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# Nutritional benefits of the *Carica papaya*: A review

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**Abstract**
The Caricaceae family includes the papaya (*Carica papaya* Linn.), renowned worldwide for its therapeutic and dietary benefits. The fruit is nutritious and delicious, and all plant components, including the fruit, the root, the bark, the peel, the seeds, and the pulp, are known to offer medical benefits. The health advantages of raw papaya are likely to be extensive. Given that it is available year-round, it might be considered a nutrient powerhouse. The biological activity and therapeutic uses of papaya have undergone significant research over the past few years, and as a result, it is currently regarded as an important fruit plant for neutraceuticals. The present review has focused on the anti-diabetic, anti-cancer, anti-bacterial, and anti-inflammatory properties of *Carica papaya*, the nutritional value of the fruit, and the medicinal properties of its various parts to provide a comprehensive overview of this commercial fruit crop with multiple uses.

**Keywords:** Raw papaya, papain, neutraceutical, chymopapain, arthritis, fruit

## 1. Introduction
The *Carica papaya* L. has a single hollow, scarred stem that ranges in colour from light green to brown and bears large leaves and large oval fruits. Additionally, this plant is grown close to the equator in nations like Malaysia, Brazil, South America, Australia, and Indonesia. Depending on where it grows, the *Carica papaya* L. plant is referred to by several different names, including kepaya, paw paw, and tapaya. In fact, this plant is well-known for having therapeutic properties in almost every part of it, including the fruit, roots, leaves, and seeds. As a result, it has been applied as a conventional treatment plan for a number of illnesses [1]. Papaya's output reached 13 million metric tonnes in 2017 [2] with India and Brazil accounting for the largest global shares. Mexico, Indonesia, the Dominican Republic, and Nigeria came in second and third, respectively. The papaya fruit is eaten either fresh or processed into products like pickles, jelly, sweets, and jam [3]. There are more than 50 papaya varieties known, however, due to unchecked pollination, pure breeding types are dwindling [4]. Papaya plant parts with nutritional and therapeutic value include roots, leaves, peels, latex, flowers, fruits, and seeds [5]. The seeds and leaves of papaya have recently been found to have anticancer properties [6, 7, 8]. They have also been linked to improvements in conditions including diabetes mellitus, hepatic and renal problems, fertility, hyperglycemia, amoebic dysentery, and other conditions.

## 2. Plant Description
Even though the papaya plant can grow to a height of up to 8 meters (26 feet), its palm-like trunk is not as woody as the name might suggest (Fig 1A). The plant is crowned with deeply lobed leaves that can reach a width of 60 cm (2 ft) and are carried on hollow 60 cm long petioles (leaf stalks) (Fig 1 C). Hermaphrodite varieties of the species are known, and there are many inconsistencies in the distribution of the sexes that are prevalent. The species is typically dioecious, producing male and female flowers on distinct plants. On stalks that grow 90 cm long, male flowers are produced in clusters. The flowers are funnel-shaped, 2.5 mm (0.1 inch) long, and white with 10 stamens in the throat (Fig 1B). The five fleshy petals of the female flowers are united towards the base, and they are much larger, on very short stalks, and frequently grow alone in the axils of the leaves. The female flowers also feature a large superior ovary that is crowned by five sessile stigmas in the form of fans and five fleshy petals that are united towards the base. The fruit is typically spherical to cylindrical in shape, can range in length from 75 to 500 mm (3 to 20 inches) or even longer, and can weigh up to 9 to 11.5 kg (20 to 25.5 pounds) at times (Fig 1 B). The extremely delicious flesh has a rich yellow,

orange, or crimson hue.

Numerous rounds of wrinkly, black seeds are adhered to the walls of the huge central chamber. The unripe fruit has a milky juice that contains pepsin, a protein-digesting enzyme that has a digestive function very similar to that of the pepsin found in animals. This juice is employed in the creation of a number of indigestion cures as well as in the production of meat tenderizers.

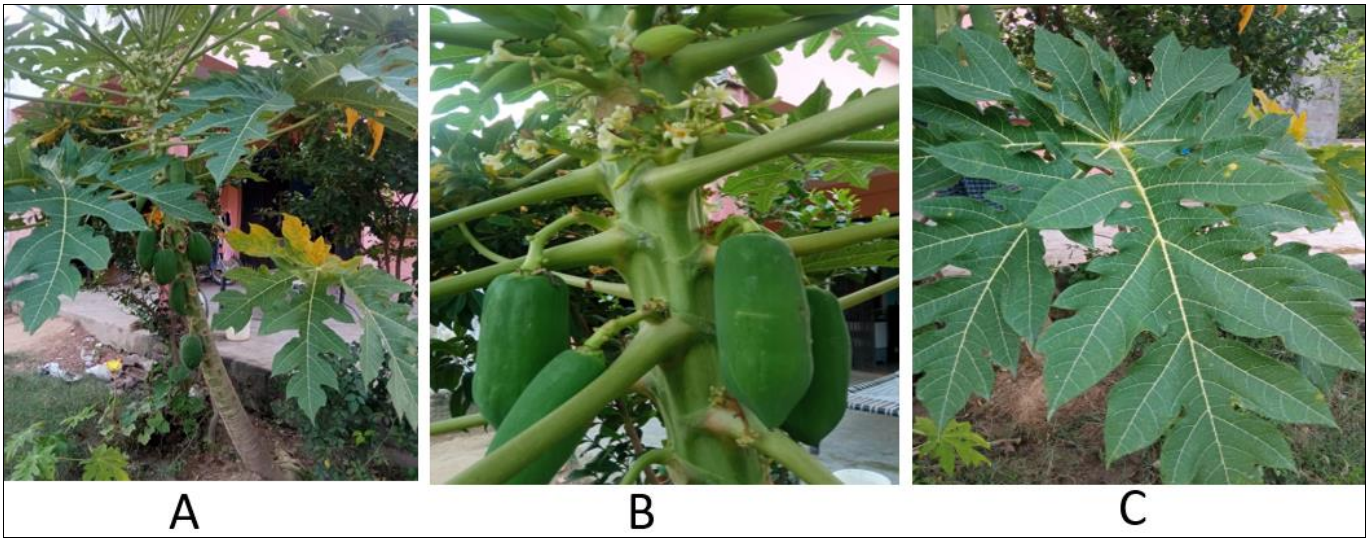


**Fig 1:** Fig A shows the Papaya tree; Fig B shows the fruit; and Fig C shows the Papaya leaf

## 3. Botanical Classification of *Carica papaya*

**Table 1:** Classification (source: Ayurvedic pharmacopeia of India, Govt of India [9]

| Domain | Flowering plant |
|---|---|
| Kingdom | Plantae |
| Sub Kingdom | Tracheobionta |
| Class | Magnoliopsida |
| Subclass | Dilleniidae |
| Super division | Spermatophyta |
| Phylum | Steptophyta |
| Order | Brassicales |
| Family | Caricaceae |
| Genus | *Carica* |

### 3.1 Methodology

Search phrases such as *Carica papaya*, inflammation, anti-cancer, anti-diabetes, anti-aging, and wound healing were used to find all relevant articles in the databases (PubMed, Semantic Scholar, Web of Science, World Wide Science, and Embase). From similar review articles that were found in the initial search, we were able to find further pertinent publications. In this review, the disease problems that have been extensively reported to be alleviated or improved by papaya or items derived from papaya were covered.

## 4. Result and Discussion

The papaya plant, comprising the fruit, leaves, seeds, bark, latex, and other parts of it, has a significant impact on how diseases are managed as they progress. Alkaloids, glycosides, tannins, saponins, and flavonoids are some of the active ingredients in *Carica papaya* leaf that give it its medicinal properties. Papaya leaf juice also raises platelet counts in dengue fever patients, another benefit.

### 4.1 Bioactive Components of *Carica papaya*

The *C. papaya* plant contains healthy compounds in various concentrations in its fruits, leaves, and seeds. A phytochemical analysis of the leaves revealed that tannin was absent, but the leaves did contain alkaloids, cardiac glycosides, and saponins [10]. One important study [11], revealed that the predominant substance in the leaves of *C. papaya* was phenolic acids, whereas chlorogenic acid was only present in trace amounts. This contrasted with the flavonoids and coumarin compounds, which were found in small amounts. Fruits include numerous important vitamin and mineral varieties, flavonoids, and other minerals. A good source of calcium, vitamins A and C, and other nutrients, according to [12], is ripe fruit. According to studies by [13-14] raw papaya is a rich source of vitamin C, albeit the amount varies depending on the stage of development. Furthermore, papaya seeds contain important nutrients that have been connected to both the prevention and treatment of disease. A key study that found seeds are a great source of proteins, lipids, and crude fiber also discovered the presence of toxicants such as glucosinolates. Additionally, the study discovered that the seeds contained sizable levels of calcium and phosphorus. *Carica papaya Linn* is a useful plant that is used in a variety of medical procedures. [15-17], the *Carica papaya* is used in ethnomedicine for its fruit, leaves, and seeds.

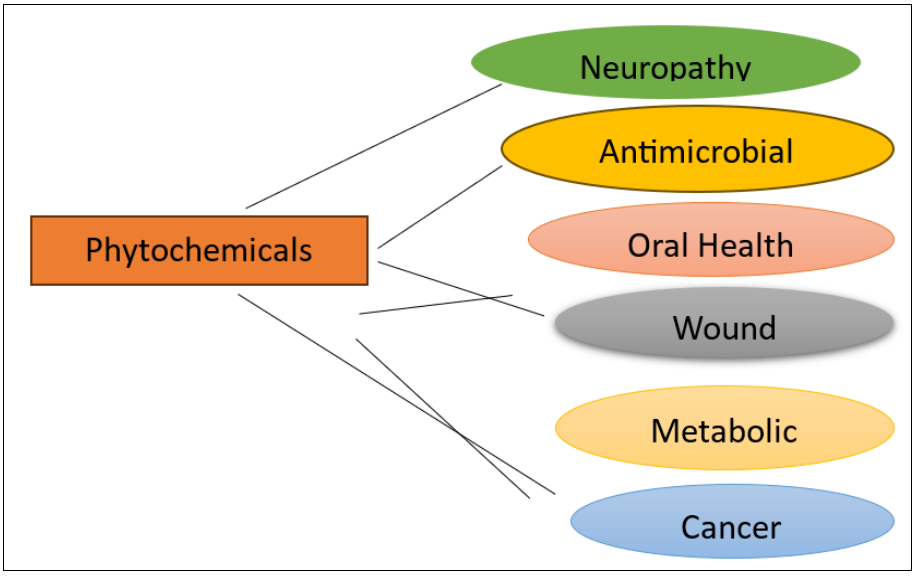


**Fig 2:** Pharmacology properties of *Carica papaya*

**Table 2:** Bioactive composition of various parts of *Carica papaya* Linn. Plant

| Plant Parts | Bioactive components |
|---|---|
| Bark | β-sitosterol, glucose, fructose, sucrose, galactose and xylitol |
| Leaves | Alkaloids carpain, pseudocarpain and dehydrocarpaine I and II, choline, carposide, vitamin C and E |
| Fruit | Protein, fat, fiber, carbohydrates, minerals, calcium, phosphorus, iron, vitamin C, thiamine, riboflavin, niacin, caroxene, amino acid, citric acids, and malic acid (green fruits), volatile compounds: linalol, benzyl isothiocyanate, cis and trans 2, 6-dimethyl-3,6 expoxy-7 octen-2-ol. Alkaloid, α; carpaine, benzyl-β-d glucoside, 2-phenylethl-β-D-glucoside, 4-hydroxyl -phenyl-2 ethyl-B-D glucoside and four isomeric malonated benzyl-β-D glucosides |
| Juice | N-butyric, n-hexanoic, and n-octanoic acids, lipids; myristic, palmitic, stearic, linoleic, linolenic acids-vaccenic acid and oleic acids |
| Seed | Fatty acids, crude proteins, crude fibre, papaya oil, carpaine, benzylisothiocynate, benzylglucosinolate, glucotropacolin, benzylthiourea, hentriacontane, β-sistosterol, caricin and an enzyme nyrosin |
| Latex | proteolytic enzymes, papain and chemopapain, glutamine cyclotransferase, chymopapain A, B, and C, peptidase A and B, and lysozyme |

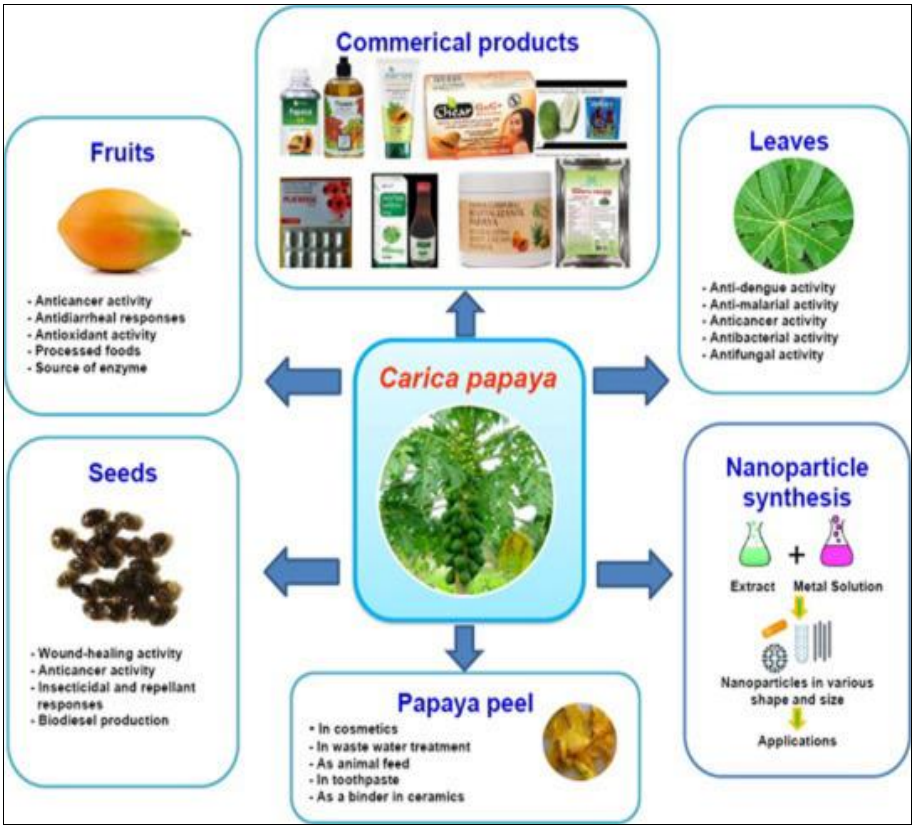


**Fig 2:** Different Phytochemical activities of *Carica papaya*

**Pharmacological activities of *Carica papaya***

**a) Antioxidant Activity:** Antioxidants are found in abundance in natural or plant-based goods and play a crucial part in the treatment and prevention of disease. Important study findings indicate that *C. papaya* seed water extract has potent antioxidant activity in human skin Detroit 550 fibroblasts subjected to $H_2O_2$ oxidative stress. These findings also support the fact that the extract is non-toxic, reduces cell death, maintains $Ca^2$+ homeostasis, and inhibits mitochondrial function [18]. The effects of *C. papaya* leaf aqueous extract on alcohol-induced acute gastrointestinal injury were examined, and the study's findings showed that the gastric ulcer index was considerably lower in rats pretreated with CPL extract than in rats treated with alcohol. A decrease in plasma lipid peroxidation level and an increase in erythrocyte glutathione peroxidase activity were further findings that supported the claim that CPL extract provided some protection [19].

**b) Anti-inflammatory:** The severity of illnesses including asthma, osteoarthritis, and rheumatoid arthritis is lessened by protein enzymes like papain and chymopapain as well as antioxidant minerals like vitamin C, vitamin E, and beta-carotene contained in papaya. The various sections of the papaya plant have been demonstrated in numerous studies to have considerable immunomodulatory and anti-inflammatory effects via various mechanisms. There hasn't been any research on how these variables affect the bioactivity of papaya, despite the possibility that they may influence the amounts and types of bioactive phytochemicals [21], the degree of ripeness, cultivar type, various plant parts, and extraction technique.

**c) Anti-fungal activity:** Fluconazole and papaya latex work together to prevent *Candida albicans* development synergistically. Bioactivity has been demonstrated for extracts from various papaya tissues. Aqueous and organic seed extracts have been shown to have anti-helminthic action against *Caenorhabditis elegans* [22, 23]. In contrast, aqueous and organic extracts of seeds have been shown to have antifungal activity against *Colletotrichum gloeosporioides* [24].

**d) Anti-bacterial activity:** It has been discovered that the seeds of *Carica papaya* have bacteriostatic activity against a number of enteropathogens, including *Bacillus subtilis*, *Enterobacter cloacae*, *Staphylococcus aureus*, *Escherichia coli*, *Salmonella typhi*, *Proteus vulgaris*, *Pseudomonas aeruginosa*, and *Klebsiella pneumoniae*. The gram-negative bacteria were more responsive to the extracts than the gram-positive bacteria. Given that both gram-positive and gram-negative bacteria were examined, the extracts' ability to kill both types of bacteria suggests they have a wide range of activity [25].

**e) Anti-diabetic activity:** According to [25], diabetes is a chronic disease that is primarily brought on by the insulin resistance or insufficiency phenomenon, which causes elevated blood glucose levels, or hyperglycemia. Diabetes patients' quality of life may ultimately suffer as a result of different macro and microvascular problems brought on by uncontrolled diabetes. According to research by [27], oxidative stress has been demonstrated to be a significant factor in both the onset and progression of diabetes. There is a tonne of evidence to support the idea that unchecked hyperglycemia can cause oxidative stress by encouraging the production of ROS and weakening antioxidant defences through a number of mechanisms, such as by increasing protein glycation, glucose oxidation, and the lipid peroxidation of low-density lipoprotein (LDL). Advanced glycation end products (AGEs) are created and nitric oxide (NO) is increased by the non-enzymatic interaction of glucose with proteins. The pancreatic islets of Langerhans cells may malfunction as a result of too many free radicals, which might have negative consequences. Therefore, these results are consistent with the role antioxidants play in the management of diabetes [28, 29].

**f) Anti-dengue activity:** There are between 50 and 100 million cases of dengue each year, which is a panic disorder that affects individuals everywhere. The Aedes albopictus mosquito transmits dengue, which is brought on by the dengue virus (DENV) 1-4, a member of the Flaviviridae family. Personal protection, illness management, and vector control are the main methods to combat dengue fever. When it came to controlling vectors, ensuring one's own safety, and using medication to treat diseases, there were no specialized antibiotics or methods available. Finding the least expensive and most potent anti-dengue medications becomes necessary and unavoidable over time. An alternate method of treating dengue is herbal medication. A considerable increase in platelet count was seen after taking *C. papaya* leaf extract, which fell during dengue infection. DENV1, DENV2, DENV3, and DENV4 all displayed dengue dandy fever (DF) or a break bone (fever, lymphadenopathy, muscle, headache), which was followed by dengue hemorrhagic fever (DHF) (abdominal pain, vomiting, nausea, sore throat), thrombocytopenia, and finally bleeding in the mucous membrane, with some strains also being predisposed to spontaneous ocular haemorrhages). According to a 2012 experiment by [30] the papaya leaf has significant qualities that can stabilize the membrane, shield blood cells from stress-related oxidation, and stop platelet lysis in dengue patients. Papaya leaf juice may be helpful in treating patients with dengue viral infection, according to a 2012 study by [30]. In an *in vitro* hemolytic experiment, papaya leaf extracts demonstrated promise for membrane stabilization.

## 5. Conclusion

This review summarised the therapeutic medicinal potential of papaya and its various portions for a variety of ailments. The research mentioned above showed that the papaya fruit, leaf, bark, stem, and other parts of the plant contain bioactive phytochemicals that may be useful for treating and preventing diseases. In light of the situation, phytomolecules are anticipated to revolutionize cancer prevention and therapy in the following ten years and will offer a promising and potent alternative to traditional medications. They can be found naturally as fruit and leaves, and it is generally known that the phytochemicals in them have the power to treat fatal illnesses. There is a need to investigate the benefits of including fruit in our daily diet due to rising health consciousness and increased usage of phytochemicals in the prevention and treatment of common and serious diseases. Numerous illnesses and disorders, including cancer, are treated or prevented using papaya as a nutraceutical. It has also historically been used as a contraceptive, acne treatment, menstrual pain reliever, and apatite booster, among other things. According to the results of the current survey, papaya plant parts have a wide range of potent properties, including hepatoprotective, anti-cancer, anti-plasmodial, anti-dengue, and antitrichomonal effects. Additionally, it has shown promise as a contraceptive agent, anti-inflammatory, antibacterial, and treatment for heart disease and sickle cell anemia. Before moving on to clinics,

significant *in vivo* or *in vitro* research is needed to assess the potential therapeutic application of these phytochemicals. Through social media, *C. papaya* is used as a meal or a sort of treatment to treat or prevent a number of ailments.

**Authors' contributions**

The draft of the article and its conception were greatly aided by the corresponding authors. All additional participants collected the data and thoroughly reviewed the article for crucial intellectual elements.

**Conflicts of Interests**

The authors have no financial interests or conflicts of interest. Ingredient that aids digestive system, and again used in treatment of arthritis.

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