



Current Trends in the Research of *Emblica officinalis* (Amla): A Pharmacological Perspective

Swetha Dasaroju*, Krishna Mohan Gottumukkala

Centre for Pharmaceutical Sciences (CPS), Institute of Science and Technology (IST), Jawaharlal Nehru Technological University – Hyderabad (JNTUH), Andhra Pradesh, India.

*Corresponding author's E-mail: dswetha47@gmail.com

Accepted on: 20-11-2013; Finalized on: 31-01-2014.

ABSTRACT

Phyllanthus emblica Linn. Or *Emblica officinalis* Gaertn. commonly known as Indian gooseberry or *Amla* is one of the most important medicinal plants in Indian traditional systems of medicine (Ayurveda, Unani and Siddha). It is a well-known fact that all parts of amla are useful in the treatment of various diseases. Among all, the most important part is *fruit*. Amla fruit is widely used in the Indian system of medicine as diuretic, laxative, liver tonic, refrigerant, stomachic, restorative, anti-pyretic, hair tonic, ulcer preventive and for common cold, fever; as alone or in combination with other plants. Phytochemical studies on amla disclosed major chemical constituents including tannins, alkaloids, polyphenols, vitamins and minerals. Gallic acid, ellagic acid, emblicanin A & B, phyllembin, quercetin and ascorbic acid are found to be biologically effective. Research reports on amla reveals its analgesic, anti-tussive, anti-atherogenic, adaptogenic; cardio, gastro, nephro and neuroprotective, chemopreventive, radio and chemo modulatory and anti-cancer properties. Amla is also reported to possess potent free radical scavenging, antioxidant, anti-inflammatory, anti-mutagenic, immunomodulatory activities, which are efficacious in the prevention and treatment of various diseases like cancer, atherosclerosis, diabetes, liver and heart diseases. In this article, we discuss the nutritional value, biochemical constituents, traditional uses, medicinal value of amla and its use as a household remedy. We also emphasized the mechanisms behind the pharmacological activities based on the recent research reports and tried to summarize the results of research done from the past 5 years with proper specifications on the future prospects in a pharmacological perspective.

Keywords: Amla, traditional uses, chemical constituents, pharmacological activities, mechanisms, therapeutic applications.

INTRODUCTION

Mother Nature has gifted mankind with tremendous medicinal plants to create a disease free and healthy life. Abundant medicinal plants are presented in the Indian traditional systems of medicine (like Ayurveda, Unani, siddha), mostly used one amongst them is Indian gooseberry or *Amla*, also known as *Phyllanthus emblica* Linn. (Syn. *Emblica officinalis* Gaertn.) belongs to the family Euphorbiaceae,¹ which is an important medicinal herb in Ayurveda and Unani systems of medicine. It is enormously used as a tonic to restore the lost body's energy and vigor.

Amla is a small to medium sized deciduous tree, found in throughout India, Pakistan, Uzbekistan, Sri Lanka, South East Asia, China and Malaysia. It grows about 8-18m height with thin light grey bark, leaves are simple, light green, sub-sessile, closely set along the branchlets looks like pinnate leaves; flowers are greenish yellow; fruits are globose, fleshy, pale yellow with six obscure vertical furrows enclosing six trigonous seeds in two seeded three crustaceous cocci.

Amla is highly nutritious and is one of the richest sources of vitamin-C, amino acids and minerals.² It contains several chemical constituents like tannins, alkaloids and phenols.³ Among all hydrolysable tannins, Emblicanin A and B; gallic acid, ellagic acid are reported to possess biological activity. Almost all parts possess medicinal

properties, particularly fruit, which has been used in Ayurveda as a powerful *rasayana* and in customary medicine in the treatment of diarrhoea, jaundice, inflammation and several other ailments.⁴ Amla fruit is widely used in the Indian system of medicine as alone or in combination with other plants and is used to treat common cold and fever, as diuretic, laxative, liver tonic, refrigerant, stomachic, restorative, anti-pyretic, hair tonic; to prevent ulcer and dyspepsia.

Pharmacological research reports on amla reveals its analgesic,⁵ anti-tussive,⁶ anti-atherogenic,⁷ adaptogenic;⁸ cardio,⁹ gastro,¹⁰ nephro,¹¹ neuro¹² protective and anti-cancer¹³ properties. Amla is also reported to possess chemopreventive,¹⁴ radio,¹⁵ chemo¹⁶ and immunomodulatory,¹⁷ free radical scavenging,¹⁸ antioxidant,¹⁹ anti-inflammatory,²⁰ anti-mutagenic activities. These properties are efficacious in the prevention and treatment of various diseases like cancer, atherosclerosis, diabetes, peptic ulcer, anemia, liver, heart diseases and various other disorders.

The present work is a trial to understand the nutritional value, traditional uses, biochemical constituents and important medicinal values of Amla by emphasizing the mechanisms behind the activities and enlightens the therapeutic applications and clinical trials. It also summarizes the research done on amla from the past 5 years and also specifies the aspects that warrant future research establishing its activity and use in several diseases.



CHEMICAL CONSTITUENTS

Amla is one of the most extensively studied plants. Reports suggest that it contains tannins, alkaloids and phenols.³ Fruits have 28% of the total tannins distributed in the whole plant. The fruit contains two hydrolysable tannins Emblicanin A and B,²¹ which have antioxidant properties; one on hydrolysis gives gallic acid, ellagic acid and glucose wherein the other gives ellagic acid and glucose respectively. The fruit also contains Phyllembin.²² Activity directed fractionation revealed the presence of several phytochemicals like gallic acid, corilagin, furosin and geraniin.²³ Flavonoids like quercetin, alkaloids like phyllantine and phyllantidine are found. Along with these, it primarily contains amino acids, carbohydrates and other compounds given in Table 1. Its fruit juice contains the highest concentration of vitamin-C (478.56mg/100mL). Vitamin C levels are more than those in oranges, tangerines and lemons.^{24,25} The composition of fruit pulp of *Emblia officinalis* are given in Figure 1.

Table 1: Amla fruit: Chemical constituents

Type	Chemical Constituents
Hydrolysable Tannins	Emblicanin A and B, Punigluconin, Pedunculagin, Chebulinic acid (Ellagitannin), Chebulagic acid (Benzopyran tannin), Corilagin (Ellagitannin), Geraniin (Dehydroellagitannin), Ellagotannin
Alkaloids	Phyllantine, Phyllembin, Phyllantidine
Phenolic compounds	Gallic acid, Methyl gallate, Ellagic acid, Trigallayl glucose
Amino acids	Glutamic acid, Proline, Aspartic acid, Alanine, Cystine, Lysine
Carbohydrates	Pectin
Vitamins	Ascorbic acid
Flavonoids	Quercetin, Kaempferol
Organic acids	Citric acid

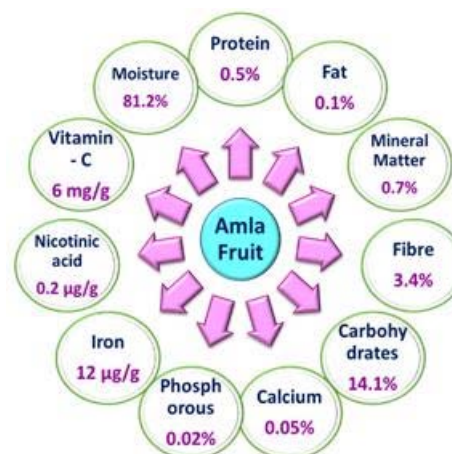


Figure 1: Amla fruit pulp: Composition

In comparison with apple, the edible fruit tissue is rich with proteins 3-fold and ascorbic acid 160-fold and contains considerably higher concentration of most minerals and amino acids. Glutamic acid, proline, aspartic acid, alanine, and lysine are 29.6%, 14.6%, 8.1%, 5.4% and 5.3% respectively of the total amino acids. Some of the phytochemicals are shown in Figure 2.²⁸

Pulpy portion of fruit, after drying found to contain: gallic acid 1.32%, tannin, gum 13.75%; albumin 13.08%; crude cellulose 17.08%; mineral matter 4.12% and moisture 3.83%. Amla fruit ash contains chromium-2.5ppm, zinc-4 ppm and copper-3 ppm. Compounds isolated from amla fruit are gallic acid, ellagic acid, 1-O-galloyl-beta-D-glucose, 3,6-di-O-galloyl-D-glucose, chebulinic acid, quercetin, chebulagic acid, corilagin, 1,6-di-O-galloyl beta-D-glucose, 3-Ethylgallic acid (3-ethoxy 4,5-dihydroxybenzoic acid) and isostrictinin.²⁶ Amla fruit also contains flavonoids, kaempferol-3-O-alpha L-(6''-methyl) rhamnopyranoside and kaempferol-3-O-alpha L-(6''-ethyl) rhamnopyranoside.²⁷

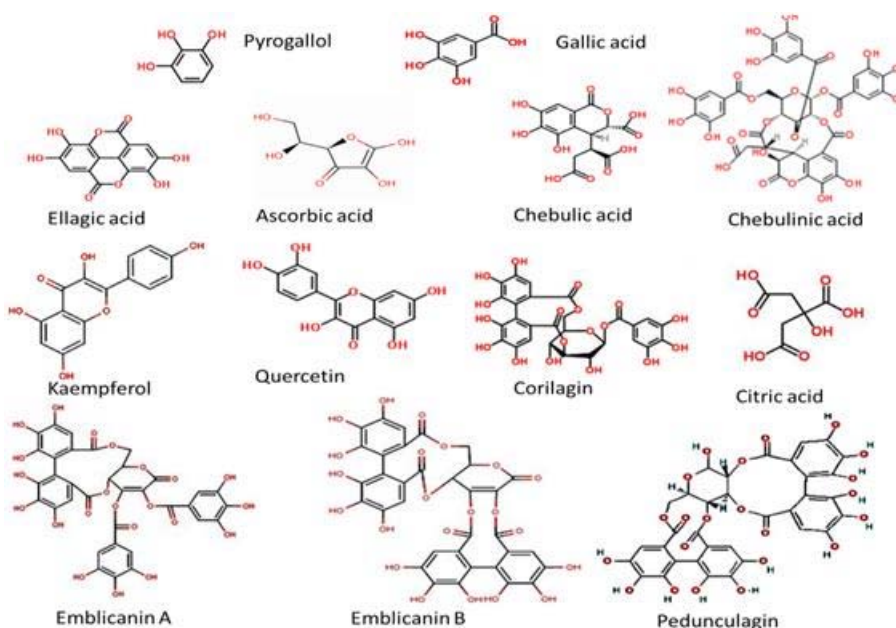


Figure 2: Amla fruit: Structures of chemical constituents

TRADITIONAL USES

Ayurveda, Siddha, Unani systems of India, Tibetan, Sri Lankan and Chinese systems of medicine utilizes Amla for a variety of ailments. It is considered as *rasayana* (rejuvenator)⁴ and used in delaying the degenerative and senescence related processes.

In folk medicine, the fruits, which are sour, astringent, bitter, acrid, sweet and anodyne. Exert several beneficial effects include cooling, ophthalmic, carminative, digestive, stomachic, laxative, dyspepsia, aphrodisiac, rejuvenative, diuretic, antipyretic and tonic. They are

useful in vitiated conditions of tridosha, diabetes, cough, asthma, bronchitis, cephalalgia, ophthalmopathy, dyspepsia, colic, flatulence, hyperacidity, peptic ulcer, erysipelas, skin diseases, leprosy, haematogenesis, inflammations, anaemia, emaciation, hepatopathy, jaundice, diarrhoea, dysentery, haemorrhages, leucorrhoea, menorrhagia, cardiac disorders, intermittent fevers and premature greying of hair (Hair tonic).²⁸ Amla is also stated to have hepato, cardio, nephro and neuroprotective effects; antioxidant, anti-inflammatory, analgesic, antipyretic and restorative properties. List of amla traditional applications are given in Table 2.^{29,30}

Table 2: Amla: Traditional uses^{32,33}

As a Vermifuge: Juice of the fruit with honey is used. The recommended dose is from 1 to 3 drachms.
Appetizer: Use of pickles and preserves made from the green fruits.
Irritability of the bladder, In retention of urine, To the forehead in cephalalgia: Use a paste of the fruit alone or with <i>Nelumbium speciosum</i> , Saffron and rose water. Applying it over the affected region.
As a febrifuge and in diabetes: Using an infusion of the seeds.
For hiccup and for painful respiration: Use of juice or extract of the fruit combined with honey and pipli.
For hemorrhage, diarrhea and dysentery: Using dried fruit. A decoction prepared from the fruit combined with <i>T. chebula</i> and <i>T. belericais</i> useful in chronic dysentery and biliousness, in doses of 1 oz. once or twice daily.
For diarrhea of children: <ul style="list-style-type: none"> ➤ A compound powder of the amla seed, Chitrak root, chebulic myrobalan, pipli and palelone is given in suitable doses, according to age, in warm water twice daily, morning and at bed time. ➤ Tender shoots given in butter-milk cure indigestion and diarrhea; green fresh leaves combined with curds have a similar effect. ➤ Leaves are used as infusion with fenugreek seeds in chronic dysentery and as a bitter tonic. ➤ Soak one tola of the seeds in a tinned vessel during the night. Grind it. Add cow's milk and use. This is a good remedy for biliousness.
For anemia, jaundice and dyspepsia: <ul style="list-style-type: none"> ➤ Use dried fruit with iron. A fermented liquor prepared from the root is used in jaundice, dyspepsia, cough, etc. ➤ Take 20 to 40 grains of Dhatri Leha for anemia, jaundice and dyspepsia. ➤ Dhatri Arista is used for jaundice, dyspepsia, indigestion, and cough.
For burning in the vagina: A mixture of the fruit juice and sugar is prescribed as a remedy for burning in the vagina. Juice of the bark combined with honey and turmeric is a remedy for gonorrhoea.
To stop nausea and vomiting: A powder of the amla seed and red sandalwood is given with honey, to stop emesis.
For bleeding of the nose: Seed fried in ghee and ground in conjee is applied as Lep to the forehead to stop bleeding from the nose.
For scabies or itch: Apply the seed burnt, powdered and mixed in oil for scabies or itch.
As a restorative invigorator: <ul style="list-style-type: none"> ➤ Make a powder from an equal quantity of amla seed and root of <i>Withania somnifera</i>. Add ghee and honey. Mix well. This is a restorative invigorator, especially in winter days. ➤ Combine half a drachm each of amla seed and gokhru. Grind and make them into a powder. Mix with 15 grains of essence of Gulancha. Give this in early morning with ghee and sugar. This is a nutrient tonic.
Other uses: <ul style="list-style-type: none"> ➤ It helps in regulating blood sugar. ➤ It is very powerful anti-inflammatory herb, a wonderful antioxidant and a natural Source of Vitamin C. Amla helps scavenge free radicals. ➤ Amla is powerful food for the brain and helps lower cholesterol. ➤ Amla also helps maintain the functioning of the liver, increases haemoglobin, red blood cell count. It is useful for Cough, Bronchitis, and Asthma. ➤ Amla cleanses the mouth, strengthens the teeth. Its decoction is used in hyperacidity and with honey as an anthelmintic. ➤ The presence of Amla results in an enhanced cell survival, decreased free radical production and higher antioxidant levels. ➤ There are various classic Ayurvedic preparations, such as Chyawanprash in which Amla is used as a chief ingredient. It help improve intelligence and memory power. ➤ Triphala and Brahmarasayana are other classic medicine in which Amla is being used since time immemorial.



Table 3: Amla: Health benefits / Medicinal importance^{31,32}

Medicinal importance	Description
Healing options	<ul style="list-style-type: none"> Protects cells against free radical damage and provides antioxidant protection. To treat skin disorders, respiratory infections, and premature aging. Useful in haemorrhage, diarrhoea, dysentery and diabetes. Prevents infection and healing of ulcers. Laxative to relieve constipation in piles.
Immunity booster	Increases white blood cell counts and other measures of strengthened immunity in rodents given with Amla tonic.
Promotes vigor	One tablespoon juice with honey daily morning for few days.
Respiratory disorders	Useful in tuberculosis of the lungs, asthma and bronchitis.
Diabetes	High vitamin C content, is effective in controlling diabetes. Amla juice with bitter gourd juice, used daily for 2 months stimulates the pancreas and enables to secrete insulin.
Heart disorders	<ul style="list-style-type: none"> Effective remedy for heart disease. Tones up the functions of all the organs of the body and builds up health by destroying the heterogeneous or harmful and disease causes elements. It also renews energy.
Eye disorders	<ul style="list-style-type: none"> With honey is useful in preserving eyesight. Beneficial in the treatment of conjunctivitis and glaucoma. Reduces intra ocular tension in a remarkable manner when juice mixed with honey and taken twice daily.
Rheumatism	Teaspoonful powder with 2 teaspoonful of jiggery, twice daily for a month.
Scurvy	Rich source of vitamin C, best remedy for scurvy. Amla powder with sugar in equal quantities, 3 times a day with milk.
Diarrhoea and dysentery	A drink made from <i>amla</i> mixed with lemon juice and <i>misiris</i> considered highly beneficial in controlling acute ancillary dysentery. One tablespoonful of the paste of leaves mixed with honey or butter-milk is an effective Medicare in the treatment of diarrhoea and dysentery.
Ageing	<ul style="list-style-type: none"> Revitalizing effects. Prevent ageing and maintains strength in old age. Improves body resistance, strengthens heart, hair and glands of body. Rejuvenating effect on all organs. It is said that the great ancient sage Muni Chyawan rejuvenated himself in his late 70s and regained his virility by the use of amla.
Hair tonic	<ul style="list-style-type: none"> Enriches hair growth and pigmentation. Dried fruit boiled in coconut oil till solid matter becomes charres, prevents greying. The water in which dried amla pieces are soaked overnight is also nourishing to hair. This water should be used for the last rinse while washing the hair.

Several formulations containing amla were presented in numerous medicine systems for curing different diseases. Some of them are Triphala, EuMil, Kalpaamrutha, Chyawanprash, Immu-21, DHC-1, Ophthacare, Pepticare, Hyponidd, Brahma Rasayana and Maharishi-4.³¹

Amla fruit has showed a wide range of health benefits with medicinal value (Table 3).^{30,31}

From ages, it is used as a household remedy for a variety of ailments. The way of use as home remedy in several conditions is presented in table 4.³²

The Ayurvedic description of amla^{33,29}

According to the Ayurvedic classifications, amla fruit exert below properties:

Rasa (taste): Sour and astringent are the most dominant, but the fruit has five tastes, including sweet, bitter, and pungent

Veerya (nature): Cooling, treatment of burning sensation in inflammation and fever which are considered to be manifestations of pitta (fire) agitation³⁴

Vipaka (taste developed through digestion): Sweet

Guna (qualities): Light, dry

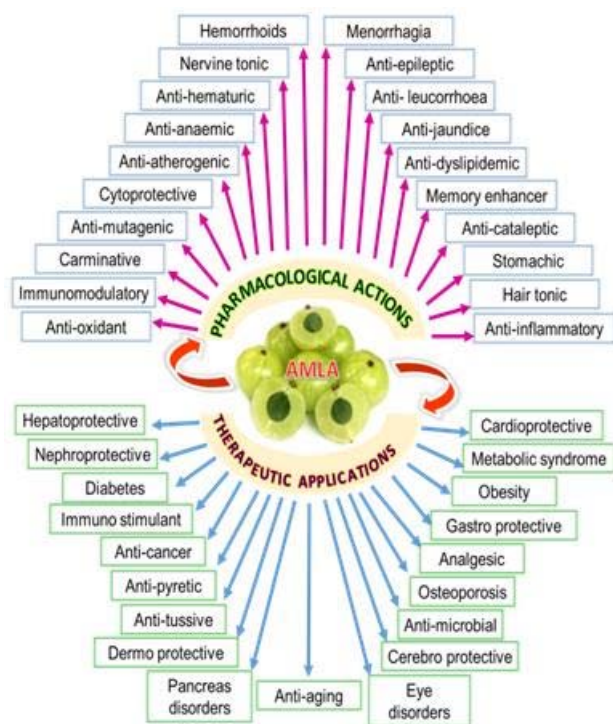
Doshas (effect on humors): Quietens all three doshas: vata, kapha, pitta, and is especially effective for pitta. Based on this, Amla has been considered the best of the Ayurvedic rejuvenative herbs.

Inimitably, amla exerts natural balance of tastes (sweet, sour, pungent, bitter and astringent), that stimulates brain to rebalance the three main components (water, fire and air in the body) of all physiological functions.²⁹



Table 4: Amla: Home remedies³²

Home remedy	Way of use
Stabilizer of blood sugar	Amla seeds or dried amla powder in the form of capsules with bitter gourd juice daily.
Natural cholesterol remedy	It strengthens the heart muscles and causes a significant decrease in total cholesterol, LDL cholesterol, VLDL cholesterol and triglycerides. A 500 mg capsule of dried Amla powder can be added to your daily routine after consulting with doctor.
Treats hypertension	High vitamin-C helps control blood pressure. Amla choorna (powder) or in the form of triphala tablets or decoction. Triphala, a combination of amla and two other herbs is an excellent medication for high blood pressure.
Natural cure for Anemia	Amla is rich in Vitamin-C or ascorbic acid, an essential ingredient that helps in the absorption of Iron.
Anti-ageing	Fresh amla fruit has revitalizing effect on the body as it contains several nutrients and helps in preserving the stamina in aged people.
Herbal cough remedy	Add a teaspoon of Amla juice or powder to a glass of warm milk and drink this thrice a day. This will clear an unpleasant throat, adding some ghee to this decoction will clear a cough. Mix amla powder with honey and suck this mixture twice a day to cure a chronic dry cough. Amla is invaluable in the treatment of tuberculosis, asthma and bronchitis.
Natural eye tonic	Fresh Amla juice or dried Amla capsules are a good supplement to improve near-sightedness, cataract and glaucoma. It reduces intra ocular tension and corrects the vision.
Promotes hair growth	Dried amla fruits are boiled in coconut oil and then ground to form amla oil. This is a very effective conditioner and prevents balding and greying of hair. For oily hair, mix half a cup of Amla juice, half a cup of lime juice and some water. Apply this to make an anti-grease hair wash.
A pitta pacifier	Amla boiled in coconut water and the ground mixture is applied to the scalp. Amla oil is an excellent way to reduce heat associated with summer season. It is a good remedy to pacify pitta conditions.
Treats white spots on the nails	As a source of Vitamin C, serves as an effective remedy in vitamin deficit condition. Addition of Amla juice/powder in diet overcomes this condition.
Remedy for menstrual disorders	White discharge can be relieved with powdered and dried Amla Seeds. Mixture of amla with honey and saunf (fennel) or mixing it with squished banana and consuming.

**Figure 3:** Amla: Pharmacological actions and therapeutic applications**PHARMACOLOGICAL ACTIVITIES³⁵ AND MECHANISMS³⁶**

Alteration in basic homeostatic balance of the body is the origin of disease. Imbalance between pro-oxidant and anti-oxidant homeostasis place a major role in majority of ailments. Pro-oxidant condition dominates either due to increased generation of free radicals and/or their poor quenching/scavenging by the anti-oxidants (which protects the body against the deleterious effects of free radicals).^{18, 37}

Amla is one of the richest sources of vitamin-C and low molecular weight hydrolysable tannins which makes Amla a good antioxidant. The tannins of amla like emblicanin-A (37%), emblicanin-B (33%), punigluconin and pedunculagin are reported to provide protection against oxygen radical included haemolysis of rat peripheral blood erythrocytes.³⁸ The mechanism behind antioxidant activity is due to the recycling of sugar moiety and conversion of the polyphenol into medium and high molecular weight tannins. The powerful antioxidant Ellagic acid, present in *Amla*, can inhibit mutations in genes and repairs the chromosomal abnormalities.³⁹

Amla inhibits the growth and spread of various cancers like breast, uterus, pancreas, stomach and liver cancers. It

can prevent and/or reduce the side effects of chemotherapy and radiotherapy.^{21, 39} More than 18 compounds were identified in amla fruit which can exert anti-proliferative activity on gastric and uterine cancer cells. The main mechanism behind its activity is by enhancing Natural Killer (NK) cell activity in various tumor

cells.¹³ Emblicanin A & B of amla fruit are reported to possess strong antioxidant and anti-cancer properties.

Amla exert its pharmacological activities by altering several physiological pathways/ mechanisms in the body. Some of them are presented in the Table 5.

Table 5: Mechanisms reported for the pharmacological activities of amla fruit during the last 5 years

Research	Methods	Mechanism
Anti-oxidant ^{11,16,18,19,35,37,40}	DPPH radical scavenging, Ferric reducing antioxidant power (FRAP), DNA nicking assay	Free radical scavenging ¹⁸
	DPPH, ABTS radicals scavenging, FRAP assay, cellular antioxidant status on Human myeloleukemic U937 cells.	Free radical scavenging ^{37,40}
	DPPH, ABTS, hydroxyl, superoxide, H ₂ O ₂ , peroxy nitrite, singlet oxygen, hypochlorous acid scavenging; Reducing power assay; <i>in vivo</i> antioxidant enzyme levels (SOD, CAT, GSH, GST)	Free radical scavenging; Strengthening of endogenous antioxidant defense enzymes ¹⁹
	Reduces elevated levels of serum creatinine, urea nitrogen, TBARS ; decreased iNOS, COX 2 expression in aged rats	Amelioration of Renal and aortic oxidative stress by inhibiting NF κB activation ¹¹
	Reduced hexachlorocyclohexane (HCH) induced raisenin renal gamma glutamyltranspeptidase (GGT) activity	Elevation of hepatic antioxidant system ³⁵
	Decreased albumin, increased adiponectin levels and improved glucose levels in diabetic rats	Best regulation of glucose levels ¹⁶
Skin anti-aging ^{41,42}	Protects skin from devastating effects of free radicals, non-radicals and transition metal induced oxidative stress	Suitable for using skin anti-aging ⁴¹
	Matrix metalloproteinase-1 (MMP-1) production from fibroblasts was dramatically decreased; Tissue inhibitor of metalloproteinase-1 (TIMP-1) was significantly increased	Promotes procollagen production and inhibits MMP-1 in human skin fibroblasts ⁴²
Cardio protective ^{10, 21,22,39}	Emblicanin A, B showed antioxidant effect in vitro and in vivo like ascorbic acid (cardio protective)	Prevents ischemia-reperfusion induced oxidative stress ^{21,10}
	Ellagic acid inhibited mutations in genes and chromosomal abnormalities	Inhibits oxidation of DNA ³⁹
	Phyllaemblicin B inhibits Cocksackie virus B3 induced apoptosis and myocarditis	Antiviral and cardio protective ²²
Anti-inflammatory ²⁰	Reduced inflammation by Carrageenan induced rat paw edema method (Acute); Regin pellet granuloma method (Chronic); Leukocyte emigration rat paw edema method	Anti-inflammatory activity in both acute as well as chronic model of inflammation comparable to diclofenac
Anti-cancer and Immuno modulatory ^{13-17,21,22,43-51}	Reduction of Ascites and solid tumors induced by Dalton's lymphoma ascites cells in mice; Increased lifespan of mice	Enhancing Natural Killer (NK) cell activity ^{13,43}
	Chemoprevention by amla extract on 7, 12-dimethylbenz(a)anthracene (DMBA) induced skin tumorigenesis in swiss albino mice assessed by decreased frequency of micronuclei.	Chemoprevention due to antioxidant activity and through immuno modulatory effect on hepatic activation and detoxifying enzymes ^{14,21,22}
	Induction of apoptosis in Dalton's lymphoma ascites and CeHa cell lines; Inhibition of DNA-Topoisomerase I and cdc25 tyrosine phosphatase in <i>Saccharomyces cerevisiae</i> , mutant cell cultures	Inhibition of expression of mutant genes ⁴⁴
	Inhibition of <i>in vitro</i> cell proliferation in human tumor cell lines like human erythromyeloid K562, T-lymphoid Jurkat, B-lymphoid Raji, erythro leukemic HEL cell lines	Antioxidant and Anti-proliferative ⁴⁵
	DPPH, ABTS, Superoxide scavenging; Iron chelation; anti-proliferative activity against MCF-7 tumor cells; MTT assay	Mallotusin and mucic acid 1,4-lactone 3-O-gallate reported first time to have antioxidant and anti-proliferative activities ⁴⁵
	Progallin A from leaves of amla induces apoptosis of human hepatocellular carcinoma BEL-7404 cells	Up-regulation of Bax expression and down-regulation of Bcl-2 expression ⁴⁶
	Prevents side effects of Cyclophosphamide treatment when used in combination	Hemato and immuno protective; prevents mutagenicity ⁴⁷
	Prevents chromium induced oxidative damage (decreased GSH, GPx activity in macrophages) and immunosuppression (by restoring phagocytosis and gamma-interferon production by macrophages)	Cytoprotective and immuno modulatory ⁴⁸
	Reduced lymphocyte proliferation and synovial hyperplasia in Freund's adjuvant induced arthritis rat model	Immunomodulatory and anti-arthritic and chondroprotective ⁴⁹
	Inhibition of arsenic induced oxidative damage and apoptosis in thymocytes of mice (decreased lipid peroxidation, ROS production, activity of caspase-3 (apoptosis) and increased levels of antioxidant enzymes, cytochrome-c oxidase and mitochondrial membrane potential)	Immuno modulatory ⁵⁰
Promote pro-collagen content and inhibit matrix metalloproteinase levels in UV-B induced skin photo aging in fibroblasts by MTT assay, inhibition of MMP-1, hyaluronidase activities	By strong ROS scavenging ability ^{15,51}	

Research	Methods	Mechanism
	Reduction of NO levels, erythrocyte membrane lipid peroxidation, C/P ratio, activities of Na ⁺ /K ⁺ and Mg ²⁺ ATPases and fluorescent anisotropic values in alcohol treated rats.	Protective effect on rat erythrocyte membranes; immunomodulatory effect ¹⁷
Anti-diarrheal and spasmolytic ⁵²	Inhibition of castor oil-induced diarrhea and intestinal fluid accumulation in vivo and in vitro experiments on isolated rabbit jejunum and guinea pig ileum	By dual blockade of muscarinic receptors (anticholinergic), Ca ²⁺ channels
Anti-diabetic ⁵³⁻⁵⁶	Cell based antioxidant activity, antidiabetic activity via inhibition of α -amylase, α -glucosidase and antiglycation assays; DPPH, hydroxyl, superoxide and nitric oxide scavenging assays	Ellagic acid in amla is potent α -amylase and α -glucosidase inhibitor with significant antiglycation and antioxidant activity ⁵³
	Reduced oxidative markers (SOD, CAT, GSH, GPx, LPO); biochemical parameters (plasma insulin, Serum creatinine, urea, glucose, SGPT, SGOT, ALP) in streptozotocin induced diabetic rats.	Hypoglycemic and antioxidants effects ⁵⁴
	Prevent hyperglycemia-induced lens opacification, aggregation and insolubilization of lens proteins on streptozotocin (STZ)-induced diabetic cataract in rats.	Inhibition of Aldose Reductase activity as well as sorbitol formation in the lens by inhibiting the polyol pathway-induced oxidative stress ⁵⁵
	Improvement in biomarkers of oxidative stress (malondialdehyde, nitric oxide, and glutathione), high sensitivity C-reactive protein levels, the lipid profile, and glycosylated hemoglobin (HbA1c) levels	Protective effects on endothelial dysfunction and biomarkers of oxidative stress in patients with type 2 diabetes mellitus ⁵⁶
Anti-microbial ⁵⁷⁻⁶¹	Amla interferes with the adhesion of <i>C. albicans</i> to buccal epithelial cells and denture acrylic surfaces in vitro.	Antimicrobial effect by inhibiting adhesion ⁵⁷
	Synergistic increase in zone of inhibition against <i>Staphylococcus</i> with amoxicillin by agar diffusion and disk diffusion methods.	Antibacterial activity ⁵⁸
	Control of the <i>Aedes aegypti</i> and <i>Culex quinquefasciatus</i> .	Larvicidal activity ⁵⁹
	Significant reduction in the mean colony count of <i>Escherichia coli</i> , <i>Staphylococcus aureus</i> , <i>Klebsiella pneumoniae</i> and <i>Pasteurella multocida</i> by tube dilution method.	Anti-bacterial ^{60,61}
Anti-viral ⁶²	Pentagalloylglucose can inhibit Influenza A virus replication with a dual mode of action assessed by WST-1 assay, Plaque-forming unit assay, Time-of-addition assay and Hemagglutination inhibition (HI) assay.	Via two mechanisms: prevention of virus adsorption and suppression of virus release.
Ulcer protective ¹⁰	Biphasic activity in ulcerated mice, with healing effect observed at 60mg/kg and an adverse effect at 120 mg/kg assessed by total antioxidant status, thiol concentration, lipid peroxidation, protein carbonyl content followed by mucin content, PGE2 synthesis and cytokine status.	Dose dependent switching from anti-oxidant to pro-oxidant shift and immunomodulatory property. Efficiently reduced pro-inflammatory cytokine (TNF- α and IL-1 β) levels and appreciably up regulated anti-inflammatory cytokine (IL-10) concentration
Wound healing ⁶³	Improved wound closure; Assessment of granulation tissue on every fourth day showed significant reduction in bacterial count with significant level of collagen, hexosamine, uronic acid, and superoxide dismutase; Reduction of matrix metalloproteinase expression	Antibacterial, wound healing, and antioxidant activities
Nephro protective ¹¹	Reduced the elevated levels of serum creatinine and urea nitrogen; thiobarbituric acid-reactive substance levels of serum, renal homogenate in aged rats	Reduction of iNOS and COX-2 expression levels by inhibiting NF- κ B activation; reduction of elevated expression level of bax, a proapoptotic protein
Hepato protective ⁶⁴	Antioxidant activity (DPPH scavenging) and high levels of hepatoprotection against tert-butyl hydroperoxide (t-BH) induced toxicity in HepG2 cells	Hepatoprotective and antioxidant
Memory enhancer ¹²	Improved memory (Elevated plus maze and passive avoidance apparatus); reduced total serum cholesterol levels and increased brain cholinesterase activity in aged mice	Increased Acetylcholinesterase activity may improve learning and memory
Anti-hypercholesterolemic/hypolipidemic/Anti-atherogenic ⁷	Showed improved lipid profile studied by comparing levels of Total Cholesterol, Triglycerides, HDL, LDL, and Atherogenic index with Atorvastatin in high fat fed Albino mice	Significant anti-hyperlipidemic, hypolipidemic, and anti-atherogenic effect which may contribute to its anti-atherogenic activity
Anti-amnesiac ⁶⁵	Elevated plus-maze and passive avoidance tests in Swiss Albino mice; showed memory enhancing, antioxidant and anti-cholinesterase activity	Treatment of cognitive impairments induced by cholinergic dysfunction and dementia
Hair growth promotion ⁶⁶	5 α - reductase activity assay and hair growth promoting activity on rat liver microsomal suspension promoter, compared to finasteride and minoxidil; Histological determination of hair follicles in dorsal skins	Potent 5 α - reductase inhibitor and hair growth promoter

POTENTIAL THERAPEUTIC APPLICATIONS

Amla fruit has been said to be useful against many several diseases, including cancer, diabetes, hepatic disorders and heart diseases. A list of scientifically explored therapeutic applications and pharmacological activities are presented in figure 3. Research has been done with amla evaluating its role as an antioxidant, in ulcer

prevention, for people with diabetes, for mental and memory effects, and its anti-inflammatory benefits. Amla extract supplements are not only retains the lost body energy and vigor, also be helpful in those undergoing radiation therapy i.e., protect the cancer cells that the radiation is trying to destroy. Amla Tonic has a hematinic and lipolytic function useful in Scurvy and Jaundice. It



prevents indigestion and controls acidity as well as it is a natural source of anti-ageing.

Clinical tests on patients suffering from pulmonary tuberculosis have shown that the high concentration of vitamin C in amla fruit is more quickly assimilated in the body than the synthetic vitamin. Even though Amla is a known herb in Ayurveda and several other indigenous systems of medicine, some of its medicinal properties are yet to be explored and evidenced scientifically for human use.

CONCLUSION

Now a days, research on Indian traditional medicinal plants has gained a new recommence. Although, the other systems of medicine are effective they come with a number of undesired effects that often lead to serious complications. Being natural, herbal medicine alleviates all these problems. *Emblica officinalis* (Amla) has an important position in Ayurveda- an Indian indigenous system of medicine. Amla due to its strong antioxidant and biological properties prevent innumerable health disorders as it contains essential nutrients and highest amount of vitamin C. It can be used as a possible food additive or in nutraceuticals and biopharmaceutical industries. Several researchers revealed that various extracts and herbal formulations of amla showed potential therapeutic benefits against various diseases and the results are similar to standard drugs. In this review, we tried to make a summary the traditional and scientifically proven uses of amla and tried to establish their basic mechanisms. Even though, amla has various medicinal properties since ages, there is a colossal necessity to scientifically explore and evident its medicinal values at molecular level with help of various latest biotechnological tools and techniques.

REFERENCES

- Maurya U, Srivastava S, Traditional Indian herbal medicine used as antipyretic, antiulcer, anti-diabetic and anticancer: A review, International Journal of Research in Pharmaceutical Chemistry,1(4), 2011, 1152-9.
- Srivastuki KP, Nutritional and health care benefits of Amla, Journal of Pharmacognosy, 3(2), 2012, 141-51.
- Zhang LZ, Zhao WH, Guo YJ, Tu GZ, Lin S, Xin LG, Studies on chemical constituents in fruits of Tibetan medicine *Phyllanthus emblica*, ZhongguoZhong Yao ZaZhi, 28(10), 2003, 940-3.
- Udupa KN, Ayurveda for Promotion of Health, Journal of Ayurveda, 3, 1985.
- Sharma SK, James B, Perianayagam, Aney Joseph AJM, Christina, Evaluation of anti-pyretic and analgesic activity of *Emblica officinalis* Gaertn, Journal of Ethnopharmacology, 95, 2004, 83-5.
- Nosal ova G, Mokry J, Hasan KM, Antitussive activity of the fruit extract of *Emblica officinalis* Gaertn, (Euphorbiaceae), Phytomedicine, 10, 2003, 583-9.
- Santoshkumar J, Manjunath S, Pranavkumar MS, A study of anti-hyperlipidemia, hypolipidemic and anti-atherogenic activity of fruit of *Emblica officinalis* (amla) in high fat fed Albino Rats, International Journal of Medical Research and Health Sciences, 2(1), 2013, 70-77.
- Muruganandam AV, Kumar V, Bhattacharya SK, Effect of poly herbal formulation, EuMil, on chronic stress-induced homeostatic perturbations in rats, Indian Journal of Experimental Biology, 40(10), 2002, 1151-60.
- Baliga MS, Prabhu AN, Prabhu DA, Shivashankara AR, Abraham A, Palatty PL, Antidiabetic and Cardioprotective Effects of Amla (*Emblica officinalis* Gaertn) and its Phytochemicals: Preclinical Observations, Bioactive Food as Dietary Interventions for Diabetes, 2013, 583-600.
- Chatterjee A, Chattopadhyay S, Sandip K, Bandyopadhyay, Biphasic Effect of *Phyllanthus emblica* L. Extract on NSAID-Induced Ulcer: An Anti-oxidative Trail Weaved with Immunomodulatory Effect, Evidence-Based Complementary and Alternative Medicine, 2011, 2010, 1-13.
- Yokozawa T, Kim HY, Kim HJ, Tanaka T, Sugino H, Okubo T, Chu D, Juneja LR, Amla (*Emblica officinalis* Gaertn.) Attenuates Age-Related Renal Dysfunction by Oxidative Stress, Journal of Agricultural and Food Chemistry, 55, 2007, 7744-52.
- Vasudevan M, Parle M, Memory enhancing activity of Anwalachurna (*Emblica officinalis* Gaertn.): An Ayurvedic preparation, Physiology & Behaviour, 91(1), 2007, 46-54.
- Madhuri S, Studies on estrogen induced uterine and ovarian carcinogenesis and effect of Prolmu in rat, PhD thesis, Jabalpur, MP, RDVV, 2008.
- Krishnaveni M, Mirunalini S, Chemopreventive efficacy of *Phyllanthus emblica* L. (amla) fruit extract on 7,12-dimethylbenz(a)anthracene induced oral carcinogenesis – A dose-response study, Environmental Toxicology and Pharmacology, 34(3), 2012, 801-10.
- Adil MD, Kaiser P, Satti NK, Zargar AM, Vishwakarma RA, Tasduq SA, Effect of *Emblica officinalis* (fruit) against UVB-induced photo-aging in human skin fibroblasts, Journal of Ethnopharmacology, 132(1), 2010, 109-14.
- Deep G, Dhiman M, Rao AR, Kale RK, Chemopreventive potential of Triphala (a composite Indian drug) on benzo(a)pyrene induced fore stomach tumorigenesis in murine tumor model system, Journal of Experimental and Clinical Cancer Research, 24(4), 2005, 555-63.
- Varadacharyulu N, Damodara Reddy, Padmavathi P, Paramahansa M, Modulatory role of *Emblica officinalis* against alcohol induced biochemical and biophysical changes in rat erythrocyte membranes, Food and Chemical Toxicology, 47, 2009, 1958-63.
- Prakash D, Upadhyay G, Gupta C, Pushpangadan P, Singh KK, Antioxidant and free radical scavenging activities of some promising wild edible fruits, International Food Research Journal, 19(3), 2012, 1109-16.
- Nripendranath, Bibhabasu H, Rhitajit S, Santanu B, Comparative study of the antioxidant and reactive oxygen species scavenging properties in the extracts of the fruits of *Terminalia chebula*, *Terminalia bellerica* and *Emblica officinalis*, BMC Complementary and Alternative Medicine, 10, 2010, 1-15.
- Santoshkumar J, Devarmani MS, Sajjanar M, Pranavakumar MS, Dass P, A study of Anti-inflammatory activity of fruit of *Emblica officinalis* (Amla) in Albino rats, Medical Innovation, 2(1), 2013, 17-26.
- Bhattacharya SK, Bhattacharya A, Sairam K, Ghosal S, Effect of bioactive tannoid principles of *Emblica officinalis* on ischemia-reperfusion induced oxidative stress in rat heart, Phytomedicine, 9(2), 2002, 171-4.
- Yi-Fei W, Ya-Feng W, Xiao-Yana W, Zhea R, Chui-Wena Q, Yi-Cheng L, Kitazatoc K, Qing-Duan Q, Yan W, Li-Yun Z, Jin-Hua Z, Chong-Rene Y, Qinge L, Ying-June Z, Phyllaemblicin B inhibits Coxsackie virus B3 induced apoptosis and myocarditis, Antiviral Research, 84, 2009, 150-58.
- Rehman H, Yasin KA, Choudhary MA, Khaliq N, Rahman A, Choudhary MI, Malik S, Studies on the chemical constituents of



- Phyllanthus emblica*, Natural Product Research, 21(9), 2007, 775-81.
24. Jain SK, Khurdiya DS, Vitamin C enrichment of fruit juice based ready-to-serve beverages through blending of Indian gooseberry (*Emblca officinalis* Gaertn.) juice, Plant Foods for Human Nutrition, 59(2), 2004, 63-6.
 25. Scartezzini P, Antognoni F, Raggi MA, Poli F, Sabbioni C, Vitamin C content and antioxidant activity of the fruit and of the Ayurvedic preparation of *Emblca officinalis* Gaertn, Journal of Ethnopharmacology, 104(1-2), 2006, 113-8.
 26. El-Desouky SK, Ryu SY, Kim YK, A new cytotoxic acylated apigenin glucoside from *Phyllanthus emblica* L, Natural Product Research, 22(1), 2008, 91-5.
 27. Zhang LZ, Zhao WH, Guo YJ, Tu GZ, Lin S, Xin LG, Studies on chemical constituents in fruits of Tibetan medicine *Phyllanthus emblica*, Zhongguo Zhong Yao Za Zhi, 28(10), 2003, 940-3.
 28. Krishnaveni M, Mirunalini S, Therapeutic potential of *Phyllanthus emblica* (amla): the ayurvedic wonder, Journal of Basic and Clinical Physiology and Pharmacology, 21, 2010, 93-105.
 29. Bajracharya MB, Ayurvedic Medicinal Plants. Kathmandu, Piyusavarsi Ausadhalaya, 1979.
 30. Sankaran M, Velusamy V, Mani K, Amla: a novel ayurvedic herb as a functional food for health benefits" - A mini review, International Journal of Pharmacy and Pharmaceutical Sciences, 5(1), 2013, 1-4.
 31. Khan KH, Roles of *Emblca officinalis* in Medicine - A Review, Botany Research International, 2 (4), 2009, 218-228.
 32. Sampath Kumar KP, Bhowmik D, Dutta A, Yadav A, Paswan S, Shweta S, Lokesh D, Recent Trends in Potential traditional Indian Herbs *Emblca Officinalis* and Its Medicinal Importance, Journal of Pharmacognosy and Phytochemistry, 1(1), 2012, 24-32.
 33. Singh E, Sharma S, Pareek A, Dwivedi J, Yadav S, Sharma S, Phytochemistry, traditional uses and cancer chemopreventive activity of Amla (*Phyllanthus emblica*): The Sustainer, Journal of Applied Pharmaceutical Science, 2(1), 2011, 176-183.
 34. Linda T, Amla Traditional food and medicine, Herbal Gram, The Journal of the American Botanical Council, 31(26), 1994.
 35. Kumar A, Singh A, Dora J. Essential perspectives for *Emblca officinalis*, International journal of pharmaceutical and chemical sciences, 1(1), 2012, 11-18.
 36. Shweta K, Sunny S, A short description on pharmacogenetic properties of *Emblca officinalis*, Spatula DD, 2(3), 2012, 187-193.
 37. Prakash D, Upadhyay G, Pushpangadan P, Gupta C, Antioxidant and free radical scavenging activities of some fruits, Journal of Complementary and Integrative Medicine, 8(1), 2011, 1-16.
 38. Ghosal S, Tripathi VK, Chauhan S, Active constituents of *Emblca officinalis*, Part I, the chemistry and antioxidant effects of two new hydrolysable tannins, emblicanin A and B, Indian Journal of Chemistry, 35, 1996, 941-8.
 39. Pandey, Govind, Some important anti-cancer herbs: A review, International Research Journal of Pharmacy, 2(7), 2011, 45-52.
 40. Juree Ch, Ngamkitidechakul Ch, Noppamas S, Kanjana J, Sireeratawong S, Antioxidant activities of the standardized water extract from fruit of *Phyllanthus emblica* Linn, Songklanakarin Journal of Science and Technology, 32 (6), 2010, 599-604.
 41. Chaudhari RK, *Emblca* cascading antioxidant: A novel natural skin care ingredient, Skin Pharmacology and Applied Skin Physiology, 15(3), 2002, 374-380.
 42. Fujii T, Wakaizumi M, Ikami T, Saito M, Amla (*Emblca officinalis* Gaertn.) extract promotes procollagen production and inhibits matrix metalloproteinase-1 in human skin fibroblasts, Journal of Ethnopharmacology, 119, 2008, 53-57.
 43. Suresh K, Vasudevan DM, Augmentation of murine natural killer cell and antibody dependent cellular cytotoxicity activities by *Phyllanthus emblica*, a new immunomodulator, Journal of Ethnopharmacology, 44(1), 1994, 55-60.
 44. Rajesh kumar NV, Pillai MR, Kuttan R, Induction of apoptosis in mouse and human carcinoma cell lines by *Emblca officinalis* polyphenols and its effect on chemical carcinogenesis, Journal of Experimental & Clinical Cancer Research, 22(2), 2003, 201-12.
 45. Luo W, Zhao M, Yang B, Ren J, Shen G, Rao G, Antioxidant and antiproliferative capacities of phenolics purified from *Phyllanthus emblica* L. fruit, Food Chemistry, 126(1), 2011, 277-82.
 46. Zhong Z, Wu D, Huang J, Liang H, Pan Z, Zhang W, Lu H, Progalin A isolated from the acetic ether part of the leaves of *Phyllanthus emblica* L. induces apoptosis of human hepatocellular carcinoma BEL-7404 cells by up-regulation of Bax expression and down-regulation of Bcl-2 expression, Journal of Ethnopharmacology, 133(2), 2011, 765-72.
 47. Haque R, Bin-Hafeez B, Ahmad I, Parvez S, Pandey S, Raisuddin S, Protective effects of *Emblca officinalis* Gaertn. In cyclophosphamide treated mice, Human & Experimental Toxicology, 20(12), 2001, 643-50.
 48. Liu, Zhao M, Wu K, Chai X, Yu H, Tao Z, Wang J, Immunomodulatory and anticancer activities of phenolics from *emblca* fruit (*Phyllanthus emblica* L.), Food Chemistry, 131(2), 2012, 685-90.
 49. Ganju L, Karan D, Chanda S, Srivastava KK, Sawhney RC, Selvamurthy W, Immunomodulatory effects of agents of plant origin, Biomedicine and Pharmacotherapy, 57(7), 2003, 296-300.
 50. Sanjay K, Singh MK, Yadav SS, Gupta V, Immunomodulatory role of *Emblca officinalis* in arsenic induced oxidative damage and apoptosis in thymocytes of mice, BMC Complementary and Alternative Medicine, 13, 2013, 193-7.
 51. Fujii T, Okuda T, Yasui N, Wakaizumi M, Ikami T, Ikeda K, Effects of amla extract and collagen peptide on UV B-induced photoaging in hairless mice, Journal of Functional Foods, 5(1), 2013, 451-59.
 52. Mehmood MH, Siddiqi HS, Gilani AH, The anti-diarrheal and spasmolytic activities of *Phyllanthus emblica* are mediated through dual blockade of muscarinic receptors and Ca²⁺ channels, Journal of Ethnopharmacology, 133(2), 2011, 856-65.
 53. Nampoothiri SV, Prathapan A, Cherian OL, Raghu KG, Venugopalan VV, Sundaresan A, In vitro antioxidant and inhibitory potential of *Terminalia bellerica* and *Emblca officinalis* fruits against LDL oxidation and key enzymes linked to type 2 diabetes, Food and Chemical Toxicology, 49(1), 2011, 125-131.
 54. Nain P, Saini V, Sharma S, Nain J, Anti-diabetic and antioxidant potential of *Emblca officinalis* Gaertn. leaves extract in streptozotocin-induced type-2 diabetes mellitus (T2DM) rats, Journal of Ethnopharmacology, 142(1), 2012, 65-71.
 55. Suryanarayana P, Saraswat M, Petrash JM, Reddy GB, *Emblca officinalis* and its enriched tannoids delay streptozotocin induced diabetic cataract in rats, Molecular Vision, 13, 2007, 1291-7.
 56. Usharani P, Fatima N, Muralidhar N, Effects of *Phyllanthus emblica* extract on endothelial dysfunction and biomarkers of oxidative stress in patients with type 2 diabetes mellitus: a randomized, double-blind, controlled study, Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy, 6, 2013, 275-84.
 57. Thaweboon B, Thaweboon S, Effect of *Phyllanthus emblica* Linn. on candida adhesion to oral epithelium and denture acrylic, Asian Pacific Journal of Tropical Medicine, 4(1), 2011, 41-45.
 58. Mandal S, Deb Mandal M, Pal NK, Krishnendu Saha K, Synergistic anti-Staphylococcus aureus activity of amoxicillin in combination with *Emblca officinalis* and *Nymphaeodorata* extracts, Asian Pacific Journal of Tropical Medicine, 3(9), 2010, 711-14.
 59. Kumar A, Tantry BA, Rahiman S, Gupta U, Comparative study of antimicrobial activity and phytochemical analysis of methanolic

- and aqueous extracts of the fruit of *Emblica officinalis* against pathogenic bacteria, Journal of Traditional Chinese Medicine, 31(3), 2011, 246-50.
60. Patil SG, Deshmukh AA, Padol AR, Kale DB, In vitro antibacterial activity of *Emblica officinalis* fruit extract by tube Dilution Method, International Journal of Toxicology and Applied Pharmacology, 2(4), 2012, 49-51.
 61. Kamal R, Yadav S, Mathur M, Katariya P, Antiradical efficiency of 20 selected medicinal plants, Natural Product Research, 26(11), 2012, 1054-62.
 62. Liu G, Xiong S, Xiang S, Guo CW, Ge F, Yang CR, Zhang Y, Wang Y, Kitazato K, Antiviral activity and possible mechanisms of action of pentagalloylglucose (PGG) against influenza A virus, Archives of Virology, 156, 2011, 1359-69.
 63. Senthil Kumar M, Kirubanandan S, Sripriya R, Sehgal PK, Triphala Promotes Healing of Infected Full-Thickness Dermal Wound, Journal of Surgical Research, 144(1), 2008, 94-101.
 64. Srirama R, Deepak HB, Senthilkumar U, Ravikanth G, Gurumurthy BR, Shivanna MB, Chandrasekaran CV, Agarwal A, Shaanker RU, Hepatoprotective activity of Indian Phyllanthus, Pharmaceutical Biology, 50(8), 2012, 948-53.
 65. Golechha, Mahaveer, Bhatia, Jagriti, Arya, Singh D, Studies on effects of *Emblica officinalis* (Amla) on oxidative stress and cholinergic function in scopolamine induced amnesia in mice, Journal of Environmental Biology, 33(1), 2012, 95-99.
 66. Kumar N, Rungseevijitprapa W, Narkkhong N, Suttajit M, Chaiyasuta Ch, 5 α -reductase inhibition and hair growth promotion of some Thai plants traditionally used for hair treatment, Journal of Ethnopharmacology, 139, 2012, 765-71.

Source of Support: Nil, Conflict of Interest: None.

Corresponding Author's Biography: Mrs. Swetha Dasaroju



Mrs. Swetha Dasaroju graduated at Osmania University, Hyderabad and post graduated from the same University in Pharmacology specialization. At post-graduation level she stood as topper of University and completed master thesis in "Role of Dietary antioxidants in Brain Ageing and related disorders". She is an awardee of INSPIRE FELLOWSHIP from Department of Science and Technology (DST), Govt. of India. Currently she is pursuing her PhD at Jawaharlal Nehru Technological University, Hyderabad. Her research is focused on "Role of Dietary components in slowing Ageing".