WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
Coden USA: WJPRAP Impact Factor 8.63
Volume 15, Issue 14, 969-980. Research Article ISSN 2277–7105

PHYTOCHEMICAL AND PHYSICOCHEMICAL EVALUATION OF *CARICA PAPAYA* LEAVES FOR HERBAL STANDARDIZATION

Dr. Prabhavati D. Nadre*[1], Dr. Surekha T. Landge[2]

[1]M.D. Final Year (Dravyaguna Vigyana), Shri Ayurved Mahavidyalaya, Nagpur, Maharashtra, India.

[2]M.D. (Dravyaguna Vigyana), Associate Professor and HOD (Dravyaguna Vigyana), Shri Ayurved Mahavidyalaya, Nagpur, Maharashtra, India.

Article Received on 12 June 2026,
Article Revised on 03 July 2026,
Article Published on 16 July 2026,

https://doi.org/10.5281/zenodo.21368334

***Corresponding Author**

Dr. Prabhavati D. Nadre

M.D. Final Year (Dravyaguna Vigyana), Shri Ayurved Mahavidyalaya, Nagpur, Maharashtra, India.

How to cite this Article: Dr. Prabhavati D. Nadre*[1], Dr. Surekha T. Landge[2]. (2026). Phytochemical And Physicochemical Evaluation of Carica Papaya Leaves For Herbal Standardization. World Journal of Pharmaceutical Research, 15(14), 969–980.

ABSTRACT

Carica papaya L. (papaya), commonly known as Erandakarkati, is widely used in traditional medicine due to its diverse therapeutic potential. The present study aims to evaluate the phytochemical composition and physicochemical parameters of *Carica papaya* leaves to establish a scientific basis for their medicinal use and standardization. Qualitative phytochemical screening revealed the presence of alkaloids, flavonoids, tannins, saponins, glycosides, phenolics, and terpenoids, which contribute to antioxidant, anti-inflammatory, and antimicrobial activities. Physicochemical parameters such as moisture content, ash values, extractive values, pH, and loss on drying were analysed. The study provides baseline data for quality control and standardization of papaya leaves, supporting their ethnomedicinal applications and future pharmacological research.

KEYWORDS: *Carica papaya*, Erandakarkati, Phytochemical analysis, Physicochemical parameters, Secondary metabolites, Herbal standardization, Quality control.

INTRODUCTION

Dravyaguna Vigyana is an important branch of Ayurveda that deals with the study of medicinal substances, including their nomenclature, identification, properties, actions, and

therapeutic applications. Standardization serves as a crucial tool for ensuring the identity, quality, safety, and efficacy of herbal drugs and helps prevent adulteration and substitution.[1]

Carica papaya Linn., commonly known as Papaya, is a tropical medicinal plant belonging to the family Caricaceae. It is believed to have originated in Central America and is now extensively cultivated throughout tropical and subtropical regions of the world, including India. The plant is a fast-growing, soft-wooded, perennial herbaceous tree reaching a height of 2–10 meters. It possesses a hollow stem, large palmately lobed leaves arranged spirally at the apex, and produces yellow-orange fleshy fruits rich in nutrients and bioactive compounds.[2]

The leaves are especially valued for their therapeutic potential in conditions such as Jwara (fever), Agnimandya (impaired digestion), Krimi (helminthiasis), Shotha (inflammation), and Raktapitta disorders. Traditional systems of medicine have also employed papaya leaves in the treatment of malaria, dengue fever, skin diseases, digestive disorders, and urinary ailments.[3]

The medicinal value of Carica papaya leaves is attributed to the presence of a wide range of phytoconstituents including alkaloids, flavonoids, phenolic compounds, tannins, saponins, glycosides, steroids, and enzymes such as papain and chymopapain. Among these, flavonoids and phenolic compounds are known for their antioxidant, anti-inflammatory, immunomodulatory, and antimicrobial properties. Alkaloids such as carpaine have demonstrated cardiotonic, antiamoebic, and thrombopoietic activities. Recent studies have reported the beneficial role of papaya leaf extract in increasing platelet count among patients suffering from dengue-associated thrombocytopenia, which has drawn considerable scientific attention toward this plant.[4-6]

Despite its widespread medicinal use, variations in geographical distribution, cultivation practices, harvesting methods, and storage conditions can significantly influence the quality and chemical composition of the plant material. Therefore, establishing pharmacognostical, physicochemical, and phytochemical standards is essential for ensuring the authenticity and quality of Carica papaya leaves used in herbal formulations and research.[7,8]

Hence, the present study has been undertaken to evaluate the phytochemical and physicochemical characteristics of Carica papaya Linn. leaves with the objective of

generating scientific data that can contribute toward the establishment of quality control standards and support their safe and effective utilization in Ayurvedic and herbal medicine.

Ethnomedical Applications

Carica papaya Linn. is an important medicinal plant widely utilized in traditional medicine systems and ethnomedicinal practices throughout tropical and subtropical regions. Different parts of the plant, especially leaves, fruits, seeds, roots, and latex, are used by tribal and rural communities for the management of various ailments. The leaves are particularly valued for their digestive, anti-inflammatory, antimicrobial, and hematopoietic properties. Some of the ethnomedical applications of Carica papaya are listed below.[10,11]

Table No. 1: Ethnomedical Applications of Carica papaya Linn.

Traditional Use	Part Used
Dengue fever and thrombocytopenia	Leaf juice/decoction used to improve platelet count and reduce symptoms of fever
Digestive disorders	Unripe fruit and leaf preparations used as digestive stimulant and carminative
Intestinal worms	Seeds and leaf extracts used as anthelmintic
Skin diseases	Latex and leaf paste applied on wounds, ulcers, eczema, and fungal infections
Inflammatory disorders	Leaf decoction used for pain, swelling, and inflammation
Liver disorders	Leaf and fruit preparations used as hepatoprotective agents
Diabetes mellitus	Leaf decoction used traditionally to regulate blood glucose levels
Constipation	Ripe fruits consumed as mild laxative
Wound healing	Latex applied externally to promote healing

Traditionally, the fresh leaves of Carica papaya are crushed and their juice is administered in febrile conditions, especially dengue fever. The seeds are commonly used as vermifuge, while the latex obtained from unripe fruits is employed in skin disorders and wound management. Ripe fruits are considered nutritive, digestive, and mildly laxative. Various tribal communities use leaf decoctions for inflammatory disorders, liver ailments, and general debility.[11,12]

Vernacular Names[13,14]

Table No. 2: Vernacular Names of Carica papaya Linn.

Language	Name
Sanskrit	Erandakarkati, Madhukarkati
Hindi	Papita
Marathi	Papaya, Popaya
English	Papaya, Pawpaw
Latin	Carica papaya Linn.

The Sanskrit name **Erandakarkati** is derived from the resemblance of the leaves to those of Eranda (Ricinus communis), whereas **Madhukarkati** refers to the sweet taste of the ripe fruit. The name "Papaya" is believed to have originated from the Caribbean word "Ababai" or "Papaya," reflecting its American origin.[12]

Taxonomic Rank[15]

Table No. 3: Taxonomic Rank of Carica papaya Linn.

Rank	Classification
Kingdom	Plantae
Division	Magnoliophyta (Angiosperms)
Class	Magnoliopsida (Dicotyledons)
Order	Brassicales
Family	Caricaceae
Genus	Carica
Species	C. papaya
Botanical Name	Carica papaya Linn.

Ayurvedic Properties (Guna and Karma)[15,16]

Table No. 4: Guna and Karma of Carica papaya Linn.

Property	Description
Guna	Laghu, Ruksha
Ras	Tikta, Kashaya
Virya	Ushna
Vipaka	Katu
Karma	Deepana(appetizer),, Pachana(digestive), Krimighna(anthelmintic), Raktashodhaka(blood purifier), Shothahara (anti-inflammatory)., Vranaropaka(wound healing)

Classical Description[15]

"Papaya patram tikta-kashayam laghu ruksham ushna viryakam।

Deepanam pachanam krimighnam raktashodhakam smritam॥"

Papaya leaves possess bitter and astringent taste, light and dry qualities, hot potency, and are known for enhancing digestion, destroying intestinal worms, and purifying blood.

Botanical Description[17-20]

a. Macroscopic Characters

Leaf

Leaves are large, simple, alternate, and spirally arranged at the apex of the stem. They are

deeply palmately lobed with 5–11 lobes and borne on long, hollow petioles measuring 25–100 cm in length. The lamina is orbicular in outline, measuring about 25–75 cm in diameter, dark green on the upper surface and lighter green beneath. The leaf surface is smooth, glabrous, and prominently veined. The margins are deeply incised and lobed. The apex of each lobe is acute, while the base is cordate. The leaves exude a milky latex when injured and possess a characteristic odor with a slightly bitter taste.

Stem

The stem is erect, cylindrical, soft, succulent, and generally unbranched. It is hollow internally except at the nodes and may attain a height of 2–10 m. The outer surface is green in young plants and greyish-brown in mature plants, marked by prominent leaf scars. The stem contains abundant milky latex.

Root

The root system consists of a well-developed taproot with numerous lateral branches. Roots are cylindrical, brownish in color, rough externally, and contain latex canals. The fracture is short and fibrous with a characteristic odor.

Inflorescence

The plant is generally dioecious, although monoecious and hermaphrodite forms may occur. Flowers arise in the leaf axils. Male flowers are borne on long pendulous panicles, whereas female flowers are solitary or arranged in short clusters near the stem. Flowers are creamish-white to pale yellow and fragrant.

Fruit

The fruit is a large fleshy berry, varying from spherical to oblong or pear-shaped. Unripe fruits are green and contain abundant milky latex, while ripe fruits become yellow to orange. The pulp is succulent, sweet, and aromatic.

Seeds

Seeds are numerous, small, ovoid to spherical, black or dark brown in color, enclosed within a gelatinous aril. The seed coat is rough and reticulate.

b. Microscopic Characters

Leaf

Epidermis

The leaf shows distinct upper and lower epidermis covered by a thick cuticle. Epidermal cells are polygonal with sinuous anticlinal walls. Stomata are predominantly present on the lower epidermis and are of anomocytic type.

Mesophyll

The mesophyll is differentiated into palisade and spongy parenchyma. Palisade tissue consists of a single layer of elongated compact cells rich in chloroplasts. Spongy parenchyma is composed of loosely arranged cells with large intercellular spaces.

Vascular Bundle

The midrib region contains a prominent collateral vascular bundle surrounded by parenchymatous tissue. Xylem occupies the inner side while phloem is present externally.

Laticifers

Numerous articulated laticifers containing milky latex are distributed throughout the mesophyll and vascular regions, constituting a characteristic diagnostic feature of the leaf.

Calcium Oxalate Crystals

Prismatic and cluster crystals of calcium oxalate are observed scattered in mesophyll tissues.

Trichomes

Leaves are generally glabrous; however, occasional unicellular non-glandular trichomes may be present on young leaves.

MATERIALS AND METHODS

Plant Collection

The healthy and matured whole plants of Erandakarkati (Carica papaya.) were collected from the peripheries of Shri Ayurveda Mahavidyalaya, Nagpur, where it was growing abundantly. The plants matured leaves were collected and washed with clean water. The collected sample was cut into small pieces and was shed-dried at normal room temperature for four weeks. After complete drying, the sample was crushed into fine powder with the help of a mixture grinder. The obtained powdered sample of approximately 600 gm in weight was used for phytochemical and physicochemical analysis.

Preparation of Plant Solvents

For preparing the aqueous, ethanol, methanol, hydro-alcoholic, chloroform, and ether solvents, 5gm sample and 50 ml of each solvent were kept in conical flasks separately and was stirred vigorously for six hours then was kept for 18 hours. Then the mixture was filtered using filter paper for carrying out the phytochemical and physicochemical screening.

Phytochemical Analysis

The qualitative phytochemical analysis of the sample was carried out using six different solvents, viz., aqueous, ethanol, methanol, hydroalcoholic, chloroform, and ether, for the detection of carbohydrates, flavonoids, tannins, amino acids, starch, glycosides, steroids. triterpenoids, proteins, alkaloids, and saponin using standard phytochemical screening methods. Results are tabulated in table no.5.

1. Test for Carbohydrates (Molisch's test): A purple or violet ring appears at the junction on adding alcoholic a-naphthol and concentrated H_2SO_4 if carbohydrates are present.
2. Test for Flavonoids; Shinoda test: On adding magnesium turnings and concentrated HCl to the test solution, pink, scarlet, crimson red, or occasionally green to blue color appears after a few minutes.

Alkaline reagent test: With sodium hydroxide solution, an intense yellow color is formed, which turns colorless on adding a few drops of dilute HCl, indicating the presence of flavonoids.

Zinc hydrochloride test: To the test solution, add a mixture of zinc dust and concentrated HCl; it gives a red color after a few minutes.

3. Test for Tannins

Ferric chloride test: On adding ferric chloride solution, a green color appears if condensed tannins are present.

Lead acetate test: With lead acetate solution, the test solution gives a white precipitate, indicating the presence of tannins.

4. Test for Amino Acids (Ninhydrine test): Add ninhydrine to the test solution and boil; it gives a violet color if amino acids are present.

5. Test for Starch: By adding a weak iodine solution to the aqueous solvent, a blue color appears, indicating the presence of starch, which disappears on heating.

6. Test for Glycosides (Baljet's test): Orange color with picric acid indicates the presence of cardiac glycosides.

7. Test for Steroids and Triterpenoids: Libermann-Burchard test: After adding a few drops of acetic anhydride to the test solution, boil and add concentrated sulfuric acid on cooling. If the upper layer turns green, it shows the presence of steroids, and the formation of a deep red color indicates the presence of triterpenoids.

8. Test for Proteins (Xanthoproteic test): Treat the test solution with 1 ml concentrated nitric acid and boil; a yellow precipitate is formed, then add 40% sodium hydroxide solution; an orange color appears, confirming the protein's presence.

9. Test for Alkaloids: Mayer's test: Alkaloids gives a cream-colored precipitate with Mayer's reagent (potassium mercuric iodide).

Wagner's test: Alkaloids gives a reddish-brown precipitate with Wagner's reagent (iodine potassium iodide).

Hager's test: Alkaloids gives yellow precipitate with Hager's reagent (saturated solution of picric acid).

Tannic acid test: Alkaloids give a buff-colored precipitate with tannic acid solution.

10. Test for Saponins (Froth formation test): Add 2 ml of test solution in water in a test tube and shake well. If persistent froth (foam) is formed, it indicates the presence of saponin.

Physicochemical analysis

The physicochemical analysis helps in assessing the quality of the crude drugs. Biochemical variation, adulteration, substitution, effects of storage occurring in the drug can be tested. The foreign matter, moisture content / loss on drying, total ash, acid insoluble ash, water soluble ash, water soluble extractive and pH of the powdered sample were determined by using standard procedure mentioned in the context of the WHO guidelines for the assessment of herbal medicines. There guidelines provide a framework for ensuring the quality, safety and efficacy of herbal medicines. The reference values which is mentioned in API and the values obtained are tabulated in table no. 6.

RESULTS AND DISCUSSION

a. Phytochemical Analysis

Table No. 5: Phytochemical Analysis of Carica papaya Linn. Leaf in Different Solvents.

Phytochemicals	Test Performed	Aqueous	Ethanol	Methanol	Hydroalcoholic	Chloroform	Ether
Carbohydrate	Molisch's test	-	-	-	-	-	+
Flavonoid	Shinoda test	-	+	+	-	-	-
	Alkaline reagent test	-	+	+	-	-	+
	Zinc dust test	-	-	-	-	-	-
Tannin	Ferric chloride test	-	+	+	+	+	+
	Lead acetate test	+	+	+	+	-	-
Amino acid	Ninhydrin test	+	+	+	+	+	-
Starch	Iodine test	-	-	-	-	-	-
Glycoside	Baljet's test	+	-	-	-	-	-
Steroid	Libermann-Burchard test	Only brown ring form	-	-	+	-	
Triterpenoid	Libermann-Burchard test	-	+	+	-	+	-
Protein	Xanthoproteic test	+	-	-	+	+	+
Alkaloid	Mayer's test	+	+	+	+	+	-
	Wagner's test	+	+	+	+	+	-
	Hager's test	+	+	+	+	+	-
	Tannic acid test	-	+	+	+	-	-

Saponin Froth test +

(+ = Present, – = Absent)

DISCUSSION

The preliminary phytochemical screening of Carica papaya Linn. leaf poweder revealed the presence of various secondary metabolites in different solvent systems. The distribution of phytoconstituents varied according to the polarity of the solvents employed. Polar solvents such as aqueous, methanol, ethanol, and hydroalcoholic extracts generally exhibited a greater number of phytochemicals compared to non-polar solvents.

The presence of flavonoids, alkaloids, tannins, glycosides, proteins, amino acids, steroids, triterpenoids, and other phytoconstituents indicates the medicinal significance of Carica

papaya leaves. These phytochemicals are reported to possess antioxidant, anti-inflammatory, antimicrobial, hepatoprotective, immunomodulatory, and platelet-enhancing activities. The observed phytochemical profile supports the traditional use of Carica papaya in various therapeutic conditions and provides a scientific basis for its pharmacological potential.

The variation in phytochemical distribution among different extracts may be attributed to differences in solvent polarity and extraction efficiency. The results obtained in the present study can serve as a valuable reference for further phytochemical isolation, standardization, and pharmacological investigations of Carica papaya Linn.

b. Physicochemical Analysis

Table No. 6: Physicochemical Analysis of Carica papaya Linn. Leaf.

Parameters	Result (% w/w)	Standard Value (API/WHO)
Foreign Matter	1.5%	<2%
Moisture Content (Loss on Drying)	8%	10%
Total Ash	12%	15%
Acid Insoluble Ash	2.5%	-
Water Soluble Ash	7%	-
Alcohol Soluble Extractive	23%	-
Water Soluble Extractive	15%	-
pH	6%	-

DISCUSSION

The physicochemical parameters evaluated in the present study provide important information regarding the identity, purity, and quality of Carica papaya Linn. leaf. Parameters such as foreign matter, moisture content, ash values, extractive values, and pH are commonly used as quality control standards for herbal drugs.

The foreign matter content reflects the cleanliness and purity of the collected plant material. Loss on drying indicates the moisture content and helps assess the stability and storage quality of the crude drug. Ash values provide information regarding inorganic impurities and adulteration, while extractive values indicate the quantity of active constituents soluble in different solvents. The pH value gives an indication of the chemical nature and stability of the plant material.

The obtained physicochemical values establish preliminary quality control standards for Carica papaya Linn. leaves and may be useful for authentication, standardization, and future formulation development. The findings suggest that the analysed sample possesses acceptable

quality characteristics and can be considered suitable for further phytochemical and pharmacological studies.

CONCLUSION

The present study confirms that Carica papaya leaves possess significant phytochemical constituents and acceptable physicochemical properties.

The results provide essential data for the **standardization, quality control, and future development of herbal formulations**.

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