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Medicinal Value of *Carica Papaya*: From Traditional Use to Modern Science

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Abstract

Carica papaya (papaya) is a widely cultivated tropical fruit plant valued not only as a nutritional food but also as a potent medicinal resource in traditional and modern medicine. Different parts of the plant—including leaves, fruits, seeds, latex, and roots—have been used in Ayurveda, folk medicine, and ethnomedicine for treating digestive disorders, infections, inflammation, diabetes, dengue fever, and parasitic infestations. Scientific investigations have identified numerous bioactive phytoconstituents such as papain, chymopapain, flavonoids, alkaloids, phenolics, and carotenoids that contribute to its pharmacological properties. This chapter comprehensively reviews the ethnomedicinal background, phytochemistry, pharmacological activities, mechanisms of action, clinical evidence, safety profile, and future prospects of *Carica papaya*. The integration of traditional knowledge

with modern scientific validation highlights papaya as a promising candidate for nutraceutical and pharmaceutical development.

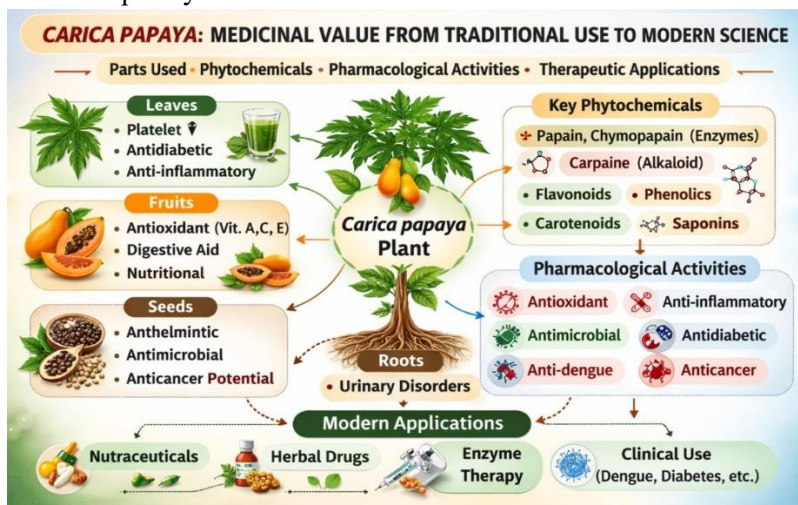
Keywords: *Carica papaya*, papain, ethnomedicine, phytochemistry, pharmacology, dengue, nutraceutical.

Introduction

Carica papaya Linn., commonly known as papaya or pawpaw, is an economically important tropical plant belonging to the family Caricaceae [2]. Native to Central America and now extensively cultivated in tropical and subtropical regions including India, papaya is valued both as a nutritious fruit and a versatile medicinal plant. For centuries, various parts of the plant—such as leaves, fruits, seeds, latex, and roots—have been utilized in Ayurveda, traditional African medicine, and other ethnomedical systems for the management of digestive disorders, parasitic infections, inflammation, wound healing, and febrile illnesses [1,19].

The growing global interest in plant-based therapeutics has prompted extensive scientific investigation into *Carica papaya*. Phytochemical studies have revealed the presence of important bioactive constituents, including proteolytic enzymes (papain and chymopapain), alkaloids (carpaine), flavonoids, phenolic compounds, and carotenoids [2,10]. These constituents are responsible for a wide spectrum of pharmacological activities such as antioxidant, anti-inflammatory, antimicrobial, antidiabetic, anthelmintic, and platelet-enhancing effects [6,10]. Notably, papaya leaf extract has gained considerable attention for its supportive role in dengue management [4,9].

Despite substantial traditional usage and promising experimental evidence, challenges related to standardization, dosage optimization, and clinical validation remain. Therefore, a systematic integration of traditional knowledge with modern scientific approaches is essential to fully exploit the therapeutic potential of *Carica papaya* in contemporary healthcare.



Botanical Description of *Carica papaya*

Table1: Botanical Parameters

Parameter	Description	Example / Notes
Scientific name	<i>Carica papaya</i> Linn.	Valid botanical name used in pharmacognosy
Family	Caricaceae	Small tropical family of flowering plants
Common names	Papaya, Pawpaw	Known as “Papita” in Hindi
Plant type	Fast-growing herbaceous tree	Soft, hollow, non-woody stem
Height	2–10 m	Typically ~3–5 m in cultivated fields
Stem	Erect, cylindrical, hollow, green	Bears leaf scars on surface
Leaves	Large, palmate, deeply lobed	50–70 cm diameter; long petiole
Flowers	Unisexual or bisexual, cream-white	Male and female flowers on separate plants (dioecious)
Fruit	Berry, oval to pear-shaped	Green when unripe, yellow-orange when ripe
Seeds	Numerous, black, mucilaginous	Pepper-like appearance
Latex	Milky white, rich in proteolytic enzymes	Contains papain and chymopapain



Figure 1. Morphological characteristics of *Carica papaya* Linn.

Labelled Parts Typically Include

- Whole plant habit
- Palmate leaf
- Flower
- Fruit (raw and ripe)
- Seeds
- Latex exudation

Traditional and Ethnomedicinal Uses

Papaya has a long history in Ayurveda, traditional African medicine, and Latin American folk medicine [1,19]. *Carica papaya* has been widely used in traditional and ethnomedicinal systems across tropical regions. The leaves are commonly employed in Ayurveda and Sri Lankan practice to manage dengue fever, malaria, and diabetes due to their perceived immunomodulatory and antipyretic effects [4,9]. Unripe fruit is valued as a digestive aid and anthelmintic because of its rich papain content [2]. Ripe fruit serves as a nutritive tonic and mild laxative globally [10]. Seeds exhibit anthelmintic and antibacterial properties in African folk medicine [7,14]. The latex is traditionally applied for wound debridement and healing, while roots are used in folk remedies for urinary disorders [1].

Table 2. Traditional Uses of Different Parts of *Carica papaya*

Plant Part	Traditional Use	Region/System
Leaves	Dengue fever, malaria, diabetes	Ayurveda, Sri Lanka, India
Unripe fruit	Digestive aid, anthelmintic	Ayurveda
Ripe fruit	Laxative, nutritive tonic	Global
Seeds	Anthelmintic, antibacterial	African folk medicine
Latex	Wound healing, debridement	Traditional medicine
Roots	Urinary disorders	Folk medicine

Phytochemical Constituents

Papaya contains a rich array of primary and secondary metabolites responsible for its pharmacological effects.

Carica papaya is rich in diverse phytochemicals that contribute to its therapeutic potential. The latex and unripe fruit contain proteolytic enzymes such as papain and chymopapain, which aid digestion and wound debridement [2]. Leaves are a significant source of the alkaloid carpaine along with flavonoids like quercetin and kaempferol, known for antioxidant activity [15]. Phenolic acids including caffeic and ferulic acid further enhance free-radical scavenging [17]. Ripe fruit is abundant

in carotenoids (β -carotene, lycopene) and vitamins C, A, and E, supporting nutritional value [10]. Seeds contain saponins and glucosinolates such as benzyl isothiocyanate, associated with antimicrobial and anthelmintic effects [7,12].

Table 3. Major Phytoconstituents of *Carica papaya*

Class	Compounds	Plant Part
Proteolytic enzymes	Papain, chymopapain	Latex, fruit
Alkaloids	Carpaine	Leaves
Flavonoids	Quercetin, kaempferol	Leaves, fruit
Phenolics	Caffeic acid, ferulic acid	Leaves
Carotenoids	β -carotene, lycopene	Ripe fruit
Vitamins	Vitamin C, A, E	Fruit
Saponins	Various	Seeds
Glucosinolates	Benzyl isothiocyanate	Seeds

Pharmacological Activities

1. Antioxidant Activity

Papaya exhibits strong antioxidant potential due to flavonoids, vitamin C, and carotenoids [17]. *Carica papaya* demonstrates potent antioxidant activity attributed mainly to its rich content of flavonoids (quercetin, kaempferol), vitamin C, and carotenoids such as β -carotene and lycopene. These phytoconstituents neutralize reactive oxygen species (ROS) through multiple mechanisms. Primarily, papaya extracts act as effective free radical scavengers, donating electrons to stabilize DPPH and other radicals. In addition, the plant inhibits lipid peroxidation, thereby protecting cellular membranes from oxidative damage. Another important mechanism is the upregulation of endogenous antioxidant defense systems, including superoxide dismutase (SOD), catalase, and glutathione peroxidase.

In vitro studies have demonstrated that papaya leaf extract exhibits significant DPPH radical scavenging activity comparable to ascorbic acid, indicating strong antioxidant potential. Collectively, these actions suggest that *C. papaya* may help mitigate oxidative stress-related disorders such as inflammation, cardiovascular diseases, and metabolic complications.

Mechanism

- Free radical scavenging
- Lipid peroxidation inhibition
- Enhancement of endogenous antioxidant enzymes

Example

Papaya leaf extract showed significant DPPH radical scavenging activity comparable to ascorbic acid in in-vitro studies.

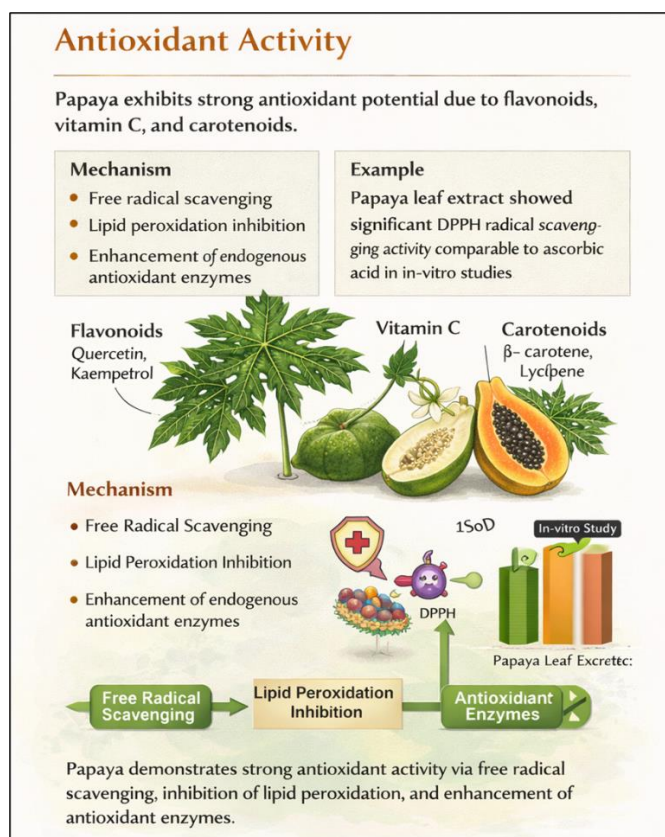


Fig. 2: Antioxidant Activity

2. Antidiabetic Activity

Carica papaya leaf extract has shown promising antidiabetic potential in various experimental studies [8]. The hypoglycemic effect is primarily attributed to its rich phytochemical profile, including flavonoids, alkaloids (carpaine), phenolics, and antioxidants. One of the key proposed mechanisms is the enhancement of insulin secretion from pancreatic β -cells. Bioactive constituents may stimulate surviving β -cells or improve their functional capacity, thereby promoting better glucose utilization.

Another important mechanism is the protection of pancreatic β -cells against oxidative stress-induced damage. Diabetes, particularly when induced by agents such as streptozotocin (STZ), is associated with β -cell destruction mediated by free radicals. The antioxidant constituents of papaya help neutralize reactive oxygen species, preserving pancreatic architecture and function.

Additionally, papaya leaf extract has been reported to inhibit intestinal α -glucosidase activity. This enzyme is responsible for the breakdown of complex carbohydrates into glucose. Its inhibition delays glucose absorption in the intestine, thereby reducing postprandial hyperglycemia.

Experimental evidence supports these mechanisms. In streptozotocin-induced diabetic rat models, administration of papaya leaf extract resulted in a significant reduction in fasting blood glucose levels compared with untreated diabetic controls. Some studies also reported improvements in lipid profile and body weight.

Overall, these findings suggest that *C. papaya* leaf extract possesses multifactorial antidiabetic activity and may serve as a promising adjunct in the management of diabetes mellitus, although well-controlled clinical studies are still required for confirmation.

Proposed mechanisms:

- Enhancement of insulin secretion
- Protection of pancreatic β -cells
- Inhibition of α -glucosidase

Example

Streptozotocin-induced diabetic rats treated with papaya leaf extract showed significant reduction in blood glucose levels [8].



Fig.3: Antidiabetic Activity

3. Anti-Dengue (Platelet Enhancing) Activity

Carica papaya leaf extract has attracted clinical interest for managing dengue-associated thrombocytopenia [4,9]. Its platelet-enhancing effect is linked to multiple mechanisms, including upregulation of platelet production genes such as ALOX12 and PTAFR, which promote megakaryopoiesis. Phytoconstituents like flavonoids and phenolics also stabilize platelet membranes, protecting them from oxidative damage and premature destruction. Additionally, the extract exhibits immunomodulatory and antioxidant activities that support hematological recovery during dengue infection. Small clinical studies report increased platelet counts within 24–72 hours after papaya leaf juice administration [4]. However, larger randomized controlled trials are still required to confirm definitive efficacy and safety.

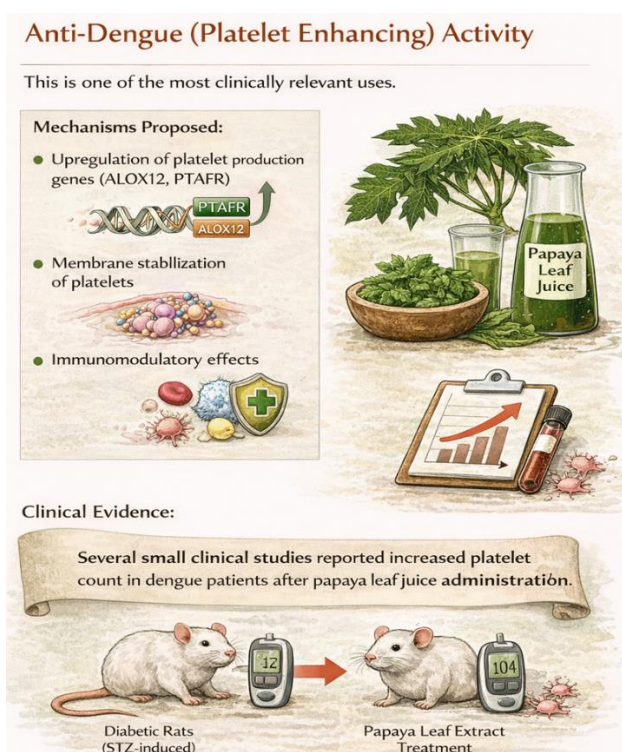


Fig.4: Anti-Dengue (Platelet Enhancing) Activity

4. Antimicrobial Activity

Carica papaya extracts possess notable antimicrobial activity against a wide range of bacteria, fungi [7,13], and certain parasites. This activity is mainly attributed to key phytoconstituents such as benzyl isothiocyanate, flavonoids, phenolic compounds, and the proteolytic enzyme papain. These bioactive molecules act through multiple complementary mechanisms, making papaya a promising natural antimicrobial source.

Benzyl isothiocyanate, predominantly present in papaya seeds, exhibits strong bactericidal and fungicidal properties. It disrupts microbial cell membranes, increases permeability, and interferes with essential enzymatic systems required for microbial survival. Flavonoids contribute by generating oxidative stress within microbial cells and inhibiting nucleic acid synthesis, thereby suppressing microbial growth and replication. Papain enhances antimicrobial effects by hydrolyzing structural proteins on microbial surfaces, weakening cell integrity and facilitating pathogen destruction.

Experimental studies have demonstrated significant inhibitory activity of papaya extracts against several clinically important pathogens. Notably, activity has been reported against *Escherichia coli*, a common Gram-negative bacterium responsible for gastrointestinal infections, and *Staphylococcus aureus*, a Gram-positive pathogen associated with skin, wound, and systemic infections. Antifungal efficacy has also been observed against *Candida albicans*, an opportunistic yeast causing candidiasis.

The synergistic interaction of these phytochemicals contributes to the broad-spectrum antimicrobial profile of *C. papaya*. Nevertheless, further standardization, toxicity evaluation, and well-designed clinical trials are required to establish its therapeutic applicability in modern medicine [7,13].

Active components: benzyl isothiocyanate, flavonoids, papain.

Example Organisms Affected

- *Escherichia coli*
- *Staphylococcus aureus*
- *Candida albicans*

5. Anti-Inflammatory Activity

Carica papaya leaf and fruit extracts exhibit significant anti-inflammatory activity supported by both experimental and phytochemical evidence [11]. The activity is mainly attributed to the presence of flavonoids, phenolic compounds, vitamins (especially vitamin C), and alkaloids such as carpaine. These constituents act through multiple pathways to suppress inflammatory responses.

One major mechanism involves inhibition of cyclooxygenase (COX) enzymes, particularly COX-2, which play a key role in the biosynthesis of pro-inflammatory prostaglandins. By reducing prostaglandin formation, papaya extracts help decrease classical signs of inflammation such as pain, swelling, and redness.

Another important mechanism is the downregulation of pro-inflammatory cytokines including tumor necrosis factor-alpha (TNF- α), interleukin-1 beta (IL-1 β), and interleukin-6 (IL-6). The antioxidant components of papaya neutralize reactive oxygen species that normally trigger cytokine release, thereby interrupting the inflammatory cascade.

Papaya extracts also stabilize lysosomal membranes, preventing the release of proteolytic enzymes that contribute to tissue damage during inflammation. This membrane-stabilizing property further protects cells and reduces edema formation [11].

Experimental studies in animal models have demonstrated significant reduction in paw edema and inflammatory markers following administration of papaya leaf or fruit extracts. Collectively, these mechanisms suggest that *C. papaya* possesses promising natural anti-inflammatory potential and may be useful as an adjunct in managing inflammatory disorders, although more controlled clinical studies are needed.

Mechanisms

- COX inhibition
- Reduction of pro-inflammatory cytokines
- Stabilization of lysosomal membranes

6. Anthelmintic Activity

Carica papaya seeds have long been used in traditional medicine as a natural anthelmintic for the treatment of intestinal worm infestations [14]. The anthelmintic activity is primarily attributed to the presence of proteolytic enzymes (such as papain) and bioactive compounds like benzyl isothiocyanate. These constituents act synergistically to impair parasite survival.

One important mechanism involves the proteolytic degradation of the parasite cuticle. Papain and related enzymes digest structural proteins present on the surface of helminths, leading to loss of integrity, paralysis, and eventual death of the worms. This enzymatic action weakens the parasite and facilitates its expulsion from the gastrointestinal tract [14].

Additionally, benzyl isothiocyanate present in papaya seeds exhibits direct toxic effects on helminths. It disrupts metabolic processes and membrane function within the parasite, further enhancing anthelmintic efficacy.

Experimental studies support these traditional claims. Papaya seed powder and extracts have shown significant activity against *Ascaris lumbricoides* and other intestinal worms in in vitro and in vivo models.

Overall, *C. papaya* seeds represent a promising plant-based anthelmintic agent. However, standardized dosing, safety evaluation, and clinical validation are still required for routine therapeutic use [14].

Mechanism

- Proteolytic degradation of parasite cuticle
- Benzyl isothiocyanate toxicity to helminths

Example

Papaya seed powder showed significant activity against *Ascaris lumbricoides* in experimental models.

7. Anticancer Potential

Carica papaya has attracted research interest for its potential anticancer properties. Various in vitro studies indicate that papaya leaf and fruit extracts exhibit cytotoxic effects against several cancer cell lines [3,6]. The activity is largely attributed to flavonoids, phenolic compounds, alkaloids, and carotenoids present in the plant.

One major mechanism is the induction of apoptosis (programmed cell death) in malignant cells through activation of caspase pathways and mitochondrial dysfunction. Papaya constituents have also been reported to cause cell cycle arrest, particularly at the G0/G1 or G2/M phases, thereby inhibiting uncontrolled cancer cell proliferation. In addition, strong antioxidant activity helps protect normal cellular DNA from oxidative damage while selectively affecting tumor cells.

Experimental evidence shows that papaya leaf extract significantly inhibited the growth of breast and liver cancer cell lines. However, further in vivo studies and clinical trials are necessary to confirm its therapeutic potential [3].

Mechanisms

- Induction of apoptosis
- Cell cycle arrest
- Antioxidant-mediated DNA protection

Example

Papaya leaf extract demonstrated growth inhibition in breast and liver cancer cell lines.

Clinical Evidence

Table 4. Selected Clinical and Preclinical Studies

Study Type	Preparation	Indication	Key Outcome
Clinical trial	Papaya leaf juice	Dengue	Increased platelet count
Animal study	Leaf extract	Diabetes	Reduced blood glucose
In vitro	Seed extract	Antibacterial	Inhibited <i>E. coli</i>
Animal study	Latex papain	Wound healing	Faster epithelialization

Mechanism of Action

Papaya exerts therapeutic effects through multiple pathways [2,6,10].

- Enzymatic proteolysis → digestive and anthelmintic effects

- Antioxidant defense → anti-aging and cytoprotection
- Immunomodulation → antiviral and anti-dengue action
- Metabolic regulation → antidiabetic effect
- Anti-inflammatory signaling suppression → pain and inflammation relief

Safety and Toxicity

Although generally safe as food, medicinal use requires caution [10,19].

Potential Adverse Effects

- Latex allergy
- Gastrointestinal irritation (high doses of seeds)
- Possible uterotonic effect of unripe fruit latex (avoid in pregnancy)

Table 5. Toxicity summary

Part	Safety Note
Ripe fruit	Generally safe
Leaf extract	Safe in moderate doses
Seeds	High doses may cause toxicity
Latex	May cause allergy

Modern Formulation Approaches

Recent pharmaceutical research focuses on:

- Papaya leaf tablets/capsules
- Standardized extracts
- Papain enzyme formulations
- Nanoformulations (emerging)
- Herbal syrups for dengue support [10].

Example: Spray-dried papaya leaf powder for improved stability and dosing accuracy.

Discussion

The medicinal potential of *Carica papaya* represents a successful bridge between traditional knowledge and modern pharmacological validation. Ethnomedicinal claims—particularly for digestive disorders, helminth infections, and febrile illnesses—are strongly supported by phytochemical and experimental studies. The presence of proteolytic enzymes such as papain provides a clear biochemical basis for many therapeutic effects.

However, despite promising preclinical data and some clinical evidence (notably in dengue management), several limitations remain. Most clinical studies are small,

lack standardization of extracts, and vary in dosage forms. There is also insufficient long-term safety data for concentrated leaf and seed preparations.

Future research should emphasize:

- Large randomized clinical trials
- Standardization of active markers
- Mechanistic molecular studies
- Advanced drug delivery systems
- Toxicological profiling

Integration into evidence-based phytotherapy requires rigorous quality control and regulatory compliance.

Conclusion

Carica papaya is a multifunctional medicinal plant with significant therapeutic potential supported by both traditional use and modern scientific evidence. Its rich phytochemical profile—particularly papain, flavonoids, and alkaloids—contributes to diverse pharmacological activities including antioxidant, antidiabetic, anti-dengue, antimicrobial, anti-inflammatory, and anthelmintic effects.

While current evidence is promising, especially for dengue supportive therapy and digestive health, further well-designed clinical studies and standardized formulations are essential for full pharmaceutical exploitation. With proper validation and formulation development, *Carica papaya* holds strong promise as a nutraceutical and phytopharmaceutical agent in modern healthcare.

References

1. Aravind, G., Bhowmik, D., Duraivel, S., & Harish, G. (2013). Traditional and medicinal uses of *Carica papaya*. *Journal of Medicinal Plants Studies*, 1(1), 7–15.
2. Krishna, K. L., Paridhavi, M., & Patel, J. A. (2008). Review on nutritional, medicinal and pharmacological properties of *Carica papaya*. *Natural Product Radiance*, 7(4), 364–373.
3. Otsuki, N., Dang, N. H., Kumagai, E., Kondo, A., Iwata, S., & Morimoto, C. (2010). Aqueous extract of *Carica papaya* leaves exhibits anti-tumor activity. *Journal of Ethnopharmacology*, 127(3), 760–767. <https://doi.org/10.1016/j.jep.2009.11.024>
4. Subenthiran, S., Choon, T. C., Cheong, K. C., et al. (2013). *Carica papaya* leaf juice significantly accelerates platelet count increase among dengue patients. *Evidence-Based Complementary and Alternative Medicine*, 2013, 616737. <https://doi.org/10.1155/2013/616737>
5. Imaga, N. O. A., Gbenle, G. O., Okochi, V. I., et al. (2009). Antisickling property of *Carica papaya* leaf extract. *African Journal of Biochemistry Research*, 3(4), 102–106.

6. Nguyen, T. T., Shaw, P. N., Parat, M. O., & Hewavitharana, A. K. (2013). Anticancer activity of *Carica papaya*: A review. *Molecular Nutrition & Food Research*, 57(1), 153–164. <https://doi.org/10.1002/mnfr.201200388>
7. Kaur, G. J., & Arora, D. S. (2009). Antibacterial and phytochemical screening of *Carica papaya* seed extract. *Journal of Medicinal Plants Research*, 3(4), 306–311.
8. Adeneye, A. A., & Olagunju, J. A. (2009). Preliminary hypoglycemic and hypolipidemic activities of aqueous seed extract of *Carica papaya*. *Biology and Medicine*, 1(1), 1–10.
9. Charan, J., Saxena, D., Goyal, J. P., & Yasobant, S. (2016). Efficacy and safety of *Carica papaya* leaf extract in dengue: A systematic review and meta-analysis. *International Journal of Applied and Basic Medical Research*, 6(4), 249–254. <https://doi.org/10.4103/2229-516X.192596>
10. Alara, O. R., Abdurahman, N. H., & Alara, J. A. (2022). *Carica papaya*: A comprehensive review of nutritional values, phytochemicals and pharmacological activities. *Advances in Traditional Medicine*, 22, 17–47. <https://doi.org/10.1007/s13596-020-00485-4>
11. Owoyele, B. V., Adebukola, O. M., Funmilayo, A. A., & Soladoye, A. O. (2008). Anti-inflammatory activities of ethanolic extract of *Carica papaya* leaves. *Inflammopharmacology*, 16(4), 168–173. <https://doi.org/10.1007/s10787-007-0011-5>
12. Nwofia, G. E., Ojmelukwe, P., & Eji, C. (2012). Chemical composition of leaves, fruit pulp and seeds in some *Carica papaya* genotypes. *International Journal of Medicinal and Aromatic Plants*, 2(1), 200–206.
13. Emeruwa, A. C. (1982). Antibacterial substance from *Carica papaya* fruit extract. *Journal of Natural Products*, 45(2), 123–127. <https://doi.org/10.1021/np50020a002>
14. Baskaran, C., Ratha Bai, V., Velu, S., & Kumaran, K. (2012). The efficacy of *Carica papaya* seed extract on helminth parasites. *Journal of Pharmaceutical Research*, 5(1), 190–192.
15. Canini, A., Alesiani, D., D’Arcangelo, G., & Tagliatesta, P. (2007). Gas chromatography–mass spectrometry analysis of phenolic compounds from *Carica papaya* L. leaf. *Journal of Food Composition and Analysis*, 20(7), 584–590. <https://doi.org/10.1016/j.jfca.2007.03.009>
16. Mohanapriya, G., Ramaswamy, L., & Rajendran, R. (2013). Health and medicinal properties of *Carica papaya*: A review. *Journal of Medicinal Plants Research*, 7(32), 2348–2357.
17. Maisarah, A. M., Amira, B. N., Asmah, R., & Fauziah, O. (2013). Antioxidant analysis of different parts of *Carica papaya*. *International Food Research Journal*, 20(3), 1043–1048.

18. Nisar, M. F., et al. (2011). Nutritional and therapeutic perspectives of *Carica papaya* Linn. *Asian Pacific Journal of Tropical Biomedicine*, 1(4), 330–333. [https://doi.org/10.1016/S2221-1691\(11\)60055-2](https://doi.org/10.1016/S2221-1691(11)60055-2)
19. Yogiraj, V., Goyal, P. K., Chauhan, C. S., Goyal, A., & Vyas, B. (2014). *Carica papaya* Linn.: An overview. *International Journal of Herbal Medicine*, 2(5), 1–8.
20. Pham, H. T., et al. (2024). Immunomodulatory and platelet-enhancing effects of *Carica papaya* leaf extract. *Viruses*, 17(2), 271. <https://doi.org/10.3390/v17020271>