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Review article

Nutritional, medicinal and pharmacological properties of papaya (*Carica papaya* linn.): A review

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Abstract

Papaya (*Carica papaya* linn) is well known for its exceptional nutritional and medicinal properties throughout the world. From the times immemorial, the whole Papaya plant including its leaves, seeds, ripe and unripe fruits and their juice is used as traditional medicine. Nowadays, Papaya is considered as nutraceutical fruit due to its multifaceted medicinal properties. The prominent medicinal properties of papaya include Anti-fertility, Diuretic, Uretonic, Anti-hypertensive, Hypolipidemic, Anti-helmintic, Wound healing, Anti-fungal, Antibacterial, Antitumor and free radical scavenging activities. Phytochemically, the whole plant contains enzymes (Papain), lycopene, carotenoids, alkaloids, monoterpenoids, flavonoids, mineral and vitamins. This important nutricious fruits feed the body and immune system. In present review article, a attempt is made to compile all the strange facts available about this tasty fruit. This tasty fruit of papaya is popular among family members of all ages for the delicious dishes derived from it.

Key words: *Carica papaya* Linn, Papaya, Nutraceutical, Wound healing.

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1. Introduction

Papaya, a juicy and tasty fruit, belonging to family Caricaceae is scientifically known as *Carica papaya* Linn. It is grown in various parts of the world, including India, tropical America and Europe. It is commonly known as Papaya melon tree, Pawpaw or papau, Kapaya, Lapaya, Papyas, Papye, Tapayas, Fan mu gua. Papaya plant is laticeferous as they contain specialized cells known as laticifers. Lactifiers secrete latex and dispersed throughout most plant tissues [1]. Papaya tree is basically short lived Indian tree. In the historic times, it was considered as an exotic fruit because of its buttery taste and appearance. Papaya was the first genetically modified fruit consumed by human beings for its nutritional and medicinal properties [2].

Nutritional Value of Papaya

The papaya is a large, tree- like plant, with a single stem growing from 5 to 10 m (16 to 33 ft) tall, with spirally arranged leaves

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confined to the trunk. The leaves are large, 50-70 cm in diameter, deeply palmately lobed, with seven lobes. The tree is unusually un-branched, unless lopped. The flowers appear on the axils on the leaves, maturing into large fruit. The fruit is ripe when it feels soft and its skin has attained amber to orange hue [3]. Ripe and green papaya has difference in nutritional value.

Table 1. Botanical Classification of Papaya

Domain	Flowering plant
Kingdom	Plantae
Subkingdom	Tracheobionta
Class	Magnoliopsida
Subclass	Dilleniidae
Division	Magnoliophyta
Subdivision	Spermatophyta
Phylum	Steptophyta
Order	Brassicales
Family	Caricaceae
Genus	Carica
Botanical name	*Carica papaya* Linn.

Table 2. Nutritional value [4]

Constituents	**Ripe Papaya**	**Green Papaya**
Water	89.1 gm	92.6 gm
Proteins	8.26 gm	10.8 gm
Total lipid	0.93 gm	1.35 gm
Ash	4.59 gm	6.76 gm
Carbohydrates	86.2 gm	81.1 gm
Total DF	11.9 gm	27.0 gm
Sugar		
Mineral Macronutrients		
Sodium	128.4 mg	283.8 mg
Potassium	1238 mg	2743 mg
Magnesium	229.4 mg	635.1 mg
Phosphorus	NR	NR
Calcium	146.8 mg	432.4 mg
Micronutrients		
Iron	12.84 mg	8.11 mg
Copper	0.18 mg	0.14 mg
Zinc	0.92 mg	0
Manganese	NR	NR
Selenium	NR	NR
Vitamins		
Vitamin C	568.8 mg	391.9 mg
Thiamine	0.28 mg	0.54 mg
Riboflavin	0.28 mg	26 mg
Niacin	2.80 mg	4.05 mg
Pantothenic acid	NR	NR
Vitamin B 6	NR	NR
Folate	NR	NR
Vitamin B 12	NR	NR
Vitamin A	NR	NR
Vitamin E	NR	NR
Vitamin K	NR	NR

Carotene	7807 ug	0
Cryptoxanthin	NR	NR
Lutein + Zeaxanthin	NR	NR

Phyto-constituents of Papaya

Papaya fruit is highly appreciated worldwide for its flavor, nutritional qualities and digestive properties [5].When unripe, it contains the enzyme papain (EC3.4.22.2), a cysteine protease with action similar to that of the pepsin in gastric juice. The latex, which contains papain, is harvested from unripe fruit by making incision in the fruit surface during a 4-5 day period and collecting the latex until it stops flowing. The greener the fruit, more active is the papain. Three other cysteine proteases have been isolated from papaya latex: chymopapain (EC 3.4.22.6); caricain (EC 3.4.22.30) and papaya protease IV (EC 3.4.22.25) [6]. These have been purified and biochemically characterized [7].

Papain

It is belongs to the papain superfamily, as a proteolytic enzyme, papain is of critical importance in many vital biological processes in all living organisms. Papain shows extensive proteolytic activity towards proteins, short chain polypeptides, amino acid ester and amide links and is applied extensively in the fields of food and medicine. It preferentially cleaves peptide bonds involving basic amino acids [8]. Papain is a single chain globular protein with molecular weight of 23406 DA and consists of 212 amino acids with four disulphide bridges. The graphical representation of amino acid composition of papain is shown in figure 1. It is stable and active under a wide range of conditions even at elevated temperatures [9].

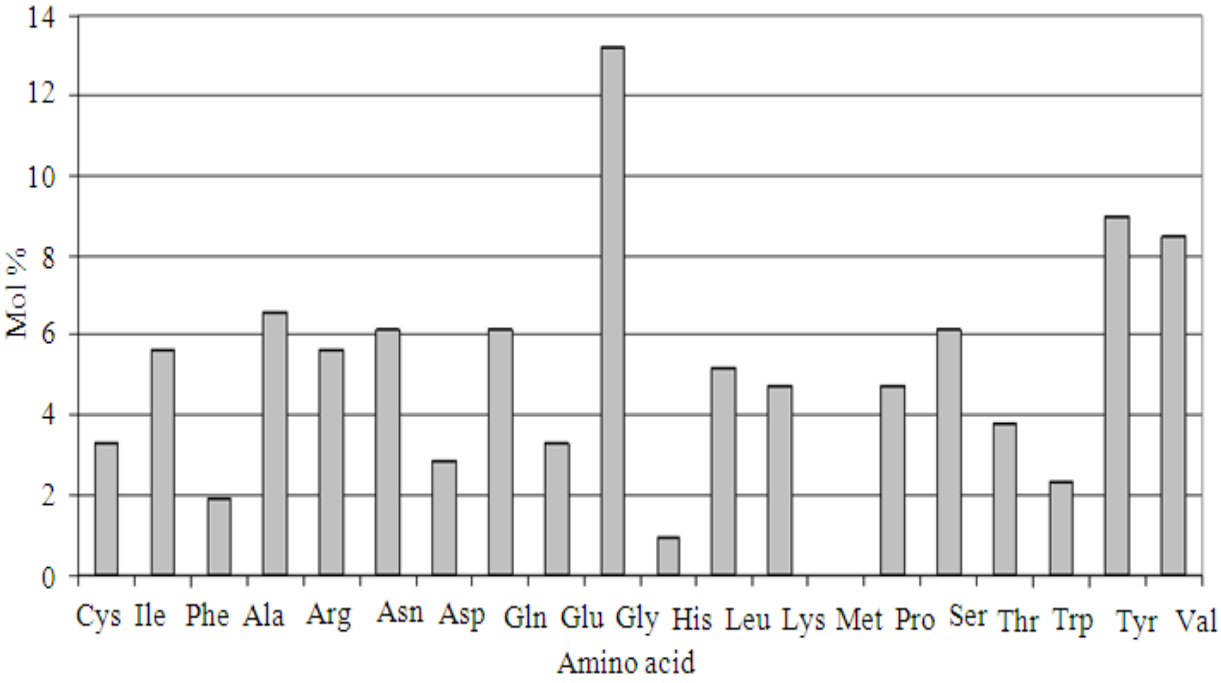


Figure 1. Graphical representation of amino acid composition of papain

Table 3. Chemical composition of various parts of Papaya plant [4, 10, 11]

Part	Constituents
Fruits	Protein, fat, carbohydrates, minerals, vitamins, volatile compound, alkaloids, glycosides.
Juice	N-butyric, n-hexanoic and n-octanoic acid, lipid, myristic, palmitic, stearic linoleic, linolenic acid and oleic acid
Seed	Fatty acid, crude protein, crude fibres, papaiya oil, carpaine, benzyl isothiocyanate, benzylthiourea, β-sitosterol, caricin and enzyme myrosin.
Root	Caproside and enzyme myrosine
Leaves	Alkaloids carpain, pseudocarpain and dehydrocarpain 1,2, choline, caproside, vitamin C and E.
Bark	β-sitosterol, glucose, fructose, galactose and xylitol.
Latex	Proteolytic enzyme papain, chemopapain, glutamine cyclotransferase, chymopapain A,B,C, peptidase A and B, lysosome.

Pharmacological properties

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 [12]. Anti-inflammatory activity of papaya seeds were also reported [13]. The anti-inflammatory effect of the leaves extract including the reference drug was very poor when using the carrageenan method, the 100 mg/kg extract produced its highest effect at 3 hr (2.7%) after carrageenan injection while the 200 mg/kg extract also produced its effects at 3 hr (6.7%) after injection. The reference drug indomethacin produced time dependant reduction as the effect was more pronounced at 3 hr (11.4%) of carrageenan administration. The results of this investigation revealed that the aqueous extract of the leaves was slightly less effective than that of indomethacin [14].

Wound healing activity

The similarities between latex coagulation in papaya and the mammalian coagulation process led us to propose that some analogous factor may be present in both systems. If putative analogies do occur, it is possible that some plant metabolites intervening during plant healing may also act during the healing process ensuring clot formation in mammals [15]. The proliferative effect of papain attained 15% above control, suggesting that this properly is specific for some proteolytic enzymes [16]. Also one study showed that papain from C. papaya latex was effective in protecting histamine-induced ulcer in rat by blocking the acid secretion [17].

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 [18]. 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 [1,19]. Moreover, they decrease the risk of oxidative damage to tissue also they show burn healing

properties as the increment in hydroxyproline content [20].

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 riped. Chloroform extract of *Carica papaya* seeds induced long term azoospermia in languor monkey [21]. Papaya also showed the anti-implantation and abortifacient effect [22].

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 [23]. In 1940, the worm digesting activity of a preparation of papain from C.papaya latex was described as they rapidly digest the ascaris cuticle

Anticancer activity

Initially pharmaceutical preparations containing various proteolytic enzymes (papain) have been used as adjuvant in the treatment of malignant diseases, despite lack of knowledge of their mode of action. Experiments indicate that the effects after oral administration of polyenzymes preparations are related to the induction of cytokines production by human peripheral blood mononuclear cells [25]. Papaya in vitro study shows that it will treat many cancer cell line and they have anticancer activity. Papain enzyme from papaya effective against cancer. 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 effective against breast, lung, colon, pancreas, prostate as well as leukemia. These enzymes capable of inhibiting both formation and development of cancer cell [4].

Antifungal activity

The latex of papaya and fluconazole has synergistic action on the inhibition of Candida albicans growth [26]. 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 and minimum protein concentration for producing a complete inhibition was reported as about 138 mg/dl [27].

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 [28, 29, 30].

Anti-hypertensive activity

Papaya leaves decoction can be used as an anti-hypertensive agent. A study on villagers of Agboville located at 80 km of Abidjan (West Africa), showed the

hypotensive activity of papaya plant when administered orally [31].

Anti-amoebic activity

The cold macerated aqueous extract of matured papaya seeds has shown anti-amoebic activity against *Entamoeba histolytica* [32, 33].

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 [34, 35].

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 [36]. Another study showed the potent anti-sickling property of Carica papaya leaf extract in a dose- dependent manner [37]. Aqueous root extract of papaya when given orally at a dose of 10 mg/kg to rats produces significant increase in urine output and shows similar profiles of urinary electrolyte excretion to that of hydrochlorothiazide [38, 39].

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, steady and progressive hypo-glycemic and hypo-lipidemic effect[40].

Safety Profile

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. However, the leaves and root of Carica papaya contain cyanogenetic glucosides, which form cyanide leading to fatal consequences.

Conclusion

Papaya (*Carica papaya* Linn.) is well known for its exceptional and medicinal properties throughout the world. The whole Papaya plant including its leaves, seeds, ripe and unripe fruits and their juices is used as traditional medicine. The available literature does not reveal any adverse/toxic effects upon consumption. Quite a significant amount of work has been done on the biological activity and hence extensive investigation on its pharmacodyanamics, kinetics and proper standardization and clinical trials is needed to exploit their therapeutic utility to combat various diseases.

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