Review Article

A comprehensive review on Pharmacological and Ayurvedic aspect of *Phyllanthus emblica* (Amalki)

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Abstract

Phyllanthus emblica, also known as *Emblica officinalis*, is commonly called as Amla, Amalaki or Indian gooseberry. This plant is mainly known for its fruit. It is considered an essential ayurvedic plant in the Indian traditional medicinal system. Different parts of this plant are used to treat various ailments or diseases such as cough, cold, fever, stomachache, dyspepsia, diarrhoea, diabetes and others. It shows significant results against peptic ulcers and acidity. It is used as a laxative, diuretic, refrigerant and liver tonic. The plant is a rich source of Vitamin C, amino acids, phenolic compounds, tannins, steroids, flavonoids, alkaloids and other chemical constituents. These chemical constituents of the *P. emblica* plant are associated with diverse pharmacological properties such as antioxidant, antimicrobial, anti-inflammatory, radio-active, hepatoprotective, immunomodulatory, neuroprotective, antidiabetic, antitussive and other properties. In Ayurveda, this plant's fruit is considered a powerful Rasayana, which is used to treat jaundice, diarrhoea, inflammation, etc. The current review article summarizes the traditional and modern uses of the *P. emblica* plant.

Keywords: Amlaki, Ayurveda, Folk uses, Rasapanchak, Pharmaceutical properties.

Introduction

Phyllanthus emblica (syn. *Emblica officinalis*) is commonly known as Amalaki, Amla or Indian gooseberry belongs to the family *Euphorbiaceae* (Khan, 2009). As per Indian mythology, it is the first tree created in the universe. The plant is well known for its highly nutritious fruit and is a source of Vitamin C, amino acids, and phenolic compounds (Srivasuki, 2012). *P. emblica* (Figure 1) is a euphorbiaceous plant mainly found in the tropical and subtropical regions of Indonesia, India, China, Thailand and Malaysia (Khurshid et al., 2020). In Ayurveda, Amla is used in various ayurvedic formulations such as Triphala churna, which is associated with anti-aging, improves mental disorders (Sripanidkulchai and Fangkrathok, 2014) and Chyawanprash, which is generally used as a tonic (Jagetia, 2002). *P. emblica* fruit carries excellent medicinal value and is one of the top-selling fruit in the market, which carries diverse

Figure 1. *Phyllanthus emblica*

food, healthcare, and cosmetic industry applications. It is also used in various preparations such as jellies, pickles and preserves and is used as an expectorant, purgative diuretic, laxative and liver tonic (Manjunatha et al., 2001). The leaves of the plant are used as an aphrodisiac agent and considered a rejuvenating herb used to treat cough and skin disorders (Priya and Islam, 2019). The plant's fruit is used as a powerful Rasayana in Ayurveda to treat diarrhoea,

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Table 1. Vernacular names

Marathi	Amla	Indian
Gujrati	Ambala	
Malayalam	Nelli kayi	
English	Emblic myrobalan, gooseberry	
Kashmiri	Aomla	
French	Phyyanthe emblica	
Chinese	Anmole	
German	Amla	
Italian	Mirobolena emblico	
Malaysian	Popok, Melaka	
Punjabi	Anula, Amla	
Orissa	Anala, Ainla	
Hindi	Amla	
Sanskrit	Amalaki	
Bengali	Amlaki	
Nepali	Amala	
Kannada	Nellikaai	

Table 2 Taxonomical Classification

Taxonomical rank	Taxon
Kingdom	Plantae
Subkingdom	Tracheobionta
Superdivision	Spermatophyta
Division	Angiospermae
Class	Dicotyledonae
Subclass	Rosidae
Order	Geraniales
Family	<i>Euphorbiaceae</i>
Genus	<i>Phyllanthus</i>
Species	<i>emblica</i>
Common name	Amla

inflammation, jaundice, dysentery and other diseases (Shanmugasundaram, 1983). The fruit of this plant is diuretic and is mainly consumed in the form of pickle in India (Unander et al., 1990). Table 1 and 2 represents the vernacular name and taxonomical classification of *P. emblica* plant.

Botanical Description

Phyllanthus emblica is a deciduous tree of small to medium-sized that belongs to the family *Euphorbiaceae*. The height of this plant reaches up to 8-18 m with spreading branches and a crooked trunk. The branchlets are usually 10-20 cm long, finely pubescent, glabrous and deciduous. The average diameter of the stem is 70 cm (Kulkarni and Ghurghure, 2018). The bark is thick, light grey, which exfoliates thin small irregular flakes, exposing the fresh surface underneath older bark. Leaves are pinnate,

narrowly linear, obtuse, simple, alternate, sub sessile, 10-13mm long, and 3 mm wide and form feathery like appearance. Sometimes, the main trunk is further divided into 2-7 scaffolds near the base (Yahia, 2019). Flowers are pale greenish, unisexual, 4 to 5 mm long, borne in leaf axils and form a cluster of about 6 to 10 (Kulkarni and Ghurghure, 2018). Fruits are depressed to globose shaped, fleshy with a diameter 2.1-2.4 cm in diameter, 4.5-5.0 mL in volume and 5.3-5.7 g in weight. The fruit stone is six ribbed, splitting into three segments, each containing two seeds. The seeds are 2-3 mm in width and 4-5 mm in length with a weight of 572 to 590 mg (Scartezzini and Speroni, 2000).

Geographical Distribution

P. emblica is a native species of India and is mainly found in the tropical and subtropical regions of the country. The plant is distributed primarily in Malaysia, Bangladesh, Bhutan, Sri Lanka, Myanmar, Pakistan, China, Uzbekistan and Mascarene Island (Thilaga et al., 2013). In India, it is mainly found in the tropical, subtropical coastal districts and primarily cultivated in the hilly and plain areas of Kashmir valley (Rai et al., 2012).

Phytochemical Constituents

The different chemical constituents present in the *P. emblica* plant are alkaloids, tannins, phenolic acid, flavonoids such as quercetin, kaempferol, carbohydrates (pectin), amino acids, Vitamin C, citric acid, ebellicanin-A and B, pectin, ascorbic acid and triallyl glucose (16). The fruits of the plant constitute 28% of tannins. It consists of two hydrolyzable tannins Emblicanin A and B. In addition, different parts of *P. emblica* such as fruit, seeds, leaves, root, stem contain various phytochemical constituents (Bhattacharya et al., 2002). Figure 2 represents the chemical structures of phytochemical constituents of *P. emblica* plant.

Fruits: It contain proteins (0.5%), fats (0.1%), fibers (3.4%), gum (13.75%), albumin (13.08%), crude cellulose (17.08%), mineral matter (4.12%) moisture (81.2%), nicotinic acid (0.2 mg/100g), phyllembelin (Talreja et al., 2019), gallic acid, methyl gallate, citric acid, ellagic acid, quercetin, carbohydrate (14.1%), Vitamin C (6mg/g) ellagitannin (chebulinic acid), (14.1%), corilagin, geraniin (dehydroellagitannin), 3,6-di-O-galloyl-D-glucose, corilagin, 1,6-di-O-galloyl beta-D-glucose, isostrictinin and 3-ethylgallic acid (El-Desouky et al., 2008; Dasaroju and Gottumukkala, 2014).

Seeds: It contains fatty acids, essential oil, phosphatides and fixed oil (16%). The fatty acids include linoleic acid (44.0%), linolenic (8.8%), stearic acid (2.15%), myristic

Figure 2. The chemical structures of some major phytochemical constituents of *Phyllanthus emblica*.

acid and palmitic acid (3.0%) (Khan, 2009).

Leaves: The leaves are a rich source of tannins. It contains ellagic acid, gallic acid, chebulagic acids, chebulic, chebulinic acids, malic acid (gallotannin), phyllantine, phyllembin and alkaloids phyllantidine.

Bark: It contains proanthocyanidin and leukodelphinidin.

Roots: Ellagic acid and lupeol are present in roots.

Traditional and Modern View

Ayurvedic View: *P. emblica* plant is used to balance the vitiated tridoshas of the human body, i.e. Vata, Kapha and Pitta. In Ayurveda medicinal system, the *P. emblica* plant is used as a rejuvenator (Rasayana). The plant is associated with expectorant, spasmolytic, hepatoprotective, purgative, hypolipidemic, and hypoglycemic properties (Mirunalini and Krishnaveni, 2010). The fruit of this plant is bitter, sour, astringent, anodyne and sweet and is associated with antipyretic, aphrodisiac, diuretic, laxative, rejuvenative, cooling and carminative properties. Amalaki is used to treat several diseases such as cephalalgia, bronchitis, dyspepsia, colic, flatulence, peptic ulcer, leprosy, anaemia, hepatopathy, diarrhoea, dysentery, menorrhagia, cardiac disorders, ophthalmopathy, intermittent fevers, inflammations, leucorrhoea, skin disorders, diabetes and

premature greying of hairs (Sanskaran et al., 2013). Also, the plant is associated with antioxidant, hepatoprotective, nephroprotective, cardioprotective, anti-inflammatory, antipyretic, analgesic and therapeutic properties (Mirunalini and Krishnaveni, 2010). The fruit powder combined with red sandalwood and honey is used to cure vomiting and nausea (Sankaranarayanan and Jolly, 1993). The rasapanchak (properties) of the plant is shown in table 3.

Actions and Properties

Doshakaram: It balances the vitiated tridoshas of the body, i.e. Vata, Pitta and Kapha.

Sansthanik-Karam: Amalaki in paste form helps to decrease the burning sensation, relieves pain and helps in urine obstruction. The decoction of this plant is beneficial for the eyes and hairs.

Abhyanga-naadisasthan: It is used as a nervine or brain tonic.

Paachansasthan: It acts as an appetizer, helps to cure constipation, diarrhoea, dysentery and stimulating liver functions.

Raktavahsansthan: It is used to treat cardiac disorders and helps in promoting haemoglobin.

Shwasansasthan: It helps in removing excessive phlegm out of the body.

Prajanansasthan: It helps in conceiving and maintains pregnancy. It is also used to strengthen the uterus, treat menorrhoea, leucorrhoea, spermaturia and is associated with the aphrodisiac property.

Table 3. The rasapanchak (properties) of *P. emblica* plant

Sanskrit/English	Sanskrit/English
Veerya/ Potency	Sheet / Cold
Vipak/ Metabolic property	Madhur / Sweet
Guna / Physical property	Guru / Heavy, Ruksha / dry, Sheet / Cold
Rasa / Taste	Panchrasa(sour, bitter, sweet, pungent, astringent), Amlapradhan / Sour

Mutravahsansthan: It is used to treat urine obstruction, dysuria, and diuretic and anti-diabetic property.

Twacha: It is used to cure skin disorders.

Taapkram: It reduces the overall burning sensation of the body, excessive thirst and possesses antipyretic property.

Satmikaran: It is used as a rejuvenator and helps in the treatment of generalized weakness.

Folk Uses

As per ethnobotanical beliefs, it is the first tree to be created in the universe. The fruit of this plant, when mixed with honey, is used as a vermifuge. It is also used as a pickle and preserves made from green fruits. The fruit paste of the plant alone or in combination with *Nelumbium speciosum* is used to cure bladder irritation and retain urine. The seeds infusion of the plant is used as a febrifuge and is used to cure diabetes (Grover et al., 2015). The fruit extract of the plant, when mixed with honey, is used to heal painful respiration and hiccups. The fruit decoction, when admixed with *T. chebula* and *T. belerica* is used to cure chronic dysentery, diarrhoea, bleeding and biliousness. In children, the leaves infusion combined with fenugreek seeds is used to treat chronic dysentery and as a bitter tonic. The dried fruit of this plant is used to cure jaundice, anaemia and dyspepsia. The fruits of this plant are used for the treatment of diarrhoea, ingestion, nausea, inflammation, skin sores and wounds (Kumar et al., 2012). The plant leaves are used to cure asthma, bronchitis, vomiting and acts as an antipyretic and aphrodisiac agent. This plant is also used for the treatment of cancer, scurvy and heart disorders (Dhale and Mogle, 2011). The dry fruit in combination with coconut oil helps in preventing hair from greying (Mirunalini and Krisnaveni, 2010).

Modern View

The consumption of herbal medicines has increased world widely. Reported studies have revealed an increased growth in the sale of herbal products from the year 2000 to 2008 ranges from 3% to 12% per year (Organizacion, 2003). Due to the increased demand for herbal products, the risk with the herbal medicines also rises as the quality of the end product compromises because of the contaminated raw material with toxic metals, microbes, and other residues, adulteration (addition of fake or inferior plant material, conventional drugs, foreign material) which results in the poor quality of raw material and end product. Internal issues like non-uniformity (rises due to environmental factor and geographical distribution, use of pesticides, fertilizers) and complexity in the ingredients of herbal medicines also rise, affecting the quality of herbal medicines. Lack of standardization techniques is also responsible for the poor quality of drugs. It fails to detect the original drug, which

exploits its usage in the conventional system of medicines (Yee et al., 2005). To fulfil the demand of traditional international markets, rapid and modern techniques are required to check the authentication of herbal drugs (Kumar et al., 2020).

Reported therapeutic and pharmacological properties

P. emblica is the most significant herbal plant which is used to treat a variety of diseases. The phytochemical constituents present in the plant are responsible for various pharmacological and therapeutic properties. Some of the reported studies on its therapeutic properties are discussed below.

Antioxidant

The aqueous extract of Amla possesses antioxidant activity when examined in a rat model. The extract inhibits the radiation, which induces lipid peroxidation and superoxide dismutase, damaging the rat liver microsomes and rat liver mitochondria (Khopde et al., 2001). In another study, the antioxidant potential of *P. emblica* was tested to increase the oxidation stability of jatropha biodiesel (JBD) and Pongamia biodiesel (PBD) synthesized by transesterification. The antioxidant potential was determined against DPPH radical and total phenolic content by the Folin-Ciocalteu method. The oxidation stability of neat JBD and PBD was 4.24 h and 3.71 h, respectively. After loading *P. emblica* at different weight proportions, it was observed that *P. emblica* enhances the OS of JBD and PBD up to 15.63 h to 14.26 h with 1000 ppm blending, respectively (Singh et al., 2019). The free radical scavenging activity of the ethanolic extract of the plant was observed as 68 ± 0.33 % compared to rutin (58 ± 1.15 %) at a dosage of 2.56 mg/ml (Bashir et al., 2018).

Antimicrobial

The antimicrobial activity of the alcoholic and aqueous extract of the plant was evaluated for the antimicrobial activity against different gram-positive and gram-negative bacteria such as *Staphylococcus aureus*, *E. coli* and *Candida albicans* the agar well diffusion method. The extract was found to exhibit growth inhibitory activity in a dose-dependent manner (Gandhi et al., 2020).

Antidiabetic

The methanolic extract of *P. emblica* fruit was examined for antidiabetic activity against streptozotocin-induced diabetic rats. The quercetin constituent present in the methanolic section showed significant antidiabetic activity when administered daily for 28 days. The extract reduces the blood glucose and urine sugar levels with a substantial increase in

plasma insulin and haemoglobin levels at a dosage of 25, 50 and 75 mg/kg body weight (Srinivasan et al., 2018). Another *in vivo* study was conducted in the rat model to determine the antidiabetic property of the plant extract. The administration of the plant extract significantly decreases the glucose level in diabetic rats up to 166 ± 0.7 mg/dl on day 8th at 8^h compared to diabetic rats 380 ± 0.7 mg/dl at a dosage of 80 mg/kg. It also reduces the weight in rats up to 274.11 ± 0.97 g (Bashir et al., 2018). Another study was conducted in alloxan-induced diabetic rats in which the aqueous extract of the plant was administered on type II diabetes, triglycerides and liver-specific enzyme. The extract at the dosage of 200 mg/kg body weight reduces the blood glucose level when administered intraperitoneal and induced hypotriglyceridemia by decreasing TG levels at 0, 1, 2 and 4 hours in diabetic rats (Qureshi et al., 2009).

Hepatoprotective

The amlaki extract of *P. emblica* showed hepatocarcinogenic activity. The oral administration of amla extract reduces the N-nitrosodiethylamine-induced liver tumours in the rat model. It showed effective results in preventing diethylnitrosamine-induced and 2-acetylaminofluorene-promoted hepatocarcinogenesis in rats. The methanolic fruit extract of the plant at the dosage of 100 and 200 mg per body weight showed recovery of pathological manifestations in rat liver. The quercetin constituent present in the amla plant decreased dimethylnitrosamine-induced fibrogenic effects and liver injury (Baliga et al., 2019). The *P. Emblica* plant is a rich source of various chemical components such as gallic acid, tannins, flavonoids, alkaloids, vitamin C, ellagic acid, etc. The plant extracts and their constituents were investigated for hepatoprotective activity. Different studies on the Amla plant showed hepatoprotective activity by inhibiting the effect on hepatic steatosis and liver fibrosis *in vitro*. Gallic acid was found to improve high-fat diet (HFD)-induced dyslipidemia, oxidative stress and hepatosteatosis *in vivo*. The water extract of the plant was observed to reduce the peritoneal fat, epididymal fat, body weight and improves steatosis through decreasing adiponectin in adipocytes and PPAR-alpha in the liver as well as lowering SREBP-1c in the liver of rats with a high-fat diet (Huang et al., 2017).

Nephroprotective

Yokozawa et al. (2007) examined the Nephroprotective activity of *E. officinalis* on renal dysfunction involved in oxidative stress during the ageing process. The plant extract was found to reduce the raised level of serum creatinine and urea nitrogen in aged rats when administered. In addition, a significant decrease in the tail arterial blood pressure, thiobarbituric acid-reactive substance levels of serum, mitochondria and the renal homogenate were also observed in aged rats (Yokozawa et al., 2007). In another study, the plant's ethanol extract was examined for the nephroprotective activity against rat model. The extract was found to decrease creatinine and urea levels in rats induced by ethylene glycol and ammonium

chloride at a dosage of 50, 100 and 150 mg/kg body weight (Girsang et al., 2019).

Anti-inflammatory

To evaluate the anti-inflammatory activity of the plant, the inflammation model was induced by lipopolysaccharide-induced RAW264.7 macrophages. The various solvent extracts such as ethyl acetate, petroleum ether of *P. emblica* was found to inhibit the secretion of NO and cytokines (TNF-alpha, IL-1beta, IL-6) in RAW264.7 macrophages (Wei et al., 2018). In another study, the ethanolic extract of the *P. emblica* leaves was examined for the anti-inflammatory activity against the carrageenan-induced mice model. The *in vivo* study was carried out in 25 mice models divided into five groups containing five mice in each group. Group 1 were not given amlaki leaves extract and piroxicam. The 2nd group was treated with 20 mg of piroxicam suspension. The ethanolic extract was given to the mice group of 3, 4 and 5 at a dosage of 100, 200 and 300 mg/kg body weight. The measurements were performed on the 5th day by collecting exudates using a syringe. Results showed that the oedema volume in the negative control group was 0.09 ± 0.02 ml and 0.05 ± 0.03 ml in positive control groups. The oedema volume was comparatively higher in groups 3, 4 and 5, i.e. 0.07 ± 0.01 ml, 0.06 ± 0.02 ml and 0.07 ± 0.01 ml, respectively which showed significant anti-inflammatory activity (Asmilia et al., 2020).

Antitussive

The *P. emblica* extract of the plant was investigated for the antitussive property in conscious cats by mechanical stimulation of the laryngopharyngeal and tracheobronchial mucous areas of airways. The oral administration of the extract at the dosage of 50 mg/kg body weight, cough suppressive effect of the section was not transparent. The results were effective at higher dosages, i.e. at 200 mg/kg body wt. and showed a remarkable decrease in cough (NE/min-1) frequency and several cough efforts (NE). The intensity of cough attacks in inspirium (IA+) and expirium (IA-) was more noticeable. The standard drug used for this study were codeine and dropipizine, where the extract showed less effective results than the classical narcotic antitussive drug codeine and found more effective than non-narcotic antitussive agent dropipizine (Urban, 2003).

Antihyperlipidemic

The fruit juice and gallic acid of *P. emblica* were investigated for hyperlipidemic activity in different experimental animal models. The administration of poloxamer-407, high fat diet and tyloxapol supplements induced hyperlipidemia in the rat model. The reduction in

plasma cholesterol and decreased rate of oil filtration in the liver and aorta was found after the treatment with gallic acid and fruit juice of *P. emblica* in the rat model. Furthermore, the plant extract enhanced the level of lipid oxidation through carnitine palmitoyltransferase (CPT) and increased peroxisome proliferator-activated receptors- α (PPAR α) expression with the decreased activity of hepatic lipogenic enzymes. In addition, the reduced rate of LDL-receptor degradation due to a reduction in proprotein convertase subtilisin/Kexin type 9 (PCSK9) and increased cholesterol uptake through increased LDL-receptor expressions on hepatocytes was also observed. Also, *P. emblica* restored glucose homeostasis through increased Glut4 and PPAR γ protein expression in adipose tissue. Thus it showed significant hyperlipidemic activity by the upregulation of PPARs, lipogenic enzymes and Glut4 and reduced expression of PCSK9 and lipogenic enzymes (Variya et al., 2018).

Antidiarrheal

To evaluate the antidiarrheal activity, three groups of mice containing five mice in each group were selected randomly, where diarrhoea was induced by giving castor oil. The first group was provided with distilled water containing 1% Tween-80 (10 ml/kg). A standard motility drug named LO (leperamide) at 3 mg/kg was administered orally to the second group. The third group was orally administered with the fruit extract of the plant at 500 mg/kg body weight of dosage. The methanol extract of *P. emblica* showed antidiarrheal activity by a significant reduction in GIT motility in the rat model at a dosage of 50, 100 and 150 mg/kg, respectively (Khurshid et al., 2020).

Gastro-protective

The gastro-protective potential of the ethanolic extract of *P. emblica* dried fruit was evaluated in patients with gastrointestinal disorders. Thirty patients were selected for the examination are divided into three groups (10 in each group). These three groups were treated with *P. emblica* ethanolic extract, lactose (placebo) and omeprazole for 14 days, respectively. The test group was given the ethanolic extract at a dose of 500 mg/day. The lactose capsules of 500 mg were given three times a day to the patients of the negative control group (placebo). Finally, the positive control groups were given with omeprazole at a recommended 40 mg/day dosage. Results showed that the ethanolic extract reduced vomiting, pain, sleep disturbances and healing of damaged mucosa (Iqbal et al., 2017).

Immunomodulatory

The aqueous extract of *P. emblica* and *Costus speciosus* was tested for the immunomodulatory activity in forty-two mature male albino rats of bodyweight 150-200 g divided into 6 groups (n=7). The group administered with the aqueous extract showed

increased immunomodulatory activity by raising the blood levels of CD4, CD8, CD19, CD16, IgM and IgG. Hence, increased the serum level of albumin and globulins at a dosage of 250 and 500 mg/kg (Bakr and Naga, 2020).

Conclusion

As per the literature study, this plant is used for medicinal purpose since ancient times. *P. emblica* is used by various traditional healers to treat several diseases. The most utilized part of this plant is its fruit, a rich source of Vitamin C and other phytochemical constituents such as phenolic compounds, flavonoids, tannins, and others. Traditionally, the plant parts are used to treat liver disorders, diabetes, cough, respiratory disorders such as asthma, bronchitis, and cancer treatment. In addition, the fruit of this plant is used in various ayurvedic formulations as a main ingredient such as Chyavanprash and other preparations lie khada (improves digestion), Panaka (pacifies pitta related disorders) and Raga Shadava (provide nourishment). The chemical constituents of the plant are associated with various biological and biopharmaceutical properties such as antidiabetic, hepatoprotective, nephroprotective, anti-inflammatory and others. However, further studies need to be done on the plant to evaluate the unexplored phytochemical constituents to find out its more pharmacological properties, leading to the development of new drugs.

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