Bioactive Compounds in Jamun (*Syzygium Cumini* L.) Ensuring Plant Tolerance Towards Diseases

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Jambolan fruit exhibits a high concentration of bioactive phenolic compounds, which have the potential to exert beneficial effects on human health. The jambolan plant is known to possess many phenolic compounds, including phenolic acids, flavonoids (primarily anthocyanins, flavonols, flavanols, and flavanonols), and tannins, which are present in its diverse anatomical components. This resource is mostly employed for the cultivation of timber and the establishment of fruit orchards. The fruit has been attributed with a range of properties including anti-diabetic, anti-hyperlipidemic, anti-oxidant, anti-ulcer, hepatoprotective, anti-allergic, anti-arthritic, anti-microbial, anti-inflammatory, anti-fertility, anti-pyretic, anti-plaque, radioprotective, neuropsychopharmacological, nephroprotective, and anti-diarrheal effects. The jambolan fruit skin contains a high concentration of anthocyanins, specifically delphinidin, petunidin, and malvidin in glycosylated forms. On the other hand, the majority of the fruit pulp is composed of phenolic acids, including gallic acid and ellagic acid, as well as tannins. Moreover, it has been asserted that the jambolan fruit contains a plethora of other chemicals. Flavonoids such as quercetin, myricetin, and flavonol glycosides have been identified in the leaves of the jambolan tree, as well as in the skin and pulp of its fruit. Jambolan possesses phenolic compounds that have been associated with a wide range of health advantages, including inflammation, allergies, blood sugar regulation, cancer prevention, cardiovascular well-being, radiation treatment support, bacterial infections, chemotherapy efficacy, and more benefits. This chapter provides a comprehensive analysis of the pharmacological, nutritional, and physiological advantages associated with jamun, along with an examination of the diverse bioactive components present in this fruit. Jamun seeds contain both the alkaloid jambosine and the glycoside jambolin, which is also referred to as antimellin.

The fruit commonly known as jamun (Syzygium cumini) has garnered attention in recent years due to its high content of antioxidants and potential contributions to nutritional security. Jamun is rich in bioactive chemicals that have been associated with various health benefits.

Phytochemicals

Phytochemicals are a class of food additives that have demonstrated the capacity to confer health advantages, such as a less susceptibility to chronic ailments, but lacking inherent nutritional value. Phenolic compounds, a chemical family found in plants, have garnered the attention of researchers due to their possible antioxidant properties (Ignat et al., 2011; Singh et al., 2016). Certain types of these molecules, such as tannins, possess unfavorable characteristics, leading to the initial perception of these chemicals and other secondary metabolites in plants as antinutrients (Treutter, 2010). The prevailing notion has been conclusively debunked by the abundance of epidemiological studies that have established the significance of phenolic chemicals in conferring health advantages to individuals. The recent change in mindset has captured the attention of scientists in the field of food technology and allied disciplines, who are now focused on the characterization and quantification of phenolic chemicals present in various food sources. Jambolan (*Syzygium cumini* Skeels) is a prominent evergreen tree that is widely distributed in tropical and subtropical regions. It is alternatively referred to as jamun, jambul, black plum, or Indian blackberry.

Throughout decades, this substance has been employed in many alternative medicinal practices for its stomachic, diuretic, anti-diabetic, and diarrheic properties. Although there is a general agreement on the possible medicinal benefits of this herb, there is a notable absence of robust scientific data to support these claims jambolan possesses several pharmacological properties, including antioxidant, antibacterial, chemopreventive, anti-inflammatory, anti-allergic, anti-hyperglycemic, anti-cancer, cardioprotective, radioprotective, and radioprotective activities.

Phenolic compounds

Phenolic compounds,which are bioactive secondary phytochemicals, are predominantly synthesized in higher plants by either the shikimic acid or phenylpropanoid pathways. Phytochemicals are predominantly found in the external layers of plant tissues and in seeds, where they exhibit defensive properties. Phenolic acids encompass a group of chemical compounds, including caffeic acid and coumaric acid generated from hydroxycinnamic acid, as well as gallic acid and ellagic acid obtained from hydroxybenzoic acid. Flavonoids are a class of phenolic compounds characterized by a structural arrangement of C6-C3-C6, wherein two aromatic rings are interconnected by a heterocyclic ring composed of three carbon atoms. Several examples of these substances are flavonols, flavanols, flavones, flavanones, isoflavones, and anthocyanins. Tannins possess a taste characterized by bitterness and astringency, and have molecular weights typically ranging from 500 to 3000, rendering them phenolic compounds that are soluble in water. Phenolic compounds find application in the food business for their preservation properties, ability to enhance flavors, and serve as colorants, with a particular emphasis on anthocyanins, which belong to the flavonoid family. Various methods exist for the detection of total phenolic content, with the Folin-Ciocalteu reagent being the most used. This method entails the reduction of phosphomolybdic or phosphotungstic acid in an alkaline solution, resulting in the formation of a complex that exhibits a distinct blue coloration. Furthermore, the utilization of mass spectrometry enables the confirmation of the existence of phenolic chemicals. In the context of high-performance liquid chromatography (HPLC) analysis, it is common practice to only utilize reversed phase C18 columns. Binary solvent systems commonly employ polar solvents in the majority of instances. It is necessary to obtain fresh samples in order to extract phenolic compounds from fruits such as jambolan. Nevertheless, due to the inherent perishability of these fruits, freeze drying or other preservation processes are commonly necessary. The quantity of phenolic chemicals present in an extract may exhibit significant variability, contingent upon the specific methodology employed during its preparation. Numerous techniques outlined in the existing body of research are characterized by a significant investment of time and complexity in terms of reproducibility (Aqil et al., 2014). On the other hand, hydrolyzable tannins and flavonols were shown to be more susceptible to oxidation and longer heating durations. The researchers discovered that the advantageous constituents, such as anthocyanins, present in jambolan juice had a notable degradation when subjected to processing temperatures exceeding 70 °C.

Flavonoids

Faria et al. (2011) discovered that jambolan fruit extracts, including both the pulp and peel, exhibited a diverse range of flavonols and flavanonols. The compounds identified in the study encompassed myricetin, myricetin pentoside, myricetin rhamnoside, myricetin glucoside, and myricetin acetylrhamnoside. Tavares et al. (2016) identified and quantified various flavanols in jambolan fruit pulp. These flavanols include myricetin 3-O-glucoside, syringetin 3-O-galactoside, myricetin 3-O-pentose, myricetin 3-O-rhamnose, syringetin 3-O-glucoside, myricetin 3-O-glucuronide, laricitrin 3-O-glucoside, laricitrin 3-O-galactoside, and myricetin 3-O-galactoside. The respective quantities of these flavanols were determined to be 30.31, 17.74, 11.55, 10.64, 8.92, 7.53, 5.82, 5.00, and 2.50 mg kg^-1 fresh weight (FW). In contrast, Tavares et al. (2016) identified several flavanols in the peel of jambolan fruit, including myricetin 3-O-glucoside, myricetin 3-O-rhamnose, myricetin 3-O-glucuronide, laricitrin 3-O-glucoside, myricetin 3-O-pentose, syringetin 3-O-glucoside, syringetin 3-O-galactoside, myricetin 3-O-galactoside, and laricitrin 3-O-galactoside. The respective concentrations of these flavanols were reported as 64.4, 11.92, 8.0, 5.04, 3.21, 2.13, 1.91, 1.76, and 1.62 mg kg-1 FW.

The extent or level of phenolic compounds which provides resistance against diseases:

The peel of the jambolan fruit exhibited a considerably higher total phenolic content (TPC) compared to the combined TPC of the pulp and seed. According to Bajpai et al. (2005), the jambolan seed crude extract contains ellagic acid (38 µg/g), gallic acid (646 µg/g), quercetin (98 µg/g), and kaempferol (59 µg/g). According to Aqil et al. (2012), the amounts of total phenolic compounds (TPC) in jambolan pulp and seed powder are 1.15 percent and 2.69 percent, respectively. In their study, Arun et al. (2011) documented the total phenolic compound (TPC) concentrations in various solvents. The TPC concentrations were found to be 16,833 mg GAE/100 g in water, 47,167 mg GAE/100 g in ethanol, 23,000 mg GAE/100 g in acetone, and 37,500 mg GAE/100 g in ethyl acetate. The study conducted by Mohamed et al. (2013) found that the methanolic and methylene chloride extracts of Jambolan leaf contained 1403 and 655 mg GAE/100 g DW of total phenolic compounds (TPC), respectively. According to Brandrao et al. (2011), the phenolic components in jambolan fruit were shown to be more abundant at the unripe stage, but their concentration dropped as the fruit underwent ripening.

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Declaration of Conflict of Interest

The authors declare that they have no conflict of interest.

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