

## ***Emblica officinalis* Geart.: A Comprehensive Review on Phytochemistry, Pharmacology and Ethnomedicinal Uses**

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### **ABSTRACT**

*Emblica officinalis* Geart. fruit is an important dietary source and its use as a medicinal plant has increased many fold over a period of time. A survey of the literature relating to the medicinal uses of *E. officinalis* fruit reveals it to be one of the widely used medicinal plants. It finds place in folklore medicine, Ayurveda, Unani and other indigenous systems of medicine. Following a large number of claims on the wide range of traditional medicinal properties of the plant, considerable efforts have been made to verify its efficacy as a curative agent through pharmacological investigations. In this study, a comprehensive account of the phytochemical investigation and therapeutic potential of *E. officinalis* fruit is presented.

**Key words:** *Emblica officinalis*, gallic acid, pharmacology, photochemistry, tannin

### **INTRODUCTION**

World Health Organization (WHO) has approved the use of traditional medicines as a part of the health program for the treatment of various diseases. According to the WHO survey 80% of the populations living in the developing countries rely almost exclusively on traditional medicine for the primary health care needs (WHO, 1993; Goyal, 2005). The potential of plant as a source for new drugs is yet to be explored systematically. Among the all estimated plant species, only 6% have been studied for biological activity and about 15% have been investigated phytochemically (Verpoorte *et al.*, 1999). India has an ancient heritage of traditional medicine. Materia Medica of India provides lots of information on the folklore practices and traditional aspects of therapeutically important natural products. With the emerging interest in the world to adopt and study the traditional system and to exploit their potentials, the evaluation of the rich heritage of the traditional medicine is essential along with quality control of herbal and herbo-mineral products. Numerous drugs have entered the international market through exploration of ethnopharmacology and traditional medicine (Goyal and Patel, 2010; Cooper, 2004). In this view, we have investigated potential of *E. officinalis* as a drug through exploration of phytopharmacology and ethnomedicinal use.

**Geographical distribution:** *E. officinalis* Geart. genus *Phyllanthus* (Euphorbiaceae) is widely distributed in most tropical and subtropical countries. It grows in tropical and subtropical parts of China, India, Indonesia and on the Malay Peninsula (Perianayagam *et al.*, 2005) and indigenous to tropical India and Southeast Asia (Barthakur and Arnold, 1991).

**Plant profile:** It is a tree of small or moderate size with a greenish-grey bark and greenish-yellow flowers, formed in axillary clusters. The feathery leaves are linear-oblong, with a rounded base and obtuse or acute apex, subsessile, closely set along branchlets, light green and resembling pinnate leaves. The flowers are greenish yellow, borne in axillary fascicles, giving way to a globose fruit (Warrier *et al.*, 2007; Kirtikar and Basu, 1935). The tender fruits are green, depressed, globose or oblate, indented at the base, smooth, fleshy and shining. The nearly stem less fruits are obscurely 6-lobed splitting into three segments. Fruits are about 1.5-2.5 cm in diameter with six softly defined ridges and six seeds and green at first, become whitish or a dull, greenish-yellow or more rarely, brick-red as it matures. They are hard and unyielding to the touch. The skin is thin, translucent and adherent to the very crisp, juicy, concolorous flesh. They average 5 to 6 g in weight and 4 to 5 mL in volume. Ripe fruits are astringent, extremely acidic and some are distinctly bitter. They are capsular (drupaceous) berries with a fleshy exocarp. The edible part of the fruit is the mesocarp and the endocarp forms the hard stone which encages the seeds (Nadkarni and Nadkarni, 1999).

The origin of the name is from Sanskrit Amlaki. *Emblica officinalis* known as Amla in Hindi, and Yeowkan in Chinese, Emblic myrobalan and Indian gooseberry in English and Phylontha emblic in French. Amla is one of the important herbal drugs used in Unani and Ayurvedic systems of medicine. It is used both as a medicine and as a tonic to build up lost vitality and vigor. In Unani medicine, it is described as a tonic for heart and brain. The fruits of Amla are used in many medicinal preparations of Ayurvedic and Unani systems of medicine as well as food supplement (Kirtikar and Basu, 1935; Mishra *et al.*, 2011). According to the two main classic texts on Ayurved, *Charak Samhita* and *Sushrut Samhita*, Amalaki is regarded as “the best among rejuvenative herbs”, “useful in relieving cough and skin disease” and “the best among the sour fruits”. According to Charaka amla fruits are useful in hemorrhage, diarrhea and dysentery and acts as anabolic, antibacterial and resistance building. Many polyherbal formulations like Trifala, Cogent db, Diasulin contains *Emblica officinalis* as one of the ingredient (Patel *et al.*, 2009; Naik *et al.*, 2006; Ramalingam and Pari, 2005; Pari and Saravanan, 2002).

**Phytochemistry of *E. officinalis*:** Zhang and coworkers have reported that fruit juice of *E. officinalis* contains phenolic constituents like gallic acid, L-malic acid 2-o-gallate, Mucic acid 2-o-gallate, Corilagin Chebulagic acid, putrajivain A, elacocarpusin, mucic acid, 1-o-galloyl- $\beta$ -D-glucose, Mucic acid 6-methyl ester 2-o-gallate, Mucic acid 1,4-lactone 2-o-gallate, Mucic acid 1-methyl ester 2-o-gallate, Mucic acid 2-o-gallate, Mucic acid 1, 4-lactone 6-methyl ester 2-o-gallate, mucic acid 1, 4-lactone 3-o-gallate, mucic acid 1,4-lactone 3,5-di-o-gallate (Zhang *et al.*, 2001; Zhang *et al.*, 2004) (Fig. 1).

Ghosal *et al.* (1996) have reported that fresh pericarp of *E. officinalis* contain higher amount of hydrolysable tannins like emblicanin A and B, punigluconin, pedunculagin The structure have been established by spectroscopic analysis and chemical transformation (Fig. 2).

Kumaran and karunakaran have performed an activity-directed fractionation and purification process to identify phytochemicals present in *E. officinalis*. They have identified gallic acid, methyl gallate, corilagin, furosin and geraniin in *E. officinalis* by chromatographic and spectroscopic method (Kumaran and Karunakaran, 2006) (Fig. 2).

Phytochemical investigations revealed that *E. officinalis* contains higher amount of flavonoid like quercetin (Anila and Vijayalakshmi, 2002; Gulati *et al.*, 1995) and fruits were also analyzed for their alkaloidal content. Alkaloids like phyllantine and phyllantidine were confirmed by chromatography and IR spectral studies (Khanna and Bansal, 1975).

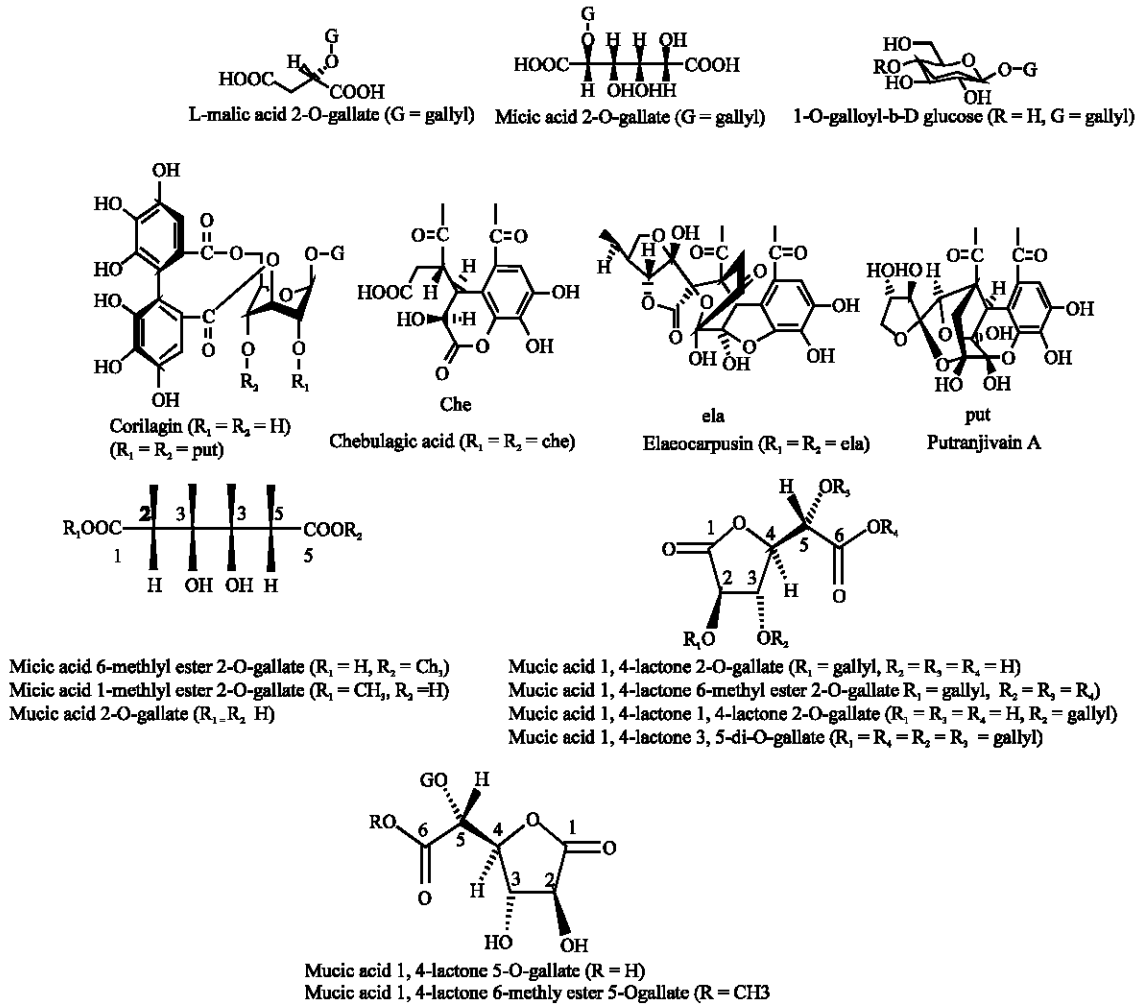


Fig. 1: Structures of phenolic compounds from fruit juice of *E. officinalis*

It has been reported that fruits of *E. officinalis* contains higher amount of Vitamin C (Scartezzini *et al.*, 2006; Khopde *et al.*, 2001; Nisha *et al.*, 2004; Paul and Shaha, 2004) and considerably higher concentrations of most minerals, protein and amino acids like Glutamic acid, proline, aspartic acid, alanine, cystine and lysine (Barthakur and Arnold, 1991).

### Pharmacological actions of *E. officinalis*

**Antioxidant activity:** Ghosal *et al.* (1996) has established by comprehensive chromatographic, spectroscopic and crucial chemical analysis of fresh juice and extractive that the antioxidant effect of amla is not due to its rich Vitamin C content but the activity is located in the low molecular weight hydrolysable tannins. Tannins like embelicanin-A, emblicanin-B, punigluconin, pedunculagin have been found to provide protection against oxygen redical induced haemolysis of rat peripheral blood erythrocytes. The mechanism of action of antioxidant activity has been suggested to be due to recycling of sugar reductone moiety and conversion of the polyphenol in to medium and high molecular weight tannins.

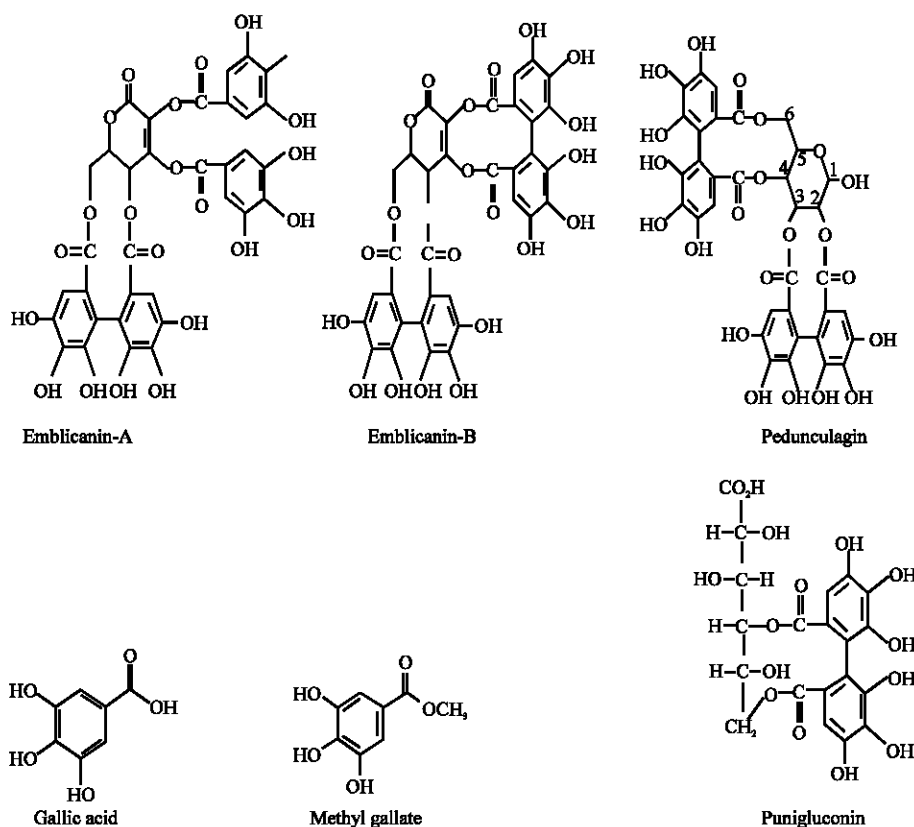


Fig. 2: Major gallotannins from fruit exudates of *E. officinalis*

Antioxident activity of tannoid principal of *Embelica officinalis* was investigated on the basis of their effects on rat brain frontal cortical and striatal concentration of oxygen free radical scavenging enzymes like superoxide dismutase, catalase, glutathione peroxidase, lipidperoxidation in terms of thiobarbuturic acid reactive products (Bhattacharya *et al.*, 2000).

Nitric Oxide (NO) radical scavenging phenolic principles were quantitatively analyzed from *E. officinalis* by *in vitro* method. It was found that Geraniin showed highest NO scavenging activity among the isolated compounds from amla (Kumaran and Karunakaran, 2006).

Aqueous extract of *E. officinalis* was found to be a potent inhibitor of lipid peroxide formation and scavenger of hydroxyl and superoxide radicals *in vitro* (Jose and Kuttan, 1995; Naik *et al.*, 2005).

The antioxidant activity of free and bound phenolics of *E. officinalis* turmeric was investigated by Kumar *et al.* (2006). Higher level of antioxidant activity in *Embelica officinalis* has been attributed to the phenolic content (12.9%, w/w) in them. Gallic acid and tannic acid were identified as the major antioxidant components in phenolic fractions of *Embelica officinalis*.

Antioxidant activity is enhanced by processing fruit according to a method named "Svaras Bhavana", whereby the therapeutic potential of the plant is enhanced by treating the main herb with its own juice. It has also been found that it increases the content of ascorbic acid (1.28%, w/w) antioxidant activity approximately 45-70% of the antioxidant activity (Scartezzini and Speroni, 2000).

Aqueous extract of *E. officinalis* is able to inhibit  $\gamma$ -radiation-induced Lipid Peroxidation (LPO) in rat liver microsomes and Superoxide Dismutase (SOD) damage in rat liver mitochondria (Khopde *et al.*, 2001).

The antioxidant properties of *E. officinalis* extracts and their effects on the oxidative stress in streptozotocin-induced diabetes were examined in rats. Amla showed strong inhibition of the production of advanced glycosylated end products which is a glycosylated protein that is an indicator of oxidative stress. Furthermore, thiobarbituric acid-reactive substances levels were significantly reduced with amla, indicating a reduction in lipid peroxidation. In addition, the decreased albumin and adiponectin levels in the diabetic rats were significantly improved with amla (Rao *et al.*, 2005).

**Prevention of hyperthyroidism:** The ethanolic extract from the fruits of *E. officinalis* was investigated to evaluate its possible ameliorating effects, on the L-thyroxine (L-T4) induced hyperthyroidism in mice. While an increase in serum T3 (triiodothyronine) and T4 (thyroxine) concentrations and in a thyroid dependent parameter, hepatic glucose 6-phosphatase (glu-6-pase) activity was observed in L-T4 (Panda and Kar, 2003).

**Gastroprotective activity:** An ethanolic extract of *E. officinalis* was examined for its antisecretory and antiulcer activities employing different experimental models in rats, including pylorus ligation Shay rats, indomethacin, hypothermic restraint stress-induced gastric ulcer and necrotizing agents induced ulcer (Al-Rehaily *et al.*, 2002).

**Immunomodulating activity:** The fruits extracts of *E. officinalis* has been reported to have strong immunomodulatory properties. immunomodulatory properties of Amla was evaluated using chromium (VI) as an immunosuppressive agent. It also inhibited apoptosis and DNA fragmentation and relieved the immunosuppressive effects of Cr on lymphocyte proliferation and even restored the IL-2 and  $\gamma$ -IFN production considerably (Sairam *et al.*, 2002a; Ganju *et al.*, 2003).

**Hepatoprotective activity:** Hepatoprotective activity of *E. officinalis* fruit extracts were studied using carbon tetrachloride induced liver injury model in rats. Extract was found to reduce elevated levels of collagen-hydroxyproline significantly, indicating that the extract could inhibit the induction of fibrosis in rats (Jose and Kuttan, 2000; Achliya *et al.*, 2004; Jeena *et al.*, 1999).

**Prevention of cataract:** *E. officinalis* is widely used against many chronic ailments including diabetic cataract. Aqueous extract of *E. officinalis* and its major constituent tannins produced inhibition against rat lens, purified recombinant human aldose reductase and sugar-induced osmotic changes (Suryanarayana *et al.*, 2004).

**Antidiarrheal:** The methanol extract of *E. officinalis* showed a significant inhibitory effect on castor oil and magnesium sulfate induced diarrhea and reduction in gastrointestinal motility in charcoal meal tests in rats. It also significantly inhibited PGE2-induced enteropooling in rat (Perianayagam *et al.*, 2005).

**Antitussive activity:** The antitussive activity of *E. officinalis* was tested in conscious cats by mechanical stimulation of the laryngopharyngeal and tracheobronchial mucous areas of airways. Antitussive activity of *E. officinalis* is due to antiphlogistic, antispasmodic, antioxidant and mucus secretory activity in the airways (Nosál'ova *et al.*, 2003).

**Anti-pyretic and analgesic activity:** Extracts of *E. officinalis* fruits showed potent anti-pyretic and analgesic activity in several experimental models like brewer's yeast induced hyperthermia in rats, tail-immersion test and acetic acid-induced writhing response in mice as well as in a double-blind, randomized clinical trial (Perianayagam *et al.*, 2004; Gupta *et al.*, 2008a; Perianayagam *et al.*, 2004; Gupta *et al.*, 2008b).

**Prevention of atherosclerosis and hyperlipidemia:** Amla may be effective for hypercholesterolemia and prevention of atherosclerosis. Fresh juice and ethylacetate extract of amla exhibited more potent serum lipid lowering effect. Serum cholesterol, TG, phospholipid and LDL levels were significantly decreased by the administration of amla (Kim *et al.*, 2005; Thakur *et al.*, 1988; Mathur *et al.*, 1996; Mishra *et al.*, 1981).

**Antimicrobial activity:** Alcoholic extracts of *E. officinalis* was found to show potential antibacterial activity against one or more test pathogens (Ahmad *et al.*, 1998; Rahman *et al.*, 2009).

**Antitumour:** *E. officinalis* extract was found to inhibit cell cycle regulating enzymes cdc 25 phosphatase in a dose dependent manner that needed for inhibition of cdc2 kinase. The results suggested that antitumour activity of amla may partially be due to its interaction with cell cycle regulation (Jose *et al.*, 2001). *E. officinalis* also induces apoptosis in Dalton's Lymphoma Ascites and CeHa cell lines (Rajeshkumar *et al.*, 2003; Sharma *et al.*, 2000; Rahman *et al.*, 2009).

**Adaptogenic:** *E. officinalis* induce genotypic adaptation appeared to depend on the ability of target tissues to synthesize prostaglandins (Rege *et al.*, 1999).

**Antidiabetic activity:** Oral administration of extracts of *E. officinalis* reduced the blood sugar level in normal and in alloxan induced diabetic rats (Sabu and Kuttan, 2002; Tripathi *et al.*, 1979; Hakim *et al.*, 1996).

**Protection against ischemia-reperfusion induced oxidative stress:** The tannoid principles of the fruits of *E. officinalis* have been reported to exhibit antioxidant activity in against ischemia-reperfusion-induced oxidative stress in rat heart. It confirms the antioxidant effect of *E. officinalis* and indicates that the fruits of the plant may have a cardioprotective effect (Bhattacharya *et al.*, 2002; Rajak *et al.*, 2004).

**Antiproliferative activity:** Phenolic compounds from the fruit juice showed stronger antiproliferative activities against MK-1 (human gastric adenocarcinoma), HeLa (human uterine carcinoma) and B16F10 (murine melanoma) cells (Zhang *et al.*, 2004). *E. officinalis* also showed antiproliferative activity on MCF7 and MDA-MB-231 breast cancer cell lines (Lambertini *et al.*, 2003).

**Antiulcerogenic:** The ulcer protective potential of methanolic extract of *E. officinalis* was assessed in different acute gastric ulcer models in rats induced by aspirin, ethanol, cold restraint stress and pyloric ligation and healing effect in chronic gastric ulcers induced by acetic acid in rats (Sairam *et al.*, 2002b).

Table 1: Ethnomedicinal uses of different parts of *E. officinalis*

Medicinal use	Description
Aphrodisiac	<i>E. officinalis</i> is believed to be one of the strongest rejuvenative herbs in ayurvedic medicine in combination with ghee known as the "rasayana" and it is the primary ingredient in one of the renowned ayurvedic herbal formulation, called <i>Chayavanaprasha</i> .
Boils, spots and pruritus	Decoction of pericarp is often used along with cow ghee on boils while burnt seed powder mixed in oil is a useful application for scabies or itch.
Appetite inducer constipation, indigestion	The green fruits are made into pickles to stimulate appetite. Fresh fruit is extensively used as a laxative as one of the constituent of " <i>Triphala</i> and is also used as carminative and stomachic to improve digestion (Nadkarni, and Nadkarni, 1999).
Diuretic	A paste of the fruit alone or in combination with <i>Nelumbium speciosum</i> (the Egyptian Lotus), saffron and rose water is a useful in irritability of the bladder and retention of urine (Nadkarni and Nadkarni, 1999).
Fever	The fresh fruit infusion and a compound powder composed of equal parts of the emblica seed, chitrak root, chebulic myrobalan, pipli and saindhava used in fever (Nadkarni and Nadkarni, 1999).
Hair growth	<i>E. officinalis</i> is an accepted hair tonic for strengthening and promoting hair growth and also for preventing hair graying (Thakur <i>et al.</i> , 1988).
Headache, nausea and vomiting	A paste of the fruit is a useful application to the forehead in cases of headache and mixer of fruit powder with red sandalwood ( <i>Pterocarpus santalinum</i> ) prepared in honey used to relieve nausea and vomiting.
Respiratory problems	The expressed juice of the fruit along with other ingredients is used to cure cough, hiccough, asthma, painful respiration and other diseases like dyspnoea and inflammations of the lungs.
Vaginal burning, vermifuge	Fruit juice is used for the relief of burning in the vagina and as a vermifuge (Nadkarni and Nadkarni, 1999).

**Ethnomedicinal uses of *E. officinalis*:** *E. officinalis* is among the most important medicinal plants in the Ayurvedic Meteria Medica. It has been used a single substance or as a valuable ingredient of various medicines or formulations in various disorders. Several ethnomedicinal importances of *E. officinalis* is given in Table 1.

## CONCLUSION

Evidenced based studies on the efficacy and safety of traditional Indian systems are limited. A critical analysis of the literature screened for this review reveals the fact that although the number of diseases for which *E. officinalis* Fruit finds use as a medicine is fairly large. Further it is also interesting to note that very little efforts have been made to isolate and identify the active principles present in the fruit. In view of the wide range of medicinal uses of *E. officinalis* fruit as mentioned in Ayurveda and Unani and otherwise, it is imperative that more clinical and pharmacological trials should be conducted to investigate unexploited potential of *E. officinalis* fruit as a drug. At the same time serous efforts for high quality studies are necessary to evaluate and compare the value of traditional Indian drugs to modern medicine along with identification of the active constituents of the plant.

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