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CARICA PAPAYA: NATURE'S GIFT HAMPER FOR MAN

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ABSTRACT
Papaya (*Carica papaya* Linn.) is commonly called as paw-paw and it belongs to the family Caricaceae. Papaya is a powerhouse of nutrients and is available throughout the year. Papaya possess excellent medicinal properties for treatment of different ailments like warts, corns, sinuses, eczema, blood pressure, dyspepsia, constipation, amenorrhea. Ayurvedic literature reveals that papaya leaf extract has haemostatic properties and recent studies revealed its ability on platelet augmentation in cyclophosphamide induced thrombocytopenia rat model. Benefits of papaya are owed due to high content of vitamin A, B and C, proteolytic enzymes like papain and chymopapain which have antiviral, antifungal and antibacterial properties. It can be chosen as a source of papain for the development of various industrial and pharmaceutical products. In the present review, nutritional value of fruit and medicinal properties of its various parts and side/toxic effects as well have been discussed to provide beneficial information on papaya.

KEYWORDS: Proteolytic enzymes, antiviral, antifungal, antibacterial etc.

1. INTRODUCTION

Papaya, a juicy and tasty fruit, belonging to the family Caricaceae is scientifically known as *Carica papaya* Linn. Papaya tree is basically a short lived Indian tree. Papaya plant is laticiferous as they contain specialized cells known as "Laticifers". Laticifers secrete latex and are dispersed throughout most plant tissues.[1]

Papaya is now widely grown and used in different parts of the world not only for food but also for ornamental purpose.[2]

Papaya is a powerhouse of nutrients and is available throughout the year. It is recognized by its weak and branched soft stem yielding copious white latex and crowded by a terminal cluster of large and long stalked leaves, is rapidly growing and can grow up to 20m tall. Traditionally leaves have been used for treatment of a wide range of ailments like in treatment of malaria, dengue, jaundice, immunomodulatory and antiviral activity.[3]

Papain a major chemical compound extracted from fruit and stem latex is used in brewing and wine making and in the textile and tanning industries. Papaya contains broad spectrum of phytochemicals including polysaccharides, vitamins, minerals, enzymes, proteins, alkaloids, glycosides, fats and oils lectins, saponins, flavonoids, sterols etc. [4]

Papaya is also well known for its exceptional nutritional and medicinal properties throughout the world. The whole plant including its leaves, seeds, ripe and unripe fruits and their juice is used as a traditional medicine. Therefore, Papaya is considered as a nutraceutical fruit due to its multifaceted medicinal properties.[5] The fermented papaya fruit is a promising neutraceutical as an antioxidant. It improves the antioxidant defence in elderly patients even without any overt antioxidant deficiency state at the dose of 9gm/day orally.[6]

It is a rich source of three powerful antioxidants vitamin C, vitamin A and vitamin E that are highly essential for maintaining a good health. Papaya lower high cholesterol levels as it is a good source of fiber.[7]

Papaya was the first genetically modified fruit consumed by human beings for its nutritional and medicinal properties.[5]

The present review deals with nutritional value, medicinal properties and reported research findings on papaya.

2. Botanical Discription

The papaya belongs to a small family Caricaceae, having four genera in the world. The genus *Carica* Linn. is represented by four species in India, of which *C. papaya* Linn. is the most widely cultivated and best known species. It is commonly known as papaya, melon tree,

pawpaw or papau, fan mugua, papita, arand-kharpuja, papayabaum. *Carica papaya* (Caricaceae) is believed to probably originate from Southern Mexico and Costa Rica and then plantation crop was started in almost all regions of tropical and subtropical.[8]

Domain	Flowering Plant
Kingdom	Plantae
Division	Magnoliophyta
Phyllum	Steptophyta
Order	Brassicales
Family	Caricaceae
Genus	Carica
Botanical Name	*Carica papaya* Linn.

3. Plant Profile

Papaya is probably originated in Southern Mexico and Costa Rica; subsequently it was introduced as a plantation crop in Australia, Hawaii, Philippines, South Africa, Shrilanka, India and in all tropical and subtropical regions. It is grown both commercially and in home gardens. Papaya is a polygamous species and is difficult to identify a plant whether it is male, female or hermaphrodite.[4] Papaya plant is a large, single stemmed herbaceous perennial tree having 20-30 feet height. The leaves are very large (upto 2½ feet wide), palmately lobed or deeply incised with entire margins and petioles of 1-3 feet in length. Stems are hollow, light green to tan brown in color with diameter of 8 inches and bear prominent of scars.[7] The fruits are big oval in shape and sometimes called pepo-like berries, since they resemble melon by having a central seed cavity. Fruits are borne axillary on the main stem, usually singly but sometimes in small clusters. Fruits weigh from 0.5 up to 20 lbs, and are green unlike ripe, turning yellow or red orange. Flesh is yellow-orange to salmon (pinkish orange) at maturity.[9,10] Papaya plants are dioecious or hermaphroditic, producing only male, female or bisexual (hermaphroditic) flowers. Papaya as are sometimes said to be "trioecious" meaning that separate plants bear either male, female, or bisexual flowers. Female and bisexual flowers are waxy, ivory white, and borne on short penducles in leaf axils, along the main stem. A male papaya is distinguished by the smaller flowers borne on long stalks. Female flowers of papaya was pear shaped, when unopened whereas, bisexual flowers are cylindrical.[11]

4. Chemical Constituents

The different parts of papaya such as fruit, fruit juice, leaves, seed, root, bark, latex contains various chemical constituents;

Table 1: Chemical constituents of papaya plant.[9,10,11]

Parts	Constituents
Unripe Fruits	Protien, fat, fibre, carbohydrates, minerals; Calcium, phosphorus, iron, vitamin C, thiamine, riboflavin, niacin and carotene, amino acids, citric and malic acids (green fruits). Volatile compounds: linalool, benzyl isothiocyanate, cis and trans 2, 6-dimethyl-3,6 Epoxy-7 octen-2-ol, Alkaloid, α-carpain, benzyl β-D-glucoside, 2-phenylethyl- β-D-glucoside, 4-hydroxy-phenyl-2-ethyl- β-D-glucoside and four isomeric malonated benzyl- β-D-glucosides.
Juice	N-butyric, n-hexanoic and octanoic acids, lipids; myristic, palmitic, stearic, linoleic, linolenic and cis-vaccenic and oleic acids.
Seed	Fatty acids, crude protein, crude fibre, papaya oil, carpaine, benzylisothiocyanate, benzylglucosinolate, glucotropacolin, benzylthiourea, hentria contane, β-sitosterol, caricin and an enzyme myrosin.
Root	Carposide and an enzyme myrosin
Leaves	Alkaloids carpain, pseudocarpain and dehydrocarpain I and II, choline, carposide, vitamin C and E.
Bark	β-sitosterol, glucose, fructose, sucrose, galactose and xylitol.
Latex	Proteolytic enzymes, papain and chemopapain, glutamine, cyclotransferase, chymopapains A, B and C, peptidase A and B and lysozymes.

5. Nutritional Value Of Papaya Plant

Papaya is a reasonably priced fruit has a high nutritive value. It is low in calories and rich in natural vitamins and minerals. The comparative low calories content makes this a favorite fruit for obese people who are into weight loss regime.

Table 2: Nutritive value of 100gm of papaya fruit.[12]

Constituent	Green Papaya	Ripe Papaya
Protein	0.6 g	0.7 g
Fat	0.1 g	0.2 g
Mineral	0.5 g	0.5 g
Carbohydrate	7.2 g	5.7 g
Fiber	0.8 g	0.9 g
Energy	32 Kcal	27 Kcal
Total Carotene	2740 µm	0
Beta Carotene	888µm	0

6. Pharmacological Activities Of Different Parts Of Papaya Plant

Anthelmintic activity

A wide range of plants and plant extracts has been used traditionally for the treatment of helminthes infections including papaya, which is rich in proteolytic enzymes known to digest nematode cuticles, have low toxicity and have been used in traditional medicine against gastrointestinal nematodes for decades. In 1940, the worm digesting activity of a preparation of papain from *C. papaya* latex was described as they rapidly digest the ascaris.[13]

Antifungal activity

The latex of papaya and fluconazole has synergistic action on the inhibition of *Candida albicans* growth. This synergistic effect results in partial cell wall degradation due to lack of polysaccharides constituents in the outermost layers of fungal cell wall and release of cell debris into the cell culture. Latex proteins appear to be responsible for antifungal action.[14]

Antibacterial activity

The seeds of *Carica papaya* were found to possess bacteriostatic activity against several enteropathogens such as *Bacillus subtilis, Enterobacter cloacae, Escherichia coli, Salmonella typhi, Staphylococcus, Proteas vulgaris, Pseudomonas aeruginosa* and *Klebsiella pneumonia*. Among the gram positive and gram-negative bacteria tested the gram negative bacteria were more susceptible to the extract.[15]

Antioxidant activity

The total phenolic content of the extracts was determined by Folin-Ciocalteu method and antioxidant activity was assayed using DPPH method.[16]

Hypoglycemic and hypolipidemic activity

Study show that oral treatment with 0.1 mg/kg/day of glibenclamide and 100-400 mg/kg/day of aqueous seed extract of *Carica papaya* induced significant, steadyand progressive hypo-glycemic and hypolipidemic effect.[17]

Antipyretic activity

The platelet increasing property of *Carica papaya* leaves juice (CPLJ) investigated in patients with dengue fever (DF). An open labeled randomized controlled trial was carried out on 228 patients with DF and dengue hemorrhagic fever (DHF). It was concluded that CPLJ does significantly increase the platelet count in patients with DF and DHF.[18]

Anti-inflammatory activity

The anti-inflammatory property of plant cysteine proteinases were already noted in literature. In a clinical study, the histological severity of inflammatory bowel disease was determined for treatment of chronic inflammatory and related diseases papain has found to be safe and efficacious. Anti-inflammatory activity of papaya seeds was also reported.[19]

Anti-fertility activity

The anti-fertility effects of *Carica papaya* were investigated by feeding adult and pregnant rat with different components of the fruit. No attempt was made to force feed the animal and the result indicated that the unripe fruit interrupted the estrous cycle and induced abortion. This effect vanished as the fruit became stale or over ripped.[20] Papaya also showed the anti-implantation and abortifacient effect.[21]

Anticancer activity

Papaya *in vitro* study shows that it will treat many cancer cell line and they have anticancer activity. Papain breaks down the fibrin cancer cell wall and protein into amino acid form. Other than papain it also contain lycopene which highly reactive towards oxygen and free radical. Isothiocyanate was found to be effective against breast, lung, colon, pancreas, prostate as well as leukemia. These enzymes have the capacity to inhibit both formation and development of cancer cell.[22]

Anti-hypertensive activity

Papaya leaves decoction can be used as an anti-hypertensive agent.[23] Comparison studies on the effects of doses of a mixture of 20 mg/kg of unripe fruit *Carica papaya* extract and 200 mcg per 100 g antihypertensive hydralazine intravenously were carried out on two groups of rats. The investigators found that both treatments produced salt-hypertensive and depression in the value of arterial pressure in the rats. The arterial pressure was reduced by 28% in the hydralazine rat groups compared to the hypertensive ones. The study concluded that the unripe fruit of *Carica papaya* may contains antihypertensive agents which caused alpha-adrenoceptor activity in the experimental rats.[24]

Immunomodulatory activity

Papain induces human eosinophils to degranulate and to produce superoxide anion. The E-64 inhibitors abolished the activation by papain suggesting that the protease activity is required to trigger eosinophil response. It is likely that this action in eosinophils is mediated by protein G linked receptor. As it stands it appears that bromelaine and papain depending on the target cell display opposite effects.[25]

Wound healing

The proliferative effect of papain attained 15% above control, suggesting that this properly is specific for some proteolytic enzymes. Also one study showed that papain from *C. papaya* latex was effective in protecting histamine-induced ulcer in rat by blocking the acid secretion.[26] Papain major component of papaya latex is nonspecific cysteine proteinase that is capable of breaking down a wide variety of necrotic tissue substrates over a wide pH range from 3.0 to 12.0.[27] This factor may also have contributed to the faster wound healing and was facilitated by the action proteinases. Papain also known to be effective in disloughing necrotic tissue, prevention of infection and the antimicrobial and

antioxidant properties related to hydroxyl scavenging and iron chelating properties. Moreover they decrease the risk of oxidative damage to tissue also they show burn healing properties as the increment in hydroxyproline content.[28]

Anti- HIV agent

Evaluation of anti-HIV-1 effect of *Carica papaya* aerial parts polar extracts and also the investigation of the chemical content from the polar extracts of the plant. The methanol and aqueous extracts of *Carica papaya* were tested for their anti-HIV-1 activity using the syncytia formation assay. Methanol and aqueous extracts of *Carica papaya* aerial parts showed activity as anti HIV-1 agents, both of the extracts therapeutic index (TI) of 5.51 and 7.13 compared with the standard drug. Phytochemical analysis of both the extracts proves the presence of phytocomponents as flavonoids, tannins, alkaloids, carbohydrates and triterpenes. The results have shown that *Carica papaya* methanol and aqueous extracts have drug ability as anti- HIV agent.[29]

Antihelmintic activity

A wide range of plants and plant extracts has been used traditionally for the treatment of helminthes infections including papaya, which is rich in proteolytic enzymes known to digest nematode cuticles, have low toxicity and have been used in traditional medicine against gastrointestinal nematodes for decades.[30]

Anti-amoebic activity

The cold macerated aqueous extract of matured papaya seeds has shown anti-amoebic activity against *Entamoeba histolytica*.[31]

Anti-sickling activity

Sickle cell disease (SCD) results from a mutation in hemoglobin inside the red blood cells, where a glutamic acid at 6th position is replaced by valine. Recent studies showed that unripe papaya fruit extract has anti-sickling activity.[32] Another study showed the potent anti-sickling property of *Carica papaya* leaf extract in a dose-dependent manner.[33]

7. Home Remedies And Medicinal Uses Of Papaya

Table 3: Benefits and uses of home remedies practices of papaya.[7]

Part	Preparation	Uses
Biologically active compounds	Two important compounds are chymopapain and papain. The level of the compounds varies in the fruit, latex, leaves and roots.	It has been used for treating digestive problems and intestinal worms. The softening qualities of papain have been taken advantage of, in the treatment of warts, corns, sinuses, and chronic forms of scaly eczema, cutaneous tubercles, and other hardness of the skin produced by irritation. It is used to treat arthritis.
Peel	Application of peel with a little milk and honey	Protects, soothe and moisturize the skin.
	Apply peel as the face mask for about 20 minutes	To get rid of blemishes on skin and face.
	Soak sliced papaya in vinegar for several weeks. Remove the peel and this preparation can be applied with lemon juice to the scalp for 20 minutes prior to shampooing.	Fights dandruff.
	Peel simmered in olive oil, almond oil and rose oil, and the resulting papaya oil massaged into the skin and use with honey and rose water	Works as skin toner and skin cleanser.
Fruit	Eat fresh ripe papaya in the morning	Indigestion, constipation, flatulence, improve appetite
	Apply unripe papaya juice on affected area.	pimples, eczema, mouth ulcer
	Ripe fruit	Eliminate acid reflux; it is used to treat mouth ulcer and toothache.
	Unripe fruit	Contraceptive in some Asian countries.
	Soup made from fish and nearly ripen fruit	In Southern China, lactating mothers drink the soup to improve milk flow.
Leaves	Wash the leaf and cut into smaller pieces Squeeze the pulp and filter with the cloth. Two tablespoons serving per day	Can cure dengue fever.
	Leaves of Papaya	Used for dressing wounds and injuries, treating nervous pains and elephantoid growths.
Root	A decoction formed by boiling the outer part of the roots	Cure of dyspepsia.
	The sinapism prepared from the root of the	Beneficial in treating the tumors of uterus.

	plant	
	Root infusion	Used for syphilis in Africa and reduce urine concretions.
Seeds	Fresh or dry crushed seeds	Bacteriostatic, bactericidal and fungicidal.
	Take half ground papaya seed with warm water in the morning before breakfast, follow 2 hours later with 50 ml castor oil and 350 ml milk on an empty stomach, take this for 2-4 days	Expel intestinal worms.
	Seeds	Detoxify the liver.
Flowers	The flowers from the plant	Used in treating jaundice.
Latex	Latex of plant	Used in curing psoriasis and ringworm in Cuba. It is also used as a local antiseptic in many parts of the world. Papaya latex, also used as dyspepsia cure, is applied to burns and scalds externally.

Table 4: Some medicinal uses of papaya plant as mentioned in ancient Ayurvedic literature.[10,11,34]

Parts	Uses
Latex	Anthelmintic relieves dyspepsia, cure diarrhea, pain of burns and topical use, bleeding hemorrhoids, stomachic, whooping cough.
Ripe Fruits	Stomachic, digestive, carminative, diuretic, dysentery and chronic diarrhea, expectorant, sedative and tonic, relieves obesity, bleeding piles, wounds of the urinary tract, ringworm and skin diseases psoriasis.
Unripe fruit	Laxative, diuretic, dried juice reduces enlarged spleen and liver, used in snakebite to remove poison, abortifacient, antiimplantation activity and antibacterial activity.
Seeds	Carminative, emmenagogue, vermifuge, abortifacient, counter irritant, as paste in the treatment of ringworm and psoriasis, antifertility agents in males.
Seed Juice	Bleeding piles and enlarged liver and spleen.
Root	Abortifacient, diuretic, checking irregular bleeding from the uterus, piles, antifungal activity.
Leaves	Young leaves as vegetable, jaundice (fine paste), urinary complaints and gonorrhea (infusion), dressing wounds (fresh leaves), antibacterial activity, vermifuge in colic, fever, beri-beri, abortion (infusion), and asthma (smoke).
Flowers	Jaundice, emmenagogue, febrifuge and pectoral properties.
Stem bark	Jaundice, anti-haemolytic activity, sore teeth (inner bark), anti-fungal activity.

8. Safety Profile And Caution.[5,7]

- The available literature does not reveal any adverse/toxic effect upon consumption of papaya fruit over a long period of time except that it causes infertility.
- In animal studies, aqueous extracts of *Carica papaya* can cause temporary infertility and irregular oestrous cycles that is reversible when treatment was stopped. Extracts of papain found in *Carica papaya* were also found to induce abortion after conception by dissolving the protein needed by the newly fertilized egg to adhere to the uterus wall. The abortifacient property is a matter of high dose side effect of *Carica papaya* toxicity which affects the fetus.
- The leaves and roots of *Carica papaya* contain cyanogenic glycosides, which form cyanide leading to fatal consequences.
- The acrid fresh latex can become the cause of severe conjunctivitis and vesication.
- Too much consumption of C. *papaya* may cause discolouration of the skin. This discoloration will attack the palm of the hand and the soles of the foot and sometimes visible area.
- The enzyme papain may sometimes be allergic to some patients and this may cause constant symptoms like fever, asthma, wheezing and breathing difficulty.
- Right quantity of papain causes release of digestive problems but too much of papain causes stomach upset. High fiber content causes unrest to the digestive system.
- The latex from the unripe papaya fruit causes gastritis.

CONCLUSION

Carica papaya is a neutraceutical plant having wide range of medicinal uses. *C. papaya* is an important and promising natural medicinal plant which could be utilized in several pharmaceutical and medical applications because of its effectiveness, availability and safety. C. papaya possesses rich source of vitamins, antioxidants, flavonoids, polyphenols etc and hence regular intake of papaya will improve our health by quenching the free radicals generated in the body and enhance our immune system to fight against the foreign pathogens. Thus, intake of papaya as fruit salads, fruit juice, leaf extract, decoction prepared through papaya

leaves etc should be a part of our diet. The available literature does not reveal any adverse/toxic effects upon consumption of papaya fruit over a long period of time except that it causes infertility. Extensive investigation on its pharmacodynamics, kinetics and proper standardization and clinical trials is needed to exploit their therapeutic utility to combat various diseases.

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