

# A Review of Morphology, Bioactive Compounds and Anti-Bacterial Activities of Solvents and its Extracts of the Plant *Phyllanthus emblica*, the Indigeneous Medicinal Plant of the Sikkim Himalayas

Januka Pradhan<sup>1</sup>, Dr. Karma G. Dolma<sup>2</sup>, Dr. Jyotsna Kapil<sup>3</sup>, Dr Sushen Pradhan<sup>4</sup>

<sup>1</sup>PhD Scholar, Department of Microbiology, Sikkim Manipal Institute of Medical Sciences, Tadong Sikkim, India

<sup>2</sup>Associate Professor, Department of Microbiology, Sikkim Manipal Institute of Medical Sciences, Tadong, Sikkim, India

<sup>3</sup>Professor, Department of Microbiology, Sikkim Manipal Institute of Medical Sciences, Tadong, Sikkim, India

<sup>4</sup>Research Associate, Department of Science and Technology and Climate Change, Deorali, Sikkim, India

**Abstract:** India on account of a large burden of infectious diseases is one amongst the largest consumers of antibiotics in the world. Bacterial diseases still play a considerable role in our country. The resistant bacterial strains emerged are spread either through the hospital-acquired infections or from the community. The development of multi drug resistance in pathogenic microbes has put up a huge challenge to find the alternative medicine. Sikkim has a vast repository of diverse plant species where plants species have been claimed as having significant medicinal values. *Phyllanthus emblica*, commonly known as Indian gooseberry or Amla, is perhaps the most important medicinal plant in the Indian traditional system of medicine. Several parts of these plants are used to treat variety of diseases, but the most important is the fruit. *Phyllanthus emblica* extracts have been claimed for antibacterial, antifungal, antiviral, anti-inflammatory, antioxidant, cryoprotective, antiaging, nephrotoxicity modulation, antidiabetic, hepatoprotective, anti-hyperlipidemic, insecticidal, anti-cancer, anti-atherogenic, anti-proliferative, anti-diarrheal, immunomodulator, gastroprotective, cardioprotective, neuroprotective, and radio-protective activity. The current review paper summarizes the morphology, bioactive compounds, antibacterial activity, uses of different solvents and its extracts and their properties, and ethno medicinal uses of the plant *Phyllanthus emblica* (syn. *Emblica officinalis*). Different types of extracts and herbal formulations derived from *P. emblica* have shown tremendous therapeutic and beneficial health effects in countering several diseases and disorders. On the basis of its medicinal properties, various potential remedies can be discovered through the whole plant, making it as an alternate source for the further drug development.

**Keywords:** Bioactive compounds, extracts and its properties, antibacterial activity, Sikkim

## 1. Introduction

Sikkim is a landlocked Indian state located in the Himalayan Mountain bordering Tibet in the North and Northeast, Bhutan in the East, Nepal in the West, and West Bengal in the South. Sikkim (27°4'46" to 28°7'48" N, and 88°58' to 88°5'25") in North-Eastern India with an area of 7096 sq. km and altitude ranges from 100 meters above sea level (H. Birkumar Singh et al., 2002). Gangtokis the capital of the state of Sikkim and the state experiences an annual average temperature of 18°C (64 °F), however most of the inhabitable regions have a temperature seldom exceeding 28 °C (82 °F) in summer including alpine and subtropical climates. (O'Neill, A. R., 2019). Sikkim is remarkably well known for its guardian peak Mt. Kangchenjunga which is the highest peak in India and the third highest in the world. The Khangchendzonga National Park-a UNESCO World Heritage Site covers around 35% area of the state. (O'Neill, Alexander, 2017). Sikkim exhibits a variety of climatic types, from almost tropical conditions in the south to severe mountain climates in the north. Sikkim is basically divided into three different zones, tropical from sea level (5000 ft), temperate (5000-11000 ft) and alpine above (11000ft). The

entire State comprises of hilly terrain with forests on hilltops and valleys. Several species of medicinal plants and herbs are found throughout the State. The forests of Sikkim are covered under four forest divisions viz. East, North, South and West Forest Divisions. Sikkim is bountiful to a wide range of flora and fauna varying from flowering plants to rare orchids, rhododendrons, oaks, bamboos, medicinal plants and various ferns etc. (O'Neill, A. R. (2019).

Medicinal plants are the nature's gift to human being to make disease free healthy life. Medicinal plants have natural products being essential source of drug discovery (Harvey et al., 2015). According to the World Health Organization (WHO), medicinal plants would be the best source to obtain a variety of drugs (WHO, 2002) and about 80% of world wide population depends on traditional medicine and 60% of Indian population use herbal medicinal plants (Amalraj and Gopi, 2017). WHO has also approved the usage of herbal medicines for curing various diseases, from malaria to cancer (Zameer, S., Najmi et al., 2018) *Phyllanthus emblica* is considered as the important medicinal plant in Indian traditional systems of medicine and nutritional purposes also known as Indian gooseberry or amla, it may be called as

"King of Rasayana" [rejuvenation]. *Phyllanthus emblica* exhibit nutraceutical value with numerous health benefits showing antioxidant, anticarcinogenic, antitumour, antigenotoxic, antiinflammatory activities. The fruit is rich in quercetin, phyllaemblic compounds, gallic acid, tannins, flavonoids, pectin and vitamin C. A wide range of phytochemical studies includes terpenoids, alkaloids, flavonoids, and tannins possessing useful biological activities.

The medicinal value of this particular plant is much valued that the Sikkim Medicinal Plant Board, part of the State Forest Environment and Wildlife Management Department, began the campaign "National Campaign on Amla," a program supported by grants from the National Medicinal Plant Board in the central Indian government at a school in Lower Dzongu North Sikkim. The campaign is encouraging people to plant Amla in all possible places in the nation and to use the fruits extensively (Envis centre of medicinal plants).

#### **Phyllanthus Emblica:**

*Phyllanthus emblica* linn. (sync. *Emblica officinalis*) commonly called as amla or Indian gooseberry belonging to the family Euphorbiaceae. It is subdivided into 10 to 11 subgenera (Unander DW et al., 1995) and are a large genus of approx 550-750 species. It is classified as kingdom: plantae; class: magnoliopsida; order: malpighiales; division: flowering plant; family: euforbiaceae /phyllanthaceae; tribe: phyllantheae; subtribe: flueggeinae; genus: Phyllanthus; species: *P. emblica*, Zoological name-*Phyllanthus emblica*.

The amla, *P. emblica* is a small to medium sized deciduous tree and people climb the tree to harvest the fruit in the autumn season. The plant grows from 8-18 meters height. the fruit of the plant is bitter and astringent. It is reported as an important dietary source of vitamin C, minerals, and amino acids and is highly nutritious. They have antidiabetic, antioxidant (Bajpai M et al., 2005), antibacterial (Md. Rubiyat Hasan et al., 2016), hepaprotective, gastroprotective, chemopreventive properties, antiulcerogenic, hypolipidemic properties and as a tradition medicine the fruits are used for diarrhoea, jaundice, and inflammation. All plant parts of the plant like the seed, fruit, bark, leaves, root, and flowers are used in both fresh and dried forms. No reported toxicity has been observed (Qi WY et al, 2012). It is one of the most important natural sources of vitamin C which is easily absorbed by the digestive system (Suseela Lanka, 2018). The high use of herbs as

medicine by the Limboo tribe of Sikkim showed similar uses of herb as ethnomedicine used by the Irula tribe from Tamil Nadu, India (Revathi P & Parimelahagan T, 2010).

The active ingredient that has significant pharmacological action in amla is "Phyllemblicin". Various phytochemicals such as alkaloids, flavonoids, tannins and terpenoids are reported to have several pharmacological properties such as antimicrobial, antioxidant, antigenotoxic, and anticarcinogenic effects. Mainly it is considered to be a safe herbal medicine without any side effects.

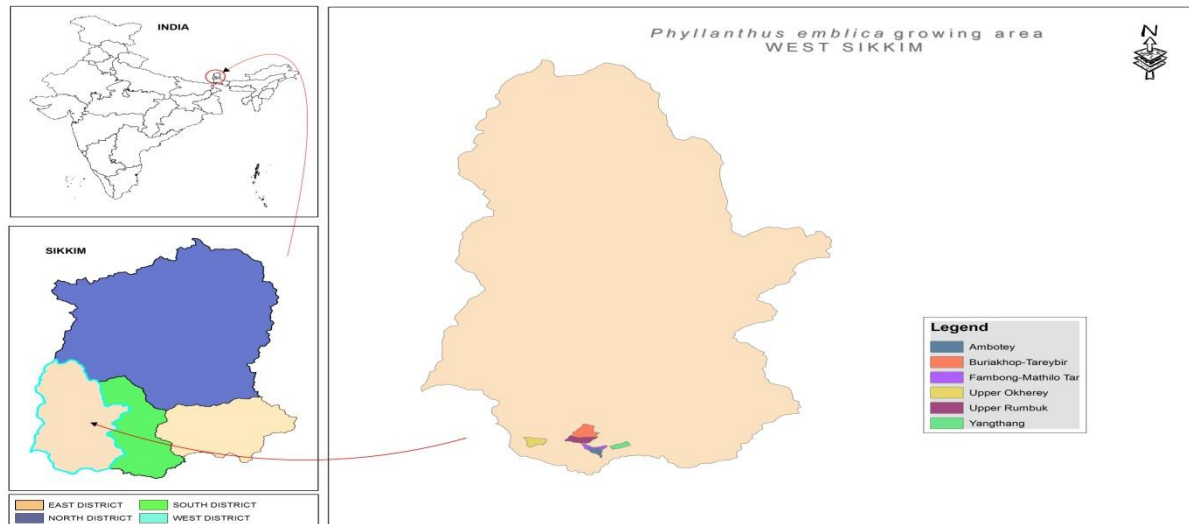
#### **Distribution in India:**

In India, it is reported to be abundant in the deciduous forests of Madhya Pradesh and in Central and Southern India (Rai et al., 2012) and are found in the plains of Himachal Pradesh, Western Ghats, Jammu & Kashmir, Uttar Pradesh, Bhutan Sikkim, Assam. This species is globally distributed in the Paleotropics. In India, it is found in the altitude of 1350 m in the mixed deciduous forests in the hills. It is often cultivated in the homeyards and gardens.

#### **Distribution in Sikkim:**






Sikkim is a part of a bio-diversity hotspot network of the world and is among identified 18 biodiversity provinces in the world. The *P. emblica* in nepali is known by its local name Rukh Amala. The State landmass measuring 7096 sq. kms has varied eco-systems from temperate habitat to humid tropical valleys, trans-Himalayan cold desert and alpine meadows. It has 37.37% of the total recorded forest area, 5841.39 sq. kms of the State. West Sikkim has a variance of many flora and fauna and which are still in use by the Indigenous and local communities.

*Phyllanthus emblica* is mainly found in West Sikkim (1, 166 square kilometres 450 sq mi)-Daramdin, Ambotey, Fambong Mathilo Tar, Upper Okhrey, Upper Rumbuk, Yangthang, the small villages which are full of vegetation of temperate type and climate and is located remotely in the West district. It is also found in Tropical/ Subtropical Lower Hill up to 4000ft. This biodiversity of Sikkim has served as a treasure house for medical purposes. However, this biodiversity is seriously threatened by human activities such as destructive harvesting, loss of habitat or degradation in its quality, leading to extinction of medicinal plants and also resultant dying out of local traditional practices.



**Morphology of the plants**

**Table 1:** Description of *P. emblica*

Features	Description
<p>Leaves</p> 	<p>Subsessile, simple, closely in the set of the branchlets, with the appearance of light green leaves, small, long leaves with 1.25–2 cm long and 3 mm wide and have a finely pinnate foliage (Bhakta Prasad Gaire and Lalita subedi, 2015)</p> <p>It is rich in Chebulagic and chebulinic acid, Gallic acid and ellagic acid.</p>
<p>Fruits</p> 	<p>The size of the fruit is 18-25 mm wide and 15-20 mm long, wider than long and with a small and slight conic depression on both apexes nearly spherical or globular.</p> <p>The mesocarp is yellow in colour and endocarp is yellowish brown when they are in ripened condition (khan, 2009). The Fresh fruits will be in light green and ripe fruits turn light brown. The fruit weight is 60-70 g (Kumar et al., 2012b).</p> <p>The fruit is rich in Vitamin C which is estimated to be (478.56 mg/100 ml).</p>
<p>Barks</p> 	<p>The bark of the tree looks thin light grey in small thin irregular flake, smooth and sometimes peeling in long flakes, contain tannin, leukodelphinidin, and proanthocyanidin (Khan, 2009).</p>
<p>Flowering and Fruiting</p> 	<p>After the plantation of the tree the seedlings start bearing fruits in 7-8 years and the budded clones starts bearing fruits from the 5th year onwards (Kumar et al., 2012a). The plant bears fruit in the month of February-May and again in December-January (Rai et al., 2012). The flowers look yellow, greenish, the fruits are globose, fleshy, pale yellow.</p>
<p>Parts used</p> 	<p>All the parts of plant of <i>Phyllanthus emblica</i> are used for medicinal purposes and especially the fruit which are used in Ayurveda (Kumar et al., 2012b). The root of the plant is high in Ellagic acid and lupeol (Sukanya MK, 2013), Phyllaemblic acid (oxygenated norbisabolol).</p> <p>Leaves, flowers, roots, barks and seeds part are used as well.</p>

### Some common source of bioactive compounds isolated from *P. Emblica*

Its biological activities are due to valuable phytochemicals which includes carbohydrate, phenolic compounds, tannins, alkaloids and amino acids. The phytochemical potentials of the leaf, fruits and bark have been proven for the beneficial of the human health. Saponin, alkaloids, flavonoids, tannin which act as a secondary metabolites helps in providing the defenses against several microorganisms. It contains organic acid-citric acid, carbohydrate-Pectin, hydrolysable tannin-emblicanin A and B, punigluconin, ellagotannin, Flavonoids-quercetin, kaempferol (Mickymaray, 2019), Vitamin-ascorbic acid, Phenolic compound-gallic acid, ellagic acid (Khan, 2019), Amino acid-Proline, lysine, alanine, Alkaloids-Phyllantine, Phyllembin, Phyllantidine (Mohammad Chand Jamali, 2016). The secondary metabolites like gallic acid, quercetin, corilagin and ellagic acid owes onwards in a time the effects of hepatoprotective to less severe toxicity of lipopolysaccharide. paracetamol, galactosamine and microcystins. The seeds of the plant is

high in phosphatides and little amount of essential oil, fatty acids myristic (1.0%) linolenic (8.8%), stearic (2.15%), linoleic (44.0%), palmitic (3.0%), Fixed oil (16%) (Nisrat Jahan and Salma Akter, 2015).

### Extracts and their Properties of *P. Emblica*

*P. emblica* methanolic seed extract shows potent free radical scavenging property of 1, 1, Diphenyl-2-picryl-hydrazil (DPPH) and produce pupicidal and larvicidal activity combating the vector of malarial (*Anopheles stephensi*), with 98% mortality (100 ppm). (Murugan K, Madhiyazhagan P, et al., 2006). The saponin presence show cytotoxic or insecticidal activity against some of the insects (Chaieb I, 2010). Extract with water shows inhibitory concentration sequence on the release and production of inflammatory mediators in rats (Jaijoy K, Soonthornchareonnon N et al., 2010), the treatment of mice previous to exposure of various doses of gamma radiation which are found to decrease the magnitude of symptoms in mortality and radiation sickness (Singh I, Sharma A et al., 2006).

**Table 2:** Properties of different solvent (extract)

Extract	Properties	Reference
Methanol and ethanol	Most used due to polar nature. Release extensive range of bioactive compound.	Saeed S et al., 2007
Alcohol and aqueous extracts	The extract was tested in mice for antipyretic and analgesic which results showed similar result like that of aspirin.	Perianayagam JB et al., 2004
Ethanol extract	Improved lipid profile, and reduced hypertension in induced metabolic syndrome.	Kim HY et al., 2010
Alcohol and aqueous extract	The extract showed protective and healing effect in induced gastric ulcers in animal experiment.	Sairam K et al., 2002
Alcohol and aqueous extract	Positive result against bacteria, fungi, viruses.	Rahman S et al., 2009
Phenolic content	Activity against Herpes simplex virus 1 and 2	Xiang Y et al., 2011
Phyllaemblicin B	Activity against coxsackie virus from the roots of the plant	Liu Q et al., 2011, Wang YF et al., 2009
Emblicanin-A and B	Antioxidant activity was found in the plant.	Madhuri et al., 2011

### Antibacterial Property

Plant extracts of *P. emblica* plays a significant antimicrobial action mostly due to the presence of several active constituents. The plant extracts possess antimicrobial properties like antibacterial, antifungal and antiviral activities. Fruits of *P. emblica* showed remedy for different microbial diseases, and shows greater effectiveness for both gram positive-negative bacteria with fungal agents (Dhama, K., Tiwari et al., 2014). *P. emblica* and its extract possess antimicrobial and cytotoxic activities. Rahman S., Akbor M. M., et al., 2009 reported that the chloroform extract of *P. emblica* fruit revealed powerful inhibitory action for *B. subtilis* and moderate inhibition for *Vibrio mimicus*, *P. aeruginosa*, *S. typhi*, *Bacillus cereus*, *E. Coli*, *Shigella boydii*, *Shigella dysenteriae*, *S. aureus*, *Sternbergia lutea*, *S. paratyphi* and *Vibrio parahaemolyticus*. Ethanol activity of *P. emblica* fruit show *in vitro* antibacterial action which has been also reported against *V. cholerae*, *S. aureus* and *P. aeruginosa* isolates (Mehrotra S, Srivastava AK et al., 2010). The extract of aqueous showed antibacterial effectiveness to inhibit *E. coli*, *S. aureus* and *B. subtilis* isolates (Jadon R, Dixit S, 2014). *P. emblica* extract of methanolic solvent showed good antimicrobial action

against *Salmonella*, *E. coli*, and *S. aureus* (Gurav N. I., Solanki B. H., et al., 2011).

The methanolic and aqueous extracts crude powder of leaf and fruit of *P. emblica* for *K. pneumoniae*, *S. aureus*, and *S. pyogenes* revealed that methanolic extract showed major changes in the features of biochemical of the pathogens. Vijayalakshmi S, Arunkumar V et al., 2007 compared between aqueous extract and ethyl acetate, methanolic extract revealed significant inhibitory action for *E. coli*, *S. aureus*, and *Candida* species. The decrease of salivary gland and total bacterial count in *S. mutans* and *Porphyromonas gingivalis* showed the effectiveness of oral microbiome due to the use of *P. emblica* fruit gum, the gum which is prepared by using 10% *P. emblica* was made sugar free chewing gum (Gao, Q., Li, X., Huang, H., et al., 2018). Rahman S, Akbor MM, Howlader A, Jabbar, 2009 investigated that the methanolic extract of chloroform soluble fraction of *P. emblica* displayed significant antimicrobial activity against some gram negative and gram positive pathogenic bacteria having a LC50 (lethal concentration) with a strong cytotoxicity of  $10.257 \pm 0.770$  microg mL<sup>-1</sup>.

**Table 3:** Antibacterial activity of different solvent (extracts) of *P. emblica*.

Sl no.	Antibacterial activity	Reference
1.	Methanol as extract posses potent antibacterial activity against <i>E. coli</i> , <i>Pseudomonas aeruginosa</i> , <i>s. paratyphi</i> , <i>Klebsiella pneumonia</i> and <i>Serratia marcescens</i> 43.	R. Jain <i>et al.</i> , 2019
2.	Ethyl acetate extract have maximum antibacterial activity against <i>Escherichia coli</i> , <i>Serratia marcescens</i> -local isolates, <i>Pseudomonas aeruginosa</i> -MTCC No.135 followed by aqueous and methanol extract.	Darshan Dharajiya <i>et al.</i> , 2015
3.	Petroleum ether, chloroform and alcohol were used as the solvent and Ampillicin (40µg/ml) as the antibiotic. Many different solvent extract of <i>Phyllanthus emblica</i> of fruits and leaves had showed antibacterial activity against <i>Staphylococcus aureus</i> <i>Escherichia coli</i> , <i>Bacillus subtilis</i> and <i>Pseudomonas aeruginosa</i> test organisms. <i>P. emblica</i> with alcohol as a solvent of leaf exhibited good activity at 20 mg/ml and 22 mm as diameter zone of inhibition. against <i>S. aureus</i> .	Dhale and Mogle 2011
4.	According to the result projected acetone, chloroform and ethanol was used as the solvent and amoxicillin as positive control in which they found that the maximum antibacterial activity was exhibited by ethanol extract in which zone of inhibition was reported as 29.2±2.3mm at a concentration of 40µl and 27.6±2.1mm at a concentration of 30µl respectively and the positive control showed an inhibition zone of 32.1±2.6.	Sini G Nath, Dr. R. Dhivya 2019,
5.	Leaf extract with the polar flavonoids and used organisms were <i>P vulgaris</i> , <i>S. aureus</i> , <i>E. coli</i> , <i>S. typhi</i> with different concentration 100, 500 and 1000mg/ml were taken. Maximum zone of inhibition (mm) was showed by <i>S. typhi</i> in 100mg/ml accordingly <i>S. aureus</i> , <i>E. coli</i> , <i>S. typhi</i> showed in 500mg/ml and <i>E. coli</i> , <i>S. typhi</i> in 100mg/ml.	Bansod, 2012
6.	Maximum zone of inhibition 12 (mm) and 22 (mm), was showed by <i>S. aureus</i> in the extract concentration of 10mg/ml and 20mg/ml respectively.	Dhale and Mogle, 2011
7.	Ethanol extract was used showing highest activity by <i>S. dysenteriae</i> with 12.7 (mm). Extract concentration used was 0.5mg/disc and ethanol, acetone (fruit extract).	Hossain <i>et al.</i> , 2012
8.	According to the result projected Hexane, chloroform, methanol was used as a solvent and, <i>K. pneumoniae</i> , <i>P. vulgaris</i> , <i>M. luteus</i> , <i>B. subtilis</i> and <i>E. coli</i> was used as organism. The extract concentration was 50mg/ml and 100mg/ml and the bacteria <i>K. pneumoniae</i> showed the maximum zone of inhibition 36 (mm) and respectively methanol showed highest activity.	Jyothi and Rao 2011
9.	Methanol seed extract with 200mg/ml extract concentration showed highest zone of inhibition followed by extract concentration 50mg/ml-14 (mm), 100mg/ml-17 (mm), 150mg/ml-18.5 (mm) 200mg/ml-21 (mm). <i>P. aeruginosa</i> , <i>E. coli</i> , <i>S. aureus</i> showed highest activity.	Priya <i>et al.</i> , 2012
10.	Tannins (isolated from leaves) with extract concentration of 5 mg/ml against <i>E. coli</i> , <i>S. subtilis</i> showed highest activity followed by 4.2 (mm) and 8.5 (mm).	Shinde <i>et al.</i> , 2010
11.	Tannin (isolated from fruits) with extract concentration of 5 mg/ml against <i>E. coli</i> , <i>S. boydii</i> showed highest activity followed by 6.8 (mm) and 8.3 (mm).	Shinde <i>et al.</i> , 2010
12.	Alcoholic and aqueous extracts showed positive results against Gram-positive bacteria and only limited efficacy against fungi. Activity against herpes simplex viruses 1 and 2 has been attributed to the phenolic content, while activity against the coxsackie virus was found for phyllaemblicin B extracted from the roots of the plant.	Suseela Lanka, 2018

## 2. Mechanism of Action

Plant extract of *Phyllanthus emblica* have antimicrobial property depending on the differences of the cell wall structure of the bacteria, generally bacterias are composed of thick layers of peptidoglycan in cell wall (i. e, Gram Positive) and a thin layer of peptidoglycan in cell wall (i. e, Gram negative) (Stainer R, 1987). The antimicrobial property of the plant extracts are exhibited due to their distinct mechanism of action. The mechanism of action of the plant extract here refers to the action of biocompounds present in the plant which actually has the healing capacity in a various human diseases. The plant has secondary metabolites which has a pharmacological effect that attributes to exhibit antibacterial effect which is specific. The mechanism of action of the antibacterial compound present in the plant extract involves destruction of cytoplasmic membrane and cell wall of the bacteria which eventually leads to leakage of the cytoplasmic content and coagulation of protein. The coagulation of protein damages the protein present and interferes with the enzyme activities that adversely affect the RNA and DNA synthesis disrupting the nutrient uptake. The energy production are also impaired inside the cells with alteration in fatty acid and phospholipid synthesis. (Hammer KA *et al.*, 1999).

Antibacterial property of *Phyllanthus emblica* extracts depend upon the different secondary metabolites, the phytochemical compounds like tannis, phenols, flavonoids which they constitute. Flavonoids, the secondary metabolites inhibits RNA synthesis in microbes owing to their B-ring which participates in intercalation or Hydrogen bonding with stacking of nucleic acid bases. The plants have the potential to promote the disruption and lysis of cell wall (Suresh mickymaray, 2019), inducing reactive oxygen species production, inhibiting biofilm formation (Ganesan K, Xu B, 2017), cell wall construction (Stapleton P, 2004), microbial DNA replication (Cushnie T. P. T *et al.*, 2007), energy synthesis (El-adawi H, 2012), and bacterial toxins to the host (Awolola G. V *et al*; 2014). The presence of alkaloids in the *Phyllanthus emblica* may affect the genetic materials of the microbes to gain the property of antimicrobial activity and the presence of kaempferol possess antibacterial properties (Shohaib T *et al.*, 2011).

### Ethnomedicinal Uses

Traditionally *P. emblica* are used for the treatment of various types of diseases from very old ages in many countries. In a study conducted (Gao, Q., Li, X., *et al.*, 2018) with chewing gum containing *P. emblica* fruit extract showed that the use of gum in a short period of time helped in the flow of salivary which have helped in the change of

the pH. It has different important properties like helping in building up the memory, help in the disorder of the ophthalmic and the reduction of the cholesterol levels. (Jain, R., Pandey, R et al., 2015). The plant can be used with or without the combination with different plants for the illness of different diseases which are used as tonic of hair, common cold and fever, preventing dyspepsia and peptic ulcer, restorative and as a diuretic, liver tonic laxative, refrigerant, stomachic, antipyretic, anti-inflammatory and as well as a digestive. It help in increasing the longevity, helps in treating the constipation and improve digestion. According to the ayurvedic system of medicine these plants helps in strengthens the heart, reduction of the fever,

decreases cough, cleanses the blood, eases asthma, benefits the eyes, encourages hair growth. (Baliga MS, Dsouza JJ, 2011). Chyawanprash is widely sold and consumed in India as a dietary supplement as it is rich in herb, minerals and spices, enhancing the function of cognitive and the general vitality which has the presence of its neuroprotective, rejuvenative, immunomodulatory, hepatoprotective, the activity of cardiogenic and antioxidant. The secondary metabolites or the constituents that are responsible for these activities are 8, 9-dehydro-9-formyl-cycloisolongifolene, 6-ethenyl-4, 5, 6, 7-tetrahydro-3, 6-dimethyl-5-isopropenyl-trans-benzofuran, eucalyptol and g-elemene (Sharma, R., Martins, N et al., 2019).

**Table 4:** Uses of different parts of plant in the ethno medicinal uses

Parts	Chemical constituents	Traditional medicinal uses
Fruits	Alanine, alagine, gallic acid, glucose, glutamic acid, niacin, pectin, phenylalanine, glucogallin, manganese, magnesium, ethyl gallate, calcium, carbohydrate chebulic acid, fat, fiber, flavonoids.	Edible, increases an appetite, applied on scalp blackens the hair and prevents premature greying of hair. (Pushpendra kumar Jain et al., 2016) Used for the treatment of the diarrhoea, ingestion, ulcers, inflammation, nausea, fever, skin sores, wounds and scurvy. Production of Red blood cells (Jain PK et al., 2015)
Juice of bark	Tannins, lupeol, leukodelphinidin	Cure gonorrhoea, cure constipation (Kumar et al., 2012b; Srivasuki, 2012)
Roots	Ellagic acid, lupeol	Cure dental problems (Kumar et al., 2012a)
Pericarp of the fruit	Gallic acid, Ellagic acid, phyllemblic acid and emblicol.	Boils and spot (Baliga and Dsouza, 2010)
Seed	Palmitic acid, oleic acid Linoleic acid, and stearic acid.	Bronchial asthma, bronchitis and biliousness (Patel and Goyal, 2011)
Dried fruits	Proline serine, succose, Selenium, silica, sodium, starch, protein, tannin, thiamine.	Hemorrhage, diarrhea, dysentery, for anemia (with iron), dyspepsia, jaundice. (Komor et al., 2016)
Milky juice of leaves and bark	Anlaic acid, astrogalin, ellagic acid, gallo-tannin, rutin, tannin.	Skin sores and wounds. (Sanswring Basumatary, 2018)

**Clinical Importance Diseases of *P. Emblica***

**Table 5:** Importance of *P. emblica* on clinical importance diseases

S. no.	Clinical Activity	Description
1.	Diabetes	Has been proved as an important inhibitor of Aldose reductase (Suryanarayan, P. et al., 2004, 2007).
2.	Cardioprotective	Antioxidant property influencing the fruits may contribute for the cardioprotective result (Rajak S, 2004). Increase in the count and viability of the human Sperm and motility (Chakraborty D et al., 2019)
3.	Anti-ulcer activities, liver	Helps in the liver and anti ulcer activity. (Pramyothin et al., 2006, Tasduq et al., 2005)
4.	Antioxidant, Cytoprotective, antitussive, gastroprotective	The plant has high antioxidant and ascorbic acid (0.4%, w/w), (sandhya et al., 2006), Vitamin C has an approximately 45-70% of the antioxidant property (Bhattacharya A et al., 2000)
5.	Immunodulation, ophthalmic disorder	Due to tannins in its aqueous extract helped recombinant human aldose reductase and the presence of sugar helped osmotic alterations. (Biswas NR et al., 2001)
6.	Antipyretic/analgesic Reduce cholesterol, and dyslipdemia	Presence of different phytochemical like flavonoids, alkaloids, tannins and amino acids is e responsible for the antipyretic/analgesic activity. (perianayagam JB et al., 2004)
7.	Memory enhancing, snake venom neutralizer	(Alam MI et al., 2003), have reported that the plant also posses snake venom neutralizing ability (Vasudewan et al., 2007) Antimicrobial/antimutagenecity (Khopde et al., 2000)
8.	Cancer	It has helped in the reduction of the growth of the cancer cells as there is the presence of the gallic acid. Presence of tannins and flavanoids exhibit antioxidant property. Exhibit significant reduction in tumor incidence and cumulative number off papillomas (Drury and Colonel Heber) (Mahata et al., 2013).
9.	Antibacterial, antifungal, antiviral, antiulcer activity	Methanoic extract has ulcer protective healing effects (Scartezini et al., 2000)
10.	Antiatherogenic effects	Have better potential for the hyperthyroidism and hepatoprotective advantage (Panda S et al2003)
11.	Anti-aging, Degaradation kinetics	Helping in the aging process vitamin C has showed the activity and also has an antioxidant synergism with vitamin E too (R. Jain et al., 2019)
12.	Chelating agents	Have good free radical ability as well and reduction of UV induced erythema (Chaudhuri RK et al., 2003)
13.	Food absorption	Improves assimilation of iron for healthy blood (Sai et al., 2003, Nosal ova et al., 2003, Al Rehaily et al 2002)
14.	Nanoparticles	For the reducing agent of the synthesis of the AG and AU the plant is used as extracellular synthesis of gold and silver nanoparticles, transmetallation reaction between hydrophobized chloroaurate has

	showed the production of gold nanoparticles in chloroform and hydrophobized silver nano particles. (Anila, 2002)
--	--

The development of new and effective antimicrobials against infections caused by antibiotic-resistant bacteria has been increasingly interested. Several studies have reported that nanoparticles made up of different noble metals like Ag, Cu, and Au, which can be applied to kill both resistant and nonresistant bacteria the development of new and effective antimicrobials against infections caused by antibiotic-resistant bacteria has been increasingly interested. Several studies have reported that nanoparticles made up of different noble metals like Ag, Cu, and Au, which can be applied to kill both resistant and nonresistant bacteria

Several studies have reported that nanoparticles made up of different noble metals like Ag, Cu, and Au, which can be applied to kill both resistant and nonresistant bacteria (Bindhu and Umadevi, 2014; C)

### 3. Conclusion

The medicinal plant with its herbal formulation has an important part which supports the healthcare system. It has been estimated that almost 80% of the world's people depend on traditional plant derived drugs which have secondary metabolites for the therapeutic uses in terms of the primary health care. It prevents number of diseases as it is high in Vitamin C. Many of our existing medicines are derived directly or indirectly from higher plants. From the current investigation, it has been seen that, the future studies can be conducted to develop new commercial or noble drugs which are basically produced from the natural sources of medicinal plant and there is a need to take further research in the area in order to explore, discover more and more value of this medicinal plants with its properties. It's high time now that there should be the traditional plant derived drugs as herbal medicine enormously in the market for the ultimate benefit of the mankind. The rising medical care given to a patient for the treatment gives interest for the use of natural herbal medicine which might require research facts and statistics collected together for reference or analysis in the field for focussing future efforts. The identified presence of the secondary metabolites of the plant extract will help in the search and production of the important component, which could be produced commercially by using the compound. The plant can be used based on secondary metabolites and use of these compounds can be helpful in medical treatment. They can be used for the production of the new drugs using the specific chemical compounds found in the plants. In the ayurvedic texts several number of raw drugs derived from the plants extracts of the rich floras of Sikkim has been described. According to various surveys done in himalayan regions of Sikkim there are 'N' number of plants used for the treatment of various diseases by the tribal peoples and local Vaidhyas inhabiting in Sikkim, among which very few are used for commercial purposes. Despite of availability of rich varieties of medicinal plant and due to lack of proper knowledge in efficacy of the medicinal plants, these plants are still unexplored. The use of medicinal plants and focus on its cultivation and production might create an employment opportunity as well in Sikkim leading to overall development and better use of rich floras of Sikkim.

Several studies have reported that nanoparticles made up of different noble metals like Ag, Cu, and Au, which can be applied to kill both resistant and nonresistant bacteria

### References

- [1] Awolola G. V., Koorbanally N. A., Chenia H., Shode F. O., Bajinath H. Antibacterial and Anti-Biofilm Activity of Flavonoids and Triterpenes Isolated from The Extracts of *Ficus Sansibarica* Warb. Subsp. *Sansibarica* (Moraceae) Extracts. *Afr. J. Trad. Complement. Altern. Med.* 2014; 11: 124. doi: 10.4314/ajtcam. v11i3.19. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
- [2] Anila, L. and N. R. Vijayalakshmi, 2002. Flavonoids from *Emblia officinalis* and *Mangifera indica*-effectiveness for dyslipidemia. *J Ethnopharmacol., Emblia officinalis--a histological study.* *Indian J.79* (1): 81-7.
- [3] Baliga MS, Dsouza JJ. Amla (*Emblia officinalis* Gaertn), a wonder berry in the treatment and prevention of cancer. *Eur J Cancer Prev* 2011; 20: 225-39.
- [4] Bhakta Prasad Gaire, Lalita subedi, *Phytochemistry, pharmacology and medicinal properties of phyllanthus emblica* Linn. January 2015, DOI: 10.1007/s11655-014-1984-2.
- [5] Bansod KD (2012). Isolation and study of antimicrobial activities of polar and non-polar flavanoids from the leaves of *Phyllanthus emblica*. *Der Pharma Chemica.* 4 (5): 1833-1835.
- [6] Chaieb I. Saponins as insecticides: a review. *Tunisian J. Plant. Prot.*, 2010; 5 (1): 39-50.
- [7] Dhale DA and Mogle UP (2011). Phytochemical screening and antibacterial activity of *Phyllanthus emblica* (L.). *Sci. Res. Rep.* 1 (3): 138-142.
- [8] Dhama, K., Tiwari, R, Chakraborty, S., Saminathan, M., Kumar, A., Karthik, K., Wani, M. Y., Amarpal, S. S., and Rahal, A. Evidence based antibacterial potentials of medicinal plants and herbs countering bacterial pathogens especially in the era of emerging drug resistance: An integrated update. *Int. J. Pharmacology*, 2014; 10 (1): 1-43.
- [9] D A Dhale and U P Mogle, *Phytochemical Screening and Antibacterial Activity of Phyllanthus emblica* (L.), 1 (3): 138-142, Nov.2011 ISSN: 2249-7846.
- [10] El-Adawi H. Inhibitory effect of grape seed extract (GSE) on cariogenic bacteria. *J. Med. Plants Res.* 2012; 6 doi: 10.5897/jmpr12.1011. [CrossRef] [Google Scholar]
- [11] Ganesan K., Xu B. Polyphenol-Rich Dry Common Beans (*Phaseolus vulgaris* L.) and Their Health Benefits. *Int. J. Mol. Sci.* 2017; 18: 2331. doi: 10.3390/ijms18112331. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
- [12] Gao, Q., Li, X., Huang, H., Guan, Y., Mi, Q., Yao, J. (2018). The Efficacy of a Chewing Gum Containing *Phyllanthus emblica* Fruit Extract in Improving Oral Health. *Current Microbiology*, 75 (5), 604-610.

- [13] Gupta, P., Parminder, N. and Jaspreet, S. Antimicrobial and Antioxidant activity on *Embolica officinalis* seed extract. *Int. J. Res. Ayurveda Pharm.*, 2012; **3** (4), 591–596.
- [14] Gurav N. I., Solanki B. H., Pandya K. R., Patel P. R. Physicochemical and antimicrobial activity of single herbal formulation-capsule, containing *Embolica officinalis* Gaertn. *Int. J. Pharm. Pharm. Sci.*, 2011; **3**: 383-386.
- [15] Hossain MM, Mazumder K, Hossen SMM, Tanmy TT and Rashid MJ (2012). In vitro studies on antibacterial and antifungal activities of *Embolica officinalis*. *Int. J. Pharm. Sci. Res.* **3** (4): 1124-1127.
- [16] Hemant K Badola, Bharat K Pradhan, Plants used in healthcare practices by Limboo tribe in South –West of Khangchendzonga Biosphere Reserve, Sikkim, India., *Indian journal of Tradition Knowledge*, Vol.12 (3) July 2013 , pp 355-369 *Indian journal of traditional knowledge* **12** (3) Project: Biodiversity and conservation programme in Sikkim.
- [17] Jaijoy K, Soonthornchareonnon N, Panthong A, Sireeratawong S. Anti-inflammatory and analgesic activities of the water extract from the fruit of *Phyllanthus emblica* Linn. *Int. J. Appl. Res. Nat. Prod.*, 2010; **3** (2): 28-35.
- [18] Jadon R, Dixit S. Phytochemical extraction and antimicrobial activity of some medicinal plants on different microbial strains. *J. Med. Plants Studies*, 2014; **2** (3): 58-63.
- [19] Jain, R., Pandey, R., Mahant, R. N., Rathore, D. S. A review on medicinal importance of *Embolica officinalis*. *Int. J. Pharm. Sci. Res.*, 2015; **6** (1): 72-84.
- [20] Jyothi S and Rao BS (2011). Screening of antibacterial activity of *Embolica officinalis* L. fruits. *Pharmacologyonline*.**3**: 848-852
- [21] Khanna, S.; Das, A.; Spieldenner, J.; Rink, C.; Roy, S. Supplementation of a standardized Extract from *Phyllanthus emblica* improves cardiovascular risk factors and platelet aggregation in overweight/class-I obese adults. *J. Med. Food* 2015 **18**, 415–420.
- [22] Kumar A, Singh A and Dora J (2012a). Essential perspectives for *Embolica officinalis*. *Int. J. Pharma. Chem. Sci.* **1** (1): 11-18.
- [23] Kavitha, A., N. Deepthi, S. C. Gladwin Joseph Year: 2012 Publisher: Ashoka Trust for Research in Ecology and the Environment (*J. Bio. Innov* **5** (6), pp: 979-984, 2016)ISSN 2277-8330 (Electronic).
- [24] Mahata S, Pandey A, Shukla S, Tyagi A, Husain SA, Das BC and Bharti AC (2013). Anticancer Activity of *Phyllanthus emblica* Linn. (Indian Gooseberry): Inhibition of Transcription Factor AP-1 and HPV Gene Expression in Cervical Cancer Cells. *Nutrition and Cancer*.**65** (1): 88-97.
- [25] Mehrotra S, Srivastava AK, Nandi SP. Comparative antimicrobial activities of Neem, Amla, Aloe, Assam Tea and Clove extracts against *Vibrio cholerae*, *Staphylococcus aureus* and *Pseudomonas aeruginosa*. *J. Med. Plants Res.*, 2010; **4** (23): 2473-2478.
- [26] Murugan K, Madhiyazhagan P, Nareshkumar A, nataraj T, Dinesh D, Hwang JS, Nicoletti M. Mosquitocidal and water purification properties of *Ocimum sanctum* and *Phyllanthus emblica*. *J. Entomol. Acarolog. Res.*, 2012; **44** (17): 90-97.
- [27] Madhuri S, Pandey G and Verma KS (2011). Antioxidant, immunomodulatory and anticancer activities of *Embolica officinalis*: an overview. *Int. Res. J. Pharm.* **2** (8): 38-42.
- [28] Mickymaray S., Al Aboody M. S. In Vitro Antioxidant and Bactericidal Efficacy of 15 Common Spices: Novel Therapeutics for Urinary Tract Infections? *Medicina*.2019; **55**: 289. doi: 10.3390/medicina55060289. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
- [29] Md. Rubaiyat Hasan, Md. Nasirul Islam and Md. Rokibul Islam, *International Current Pharmaceutical Journal*, January 2016, **5** (2): 14-21.
- [30] O'Neill, A. R. (2019). "Evaluating high-altitude Ramsar wetlands in the Sikkim Eastern Himalayas". *Global Ecology and Conservation*.**20** (e00715): 19. doi: 10.1016/j. gecco.2019. e00715.
- [31] Pemminati S, Gopalkrishana HN, Shenoy AK, Sahu SS, Mishra S, Meti V, Vinod N. Antidepressant activity of aqueous extract of fruits of *Embolica officinalis* in mice. *Int. J. App. Biol. Pharm. Technol.*, 2010; **1** (2): 449-454.
- [32] Patel SS and Goyal RK (2011). *Embolica officinalis* Gaertn.: A Comprehensive review on Phytochemistry, Pharmacology and Ethnomedicinal Uses. *Res. J. Med. Plant*, 2011.1-11.
- [33] Pushpendra kumar jain, debajyoti das, nalini pandey, prachi jain, naraina vidya peeth dr. virendra swarup, traditional indian herb *embolice officinalis* and its medicinal importance, received: 21 june 2016, revised and accepted: 09 july 2016)
- [34] Priya G, Parminder N and Jaspreet S (2012). Antimicrobial and antioxidant activity on *Embolice officinalis* seed extract. *Int. J. Res. Ayur. Pharma.* **3** (4): 591-596
- [35] Perianayagam JB, SharmaSK, Joseph A, Christina AJ. Evaluation of anti-pyretic and analgesic activity of *Embolice officinalis* Gaertn. *J Ethnopharmacol*, 2004: **95** (1); 83-85.
- [36] Rahman S, Akbor MM, Howlader A, Jabbar A. Antimicrobial and cytotoxic activity of the alkaloids of Amlaki (*Embolice officinalis*). *Pak J Biol Sci* 2009; **12**: 1152-5.
- [37] Rai N, Tiwari L, Sharma RK and Verma AK (2012). Pharmacobotanical Profile on *Embolice officinalis* Gaertn. – A Pharmacopoeial Herbal Drug. *STM Journals*.**1** (1): 29-41.
- [38] Revathi P & Parimelahagan T, Traditional knowledge on Medicinal plants used by the Iruha tribe of Hasanur Hills Erode districts, Tamil Nadu India, *Ethnobot Leaflets* **14** (2010) 136-160.
- [39] Rahman S., Akbor M. M., Howlader A., Jabbar A. Antimicrobial and cytotoxic activity of the alkaloids of Amlaki (*Embolice officinalis*). *Pak J. BiolSci.*, 2009; **12** (16): 1152-1155.
- [40] Suseela Lanka, A review on pharmacological, medicinal and ethnobotanical important plant: *phyllanthus emblica* linn. (syn. *embolice officinalis*), 2018 *World Journal of Pharmaceutical Research* **7** (4) DOI: 10.20959/wjpr20184-11103.
- [41] Stapleton P. Anti-*Staphylococcus aureus* activity and oxacillin resistance modulating capacity of 3-O-acyl-



- catechins. Int. J. Antimicrob. Agents.2004; 24: 374–380. doi: 10.1016/j.ijantimicag.2004.03.024. [PubMed] [CrossRef] [Google Scholar]
- [42] Sharma, R., Martins, N., Kuca, K., Chaudhary, A., Kabra, A., Rao, M. M., Prajapati, P. K. Chyawanprash: A Traditional Indian Bioactive Health Supplement. *Biomolecules*, 2019; **9** (5): 161.
- [43] Scartezzini, P. and E. Speroni, 2000. Review on some plants of Indian traditional medicine with antioxidan activity. *J Ethnopharmacol.*, 71 (1-2): 23-43.
- [44] Sukanya MK, Shimi, Aruna SR. Phytochemical Analysis Antimicrobial Analysis Antimicrobial careening and Antihelminthic roperties Of *Phyllanthus emblica*, International Journal of Pharma and Bio Sciences.2013; 4 (4): 55-64: ISSN: 0975-6299.
- [45] Shinde SL, Junne SB, Shinde AT, Patil SA and Wadje SS (2010). Antibacterial properties of tannins isolated from leaves and fruits of *Emblca officinalis* Gaertn. Res. J. Pharma. Biol. Chem. Sci.1 (3): 699-703.
- [46] Sini. G Nath1, Dr. R. Dhivya, Phytochemical Analysis, Antioxidant and Antibacterial Properties of *Phyllanthus emblica* Leaf Extracts against Selected Bacterial Isolates, International Journal of Science and Healthcare Research (www.ijshr. com) Vol.4; Issue: 2; April-June 2019, ISSN: 2455-7587.
- [47] Sumantran VN, Kulkarni A, Chandwaskar R, Harsulkar A, Patwardhan B, Chopra A, et al. Chondroprotective potential of fruit extracts of *Phyllanthus emblica* in osteoarthritis. *Evid Based Complement Alternat Med* 2008; 5: 329-335.
- [48] Sandip Kumar Khurana, Ruchi Tiwari, Khan Sharun, Mohd. Iqbal Yattoo, Mudasir Bashir, Gugjoo and Kuldeep Dhama, *J. Pure Appl. Microbiol.*, 2019, **13** (4): 1995-2012 | Article Number: 5909 <https://doi.org/10.22207/JPAM.13.4.11> | © The Author (s).2019
- [49] Suresh mickymaray, Efficacy and mechanism of traditional medicinal plants and bioactive compounds against clinically important pathogens, 2019 dec, 257. PMID: PMC6963422, PMID: 31835403
- [50] Saeed, S. and P. Tariq, 2007. Antibacterial activities of *Emblca officinalis* and *Coriandrum sativum* against Gram negative urinary pathogens. *Pak J. Pharm Sci.*, 20 (1): 32-5.
- [51] World Health Organization, World Health Organization, WHO Traditional Medicine Strategy, Geneva, 2002.