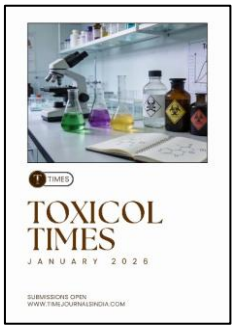
RESEARCH PAPER



Pharmacognostic Profiling of *Emblica officinalis* Gaertn. Fruit: A Foundational Approach for Toxicity Assessment of Herbal Formulations

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ABSTRACT

Emblica officinalis Gaertn. (Amla) is a widely used medicinal plant with significant therapeutic potential. However, its safety and efficacy depend on proper authentication and standardization of raw material. The present study aimed to establish a comprehensive pharmacognostic profile of *E. officinalis* fruit as a foundational approach for toxicity assessment of herbal formulations. Morphological evaluation revealed globose, greenish fruits with six distinct ridges, while microscopic analysis showed a well-defined epidermis, thick cuticle, parenchymatous mesocarp, and scattered vascular bundles. Physico-chemical analysis demonstrated higher extractive values in polar solvents, with water (58.66%) and ethanol (42.73%) indicating the abundance of polar phytoconstituents. The acidic pH (3.14 ± 0.08) further reflects its chemical nature. These parameters collectively provide reliable markers for authentication, quality control, and detection of adulteration. The study highlights the importance of pharmacognostic standardization as a prerequisite for ensuring the safety, consistency, and toxicological evaluation of herbal formulations.

KEYWORDS: *Emblica officinalis*; Pharmacognostic profiling; Physico-chemical parameters; Microscopic evaluation; Herbal formulations; Quality control; Morphological characterization

1. INTRODUCTION

Emblica officinalis (Indian gooseberry) belonging to the family Phyllanthaceae (Euphorbiaceae) is a small to medium-sized tree (8-18 m), found in mixed deciduous forests. It is popularly known as amla and is commonly found in tropical and subtropical regions with wide distribution in India, China, Pakistan, Sri Lanka and Indonesia (Raaf et al., 2022). The leaves are subsessile, linear, and densely arranged along the branchlets, imparting a characteristic pinnate appearance. The plant bears small, greenish-yellow flowers. All parts of the plant are utilized in traditional medicine; however, the fruit is of particular significance and occupies a central role in Ayurvedic formulations as a potent rasayana (rejuvenator) known for promoting longevity and overall health. It is recognized as a highly valued botanical with extensive applications in the food, nutraceutical and cosmetic industries. The fruit is highly nutritious and is reported as an important dietary source of vitamin C, along with minerals and amino acids (Gaire and Subedi, 2014). Its broad therapeutic potential is attributed to a diverse phytochemical profile, including ascorbic acid, alkaloids, ellagitannins, gallic acid, emblicanin A and B, and flavonoids such as rutin and quercetin. These bioactive constituents are associated with strong antioxidant and pharmacological activities. Quantitative analyses have reported that 100 g of fresh fruit may contain approximately 445 mg of ascorbic acid, highlighting its exceptional vitamin C content. The fruit exhibits a broad spectrum of pharmacological activities, including antioxidant, anti-inflammatory, antidiabetic, antimicrobial, immunomodulatory, hepatoprotective, cardioprotective, antitumor, analgesic, and anti-ulcerogenic effects (Gul et al., 2022). These diverse bioactivities are primarily attributed to its rich composition of polyphenols, flavonoids, and vitamin C, which collectively contribute to its therapeutic efficacy.

Despite its widespread therapeutic use, the safety and efficacy of herbal formulations depend significantly on the quality, authenticity, and standardization of the raw plant material. Variability arising from environmental conditions, processing methods, or adulteration can alter the phytochemical profile and potentially influence toxicological responses. In this context, pharmacognostic profiling serves as a fundamental approach for establishing identity, purity, and quality control parameters. Therefore, the present study aims to develop a comprehensive pharmacognostic profile of *E. officinalis* fruit as a foundational step toward its standardization and subsequent toxicological evaluation in

herbal formulations.

2. MATERIALS AND METHODS

The present study was undertaken to establish a comprehensive pharmacognostic profile of *Emblica officinalis* fruit as a preliminary step toward its quality standardization and toxicity assessment in herbal formulations. Fresh fruit samples of *E. officinalis* (amla) were procured from the local market of Amritsar (Punjab, India) and authenticated based on standard pharmacopoeial guidelines.

2.1. Morphological Observations

Macroscopic examination of fresh fruits was performed to assess diagnostic morphological features including size, colour, surface characteristics and texture. Observations were carried out with the naked eye and a magnifying lens to ensure accurate morphological identification (WHO, 2010; API, 2016).

2.2. Microscopic Observations

Fresh fruit samples were used for section cutting. The free-hand thin transverse sections were cut using a razor/blade and were collected in a petri dish filled with water. The fine sections were then placed on a glass slide. The sections were then viewed under the microscope. The characteristic anatomical features such as epidermis, cuticle, parenchymatous tissue and vascular bundles were noted and documented through photomicrography.

2.3. Physico-chemical Parameters

The fruits were shade-dried and grinded with the help of an electric grinder to form the fine powder. The different physico-chemical parameters like petroleum ether-soluble extractive value, chloroform-soluble extractive value, alcohol-soluble extractive value and water-soluble extractive value of fruit powder were determined as per standard procedures (WHO, 2010; API, 2016).

2.3.1. Petroleum ether-soluble extractive value: About 5 g of powdered fruit sample was taken in 100 ml petroleum ether in a stoppered conical flask. The samples were shaken intermittently for initial 6 h and then allowed to stand for 18 h. The samples were filtered and 25 ml of the filtrate was evaporated to dryness on a water bath followed by drying at 105°C to achieve a constant weight (WHO, 2010). The percentage of petroleum ether-soluble extractive value was then calculated as given in the formula below.

$$Petroleum\ ether\ soluble\ extractive\ value\ (\%) = \frac{Weight\ of\ extract}{Weight\ of\ crude\ sample\ (5\ g)} \times \frac{Volume\ of\ petroleum\ ether\ (100\ ml)}{Volume\ of\ filtrate\ (25\ ml)} \times 100$$

2.3.2. Chloroform-soluble extractive value: 5 g fruit powder was macerated with chloroform (100 ml) for 24 h with frequent shaking during first 6 h in a closed flask. The mixture was then filtered and the filtrate (25 ml) was allowed to evaporate in a petri dish to obtain the extract. The chloroform-soluble extractive value was calculated as follows.

$$Chloroform\ soluble\ extractive\ value\ (\%) = \frac{Weight\ of\ extract}{Weight\ of\ crude\ sample\ (5\ g)} \times \frac{Volume\ of\ chloroform\ (100\ ml)}{Volume\ of\ filtrate} \times 100$$

2.3.3. Ethanol-soluble extractive value: The maceration of powdered fruit (5 g) was carried out using 100 ml methanol in a conical flask. The solution was filtered rapidly to avoid the loss of solvent and the filtrate was evaporated to dryness at 105°C. The residue was weighed and the extractive value was assessed using formula:

$$Ethanol\ soluble\ extractive\ value\ (\%) = \frac{Weight\ of\ extract}{Weight\ of\ crude\ sample\ (5\ g)} \times \frac{Volume\ of\ alcohol\ (100\ ml)}{Volume\ of\ filtrate} \times 100$$

2.3.4. Water-soluble extractive value: The powdered sample (5 g) of fruit was macerated with 100 ml water in a closed conical flask for 24 h with frequent shaking during first 6 h. After maceration, 25 ml of each filtered solution was kept on a water bath followed by drying at 105°C. The obtained extracts were weighed and the percentage of water-soluble extractive value was calculated (WHO, 2010; API, 2016).

$$Water\ soluble\ extractive\ value\ (\%) = \frac{Weight\ of\ extract}{Weight\ of\ crude\ sample} \times \frac{Volume\ of\ water}{Volume\ of\ filtrate} \times 100$$

2.3.5. Estimation of pH value: 1% suspension of *E. officinalis* fruit powder was prepared in distilled water and pH was estimated with the aid of an electronic pH meter (Chandel et al., 2011).

3. RESULTS

The pharmacognostic profiling of *Emblica officinalis* fruit, encompassing morphological, anatomical, and physico-chemical parameters revealed the following characteristics.

3.1. Morphological Observations

3.1.1. Fresh fruit

The edible fruits were fleshy, smooth and globose shaped, 2.5-3.5 cm in diameter. The fruits were greenish in colour with six prominent ridges (Figure 1a). The cut-opened fruit also showed six vertical stripes or furrows, with a well-defined outer exocarp, fleshy mesocarp and the innermost endocarp enclosing seeds (Figure 1b).

(a) Fresh fruit (b) Cut opened fruit

Figure 1: Morphological features of fresh fruit of *Emblica officinalis*

3.1.2. Dried fruit

In the present study, the dried fruits appeared as greyish-black, curled fragments, occurring either as single segments or as aggregates of three to four segments. The fruit pieces exhibited a shrivelled and wrinkled external convex surface, occasionally marked with small whitish specks (Figure 2).

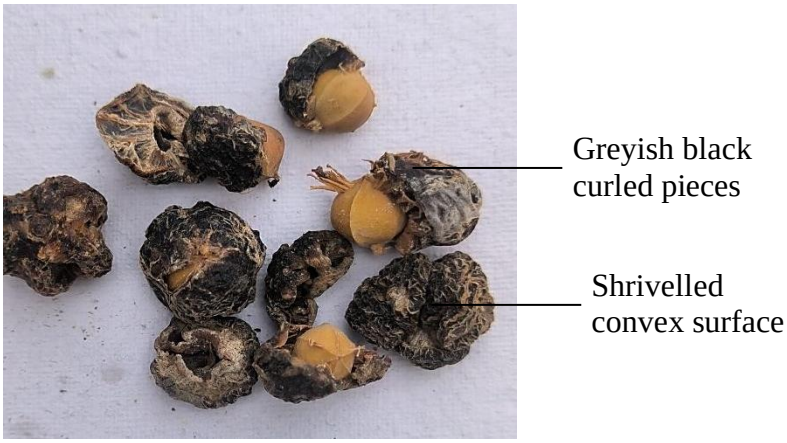

Figure 2: Morphological features of dried fruit of *Emblica officinalis*

3.2. Microscopic Characteristics

Transverse section of fruit: Microscopic examination of the transverse section displayed the presence of epicarp consisting of single layer of epidermis and two-four layers of hypodermal cells, externally covered by a thick cuticle. The mesocarp constituted the major portion of fruit consisting of parenchymatous cells with intercellular spaces. Several collateral vascular bundles, comprising xylem and phloem elements were also observed to be scattered throughout the mesocarp (Figure 3a and 3b).

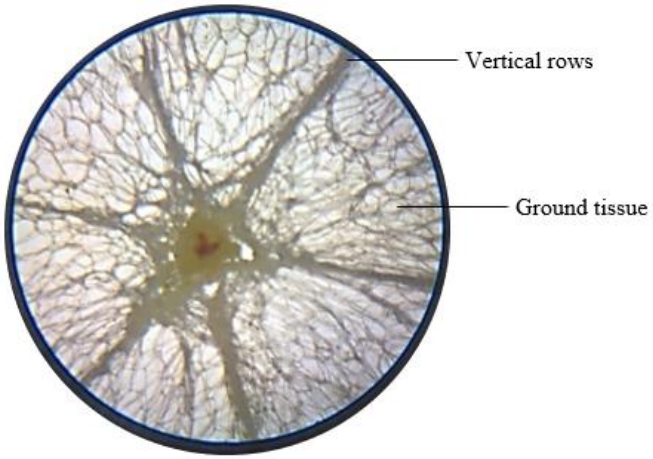

Figure 3a: Transverse section of *Emblica officinalis* fruit representing six vertical stripes and ground tissue

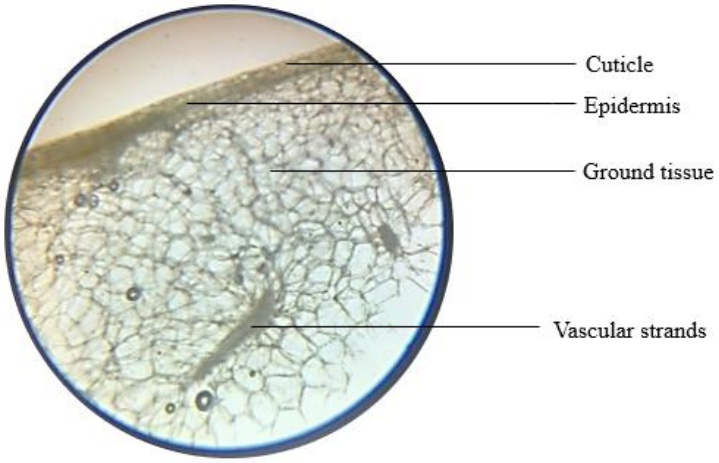

Figure 3b: Transverse section of *Emblica officinalis* fruit representing epidermis, ground tissue and vascular strands

3.3. Physico-chemical parameters

The various physico-chemical parameters of fruit powder are presented in Table 1. As seen from the table, percentage of extractive values increased with the increase in polarity of solvents. The petroleum ether-soluble extractive value was found to be 1.008% followed by chloroform-soluble extractive value of 1.269. A substantially higher extractive value was observed in ethanol (42.73%), while he highest percentage of extractive value i.e. 58.66% was observed in water as an extraction solvent. The pH of fruit peel powder was observed to be 3.14 ± 0.08 at 1% (w/v) suspension in distilled water.

Table 1 Physico-chemical parameters of *Emblica officinalis* fruit powder

S. No.	Physico-chemical parameter	Physico-chemical values (% w/w) ± Standard error
1.	Petroleum ether-soluble extractive value	1.008 ± 0.142
2.	Chloroform-soluble extractive value	1.269 ± 0.195
3.	Ethanol-soluble extractive value	42.73 ± 0.186
4.	Water-soluble extractive value	58.66 ± 0.122
5.	pH value	3.14 ± 0.08

4. DISCUSSION

The pharmacognostic profiling of *Emblica officinalis* fruit presented in this study provides a critical basis for ensuring the safety, efficacy, and standardization of herbal formulations. In the context of toxicological evaluation, such baseline characterization is indispensable, as incorrect plant identification and lack of quality control can significantly influence biological responses, including potential adverse effects (Ekor, 2014). The increasing global reliance on herbal medicines necessitates a shift from traditional empirical usage to scientifically validated quality control frameworks that integrate pharmacognostic and toxicological parameters (Jordan et al., 2010).

Macroscopic and microscopic evaluations serve as the primary steps in the authentication of crude drugs (Kaur et al., 2018). The morphological features observed in the present study such as globose fruits with characteristic six vertical ridges and greenish coloration are consistent with classical descriptions in the Ayurvedic Pharmacopoeia of India. Such features are not merely descriptive but hold toxicological relevance, as misidentification or substitution with morphologically similar species may introduce unintended phytochemicals with unknown or harmful effects. Therefore, morphological authentication acts as a first-line defence against toxicological risks arising from adulteration. Microscopic characterization further enhances the specificity of plant identification by revealing diagnostic anatomical features (Kaur et al., 2018). The presence of a well-defined epidermis, cuticle, parenchymatous mesocarp, and scattered vascular bundles in *E. officinalis* fruit confirms its structural integrity and authenticity. From a toxicological standpoint, microscopic evaluation is particularly valuable in detecting contaminants such as fungal structures, foreign plant materials, or particulate impurities that may not be visible macroscopically.

Physico-chemical parameters represent another crucial dimension of pharmacognostic standardization with direct implications for toxicity assessment (Kaur et al., 2018). The extractive values obtained in this study indicate a clear trend of increasing solubility with solvent polarity, with water and ethanol yielding the highest extractive values. This suggests a predominance of polar phytoconstituents such as tannins, phenolic acids, flavonoids, and glycosides. Although these compounds are widely recognized for their antioxidant and anti-inflammatory properties, their biological effects are often dose-dependent, necessitating careful evaluation in toxicological studies (Shahidi and Ambigaipalan, 2015; Galati and O'brien, 2004). The acidic pH of the fruit powder further contributes to its biochemical behaviour and toxicological profile. Acidic phytoconstituents can influence drug stability, gastrointestinal tolerance, and interactions with other formulation components. Comparative studies on herbal formulations have highlighted the importance of pH optimization to balance therapeutic efficacy with safety, particularly in polyherbal combinations where interactions between acidic and basic components may lead to instability or toxicity (Kumadoh and Ofori-Kwakye, 2017).

From a broader perspective, the role of pharmacognostic

profiling extends beyond individual plant species to the safety evaluation of complex herbal formulations. *E. officinalis* is a key component of several traditional formulations such as Triphala, where it interacts with other botanicals to produce synergistic effects (Baliga, 2010). However, such interactions may also modify the pharmacokinetics and toxicity of individual constituents. Comparative toxicological studies on polyherbal formulations have highlighted the need for standardized raw materials to ensure predictable and safe outcomes. The pharmacognostic parameters established in this study provide a foundational framework for such evaluations.

5. CONCLUSION

The pharmacognostic profiling of *Emblica officinalis* fruit offers a comprehensive baseline for its identification, quality assessment, and safety evaluation. The data presented in this study highlights the interconnectedness of morphological, anatomical, and physico-chemical parameters with toxicological outcomes. This study contributes to minimizing risks associated with adulteration, contamination, and variability, thereby enhancing the safety and reliability of herbal formulations. Future studies should focus on correlating these pharmacognostic parameters with in vitro and in vivo toxicological data to develop a holistic understanding of the safety profile of *E. officinalis* and its derived formulations.

6. REFERENCES

Ahmad B, Hafeez N, Rauf A, Bashir S, Linfang H, Rehman MU and Rengasamy KR (2021) *Phyllanthus emblica*: A comprehensive review of its therapeutic benefits. South African Journal of Botany. 138: 278-310. DOI: 10.1016/j.sajb.2020.12.028

API (2016) *The Ayurvedic Pharmacopoeia of India* Part-I, Vol IX, Ministry of AYUSH, Pharmacopoeia Commission for Indian Medicine and Homoeopathy, Ghaziabad, Govt. of India.

Baliga MS (2010) Triphala, Ayurvedic formulation for treating and preventing cancer: a review. Journal of Integrative and Complementary Medicine. 16(12): 1301-1308. DOI: 10.1089/acm.2009.0633

Chandel HS, Pathak AK and Tailang M (2011) Standardization of some herbal antidiabetic drugs in polyherbal formulation. Pharmacognosy Research. 3(1): 49-56. DOI: 10.4103/0974-8490.79116

Ekor M (2014) The growing use of herbal medicines: issues relating to adverse reactions and challenges in monitoring safety. Frontiers in Pharmacology. 4:177. DOI: 10.3389/fphar.2013.00177

Gaire BP and Subedi L (2014) Phytochemistry, pharmacology and medicinal properties of *Phyllanthus emblica* Linn. Chinese Journal of Integrative Medicine 1-8. DOI: 10.1007/s11655-014-1984-2

Galati G and O'brien PJ (2004) Potential toxicity of flavonoids and other dietary phenolics: significance for their chemopreventive and anticancer properties. Free Radical Biology and Medicine. 37(3): 287-303. DOI: 10.1016/j.freeradbiomed.2004.04.034

Gul M, Liu ZW, Rabail R, Faheem F, Walayat N, Nawaz A, Shabbir MA, Munekata PE, Lorenzo JM and Aadil RM (2022) Functional and nutraceutical significance of Amla (*Phyllanthus emblica* L.) : a review. Antioxidants: 11(5): 816. DOI: 10.3390/antiox11050816

Jordan SA, Cunningham DG and Marles RJ (2010) Assessment of herbal medicinal products: challenges, and opportunities to increase the knowledge base for safety assessment. Toxicology and Applied Pharmacology. 243(2): 198-216. DOI: 10.1016/j.taap.2009.12.005

Kaur P, Kataria SK, Singh B and Arora S (2018) Pharmacognostic profile of *Trigonella corniculata* L. seeds and effect of its aqueous extract on growth inhibition of cancer cells. Research Journal of Pharmacy and Technology.11(5): 2022-2029. DOI: 10.5958/0974-360X.2018.00375.X

Kumadoh D and Ofori-Kwakye K (2017) Dosage forms of herbal medicinal products and their stability considerations-an overview. Journal of Critical Reviews. 4(4): 1-8. DOI: 10.22159/jcr.2017v4i4.16077

Raaf A, Putra TW, Mulana F, Syamsuddin Y and Supardan MD (2022) Investigation of kinetics of amla (*Emblica officinalis*) fruit drying process. South African Journal of Chemical Engineering. 41:10-16. DOI: 10.1016/j.sajce.2022.03.011

Shahidi F and Ambigaipalan P (2015). Phenolics and polyphenolics in foods, beverages and spices: Antioxidant activity and health effects–A review. Journal of Functional Foods. 18: 820-897.

WHO (2010) Quality control methods for medicinal plant materials. World Health Organisation Press, Geneva, Switzerland.

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All the authors conceived the concept, wrote and approved the manuscript.

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