Scholars Academic Journal of Biosciences
Abbreviated Key Title: Sch Acad J Biosci
ISSN 2347-9515 (Print) | ISSN 2321-6883 (Online)
Journal homepage: https://saspublishers.com
NLM ID:101629416

OPEN ACCESS

Nutrition

Phyllanthus emblica: Its Health Benefits and Phytochemistry; A Detailed Review

Anum Shoukat[1*], Nudrat Khursheed[2*], Muhammad Usman Khalid[3], Mutjardah Zarrish[4], Afaq Ahmad[5], Muhammad Shahbaz Khan Afridi[6], Areeb Imtiaz[7], Sehr Sadiq[8]

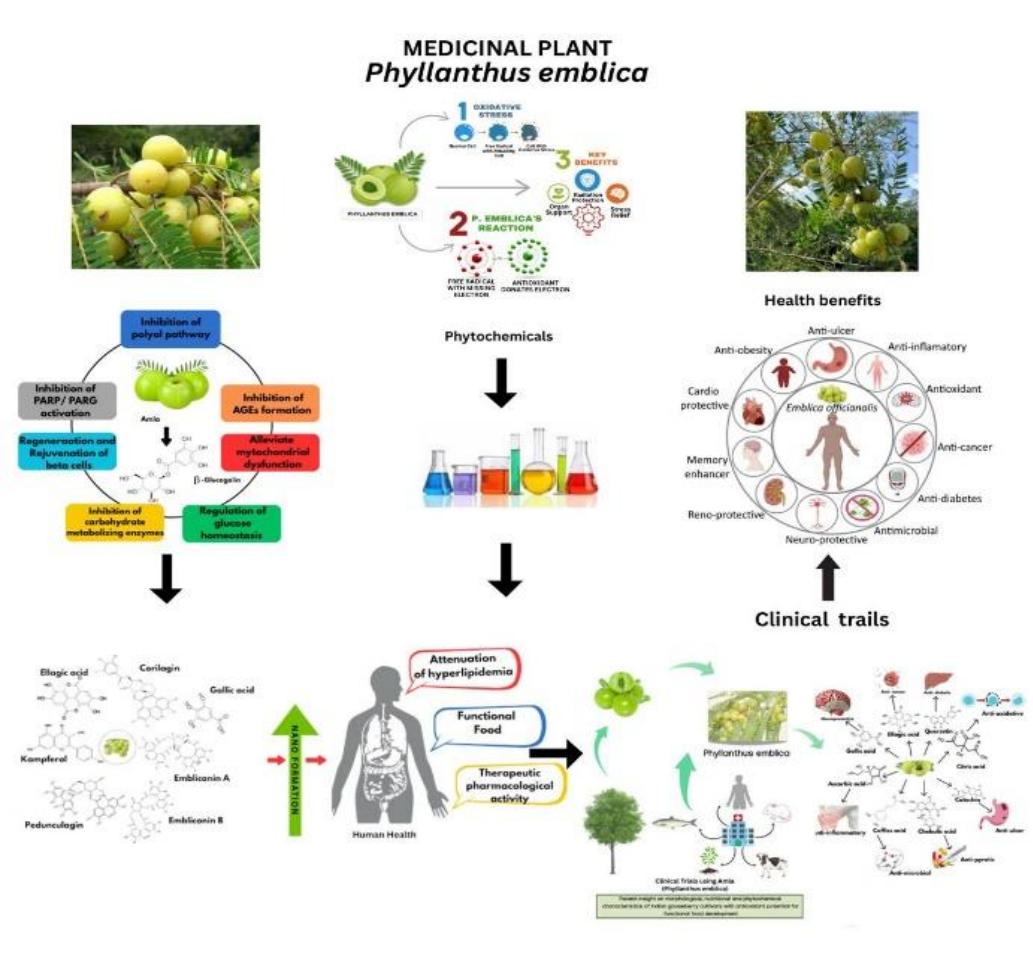
[1,2,3,4,7,8]Faculty of Food Science and Nutrition, Bahauddin Zakariya University
[5]Institute of Food Science and Nutrition, University of Sargodha
[6]University College of Pharmacy, University of the Punjab Lahore

DOI: https://doi.org/10.36347/sajb.2025.v13i06.016 | **Received:** 18.05.2025 | **Accepted:** 23.06.2025 | **Published:** 26.06.2025

***Corresponding author:** Anum Shoukat, Nudrat Khursheed
Faculty of Food Science and Nutrition, Bahauddin Zakariya University

Abstract | **Review Article**

Phyllanthus emblica L. (Indian gooseberry or Amla) is a well-known medicinal plant with high therapeutic and nutritional value. The plant is rich in tannins, flavonoids, alkaloids, phenolic acids, and ascorbic acid, which are responsible for its strong antioxidant activity. Prominent constituents like emblicanin A and B, gallic acid, and ellagic acid validate its antioxidant activity against oxidative stress and control over metabolic processes. Pharmacological studies show that it is effective against inflammation, hyperglycemia, cancer cell growth, hepatic injury, and microbial infections. Anti-diabetic action is due to its effect on glucose metabolism and the vascular system, whereas anticancer efficacy is due to inhibition of tumorigenic transcription factors and cell growth. P. emblica further influences immune functions, improves liver function, and gives relief from the gastrointestinal system through laxative and antidiarrheal activities. Evidence also shows its radio-protective and anti-mutagenic effects. Such effects are verified through in vivo and in vitro tests, though more studies are needed to determine the exact mechanisms and active compounds. Although it has a vast traditional history of use and encouraging bioactivities, the clinical utility of P. emblica is currently restricted owing to a lack of standardization and controlled human trials. This review discusses its taxonomic classification, dense phytochemical content, and varied pharmacological activities, also underscoring the imperative need for more advanced research in terms of isolation of compounds, studies on molecular interactions, and clinical validation to unleash its full therapeutic potential. P. emblica may be an important contender for evidence-based inclusion into contemporary pharmacotherapy.



Keywords: Phyllanthus emblica, phytochemical, anti-inflammatory, antioxidant, traditional medicine.

INTRODUCTION

Nature has bestowed upon us a diverse botanical life and a vast array of plant species grown in various parts of the globe. Plants are the foundation of a complicated traditional medical system. Natural products derived from medicinal plants are a great source of active and lead chemicals needed for drug development. Plants and plant-based products have been used to cure ailments and injuries for millennia (Anand *et al.,* 2022). Traditional medicines are essential in meeting the healthcare needs of people in underdeveloped countries, according to the World Health Organization (WHO). Many medicinal plants have a high safety index, which encourages their usage by people from all walks of life all over the world (Sridhar *et al.,* 2023).

Many medicinal or nutritional plants, as well as their components, may operate as both therapeutic and preventive agents, delaying and minimizing the negative consequences of many chronic diseases (Stadler and Marsche, 2021). One element of investigating plants for medicinal purposes is determining the availability of physiologically active compounds that can be utilized directly as medications, such as morphine, taxol, vincristine, vinblastine, digoxin, reserpine, and digitoxin. Plants are also employed to make novel and improved bioactive molecules, such as nabilone, texotere, metformin, and amiodarone-like, that have better results and fewer adverse effects than synthetic medications.

Pharmacological agents can be made from plant-derived bioactive chemicals like mescaline, yohimbine, and lysergic acid diethylamide. St. John's wort (*Hypericum perforatum* L.), garlic (*Allium sativum* L.), Echinacea genus species, saw palmetto (Serenoa repens (W. Bartram), Ginkgo biloba L, and cranberry (*Vaccinium macrocarpon Aiton*) are examples of traditional herbal medicine—higher plants, which include gymnosperms and angiosperms, number around 250,000 species (Ahmad *et al.,* 2021).

Taxonomy

The Taxonomic classification of *Phyllanthus emblica* (P. emblica) is summarized in Table 1(Acharya *et al.,* 2021).

Table 1: Taxonomic classification of phyllanthus emblica

Kingdom	**Plantae -plants**
Sub kingdom	Tracheobionta-vascular plants
Super division	Spermatophyta-seed plants
Division	Magnoliophyta-Flowering plant
Class	Magnoliopsida-Dicotyledons
Subclass	Rosidae
Order	Malpighiales
Family	Phyllanthacae
Genus	Phyllanthus L. (Leaf-flower)
Species	Phyllanthus emblica L. (Emblic)

Synonyms

Phyllanthus emblica, also known as Cicca emblica (L.) Kurz., Diasperus emblica (L.) Kuntze Dichelactina nodicaulis Hance, Emblica arborea Raf., Emblica officinalis Gaertn., Phyllanthus glomeratus Roxb. ex Wall. nom. inval., Phyllanthus mairei H. Lév., Phyllanthus mimosifolius Salisb., Phyllanthus taxifolius D. Don (Priya and Islam, 2019).

DISTRIBUTION

Phyllanthus emblica fruit is a rare and valuable natural gift from Pakistan. It's mostly found on hilltops and in coastal areas above 200 meters (Gantait et al., 2021). This deciduous tree is endemic to tropical southeastern Asia, including central and southern India, Pakistan, Bangladesh, Sri Lanka, south China, the Mascarene Islands, and Malaysia. It grows to a height of 8-18 meters. Amla is high in fiber, carbohydrates, iron, and vitamin C and is said to be the richest source of the vitamin (Taleuzzaman *et al.,* 2021). The fruit is also used in a traditional Thai herbal formulation called Triphala, which is made up of Emblica officinalis, Terminalia belerica, and Terminalia chebula.

Vernacular name

Arabic: Amliy, Amlaj. **Assami:** Amalaki, Amluki, sohmyrlain. **Bengali:** Ambolati, Amla, Amalaki, Amlati, Amulati, Aunlah, Yeonlah. **Burma:** Hziphyu, Shabju, Siphiyusi, Tasha, Zibyu, Ziphiyusi. **Cuttack:** Alathanda. **English:** Emblic myrobalan tree, Indian Gooseberry. **Gujarati:** Amli, Ambala, Ambri, Amla, Bhoza, Bhozzmali. **Hindi:** Amalaci, Amla, Amlika, Anola, Anuli, anvula, Anvurah, Anwerd, Aonla, aungra, Aunra, Daula. **Kashmiri:** Ambali, Amli Aonla **Konkani:** Anvallo, Dogranvalli, Dogranvallo. **Malayalam:** Amalakam, Nelli, Nellikka. **Marathi:** Anvala, Aonli, Avla, Arola, Bhuiawali. **Nepal:** Amla. **Punjabi:** Ambal, Ambli, Ambul, Amla, Aonla. **Sanskrit:** Dhartiphala, Amraphalam, Amalku, Adiphala **Sinhalese:** Awusadanelli, Nelli, Nellika. **Tamil:** Amalagam, Andakoram, Indul, Kattunelli, Nelli, Perunelli, Sirottam, Tattiri, Topunelli. **Telugu:** Amalakamu, amalaki, Nelli, pullayusirika, Usirika, Usirikaya, Usiriki. **Tulu:** Nelli. **Urdu:** Anwala. Uriya: Khondona, Onola (Anjum & Nafees, 2020).

BOTANICAL DESCRIPTION

Phyllanthus emblica is primarily found in Pakistan, Bangladesh, Sri Lanka, Malaysia, southern China, the Mascarene Islands, South East Asia, and Uzbekistan central and southern India (Sultana et al., 2023). It is a Medium-sized deciduous tree with thin, light grey bark that exfoliates in small, thin, irregular flakes, growing to a height of 8-18 meters (Narayana 2021). Different parts of the plant are utilized for various purposes, including dried fruits, fresh fruits, seeds, leaves, root bark, and flowers (Gul *et al.,* 2022). The fruits are approximately 15-20 mm in length and 18-25 mm wide, roughly spherical or globular in shape, and with a tiny conic depression on both apexes. When fully matured, the mesocarp is yellow, and the endocarp is yellowish-brown. These fruits are Globose, juicy, pale yellow crustaceous cocci with six indistinct vertical furrows enclosing six trigonous seeds. Seedlings begin to bear fruit in 7-8 years after planting, while budded clones begin giving fruit in the fifth year.

The leaves of the tree are Simple, sub-sessile, densely arranged along the branchlets, giving a pinnate look due to their pale green color (Javed *et al.,* 2023). The bark is Shiny greyish brown or greyish green, up to 12 mm thick. The seeds are smooth, dark brown, and usually found in groups of four to six (Manohar *et al.,* 2024). The plant typically flowers between December – January and the fruiting season follows February – May (Narayana *et al.,* 2022).

Phytochemistry

Phyllanthus emblica is among the plants that have been examined the most from nutritional prospective. Tannins, alkaloids, and polyphenols are all present. Tannins account for around 28% of the Phyllanthus emblica part. The fruit possesses antioxidant effects and contains phyllanthus emblicin, a chemical element. It contains phytochemicals such as gallic acid and geraniin. The fruit juice contains the highestHuang concentration of vitamin C. It also includes hydrolyzable tannins, including emblicanin A and emblicanin B. Alkaloids found in Phyllanthus emblica include Phyllantine and Phyllembein. Gallic acid and ellagic acid are phenolic compounds found in it. Amino acids, carbohydrates, vitamins, organic acids, and different flavonoids are also present (Hussain *et al.,* 2021). Apigenin, gallic acid, ellagic acid, chebulinic acid,

quercetin, chebulagic acid, corilagin, isostrictiniin, methyl gallate, luteolin, and other beneficial components are found in this herb. Tannins found in Emblica officinalis include emblicanin A, emblicanin B, phyllaemblicin B, punigluconin, and pedunculagin. Glutamic acid, proline, aspartic acid, alanine, and lysine each account for 29.6%, 14.6%, 8.1%, 5.4%, and 5.3% of total amino acids, respectively. Gallic acid 1.325, tannin, gum 13.75%, albumin 13.08%, crude cellulose 17.08%, mineral matter 4.12%, and moisture 3.83% are found in the pulpy component of the fruit after it has been dried and separated from the nuts.

Tannins, flavonoids, phenolic compounds, saponins, terpenoids, ascorbic acids, carbohydrates, and a variety of other chemicals are found in E. officinalis (Rachitha *et al.,* 2023). Individuals suffering from anaemia benefit significantly from fresh amla fruit supplements. Fresh amla fruit juice is used as a diuretic, anti-bilious treatment, and tonic. It can also aid with excessive thirst, indigestion, burning sensations, and other digestive system issues (Gantait *et al.,* 2021). P. emblica was used to treat sore throats, hypertension, dropsy, and hepatitis B in the Chinese, and malaria, jaundice, and renal calculus in Africans.

Amla fruit ash includes 2.5 parts per millions of chromium, 4 parts per millions of zinc, and 3 parts per millions of copper (Sharma *et al.,* 2021). Proximate analysis of *Phyllanthus emblica* shows 81.2% moisture, 0.5% protein, 0.1% fat, 0.7% mineral matter, 3.4% fiber, 14.1% carbohydrate, 0.05% calcium, 0.02% phosphorus, 1.2 mg/100g iron, 600 mg/100g vitamin C, and 0.2 mg/100g Nicotinic acid (Maiuolo *et al.,* 2021).

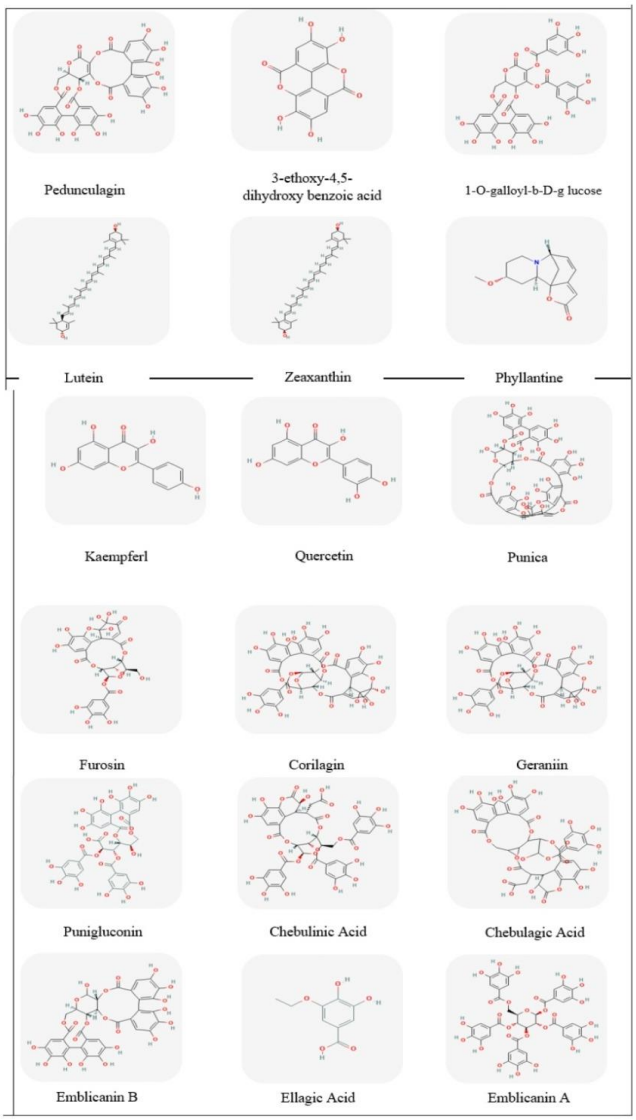


Figure 1: Phyllanthus emblica contains a wide range of phytochemicals, including flavonoids (quercetin and kaempferol), phenolics (gallic acid, ellagic acid, 1-O-galloyl-β-D-glucose), and tannins (emblicanin A and B, chebulagic acid, chebulinic acid, corilagin, and pedunculagin). These compounds have strong hepatoprotective, anti-inflammatory, and antioxidant properties. Alkaloids like phyllantine and carotenoids like lutein and zeaxanthin further boost the cytoprotective and antibacterial properties. Additionally, other substances including furosin, geraniin, and 3-ethoxy-4,5-dihydroxybenzoic acid continue to support this substance's therapeutic potential against oxidative stress and chronic illnesses

Phytochemicals or nutrients present in *Phyllanthus emblica* are polyphenolic contents. Polyphenolics contents contains Alkaloids (Phyllantidine and phyllantine), Tannins (chebulagic acid, chebulinic acid, gallic acid, punigluconin, emblicanin A, ellagic acid, emblicanin B, 1 -O-galloyl-b-D-glucose, ellagic acid, ellagitannins, 3-ethylgallic acid (3- thoxy-4,5-dihydroxy benzoic acid), pectin, corilagin, citric acid, pedunculagin, trigallaylglucose, 3,6-diO-galloyl-D-glucose, isostrictiniin and 1,6-di-O-galloyl-b-D-glucose) (Choi 2022). Other phenolic contents include gallic acid, flavonoids, kaempferol, and ellagic acid, as well as phyllanemblinin, methyl gallate, geraniin, corilagin, furosin and punica (Balkrishna *et al.,* 2023). It contains unsaturated fatty acids such as linoleic acid, linolenic acid, myristic acid, palmitic acid and oleic acid, and minerals like calcium, magnesium, iron, selenium, potassium, copper, phosphorus, and sodium are present in reasonable amounts. In other investigations, the polyphenol content of *Phyllanthus emblica* water extract was determined to be 34.22 plus or minus 1.74g gallic acid/100 g extract. Phyllanthus emblica has a high ascorbic acid level of 0.34% -0.38% and 0.40% w/w of the fruit, which has 45-70% antioxidant activity (Selvamuthukumaran, 2020).

Biological use in modern medicine

P. emblica has been used as food in many parts of the world due to its high nutritional content, especially in micronutrients. The elements of this plant have been used to make a variety of herbal and patent medications (Saini *et al.,* 2022). Tannins, flavonoids, phenolic compounds, saponins, terpenoids, ascorbic acids, carbohydrates, and a variety of other chemicals are found in E. officinalis (Rachitha *et al.,* 2023). Furthermore, P. emblica offers a wide range of therapeutic qualities and applications for many disorders.

Details on the recorded medicinal purposes and activity against various diseases and disorders are discussed below.

Anti-inflammatory activity of P. emblica

An ethanolic extract of the leaves was tested for P. emblica anti-inflammatory activity against a carrageenan-induced mouse model in another investigation. The experiment was carried out on 25 mice in vivo models, which were separated into five groups, each with five animals. Amlaki leaf extract exhibited notable anti-inflammatory properties, with the 200mg/kg dose showing the most significant reduction in edema among the treated groups. The edema volume in the negative control group was 0.090.02 ml, while it was 0.050.03 ml in the positive control group. The edema volume in groups 3, 4, and 5 was considerably greater, i.e., 0.07±0.01ml, 0.06±0.02 ml, and 0.07±0.01 ml, respectively, indicating anti-inflammatory solid efficacy (Grover, 2021). Lipopolysaccharide-stimulated RAW264.7 macrophages created the inflammation model to test the plant's anti-inflammatory effects. The secretion of NO and cytokines (TNF-alpha, IL-1beta, IL-6) in RAW264.7 macrophages was reported to be inhibited by several solvent extracts of P. emblica, such as ethyl acetate and petroleum ether (Khursheed *et al.,* 2020).

Antioxidant activity of P. emblica

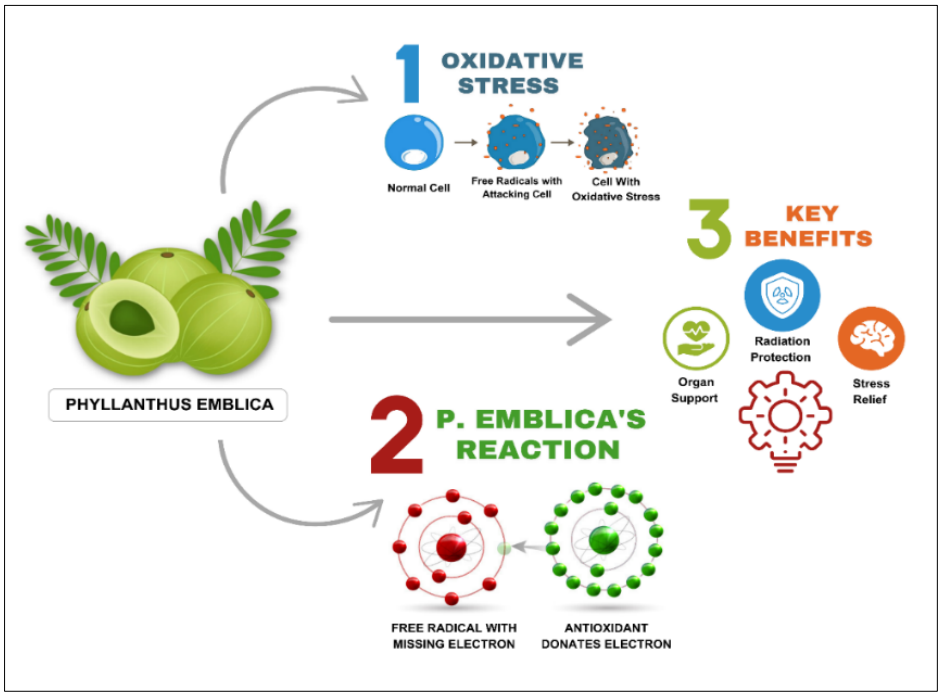


Figure 2: Phyllanthus emblica provides advantages such organ support, radiation protection, and stress reduction by giving electrons to neutralize free radicals and reduce oxidative stress

Oxidative stress due to an imbalance between pro-oxidant and antioxidant systems is being increasingly found to be a key factor in multifactorial diseases. High levels of free radicals and inefficient antioxidant defenses like superoxide dismutase (SOD) may cause tissue injury as shown in Figure 2. Phyllanthus emblica has been shown to possess strong antioxidant activity, with high SOD-like activity. A study in Japan's Niwa Institute of Immunology had its high free radical scavenging activity substantiated, signaling its promise to be used as a therapeutic in oxidative stress-induced conditions (Sharma *et al.,* 2020).

P. emblica also has a high amount of phenolic components (such as Gallic acid) and ascorbic acid (Naik & David, 2022). Gallic acid, equivalent to total phenolic content in E. officinalis fruit and seed, has high antioxidant properties and plays a key role as a free radical scavenger in the maintenance of redox homeostasis, which is linked to various degenerative disorders (Pattanaik & Sharma, 2022). Another study also proves that Gallic acid is a phenolic molecule with hydroxyl groups that can donate their protons. This activity aids in the breakdown of a chain reaction involving numerous free radicals. According to research, gallic acid protects the liver, heart, and brain from injuries caused by toxic chemicals and ischemia. The effects of Emblica officinalis (EO) on cold stress-induced behavioral and biochemical abnormalities were investigated. Cold stress-induced behavioral and biochemical abnormalities in albino rats were considerably reduced when P. emblica was given orally at a dose of 1g/kg/animal body weight for 48 days. As a result, P. emblica supplementation might be considered a stress-relieving medication (Hegde *et al.,* 2022).

High xanthine oxidoreductase activity and lower superoxide dismutase activity were identified in the intestines of mice exposed to whole-body gamma irradiation (WBI), which returned to sham-irradiation controls when the animals were fed P. emblica for 7 days before irradiation. It suggested that after feeding animals P. emblica, they would be protected against oxidative damage produced by whole-body radiation exposure. Triphala protected whole-body irradiated mice. Inhibition of oxidative damage in cells and organs provided protection. It was discovered that this drug could become a unique herbal radio-protector for use in mice. Inhibition of oxidative damage in cells and organs provided protection. This medicine has the potential to develop into a unique herbal radio-protector with practical applications, according to the study (Gupta *et al.,* 2021). According to a different study, the aqueous extract of E. officinalis fruit made according to Thai Herbal Pharmacopoeia has a high potential for free radical scavenging, ferric reduction, and ROS (reactive oxygen species) inhibition (Wetchakul *et al.,* 2019) (Asmilia *et al.,* 2020).

Immunomodulatory activity of P. emblica

P. emblica has a high antibacterial potency and can be used to fight infections, resulting in the development of resistance to disease-causing organisms and increased immunity (Pandey 2021). In Emblica-treated albino mice, there was a significant dose-dependent increase in haemagglutination antibody titer, macrophage migration index, hypersensitivity reaction, peritoneal macrophage respiratory burst activity, total leukocyte count, percentage lymphocyte distribution, serum globulin, and relative lymphoid organ weight, indicating its ability to stimulate humoral and cell-mediated immunity as well as macrophage phagocyte activity (Chen *et al.,* 2023).

The immunomodulatory characteristics of P. emblica were studied using chromium (VI) as an immune suppressant. P. emblica not only alleviates Chromium (VI) inhibitory effect on lymphocyte proliferation but also decreases DNA fragmentation and death, according to the findings (Altındağ *et al.,* 2021).

Anticancer activity of P. emblica

E. officinalis inhibits activator protein-1 and targets transcription of viral oncogenes that cause cervical cancer, suggesting its potential usefulness in the treatment of human papillomavirus-induced cervical malignancies (Li *et al.,* 2022). An ethanolic whole plant extract of E. officinalis at a dosage of 100µg/mL was used in an in vitro cytotoxicity test against five human cancer cell lines. Plant extract inhibited the growth of the lung (A-549) cell line by 82%. The plant extract had little effect in the liver cell line (Hep-2), while it had the most activity in the colon 502713 cell line. The plant extract showed 97% activity in the IMR-32 neuroblastima cell line and 98% activity in the HT-29 liver human cancer line, respectively (NAZ *et al.,* 2021).

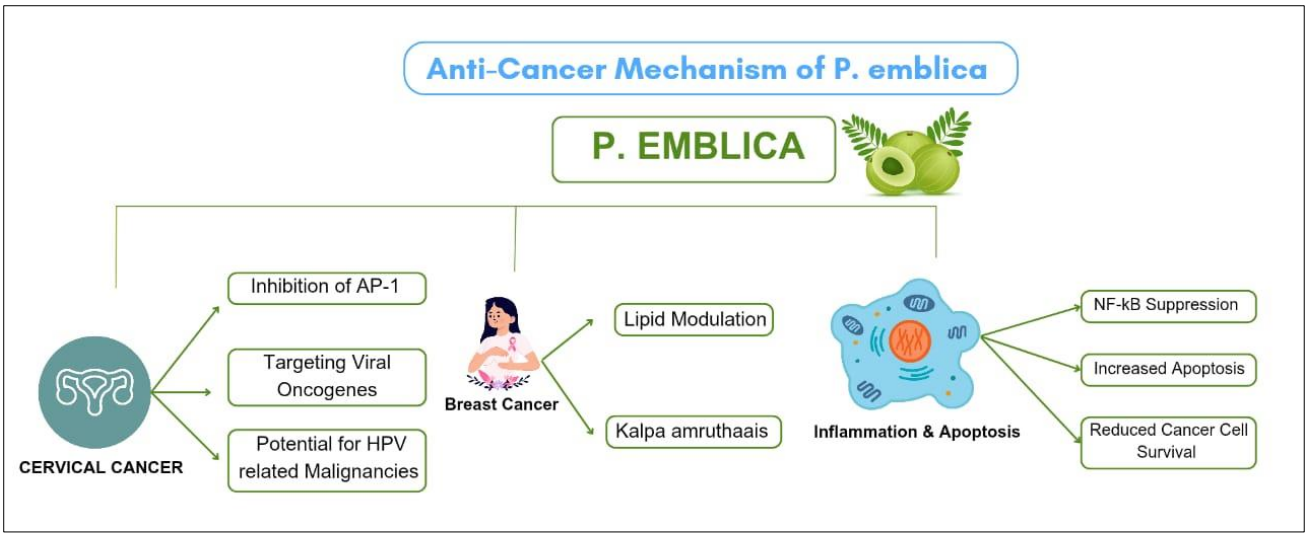


Figure 3: Phyllanthus emblica has anti-cancer properties through apoptosis promotion, inflammation modulation, and targeting of the processes that lead to the development of breast and cervical cancer

Necrosis factor kappa B is responsible for cancer survival and significant apoptosis in numerous cancer cell lines, which leads to inflammation as mentioned in Figure 3. In this situation, binding of this transcript item to DNA binding elements may result in kappa B factor suppression (Rana *et al.,* 2021).

Breast cancer:

Breast cancer is one of the most common cancers that affects primarily women. The induction of breast cancer has been connected to a range of lipoproteins, lipid metabolizing enzymes, and lipids (Pandrangi *et al.,* 2022). Kalpa amruthaais, for example, is a Siddha preparation that is given to patients along with honey and Semecarpus anacardium to lower high levels of free fatty acids, cholesterol, phospholipids, and triglycerides, reducing the levels of ester cholesterols in the liver, kidney, and plasma of cancer-affected animals. Animals returned to their normal state after treatment (Chaudhry 2021).

Anti-diabetic activity of P. emblica

Diabetic patients are expected to increase from 171 million in 2000 to 366 million in 2030, according to projections (Francavilla & Joye, 2020). Diabetes mellitus is a metabolic condition in which the body's lipid, protein, and glucose metabolism is disrupted, resulting in hyperglycemia. The dysfunction of insulin and its secretion from beta cells causes hyperglycemia (Sharma *et al.,* 2020). In normal and Alloxan-induced diabetic rats, herbal formulations containing extracts of *Tinospora cordifolia*, *Trigonella foenum*, and *Emblica officinalis* were evaluated for hypoglycemic effects and Oral Glucose Tolerance Test (OGTT), and significant, marginal, and very small decreases in blood glucose levels were observed when different herbal combinations were used (Huang *et al.,* 2021).

Streptozotocin (STZ) at a dose of 35 mg/kg body weight, intraperitoneally, was used to induce diabetes in Wistar-NIN rats, and a 2% P. emblica pericarp and a 0.2% standard blend of its tannoids were investigated. Both blood glucose and insulin levels indicate that STZ-induced hyperglycemia was not prevented (Suryanarayana *et al.,* 2007). However, slit lamp microscopic examination revealed that they slowed cataract growth. Due to reversal changes in protein carbonyl concentration, antioxidant enzyme activities, and lipid peroxidation activities, P. emblica and its tannoids content may reverse oxidative stress via the polyol pathway, according to this study. Both also prevented lens protein in solubilization and aggregation caused by hyperglycemia (Susilawati *et al.,* 2021).

Because the impacts of diabetic vascular problems involving ellagitannin-derived urolithin metabolites are uncommon, the influence of P. emblica fruits was investigated. In rats, streptozotocin was used to cause hyperglycemia. The hyperglycemic rats were subsequently utilized to investigate acetylcholine-induced endothelium-independent relaxation in the aortas, which was aided by P. emblica fruit eating. Fruit-eating decreased Akt (Thr308) phosphorylation in hyperglycemic aortas (Harikrishnan & Balasundaram, 2020).

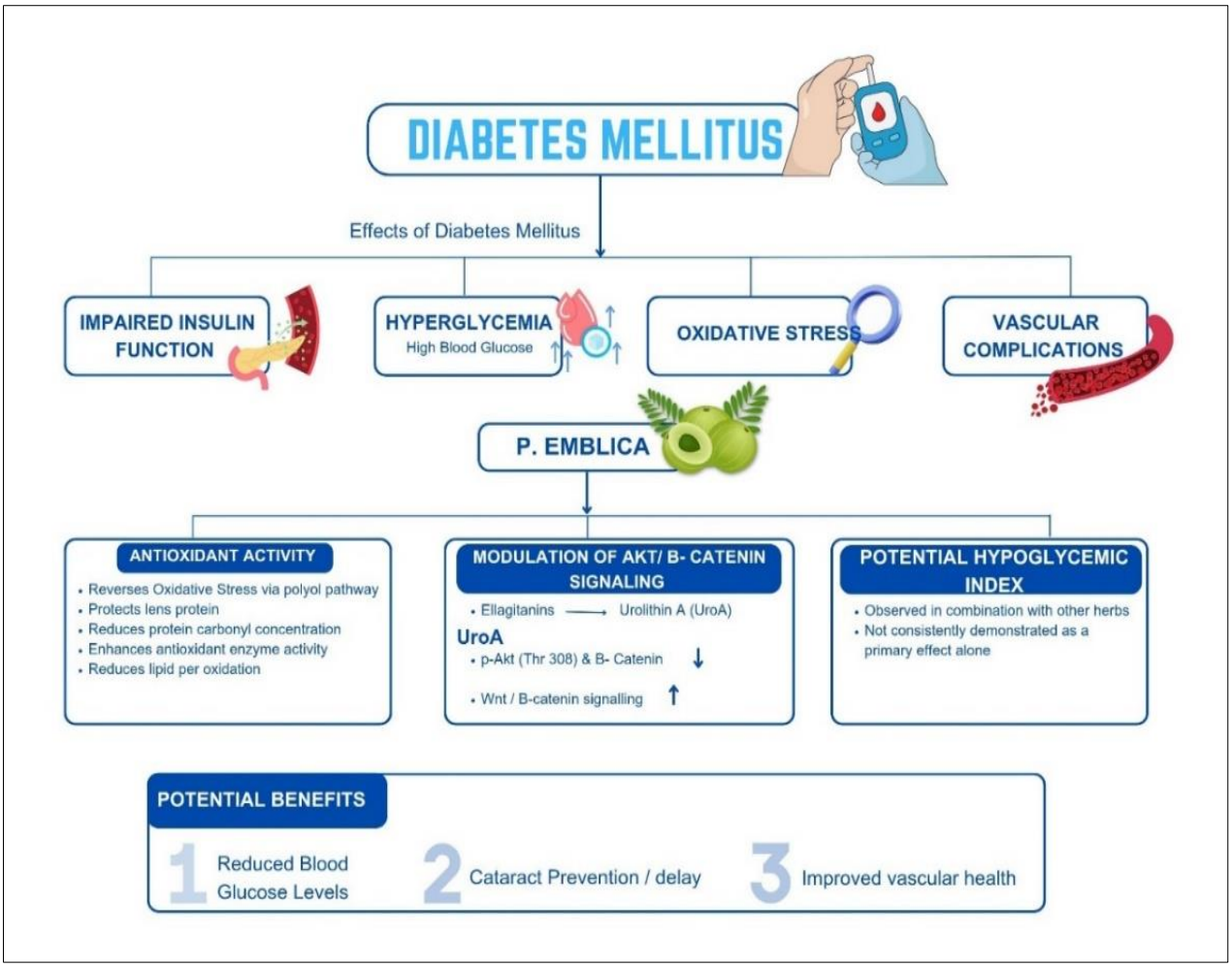


Figure 4: Phyllanthus emblica supports blood glucose regulation and vascular health, lowers oxidative stress, and modifies important signaling pathways to help manage diabetes

Urolithin A (UroA) and its derivative phase II metabolites were identified as the metabolites released following fruit ingestion using HPLC-ESI-Q-TOF-MS. In a high glucose-induced A7r5 vascular smooth muscle cell proliferation paradigm, UroA was found to reduce phosphor-Akt (Thr308) and b-catenin protein production as shown in Figure 4. Furthermore, UroA treatment resulted in the activation of Wnt/b-catenin signaling in LiCl-triggered A7r5 cells, as well as the accumulation of b-catenin protein. As a result, by regulating Akt/b-catenin signaling, this study demonstrated the facilitation impact of P. emblica fruits on vascular function at a hyperglycemic rate. To illustrate ellagitannins' anti-diabetic potential, tested their effects on P. emblica (emblica leaf flower fruits).

Hepatoprotective activity of P. emblica

The Hepatoprotective activity of P. emblica extract (0.5 and 1 mg/mL) on ethanol-induced liver damage in rats was investigated. The study found that reducing transaminase release boosted the viability of cells treated with ethanol (96 mL/mL). The hepatotoxicity markers employed in the histopathology were TNF-alpha, serum triglyceride (STG), IL-1beta, serum transaminases (AST and ALT), and hepatic triglyceride (HTG). Pretreatment with P. emblica at 25, 50, and 75 mg/kg, as well as SL (silymarin; a standard Hepatoprotective drug) at 5 mg/kg, given 4 hours before ethanol, reduced ethanol-induced levels of IL-1beta, ALT, and AST as the mechanism shown in Figure 5 . The recovery of liver cells was accelerated by a dose of 75 mg/kg. P. emblica extract (extracted with 50% ethanol) for seven days, followed by 21 days of ethanol (4 g/kg/day, p.o.) to normalize the levels of IL1beta, ALT, and AST, as well as SL (5 mg/kg/day). As a result, the findings demonstrated that P. emblica extract has a liver-protective effect (Khoa *et al.,* 2020). In Wistar rats, EO also reduced liver toxicity (Akbar, 2020).

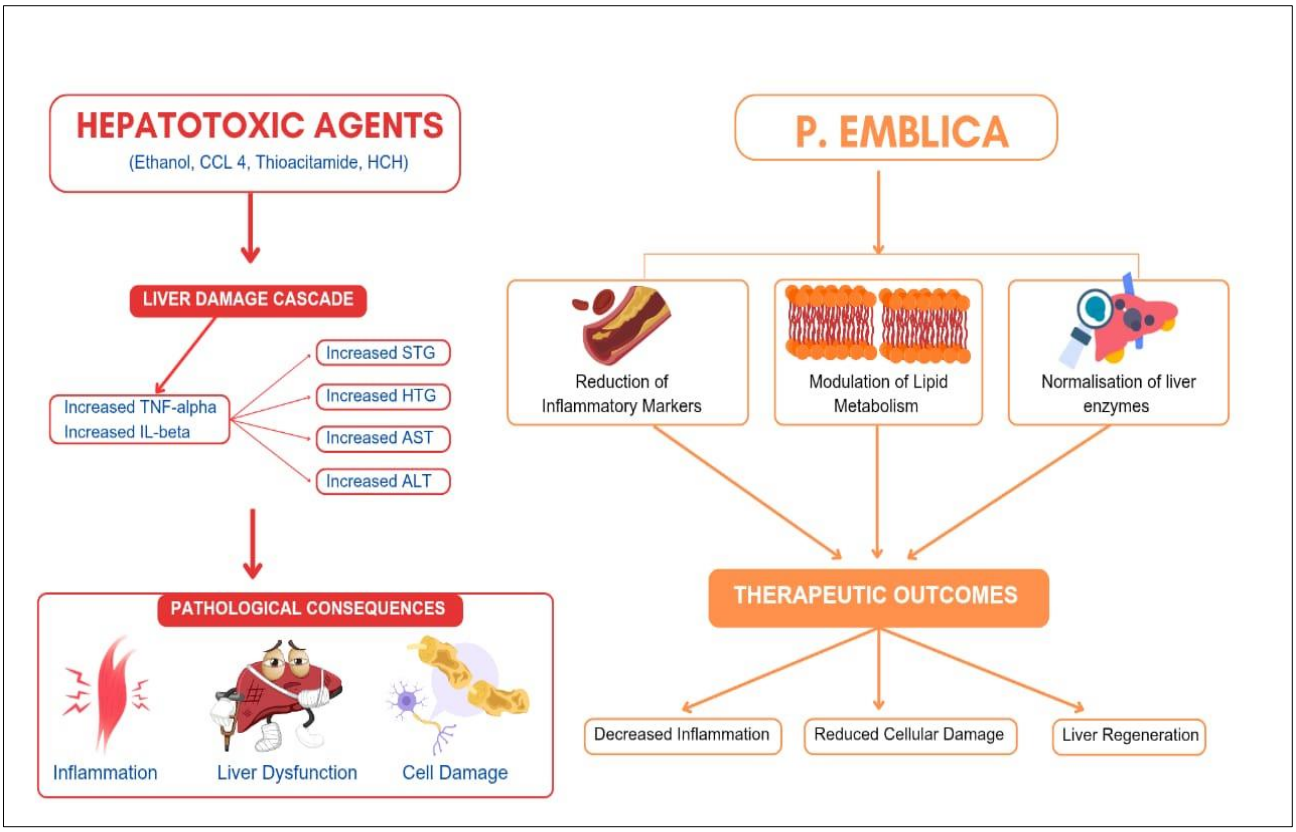


Figure 5: In order to promote liver regeneration and cellular protection, Phyllanthus emblica normalizes liver enzymes, reduces inflammation, and modifies lipid metabolism

A histopathological investigation was conducted to show that a 50% hydroalcoholic extract of the fresh fruit of E. officinalis protected rats from chronic toxicity caused by carbon tetrachloride and thioacetamide. E. officinalis restored aberrant histology by speeding regeneration activity in the liver sections of the tested rats, and hepatocytic damage was found to be insignificant in a few cases in the E. officinalis treated group of rats (Anbesse, 2020).

Pre-feeding Amla appears to minimize the increase in renal gamma-glutamyl transpeptidase (GGT) activity caused by hexachlorocyclohexane (HCH). It demonstrates an increase in the hepatic antioxidant system and a decrease in cytotoxic chemicals, which were otherwise influenced by HCH delivery (Jagdale *et al.,* 2021).

Anti-mutagenic activity of P. emblica

The antimicrobial activity of Phyllanthus emblica has been reported and its aqueous, acetone, choloroform extracts have been tested for antimutagenic properties. In this investigation, the direct-acting mutagens 4-nitro-o-phenylenediamine (NPD), sodium azide, and the indirect-acting pro-mutagen 2-aminofluorene (2AF) were tested against the TA98 and TA100 tester strains of Salmonella typhimurium in the presence of phenobarbitone-induced rat hepatic S9. For all direct and S9-dependent mutagens employed, acetone and chloroform extracts of Triphala showed anti-mutagenic properties (Anushya *et al.,* 2020). In vitro, P. emblica affects the acrylic surfaces of dentures. It also inhibits C. albicans adhesive activity, enhancing its antibacterial properties (Sarkar *et al.,*2022).

An experiment on Swiss albino mice revealed that a 50% methanolic extract of the Emblica fruit can protect mice from the chromosome-damaging effects of the well-known mutagen cyclophosphamide (Xin *et al.,* 2022).

Antidiarrheal activity of P. emblica

To test the antidiarrheal activity, three groups of mice were chosen at random, each with five mice, and diarrhea was caused by administering castor oil. The first group received 10 ml/kg of distilled water with 1% Tween-80. The second group received a conventional motility medicine called LO (leperamide) at a dose of 3 mg/kg orally. The plant's fruit extract was given orally to the third group at an amount of 500 mg/kg body weight. At doses of 50, 100, and 150 mg/kg, the methanol extract of P. emblica showed antidiarrheal activity in the rat model, resulting in a significant reduction in GIT motility (Swathi *et al.,* 2023).

The anti-tussive activity of P. emblica

The anti-tussive properties of P. emblica extract were examined in conscious cats using mechanical stimulation of the laryngopharyngeal and tracheobronchial mucous regions of the airways. The

cough-suppressing action of the section was not explicit after oral administration of the extract at a dose of 50 mg/kg body weight. The results were beneficial at more significant amounts, such as 200 mg/kg body weight, and demonstrated a significant reduction in cough frequency (NE/min-1) and cough attempts (NE). Cough attacks were more intense in inspirium (IA+) and expirium (IA-) patients. The standard drugs employed in this investigation were codeine and dropropizine, and the extract was found to be less effective than the traditional narcotic anti-tussive medicine codeine but more effective than the non-narcotic anti-tussive drug dropropizine. These findings demonstrated that E. officinalis had dose-dependent cough suppression (Zhang *et al.,* 2022).

The laxative activity of P. emblica

The fruit or fresh fruit of P. emblica that has been pickled or kept in sugar can be used as a laxative agent daily. It alleviates constipation (Mandliya *et al.,* 2023). Amla plant is much effective in treating diarrheal conditions and dysentery by introducing a drink prepared by Amla juice mixed with honey or lemon. It also aids in eliminating burning sensation while urination (Tewani *et al.,* 2017; Dasaroju, & Gottumukkala, 2014). Indian gooseberry is sometimes used to relieve constipation and hyperacidity in stomach. Phyllanthus emblica (amla) has been used traditionally to treat gastrointestinal disorders like dysentery and persistent diarrhea. In Ayurvedic and traditional traditions, amla decoctions are frequently mixed with milk-based carriers. Because of its high fiber content, constipation is lessened by promoting intestinal regularity. Clinical preparations frequently take into account standardized quantities depending on therapeutic need, even though traditional doses may vary (Yallesh Kumar *et al.,* 2018).

CONCLUSION

Phyllanthus emblica, commonly known as Indian gooseberry or Amla, is a medicinally valued plant across the world with vast therapeutic, nutritional, and ethnobotanical applications. Being used in various traditional remedies traditionally, the plant has been a focus of many studies due to its capability to yield a wide variety of bioactive compounds. The content of phytochemicals like tannins, flavonoids, phenols, alkaloids, saponins, and ascorbic acid in high concentration is responsible for its potent antioxidant activity. Phytochemical extracts from various parts of P. emblica have shown promising health benefits like anti-diabetic, anticancer, anti-inflammatory, hepatoprotective, antimicrobial, anti-mutagenic, and immunomodulatory effects. Experimental research, typically employing rodent models, has validated these pharmacological activities and demonstrated their effectiveness in the treatment of disorders from metabolic syndromes to oxidative stress-related disorders.

Preferably, the plant is also beneficial for gastrointestinal health and possesses laxative activity, which adds further to the conventional utility. In spite of this broad range of noticed benefits, limitations still exist in the knowledge base around the precise mechanism of action and the active phytoconstituents responsible for these activities. Further studies should involve meticulous phytochemical isolation, molecular docking experiments, and rigorous clinical trials to ascertain the efficacy, safety, and therapeutic potential of P. emblica. Subject to further research, the plant could be formulated into standardized, evidence-based medicines used in conventional medicine and integrative health programs.

REFERENCES

1. Acharya, C. K., Khan, N. S., & Madhu, N. R. (2021). Medicinal uses of amla, Phyllanthus emblica L.(Gaertn.): a prospective review. Mukt Shabd Journal, 10(10), 297-310.
2. Ahmad, B., Hafeez, N., Rauf, A., Bashir, S., Linfang, H., Rehman, M. U., & Rengasamy, K. R. (2021). Phyllanthus emblica: A comprehensive review of its therapeutic benefits. South African Journal of Botany, 138, 278-310.
3. Akbar, S. (2020). Handbook of 200 medicinal plants: a comprehensive review of their traditional medical uses and scientific justifications.
4. Altındağ, F., Rağbetli, M. Ç., Özdek, U., Koyun, N., Alhalboosi, J. K. I., & Elasan, S. (2021). Combined treatment of sinapic acid and ellagic acid attenuates hyperglycemia in streptozotocin-induced diabetic rats. Food and Chemical Toxicology, 156, 112443.
5. Anand, U., Tudu, C. K., Nandy, S., Sunita, K., Tripathi, V., Loake, G. J., & Proćków, J. (2022). Ethnodermatological use of medicinal plants in India: From ayurvedic formulations to clinical perspectives–A review. Journal of ethnopharmacology, 284, 114744.
6. Anbesse, R. W. (2020). Impact of Embalica Officinalis: A miracle multipurpose plant. Journal of Medical Research and Innovation, 4(1), e000199-e000199.
7. Anjum, A., & Nafees, H. (2020). A Comprehensive Review on a Unani Dynamic Drug: Amla (Emblica officinalis). Asian Plant Research Journal, 5(4), 1-6.
8. Anushya, P., Priya, A. J., & Arivarasu, L. (2020). Role of herbal medicine in dental health-a detailed review. Eur J Molec Clin Med, 7(1), 2185-96.
9. Asmilia, N., Sutriana, A., Aliza, D., & Sudril, N. (2020). Anti-inflammatory activity of ethanol extract from malacca leaves (Phyllanthus emblica) in carrageenan induced male mice. In E3S Web of Conferences (Vol. 151, p. 01066). EDP Sciences.
10. Balkrishna, A., Singh, S., Srivastava, D., Mishra, S., Sharma, S., Mishra, R., & Arya, V. (2023). A systematic review on traditional, ayurvedic, and herbal approaches to treat solar erythema. International Journal of Dermatology, 62(3), 322-336.
11. Chaudhry, B. (2021). Key Rasayana Plants of Ayurveda.

12. Chen, Y. Y., Chen, S. Y., Lin, J. A., & Yen, G. C. (2023). Preventive Effect of Indian Gooseberry (Phyllanthus emblica L.) Fruit Extract on Cognitive Decline in High-Fat Diet (HFD)-Fed Rats. Molecular Nutrition & Food Research, 2200791.
13. Choi, M. (2022). Anti-Aging Effects of Terminalia bellirica, Phyllanthus emblica, Triphala, and Carica papaya Extracts for Sustainable Youth. Sustainability, 14(2), 676.
14. Dasaroju, S., & Gottumukkala, K. M. (2014). Current trends in the research of Emblica officinalis (Amla): A pharmacological perspective. Int J Pharm Sci Rev Res, 24(2), 150-9.
15. Francavilla, A., & Joye, I. J. (2020). Anthocyanins in whole grain cereals and their potential effect on health. Nutrients, 12(10), 2922.
16. Gantait, S., Mahanta, M., Bera, S., & Verma, S. K. (2021). Advances in biotechnology of Emblica officinalis Gaertn. syn. Phyllanthus emblica L.: a nutraceuticals-rich fruit tree with multifaceted ethnomedicinal uses. 3 Biotech, 11, 1-25.
17. Grover, M. (2021). A comprehensive review on Pharmacological and Ayurvedic aspect of Phyllanthus emblica (Amalki).
18. Gul, M., Liu, Z. W., Rabail, R., Faheem, F., Walayat, N., Nawaz, A., & Aadil, R. M. (2022). Functional and Nutraceutical Significance of Amla (Phyllanthus Emblica L.): A Review. Antioxidants, 11(5), 816.
19. Gupta, M., Kapoor, B., Gupta, R., & Singh, N. (2021). Plants and phytochemicals for treatment of peptic ulcer: An overview. South African Journal of Botany, 138, 105-114.
20. Harikrishnan, R., & Balasundaram, C. (2020). Potential of Herbal Extracts and Bioactive Compounds for Human Healthcare. In The Role of Phytoconstitutents in Health Care (pp. 3-158). Apple Academic Press.
21. Hegde, S. K., Rao, S., Rao, P., Raghu, S. V., Meera, S., & Baliga, M. S. (2022). Aqueous Extract of Emblica officinalis Linn (Indian gooseberry) in Combination with Iodine is More Efficacious than Iodine Alone in Mitigating Mucositis in Head and Neck Cancer Patients Undergoing Curative Radiotherapy: Retrospective Observations. Indian Journal of Otolaryngology and Head & Neck Surgery, 1-9.
22. Huang, H. Z., Qiu, M., Lin, J. Z., Li, M. Q., Ma, X. T., Ran, F., & Zhang, D. K. (2021). Potential effect of tropical fruits Phyllanthus emblica L. for the prevention and management of type 2 diabetic complications: a systematic review of recent advances. European Journal of Nutrition, 1-18.
23. Hussain, S. Z., Naseer, B., Qadri, T., Fatima, T., & Bhat, T. A. (2021). Anola (Emblica officinalis): Morphology, Taxonomy, Composition and Health Benefits. In Fruits Grown in Highland Regions of the Himalayas: Nutritional and Health Benefits (pp. 193-206). Cham: Springer International Publishing.
24. Jagdale, Y. D., Mahale, S. V., Zohra, B., Nayik, G. A., Dar, A. H., Khan, K. A., & Karabagias, I. K. (2021). Nutritional profile and potential health benefits of super foods: a review. Sustainability, 13(16), 9240.
25. Javed, S., Nasim, T., & Zia-Ul-Haq, M. (2023). Amla. In *Essentials of Medicinal and Aromatic Crops* (pp. 53-81). Cham: Springer International Publishing.
26. Khoa, P. T., Quy, P. B., Lien, D. T. M., Phung, N. K. P., & Tuyet, N. T. A. (2020). Chemical study of the stem bark of Phyllanthus emblica (Phyllanthaceae). Vietnam Journal of Chemistry, 58(4), 559-564.
27. Khursheed, R., Singh, S. K., Wadhwa, S., Gulati, M., & Awasthi, A. (2020). Enhancing the potential preclinical and clinical benefits of quercetin through novel drug delivery systems. Drug discovery today, 25(1), 209-222.
28. Li, X., Lin, Y., Jiang, Y., Wu, B., & Yu, Y. (2022). Aqueous Extract of Phyllanthus emblica L. Alleviates Functional Dyspepsia through Regulating Gastrointestinal Hormones and Gut Microbiome In Vivo. Foods, 11(10), 1491.
29. Maiuolo, J., Gliozzi, M., Carresi, C., Musolino, V., Oppedisano, F., Scarano, F., ... & Mollace, V. (2021). Nutraceuticals and cancer: Potential for natural polyphenols. Nutrients, 13(11), 3834.
30. Mandliya, S., Majumdar, J., Misra, S., Pattnaik, M., & Mishra, H. N. (2023). Evaluation of dry microwave and hot water blanching on physicochemical, textural, functional and organoleptic properties of Indian gooseberry (Phyllanthus emblica). Journal of Food Measurement and Characterization, 1-11.
31. Manohar, A., Shukla, G., Gantait, S., Das, A. P., & Chakravarty, S. (Eds.). (2024). *Propagation to Pharmacopeia: Modern Approaches in Medicinal Plants*. CRC Press.
32. Naik, J., & David, M. (2022). Phytofabrication of silver and zinc oxide nanoparticles using the fruit extract of Phyllanthus emblica and its potential anti-diabetic and anticancer activity. Particulate Science and Technology, 1-13.
33. Narayana, C. K. (2021). Phytochemicals in Fruits and Their Therapeutic Properties. CRC Press.
34. NAZ, G., & PANDEY, N. (2021). AMLA (Emblica officinalis) A WONDER BERRY USED IN TREATMENT OF DIABETES AND CANCER. Journal of Biochemistry International, 1-10.
35. Pandey, S. (2021). Potential of Medicinal Plants as Immunity Booster against Covid-19. In Traditional Herbal Therapy for the Human Immune System (pp. 455-474). CRC Press.
36. Pandrangi, S. L., Chittineedi, P., Chikati, R., Mosquera, J. A. N., Llaguno, S. N. S., Mohiddin, G. J., ... & Maddu, N. (2022). Role of lipoproteins in the pathophysiology of breast cancer. *Membranes*, *12*(5), 532.

37. Pattanaik, S., & Sharma, D. (2022). Chapter-1 Amla: A Good Nutritive Tonic and Blood Purifier. AND ITS BENEFITS, 1.
38. Priya, F. F., & Islam, M. S. (2019). Phyllanthus emblica Linn. (Amla)—a natural gift to humans: an overview. J. Dis. Med. Plants, 5, 1-9.
39. Rachitha, P., Krishnaswamy, K., Lazar, R. A., Gupta, V. K., Inbaraj, B. S., Raghavendra, V. B., & Sridhar, K. (2023). Attenuation of Hyperlipidemia by Medicinal Formulations of Emblica officinalis Synergized with Nanotechnological Approaches. Bioengineering, 10(1), 64.
40. Rana, D., Bhatt, A., Lal, B., Parkash, O., Kumar, A., & Uniyal, S. K. (2021). Use of medicinal plants for treating different ailments by the indigenous people of Churah subdivision of district Chamba, Himachal Pradesh, India. Environment, Development and Sustainability, 23, 1162-1241.
41. Saini, R., Sharma, N., Oladeji, O. S., Sourirajan, A., Dev, K., Zengin, G., & Kumar, V. (2022). Traditional uses, bioactive composition, pharmacology, and toxicology of Phyllanthus emblica fruits: A comprehensive review. Journal of ethnopharmacology, 282, 114570.
42. Sarkar, T., Mukherjee, A., Chatterjee, K., Ermolaev, V., Piotrovsky, D., Vlasova, K., & Lorenzo, J. M. (2022). Edge detection aided geometrical shape analysis of Indian gooseberry (Phyllanthus emblica) for freshness classification. Food Analytical Methods, 15(6), 1490-1507.
43. Selvamuthukumaran, M. (2020). Amla (Indian Gooseberry): Characteristics, Therapeutic Potential, and Its Value Addition. In Asian Berries (pp. 363-380). CRC Press.
44. Sharma, P., Joshi, T., Joshi, T., Chandra, S., & Tamta, S. (2020). In silico screening of potential antidiabetic phytochemicals from Phyllanthus emblica against therapeutic targets of type 2 diabetes. *Journal of ethnopharmacology*, *248*, 112268.
45. Sharma, U. N. S., Fernando, D. D., Wijesundara, K. K., Manawadu, A., Pathirana, I., & Rajapakse, R. J. (2021). Anticoccidial effects of Phyllanthus emblica (Indian gooseberry) extracts: Potential for controlling avian coccidiosis. Veterinary Parasitology: Regional Studies and Reports, 25, 100592.
46. Sridhar, K., Usmani, Z., & Sharma, M. (2023). Bioactive Formulations in Agri-Food-Pharma: Source and Applications. Bioengineering, 10(2), 191.
47. Stadler, J. T., & Marsche, G. (2021). Dietary strategies to improve cardiovascular health: focus on increasing high-density lipoprotein functionality. Frontiers in Nutrition, 8, 761170.
48. Sultana, A., Sikder, M. M., & Alam, N. (2023). Identification and Fungal Biology of Post-harvest Fungi Associated with Amla Fruits and It's In Vitro Control Measures.
49. Suryanarayana, P., Saraswat, M., Petrash, J. M., & Reddy, G. B. (2007). Emblica officinalis and its enriched tannoids delay streptozotocin-induced diabetic cataract in rats.
50. Susilawati, E., Lister, I. N. E., & Fachrial, E. (2021). The protective effect of Phyllanthus emblica Linn. extract against doxorubicin-induced hepatotoxicity in rats. Pharmaciana, 11(1), 153-162.
51. Swathi, V., Kumar, J. S., Prasad, P. D., Salma, S., Rani, M., Aslam, S. A., & Tipsy, K. (2023). A Review on Phyllanthus emblica: Anti-inflamatory and Antioxidant Effect. UTTAR PRADESH JOURNAL OF ZOOLOGY, 23-32.
52. Taleuzzaman, M., Mahapatra, D. K., & Gupta, D. K. (2021). Emblicanin-A and Emblicanin-B: Pharmacological and Nano-Pharmacotherapeutic Perspective for Healthcare Applications. In Applied Pharmaceutical Practice and Nutraceuticals (pp. 13-27). Apple Academic Press.
53. Tewani, R., Sharma, J. K., & Rao, S. V. (2017). Indian Gooseberry (Amla) Natural Purgative. International Journal of Applied Research and Technology, 2(2), 157-164.
54. Wetchakul, P., Goon, J. A., Adekoya, A. E., Olatunji, O. J., Ruangchuay, S., Jaisamut, P., ... & Chusri, S. (2019). Traditional tonifying polyherbal infusion, Jatu-Phala-Tiga, exerts antioxidant activities and extends lifespan of Caenorhabditis elegans. *BMC Complementary and Alternative Medicine*, *19*, 1-11.
55. Xin, Y., Xu, J., Lv, J. J., Zhu, H. T., Wang, D., Yang, C. R., & Zhang, Y. J. (2022). New ent-Kaurane and cleistanthane diterpenoids with potential cytotoxicity from Phyllanthus acidus (L.) Skeels. Fitoterapia, 157, 105133.
56. Yallesh Kumar, H. S., Hippargi, K., Nataraj, S. K., Shivakumar, B. S., Hullur, S., Ganapathi, M., & Kamble, A. K. (2018). Nutraceutical and medicinal values of minor fruits in Western Ghats of South India. *Journal of Pharmacognosy and Phytochemistry*, 404-408.
57. Zhang, M., Cui, S., Mao, B., Zhang, Q., Zhao, J., Zhang, H., & Chen, W. (2022). Ellagic acid and intestinal microflora metabolite urolithin A: A review on its sources, metabolic distribution, health benefits, and biotransformation. Critical Reviews in Food Science and Nutrition, 1-23.