations as the centerpiece of an effective therapy for counteracting the slow debilitating impacts of diabetes [49]. The seed extract is used to treat cold, cough, fever and skin problems such as rashes and the mouth, throat, intestines and genitourinary tract ulcers [infected by *Candida albicans*] by the villagers of Tamil Nadu [50]. Jambolan fruit can be eaten raw and can be made into tarts, sauces and jams. Good quality jambolan juice is excellent for sherbet, syrup and "squash", an Indian drink.

Variations in *Syzygium cumini* use patterns: A total of 34 different uses were recorded for six parts of *Syzygium cumini*, namely fruits, leaves, bark, trunk, branches and roots (Table 1). Those uses were classified into five use categories such as household food consumption, folk medicine, sales, construction material and fuel, and others (stools, handcrafts, ink making). The values of Informant Agreement Ratio (IAR) calculated for each use category revealed a consensus on the use of the different plant parts (Table 2). All plant parts are used but roots are only used in folk medicine. Leaves and fruits are used for human food and also sold in markets to generate income. All plant parts had applications in traditional medicine, except trunk and branches; the most commonly treated ailment being haemorrhoids.

Table-1: *Syzygium cumini* plant parts and their uses

Plant parts used	Use categories	Uses
Roots	Folk medicine	Against snake and scorpion bites, haemorrhoids, malaria, ulcers, diabetes, sexual impotence, stomach-ache, wounds, constipation, eye pains, intestine worms, sprain
Bark	Folk medicine	Sterility, haemorrhoids, snake and scorpion bites, intestine worms, ulcers, stomach-ache, diabetes, constipation, malaria, wounds, sexual impotence, eye pain, cough, amenorrhea, dysmenorrheal, strokes
Trunk and branches	Construction and fuel	Fuel wood, charcoal, planks, beam
	Other uses	Drums, stool of the king
Leaves	Food	Household use for consumption as cooked vegetable
	Sales	Sale as cooked vegetable
	Folk medicine	Hemorrhoids, snake bites, mouth candidiasis, whitlow, annulet, malaria, ulcers, sexual impotence, stomach-ache
	Other uses	Ink
Fruits	Food	Direct consumption of fruits, juice making
	Sales	Sale of fruits for direct consumption
	Folk medicine	Haemorrhoids

Table-2: Syzygium cumini major use types and Informant Agreement Ratio

Use categories	Number of use citations [nr]	Plant parts involved	Number of parts involved [na]	IAR
Construction and fuel	3	Trunk and branches	2	0.500
Food	298	Fruits and leaves	2	0.996
Sales	120	Fruits and leaves	2	0.992
Folk medicine	58	Fruits, leaves, bark, roots	4	0.947
others	11	Trunk, branches, and leaves	3	0.800

Suggestion

- Diabetes causes high blood sugar (glucose) levels due to lack of insulin production or function. It is mainly classified as either Type 1, in which the body fails to produce insulin, or Type 2, in which the body is not able to properly use the insulin it produces.
- It is essential to control diabetes because it can lead to a host 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

glucose levels. 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 glycemic index and glycemic load as they offer information on how different foods affect blood sugar and insulin levels.
- Low glycemic index foods are believed to have a beneficial effect on blood glucose control as they do not significantly impact blood sugar levels. Usually, foods with a glycemic index score of 55 and below are classified as low glycemic index foods**.** Those with a glycemic index score of 70 and above are considered high glycemic index foods.

Benefits of Black Plum: Black plums, also known as Jambul or Jamun, can help a lot in controlling blood sugar. Researchers from the Father Muller Medical College in India looked at the effects of black plums in the treatment of diabetes. The presence of anthocyanins, ellagic acid and hydrolysable tannins in black plums makes this fruit extremely beneficial for diabetic people. The fruit helps control the conversion of carbohydrates into blood sugar. The excessive thirst and frequent urination problems common among diabetic people can also be controlled by this fruit. Along with the fruit, the leaves, berry and seeds of the black plum tree can be used to control blood sugar level.

Suggested serving size: One-half cup of black plums daily is recommended, when the fruit is available in the market. You can also make a powder of dried seeds and eat one teaspoon of the powder with water twice a day. (http://www.top10homeremedies.com/kitchen-ingredients/top-10-fruits-diabetics.html)

Conclusion: Jambolan is widely used by the traditional healers for the treatment of various diseases especially diabetes and related complications. The plant has many important compounds which confer the most of the characteristics of the plant. 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 jambolan.

The evaluation of nutrient composition of *Syzygium cumini* young leaf showed that it is highly rich in nutrients and therefore good for human consumption for the maintenance of health and vitality. The nutrients analysis shows that *Syzygium cumini* young leaf contains the nutrient levels that fall within those of edible vegetables: Carbohydrate, crude protein, crude fat, crude fibre, moisture, ash (minerals) and vitamins and low content of anti-nutrients. The high moisture content of blackplum young leaves will encourage microbial growth, increase the rate of enzymatic reaction and hence deterioration. Blackplum young leaves contain essential vitamins necessary for body to survive. However, the value of vitamin B2 is relatively low, but not too low for plant based vitamins.

The health implications of anti-nutrients are well known. Some anti-nutritive factors such as tannins, alkaloids and saponin were detected from the result of the analysis. These were present in small quantities; these factors may not pose any serious nutritional problem in its consumption. Reduction of these anti-nutrients during the processing of blackplum young leaves such as boiling is therefore of great importance for the safety of the product.

References

1. Davies, M., Lavalle-González, F., Storms, F., Gomis, R. (2008). Initiation of insulin glargine therapy in type 2 diabetes subjects suboptimally controlled on oral antidiabetic agents: results from the AT.LANTUS trial*. *Diabetes Obes Metab.*, 10(5):387–99.10.1111/j.1463-1326.2008.00873.x
2. Pradhan, A.D., Everett, B.M., Cook, N.R., Rifai, N., Ridker, P.M. (2009). Effects of initiating insulin and metformin on glycemic control and inflammatory biomarkers among patients with type 2 diabetes: the LANCET randomized trial. *JAMA*, 302(11):1186–94.10.1001/jama.2009.1347
3. Bretzel, R.G., Nuber, U., Landgraf, W., Owens, D.R., Bradley, C., Linn, T. (2008). Once-daily basal insulin glargine versus thrice-daily prandial insulin lispro in people with type 2 diabetes on oral hypoglycaemic agents (APOLLO): an open randomised controlled trial. *Lancet*, 371 (9618):1073–84.10.1016/S0140-6736(08)60485-7

4. Inzucchi, S.E., Bergenstal, R.M., Buse, J.B., Diamant, M., Ferrannini, E., Nauck, M., et al. (2012). Management of hyperglycemia in type 2 diabetes: a patient-centered approach: position statement of the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). *Diabetes Care*, 35(6):1364–7910.2337/dc12-0413
5. Brown, J.B., Nichols, G.A., Perry, A. (2004). The burden of treatment failure in type 2 diabetes. *Diabetes Care*, 27(7):1535–40.10.2337/diacare.27.7.1535
6. Butler, D. (2008). Translational research: crossing the valley of death. *Nature*, 453:840–210.1038/453840a
7. National Institute for Health Research. (2014). NHS National Institute for Health Research, Evaluation, Trials and Studies. Available from: http://www.nets.nihr.ac.uk/
8. Van, Weel, C. (2014). Primary health care and family medicine at the core of health care: challenges and priorities in how to further strengthen their potential. *Front Med.*, 1:37.10.3389/fmed.2014.00037
9. Sagrawat, H., Mann, A.S., Kharya, M.D. (2006). Pharmacological potential of Eugenia jambolana: a review. *Pharmacognosy Magazine*, 2: 96-105.
10. Veigas, J.M., Narayan, M.S., Laxman, P.M., et al. (2007). Chemical nature, stability and bioefficacies of anthocyanins from fruit peel of Syzygium cuminiskeels. *Food Chemistry*, 105, 619-27.
11. Veigas, J.M., Shrivasthava, R., Neelwarne, B. (2008). Efficient amelioration of carbon tetrachloride induced toxicity in isolated rat hepatocytes by Syzygium cumini Skeels extract. *Toxicology In Vitro*, 22, 1440-6.
12. Chaturvedi, A., Bhawani, G., Agarwal, P.K., et al. (2009b). Antidiabetic and antiulcer effects of extract of Eugenia jambolana seed in mild diabetic rats: study on gastric mucosal offensive acid-pepsin secretion. *Indian J Physiol Pharmacol*, 53, 137-46.
13. Chaturvedi, A., Bhawani, G., Agarwal, P.K., et al. (2009a). Ulcer healing properties of ethanolic extract of Eugenia jambolana seed in diabetic rats: study on gastric mucosal defensive factors. *Indian J Physiol Pharmacol*, 53, 16-24.
14. Chaturvedi, A., Kumar, M.M., Bhawani, G., et al. (2007). Effect of ethanolic extract of Eugenia jambolana seeds on gastric ulceration and secretion in rats. *Indian J Physiol Pharmacol*, 51, 131-40.
15. Prince, P.S., Menon, V.P., Pari, L. (1998). Hypoglycemic activity of Syzigium cumini seeds: effect on lipid peroxidation in alloxan diabetic rats. *J Ethnopharmacol*, 61, 1-7.
16. Ravi, K., Ramachandran, B., Subramanian, S. (2004). Protective effect of Eugenia jambolana seed kernel on tissue antioxidants in streptozotocin-induced diabetic rats. *Biol Pharm Bull*, 27, 1212-7.
17. Morton, J. (2004). *Fruits of warm climates*. Miami: Julia Morton Winterville North Carolina; p. 1987.
18. "Syzygium cumini". (2017). World Checklist of Selected Plant Families (WCSP). Royal 2. Botanic Gardens, Kew. Retrieved 16 June 2017.
19. Chen, Jie & Craven, Lyn, A. (2015). *"Syzygium"*, in Wu, Zhengyi; Raven, Peter H. & Hong, Deyuan, *Flora of China (online)*, eFloras.org, retrieved 2015-08-13.
20. Ravi, K., Ramachandran, B., Subramanian, S. (2004). Protective effect of *Eugenia jambolana* seed kernel on tissue antioxidants in streptozotocin induced diabetic rats. *Biol Pharm Bull.*, 27:1212–1217.
21. Ravi, K., Ramachandran, B., Subramanian, S. (2004a). Effect of *Eugenia jambolana* seed kernel on antioxidant defense system in streptozotocin induced diabetes in rats. *Life Sci.*, 75:2717–2731.
22. Bajpai, M., Pande, A., Tewari, S.K., Prakash, D. (2005). Phenolic contents and antioxidant activity of some food and medicinal plants. *Int J Food Sci Nutr.*, 56:287–291.
23. Council of Scientific and Industrial Research. (1948). The wealth of India. New Delhi: Council of Scientific and Industrial Research; pp. 1976.
24. Timbola, A.K., Szpoganicz, B., Branco, A., Monache, F.D., Pizzolatti, M.G. (2002). A new flavonoid from leaves of *Eugenia jambolana*. *Fitoterapia*, 73:174–176.
25. Gupta, G.S., Sharma, D.P. (1974). Triterpenoid and other constituents of *Eugenia jambolana* leaves. *Phytochemistry*, 13:2013–2014.
26. Bhatia, I.S., Sharma, S.K., Bajaj, K.L. (1974). Esterase and galloyl carboxylase from *Eugenia jambolana* leaves. *Indian J Exp Biol.*, 12:550–552.
27. Sengupta, P., Das, P.B. (1965). Terpenoids and related compunds part IV triterpenoids the stem-bark of *Eugenia jambolana* Lam. *Indian Chem Soc.*, 42:255–258.
28. Bhargava, K.K., Dayal, R., Seshadri, T.R. (1974). Chemical components of *Eugenia jambolana* stem bark. *Curr Sci.*, 43:645–646.
29. Kopanski, L., Schnelle, G. (1988). Isolation of bergenin from barks of *Syzygium cumini*. *Plant Med.*, 54:572.
30. Bhatia, I.S., Bajaj, K.L. (1975). Chemical constituents of the seeds and bark of *Syzygium cumini*. *Plant Med.*, 28:347–352.
31. Nair, R.A.G. (1962). Subramanian SS. Chemical examination of the flowers of *Eugenia jambolana*. *J Sci Ind Res.*, 21B:457–458.
32. Vaishnava, M.M., Tripathy, A.K., Gupta, K.R. (1992). Flavonoid glycosides from roots of *Eugenia jambolana*. *Fitoterapia*, 63:259–260.

33. Vaishnava, M.M., Gupta, K.R. (1990). Isorhamnetin 3-O-rutinoside from *Syzygium cumini* Lam. *J Indian Chem Soc.*, 67:785–786.
34. Srivastava, H.C. (1953). Paper chromatography of fruit juices. *J Sci Ind Res.*, 12B:363–365.
35. Lewis, Y.S., Dwarakanath, C.T., Johar, D.S. (1956). Acids and sugars in *Eugenia jambolana*. *J Sci Ind Res.*, 15C:280–281.
36. Jain, M.C., Seshadri, T.R. (1975). Anthocyanins of *Eugenia jambolana* fruits. *Indian J Chem.*, 3:20–23.
37. Venkateswarlu, G. (1952). On the nature of the colouring matter of the jambul fruit (*Eugenia jambolana*) *J Indian Chem Soc.*, 29:434–437.
38. Sharma, J.N., Sheshadri, T.R. (1955). Survey of anthocyanins from Indian sources Part II. *J Sci Ind Res.*, 14:211–214.
39. Noomrio, M.H., Dahot, M.U. (1996). Nutritive value of *Eugenia jambosa* fruit. *J Islam Acad Sci.*, 9:1.
40. Lago, E.S., Gomes, E., da Silva, R. (2004). Extraction and anthocyanic pigment quantification of the Jamun fruit (*Syzygium cumini* Lam.), (Online) Available from: http// www.iqsc.usp.br/outros/eventos/2004/bmcfb/trab alhos/docs/trab-76.pdf. (Accessed on 20 August, 2010)
41. Veigas, J.M., Narayan, M.S., Laxman, P.M., Neelwarne, B. (2007). Chemical nature stability and bioefficacies of anthocyanins from fruit peel of *Syzygium cumini* Skeels. *Food Chem.*, 105:619–627.
42. Kumar, A., Naqvi, A.A., Kahol, A.P., Tandon, S. (2004). Composition of leaf oil of *Syzygium cumini* L, from north India. *Indian Perfum.*, 48:439–441.
43. Craveiro, A.A., Andrade, C.H.S., Matos, F.J.A., Alencer, J.W., Machado, M.I.L. (1983). Essential oil of *Eugenia jambolana*. *J Nat Prod.*, 46:591–592.
44. Vijayanand, P., Rao, L.J.M., Narasimham, P. (2001). Volatile flavour components of Jamun fruit (*Syzygium cumini*) *Flavour Fragr J.*, 16:47–49.
45. Daulatabad, C.M.J.D., Mirajkar, A.M., Hosamani, K.M., Mulla, G.M.M. (1988). Epoxy and cyclopropenoid fatty acids in *Syzygium cumini*i seed oil. *J Sci Food Agric.*, 43:91–94.
46. Gupta, R.D., Agrawal, S.K. (1970). Chemical examination of the unsaponifiable matter of the seed fat of *Syzygium cumini*. *Sci Cult.*, 36:298.
47. Nadkarni, K.M. (1976). *Indian materia medica*. Bombay: Popular Prakashan Ltd.
48. Kiritikar, K.R., Basu, B.D. (1987). *Indian medicinal plants*. Dehradun: International Book Distributors, pp. 1052–1054.
49. Ratsimamanga, U. (1998). Native plants for our global village. *TWAS Newslett*., 10:13–15.
50. Chandrasekaran, M., Venkatesalu, V. (2004). Antibacterial and antifungal activity of *Syzygium jambolanum* seeds. *J Ethnopharmacol.*, 91:105–108.