



**PHYLLANTHUS EMBLICA – A CONCISE REVIEW**

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### ABSTRACT

Medicinal plants have been integral to healthcare throughout human history. *Phyllanthus emblica* is highlighted as an important plant in Ayurveda. *Phyllanthus emblica* is noted for its strong antioxidant properties, high vitamin C content, and essential biological properties. Various extracts and herbal formulations of *P.emblica* have demonstrated activities against various diseases. While traditional uses of *P.emblica* encompass a wide range of health ailments, there is a call for further exploration and validation through clinical research. This review aims to provide a comprehensive overview of the various medicinal properties and therapeutic applications associated with *Phyllanthus emblica*. *P. emblica* is seen as a promising subject for future research and development in the field of alternative and complementary medicine.

**KEYWORDS:** *Phyllanthus emblica*, Phytoconstituents, Pharmacological importance and uses.

## 1. INTRODUCTION

*Phyllanthus emblica* is a great boon to humanity as it is used to treat and manage many diseases since ancient times. *Phyllanthus Emblica* which is known as King of Rasayana is one of the natural healing plant that is indigenous to India. It dates back 5000 years but is still one of the top-selling botanicals having various applications in the healthcare, food, and cosmetic industries. It is one of the key ingredients in the popular Ayurvedic recipe, Chyavanaprasha.<sup>[1,2]</sup> In Sanskrit, this plant is known as “Divya” and “Amrut” or “Amrit Phala” which literally means “Fruit of heaven” or “Nectar fruit”. The Sanskrit name Amlaki means the “Sustainer” or the fruit where the “Goddess of Prosperity resides”. This plant is a reservoir of minerals, Vitamins, and other bio-chemical substances.<sup>[3]</sup>

### 1.1 Triphala Formation

Triphala formulation where “Tri” means “Three” and “Phala” means “Fruits”. It is an ayurvedic preparation composed of three herbal fruits namely *Terminalia chebula*, *Phyllanthus emblica*, and *Terminalia bellerica*. Triphala formulation is very rich in Polyphenols, Vitamin C and Flavanoids.<sup>[1]</sup>

### 1.2 History

The medicinal uses of *Phyllanthus emblica* were mentioned first in the Rigveda, which is said to be written between 4500 – 1600 B.C and is supposed to be the oldest repository of human knowledge. Medicinal use

of *P.emblica* have been found in Arabic, Tibetan, and Egyptian texts as well as in the Siddha, Ayurvedic, and Unani systems of medicines. The entire plant is used both in dried and fresh forms.<sup>[4]</sup>

### 1.3 Distribution

*P.emblica* is native to tropical Southeastern Asia, particularly in Central and Southern India, Nepal, Pakistan, Bangladesh, Bhutan, Sri Lanka, Malaya, Myanmar and the Mascarene Islands. It is widely distributed in most tropical and subtropical countries including China, Indonesia, and on the Malay Peninsula. It grows abundantly in Madhya Pradesh deciduous forests. Originally, it was cultivated in Madagascar.<sup>[5]</sup>

### 1.4 Propagation

*P. emblica* is primarily propagated using seeds. In commercial settings, grafting methods are also employed for propagation. Studies on propagation reveal that the season of grafting significantly influences the success of the graft. In November grafting, 87.50% of success has been achieved, followed by 66.69% success in December.<sup>[6]</sup>

### 1.5 Taxonomical Classification<sup>[7]</sup>

<b>Kingdom</b>	Plantae
<b>Division</b>	Magnoliophyta
<b>Class</b>	Magnoliopsida
<b>Subclass</b>	Rosidae
<b>Order</b>	Euphorbiales
<b>Family</b>	Euphorbiaceae
<b>Genus</b>	<i>Phyllanthus L.</i>
<b>Species</b>	<i>Phyllanthus Linn. emblica</i>

### 1.6 Vernacular Names<sup>[8]</sup>

<b>Botanical name</b>	<b>Phyllanthu emblica</b>
<b>Arabic</b>	Haliilaj or Ihlilaj
<b>Assamese</b>	Amlakhi
<b>Bengali</b>	Amloki
<b>Bengali</b>	Amlaki
<b>Chinese</b>	Anmole
<b>English name</b>	Indian Gooseberry, Emblic myroblan
<b>French</b>	Phyllanthus Emblica
<b>German</b>	Amla
<b>Gujarati</b>	Amla
<b>Hindi</b>	Amla
<b>Indonesia</b>	Balakka
<b>Italian</b>	Mirabolano emblico
<b>Kannada</b>	Bettada neilkkai
<b>Konkani</b>	Aavalo
<b>Lao</b>	Mak kham bom
<b>Maithili</b>	Dhatric
<b>Malayalam</b>	Neilli
<b>Malaysia</b>	Melaka
<b>Manipuri</b>	Heikru
<b>Marathi</b>	Avala, Awla
<b>Nepalese</b>	Amba, amala
<b>Odiya</b>	Aanla
<b>Portuguese</b>	Mirabolano emblica
<b>Punjabi</b>	Aula, Olay
<b>Sanskrit</b>	Dhatrithala, Amla, Amaliki, Amalakan, Sripthalam, Vayastha, Amalaka, Dhatri
<b>Tamil</b>	Nellikai
<b>Telugu</b>	Usiri kaay
<b>Telugu</b>	Usiri
<b>Thai</b>	Ma kham pom
<b>Tibetian</b>	Skyu-ru-ra
<b>Urdu</b>	Awla

### 1.7 Cultural Importance<sup>[9]</sup>

*P.emblica* is considered a sacred tree in India, and it holds cultural and religious importance. The tree was worshipped as Mother Earth, symbolizing nurturing qualities. It is believed to have a nurturing role for humankind, particularly because of the nourishing fruits it produces. Specific religious practices and orders, such as Kartik Mahatma and Vrat Kaumudi, prescribe the worship of the *P.emblica* tree. The leaves of the *P.emblica* tree are offered in worship on various occasions, including Shri Satyanarayana Vrata, Shri Shani Pradosha Vrata, and Nitya Somvara Vrata. In Himachal Pradesh, this tree is worshipped as propitious and chaste, particularly in the month of Kartik.

### 2. Morphology of the Plant<sup>[10]</sup>

*P.emblica* is small to medium sized deciduous tree which is about 8-18 meters height with thin light grey bark.

**Seeds:** The seeds of *P.emblica* are Obviate- triangular, three celled and has two seeds in each cell.

**Leaves:** The leaves of *P.emblica* are simple, Sub sessile, closely set along the branchlets and light green in colour.

**Flowers:** The flowers of *P.emblica* are small, greenish-yellow and unisexual. The male flowers are numerous and has short and slender pedicles. The females are few, sub-sessile and has three celled ovary.

**Fruits:** The fruits of *P.emblica* are globose and fleshy. It is pale yellow in colour with six obscure vertical furrows enclosing six trigonous seeds in 2-seeded 3 crustaceous cocci.

### 2.1 Phytochemistry<sup>[11]</sup>

**Fruit:** The *P.emblica* contains Phyllemblin, Phyllemblic acid, Gallic acid, Emblicol, Quercetin, Hydroxymethyl furfural, Ellagic acid, Pectin, Putranjivan, Punigluconin, Pendunculagin and also contains two new hydrolyzable tannins called Emblicannin A and B.

**Nutritional Value:** The fruit contains average of 81.2% moisture, 0.5% Protein, 0.1% Fat, 14.1% Carbohydrates, 0.7% Mineral matter, 3.4% Fiber, 0.05% Calcium, 0.02% Potassium, 1.2mg/100g of Iron, 0.2mg/g of Nicotinic acid.<sup>[3]</sup>

**Leaves:** The *P.emblica* leaves have been reported with Gallic acid, Ellagic acid, Chebulic acid, Chebulagic acid, Chebulinic acid, a Gallotannins called Amlic acid, Alkaloids, Phyllatidine and Phyllantine.

**Bark:** *P.emblica* barks have been reported with Leucodephinidin, Tannin and Proanthoyanidin.

**Root:** The *P.emblica* roots contains Ellagic acid.

### 3. Ethnobotanical Importance<sup>[2]</sup>

According to ancient Indian mythology, it is the first tree created in the universe and this plant is mentioned as rasayana in Charaka Samhita. Hence it is known to prevent aging and promote longevity. This plant has a natural balance of five tastes namely sour, astringent, sweet, bitter, and pungent. It is one of the ingredients of Triphala formulation and many other herbal formulations. This plant contains Vitamin C in greater amounts than orange and tomato. In Ayurveda it is described as a potent antacid and also helps in reducing all three bodily doshas namely vata, pitta, and kapha. The fruits possess antibacterials, antifungal, and antiviral properties. Fruits are diuretic and are also used for the treatment of diarrhea, ingestion, ulcers, inflammation, nausea, scurvy, fever, skin sores and wounds. The pericarp of the fruit is used in decoction along with other ingredients and is applied to boils and spots. These fruits are excellent antioxidants and act as potent scavengers of free radicals. It also prevents premature greying of hairs and makes them strong and free from dandruff. Its regular use improves immunity and protects the heart, brain, and other vital organs of body. Roots are used to cure dental problems. Juice of bark is used to treat gonorrhoea.

#### 3.1 Ayurvedic Properties<sup>[P3]</sup>

The ayurvedic properties of *Phyllanthus Emblica* are

- Rasa (Taste): The dominant tastes of *P. emblica* are sour and astringent. However, it also contains sweet, bitter, and pungent tastes, making it a unique fruit with a balance of all five tastes.

- Veerya (Nature): *P. emblica* has a cooling nature, making it suitable for the treatment of conditions associated with pitta (fire) agitation. It is particularly used for addressing burning sensations, inflammation, and fever.
- Vipaka (Taste developed through digestion): *P. emblica* develops a sweet taste after digestion.
- Guna (Qualities): *P. emblica* is described as light and dry in qualities.
- Doshas (Effect of Humors): *P. emblica* has a balancing effect on all three doshas—vata, kapha, and pitta. It is especially effective for pacifying pitta dosha.

### 3.2 Versatile Applications In Indian Cuisine

*P.emblica* fruits are important culinary, dietary, and medicinal agent in the Indian subcontinent. The fruits are used to make the following dishes such as Murabbah, Bur, Ladu, Fresh juice, Pickle, Chutneys and Curries. The juice prepared from the ripe fruits is being marketed as an excellent coolant in the hot summer.<sup>[8,12]</sup>

### 3.3 Nutritional Value<sup>[2]</sup>

The nutritional content of *P. emblica* (Amla) in terms of Vitamin C can vary depending on the form of the fruit.

- Fresh *P.emblica* fruit: provides 600 milligram of Vitamin C per 100 gram.
- Pressed juice: provides 920 milligrams of vitamin C per 100 milliliters
- Dehydrated fruit: provides a higher concentration of Vitamin C, ranging from 2500 to 3500 milligram per 100 grams.
- Dried and powdered fruit: provides a range of 1800 to 2600 milligrams of Vitamin C per 100 gm.

### 4. Pharmacological Importance

#### 4.1 Ameliorating Effects

The ethanolic extract from the fruits of *P. emblica*, when administered concurrently with LT4-induced hyperthyroidism in mice, demonstrated positive effects on thyroid hormone levels, hepatic glucose metabolism, and potentially on hepatic lipid peroxidation. These findings suggest a potential therapeutic or protective role of the plant extract in the context of hyperthyroidism and associated liver function.<sup>[13]</sup>

#### 4.2 Analgesic and Antipyretic Properties

The ethanol extracts and aqueous extracts from *P. emblica* fruits, when administered in a single oral dose, demonstrated significant antipyretic activity by reducing fever induced by brewer's yeast in rats. Additionally, the extracts exhibited analgesic activity by inhibiting the writhing response to acetic acid in mice. These findings suggest a potential therapeutic role for the plant extracts in managing fever and providing pain relief.<sup>[14]</sup>

#### 4.3 Anti Diabetic Effects of Emblica

In both single-dose and multiple-dose studies, *P. emblica* reduced blood glucose levels in rat models with induced diabetes. Within 20 days of receiving *P. emblica*, rats

showed a decrease in serum creatinine levels and an increase in serum albumin levels. This suggests a potential positive impact on kidney function and protein levels in the blood.<sup>[15,16]</sup> Additionally *P. emblica* administration was associated with a decrease in neuropathic pain in rats with induced diabetes, possibly through antioxidative mechanisms.<sup>[17]</sup> In vitro research suggests that *P. emblica* may exert its effects through alpha-amylase and glucosidase inhibition, which are enzymes involved in carbohydrate metabolism. While *P. emblica* delayed the development of cataracts in diabetic rats, it did not prevent hyperglycaemia in the same study.<sup>[18]</sup> In a clinical study involving healthy and type 2 diabetic volunteers, powdered, dried fruit of *P. emblica* showed decreases in fasting and two-hour postprandial serum glucose levels when taken for 21 days. However, in a different study involving patients with end-stage renal disease (ESRD) and uraemia, no impact on diabetic indices was observed.<sup>[19,20]</sup>

#### 4.4 Anti-Aging Activity

*Phyllanthus emblica* is recognized for its potential anti-aging effects. The specific focus is on its ability to protect human AMD RPE hybrid cells from deterioration. The studies revealed that a higher dose of *Phyllanthus emblica* was necessary to observe the anti-aging effects.<sup>[21]</sup>

#### 4.5 Antibacterial Activity

The study found that *Phyllanthus emblica* demonstrated good inhibitory action against a wide range of pathogenic bacteria such as *Escherichia coli*, *Serratia marcescens*, *Pseudomonas aeruginosa*, and *Bacillus cereus*, suggesting it is potential as a source of antibacterial compounds.<sup>[22]</sup>

#### 4.6 Anticancer Agent

Rats given *P. emblica* extracts responded to heavy metal carcinogens (arsenic, chromium, nickel) by showing fewer damaged cells, fewer micronuclei in bone marrow cells, lower levels of free radical production, and higher cell survival. In response to tumor cells (lymphoma and mammary carcinoma), rats fed with *P. emblica* extracts displayed increased natural killer cell activity, antibody-dependent cellular cytotoxicity, and improved survival rates.<sup>[23,24,25]</sup> One experiment showed a decrease in tumor volume but no effect on tumor growth. Tannins that can be hydrolyzed and organic acid gallates have demonstrated toxicity to tumor cells. Emblica extracts improved 30-day survival rates and reduced overall mortality in irradiated mice, providing protection from radiation sickness.<sup>[26]</sup> In vitro studies has been conducted on human cancer cell lines, including lung, liver, cervical, ovarian, and breast cells. Different Emblica extracts reduced the incidence of tumors and measured enzyme levels, indicating potential benefits in preventing hepatocarcinogenesis (liver cancer development).<sup>[23,27,28,29,30]</sup>

#### 4.7 Antidepressant Effects

The aqueous extract from *P. emblica* fruit has potential antidepressant properties, as evidenced by its efficacy in two well-established behavioral tests. The fact that the antidepressant recreation was comparable to imipramine, a known antidepressant medication, is notable and suggests that *P. emblica* may be a promising candidate for further investigation in the development of antidepressant treatments.<sup>[31]</sup>

#### 4.8 Anti-Diarrheal Activity

*Phyllanthus emblica*, when administered in methanol extract form, exhibited significant antidiarrheal activity in a rat model of induced diarrhoea. The observed decrease in GI motility and the dose-dependent response further support the potential efficacy of *Phyllanthus emblica* in mitigating diarrhea.<sup>[32]</sup>

#### 4.9 Anti-Fungal Activity

The effectiveness may depend on the specific type of fungus being targeted. Ethanol and acetone extracts of *P. emblica* demonstrated antifungal activity against *Candida albicans* and *Fusarium equiseti*.<sup>[33]</sup> *Aspergillus niger* F2723, which is a phytopathogenic fungus, was found to be not susceptible to the antifungal effects of the plant methanolic extract of *P. emblica*.<sup>[34]</sup>

#### 4.10 Anti-Inflammatory Agent

Limited anti-inflammatory effects have been observed in animal models of both acute and chronic inflammation. At higher dosages, there is a reported reduction in edema (swelling) and granulomatous tissue. According to research, there are no clinical trial results available on the use of *P. emblica* as an anti-inflammatory agent. This indicates a gap in clinical evidence for its effectiveness in human subjects. In vitro experiments, bronchial epithelial cells from a patient with cystic fibrosis were used to demonstrate that *P. emblica* inhibited the expression of pro-inflammatory cytokines. This suggests a potential anti-inflammatory effect at the cellular level.<sup>[35]</sup> In vitro experiments revealed that dried *P. emblica* fruit extract inhibited the enzymes collagenase and hyaluronidase. These enzymes are associated with the degradation of cartilage. Donor cartilage from osteoarthritic patients was used in these experiments, indicating a potential protective effect on cartilage. Crude extracts of *P. emblica* have been shown to cause mature osteoclasts to undergo apoptotic cell death without affecting osteoclastogenesis. This suggests a potential regulatory effect on bone-resorbing cells.<sup>[36,37,38]</sup>

#### 4.11 Antimicrobial Agent

Both alcohol and water extracts of *P. emblica* demonstrated efficacy against a variety of typical human pathogens, including bacteria, viruses, and fungi.<sup>[39,40,41,42]</sup> The phenolic content of *P. emblica* extracts has been linked to activity against herpes simplex viruses 1 and 2.<sup>[43]</sup> Phyllaemblicin B, an extract from the roots of the plant, was found to have activity against the coxsackie virus. Coxsackie viruses are a type

of enterovirus that can cause various infections in humans.<sup>[44,45]</sup> In mice, induced *Klebsiella pneumoniae* responded to dietary fruit powder supplementation over a 30-day period. *Klebsiella pneumoniae* is a bacterium associated with respiratory and urinary tract infections.<sup>[46]</sup>

#### 4.12 Anti-Oxidant Activity

*P. emblica* is described as rich in polyphenols and vitamin C (ascorbic acid). The aqueous extract of *P. emblica* is being tested for its ability to prevent damage caused by radiation-induced lipid peroxidation and superoxide dismutase to rat liver microsomes and mitochondria. Radiation-induced damage can lead to oxidative stress, and antioxidants. *P. emblica* may have protective effects against such damage.<sup>[47]</sup>

#### 4.13 Antitussive Effects

The antitussive effect of the alcoholic extract of *P. emblica* was mentioned to be less potent than codeine, a known cough suppressant. However, the extract exhibited a dose-dependent effect resembling that of dropropizine, another cough suppressant, in cats. The study used mechanical stimulation of the tracheobronchial mucous area of the airways to test the antitussive activity of *Phyllanthus emblica* in cats. *Phyllanthus emblica* demonstrated antitussive activity as a cough suppressant at a dose of 50 mg/kg in cats.<sup>[48,49]</sup>

#### 4.14 Antivenom

An alcoholic extract derived from the roots of *P. emblica* was used in the study. The study demonstrated that the alcoholic extract of *P. emblica* roots had a counteractive effect against the hemorrhagic effects induced by snake venom in mice.<sup>[50]</sup>

#### 4.15 Anti-Viral Activity

Antiviral and endocrine effects, activity on mammalian enzymes, has the capacity to regulate immune and inflammatory cell function, and effects on lipid peroxidation and oxyradical synthesis are just a few of the effects that these substances have. When tested using the WST-1 assay, plaque-forming unit assay, time of addition assay, and hemagglutination inhibition assay, pentagalloylglucose has been shown to have dual modes of action that can inhibit the replication of influenza, a disease that is extremely contagious.<sup>[51]</sup>

#### 4.16 Cardioprotective

The emblicanin-enriched fraction of *P. emblica* fruit juice have cardioprotective effects against ischemia-reperfusion injury, and the fruit juice itself may mitigate myocardial dysfunction in diabetic rats. Treatment with the fruit juice from *P. emblica* prevented various negative effects induced by streptozotocin, including weight loss, increases in food and water intake, elevated serum glucose levels, disturbed lipid profiles, increased serum LDH (lactate dehydrogenase), and creatinine kinase MB levels, as well as myocardial hypertrophy and cardiomyopathy.<sup>[52]</sup>

#### 4.17 CNS Effects

Studies on rats also show that an aqueous fruit extract of *P. emblica*, inhibited alcohol-induced brain mitochondrial dysfunction.<sup>[53]</sup>

#### 4.18 GI Effects

Both ethanolic and aqueous extracts of *P. emblica* have demonstrated protective and healing effects on induced gastric ulcers in animal studies.<sup>[54,55,56]</sup> One study reported biphasic effects of ethanolic fruit extracts, with ulceration observed on histology at higher doses, while healing was seen at lower doses. This biphasic response indicates a dose-dependent effect, where the outcome may vary at different concentrations of the extract.<sup>[57]</sup> *P. emblica* has shown antidiarrheal and spasmolytic effects in invitro studies using rodent jejunum and ileum, as well as live mice. The antidiarrheal effect may be attributed to muscarinic action and calcium channel blockade.<sup>[58]</sup>

#### 4.19 Hepatoprotective Activity

The extracts of *P. emblica* were investigated for their hepatoprotective effects against acute and prolonged CCl<sub>4</sub> administration and measured various biochemical parameters, including concentrations of serum and liver LPOs (lipid peroxides), glutamate-pyruvate transaminase (GPT), and alkaline phosphatase (ALP). The extracts of *P. emblica* were found to inhibit the hepatotoxicity induced by both acute and prolonged CCl<sub>4</sub> administration, as evidenced by decreased levels of serum and liver LPOs, GPT, and ALP. Elevated levels of collagen hydroxyproline, a marker of fibrosis, were significantly decreased by *P. emblica* extracts. Pathological examinations suggested that the extracts may prevent the induction of fibrosis in rats subjected to chronic CCl<sub>4</sub> administration. The potential prevention of liver fibrosis highlights the extracts' possible therapeutic implications in mitigating chronic liver damage.<sup>[59]</sup>

#### 4.20 Inhibitor of HIV Reverse Transcriptase (RT)

Both the aqueous fraction and the n-hexane fraction, at a concentration of 1 mg/ml, demonstrated complete inhibition of recombinant HIV-RT, with percentages of 91% and 89%, respectively. The chloroform fraction and the CCl<sub>4</sub> (carbon tetrachloride) fraction, each at a concentration of 0.12 mg/ml, showed the greatest inhibition of HIV-RT. The n-hexane fraction and CCl<sub>4</sub> fraction exhibited 50% inhibition of HIV-RT at concentrations of 0.12 mg/ml and 0.5, respectively.<sup>[60]</sup>

#### 4.21 Hypercholesterolemia Activity

The study investigated the effects of *P. emblica*, specifically Sunamla (presumably a specific formulation of Amla) and ethyl acetate extract of *P. emblica*, on Cu(2+)-induced LDL oxidation in vitro. Both sunamla and ethyl acetate extract of *P. emblica* significantly inhibited Cu(2+)-precipitated LDL oxidation. The inhibitory effects of sunamla and ethyl acetate extract were reported to be stronger than those of probucol, a known antioxidant and lipid-lowering medication. Rats fed with 1% cholesterol diet were administered either

sunamla or ethyl acetate extract for 20 days. Ethyl acetate extract showed a more impressive serum cholesterol-decreasing effect than sunamla at the same quantity.<sup>[61]</sup>

#### 4.22 Hyperlipidemic Activity

Flavonoid extracts from *P. emblica* fruit inhibited cholesterol synthesis and promoted its degradation by increasing hepatic HMG-CoA reductase.<sup>[62]</sup> Fresh fruit juice of *P. emblica* given to rabbits led to a significant reduction in induced aortic plaques, returning them to almost normal levels, while also reducing serum and tissue lipid levels. Ethanol extract of *P. emblica* improved the lipid profile and decreased hypertension in rats with induced metabolic syndrome. In a human clinical trial involving men with hypercholesterolemia (ages 35 to 55) who took *P. emblica* supplements for 28 days, a drop in serum cholesterol levels was observed. The condition could be reversed upon stopping the supplement. Volunteers with diabetes experienced a reduction in total lipids at the 3 grams daily dose.<sup>[63,64,65]</sup>

#### 4.24 Hypolipidemic Activity

Patients with type II hyperlipidemia who were treated with *P. emblica* experienced significant reductions in total cholesterol, LDL (low-density lipoprotein), TG (triglycerides). Both simvastatin (a commonly used statin medication for lowering cholesterol) and *P. emblica* treatments significantly lowered blood pressure. The beneficial effect on blood pressure was reported to be more pronounced in patients receiving *P. emblica*. Histopathological research comparing the thoracic aortas of workers treated with *P. emblica* and rats fed an untreated high-cholesterol diet showed that the *P. emblica* treated group had less atherogenicity (less plaque formation in the arteries). *P. emblica* formulation was linked to hypolipidemic effects in experimentally induced hypercholesterolemic rats.<sup>[66]</sup>

#### 4.25 Larvicidal and Mosquitocidal

Analysis tests revealed that methanolic extract of *P. emblica* had a 98% mortality rate at 100 ppm against the malarial vector *Anopheles stephensi* in both larvicidal and pupicidal routines. Aside from the larvicidal effects of ethyl acetate extract of *P. emblica*, both ethanolic and methanolic extracts of *P. emblica* exhibited 100% mortality (no hatchability) at concentrations of 400 ppm and above. The ethyl acetate extract had the highest larvicidal recreation against *Aedes aegypti* larvae, with a larvicidal lethal concentration (the concentration resulting in 50% mortality) value of 78.89 ppm. The larvicidal recreation was reported to be 99.6%.<sup>[67]</sup>

#### 4.26 Memory Enhancing Activity

The study involved the administration of three different oral doses of *P. emblica* powder—50 mg/kg, 100 mg/kg, and 200 mg/kg. Special groups of young and old mice were subjected to these doses over a period of 15 days. The passive avoidance apparatus and the elevated plus maze were utilized to assess memory in mice. The study

investigated amnesia induced by aging and scopolamine-diazepam and measured total serum LDL cholesterol levels in the mice. Cholinesterase activity in the brain was also measured.<sup>[68]</sup>

#### 4.27 Metabolic Syndrome

The ethyl acetate extract of *P. emblica* was found to be effective in lessening the adverse effects of high fructose on both hypertriacyl glycerolemia and hypercholesterolemia. The results suggest that the polyphenol-rich fraction of *P. emblica* contributes to the attenuation of metabolic syndrome induced by fructose.<sup>[69]</sup>

#### 4.28 Nephroprotective Activity

The extract significantly decreased the levels of thiobarbituric acid reactive substance (TBARS) in the serum, renal homogenate, and mitochondria of aged rats. The reduction in TBARS suggests that *P. emblica* extract has the potential to lessen oxidative stress associated with aging. There was a significant suppression of the increases in cyclooxygenase 2 (COX-2) and inducible nitric oxide synthase (iNOS) in the aorta of aging rats. COX-2 and iNOS are inflammatory markers, and their suppression suggests an anti-inflammatory effect of the *E. officinalis* extract.<sup>[70]</sup>

#### 4.29 Neuroprotectivity

The study found that *P. emblica* extract exhibited a protective effect against DNA damage. This suggests a potential role in mitigating genetic or cellular damage. Different extracts of *P. emblica* have been found to be more effective and to encourage cell growth and proliferation. This is a positive indication of its potential regenerative or supportive effects on cells.

*P. emblica* exhibits therapeutic potential for neurodegenerative diseases and reduces oxidative stress.<sup>[71]</sup>

#### 4.30 Nitric Oxide Radical Scavenging Activity

*P. emblica* dried fruit rind was initially extracted with methanol. The extract was then fractionated into hexane, ethyl acetate (Et Ac), and water phases. Among the fractions (hexane, Et Ac, and water), the Et Ac phase showed the strongest NO scavenging activity in vitro. The Et Ac fraction was further subjected to separation and purification using Sephadex LH-20 chromatography. Through spectral approaches (1H nuclear magnetic resonance [NMR], 13C NMR, and MS) and comparison with literature values, five compounds with potent NO scavenging activity were identified. The compounds were identified as gallic acid, methyl gallate, corilagin, furosin, and geraniin. The study suggests that these compounds, present in the Et Ac fraction of EO, exhibit significant NO scavenging activity.<sup>[72]</sup>

#### 4.31 Prophylactic Effect

Tridive dyskinesia was induced in rats by the once-daily administration of haloperidol (1.5 mg/kg, intraperitoneal)

for 28 days. The active tannoid components of *P. emblica* consisted of Emblicanin A (37%), Emblicanin B (33%), Punigluconin (12%), and Pedunculagin (14%). Involuntary orofacial movements, including tongue protrusion, buccal tremors, and chewing 6actions, were evaluated as TD parameters. The tannoid components of *P. emblica* were administered concurrently with haloperidol at doses of 10, 20, and 50 mg/kg orally for 28 days. Vitamin E (400 mg/kg orally), an antioxidant, and sodium valproate (200 mg/kg orally), a GABA-mimetic agent, were used as standard medications and given for the same duration. The presence of antioxidant components in *P. emblica*, such as punigluconin and pedunculagin, may contribute to its neuroprotective effects.<sup>[73]</sup>

### 5. Safety and Risk Assessment

Some phytosterol compounds from *Phyllanthus emblica* have been reported to exhibit cytotoxic effects in both tumor and non-tumor cell lines. Cytotoxicity in tumor cells is often considered a potential positive effect in the context of cancer treatment. Despite the cytotoxic effects observed in specific compounds, there is no reported overall toxicity associated with *Phyllanthus emblica*.

No specific contraindications for the use of *Phyllanthus emblica* have been identified. Information regarding the safety and efficacy of *Phyllanthus emblica* in pregnancy and lactation is lacking.<sup>[74]</sup>

### 6. CONCLUSION

*P. emblica* is widely used in Ayurvedic medicine for its diverse pharmacological properties, making it one of the most utilized Ayurvedic medicinal plants. The plant is considered as a natural source for the development of future drugs. This implies the need for research and formulation to create standardized and reliable medicinal products from Amla.

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