



## Essential oil isolates of Indian black berry leaves: A review

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### Abstract

Essential oils are the concentrated fluids of complex blends of the volatile compounds. Essential oils are an excellent source of bioactive mixtures. Jamun is a quite common aromatic plant which is found all over the world. Jamun (*Syzygium cumini*) is well known for several bioactive properties. Essential oils from Jamun can be extracted by various methods but hydrodistillation is considered as one of the best techniques to obtain good yield. *Syzygium cumini* contains appreciable amounts of polyphenols, ellagic acid, and ellagitannins. In addition to its abundantly growly potential and diversity of anthocyanins, it also possesses cancer chemopreventive potential because of its bioactive constituents. Jamun (Indian black berry) essential oil may be used as a natural preservative component in the food and some other industries like pharmaceutical and cosmetic industries because of its anti-oxidant properties. Indian black berry leaves comprise of diterpenes, terpenes, sesquiterpenes, isoquercitin, myricetin and kaempferol in varying concentrations. The phytochemicals like oxalic acid, maleic acid, gallic acid, cyanidin glycoside, flavonoids, and essential oils have been reported for anti-anaemic, anti-diarrhoeal, anti-pyretic, anti-bacterial, anti-neoplastic, anti-inflammatory, hypoglycemic, gastroprotective and hypolipidemic properties. Aqueous and methanolic extract of *Syzygium* species effectively inhibit the growth of various fungal microorganisms that involved in skin diseases.

**Key words:** Essential oil, Jamun, biological activities, anti-oxidants, steam distillation

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### 1. Introduction

Aromatic plants and their essential oils have long been used for the food safety and number of preservative applications [1-20]. Furthermore, they have got significant considerations in the health care facilities [21]. Many aromatic plants contain naturally occurring anti-microbials that have been used for inhibiting the growth and survival of several microorganisms. Various components of the plants identified from leaves, barks, fruits flowers, roots and stems with strong anti-microbial potentials [1-20]. Essential oils are hydrophobic mixtures of huge number of aromatic compounds (frequently hundreds of separate aroma compounds) [22]. There are various methods exists for the extraction of essential oils including mechanical expression, maceration, steam distillation, water distillation and steam distillation. Hydrodistillation is known as the most used technique for the extraction of essential oils as the specific characters of plant material are protected by this method. Essential oils extracted from plants is usually rich in oxygenated derivatives, complex mixture of terpenes and many other aromatic compounds [23]. The basic units of essential oils are carbon, oxygen and hydrogen. Their most common class is terpenes. Terpenes are composed of five

carbon atoms. Most part of the essential oils is not soluble in water. Essential oil have characteristic odor and are highly flammable [24]. Many species and herbs containing essential oils are usually added to food to provide the distinct flavor, fragrance and preservation from microbes. Essential oil composition depends on the part of the plant (such as leaves, wood, seeds or roots) which is used for the extraction of oil [25].

The *Syzygium cumini* (Jamun) fruit has been studied for digestive, hypoglycemic, liver stimulation and coolant properties. The leaves of Indian black berry have essential oils with a very pleasant odor. Essential oil of Indian black berry leaves comprise of diterpenes, terpenes, sesquiterpenes, isoquercitin, myricetin and kaempferol in varying concentrations. Its leaves are particularly useful in the treatment of diabetes, fever, constipation, gastropathy, dermopathy and strangury. However, it was not found effective in the treatment of type II diabetes. *Syzygium cumini* species found to possess strong anti-bacterial activity. Aqueous and methanolic extract of *Syzygium* species effectively inhibit the growth of various fungal microorganisms that involved in the skin diseases [26]. According to the traditional systems of the medicine, Jamun

can work as an excellent blood purifier. Jamun is a good general tonic to keep the body healthy. Jamun fruit powder has cooling effect. Jamun fruit is a small, sour, rough, sweet, acidic, and is used in the treatment of skin diseases due to anti-microbial activity. Jamun leaves are extensively used in traditional medicine for the treatment of diabetes, indigestion, dysentery, gastrointestinal problems, and weight loss. *Syzygium cumini* leaves oils have been widely studied for their chemical composition and other biological importance [27]. The various common names used for *Syzygium cumini* are Jambul, Indian Blackberry, Black Plum, Black Plum, Jamblang, Java Plum, and Jamun. The fruits of Jamun plant ripe one time in a year. The fruits are commonly used for fitness drinks, squashes, jellies, making jams and other drinks. Various parts of the Jamun plant have been reported for their anti-oxidant, neuropsychic, pharmacological, anti-HIV, anti-microbial, nitric oxide scavenging, anti-bacterial, anti-leishmanial, anti-fungal, free radical scavenging, anorexigenic, radioprotective and anti-ulcerogenic, anti-diarrheal, anti-fertility and gastroprotective activities [28].

Indian Java plum or black plum is an edible tropical fruit produced from the trees of *Syzygium cumini*. The fruits take the shape of square berries, with deep purple or bluish color having pink pulp. In Ayurveda medicine, fruit is used as an astringent, anti-scorbutic, stomachic, anti-diabetic, in enlargement of spleen, and in chronic diarrhea. The fruit concentrate of *Syzygium cumini* has long history and still very popular in herbal medicine because of huge market for the treatment of chronic diarrhea and various other enteric disorders [29]. The leaves of *Syzygium cumini* are used to prepare the several herbal medicines [30].

## 2. Chemical composition

Essential oils are the complex mixtures containing hundreds of different components at variable concentrations. The chemical composition of all aromatic plants significantly varies with the seasons [22]. These chemical mixtures are categorized by the presence of two or three major constituents at very high concentrations (usually above 20%), in the comparison to others constituents that are present in the trace quantities [31]. Hydrodistillation of *Syzygium cumini* leaves produces a pale essential oil with an average yield around 0.52%. Gas chromatography with flame ionization detection (GC-FID) and gas chromatography-mass spectrometry (GC-MS) analyses are used to characterize the volatile oil constituents [32-34]. A previous study recognized eleven important compounds constituting almost 99.98% of the total essential oil. The major components of essential oil were oxygenated monoterpenes and monoterpene hydrocarbons, whereas sesquiterpene hydrocarbons were present in trace amounts. (E)-bocimene (11.71%), (Z)- $\beta$ -ocimene (28.98%) and  $\alpha$ -pinene (31.85%), were the major constituents present in the

essential oil. The presence of isomers of ocimene and  $\alpha$ -pinene among the major essential-oil constituents has been observed in numerous studies [35]. The variability in the oil composition can be due to the genetic, environmental and physiological factors [36]. Chemical composition of the essential oils is affected by many factors, like geographic and climatic conditions, method of distilling the plant, day time of collection, harvest period, vegetative stages of the plant and existence of chemotypes [37].

## 3. Extraction techniques

### 3.1. Solvent extraction

Solvent extraction or liquid-liquid extraction is used for the extraction of essential oils for long time. This method is used to isolate the compounds based on their solubility ratios. In a previous study, solvent extraction of *Syzygium cumini* (Jamun) seed oil was done using petroleum ether as solvent. The seeds were found to contain 10% oil [38]. The dehydrated jamun fruit and seed samples were subjected to extraction through conventional solvent extraction using two different binary solvents methanol and ethanol and one aqueous phase to compare the extraction efficiency of conventional solvents. Phytochemical screening of the conventional extracts showed that ethanolic extract at 45 min was best among all the solvents [39]. In another study [40], 8g each of pulp and seed powder were extracted with 3 vol (w/v; 24 ml) of 75% aqueous ethanol containing 10 mM HCl. To increase the extraction efficiency, samples were sonicated for 15 min in a bath-type sonicator. The phytochemicals in both Jamun pulp and seed extract were found to contain effective anti-oxidants in different in vitro assays, including assays of free radical-scavenging (DPPH and ABTS), reducing power, and oxygen radical-absorbing capacity (ORAC), when compared with standard anti-oxidant compounds such as ascorbic acid and trolox. The obtained data also showed high anti-oxidant and anti-proliferative activities of Jamun. Authors [40] proposed Jamun berry as a viable candidate for chemoprevention of lung cancer. Solvent extraction is used to obtain higher quantities of essential oils from rose, jasmine and other expensive materials at a cheaper cost. However, in case of extraction of essential oil from Jamun plant, it was found to be a costly technique at commercial scale due to lower price of Jamun essential oil in the market.

### 3.2. Hydrodistillation

Hydrodistillation is a classical process that is used on the large-scale extraction (like industrial extraction) of essential oils. The raw plant material is fed into a distillation apparatus containing heated water. Essential oil is obtained when hot water vapors are condensed. Sometimes, obtained essential oil is redistilled, to produce purer product. Hydrodistillation is time consuming procedure that produces

low yields. Over the past few years, many different solvents and heating sources are being used to improve yield, quality and shorten extraction times. Hydrodistillation of the leaves of *Syzygium cumini* usually produces colorless or pale essential oil with an average yield around 0.50% [41-42]. Further scientific studies are needed on use of hydrodistillation for extraction of essential oil from Jamun [42].

### 3.3. Steam distillation

Steam distillation produce better quality essential oil as compared to the solvent extraction and hydrodistillation. In steam distillation plant material is not directly boiled in water as the case with hydrodistillation. The plant material is exposed to less harsh conditions during steam distillation. This results in lesser chances of decomposition and oxidation during extraction process through steam. In steam distillation, the plant material is put on a perforated grid over the steam inlet and steam is passed through the plant material. The steam is later condensed to obtain essential oil. Steam distillation is used to obtain large amount of essential oils from Jamun. A major drawback of steam distillation is the higher capital investments [43]. In another study, fresh *Syzygium cumini* leaves (250g) were finely powdered by using the electric mixer and subjected to steam distillation for about three hours. During this process, almost two liters of the distillate was collected and extracted with diethyl ether (3×100 mL) and dried by using the anhydrous sodium sulphate. Upon drying, the ether extract yielded 0.50g pale yellow leaf essential oil [44]. Future studies are required to check the effect of steam rates and extraction temperatures on extraction of essential oil from Jamun.

### 3.4. Vacuum distillation

Vacuum distillation is a process that is utilized to isolate essential oil components with variable boiling points. Vacuum distillation is becoming popular to isolate essential oil under vacuum to reduce/avoid chances of decomposition and oxidation. However, no studies on extraction of Jamun essential oil through vacuum distillation found in the previous literature.

## 4. Nanoparticles

Nanotechnology is the creation and utilization of materials with the components that exist at the nanoscale; and they are upto 100 nm in size. Nanoparticles are used in medical treatments to industrial applications. Silver and gold nanoparticles of blackberry found to possesses strong bioactivities and authors proposes that these particles with anti-oxidant coatings can be potentially used for the delivery of useful oxidants and cancer chemo-preventive agents [45].

## 5. Biological activities

### 5.1. Anti-oxidant effect

An anti-oxidant, is a substance that delays or prevents oxidation even at low concentrations [46]. The use of natural anti-oxidants, such as ascorbic acid, phenolic compounds including flavonoids, tocopherols and volatile compounds for preventing the oxidation of biomolecules which can cause cell injury and death as well [47]. Anti-oxidants are important as they play an important role in biological systems by destroying the formation of reactive oxygen species by reducing the hydroperoxides (ROO•) and H<sub>2</sub>O<sub>2</sub> and scavenging free radicals [48]. Many studies have shown conclusively that the major percentage of the anti-oxidant activity is due to the compounds like flavonoids, isoflavones, flavones and anthocyanins rather than the conventionally considered vitamins C, E and carotene. There is a direct relationship between polyphenolic content of Jamun extracts and its anti-oxidant activities. The seeds of *Syzygium cumini* are rich in flavonoids and phenolics having high anti-oxidant activity, significant scavenging potential of free radicals and a defensive impact on anti-oxidant enzymes [49].

### 5.2. Anti-bacterial activity

Essential oils of *Syzygium cumini* leaves reported to possess strong anti-bacterial activity. The phenolic plant extract of *Syzygium cumini* can be used as an effective anti-bacterial agent. In a previous study, hydroalcoholic extract of the *Syzygium cumini* leaves show anti-bacterial activity due to the presence of tannins and other phenolic constituents. *Syzygium cumini* is known to be extraordinarily rich in gallic acid, ellagic acid, polyphenol derivatives, acylated flavanol glycosides, kaempferol, myricetin, and other polyphenols. The previous results, suggest the use of *Syzygium cumini* for the treatment of skin wounds and further skin problems [50]. In another study, petroleum ether and ethanolic extracts of *Syzygium cumini* exhibited prominent anti-bacterial activity against the drug resistant strains of *E. coli* and *S. aureus* [51]. Anti-microbial properties of the essential oil of *Syzygium cumini* is due to the reason that essential oils may disturb the permeability of cellular membranes [52].

### 5.3. Antineoplastic effect

In the cancer treatment, chemotherapy has been important for more than five decades [53]. The studies suggest that 47% anti-neoplastic drugs used are from the natural sources. In vitro studies show cytotoxic effects present in whole Jamun essential oils. This effect was studied on human cancer cells, SiHa HPV-16 positive and the HeLa HPV-18 positive [54]. The methanol, ethyl acetate, and ethanolic extracts of *Syzygium cumini* seeds were found prominently effective against MCF-7 breast cancer cells [55].

#### 5.4. Jamun extracts inhibit oxidative DNA damage

Jamun polyphenolics work as a potential anti-oxidants by different mechanisms, including scavenging of reactive nitrogen species, direct scavenging of free radicals, and scavenging of reactive oxygen species that include hydroxyl and peroxy radicals. The potentials of Jamun (pulp) aqueous and organic extracts were evaluated for their efficacy to inhibit 4-OHE<sub>2</sub>/Cu<sub>2</sub><sup>+</sup> made oxidative DNA adducts generated in this system. Although, the data for the interaction of anthocyanins and anthocyanidins is small in regard to direct interaction with DNA, by covalent binding one of the Jamun's active constituents, ellagic acid has been shown to defend DNA from oxidative destruction [56].

#### 5.5. Molluscocidal and leishmanicidal activity of the leaf essential oil

*Syzygium cumini* essential displayed promising activity as a molluscocidal and leishmanicidal agent and could be valuable in fighting tropical diseases such as schistosomiasis and leishmaniasis [57].

### 6. Applications

In various traditional systems of medication, Jamun is considered as an important medicinal plant. It is extremely useful and effective in the treatment of many diseases like diabetes mellitus, inflammation, diarrhea, and ulcers. The previous studies have shown that Jamun possess chemopreventive, anti-neoplastic and radioprotective properties. For sherbet syrup and "squash" Jambolan juice is excellent. In India, there is a drink prepared by cooking the fruit for 5 to 10 minutes at the temperature 140°F after making the juice, mixing it with sugar and water and adding citric acid and sodium benzoate as a preservative [58]. Customarily the Jambul organic products, leaves, seeds, and bark are altogether utilized in ayurvedic medication. *Syzygium cumini* is a common traditional medicinal plant, whose parts have been pharmacologically proven to possess anti-bacterial, hypoglycemic, and anti-HIV activities [59]. The leaves, soaked in alcohol, are given in diabetes. The leaf juice is effective in the treatment of dysentery. In skin diseases, Jamun leaves may be helpful as poultices. The phytochemicals like oxalic acid, maleic acid, gallic acid, cyanidin glycoside, flavonoids, and essential oils have been reported for anti-anaemic, anti-diarrhoeal, anti-pyretic, anti-bacterial, anti-neoplastic, anti-inflammatory, hypoglycemic, gastroprotective and hypolipidemic properties. Numerous studies have recommended that the extracts from the different parts of *Syzygium cumini* have many interesting biological activities [57] such as anti-inflammatory [60], anti-ulcerogenic, anti-allergic [61], anti-bacterial [57], anti-oxidant [62] anti-plasmodic, and anti-tumor properties [27].

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