**BIOACTIVE COMPOUNDS IN JAMUN (*Syzygium cumini* L.) ENSURING NUTRITIONAL SECURITY**

Sruti das, Sushree sailaxmi samal, Adyasha Jena, Akankshya Jena, K. Chaitanya, Swagatika kisan, Swastik Dey and Prachi khilar

Corresponding author: srutidas2003@gmail.com

Department of Agriculture and allied sciences, C.V Raman global university, BBSR, India

**Abstract**

The jambolan fruit is well-known for the high concentration of bioactive phenolic compounds that it contains. These compounds show potential for improving the health of humans. The jambolan plant includes a range of phenolic compounds in addition to tannins. These phenolic compounds include phenolic acids, flavonoids (primarily anthocyanins, flavonols, flavanols, and flavanonols), and flavonol glycosides. Tannins are also present in the jambolan plant. Although a significant portion of the plant's resources are used in forestry and fruit propagation, the jambolan fruit has attracted a lot of attention due to the benefits that it is said to have, including those that are neuropsychopharmacological, nephroprotective, and anti-diarrheal. Anthocyanins, most notably delphinidin, petunidin, and malvidin, are present in significant numbers in the skin of the fruit, particularly in their glycosylated forms. This is notable since these anthocyanins give the fruit its distinctive color. On the other hand, the fruit pulp is mostly composed of phenolic acids such as gallic acid and ellagic acid, in addition to tannins. In addition, the leaves, skin, and pulp of the jambolan fruit include other chemicals, such as flavonoids such as quercetin and myricetin. These substances can be found in the jambolan fruit. These phenolic compounds have been linked to a wide variety of health advantages, including but not limited to anti-inflammation, anti-allergy, management of blood sugar, cancer prevention, cardiovascular health, support for radiation therapy, reduction of bacterial infections, and improvement in the efficacy of chemotherapy.

**Introduction**

The pharmacological, nutritional, and physiological benefits of jamun (Syzygium cumini) are being discussed, along with an investigation of the numerous bioactive components that may be found in this fruit. Notably, jambosine, an alkaloid, and jambolin, a glycoside also known as antimellin, are both present in jambolan seeds.

The jambolan fruit has seen a recent spike in popularity as a result of its high anti-oxidant content as well as its potential to contribute to the nutritional well-being of consumers. Jambolan has a number of bioactive chemicals that have been related to a variety of health benefits. The focus of this research is on the effects that climate change will have on global ecosystems, with a particular emphasis on the role that phytochemicals will play (despite the fact that phytochemicals do not in and of themselves supply either calories or nutrients to food). Phenolic compounds, which are a type of chemicals that are generated from plants, have particularly aroused the interest of the scientific community due to the antioxidant capabilities that they possess. Tannins and other secondary plant metabolites have historically been considered to be antinutrients due to the negative properties that they possess. The idea that phenolic chemicals have no bearing on human health has been thoroughly debunked by epidemiological research to a large extent. As a direct result of this, food technology and fields that are closely related to it have moved their focus toward defining and quantifying phenolic chemicals found in food. Within the family of Myrtaceae, the jambolan tree (Syzygium cumini Skeels), sometimes referred to as black plum, Indian blackberry, jamun, and jambul, has been recognized as a significant source of phenolic chemicals. Other names for this tree include jamun and jambol. Due to the fact that its fruits can be consumed, it was first brought to some areas in Africa; yet, its natural habitat is in India as well as other parts of South and Southeast Asia. In addition, jambolan can be located in a number of countries, such as Bangladesh, Pakistan, Nepal, Sri Lanka, Indonesia, Malaysia, and Burma, as well as the United places, namely in places such as Florida. The plant has a long history of use in both traditional Indian medicine and cuisine. Different components of the plant, such as fruits, seeds, leaves, and even the bark, have been used at various times. Phytochemicals are found in a wide variety of plant species and are thought to have the ability to exert bioactive effects.

Because of its stomachic, diuretic, anti-diabetic, and anti-diarrheal characteristics, jambolan has been utilized extensively in complementary and alternative medicine for a significant amount of time. Although there is widespread agreement that this herb may provide some health benefits, there is a dearth of reliable research to back these claims. Jambolan was found in a wide variety of processed goods, such as wine, juice, frozen yogurt, and muffins, according to research conducted by Singh et al. (2015) and Tavares et al. (2016). These researchers found jambolan in the products. The jambolan fruit includes a variety of interesting substances, including as phenolic acids, flavonoids, and tannins, which are recognized for their capacity to inhibit the production of potentially dangerous free radicals. Lestario et al. (2017) found that the presence of anthocyanins in jambolan fruit increases the fruit's capacity to act as an antioxidant. This is an important finding. Because of their water-solubility and contribution to the fruit's brilliant color, anthocyanins including delphinidin, petunidin, and malvidin are highly prized for use in the food industry as colorants, flavor enhancers, and preservatives.

Ellagic acid, gallic acid, quercetin, myricetin, kaempferol, condensed tannins, and hydrolyzable tannins are among the many secondary chemicals that may be found in jambolan fruit. Other secondary chemicals include ellagic acid and myricetin. According to Afify et al. (2011), the bioactive compounds in the plant are what give it its pharmacological significance. These compounds offer multiple therapeutic applications, such as antioxidant, antibacterial, chemopreventive, anti-inflammatory, anti-allergic, anti-hyperglycemic, anti-cancer, and cardioprotective properties. Radioprotective properties can also be found in the plant.

The phenolic compounds found in jambolan include phenolic acids, flavonoids, and tannins. These substances are separated into distinct categories according to the phenolic hydroxyl groups and structural components that connect benzene rings. Phenolic acids are a class of chemicals that include, but are not limited to, caffeic acid, coumaric acid, gallic acid, ellagic acid, and many others. Flavonoids, on the other hand, have a distinct structural arrangement known as C6-C3-C6. This configuration consists of two aromatic rings joined by a heterocyclic ring. These include anthocyanins, flavonols, flavanols, flavones, flavanones, and isoflavones. Flavones and flavanones are also included. Tannins have molecular weights that are normally between 500 and 3000 and have a flavor that is either bitter or astringent. Tannins are soluble in water. Anthocyanins, which are a type of flavonoid, are of special interest to the food business due to the fact that they may have applications in coloring, enhancing flavor, and maintaining freshness. The Folin-Ciocalteu reagent or mass spectrometry are two common methods that are utilized in the process of determining the total phenolic content. Utilizing polar solvents in binary solvent systems is a frequent practice when doing high-performance liquid chromatography (HPLC), which is often done with reversed phase C18 columns. For the successful extraction of phenolic components, fresh samples are required before moving on to following preservation techniques such as freeze-drying. The method of phenolic chemical extraction can have a significant impact on the amount of the chemical that is extracted.

According to Veigas et al. (2007) and Aqil et al. (2012), extracts of jambolan pulp and seeds have the potential to yield a substantial amount of phenolic chemicals. The procedures, on the other hand, might be very strenuous and time-consuming. It should be noted that the phenolic content of jambolan fruit peel has been the subject of research; nevertheless, this area of study is still not as well developed as that of pomegranate juice. The processing of jambolan juice can have an effect on the concentration of anthocyanins and other beneficial components, with temperature playing a key influence in the degradation of anthocyanins. Other components of jambolan juice can also be affected. The phenolic compounds found in jambolan display an unusual pattern of distribution; different plant portions contain varying quantities of these bioactive components, and this pattern is consistent throughout the plant.

**Conclusion**

The jambolan plant contains flavonoids, which are a type of naturally occurring chemicals, in virtually every section of the plant. A wide variety of flavonols and flavanonols may be found in the extracts of jambolan fruit, which include both the pulp and the peel. To cite just a few examples, myricetin 3-O-pentoside, myricetin 3-O-hexoside, and myricetin all fall within this category.

**Acknowledgments:** We thank all the resources helped us to learn and write the chapter on bioactive compounds in jamun

**Declaration of Conflict of Interest**

The authors declare that they have no conflict of interest.

**References**

Afify, A.E.M.M., Fayed, S.A., Shalaby, E.A. & El-Shemy, H.A. (2011). Syzygium cumini (pomposia) active principles exhibit potent anticancer and antioxidant activities. African Journal of Pharmacy and Pharmacology, 5, 948–956.

Ali, T.M., Abbasi, K.S., Ali, A. & Hussain, A. (2015). Some compositional and biochemical attributes of jaman fruit (*Syzygium cumini* L.) from Potowar region of Pakistan. Research in Pharmacy, 3, 1–09.

Aqil, F., Gupta, A., Munagala, R. et al. (2012). Antioxidant and antiproliferative activities of anthocyanin/ellagitannin-enriched extracts from Syzygium cumini L. (Jamun, the Indian Blackberry). Nutrition and Cancer, 64, 428–438.

Aqil, F., Jeyabalan, J., Munagala, R., Singh, I.P. & Gupta, R.C. (2016). Prevention of hormonal breast cancer by dietary jamun. Molecular Nutrition & Food Research, 60, 1470–1481.

Aqil, F., Munagala, R., Jeyabalan, J., Joshi, T., Gupta, R.C. & Singh, I.P. (2014). The Indian Blackberry (Jamun), Antioxidant Capacity, and Cancer Protection. In Cancer (pp. 101–113).

Arun, R., Prakash, M.V.D., Abraham, S.K. & Premkumar, K. (2011). Role of *Syzygium cumini* seed extract in the chemoprevention of in vivo genomic damage and oxidative stress. Journal of Ethnopharmacology, 134, 329–333.

Ayyanar, M. & Subash-Babu, P. (2012). *Syzygium cumini* (L.) Skeels: A review of its phytochemical constituents and traditional uses. Asian Pacific Journal of Tropical Biomedicine, 2, 240–246.

Bajpai, M., Pande, A., Tewari, S.K. & Prakash, D. (2005). Phenolic contents and antioxidant activity of some food and medicinal plants. International Journal of Food Sciences and Nutrition, 56, 287–291.

Baliga, M.S., Bhat, H.P., Baliga, B.R.V., Wilson, R. & Palatty, P.L. (2011). Phytochemistry, traditional uses and pharmacology of *Eugenia jambolana* Lam. (black plum): a review. Food Research International, 44, 1776–1789.

Banerjee, A., Dasgupta, N. & De, B. (2005). In vitro study of antioxidant activity of *Syzygium cumini* fruit. Food Chemistry, 90, 727–733.

Barh, D. & Viswanathan, G. (2008). *Syzygium cumini* inhibits growth and induces apoptosis in cervical cancer cell lines: a primary study. Ecancermedicalscience, 2, 83.

Benherlal, P.S. & Arumughan, C. (2007). Chemical composition and in vitro antioxidant studies on *Syzygium cumini* fruit. Journal of the Science of Food and Agriculture, 87, 2560–2569.

Bhowmik, D., Gopinath, H., Kumar, B.P. & Kumar, K. (2013). Traditional and medicinal uses of Indian black berry. Journal of Pharmacognosy and Phytochemistry, 1, 36–41.

Branco, I.G., Moraes, I.C.F., Argandona, E.J.S. ~ et al. (2016). Influence of pasteurization on antioxidant and in vitro anti-proliferative effects of jambolan (*Syzygium cumini* (L.) Skeels) fruit pulp. Industrial Crops and Products, 89, 225–230.

Brand~ao, T.S.D.O., Sena, A.R.D., Teshima, E., David, J.M. & Assis, S.A. (2011). Changes in enzymes, phenolic compounds, tannins, and vitamin C in various stages of jambolan (*Syzygium cumini* Lamark) development. Food Science and Technology (Campinas), 31, 849–855.

Brito, E.S., De Araujo, M.C.P., Alves, R.E., Carkeet, C., Clevidence, B.A. & Novotny, J.A. (2007). Anthocyanins present in selected tropical fruits: acerola, jambol~ao, jussara, and guajiru. Journal of Agricultural and Food Chemistry, 55, 9389–9394

Chandrasekaran, M. & Venkatesalu, V. (2004). Antibacterial and antifungal activity of Syzygium jambolanum seeds. Journal of Ethnopharmacology, 91, 105–108.

Chaturvedi, A., Bhawani, G., Agarwal, P.K., Goel, S., Singh, A. & Goel, R.K. (2009). Ulcer healing properties of ethanolic extract of Eugenia jambolana seed in diabetic rats: study on gastric mucosal defensive factors. Indian Journal of Physiology and Pharmacology, 53, 16–24.

Chaturvedi, A., Kumar, M.M., Bhawani, G., Chaturvedi, H., Kumar, M. & Goel, R.K. (2007). Effect of ethanolic extract of Eugenia jambolana seeds on gastric ulceration and secretion in rats. Indian Journal of Physiology and Pharmacology, 51, 131.

Choi, E.J. & Ahn, W.S. (2008). Kaempferol induced the apoptosis via cell cycle arrest in human breast cancer MDA-MB-453 cells. Nutrition Research and Practice, 2, 322–325.

Coelho, E.M., Azev^edo, L.C., Corr^ea, L.C., Bordignon-Luiz, M.T. & Lima, M.D.S. (2016). Phenolic profile, organic acids and antioxidant activity of Frozen Pulp and Juice of the Jambolan (Syzygium cumini). Journal of Food Biochemistry, 40, 211–219.

Das, S. & Sarma, G. (2009). Study of the hepatoprotective activity of the ethanolic extract of the pulp of Eugenia jambolana (jamun) in albino rats. Journal of Clinical and Diagnostic Research, 3, 1466– 1474.

do Carmo Brito, B.D.N., da Silva Pena, R., Santos Lopes, A. & Campos Chiste, R. (2017). Anthocyanins of Jambol~ao (Syzygium cumini): extraction and pH-Dependent Color Changes. Journal of Food Science, 82, 2286–2290.

Eshwarappa, R.S.B., Iyer, R.S., Subbaramaiah, S.R., Richard, S.A. & Dhananjaya, B.L. (2014). Antioxidant activity of Syzygium cumini leaf gall extracts. BioImpacts: BI, 4, 101.

Faria, A.F., Marques, M.C. & Mercadante, A.Z. (2011). Identification of bioactive compounds from jambol~ao (Syzygium cumini) and antioxidant capacity evaluation in different pH conditions. Food Chemistry, 126, 1571–1578.

Fracassetti, D., Costa, C., Moulay, L. & Tomas-Barberan, F.A. (2013). Ellagic acid derivatives, ellagitannins, proanthocyanidins and other phenolics, vitamin C and antioxidant capacity of two powder products from camu-camu fruit (Myrciaria dubia). Food Chemistry, 139, 578–588.

Frauches, N.S., do Amaral, T.O., Largueza, C.B.D. & Teodoro, A.J. (2016). Brazilian myrtaceae fruits: a review of anticancer proprieties. British Journal of Pharmaceutical Research, 12, 1–15.

Ghosh, D., Banerjee, R. & Salimath, B.P. (2017). Suppression of VEGF-induced angiogenesis and tumor growth by Eugenia jambolana, Musa paradisiaca, and Coccinia indica extracts. Pharmaceutical Biology, 55, 1489–1499.

Gordon, A., Jungfer, E., da Silva, B.A., Maia, J.G.S. & Marx, F. (2011). Phenolic constituents and antioxidant capacity of four underutilized fruits from the Amazon region. Journal of Agricultural and Food Chemistry, 59, 7688–7699.

Goyal, P.K., Verma, P., Sharma, P., Parmar, J. & Agarwal, A.(2010). Evaluation of anti-cancer and anti-oxidative potential of *Syzygium cumini* against benzo [a] pyrene (BaP) induced gastric carcinogenesis in mice. Asian Pacific Journal of Cancer Prevention, 11, 753–758.

Grover, J.K., Vats, V. & Rathi, S.S. (2000). Anti-hyperglycemic effect of Eugenia jambolana and Tinospora cordifolia in experimental diabetes and their effects on key metabolic enzymes involved in carbohydrate metabolism. Journal of Ethnopharmacology, 73, 461–470.

Helmst€adter, A. (2008). Syzygium cumini (L.) SKEELS (Myrtaceae) against diabetes–125 years of research. Die Pharmazie-An International Journal of Pharmaceutical Sciences, 63, 91–101.

Ignat, I., Volf, I. & Popa, V.I. (2011). A critical review of methods for characterisation of polyphenolic compounds in fruits and vegetables. Food Chemistry, 126, 1821–1835.

Jagetia, G.C., Baliga, M.S. & Venkatesh, P. (2005). Influence of seed extract of Syzygium cumini (jamun) on mice exposed to different doses of c-radiation. Journal of Radiation Research, 46, 59 –65.

Jagetia, G.C., Shetty, P.C. & Vidyasagar, M.S. (2008). Treatment of mice with leaf extract of jamun (*Syzygium cumini* linn. Skeels) protects against the radiation-induced damage in the intestinal mucosa of mice exposed to different doses of c-radiation. Pharmacology, 1, 169–195.

Jain, A., Sharma, S., Goyal, M. et al. (2010). Anti-inflammatory activity of *Syzygium cumini* leaves. International Journal of Phytomedicine, 2, 124–126.

Kumar, A., Ilavarasan, R., Jayachandran, T. et al. (2008). Antiinflammatory activity of Syzygium cumini seed. African Journal of Biotechnology, 7, 941–943.

Kusumoto, I.T., Nakabayashi, T., Kida, H. et al. (1995). Screening of various plant extracts used in ayurvedic medicine for inhibitory effects on human immunodeficiency virus type 1 (HIV-1) protease. Phytotherapy Research, 9, 180–184.

Lestario, L.N., Howard, L.R., Brownmiller, C., Stebbins, N.B., Liyanage, R. & Lay, J.O. (2017). Changes in polyphenolics during maturation of Java plum (Syzygium cumini Lam.). Food Research International, 100, 385–391.

Li, L., Adams, L.S., Chen, S., Killian, C., Ahmed, A. & Seeram, N.P. (2009). Eugenia jambolana Lam. berry extract inhibits growth and induces apoptosis of human breast cancer but not non-tumorigenic breast cells. Journal of Agricultural and Food Chemistry, 57, 826–831.

Maria do Socorro, M.R., Alves, R.E., de Brito, E.S., Perez-Jimenez, J., Saura-Calixto, F. & Mancini-Filho, J. (2010). Bioactive compounds and antioxidant capacities of 18 non-traditional tropical fruits from Brazil. Food Chemistry, 121, 996–1002.

Mastan, S.K., Chaitanya, G., Latha, T.B., Srikanth, A., Sumalatha, G. & Kumar, K.E. (2009). Cardioprotective effect of methanolic extract of Syzygium cumini seeds on isoproterenol-induced myocardial infarction in rats. Der Pharmacia Lettre, 1, 143–149.

Miyazawa, T., Nakagawa, K., Kudo, M., Muraishi, K. & Someya, K. (1999). Direct intestinal absorption of red fruit anthocyanins, cyanidin-3-glucoside and cyanidin-3, 5-diglucoside, into rats and humans. Journal of Agricultural and Food Chemistry, 47, 1083– 1091.

Mohamed, A.A., Ali, S.I. & El-Baz, F.K. (2013). Antioxidant and antibacterial activities of crude extracts and essential oils of *Syzygium cumini* leaves. PLoS ONE, 8, 1–8.

Mukherjee, P.K., Saha, K., Murugesan, T., Mandal, S.C., Pal, M. & Saha, B.P. (1998). Screening of anti-diarrhoeal profile of some plant extracts of a specific region of West Bengal, India. Journal of Ethnopharmacology, 60, 85–89.

Muruganandan, S., Srinivasan, K., Chandra, S., Tandan, S.K., Lal, J. & Raviprakash, V. (2001). Anti-inflammatory activity of *Syzygium cumini* bark. Fitoterapia, 72, 369–375.

Oliveira, E.R., Caliari, M., Soares J unior, M.S., Boas, V. & de Bar- ros, E.V. (2016). Bioactive composition and sensory evaluation of blended jambolan (Syzygium cumini) and sugarcane alcoholic fermented beverages. Journal of the Institute of Brewing, 122, 719–728.

Parmar, J., Sharma, P., Verma, P. & Goyal, P.K. (2010). Chemopreventive action of Syzygium cumini on DMBA-induced skin papillomagenesis

Raffaelli, F., Borroni, F., Alidori, A. et al. (2015). Effects of in vitro supplementation with Syzygium cumini (L.) on platelets from subjects affected by diabetes mellitus. Platelets, 26, 720–725.

Ramirez, R.O. & Roa, C.C. Jr. (2003). The gastroprotective effect of tannins extracted from duhat (Syzygium cumini Skeels) bark on HCl/ethanol induced gastric mucosal injury in Sprague-Dawley rats. Clinical Hemorheology and Microcirculation, 29, 253–261.

Ravi, K., Rajasekaran, S. & Subramanian, S. (2005). Antihyperlipidemic effect of Eugenia jambolana seed kernel on streptozotocin-induced diabetes in rats. Food and Chemical Toxicology, 43, 1433–1439.

Ravi, K., Sivagnanam, K. & Subramanian, S. (2004). Anti-diabetic activity of Eugenia jambolana seed kernels on streptozotocininduced diabetic rats. Journal of Medicinal Food, 7, 187–191.

Reginold, J.S. & Jeyanth, A.S. (2016). Antioxidant activity, total phenol, flavonoid, and anthocyanin contents of jamun (Syzygium cumini) pulp powder. Asian Journal of Pharmaceutical and Clinical Research, 9, 361–363.

Reynertson, K.A., Yang, H., Jiang, B., Basile, M.J. & Kennelly, E.J. (2008). Quantitative analysis of antiradical phenolic constituents from fourteen edible Myrtaceae fruits. Food Chemistry, 109, 883–890.

Ribeiro, R.M., Pinheiro Neto, V.F., Ribeiro, K.S. et al. (2014). Antihypertensive effect of Syzygium cumini in spontaneously hypertensive rats. Evidence-Based Complementary and Alternative Medicine, 2014, 1–7.

Seraglio, S.K.T., Schulz, M., Nehring, P. et al. (2018). Nutritional and bioactive potential of Myrtaceae fruits during ripening. Food Chemistry, 239, 649–656.

 Sharma, B., Viswanath, G., Salunke, R. & Roy, P. (2008). Effects of flavonoid-rich extract from seeds of Eugenia jambolana (L.) on carbohydrate and lipid metabolism in diabetic mice. Food Chemistry, 110, 697–705.

Sharma, M., Li, L., Celver, J., Killian, C., Kovoor, A. & Seeram, N.P. (2009). Effects of fruit ellagitannin extracts, ellagic acid, and their colonic metabolite, urolithin A, on Wnt signaling. Journal of Agricultural and Food Chemistry, 58, 3965–3969.

Sharma, S.B., Nasir, A., Prabhu, K.M. & Murthy, P.S. (2006). Antihyperglycemic effect of the fruit-pulp of Eugenia jambolana in experimental diabetes mellitus. Journal of Ethnopharmacology, 104, 367–373.

 Sharma, S.B., Nasir, A., Prabhu, K.M., Murthy, P.S. & Dev, G. (2003). Hypoglycaemic and hypolipidemic effect of ethanolic extract of seeds of Eugenia jambolana in alloxan-induced diabetic rabbits. Journal of Ethnopharmacology, 85, 201–206.

Singh, J.P., Kaur, A., Shevkani, K. & Singh, N. (2015). Influence of jambolan (*Syzygium cumini*) and xanthan gum incorporation on the physicochemical, antioxidant and sensory properties of glutenfree eggless rice muffins. International Journal of Food Science & Technology, 50, 1190–1197.

Tavares, I.M.d.C., Lago-Vanzela, E.S., Rebello, L.P.G. et al. (2016). Comprehensive study of the phenolic composition of the edible parts of jambolan fruit (*Syzygium cumini* (L.) Skeels). Food Research International, 82, 1–13.

Tavares, I.M.d.C., Nogueira, T.Y.K., Mauro, M.A. et al. (2017). Dehydration of jambolan [*Syzygium cumini* (L.)] juice during foam mat drying: quantitative and qualitative changes of the phenolic compounds. Food Research International, 102, 32–42.

Treutter, D. (2010). Managing phenol contents in crop plants by phytochemical farming and breeding—visions and constraints. International Journal of Molecular Sciences, 11, 807–857.

 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 Chemistry, 105, 619– 627.

Villasenor, I.M. & Lamadrid, M.R.A. (2006). Comparative antihyperglycemic potentials of medicinal plants. Journal of Ethnopharmacology, 104, 129–131.

Zhang, L.L. & Lin, Y.M. (2009). Antioxidant tannins from *Syzygium cumini* fruit. African Journal of Biotechnology, 8, 2301–2309.