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Review Article

## A REVIEW ON PHARMACOLOGICAL ACTIVITY OF CARICA PAPAYA

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Article History	Abstract
Received: 19-07-2025 Revised: 04-08-2025 Accepted: 28-08-2025	<p>Carica papaya L., commonly known as papaya, is a tropical plant widely recognized for its diverse pharmacological properties. Various parts of the plant, including leaves, fruits, seeds, and latex, contain bioactive compounds such as alkaloids, flavonoids, saponins, phenolics, vitamins, carotenoids, and proteolytic enzymes like papain. These constituents contribute to a broad spectrum of therapeutic activities. Papaya exhibits antioxidant properties by scavenging free radicals, protecting cells from oxidative stress, and enhancing the activity of antioxidant enzymes. Its anti-diabetic activity involves regulation of blood glucose levels, improvement of insulin function, and protection of pancreatic beta cells. The plant also demonstrates anti-cancer, anti-malarial, anti-dengue, anti-inflammatory, and immunomodulatory effects, as well as anthelmintic and anti-amoebic activities, making it useful against parasitic infections. Evaluation tests, including macroscopic, microscopic, physicochemical, phytochemical, and modern analytical techniques, ensure the quality, purity, and standardization of papaya extracts.</p>
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<b>Keywords:</b> Antioxidant, Anti-Inflammatory, Carica Papaya, Modern Analytical Techniques.	

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### Introduction

The word Pharmacognosy comes from two Greek words: Pharmakon meaning drug or medicine, and Gnosis meaning knowledge. It is the study of drugs that come from natural sources. Pharmacognosy involves studying the physical, chemical, biochemical, and biological properties of natural drugs. It also includes the search for new medicines from nature. Pharmacognosy teaches us about the medicinal uses of natural drugs, their history, sources, and distribution. It also explains how plants are cultivated, what active compounds they contain, how to test and identify them, how they are preserved, and how substitutes or adulterants are detected. Plant preparations used for health purposes are called medicinal or herbal.

The study of drugs from plants covers three main fields: botany, which deals with plant identification, genetics, and cultivation; chemistry, which focuses on isolating, identifying, and measuring plant chemicals; and pharmacology, which studies the effects of these chemicals on cells, animals, and humans. Pharmacognosy also checks

three key aspects of drugs: their quality (identity, purity, and consistency), efficacy (how well they work), and safety (possible side effects, interactions, and precautions) [1].

### Crude Drugs

Crude drugs are natural substances obtained from plants, animals, minerals, marine life, or microorganisms. They are mostly used in their natural form, with only simple processing like drying or size reduction. These drugs are natural products that are not modified or improved by any artificial process. Proper packaging and storage are very important to prevent spoilage and to keep their medicinal value intact. Pharmacognosy is the scientific study of drugs that come from natural sources such as plants, animals, and microorganisms. It also studies other useful compounds made from these sources. The subject includes learning about the history, distribution, and cultivation of natural substances, as well as their collection, preparation, identification, and evaluation. Pharmacognosy explains

how these natural products are used for treatment and focuses on their physical, chemical, biochemical, and biological properties.

The word Pharmacognosy comes from the Greek language. Pharmakon means drug, and gignosco means to acquire knowledge. Together, the term simply means “gaining knowledge about drugs. Pharmacognosy is the study of natural drugs in their raw form. It is a branch of Pharmacology, which is the science of medicines. Pharmacology itself includes different areas: Pharmacognosy, which deals with crude or raw drugs; Pharmacy, which is the preparation of drugs for medical use; and Pharmacodynamics, which studies the effects of drugs on living organisms. Pharmacognosy mainly focuses on drugs obtained from plants and animals, studying their botany, chemistry, and origin. Drugs made by artificial chemical processes such as salts, acids, or alkalis are usually not included, since most of the substances studied in pharmacognosy are of natural origin. In the case of plants, pharmacognosy examines their habitat, features, position in the plant kingdom, and the specific parts of the plant used as medicine. The word Pharmacognosy comes from the Greek terms Pharmakon, meaning drug or medicine, and Gnosis or Gignosis, meaning knowledge or to acquire knowledge. Therefore, Pharmacognosy means knowledge of drugs. It is the science of studying crude drugs using proper scientific methods. This field mainly deals with natural products obtained from plants, animals, and minerals. Pharmacognosy not only studies these substances but also looks into their history, distribution, cultivation, collection, preparation, identification, evaluation, and preservation [2]. It also covers the history of natural products in medicine, their value and importance, their production, and their role in the discovery of new drugs.

### **Importance of Pharmacognosy**

Pharmacognosy is very important in medicine because it plays a major role in the discovery and preparation of new medicines. Many crude or raw drugs are directly used in making medicines, and about 80% of people in the world still rely on crude drugs and folk medicine. The demand for herbal drugs is growing worldwide, which shows the wide scope of pharmacognosy in pharmacy.

### **Cultivation of Medicinal Plants**

India imports many medicinal plants, but if these plants are cultivated within the country, it can save foreign money and support national development. Cultivation is also necessary to meet industrial demand for certain plants such as Mentha, Sandalwood, Isabgol, and Tulsi.

### **Analysis of Phytochemicals**

Pharmacognosy also focuses on isolating bioactive molecules from crude drugs. These molecules are tested and analyzed using modern scientific methods such as chromatography.

### **Preparation of Tonics and Stimulants**

Modern medicine is not always effective in curing every disease, and in such cases crude drugs play an important role. Diseases like liver problems, arthritis, cancer, and AIDS can be managed with the help of natural medicines. Ayurvedic drugs such as Liv-52, Livomin, Ginseng, Tulsi, Ashwagandha, and Brahmi are widely used as tonics and stimulants [3].

### **Steroid Industry**

Pharmacognosy also supports the steroid industry, where plants like Dioscorea are used to prepare steroid-based medicines. These medicines include sex hormones, contraceptives, and corticosteroids.

### **Herbal Preparation**

Herbal medicines are becoming more popular because they are cheap, easily available, effective, and have fewer side effects compared to synthetic drugs. An example is Adhatodavasica, which is widely used in herbal treatments. From old times, people used plants and animals not only as food but also as medicine, as they helped to cure sickness and were called “drugs.” Many great scholars studied about medicines; in India, Charak and Sushruta wrote important books on Ayurveda, while Hippocrates, known as the “Father of Medicine,” contributed greatly to medical knowledge. Aristotle studied animals and plants, and Dioscorides wrote the famous book *De Materia Medica* about useful plants. Galen further explained how to prepare medicines from natural sources. All these records of natural medicines were collected in a big work called *Materia Medica*.<sup>4</sup> Ayurveda, the Indian system of medicine, began thousands of years ago and still hold great importance today.

### **History And Development of Pharmacognosy**

Pharmacognosy is the study of drugs discovered from natural products, which are important sources of medicines used for the prevention and treatment of diseases. Among natural sources, plants are the main and better source for drug discovery. The word “Pharmacognosy” comes from the Greek words Pharmakon meaning drug and Gnosis meaning knowledge, so it means “knowledge of drugs.” This term was first used by C.A. Seydler. In 77 AD, the Greek physician Dioscorides wrote the famous book *De Materia Medica*, which described about 600 crude drugs and became an important reference in pharmacology and botany. In 1815, the German scientist C.A. Seydler first used the word “pharmakognosie” in his book *Analecta Pharmacognostica*, and he is known as the father of pharmacognosy. Earlier, the Greek pharmacist Galen (131–200 A.D.) worked on extracting chemicals from plants and developed many methods of extraction, which led to the branch of pharmacy called Galenical Pharmacy. Hippocrates (460–360 B.C.), known as the father of medicine, studied human anatomy and physiology, especially the circulatory and

nervous systems, and wrote books for physicians that are still valued today. In India, the history of pharmacognosy is about 5500 years old, with medicinal plants described in the Rigveda and Atharvaveda. Ancient Ayurvedic texts like Charaka Samhita and Sushruta Samhita also recorded the properties and uses of many medicinal plants. Pharmacognosy is the study of drugs discovered from natural products, which are important sources of medicines used for the prevention and treatment of diseases. Among natural sources, plants are the main and better source for drug discovery. The word "Pharmacognosy" comes from the Greek words Pharmakon meaning drug and Gnosis meaning knowledge, so it means "knowledge of drugs." This term was first used by C.A. Seydler. In 77 AD, the Greek physician Dioscorides wrote the famous book *De Materia Medica*, which described about 600 crude drugs and became an important reference in pharmacology and botany. Pharmacognosy, often called the mother of all sciences, has a history closely connected with pharmacy and medicine.<sup>5</sup> In every community, certain people became skilled at finding, testing, and using medicinal plants to treat diseases, and this knowledge was passed down secretly through generations. Long before the Christian era, plants were used as medicine in China, India, Egypt, and Greece. The oldest known herbal book, *Pentaseo* by Shen Nung, was written around 3000 B.C. Le'mary emphasized the importance of extraction methods, noting that alcohol is the best solvent. In the early 19th century, Derosene (1803) extracted the alkaloid narcotine from opium, and Sertürner (1806) isolated morphine from opium. Reimann discovered nicotine from tobacco, and other important compounds like ergometrine, reserpine, quinine, and quinidine were identified. During the 19th century, the study of natural drugs was known as *Materia Medica*, which later became modern pharmacognosy.



Figure 01: *Carica papaya*

Pharmacognosy began in ancient times, with medicines used in Egypt and India. The Papyrus Ebers of Egypt recorded 700 drugs and 800 formulas, while Dioscorides wrote a book describing 600 crude drugs. In India, Charaka grouped 50 sets of 10 herbs, and Sushruta listed

760 herbs in 7 sets, forming part of Ayurveda, the Indian system of medicine. Pliny in Rome wrote about 1,000 plant species, and knowledge of medicines was gained through the senses and experience. In early modern times (1815–1930), C.A. Seydler first used the word "pharmacognosy." Key discoveries included Derosne isolating narcotine from opium in 1803, and Sertürner isolating morphine in 1806, while also showing that cells are the basic unit of plants. Chemistry methods, fluorescence, and chromatography were used to study crude drugs, and pharmacognosy became an independent subject. Increased international trade expanded the variety of medicines available. Modern pharmacognosy has led to the discovery of strong drugs like digitalis, belladonna, rauwolfia, and morphine from plants. Cardiac glycosides require a lactone ring for activity, while anthraquinone glycosides are active only if certain structural positions are satisfied. Methyl ergometrine shows stronger oxytocic activity than ergometrine, and steroid hormones can be synthesized from diosgenin. Morphine serves as a model for pain-relieving drugs, cocaine is used as a local anesthetic, atropine helps relieve spasms, and dicoumarol acts as an anticoagulant.<sup>6</sup> Natural substances such as antibiotics, steroids, and alkaloids remain important, and biosynthetic pathways in plants, including the Calvin cycle, shikimic acid pathway, and isoprenoid pathway, explain how these useful chemicals are produced.

### Phytochemistry

Phytochemistry is the branch of science that deals with the study of chemical compounds produced by plants. These compounds are usually called plant metabolites and are divided into two groups: primary metabolites and secondary metabolites. Primary metabolites, such as sugars, amino acids, and lipids, are essential for plant growth and development. Secondary metabolites, on the other hand, are not directly involved in growth but play a vital role in the survival of plants. They help plants protect themselves from harmful insects, pests, pathogens, herbivores, ultraviolet radiation, and environmental stress. Although these compounds are made for plant defense, they are also very important for humans because many of them have medicinal properties. Medicinal plants have been used since ancient times to cure various illnesses. Modern research has now confirmed that the healing properties of these plants come mainly from their phytochemical constituents. These phytochemicals are biologically active and naturally occurring compounds that provide health benefits. They can reduce the risk of chronic diseases like cancer, diabetes, and cardiovascular problems. They also show properties such as antioxidant, anti-inflammatory, antibacterial, antiviral, and anticancer effects. Because of these multiple benefits, phytochemicals are now seen as valuable resources for both preventive and therapeutic medicine [7]. There are thousands of phytochemicals present in nature, and more than 4,000

have already been identified by scientists. They are widely distributed in fruits, vegetables, legumes, grains, herbs, and spices. For example, garlic, ginger, turmeric, grapes, green tea, soybeans, broccoli, and carrots are common foods rich in phytochemicals. These compounds are usually found in specific parts of plants, such as seeds, roots, stems, leaves, flowers, or fruits. The levels of phytochemicals may vary depending on the variety of plant, its growing conditions, and how it is processed or stored. Because of their wide occurrence, it is possible to get a large variety of phytochemicals just by following a plant-based diet.

Phytochemicals are classified into several important groups, including alkaloids, terpenoids, flavonoids, tannins, saponins, and phenolic compounds. Each group has unique characteristics and health benefits. Alkaloids are nitrogen-containing compounds, many of which are used as medicines. For example, morphine is a strong pain reliever, and quinine is used to treat malaria. Terpenoids have many pharmacological activities, such as anticancer, anti-inflammatory, antiviral, and antibacterial effects. Flavonoids are well-known antioxidants found in fruits and vegetables; they protect the body's cells from oxidative damage. Phenolic compounds also have antioxidant and anti-aging effects. These examples show that phytochemicals are not only useful to plants but are also powerful agents for human health. Recent studies have shown that phytochemicals play a role in modulating the immune system, preventing DNA damage, regulating hormones, and supporting detoxification processes in the body. Some phytochemicals can even stop the growth of cancer cells or block harmful enzymes. Others improve cardiovascular health by lowering cholesterol and blood pressure. Because of such wide-ranging benefits, phytochemicals are sometimes called "bioactive compounds." They are biologically active in small amounts, and their effects go beyond basic nutrition. Unlike proteins, fats, and carbohydrates, which are needed in large amounts for energy and growth, phytochemicals work in smaller amounts to maintain health and prevent disease [8].

Table 01: Phytoconstituents of *Carica papaya*

Class of Phytoconstituents	General Role in Plants	Pharmacological / Industrial Importance	Examples
Alkaloids	Defense against herbivores, bitter taste deterrent	Anticancer, analgesic, antimicrobial	Morphine, Vinblastine, Quinine
Phenolics (incl.	Protection	Antioxidant, anti-	Quercetin, Resveratrol

flavonoids, tannins)	against UV radiation, pathogens	inflammatory, cardioprotective	ol, Tannic acid
<b>Terpenoids</b>	Aroma, plant growth regulation, stress tolerance	Anticancer, antimicrobial, insecticidal	Taxol (Paclitaxel), Menthol, Artemisinin
<b>Glycosides</b>	Plant defense, storage forms of active molecules	Cardiotonic, laxative, anticancer	Digoxin, Sennosides
<b>Saponins</b>	Defense against microbes, deter herbivory (soap-like foaming)	Antifungal, cholesterol-lowering, immunostimulant	Diosgenin, Ginsenosides
<b>Endophytic metabolites</b> (from fungi/bacteria)	Symbiotic benefits, stress tolerance	Alternative sources of bioactive drugs	Paclitaxel from <i>Taxus</i> endophytes, Camptothecin-like compounds
<b>Others</b> (sterols, lignans, essential oils)	Structural and ecological roles	Nutraceuticals, aromatherapy, antimicrobial	$\beta$ -sitosterol, Lignans, Essential oils <sup>9</sup>

### Modern History of Phytochemistry

The modern history of phytochemistry shows how important plant compounds have been in the development of medicine. One of the earliest major discoveries was quinine from the bark of the cinchona tree, which was used in the 17th century to treat malaria and other infectious diseases. In the 18th century, Friedrich Wilhelm isolated morphine, the first pure alkaloid, which became a powerful medicine for pain relief. Over the past 300 years, many other plant compounds have been discovered and studied, such as digitalis from foxglove in 1785 for heart

problems, picrotoxin in the 1800s as a plant-based neurotoxin, curare in the mid-19th to 20th century as a muscle relaxant, and salicin from willow bark between 1860–1877, which later led to the development of aspirin. These discoveries proved the great medicinal value of plants and gave rise to the field of phytochemistry, which continues to study natural products for new therapeutic uses today [10].

**Papaya (*Carica papaya*)** is a super common plant in tropical areas. It's one of the most popular and important plants in the Caricaceae family. Papaya originally comes from India, Malaysia, Indonesia, the Philippines, Sri Lanka, and Oman. Lots of Asian countries grow papaya for business. In some tropical countries, people even grow papaya in their gardens. Papaya has lots of good stuff like polysaccharides, vitamins, minerals, enzymes, alkaloids, glycosides, saponins, and sterols. The plant has a weak, soft stem that doesn't usually have branches. It gives out a white, milky liquid (latex) and has big leaves on long stems at the top. Papaya grows fast and can get up to 20m tall. *Carica papaya*, commonly known as papaya, is a tropical plant widely used in traditional medicine for its various health benefits. The plant contains many bioactive compounds such as papain, chymopapain, alkaloids, flavonoids, tannins, and vitamins, which are responsible for its pharmacological actions. Papaya shows several medicinal properties including anti-inflammatory, antioxidant, antimicrobial, anticancer, and hepatoprotective activities. It also helps in improving digestion, boosting immunity, and promoting wound healing. Different parts of the plant-leaves, seeds, fruit, and latex-are used for therapeutic purposes. Overall, *Carica papaya* is an important medicinal plant with multiple pharmacological actions that support its traditional use and modern medicinal value [11].

### Taxonomical Classification

**Table 1: Taxonomy of papaya fruit.**

Taxonomy	
Kingdom	Plantae
Division	Magnoliophyta
Subdivision	Spermatophyta
Class	<i>Magnoliopsida</i>
Order	Brassicales
Genus	<i>Carica</i>
Species	<i>Carica Papaya Linn</i>

Table 02: Taxonomical classification of carica papaya)

### Nutritional Values

*Carica papaya*, commonly known as papaya, is a nutrient-rich fruit with significant health benefits. Here are its key nutritional values

### Nutritional Composition

#### Moisture Content

Papaya seeds have a moisture content ranging from 4.82 to 6.23 g/100g.- Protein Content: Papaya seeds contain 34.93 to 35.62 g/100g of protein- Lipid Content: The lipid content in papaya seeds is between 30.36 to 46.23 g/100g.- Ash Content: Papaya seeds have a higher ash content, approximately two times more than balanites seeds. Mineral Content- Calcium: Papaya seeds are rich in calcium, with a content of 366-439 mg/100g.- Magnesium: The magnesium content in papaya seeds is 131-312 mg/100g.- Potassium: Papaya seeds contain 34.98 to 67.72 mg/100g of potassium.- Iron: Papaya seeds have significant iron content. Amino Acid Profile- Essential Amino Acids: Papaya seeds have a higher level of essential amino acids compared to balanites seeds.- Aspartic Acid: The most abundant amino acid in papaya seeds is aspartic acid. Fatty Acid Composition-  $\alpha$ -Linolenic Acid (Omega-3): Papaya seeds contain  $\alpha$ -linolenic acid, an essential fatty acid. Other Fatty Acids: Palmitic acid, elaidic acid, stearic acid, and linoleic acid are also present in papaya seeds [12].

Table 03: Nutritional values of carica papaya Value—USDA

nutrient database	Nutrien
88.83 g	Calcium
163 kJ/39 kcal	Magnesium
0.61 g	Iron
0.14 g	Zinc
9.81 g	Beta-carot
5.9 g	Thiamin
1.8 g	Riboflavin
Nil	Niacin
3 mg	Vitamin C
257 mg	Vitamin A

t database for reference (2006).

### Morphology

#### Plant Structure

Stem is a small, sparsely branched tree, typically growing 5-10 meters tall with a single stem. Leaves are large, deeply palmately lobed leaves, 50-70 cm in diameter, with seven lobes, spirally arranged at the top of the trunk. Flowers are five-parted, dimorphic, and highly fragrant, opening at night. Male flowers are borne in multiflowered dichasia, while female flowers are in few-flowered dichasia.- Fruit area large berry, 15-45 cm long and 10-30 cm in diameter, with numerous black seeds attached to the walls of the central cavity [13].



Figure 03: Morphology of carica papaya and stem, fruit, leaves, flower

14 All parts of the plant contain latex in articulated laticifers. Papaya roots can be severely infected by pathogens, causing the plant to wilt and collapse. Papaya plants are dioecious, with male, female, and hermaphrodite types. Hermaphrodite plants are preferred for commercial cultivation due to their ability to self-pollinate.

### Chemical Constituents

#### Leaves

Caprine an alkaloid with potential medicinal properties. Methyl gallate a compound with antioxidant and anti-inflammatory effects. Loliolide a sesquiterpene with potential biological activities. Rutin a flavonoid with antioxidant and anti-inflammatory properties. Clitorin a flavonoid with potential anti-cancer and anti-inflammatory effects. Kaempferol-3-O-neohesperidoside: a flavonoid glycoside with potential antioxidant activity. Isoquercetic a flavonoid glycoside with potential antioxidant and anti-inflammatory effects. Nicotiflorin is a flavonoid glycoside with potential antioxidant activity. Isorhamnetin-3-O-β-D-glucopyranoside: a flavonoid glycoside with potential antioxidant activity.

#### SEEDS

Oleic acid a monounsaturated fatty acid with potential health benefits. Palmitic acid a saturated fatty acid. Stearic acid a saturated fatty acid. Linoleic acid a polyunsaturated fatty acid. Benzyl isothiocyanate (BITC): a compound with potential anti-cancer and antimicrobial properties. Phytosterols including β-sitosterol, campesterol, and stigmasterol, which may help lower cholesterol levels. Triterpenic alcohols: including cycloartenol and 24-methylene cycloartanol. 15Tocopherols a group of compounds with vitamin E activity. Carotenoids pigments with potential antioxidant activity. Benzyl glucosinolate: compounds that may have potential health benefits. These chemical constituents may contribute to the potential health benefits of Carica papaya, including anti-inflammatory, antioxidant, and antimicrobial effects. However, further research is needed to fully understand the properties and benefits of these compounds.

Table 04: (Phytoconstituents of carica papaya)

Categories	Phytoconstituents	Plant Part(s)
Enzymes	Papain, chymopapain A and B, endopeptidase papain III and IV glutamine cyclotransferase, peptidase A and B and lysozymes.	Unripe fruit (Latex)
Carotenoids	β carotene, cryptoxanthin, violaxanthin, zeaxanthin.	Fruits
Alkaloid & Enzyme	Carposide, and an enzyme myrosin	Roots
Glucosinolates	Benzyl isothiocyrate, benzylthioures, β-sitosterol, papaya oil, caricin and an enzyme myrosin	Seeds
Minerals	Calcium, potassium, magnesium, iron, copper, zine.	Shoots and Leaves
Monoterpenoids	4-terpineol, linalool, linalool oxide.	Fruits
Flavonoids	Quercetin, myricetin, kaempferol	Shoots
Alkaloids	Carpine, carpaine, pseudocarpine, vitamin C and E, choline, carposidel.	Leaves and Heartwood
Vitamins	Thiamine, riboflavin, niacin, ascorbic acid, a-tocopherol	Shoots and Leaves
Carbohydrates	Glucose, sucrose, and fructose.	Fruits

### Pharmacological Profile of Carica Papaya

#### Anticancer Property

Carica papaya has shown strong anti-cancer properties due to the presence of natural compounds such as flavonoids, alkaloids, phenolic compounds, and enzymes like papain and chymopapain. These substances help stop the growth of cancer cells and protect normal cells from damage. The leaf extract of papaya is especially known for its ability to stimulate the immune system, which helps the body fight against cancer cells. It can also induce apoptosis (programmed death of cancer cells) and inhibit the spread (metastasis) of tumors. Research suggests that papaya extracts may be effective against several types of cancer, including breast, liver, cervical, pancreatic, and colon cancers. Overall, Carica papaya acts as a natural source of anti-cancer agents, supporting its traditional use in herbal medicine and showing promise for future cancer therapy [16].



Figure 03: Anti cancer property of carica papaya

Carica papaya (papaya) is a well-known medicinal plant that shows strong anti-cancer properties due to the presence of several bioactive compounds such as flavonoids, alkaloids, phenolic acids, papain, chymopapain, lycopene, and carotenoids. These compounds help prevent the growth and spread of cancer cells by acting through different mechanisms. The antioxidants present in papaya,

such as vitamin C, vitamin E, and beta-carotene, protect the body from free radical damage, which is one of the main causes of cancer. Papaya leaf extract also stimulates the immune system by increasing the production of cytokines that help white blood cells destroy cancer cells. It can induce apoptosis, which means it causes cancer cells to die naturally without affecting normal cells.<sup>17</sup> In addition, papaya extracts slow down the multiplication of cancer cells and reduce tumor growth in cancers like breast, liver, pancreatic, cervical, and colon cancer. The anti-inflammatory properties of papaya further help prevent cancer development by reducing chronic inflammation. Lycopene, present in papaya fruit, is especially effective in lowering the risk of prostate, breast, and lung cancers. Overall, *Carica papaya* acts as a natural source of anti-cancer agents, making it valuable for both the prevention and treatment of cancer [18].

### **Anti Dengue Property**

*Carica papaya* (papaya) is widely known for its anti-dengue properties, especially the use of its leaf extract in increasing platelet count during dengue fever. Dengue is a viral infection transmitted by *Aedes* mosquitoes, which often causes a dangerous drop in platelets, leading to bleeding and other complications. Papaya leaves contain several bioactive compounds such as papain, flavonoids, alkaloids, and phenolic compounds, which help in boosting the immune system and protecting blood cells. The enzymes and antioxidants in papaya leaf extract help to increase platelet (thrombocyte) and white blood cell (WBC) counts, which are essential for recovery from dengue. Studies have shown that papaya leaf juice helps stabilize the red blood cell membrane, prevents platelet destruction, and supports faster recovery. It also exhibits antiviral and anti-inflammatory effects, which reduce the severity of dengue symptoms like fever and body pain. Furthermore, papaya leaf extract helps detoxify the liver and improve its function, which is often affected during dengue infection. Overall, *Carica papaya* plays an important role in managing dengue fever naturally by improving platelet count, enhancing immunity, and supporting quicker recovery [19].

*Carica papaya*, commonly known as papaya, possesses remarkable anti-dengue properties that have been widely recognized in both traditional and modern medicine. Dengue fever, a mosquito-borne viral disease caused by the *Aedes aegypti* mosquito, often leads to a severe reduction in platelet count, resulting in complications such as bleeding and organ damage. The leaf extract of *Carica papaya* is especially beneficial in the management of dengue because it contains active compounds like papain, chymopapain, flavonoids, alkaloids, and phenolic compounds. These bioactive substances work together to increase platelet and white blood cell counts, thereby helping the body recover from the effects of the virus. The extract also enhances the bone marrow's ability to

produce new platelets and stabilizes the cell membranes, preventing further platelet destruction. Additionally, papaya leaves contain powerful antioxidants such as vitamin C and beta-carotene, which help reduce oxidative stress and strengthen the immune system. Research studies have also shown that papaya leaf extract exhibits antiviral properties that may inhibit the replication of the dengue virus and reduce the severity of symptoms like fever, fatigue, and joint pain. Its anti-inflammatory and hepatoprotective (liver-protecting) effects further support recovery by improving liver function, which is often impaired during dengue infection. Overall, *Carica papaya* serves as an effective natural remedy that not only helps raise platelet levels but also boosts immunity, reduces inflammation, and speeds up recovery in dengue patients, making it a valuable plant in the management of dengue fever.

### **Anti Inflammatory and Immunomodulatory Property**

*Carica papaya* (papaya) is a medicinal plant known for its strong anti-inflammatory and immunomodulatory properties, which play a major role in maintaining health and preventing various diseases. The plant contains many active compounds such as flavonoids, alkaloids, saponins, tannins, papain, chymopapain, and vitamins A, C, and E, which work together to reduce inflammation and strengthen the immune system. The anti-inflammatory property of *Carica papaya* helps in lowering swelling, redness, and pain caused by infections or injuries. The enzymes papain and chymopapain break down proteins involved in inflammation, helping to soothe inflamed tissues. These compounds also block the release of inflammatory mediators like prostaglandins and histamines, which are responsible for pain and tissue damage. Because of this, papaya is useful in treating conditions such as arthritis, wounds, and gastric inflammation. In addition, *Carica papaya* shows strong immunomodulatory effects, meaning it helps regulate and balance the body's immune response. The leaf and fruit extracts stimulate the production of cytokines (such as interleukins and interferons), which enhance the activity of white blood cells that fight infections. The antioxidant vitamins and polyphenols in papaya protect immune cells from oxidative stress, ensuring they function properly.<sup>20</sup> By improving both innate and adaptive immunity, papaya helps the body defend itself against bacteria, viruses, and other harmful agents.

Overall, *Carica papaya* acts as a natural anti-inflammatory and immune-boosting agent that not only reduces inflammation but also strengthens the body's defense system. These properties make it valuable in managing inflammatory disorders, infections, and immune-related diseases, supporting its traditional use in herbal medicine and its growing importance in modern therapeutic research. *Carica papaya*, commonly known as papaya, possesses significant anti-inflammatory and

immunomodulatory properties that contribute to its wide range of medicinal uses. The plant is rich in bioactive compounds such as flavonoids, alkaloids, saponins, tannins, papain, chymopapain, and vitamins A, C, and E, which work synergistically to reduce inflammation and regulate immune function. The anti-inflammatory activity of papaya helps in minimizing pain, swelling, and tissue damage caused by infections or injuries. Enzymes like papain and chymopapain play a key role by breaking down inflammatory proteins and inhibiting the release of mediators such as prostaglandins and histamines that trigger inflammation [21]. These actions make papaya useful in relieving conditions like arthritis, gastritis, wounds, and muscle pain.

### **Anti Malarial Property**

*Carica papaya* (papaya) has been widely studied for its anti-malarial properties, which support its traditional use in treating malaria and fever-related illnesses. Malaria is caused by *Plasmodium* parasites transmitted through the bite of infected *Anopheles* mosquitoes. The leaf, seed, and root extracts of *Carica papaya* contain several bioactive compounds such as alkaloids, flavonoids, phenolics, and papain enzymes, which exhibit strong anti-parasitic and antioxidant activities. These compounds help inhibit the growth and multiplication of *Plasmodium* parasites inside red blood cells, thereby reducing the severity of infection. The leaf extract of papaya is particularly effective in lowering fever and parasite load in the blood [22]. Its alkaloids—such as carpaine and pseudocarpaine—are believed to interfere with the parasite's metabolic processes, leading to its death. Additionally, papaya's antioxidant components like vitamin C, beta-carotene, and flavonoids help protect red blood cells from oxidative damage caused by the malaria infection. The extract also supports faster recovery by improving liver function and boosting immunity, which are often weakened during malaria. Studies have shown that combining *Carica papaya* leaf extract with other herbal or conventional anti-malarial agents can enhance the overall therapeutic effect. Its anti-inflammatory and hematoprotective properties further aid in reducing malaria symptoms such as fever, anemia, and body weakness. Overall, *Carica papaya* serves as a valuable natural anti-malarial agent, capable of reducing parasite levels, strengthening the immune system, and promoting recovery, making it an important plant in both traditional and modern malaria management.

*Carica papaya*, commonly known as papaya, exhibits notable anti-malarial properties that have been recognized in traditional medicine and supported by modern research. Malaria, caused by *Plasmodium* parasites transmitted through *Anopheles* mosquito bites, leads to fever, anemia, and severe health complications. The leaves, seeds, and roots of *Carica papaya* contain various bioactive compounds, including alkaloids,

flavonoids, phenolic compounds, and papain, which work together to inhibit the growth and multiplication of malaria parasites in red blood cells. The leaf extract is particularly effective in reducing parasite load, controlling fever, and protecting blood cells from oxidative damage.<sup>23</sup>

### **Anti Oxidant Property**

*Carica papaya* is rich in natural antioxidants such as vitamin C, vitamin E, carotenoids, flavonoids, and phenolic compounds. These antioxidants help neutralize harmful free radicals in the body, which can otherwise damage cells and lead to aging or chronic diseases like cancer and heart problems. The leaves, fruits, and seeds of papaya all show strong antioxidant activity, making it useful in protecting the body from oxidative stress and supporting overall health.

### **Anti Diabetic Property**

*Carica papaya* has been reported to possess anti-diabetic activity due to its bioactive compounds such as flavonoids, alkaloids, saponins, and phenolic compounds. These compounds help lower blood glucose levels by improving insulin secretion, enhancing glucose uptake by cells, and reducing oxidative stress in the pancreas. Studies suggest that both the leaves and fruit of papaya can regulate blood sugar levels and improve lipid profiles in diabetic conditions. Additionally, papaya's antioxidant properties protect pancreatic beta cells from damage, supporting better insulin function and helping in the management of diabetes. *Carica papaya* demonstrates significant anti-diabetic effects due to its rich content of bioactive compounds such as flavonoids, alkaloids, saponins, and phenolic compounds. These constituents help in lowering blood glucose levels by multiple mechanisms, including stimulating insulin secretion from pancreatic beta cells, enhancing peripheral glucose uptake, and inhibiting carbohydrate-digesting enzymes [24].

### **Anti Elmintic and Anti Amoebic Property Anthelmintic and Anti-amoebic Properties of *Carica Papaya***

*Carica papaya* exhibits both anthelmintic and anti-amoebic activities due to the presence of bioactive compounds such as papain, alkaloids, flavonoids, and saponins. The enzyme papain, found abundantly in the latex and seeds of papaya, helps break down the protective outer layers of parasitic worms, leading to their paralysis and elimination from the body [25]. Additionally, the alkaloids and flavonoids interfere with the metabolism of intestinal parasites and protozoa, including *Entamoeba histolytica*, the causative agent of amoebiasis. Studies have demonstrated that papaya seed extracts can effectively reduce worm load in experimental models and inhibit the growth of amoebic trophozoites, highlighting its potential as a natural remedy for intestinal parasitic infections. Regular use of papaya extracts may therefore aid in the treatment and prevent *Carica papaya* has been widely recognized for its anthelmintic and anti-amoebic activities, which are largely

attributed to its bioactive compounds such as papain, chymopapain, alkaloids, flavonoids, and saponins.<sup>26</sup> The proteolytic enzyme papain, found mainly in the latex and seeds, disrupts the protective outer layers of parasitic worms, leading to their paralysis and expulsion from the intestines. In addition, alkaloids and flavonoids present in papaya interfere with the energy metabolism and cellular functions of helminths, further enhancing its worm-killing effects [27].

### Evaluation Tests of Carica Papaya

The quality and authenticity of Carica papaya plant materials are assessed using several evaluation tests, including macroscopic, microscopic, physicochemical, and phytochemical analyses. Macroscopic evaluation involves examining the size, shape, color, texture, and organoleptic features of the leaves, fruits, seeds, and latex. Microscopic evaluation includes studying the cellular structure, presence of stomata, trichomes, and calcium oxalate crystals to confirm the plant material.<sup>28</sup> Physicochemical tests such as moisture content, ash values (total, acid-insoluble, and water-soluble ash), extractive values (alcohol and water), and foreign matter are performed to assess purity, quality, and storage stability. Phytochemical screening identifies the presence of bioactive compounds like alkaloids, flavonoids, saponins, tannins, phenolics, and proteolytic enzymes such as papain. Additionally, modern analytical techniques such as HPLC, UV-Vis spectrophotometry, GC-MS, and FTIR may be employed for quantitative estimation of active constituents and to ensure standardization of papaya extracts. These evaluation tests are essential to ensure the safety, efficacy, and consistency of Carica papaya used in medicinal and nutritional preparations [29].

The evaluation of Carica papaya involves a series of tests to ensure the identity, purity, quality, and potency of its plant material and extracts. Macroscopic evaluation is the first step, where characteristics such as the size, shape, color, texture, and organoleptic features of the leaves, fruit, seeds, and latex are carefully observed. This is followed by microscopic evaluation, which examines cellular structures, stomata, trichomes, calcium oxalate crystals, and other histological features to confirm the authenticity of the plant material. Physicochemical tests are performed to assess the material's purity and quality, including determination of moisture content, total ash, acid-insoluble ash, water-soluble ash, extractive values in water and alcohol, and detection of any foreign matter. Phytochemical screening identifies bioactive compounds such as alkaloids, flavonoids, saponins, tannins, phenolics, and proteolytic enzymes like papain, which contribute to its therapeutic properties. In addition to traditional methods, modern analytical techniques like HPLC (High-Performance Liquid Chromatography), UV-Vis spectrophotometry, GC-MS (Gas Chromatography-Mass Spectrometry), and FTIR (Fourier Transform Infrared Spectroscopy) are increasingly used to quantify active

constituents, ensure standardization, and verify the safety and efficacy of papaya extracts. Together, these evaluation tests provide a comprehensive assessment, ensuring that Carica papaya meets quality standards for medicinal and nutritional use.<sup>30</sup>

### Conclusion

Carica papaya is a versatile medicinal plant with a wide range of pharmacological activities, attributed to its rich content of bioactive compounds such as alkaloids, flavonoids, saponins, phenolics, vitamins, carotenoids, and proteolytic enzymes like papain. It demonstrates significant antioxidant, anti-diabetic, anti-cancer, anti-malarial, anti-dengue, anti-inflammatory, immunomodulatory, anthelmintic, and anti-amoebic effects. Both traditional uses and scientific studies support its therapeutic potential, highlighting its role in managing oxidative stress, parasitic infections, metabolic disorders, and inflammatory conditions. Proper evaluation and standardization of papaya extracts through macroscopic, microscopic, physicochemical, phytochemical, and modern analytical tests ensure their quality and efficacy. Overall, Carica papaya is a valuable natural resource with promising applications in modern medicine and health maintenance.

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### Authors Contribution

All authors are contributed equally

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