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Phyllanthus emblica (Amla): A Review of Nutritional and Medicinal Properties

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A B S T R A C T

Medicinal plants are wonderful present of nature, they can act as an important food source and medicine to mankind. *Phyllanthus emblica* hasan uncommon position in our country India (Ayurvedic), Tibetan Unani, and Turkish, medicine systems since many centuries. It has healing, therapeutic and nutritional potentials which made it an important research topic for the synthesis of new medicine formulations. They have gallic acid, alkaloids, ellagitannins, emblicanin A, vitamin C, and emblicanin B, flavonoids such as rutin and quercetin, different types of biological molecules are also seen all together makes *P. emblica*, a very important medicinal plant. This review article summarizes the literature related to the health, nutritional, and therapeutic importance of *P. emblica* such as, analgesic, anti-diabetic, anti-microbial, diuretic, anti-mutagenic, anti-aging activities, UV protectant, antioxidant and aphrodisiac. It can also enhance memory, also use in skin, respiratory, and ophthalmic disorders, and detoxification such as snake venom, are also focused. Apart from that, reviews studies on *P.emblica* for disease management. *P. emblica* is a major medicinal plant with many applications. They are used for generations as a food source as they have the rejuvenating potential applications.

Introduction

In recent years allopathic medicines have been showing various side effects, this review majorly concentrates on showing the role of Ayurvedic medicines in curing many health issues which can be used as an alternate medication. In our study, we have attempted to picturize the beneficial effects of *Phyllanthus emblica*(Indian gooseberry or Amla) which are the natural product found to be very much beneficial for the society and mankind. Various types of dried and fresh fruits of the plant are used in traditional Indian medicine. Including the fruit, seed, leaves, root, bark and flowers, all parts of the plant are used in various Ayurvedic herbal medicine preparations. The amla fruit is sour and astringent with sweet, bitter and pungent secondary taste according to Ayurveda. Amla is also known as Indian gooseberries (*Phyllanthus emblica*) which grows on a flowering tree of amla. These are round and bright or yellow-green in colour. Several health benefits such as antioxidants and vitamins are found in amla berries.

Many phenolic compounds have the potential to function as antioxidants by scavenging superoxide anion due to the presence of the conjugated ring structures and hydroxyl groups in it, (Robak and Dryglewski, 1988), The previous report showed the presence of strong antioxidant activity(Bafna and Balaraman, 2004) that can be partially due to the presence of flavonoids and several gallic acid derivatives including epigallocatachingallate (Anila and Vijayalakshmi, 2002). Recovery from illness due to the use of amla is more as it has high concentrations of vitamin C. Several flavanols, compounds are seen to be present in amla that have the beneficial effect in case of memory improvement. It (*Phyllanthus emblica*) belongs to Phyllanthaceae family and widely distributed in subtropical and tropical countries such as China, India, Indonesia, and Malaysia etc. The consumers also accepted Amla for its special taste. It contains abundant amounts of vitamin C and superoxide dismutase (Verma and Gupta, 2004), highly nutritious and is one of the richest sources of vitamin-C, amino acids and minerals (Srivasuki, 2012).Therefore, we made an attempt to raise the awareness of the beneficial use of *Phyllanthus emblica* through our scientific review and also the presence of important phytochemical and vitamins has given the best evidence that *Phyllanthus emblica* is one of the alternate sources of synthetic medicines which contributes to minimize several health issues.

Classification

Kingdom: Plantae

Class: Dicotyledons
Order: Malpighiales

Family: Phyllanthaceae

Genus: *Phyllanthus*

Species: *emblica*

The studies reviled that amla is used either alone or in combination with other plants for the treatment of many diseases such as common cold and fever. Amla is also used as a diuretic, laxative, liver tonic, refrigerant, stomachic, restorative, alterative, antipyretic, anti-inflammatory, hair tonic and it can help in preventing peptic ulcer and dyspepsia, it also acts as a digestive agent. It is reported that amla shows some important activity such as radiomodulatory, chemomodulatory, chemopreventive effects, free radical scavenging, antioxidant, anti-inflammatory, antimutagenic and immunomodulatory activities which are helpful in the treatment and prevention of cancer. Amla is also can be used as an antimicrobial agent; (Godbole and Pendse, 1960); Godbole, S. H., Pendse, G. S., 1960, Indian Journal of Pharmacy;El-Desouky S K, Ryu S Y, Kim Y K. Apigenin glucoside (cytotoxic acylate from *Phyllanthus emblica* L). Nat Prod Res. 1990, 2008; 22:91-5; (Rani and Khullar, 2004), anticancer (Jeena *et al.,* 2001); (Zhang *et al.,* 2004), and anti-inflammatory agent (Asmawi *et al.,* 1993); (Perianayagam *et al.,* 2004). They can improve the metal induced clastogenic effects (Biswas *et al.,* 1999); (Dhir *et al.,* 1990).

Amla is an anodyne, ophthalmic, carminative, digestive, stomachic, alterant, aphrodisiac, rejuvenate, antipyretic and tonic. It is 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, strangury, diarrhoea, dysentery, haemorrhages, leucorrhoea, menorrhagia, cardiac disorders, intermittent fevers and greyness of hair etc; Nadkarni K. M.; 1993.

Study on different phytochemicals, antioxidant activity, presence of nutrients in *Phyllanthus emblica*

The antioxidant activity of Indian Gooseberry (*Phyllanthus emblica)*

The antioxidant activity is defined as a limitation of the oxidation of proteins, lipids, DNA or other

molecules which occurs by blocking the propagation stage in oxidative chain reaction. The antioxidant activity of tannoid in *Phyllanthus emblica* consists of emblicanin A, emblicanin B, punigluconin and pedunculagin etc. There is a high demand of natural antioxidants because of toxicological and carcinogenic (Wanasundara *et al.*,1997; Halliwel & Gutteridge, 1989) effects of some synthetic antioxidants viz butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), on animals (Amarowicz, 2000). The antioxidants are substances which can help in defending the body against cell damage which is caused by various free radicals leading to ailments such as heart disease, hardening of the arteries, inflammatory conditions, cataracts & other visual problems, arthritis & rheumatism, cancer and diabetes (Halliwel & Gutteridge, 1989; Nenadis *et al.*, 2003; Papas 1999).

Comparative study and sample preparation

Different fruit samples and samples preparation procedure of 4 cultivars of gooseberry (*Ribes uva-crispa* L.) and 5 cultivars of currant (*Ribes* L.) with different time of maturity were studied in this current study. Briefly two green gooseberries such as Invicta (very early-ripening, originated from England) and Rixanta (early-ripening, originated from Germany), two red gooseberries such as Karat (early-ripening, originated from the Czech Republic) and Black Negus (late-ripening, originated from Ukraine), red currant cultivar NS 11 – Losinsky late (late-ripening, originated from the Czech Republic) and black currant cultivars – Focus (early-ripening, from the Czech Republic), Ben Gairn (middle early-ripening, originated from Scotland) and Otelo and Viola (both late-ripening, originated from the Czech Republic). These fruits were obtained from the experimental area of Mendel University in Brno in the cadastral area of Žabčice in the Czech Republic (185 m a.s.L., GPS coordinates: 49.011598N, 16.602572E). Soil of this area was found to be gleied alluvial soil and the topsoil is clayey-loamy with neutral or weakly acidic pH with a humus content 2.28%. The management system of sawdust mulch was used in currant and gooseberry plantings with fertilization by combined fertilizer Cererit with a dose of 35 g per m^2 applied into the soil annually in autumn season. This area has a typical continental climatic condition with a long-term average annual temperature of 9.2 °C and precipitation of 480 mm.

In 2014 which was the harvest year, climatic characteristics were higher and the average annual temperature was 11.2 °C and precipitation 576.7 mm. During the first four months the weather was very dry (with a sum of precipitation of 51.4 mm) in contrast to above-average precipitation during the growing season (with a sum of precipitation in June and July of 191.2 mm). Fully ripe fruits were harvested from June to July in 2014.

Fresh berries were homogenized and freeze-dried (lyophilized) by Alpha 1–4 LSC (Christ Gefriertocknungsanlagen GmbH Osterode am Harz, Germany) for 48 h and obtained powder was analyzed (Anil *et al.*, 2012).

Chemicals and reagents

Methanol, ethanol and acetic acid were used. Individual phenolic standards for HPLC analyses were of HPLC-grade and were obtained from Sigma Aldrich. Standards of ascorbic acid and D-α-tocopherol succinate were also used. Other chemicals and standards used for the analysis were of analytical grade and obtained from Sigma Aldrich.

Extraction of samples

The lyophilized fruit powder (0.5 g) was extracted by using 10 mL of extraction solvent (water:methanol in the ratio of 70:30, v/v) in a screw-cap test tubes with a shaking water bath (Memmert GmbH + Co.KG, Germany) at 50 °C for 60 min. Subsequently, the extracts were centrifuged at 6.000 rpm for 15 min (Velocity 13µ, Dynamica Scientific Ltd., UK). The same extraction procedure was applied for HPLC analysis of individual phenolic compounds with the only modification of composition of extraction solvent (redistilled water:methanol:acetic acid in the ratio of 69:30:1, v/v/v).

Evaluation of antioxidant activity

The antioxidant activity can be determined by DPPH. The assignment of DPPH radical-scavenger capacity is mainly based on the reaction of samples with a stable radical of DPPH (2,2-diphenyl-1-picrylhydrazyl; Sigma Aldrich, MO, USA) and reducing it to DPPH-H (diphenylpicrylhydrazine). It was performed according to Sharma and Bhat (2009) with a slight modification: 450 µL of fruit extract was added to 8.55 mL of B-solution of DPPH (10 mL of A-solution DPPH mixed with 45 mL of methanol; A solution of DPPH was prepared by dissolution of 0.024 g of DPPH in 100 mL of methanol). For 60 minutes in dark condition, the samples were incubated at room temperature. The absorbance was measured by Lambda 25 (PerkinElmer, Waltham, MA, USA) at 515 nm. Trolox (Sigma Aldrich, MO, USA) was used as a standard and results were expressed as grams of Trolox equivalent.kg−1 of dry matter (g Trolox. kg^{-1}).

Results of antioxidant activity

Antioxidant activity was analysed by different methods DPPH (2,2diphenyl -1- picrylhydrazine), ACW (Water soluble antioxidant compound) and ACL (Lipid soluble antioxidant compound) to cover a wide diversity of bioactive compounds with various mechanisms of antioxidant protection including their synergistic or antagonistic effects in plant matter.

From the study, it was found that the antioxidant activity of currants determined by DPPH was low Slightly higher DPPH values were obtained in intensively coloured fruits of gooseberry, but in green gooseberry cultivars DPPH was found less with the amounts of 2.96 g Trolox.kg^{-1} in Rixanta and 6.17 g Trolox.kg^{-1} in Invicta. Same DPPH values were found in red fruit in red gooseberry Karat of 9.94 g Trolox.kg^{-1} and Black Negus of 13.09 g Trolox.kg^{-1} and in currant cultivar NS 11 with the amount of 12.55 g Trolox.kg^{-1}. In black currant cultivars, DPPH reached higher values from 15.53 g Trolox.kg^{-1} in Viola to 18.20 g Trolox.kg^{-1} in Focus. These results are based on the already published data in red and black currant cultivars from Croatia and from Belgium. The antioxidant activity is affected by various factors, such as type of cultivar, harvesting time Bravo *et al.*,2015 and locality (Mitić *et al.,* 2011) and the extraction methods (Tabart *et al.,* 2012). In addition, the way of cultivation has been proved as a significant factor influencing antioxidant activity as well. Black currant grown on organic farms performed greater antioxidant activity than the fruit from conventional production in Poland. A significant antioxidant activity values were found in wild red currants Ribes magellanicum from Peru and Chile. Concerning photochemi-luminiscence method, similarly to DPPH, lower ACW and ACL values were determined in green gooseberry cultivars 1.07 g AK.kg^{-1} and 2.86 g Trolox.kg^{-1} in Rixanta and 1.17 g AK.kg^{-1} and 2.40 g Trolox.kg^{-1} in Invicta, respectively. In red cultivars, the values of ACW and ACL were found to be higher(3.15 g EAA.kg^{-1} and 3.03 g Trolox.kg^{-1} in Karat and 7.29 g EAA.kg^{-1} and 11.73 g Trolox.kg^{-1}) in Black Negus respectively. Unlike in gooseberries, the highest AOA in currant cultivars was established by ACL method (35.77 g Trolox.kg^{-1} in red cultivar NS 11 and 44.83 g Trolox.$kg^{-1)}$ in black currant Viola, where as in other black cultivars, it ranged from 61.67 g Trolox.kg^{-1} in Ben Gairn to 86.86 g Trolox.kg^{-1} in Otello. The lowest ACW value of 25.83 g EAA.kg^{-1} was determined in red cultivar NS 11 and it was almost two-fold higher in black currant with the values from 42.10 g EAA.kg^{-1} in Viola to 52.59 g EAA.kg^{-1} in Ben Gairn. These results are based on the published findings in red and black currant from Hungary (Balogh, Hegedűs, & Steafanovits-Bányai, 2010).

Many raw gooseberries contain more than double the amount of antioxidant activity as grape fruit and twice the amount as tangerines or cooked asparagus.

Plant materials and preparation of extract

The *Phyllanthus emblica* samples were collected from the garden in Chachoengsao province, Thailand. The seeds were separated from the fruit

and then they were dried in hot air oven at 45 ºC for 3 days, after that it was mashed to produce the powder. The Extract seed and fruit powder were macerated with ethanol at room temperature. The extracts were filtered and solvent was removed using rotary evaporator to get the extracts and it was stored in the dark at 4 °C before the activity tests (Sriwatcharakul, 2018).

Tannin, alkaloids, amino acids, carbohydrates, vitamins, fat, proteins, flavonoids, total phenolic constituents, cytotoxicity test and Superoxide anion free radical scavenging assay

Tanninis also known as tannic acid and they are the group of phenolic compounds in woody flowering plants that are important deterrents to herbivores and also have many industrial applications. Tannins are sequestered in vacuoles within the plant cell as secondary metabolites, which can protect the other cell components. They are normally available in the roots, wood, bark, leaves, and fruit of many plants.

The content of tannin can be evaluated by Folin–Denis's method, in brief, 50 µl of 0.1 mg/ml extract has to be added in 30% MeOH and make up the volume with water to a final volume of 7.5 ml and after that it has to be mixed Folin–Denis 0.5 ml and 35% of 1 ml $NaHCO_3$ before the final volume is adjusted to 10 ml and then the absorbance is measured at 700 nm (Chattheeranant and Sabaijai; 2013). The alkaloid is a class of naturally occurring organic nitrogen-containing bases and they have diverse and important physiological effects on humans and other animals. Some of the well-known alkaloids include morphine, strychnine, quinine, ephedrine, and nicotineetc.

Amino acids are a group of organic molecules that consist of a basic amino group (—NH2), an acidic carboxyl group (—COOH), and an organic 'R' group (or side chain) that is unique to each amino acid. Amino acids were determined from 20-30 mg of lyophilized sample hydrolysed in 4 ml of 6 N HCI under vacuum at 110 o C for 23 h (Moore and Stein, 1963) and the hydrolysate was washed through a glass wool column with distilled water and the volume was adjusted to 10 ml using a volumetric flask. The HCl from a 0.5 ml aliquot was evaporated in a desiccator with KOH pellets and the residue was taken up in 1 ml sodium citrate buffer (0.2 N) ofpH 2.2 which contained 250 nmol ml of norleucine as an internal standard. The Beckman amino acid standard was used for hydrolysate analysis which was utilized to calibrate the analyser. The unit was a Beckman Model 121MB, Beckman Instruments, Inc., Spinco Division, Palo Alto, CA, fitted with a single column (2.8 mm bore X 300 mm in length) packed to a height of 210 mm with type AA-10 Beckman spherical cation exchange resin. (Moore *et al.*, 1958). Carbohydrates are the main source of energy for the body. They are the sugars, starches, and dietary fibre that occur in plant foods and also in dairy products. They are mainly found in plants. The total carbohydrate content of the samples was determined as total carbohydrate by subtracting the measured protein, fat, ash and moisture from 100 by phenol sulphuric acid method as given by (AOAC, 2005). A vitamin is an organic molecule that is an essential micronutrient for an organism and all organisms need it in small quantities for the proper functioning of its metabolism.

The method [Fat (AOAC, 2005)] with Soxhlet apparatus was used to determined crude fat content of the sample. The percent of crude fat was expressed as follows:

$$\% \text{ Crude Fat} = \frac{\text{weight of dried ether soluble material X 100}}{\text{weight of sample}}$$; (Nimse, & More; 2018).

$$\% \text{ Nitrogen} = \frac{T_S - T_B \text{ X Normality of acid X } 0.014 \text{x } 100}{\text{Weight of sample}}$$; (Nimse, & More; 2018).

Protein content was determined using (AOAC, 2005) method. Percentage of nitrogen and protein calculated by the following equation:

All fruits and vegetables contain Flavonoids which belong to a diverse group of phytonutrients (more than 6000 types).

They are responsible for the vivid colours in fruits and vegetables due to carotenoids. Some of the best-known flavonoids are quercetin and kaempferol.

Flavonoid content was analysed using 250 µl of extracts (1 mg/ml) in 30% MeOH, 1.25 ml distilled water was added in to it followed by 5% of 75µl $NaNO_2$ and 10% of 150 µl $AlCl_3$. Then the mixture was incubated for 6 min and then 500µ l of 1 M NaOH and 275 µl of distilled water was added.

The absorbance of the resulting colour was measured at 510 nm (Anil *et al.,* 2012). The total phenolic constituent of the extracts was determined using Folin–Ciocalteau reagent and gallic acid as standard by colorimetric assay. 20 L of extract (0.1 mg/ml) was loaded into 96-well plate then it was mixed with 100 LFolin–Ciocalteau reagent and 80 L sodium carbonate solution (7.5%, w/v).

The mixture was incubated for 30 min and then absorbance of each well was measured at 765 nm (Chattheeranant and Sabaijai; 2013). MTT assay is used for the cell cytotoxicity evaluation which require cellular metabolic activity to convert the colourless tetrazolium to the purple colour formazan.

MCF-7 cells were prepared at mid-log phase approximately 1.0×10^5 cells/ml in 96-well plates for 24 h after that it was incubated with the plant extracts (at 0.1, 1, 10, 100, 1000 and 10 000 g/ml) and without extract as control. The 96-well plates were incubated at 37 ℃ in 5% CO_2 incubator for 72 h. 5 mg/ml of MTT (3-(4,5-dimethyl thiazol-2-yl)-2,5-diphynyl tetrazolium bromide) solution was added in to the plant extract and left for 4 h.

Then the extract was removed and replaced with DMSO to dissolve formazan crystal. The level of formazan derivative colour was analysed at 540 nm with the help of a microplate reader. The 50% cytotoxicity concentration (CC50) was calculated from the calibration curve and the activity was expressed as percentage of cell inhibition relative to control using the following equation:

$$\% \text{ cytotoxic} = \frac{[A \text{ control} - A \text{ sample}] \times 100}{A \text{ control}}$$

A sample= absorbance of treated cells; A control = absorbance of control (Sriwatcharakul, 2018).

The results of the bioactive substances (total phenolics, tannins and flavonoids) of *P. emblica* extracts were analysed. It showed that the level of tannin and flavonoid in seed extractis higher than the fruit extracts. Tannin and flavonoid contents in per gram of seed extract were found to be 126.71 mg TAE and 1016.25 mg QE respectively while the higher total phenolic compound in fruit extract was 6000 mg GAE/g (Sriwatcharakul., 2018).

The superoxide anion free radical scavenging ability was done following the method of Lee *et al.,* (2002). In brief, the reaction mixture contained 2.4 mL of NaH_2PO_4– NaOH buffer (50 mM, pH 7.4), 100 µL of dissolved extract (in NaH_2PO_4– NaOH buffer), 100 µL of 30 mM Na_2EDTA in NaH_2PO_4–NaOH buffer, 100 µL of 3 mM hypoxanthine and 200 µL of 1.42 mM nitro blue tetrazolium (NBT). After 3 minutes of incubation, the reaction was initiated by 100 µL of 0.50 U/mL xanthine oxidase solution. After 20 min equilibrium period, the absorbance was recorded at 560 nm and the IC_{50} values were estimated by a nonlinear regression algorithm (SigmaPlot 2004 version 9.01).

Table.1 Amla: home remedies.;Kumar *et al*., 2012.

Treatment	Significanceand benefits of amla
1.Use in natural cholesterol remedy	Amla can strengthens the muscles of heart and can cause a significant decrease in total cholesterol, LDL cholesterol, VLDL cholesterol and triglycerides. After consulting with doctor, a 500 mg capsule of dried Amla powder can be added inone's daily routine.
2. It can cure hypertension	Vitamin-C helps to control blood pressure. The amla powder or in the form of triphala tablets or decoction can also be used.Triphala is a combination of Amla and two other herbs and it is an excellent medication for the treatment of high blood pressure.
3. Natural cure for Anemia	As amla is rich in Vitamin-C or ascorbic acid, it is an essential ingredient which helps in the absorption of Iron.
4. Herbal cough remedy	A teaspoon of Amla juice or powder can be added to a glass of warm milk and if we drink this thrice a daywill clear an unpleasant throat.Adding some ghee to this decoction can clear cough. Amla powder can be mixed with honey and if we intake this mixture twice a day can cure chronic dry cough. Amla is helpful in the treatment of tuberculosis, asthma and bronchitis.
5.Natural eye tonic	Dried Amla capsules and fresh Amla juice are a good supplement which can improve near-sightedness, cataract and glaucoma. They can reduce intra ocular tension and corrects the vision.
6.Promotes hair growth	The dried amla fruits canbe boiledin coconut oil and then ground to form amla oil. This is a very effective conditioner and can prevent balding and greying of hair. For oily hair, we need to mix half a cup of amla juice, half a cup of lime juice and some water and then we can apply this to make an anti-grease hair wash.
7. A pitta pacifier	Amla has to be boiled in coconut water and then ground mixture can be applied to the scalp. Amla oil is excellent to reduce the heat associated with summer.
8.Treats white spots on the nails	It is a source of Vitamin C and serves as an effective remedy in vitamin deficiency condition. On addition of amla juice/powder in diet overcomes this condition.
9.Remedy for menstrual disorders	White discharge can be relieved using dried amla seeds.It can be relieved by consumingamla with honey and saunf (fennel) or mixing it with squished banana.

Table.2 Antioxidant activity of fruit (Saikia *et al*., 2016)

Fruit cultivars	DPPH [gTrolox.kg^{1}]			ACW [gAA.kg^{1}]			ACL [g Trolox. kg^{-1}]		
Gooseberry	Mean		SD	Mean		SD	Mean		SD
Green Invicinta	6.17	±	0.01	1.17	±	0.01	2.4	±	0.01
Rixanta	2.96	±	0.07	0.07	±	0.04	2.86	±	0.08
Red karat	9.94	±	0.01	3015	±	0.04	3.03	±	0.21
Black Negus	13.09	±	0.02	7.29	±	0.06	11.73	±	0.82
Currant Red NS11	12.55	±	0.02	25.83	±	0.35	35.77	±	0.53
Black Focus	18.2	±	0.01	46.34	±	0.36	81.69	±	0.57
Ben gairn	17.62	±	0.09	52.59	±	0.61	61.67	±	0.74
Otelo	15.59	±	0.02	51.71	±	0.32	86.86	±	0.38
viola	15.53	±	0.21	42.1	±	0.63	44.83	±	0.48

Table.3 Chemical constituents of *Phyllanthus emblica.*,(Charmkar& Singh., 2017).

Constituents	Composition
1.Tannins	Chebulagic acid,ellagotannin. emblicanin A, emblicanin B, punigluconin and pedunculagin, Chebulinic acid, Geraniin and Corilagin,
2.Alkaloids	Phyllantine, phyllantidine and phyllembein,
3.Amino acids	Proline, Glutamic acid, Alanine, Aspartic acid, cystine, cystine, lysine
4.Carbohydrates	Pectin
5.Vitamin	Ascorbic acid
6.Flavonoids	Citric acid

Table.4 Phytochemical contents in *P. emblica* extracts.,(Sriwatcharaku., 2020).

Phytochemicals		
	Seed extract	**Fruit**
a). Total phenolic contents (mg GAE/g extract)	4.53 ± 0.18	6.00 ± 0.18
b). Tannins (mg TAE/g extract)	126.71 ± 0.92	52.96 ± 1.04
c). Flavonoids (mg QE/g extract)	1016.25 ± 16.50	865 ± 34.28

Table.5 Chemical composition of *Phyllanthus emblica* fruit., [Dhale, D. A., & Mogle, U. P. (2011)]

Parameters	*Phyllanthus emblica*
a). Titritable Acidity (%)	2.34
b). Total Soluble Solid	8.62
c). Reducing Sugar (%)	1.42
d). Total Sugar (%)	7.32
e). pH	2.976
f). Ascorbic Acid (Vit-C) (mg/100gm)	552.6
g). Moisture (%)	85.6
h). Ash (%)	0.9
i). Fat (%)	0.5
j). Fibre content (%)	3.7
k). Protein (%)	2.187
l). Carbohydrate (%)	7.113

Table.6 Phytochemical analysis of *P. emblica* using different solvent; (Nath and Dhivya., 2019).

Phytochemical constituents	Petroleum ether		Chloroform		Alcohol	
	Leaves	Fruits	Leaves	Fruits	Leaves	Fruits
1. Alkaloids	-	+	-	+	+	+
2.Oil and Fats	+	+	+	+	+	+
3.Glyceroids	-	-	-	-	+	+
4.Carbohydrates	-	-	-	-	+	+
5.Phenolics	+	+	+	+	+	+
6.Tannins	+	+	+	+	+	+
7.Lignin	-	+	-	+	+	+
8.Saponins	+	+	+	+	+	+
9.Flavonoids	-	-	-	-	+	+
10.Terpenoid	-	-	-	-	-	+

Table.7 The antibacterial efficacy of different solvent extracts of *P.emblica* fruits; (Gautam & Shukla., 2017).

Microorganism	Strain +/-	Concentration (mg/ml)	Zone of inhibition (mm)			
			Petroleum ether	Chloroform	Alcohol	Ampicillin (40 µg/ml)
Escherichia coli	-ve	10	05	05	08	18
		20	09	10	12	
Pseudomonas aeruginosa	-ve	10	04	05	09	23
		20	10	11	15	
Staphylococcus aureus	+ve	10	08	12	20	30
		20	12	17	29	
Bacillus subtilis	+ve	10	05	08	10	25
		20	09	14	181	

Ascorbic and gallic acids were used as positive controls. The extracts demonstrated different degrees of antioxidative efficacy. The extract designated IG-3 was consistently amongst the most effective extracts in the iron (III) reduction and 1,1-diphenyl-2-picrylhydrazyl and superoxide anion radical scavenging assays while the extract designated IG-1 exhibited the most effective hydroxyl radical scavenging activity (Poltanov *et al.*,2009).

The DPPH activity in Green Invicinta, Rixanta, Red karat and Black negus, Current red NS11, Black focus, Ben gairn, Otelo and viola were found to be 6.17, 2.96, 9.94 and 13.09gTrolox/K. The value of ACW of the same nine species were found to be 1.17, 0.07,3015, 7.29, 12.55, 18.2, 17.62, 15.59, 15.53, 25.83, 46.34, 52.59, 51.71 and 42.1gAA/Kg. The ACL value of the all nine species were found to be 2.4, 2.86, 3.03,11.73, 35.77, 81.69, 61.67, 86.86 and 44.83g Trolox/Kg (Saikia *et al.*, 2016). Previous studies also reviled that the chemical constituents such as tannins, alkaloids, amino acids, carbohydrates, vitamins and flavonoids were found to be present in *P. amblica,* (Charmkar & Singh, 2017), **(**Laulloo *et al.*, 2018). The review studies say that the total phenolic contents, tannins, flavonoids of *p. amblica* were found to be 4.53, 126.71 and 1016.25 g/ extract from seed extract and 6,52.96 and 865 g/ extract from the fruits (Sriwatcharaku, 2020).Another study from the review says that the titratable acidity, total soluble solid, reducing sugar, total sugar, pH, Ascorbic acid, moisture, ash content, fat, fibre content, protein and carbohydrates in p. amblica was found to be 2.34, 8.62, 1.42, 7.32, 2.97, 552.6, 85.6, 0.9, 0.5, 3.7, 2.18 and 7.113%., Dhale, D. A., & Mogle, U. P. (2011). Phytochemical analysis of *P. emblica* showed presence of alkaloids in leaves and fruits with ethanol, oil and fats both with petroleum ether, glyceroids with ethanol, carbohydrates with alcohol, lignin with ethanol, saponins with alcohol and terpenoids with ethanol as solvent. (Nath and Dhivya., 2019). *P. Emblica* also showed antibacterial activity against *E coli, Pseudomonas aeruginosa, Staphylococcus aureus* and *Bacillus subtilis* sp respectively (Gautam & Shukla., 2017). The study of all the assay reviles the presence of important compounds in *P. Emblica* which are fantastic weapon for disease remedy and therefore P.*emblica* plays important role in Indian history, specially it highlights an unforgettable footprint in Ayurveda.

Indian gooseberry is most commonly used for high cholesterol, abnormal levels of cholesterol or blood fats (dyslipidaemia), and persistent heartburn. It is also used for diarrhoea, nausea, and cancer, but there is no good scientific evidence to support these uses. Indian gooseberry seems to work by reducing total cholesterol levels, including the fatty acids called triglycerides, without affecting levels of the "good cholesterol" called high-density lipoprotein (HDL).Indian gooseberry has several potential benefits, although more high-quality studies in humans are needed to confirm many of these possible effects (Verma *et al.*, 2018). Researchers observed that in comparison to the placebo group, amla fruit showed greater reductions in the severity of heartburn and vomiting. More research is needed to fully understand the effects of Indian gooseberry supplements on heartburn and GERD. Due to its high vitamin C content, Indian gooseberry may have some promising anti-aging benefits. Vitamin C is an antioxidant that can help to prevent cellular damage, which may help to slow down body's natural aging process. In addition to its antioxidant activity (Durazzo *et al.*, 2019). Indian gooseberry may help to prevent the breakdown of collagen, which forms the firm but flexible protein matrix in skin and soft tissues.

Indian gooseberry extract is commonly used in Thailand to promote hair growth, and some evidence shows that it may inhibit an enzyme that contributes to hair loss. In test-tube studies, Indian gooseberry extract can be used against age-related macular degeneration (AMD) by improving the mitochondrial health of eye cells. In test-tube and animal studies, Indian gooseberry extracts have killed certain types of cancer cells, including breast, cervical, ovarian, and lung cancers. Indian gooseberry extracts play an important role in cancer prevention as they have antioxidant activity. It

appears that Indian gooseberry may also help prevent cell mutations that lead to tumour growth and cancer development. It is thought that many phytochemicals, such as tannins and flavonoids, (Gantait *et al.,* 2021) in Indian gooseberries play a role in cancer prevention, along with its vitamin C and antioxidant content. One of the most common uses of Indian gooseberry is to promote heart health. There are many ways in which Indian gooseberry may decrease the risk of heart disease. Indian gooseberry extracts may use against oxidative damage that is associated with heart injury (Ruangchakpet and Sajjaanantakul., 2007). A study in people with type 2 diabetes were found to be taken 1,000 mg of Indian gooseberry in their regular diet which improved the endothelial function to the same extent as the atorvastatin drug. Human studies have noted that Indian gooseberry can significantly reduce inflammation, which is considered a key factor in the development of heart disease. Human studies have observed improved blood fat profiles after supplementing with Indian gooseberry, including lower triglyceride and total and LDL cholesterol as well as increased HDL cholesterol. Indian gooseberry may help to reduce high blood pressure levels by acting as a vasodilator, or by widening the blood vessels.

High blood pressure is linked to an increased risk of heart disease. Finally, supplementing with Indian gooseberry may help to prevent the formation of blood clots, which may cause a heart attack or stroke if they block an artery (Srinivasan, 2020). Although some human studies have been conducted, more research is needed before Indian gooseberry can be claimed to be an effective heart health supplement. The review studies describe that Indian gooseberry is helpful to lower the blood sugar levels. In a group of 32 people, it was noted that taking 1-3 grams of Indian gooseberry powder daily for 21 days can significantly decrease the fasting and post meal blood sugar levels and it was compared with a control group. Indian gooseberry has some immune-strengthening effects due to its vitamin C content. A single Indian gooseberry contains approximately 600–800% of the Daily Value (DV) for this vitamin. Vitamin C can optimize immune health in several ways. It's an antioxidant, so it works to decrease cellular damage and inflammation. The short-term inflammation is a healthy immune response while chronic inflammation is an ongoing immune response that can promote poor health. Chronic is associated with an increased risk of developing conditions like type 2 diabetes, heart disease, or autoimmune disorders The vitamin C helps to boost our immune system by promoting the proliferation of phagocytes, which are specialized immune cells that help to swallow up harmful invaders. It may also help our body to develop the protective antibodies against perceived threats. Indian gooseberry fruits can be eaten raw, although they are very sour and may not be appealing to most people. In India they are often pickled or candied in a simple syrup. Some regions of India also use Indian gooseberries in dal, a traditional lentil dish. Indian gooseberries are initially marketed and they were sold in the form of amla fruit powder or powder-filled capsules. The powder can be used to make tea or added to drinks and smoothies. Most supplements contain 500–1,000 mg of Indian gooseberry powder per serving (Gantait *et al.*,2021). Amla fruit powders are often touted for use in hair and skin care products due to their high vitamin C content. Amla fruit oils are specifically made to use on the skin and hair. In India and other Asian countries, Indian gooseberries are used to rustle up various platter and in herbal treatment. Supplements made from this fruit have many potential benefits, including anti-aging, cancer prevention, heartburn reduction, and heart-health effects. The fruits are also packed with vitamin C, so they may help to optimize the immune health.

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