

Roles of *Emblica officinalis* in Medicine - A Review

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Abstract: *Emblica officinalis* (Amla) are widely used in the Indian system of medicine and believed to increase defense against diseases. This article discusses and summarizes important medicinal values of *Emblica officinalis* (EO). In this communication, we reviewed the applications of EO in cancer, diabetes, liver treatment, heart disease, ulcer, anemia and various other diseases. The use of EO as antioxidant, immunomodulatory, antipyretic, analgesic, cytoprotective, antitussive and gastroprotective are also reviewed. Its applications for memory enhancing, ophthalmic disorders, lowering cholesterol level are focused. The effects of EO in neutralizing snake venom and as an antimicrobial are also included. This paper also review the retrospective studies on the Amla at molecular level.

Key words: *Emblica officinalis* • Diseases • Medicinal value • Formulation

INTRODUCTION

Emblica officinalis (EO) enjoys a hallowed position in Ayurveda- an Indian indigenous system of medicine. According to believe in ancient Indian mythology, it is the first tree to be created in the universe. It belongs to family Euphorbiaceae. It is also named as Amla, *Phyllanthus Emblica* or Indian gooseberry. Other vernacular names of EO have been listed in the Table 1. The species is native to India and also grows in tropical and subtropical regions including Pakistan, Uzbekistan, Srilanka, South East Asia, China and Malaysia. The fruits of EO are widely used in the Aryurveda and are believed to increase defense against diseases. It has its beneficial role in cancer, diabetes, liver treatment, heart trouble, ulcer, anemia and various other diseases. Similarly, it has application as antioxidant, immunomodulatory, antipyretic, analgesic, cytoprotective, antitussive and gastroprotective. Additionally, it is useful in memory enhancing, ophthalmic disorders and lowering cholesterol level. It is also helpful in neutralizing snake venom and as an antimicrobial. It is often used in the form of Triphala which is an herbal formulation containing fruits of EO, *Terminalia chebula* and *Terminalia bellerica* in equal proportions. A general description about EO has been summarized in Table 2.

Table1: Vernacular names of *Emblica officinalis*

S.No	Vernacular Names
1.	Sanskrit: Dhatriphala, Amla, Amaliki, Amalakan, Sriphalam, Vayastha
2.	Hindi: Amla
3.	English: Emblica myroblan
4.	Italian: Mirabolano emblico
5.	German: Amla
6.	French: Phyllanthe emblica
7.	Nepalese: Amba
8.	Chinese: An Mole
9.	Tibetan: Skyu-ru-ra
10.	Malaysian: Popok Melaka
11.	Portuguese: Mirabolano emblico

Identification and Chemical Constituents of *Emblica Officinalis*: Identification of correct genotype of medicinal plant material remained challenging to botanical drug industries. Limitations of chemical and morphological approaches for authentication have created need for newer methods in quality control of botanicals. DNA based marker for identification of EO were developed. Random Amplified Polymorphic DNA (RAPD) technique was used to identify a putative marker (1.1 kb) specific for EO. RAPD amplicon was used to generate Sequence Characterized Amplified Region (SCAR) marker. The SCAR marker was found beneficial for identification of EO in its commercial samples [1].

Table 2: General description of *Emblica officinalis*

S.No	1. Habitat
1.	Found in India, Pakistan, Uzbekistan, Srilanka, South East Asia, China and Malaysia
	2. Used Parts
1.	Dried fruits, Fresh fruit, seed, leaves, rootbark, flowers
	3. Fruits
1.	Ripen from November to February
2.	Nearly spherical or globular, wider than long and with a small and slight conic depression on both apexes
3.	Fruit is 18-25mm wide and 15-20mm long
4.	Surface is smooth with 6 obscure vertical pointed furrow
5.	Mesocarp is yellow and endocarp is yellowish brown in ripened condition
6.	In fresh fruit mesocarp is acidulous and in dried fruit it is acidulous astringent.
	4. Leaves
1.	Leaf is 8-10 mm or more long and 2-3 m broad, hairless light green outside, palegreen or often pubescent beneath.
2.	It contains gallic acid, ellagic acid, chebulic acid, chebulinic acid, chebulagic acid, a gallantonic called amlic acid, alkaloids phyllantidine. and phyllantine.
	5. Seeds
1.	Four-Six, smooth, dark brown
2.	A fixed oil, phosphatides and a small quantity of essential oil. The fixed oil (yield 16% and has the following physical and chemical characteristics: acid value 12.7; saponification value 185; iodine value 139.5; acetyl value 2.03; unsaponifiable matter 3.81%; sterol 2.70% ; saturated fatty acid 7%. Contains linolenic acid (8.78 %), linoleic (44%). oleic (28.40%), steric (2.15%), palmitic (2.99%) and miristic acid (0.95%).
	6. Barks
1.	Thick to 12 mm, shining grayish brown or grayish green.
2.	Leukodelphinidin, tannin and proanthocyanidin
	7. Roots
1.	Ellagic acid and lupeol

EO primarily contains tannins, alkaloids, phenolic compounds, amino acids and carbohydrates. Its fruit juice contains the highest vitamin C (478.56 mg/100 mL). The fruit when blended with other fruits, boosted their nutritional quality in terms of vitamin C content [2].

Compounds isolated from EO were 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 dihydroxy benzoic acid) and isostrictiniin [3]. *Phyllanthus emblica* also contains flavonoids, kaempferol 3 O alpha L (6" methyl) rhamnopyranoside and kaempferol 3 O alpha L (6"ethyl) rhamnopyranoside [4]. A new acylated apigenin glucoside (apigenin 7 O (6" butyryl beta glucopyranoside) was isolated from the methanolic extract of the leaves of *Phyllanthus emblica* together with the known compounds; gallic acid, methyl gallate, 1,2,3,4,6-penta-O-galloylglucose and luteolin-4'-O-neohesperidoside were also reported [5]. A number of compounds found in EO are listed in Table 3 and 4.

Table3: Chemical constituents found in EO

S.No	Chemical Constituents
1.	Tanins
2.	Alkalods
3.	Phenolic compounds
4.	Amino acids
5.	Carbohydrates
6.	Vitamin C
7.	Flavanoid
8.	Ellagic acid
9.	Chebulinic acid
10.	Quercetin
11.	Chebulagic acid
12.	Emblicanin-A
13.	Gallic acid
14.	Emblicanin-B
15.	Punigluconin
16.	Pedunculagin
17.	Citric acid
18.	Ellagotannin
19.	Trigallayl glucose
20.	Pectin

Table 4: Average percentage composition of the fruit pulp of *Emblca officinalis*

S.No	Components	Percentage
1.	Moisture	81.2%
2.	Protein	0.5%
3.	Fat	0.1%
4.	Mineral matter	0.7%
5.	Fibre	3.4%
6.	Carbohydrate	14.1%
7.	Calcium	0.05%
8.	Phosphorous	0.02%
9.	Iron	1,2mg/100gm
10.	Nicotinic acid	0.2mg/100gm
11.	Vitamin C	600 mg/100 gm

Applications of *Emblca Officinalis* in Cancer:

Triphala has been reported to exhibit chemopreventive potential. The presence of Triphala in diet had significantly lowered the benzo(a)pyrene [B(a)P] induced forestomach papillomagenesis in mice. It was more effective in reducing tumor incidences compared to its individual constituents. Triphala also significantly increased the antioxidant status of animals which might have contributed to the chemoprevention [6]. The breast cancer is one of the most common cancers in women. Lipid-metabolizing enzymes, lipids and lipoproteins have been associated with the risk of breast cancer. Kalpaamruthaa (KA) is a modified Siddha preparation containing EO, *Semecarpus anacardium* (SA and honey). The elevated levels of free cholesterol, total cholesterol, triglycerides, phospholipids and free fatty acids and decreased levels of ester cholesterol in plasma, kidney and liver found in cancer suffering animals were reverted back to near normal levels on treatment with KA and SA [7].

Chemoprevention with food phytochemicals is presently considered as one of the most important strategies to control cancer. EO is valued for its unique tannins and flavanoids, which exhibit very powerful antioxidant properties. The inhibition of tumor incidences by fruit extract of this plant has been evaluated on two-stage process of skin carcinogenesis in Swiss albino mice. Chemopreventive potential of EO fruit extract on 7,12-dimethylbenz(a)anthracene (DMBA) induced skin tumorigenesis in Swiss albino mice have been found [8]. The cytotoxic effects of aqueous extract of Triphala were investigated on a transplantable mouse thymic lymphoma (barcl-95) and human breast cancer cell line (MCF-7). The differential response of normal cells and tumor cells to Triphala *invitro* and the substantial regression of transplanted tumor in mice fed with Triphala indicates to

its potential use as an anticancer drug for clinical treatment [9]. The suppression of the growth of cancer cells due to the gallic acid-a major polyphenol as observed in "Triphala" have been reported [10].

Ethanollic extract of EO was experimentally evaluated for protection against genotoxicity induced by DMBA. EO fruit administered orally at different concentrations (100, 250, 500 mg/kg b.wt) for seven consecutive days in Swiss albino mice prior to a single intraperitoneal injection of DMBA decreased the frequency of bone marrow micronuclei. The protection provided by EO may be due to its antioxidant capacity and through its modulatory effect on hepatic activation and detoxifying enzymes [11]. Phenolic compounds derived from plant exhibit a number of beneficial effects and can potentially inhibit several stages of carcinogenesis. Efficacy of EO polyphenol fraction (EOP) on the induction of apoptosis in mouse and human carcinoma cell lines and its modulatory effect on N-nitrosodiethylamine (NDEA) induced liver tumors in rats was also investigated. EOP treatment could induce apoptosis in Dalton's Lymphoma Ascites (DLA) and CeHa cell lines. EOP also inhibited DNA topoisomerase I in *Saccharomyces cerevisiae*, mutant cell cultures and the activity of cdc25 tyrosine phosphatase [12]. *Invitro* antiproliferative activity of extracts from medicinal plants toward human tumor cell lines, including human erythromyeloid K562, T-lymphoid Jurkat, B-lymphoid Raji, erythroleukemic HEL cell lines were compared. Extracts from EO were the most active in inhibiting *invitro* cell proliferation have been found [13].

Cyclophosphamide is one of the most famous alkylating anticancer drugs in spite of its toxic side effects including hematotoxicity, immunotoxicity and mutagenicity. EO or its medicinal preparations may prove to be beneficial as a component of combination therapy in cancer patients under cyclophosphamide treatment [14]. Phenolic compounds and the major components from the fruit juice of EO and from the branches, leaves and roots showed stronger inhibition against B16F10 cell growth than against HeLa and MK-1 cell growth. Norsesquiterpenoid glycosides from the roots showed significant antiproliferative activities [15]. Its beneficiary uses in a number of diseases are enlisted in Table 5.

Uses of *Emblca Officinalis* in Diabetis: Oral administration of the extracts (100 mg/kg body weight) reduced the blood sugar level in normal and in alloxan (120 mg/kg) diabetic rats significantly within 4 hours. EO and an enriched fraction of its tannoids are effective in delaying development of diabetic cataract in rats [16].

Table 5: Diseases in which EO is beneficial

S.No	Diseases
1.	Cancer
2.	Diabetis
3.	Heart diseses
4.	Liver treatment
5.	Ulcer
6.	Anemia
7.	Hypercholesterolemia
8.	Hyperthermia
9.	Ophthalmic disorder
10.	Dyspepsia
11.	Lung mtastasis
12.	Healing dermal wounds
13.	Dyslipidaemia
14.	Pancreatitis
15.	Atherosclerosis
16.	Alzheimer's disease
17.	Fever
18.	Bronchitis
19.	Diarrhoea
20.	Jaundice

Aldose reductase (AR) has its involvement in the development of secondary complications of diabetes including cataract. EO is proved as an important inhibitor of AR. Exploring the therapeutic value of natural ingredients that people can incorporate into everyday life may be an effective approach in the management of diabetic complications [17].

Effects of *Emblia Officinalis* on Liver: EO fruits have been reported to be used for hepatoprotection in Ayurveda [18]. *Phyllanthus emblica* extract was investigated on ethanol induced rat hepatic injury. Protective roles of this against ethanol induced liver injury in rats are reported [19]. A hydroalcoholic (50%) extract of fruit of EO (EO-50) decreased the severity of hepatic fibrosis induced by thioacetamide and carbon tetrachloride. EO-50 effectively reversed profibrogenic events possibly due to its antioxidative activity. Hepatoprotective effect of EO-50 against antituberculosis (anti-TB) drugs-induced hepatic injury has been reported. EO-50 exhibits hepatoprotective activity due to its membrane stabilizing, antioxidative and CYP 2E1 inhibitory roles [20]. EO also inhibited hepatic toxicity in Wistar rats [21]. The extract of EO and Chyavanaprash were investigated for its hepatoprotective activity using carbon tetrachloride (CCl₄) induced liver injury in rats. Both extracts were observed to inhibit the hepatotoxicity produced by acute and chronic CCl₄ administration as

seen from the decreased levels of serum and liver lipid peroxides (LPO), glutamate-pyruvate transaminase (GPT) and alkaline phosphatase (ALP). Chronic CCl₄ administration was also found to produce liver fibrosis as seen from the increased levels of collagen-hydroxyproline and pathological analysis. Both extracts were found to inhibit these elevated levels significantly, showing that the extract could reduce the induction of fibrosis in rats model [22].

Cardioprotective Activity of *Emblia Officinalis*:

The effects of chronic oral administration of fresh fruit homogenate of Amla on myocardial antioxidant system and oxidative stress induced by ischemic-reperfusion injury (IRI) were investigated on heart in rats. Chronic EO administration produces myocardial adaptation by augmenting endogenous antioxidants and protects rat hearts from oxidative stress associated with IRI [23].

***Emblia Officinalis* and its Anti-ulcer Activities:**

A herbomineral formulation of the Ayurveda medicine named Pepticare, composed of EO, *Glycyrrhiza glabra* and *Tinospora cordifolia* was tested for its anti-ulcer and anti-oxidant activity in rats. Reports were made that Pepticare exhibit anti-ulcer activity, which can be attributed to its anti-oxidant property [24]. Methanolic extract of EO (EOE) was studied against ulcer. EOE had significant ulcer protective and healing effects and this might be due to its effects both on offensive and defensive mucosal factors [25].

Antioxidant Activities of *Emblia Officinalis*: The origin of disease of multifactorial nature is being understood due to the vitiation in basic heamostatis balance phenomenon in the body. It is increasingly being realized now that majorities of the disease are mainly due to the imbalance between pro-oxidant and anti-oxidant homeostatic phenomenon in the body. Proxidant condition dominates either due to increased generation of free radicals and/or their poor quenching/scavenging into the body. Free radicals are the fundamental to any biochemical process and represent an essential part of the aerobic life and our metabolism. They are continuously produced by body's normal use of oxygen such as respiration and some cell mediated immune functions. Naturally, there is a dynamic balance between the amount of free radicals generated in the body and anti-oxidant to quench and or /scavenge them and protect the body against their deleterious effects. It is obvious therefore that any additional burden of free radicals either from

environment or produced within the body, can tip the free radical (pro-oxidant) and anti-free radical (anti-oxidant) balance leading to oxidative stress which may result in tissue injury and subsequent diseases. Thus, the oxidant status in human reflects the dynamic balance between the anti-oxidant defence and pro-oxidant conditions and has been suggested as a useful tool in estimating the risk of oxidative damage.

EO was studied against the cold stress-induced alterations in the behavioral and biochemical abnormalities. Triphala administered orally about 1g/kg/animal body weight for 48 days significantly prevented cold stress-induced behavioral and biochemical abnormalities in albino rats. Thus Triphala supplementation can be regarded as a protective drug against stress [26].

The administration of ethyl acetate (EtOAc) extract of Amla or Sun Amla (Taiyo Kagaku Co., Ltd., Japan) reduced the elevated levels of urea nitrogen and serum creatinine in the aged rats. Oral administration of this extract significantly reduced thiobarbituric acid-reactive substance levels of serum, renal homogenate and mitochondria in aged rats, suggesting that Amla would ameliorate oxidative stress under aging. The increase of inducible nitric oxide synthase (iNOS) and cyclooxygenase (COX)-2 expression in the aorta of aging rats were also significantly suppressed by EtOAc extract of Amla or Sun Amla extract. EtOAc extract of Amla or Sun Amla reduced the COX-2 and iNOS expression levels by inhibiting NF-kappaB activation in the aged rats. Thus Amla would be a very useful antioxidant for the prevention of age-related renal disease [27]. Prefeeding of Amla appeared to reduce the hexachlorocyclohexane (HCH) -induced raise in renal gamma-glutamyl transpeptidase (GGT) activity. This shows the elevation of hepatic antioxidant system and lowering of cytotoxic products as which were otherwise affected by the administration of HCH [28].

Elevation in xanthine oxidoreductase activity and lowering in superoxide dismutase activity was observed in the intestine of mice exposed to whole body gamma-irradiation (WBI), which, however, reverted back to those levels of sham-irradiated controls, when animals were fed with Triphala for 7 days prior to irradiation. This suggested the prevention of oxidative damage caused by whole body radiation exposure after feeding of animals with Triphala. Triphala protected whole body irradiated mice. Protection was mediated through inhibition of oxidative damage in cells and organs. It indicated that this drug has potential to develop into a novel herbal radio-protector for practical applications [29].

Methanol was used to extract the dried fruit rind of *Phyllanthus emblica* and then separated into ethyl acetate, hexane and water fractions. Only the ethyl acetate phase showed strong NO scavenging activity *invitro*, when compared with hexane and water phases. In the ethyl acetate extract gallic acid was found to be a major compound that showed highest NO scavenging activity [30]. Triphala due to its antioxidant properties was also found to restore the noise-stress induced changes [31].

Vitamin C in EO accounts for approximately 45-70% of the antioxidant activity [32]. Rats were examined for the antioxidant properties of Amla extracts and its effect on the oxidative stress in streptozotocin-induced diabetes were also reported. The extracts showed strong free radical scavenging activity. Amla extracts orally administered to the diabetic rats slightly improved body weight gain and also significantly increased various oxidative stress indices of the serum of the diabetic rats. Moreover the decreased levels of albumin in the diabetic rats were significantly improved with this drug. It also significantly improved the serum adiponectin levels. Thus amla can be used for relieving the oxidative stress and improving glucose metabolism in diabetes [33].

The aqueous extract of the fruits of *Terminalia chebula*, EO and *Terminalia bellerica* and their equiproportional mixture Triphala were evaluated for their *invitro* antioxidant activity. Gamma-Radiation induced strand break formation in plasmid DNA (pBR322) was effectively inhibited by Triphala and its constituents. *Terminalia chebula* has greater radical scavenging activity while EO shows greater efficiency in lipid peroxidation and plasmid DNA assay. Their mixture, Triphala, is expected to be more efficient due to the combined activity of the individual components [34].

DHC-1, an herbal formulation was made from the important herbal plants like EO, *Bacopa monniera*, *Glycyrrhiza glabra*, *Mangifera indica* and *Syzygium aromaticum* was studied for its antioxidant activity. The protective effect of DHC-1 was studied in isoproterenol-induced myocardial infarction and cisplatin-induced renal damage. DHC-1 possesses a protective effect against both damaged kidneys and heart in rats. This protective effect may be attributed, at least in part, to its antioxidant activity [35]. The plant extract lowered hepatic lipid peroxidation (LPO) and increased the superoxide dismutase (SOD) and catalase (CAT) activities in hyperthyroid mice, exhibiting its hepatoprotective nature. It potentially ameliorate the hyperthyroidism with an additional hepatoprotective benefit [36].

Table 6: Various medicinal activities of EO

S.No	Medicinal Activities
1.	Antioxidant activity
2.	Immunomodulatory activity
3.	Antipyretic activity
4.	Analgesic activity
5.	Hepatoprotective activity
6.	Cytoprotective activity
7.	Antitussive activity
8.	Gastoprotective activity
9.	Ophthalmic disorder
10.	Antimicrobial activity
11.	Anti-inflammatory activity
12.	Radioprotective activity
13.	Chemopreventive activity
14.	Antithrogenic activity
15.	Antitumor activity
16.	Apoptotic activity
17.	Antiulcer activity
18.	Hypolipidemic activity
19.	Adaptogenic property
20.	Antimutagenic activity
21.	Hypocholesterolemic activity

EuMil is a polyherbal formulation composed of standardized extracts of *Ocimum sanctum*, *Withania somnifera*, *Asparagus racemosus* and EO, was used as an anti-stress agent to attenuate the various aspects of stress related disorders. It has significant anti-stress and adaptogenic activities, qualitatively comparable to *Panax ginseng*, against a number of behavioral, biochemical and physiological perturbations, induced by unpredictable stress, which has been proposed to be a better indicator of clinical stress than acute stress. The contribution of the individual constituents of EuMil (polyherbal formulation) in the adaptogenic action has been reported [37]. EO is used to protect the skin from the devastating effects of free radicals, non-radicals and transition metal-induced oxidative stress. It is suitable for use in, anti-aging, general purpose skin care products and as sunscreen [38]. The fruits of EO contain tannoid principles that have been reported to exhibit antioxidant activity *invitro* and *invivo*. Emblicanin-A (37%) and -B (33%) enriched fraction of fresh juice of EO fruits was investigated for antioxidant activity against ischemia-reperfusion -induced oxidative stress in rat heart. The study confirms the antioxidant effect of EO and also indicated that the fruits of the plant may exhibit a cardioprotective effect [39]. The antioxidant activity of EO extract is associated with the presence of hydrolyzable tannins having ascorbic acid-like action have been also reported [40].

A number of medicinal plants, traditionally used for thousands of years, are present in a group of herbal preparations of the Indian traditional health care system (Ayurveda) named Rasayana identified for their interesting antioxidant activities. EO have been reported for its antioxidant activity [41]. It contains tannoid principles comprising of emblicanin A, emblicanin B, punigluconin and pedunculagin, have been reported to possess antioxidant activity *invitro* and *invivo* [42]. Various medicinal activities of EO are summarized in Table 6.

Active Roles of *Emblica Officinalis* in

Immunomodulation: Immune activation is an effective as well as protective approach against emerging infectious diseases. Albino rats were used to assess the immunomodulatory activities of Triphala on various neutrophil functions like adherence, phagocytic index, avidity index and nitro blue tetrazolium. Oral administration of Triphala appears to stimulate the neutrophil functions in the immunized rats and stress induced suppression in the neutrophil functions were significantly prevented by Triphala [43]. EO and *Evolvulus alsinoides* (Shankhpushpi) were assessed for its immunomodulatory activity in adjuvant induced arthritic (AIA) rat model. Complete Freund's Adjuvant (CFA) was injected in right hind paw of the animals induced inflammation. Lymphocyte proliferation activity and histopathological severity of synovial hyperplasia were used to study the anti-inflammatory response of both the extracts. Both the extracts showed a marked reduction in inflammation and edema and caused immunosuppression in AIA rats, indicating that they may provide an alternative approach for the treatment of arthritis [44]. Immu-21 is an Ayurvedic polyherbal formulation containing extracts of EO, *Ocimum sanctum*, *Withania somnifera* and *Tinospora cordifolia*. Its immunomodulatory activity was studied on proliferative response of splenic leukocytes to T cell mitogens, concanavalin (Con)-A and phytohemagglutinin (PHA) and B cell mitogen, lipopolysaccharide (LPS) *invitro* by [3H]-thymidine uptake assay in mice. Pretreatment with Immu-21 selectively elevated the proliferation of splenic leukocyte to B cell mitogen, LPS and cytotoxic activity against K 562 cells in mice [45]. EO have been reported to inhibit Cr-induced free radical production and also restored the anti-oxidant status back to control level. It also inhibited apoptosis and DNA fragmentation induced by Cr. It relieved the immunosuppressive effects of Cr on lymphocyte proliferation and even restored the IL-2 and gamma-IFN production [46].

Antipyretic and Analgesic Activities of *Emblia Officinalis*: Extracts of EO fruits possess potent anti-pyretic and analgesic activities. A single oral dose of ethanolic extract and aqueous extract (500 mg/kg, i.p.) showed significant reduction in hyperthermia in rats induced by brewer's yeast. Both of these extracts elicited pronounced inhibitory effect on acetic acid-induced writhing response in mice in the analgesic test [47]. This may be due to the presence of tannins, alkaloids, phenolic compounds, amino acids and carbohydrates.

Cytoprotective, Antitussive, Gastroprotective Properties of *Emblia Officinalis*: EO has been reported for its cytoprotective and immunomodulating properties against chromium (VI) induced oxidative damage. It inhibited chromium induced immunosuppression and restored gamma-IFN production by macrophages and phagocytosis [48].

EO was tested for its antitussive activity in conscious cats by mechanical stimulation of the laryngopharyngeal and tracheobronchial mucous areas of airways. Antitussive activity of EO was more effective than the non-narcotic antitussive agent dromopazine but less effective than shown by the classical narcotic antitussive drug codeine. It is supposed that the dry extract of EO exhibit the antitussive activity not only due to antiphlogistic, antispasmodic and antioxidant efficacy effects, but also to its effect on mucus secretion in the airways [49].

EO (ethanolic extract) was investigated for its antisecretory and antiulcer activities using various experimental models in rats, including pylorus ligation Shay rats, indomethacin, hypothermic restraint stress-induced gastric ulcer and necrotizing agents. It was then reported that Amla extract exhibit antisecretory, cytoprotective and antiulcer properties [50].

Memory Enhancing Effects of *Emblia Officinalis*: Amla churna produced a dose-dependent improvement in memory of young and aged rats. It reversed the amnesia induced by scopolamine and diazepam. Amla churna may prove to be a useful remedy for the management of Alzheimer's disease due to its multifarious beneficial effects such as memory improvement and reversal of memory deficits [51, 52].

Management of Ophthalmic Disorders with *Emblia Officinalis*: Ophthacare is a herbal eye drop preparation containing basic principles of different herbs viz *Carum copticum*, *Terminalia belerica*, EO, *Curcuma longa*, *Ocimum sanctum*, *Cinnamomum camphora*, *Rosa*

damascena and *Melospumapum*. Clinical trial was conducted in patients suffering from different ophthalmic disorders namely, conjunctival xerosis, conjunctivitis, acute dacryocystitis, degenerative conditions and postoperative cataract patients with a herbal eye drop preparation. In most cases improvement was observed with the treatment of the herbal eye drop. During the course of study no side effects were observed and the eye drop was well tolerated by the patients. Ophthacare exhibit beneficial role in a number of inflammatory, infective and degenerative ophthalmic disorders [53].

Roles of *Emblia Officinalis* in Reducing Cholesterol and Dyslipidemia: Cu(2+)-induced LDL oxidation and cholesterol-fed rats were used to investigate the effects of Amla on low-density lipoprotein (LDL) oxidation and cholesterol levels *in vitro* and *in vivo*. It was concluded that Amla may be effective for hypercholesterolemia and prevention of atherosclerosis [54]. EO and *Mangifera indica* contains flavonoids which reduce the levels of lipid in serum and tissues of rats induced hyperlipidemia. Both causes the degradation and elimination of cholesterol [55].

***Emblia Officinalis* as Snake Venom Neutralizer:** EO and *Vitex negundo* were explored for the first time for antsnake venom activity. *Naja kaouthia* and *Vipera russellii* venom was antagonized by the plant extracts significantly both *in vivo* and *in vitro* studies. *V. russellii* venom-induced coagulant, haemorrhage defibrinogenating and inflammatory activities were significantly neutralized by both plant extracts. No precipitating bands were formed between the snake venom and plant extract which confirmed that the plant extracts possess potent snake venom neutralizing capacity and need further investigation [56].

Antimicrobial and Antimutagenicity Activities of *Emblia Officinalis*: EO has been reported for the antimicrobial activities [57]. The plant have been reported to possess potent antibacterial activity against *Escherichia coli*, *K. ozaenae*, *Klebsiella pneumoniae*, *Proteus mirabilis*, *Pseudomonas aeruginosa*, *S. paratyphi A*, *S. paratyphi B* and *Serratia marcescens* [58].

Water, chloroform and acetone extracts of Triphala were investigated to evaluate an antimutagenic effect using an Ames histidine reversion assay having TA98 and TA100 tester strains of *Salmonella typhimurium* against the direct-acting mutagens, 4-nitro-o-phenylenediamine (NPD), sodium azide and

Table 7: Various formulations in which EO is used

S.No	Formulation containing EO
1.	Triphala
2.	EuMil
3.	Kalpaamruthaa
4.	Chyawanprash
5.	Immu-21
6.	DHC-1
7.	Ophthacare
8.	Pepticare
9.	Hyponidd
10.	Brahma Rasayana
11.	Maharishi-4

the indirect-acting promutagen, 2-aminofluorene (2AF), in the presence of phenobarbitone-induced rat hepatic S9. The results with chloroform and acetone extracts showed inhibition of mutagenicity induced by both direct and S9-dependent mutagens [59].

Applications of *Emblia Officinalis* in Curing of Other

Diseases: Triphala containing one of the ingredients as EO is used to treat diseases such as anemia, fever, chronic ulcers, constipation, jaundice and asthma. Polyphenolic fractions isolated from Triphala exhibit anti-mutagenic effect [60]. Active principles of Triphala was further evaluated and used as an excellent therapeutic formulation for infected wounds [61]. Aqueous plant extract was tested on Swiss albino mice for its radioprotective properties against sublethal gamma radiation (9 Gy). Most effective dose of fruit pulp extract was found to be 100 mg/kg body weight against radiation. This dose elevated the survival time and lowered the mortality rate of mice significantly. Furthermore, body weight loss in extract administered irradiated animals was significantly less in comparison with animals who were given radiation only [62]. Various formulations of EO used for curing different diseases are summarized in Table 7.

Flavonoids derived from EO exhibit maximum beneficial action by eliciting highly potent hypolipidaemic and hypoglycaemic activities. In addition to this, flavonoids were found to be effective in elevating the haemoglobin levels in rats [63]. It is also reported to be as antitumor [64].

EO (fruit) has been evaluated against thioacetamide (TAA) and CCl₄ induced changes in rat liver. Treatment with TAA and CCl₄ produced abnormal histopathology indicative of pre-fibrogenic events. EO reversed such alterations with significant regenerative changes

indicating its preventive role in prefibrogenesis of liver [65]. Extract of *Withania. somnifera* root, but not EO fruit, caused a reproducible, dose dependent, inhibition of colony formation of CHO cells [66]. Hypercholestermia is one of the factors that create coronary artery disease. Triphala formulation exhibit hypolipidemic effects on the experimentally induced hypercholesteremic rats were reported [67].

CONCLUSION

Research in medicinal plants has gained a renewed focus recently. The prime reason is that other system of medicine although effective come with a number of side effects that often lead to serious complications. Plant based system of medicine being natural does not pose this serious problems. Though *Emblia officinalis* has various medicinal applications, but it is the need of hour to explore its medicinal values at molecular level with help of various biotechnological tools and techniques. Further studies should be conducted to elucidate the molecular mechanism of interaction of various plant based drugs with human body in different diseases.

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