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Review Article

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A Brief Study on *Carica Papaya*- A Review

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Abstract

Carica papaya belongs to caricaceae family and it is commonly known as 'papaya'. *Carica papaya* is used in ayurvedic medicines from very long time. It is used as anti-inflammatory, antioxidant, diuretic, antibacterial, abortifacient, vermifuge, hypoglycemic, antifungal activity, antihelmenthic and immunomodulatory etc. Scientific evidences suggest their versatile biological function that supports its traditional use in different diseases. Phytochemical studies shows that plant *carica papaya* contains mainly alkaloids carpaine, pseudocarpaine, tannins, flavnoids, carcin, gamma terpine, glycoside carposides, sugars etc. The plant has effective pharmacological activity such as anti-inflammatory, antioxidant, diuretic, antibacterial, abortifacient, hypoglycemic, antifungal, antihelmenthic and immunomodulatory, hepatoprotective and anticonvulsant activity.

Keywords: Carica papaya, caricaceae, abortifacient, pharmacological activity.

Contents

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1. Introduction

Ayurveda, the Indian system of medicine, is attainment superior attention and popularity in many parts of the world. The disease protective and health promotive approach of Ayurveda, which takes into consideration the entire body, mind and spirit while dealing with the maintenance of health promotions, now enjoys increasing acceptability [1]. Ayurveda had developed certain dietary and therapeutic measures to delay ageing and rejuvenating whole functional dynamics of the body organs. This revitalization and rejuvenation is known as the 'Rasayana chikitsa' [2]**.** Herbs are staging a comeback and herbal 'renaissance' is happening all over the globe. The herbal products today symbolise safety in contrast to the synthetics that are regarded as unsafe to human and environment. Although herbs had been priced for their medicinal, flavoring and aromatic qualities for centuries, the synthetic products of the modern age

surpassed their importance, for a while. However, the blind dependence on synthetics is over and people are returning to the naturals with hope of safety and security [3].Ancient pharmacopoeias from different regions of the world have recorded numerous herbal medicines purported to have psychotropic potential. These offer a vast repertory of potential substances that can be developed into modern psychiatric pharmaceuticals. Indeed, nearly 25% of today's conventional drugs originated directly or indirectly from plants; many valuable psychoactive drugs, such as yohimbine, ephedrine, tubocurarine, and galanthamine, were discovered through the study of indigenous remedies [4].

2. Cultivation and Description

Formerly from southern Mexico (particularly Chiapas and Veracruz), Central America, and northern South America, the papaya is now cultivated in most tropical countries. In cultivation, it grows rapidly, fruiting within three years. It is, however, highly frost-sensitive, limiting its production to tropical climates. Temperatures below 29° Fahrenheit are greatly harmful if not fatal. In Florida, growth is generally limited to southern parts of the state. It also prefers sandy, well-drained soil as standing water will kill the plant within 24 hours [5]. The papaya has a moderately complicated means of reproduction. The plants are male, hermaphrodite, or female [6].The male trees are uncommon, but sometimes occur when homeowners collect their own seeds. Hermaphrodite trees are the commercial standard, producing a pear shaped fruit. These plants are self pollinated [7].

Papaya exhibits strong apical dominance rarely branching unless the apical meristem is removed, or damaged. Palmately-lobed leaves, usually large, are arranged spirally and clustered at the crown, although some differences in the structure and arrangement of leaves have been reported with Malaysian cultivars [8]. Generally, papaya cultivars are differentiated by the number of leaf main veins, the number of lobes at the leaf margins, leaf shape, stomata type, and wax structures on the leaf surface, as well as the colour of the leaf petiole. Papaya fruits are borne by both female and hermaphrodite trees, but their shapes differ. Fruits from female trees are round whereas fruits from hermaphrodite trees are elongated. The fruit is a berry that can range from 5 cm in diameter and 50 g in weight to 50 cm or longer, weighing 10 kg or more [9]. Papaya fruits are covered with a smooth thin green skin that turns to yellow or red when ripe. The flesh is succulent, varying in texture and colour ranging from yellow to orange to red.

Taxonomical Classification:

Kingdom	: Plantae	**Varnacular Names:**	
Subkingdom	: Tracheobionta	**Hindi**	**:** Papita
Division	: Magnoliophyta	**English**	**:** Papaya
Class	: Magnoliospida	**Eclectics**	**:** Papaw
Family	: Caricaceae	**Brazil**	**:** Mamao
Genus	: Carica L.	**Caribbean**	**:** Ababaï
Species	: Carica papaya L.	**Cuba**	**:** Fruta de bomba

Morphology:

Papaya is a polygamous species and it is difficult to identify a plant whether it is male, female or hermaphrodite. It is a tree reaching 3-10 m in height, with the habit of a palm; the fleshy stem marked by scars where leaves have fallen off, is surmounted by a terminal panache of leaves on long petioles and with 5-7 lobes. Flowers fragrant, trimorphous, usually unisexual-dioecious, male flowers in lax many-flowered, densely pubescent cymes at the tips of the pendulous, fistular rachis; female flowers large, solitary or in few flowered racemes, with a short thick rachis, fruit a large berry, varying widely in size, elongate to globose with a large central cavity, seeds black, tuberculous and enclosed in a transparent aril. The fruit bearing trees are less than 18 month old. The leaves and unripe fruit contain milky juice in which the protein ferment papain is present.

The papaya is a large tree-like plant, with a single stem growing with spirally arranged leaves confined to the top of the trunk. The lower trunk is conspicuously scarred where leaves and fruit were borne. The leaves are large, 50–70 centimeters (20–28 in) diameter. The tree is usually unbranched, unless lopped. The flowers are similar in shape to the flowers of the *Plumeria*, but are much smaller and wax-like. They appear on the axils of the leaves, maturing into the large 15–45 centimeters (5.9–18 in) long, 10–30 centimeters (3.9–12 in) diameter fruit. The fruit is ripe when it feels soft (like a ripe avocado or a bit softer) and its skin has attained amber to orange hue. The melon-like fruit varies in size and shape, and hangs from short, thick peduncles at the leaf axil. Its flowers are mostly dioecious and resemble each other until they start to develop sexual organs. The species is polygamous and can be classified into three sex types: male staminate, hermaphroditic (bisexual) and female pistillate. In addition, some plants can produce more than one kind of flowers [10].

Figure 1. Papaya plant

The pollination mechanism of the plant is not very well known but researchers 'Baker' and `Bawa' suggested that "pollination is performed by mimicry of the pistillate flowers to the staminate nectar-producing flowers." Another theory is that oxyalate packages in the anthers of the papaya play a role in pollination as an enrichment of the nectar. Whatever the case, we do know that the fruit is of great economic importance to tropical America where it is widely grown for its luscious fruit. The fruit which is orange-yellow when ripen, is a popular breakfast staple that is also used in jellies, preserves, fruit juices and as a beverage in certain Latin countries. In addition, the leaves and root of the plant are also used in a variety of dishes. The bark can also be used for rope making and the leaves as a soap substitute, is an excellent stain remover. Finally, in Java, even the flowers are eaten. [10]

3. Chemical constituents

Fruits:

Protein, fat, fibre, carbohydrates, minerals: calcium, phosphorous, 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; carpaine, 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.[10,11]

Juice:

N-butyric, n-hexanoic and n-octanoic acids, lipids; myristic, palmitic, stearic, linoleic, linolenic and cis-vaccenic and oleic acids.[11]

Seed:

Fatty acids, crude protein, crude fibre, papaya oil, sinigrin, Carpaine, benzylisothiocyanate, benzyl glucosinolate, glucotropacolin, benzylthiourea, hentriacontane, β-sitosterol, caricin and an enzyme myrosin, leaves related alkaloids, flavonoids, saponins, tannins, cardiac glycoside, anthraquinones and cardinolodes are present.[11]

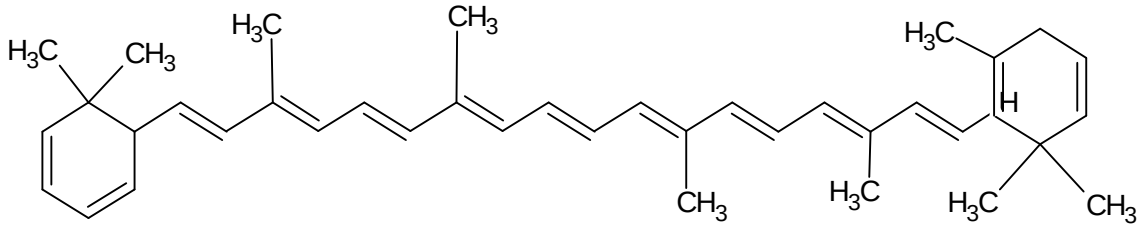

Figure 2. Beta- carotene

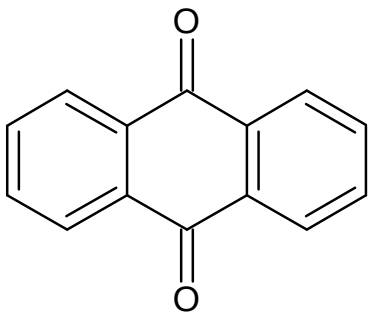

Figure 3. Anthraquinone

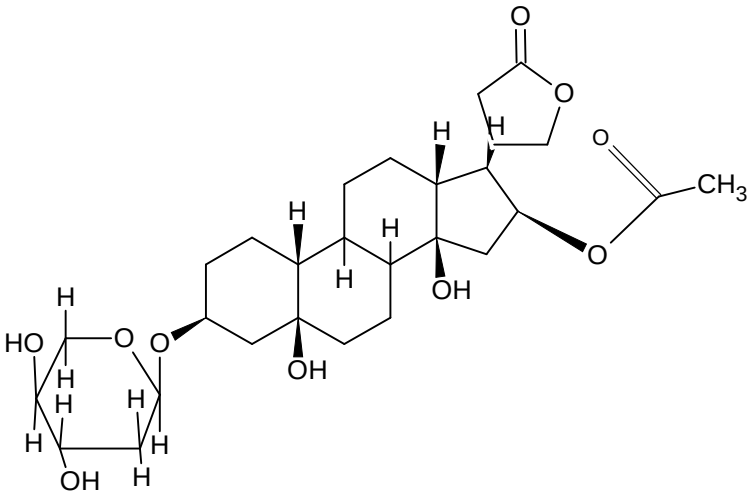

Figure 4. Cardiac glycoside

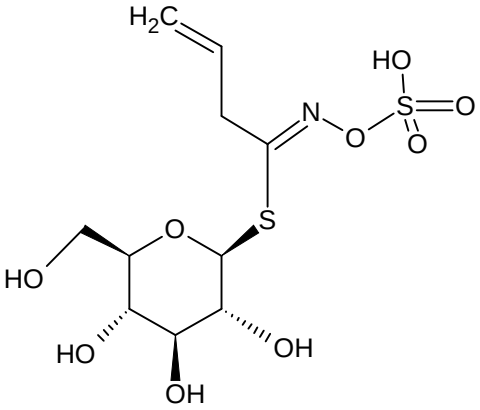

Figure 5. Sinigrin

Root:
Carposide and enzyme myrosin.
Leaves:
Alkaloids carpain, pseudocarpain and dehydrocarpaine 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.[11]

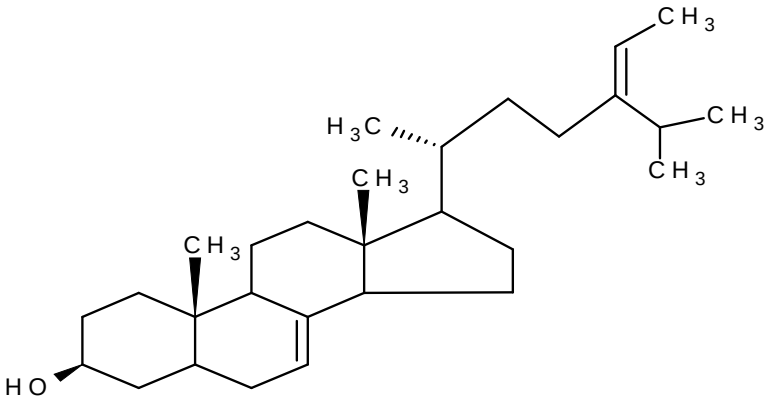

Figure 6. Avenasterol

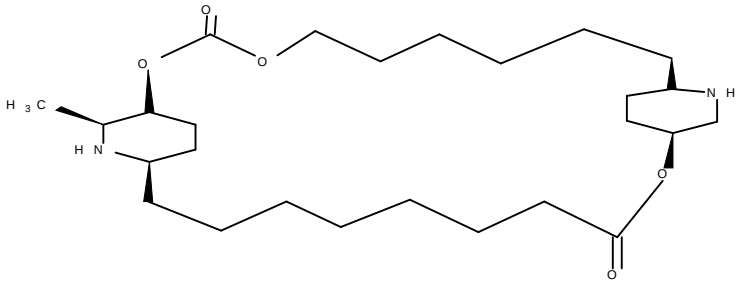

Figure 7. Carpaine

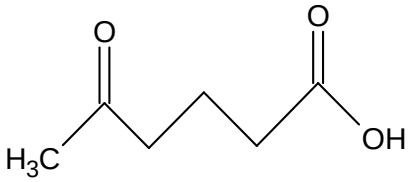

Figure 8. Glutaric acid

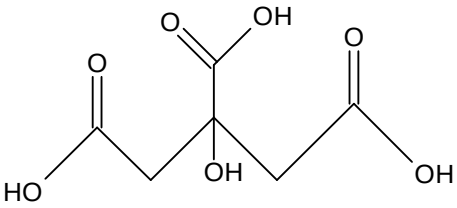

Figure 9. Citric Acid

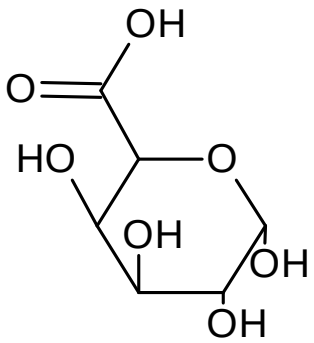

Figure 10. Galactouronic acid

Nutrient contents of the papaya

Papaya is a major fruit crop worldwide that is primarily consumed as fresh fruit. Papaya fruits consist mostly of water and carbohydrate, low in calories and rich in natural vitamins and minerals, particularly in vitamins A and C, ascorbic acid and potassium [12].

Nutritional value per 100 g (3.5 oz)	
Energy	179 kJ (43 kcal)
Carbohydrates	10.82 g
Sugars	7.82 g
Dietary fiber	1.7 g
Fat	0.26 g
Protein	0.47 g
Vitamin A equiv.	47 µg (6%)

beta-carotene	274 µg (3%)
lutein and zeaxanthin	89 µg
Thiamine (vit. B_1)	0.023 mg (2%)
Riboflavin (vit. B_2)	0.027 mg (2%)
Niacin (vit. B_3)	0.357 mg (2%)
Pantothenic acid (B_5)	0.191 mg (4%)
Vitamin B_6	0.038 mg (3%)
Folate (vit. B_9)	38 µg (10%)
Vitamin C	62 mg (75%)
Vitamin E	0.3 mg (2%)
Vitamin K	2.6 µg (2%)
Calcium	20 mg (2%)
Iron	0.25 mg (2%)
Magnesium	21 mg (6%)
Manganese	0.04 mg (2%)
Phosphorus	10 mg (1%)
Potassium	182 mg (4%)
Sodium	8 mg (1%)
Zinc	0.08 mg (1%)
Lycopene	1828 µg
Link to USDA Database entry Percentages are roughly approximated using US recommendations for adults. Source: USDA Nutrient Database (www.wikipedia.com)	

A green papaya fruit has been reported for its nutrient content, which (per 100 g) provides 26 calories, 92.1 g H2O, 1.0 g protein, 0.1 g fat, 6.2 g total carbohydrate, 0.9 g fiber and 0.6 g ash. USFDA National Nutrient database recorded an orange-freshed papaya (per 100 g) contained 39 calories, 88.8 g H2O, 0.61 g protein, 0.14 g fat, 9.81 g total carbohydrate, 1.8 g fiber, 0.61 g ash [13]. Oyoyede tested the chemical profile of unripe pulp of *carica papaya* and reported papaya fruit was very rich in carbohydrate (42.28% starch, 15.15% sugar) but low levels of fat [14]. Papaya fruit also contains high levels of vitamin C (51.2 mg/100g), vitamin A precursors including β-carotene (232.3 µg/100g), and β-cryptoxanthin (594.3 µg/100g), as well as magnesium (19.2-32.7 mg/100g), which has been reported by Wall [15]. The papaya seeds contain balance-nutrients which consist of protein (24.3%), fatty oil (25.3%) and total carbohydrate (32.5%). Although it contains significantly high level of unsaturated fatty acids, papaya seeds seem not to be good oil seeds. In some tropical countries, papaya leaves are used as food sources, which can be cooked by stir fry. The papaya leaves (per 100 g), were reported by Duke, contains 74 calories, 77.5 g H2O, 7.0 g. protein, 2.0g fat, 11.3 g total carbohydrate, 1. 8 g fiber, 2.2 g ash, 344 mg Ca, 142 mg P, 0.8 mg Fe, 16 mg Na, 652 mg K, 11,565 ug β-carotene equivalent, 0.09 mg thiamine, 0.48 mg riboflavin, 2.1 mg niacin, and 140 mg ascorbic acid, as well 136 mg vitamin E[13].

Medicinal Uses of Different Parts [16, 17, 18]

Latex: It is used as Anthelmintic, relieves dyspepsia, cure diarrhoea, pain of burns and topical use, bleeding haemorrhoids, stomachic, whooping cough.

Fruits: Ripe fruits can be used as stomachic, digestive, carminative, diuretic, dysentery and chronic diarrhea, expectorant, sedative and tonic relieves obesity, bleeding piles, wounds of the urinary tract, ringworm and skin

disease psoriasis. Unripe fruits are used as diuretic, laxative, dried fruit reduces enlarge spleen and liver, used in snake bite to remove poison, abortificient and anti implantation activity, anti bacterial activity.

Seeds: Carminative, emmenagogue, vermifuge, abortificient, counterirritant, as paste in ringworm disease, psoriasis, antifertility agent in males.

Seed juice: Bleeding piles and in large liver and spleen.

Root: Abortificient, diuretic, is checking irregular bleeding from uterus and anti fungal activity, piles.

Leaves:

Young leaves used as vegetables, jaundice, urinary complains, urinary tract infection and gonorrhea, dressing wounds, anti bacterial activity, vermifuge in colic, fever, beriberi, abortion, asthma.

Flowers: Emmengogue, jaundice, febrifuge and pectoral properties.

Stem bark: Jaundice, antifungal activity, antihelmantic activity.

General uses

Papaya can be used as a diuretic (the roots and leaves), anthelmintic (the Leave and seed) and to treat bilious conditions (the fruit). Parts of the plant are also used to combat dyspepsia and other digestive disorders (papaya contains a proteolytic enzyme which soothes the stomach and aides in digestion) and a liquid portion has been used to reduce enlarged tonsils. The juice is used for warts, cancers, tumors, corns and skin defects while the root is said to help tumors of the uterus. In Africa a root infusion is also used for syphilis and the leaf is smoked to relieve asthma attacks. The Javanese believes that eating papaya prevents rheumatism and in Cuba the latex is used for psoriasis, ringworm and the removal of cancerous growth.

Medicinal and Pharmacological properties

Many biologically active substances have been isolated from papaya and studied for their pharmacological action. An antifungal chitinase has been gene cloned and characterized from papaya fruit. The chitinase is classified as class IV chitinase based on its amino acid sequence homology with other plant chitinases. The recombinant papaya chitinase also has antibacterial activity [19]. The purified chemopapain from commercially available spray dried latex of the fruits has shown immunological properties [20].

The anthelmintic activity of papaya seed has been variously ascribed to carpaine (an alkaloid) and carpasemine (later identified as benzyl thiourea) and benzylisothiocyanate [21], cysteine proteinases from papaya fruit have also been reported [22]. Carpaine, an alkaloid with an intensively bitter taste and a strong depressant action on the heart, has been obtained from the fruit and seed, but especially from the leaves. Biological activities of papaya are reported with the crude extracts and different fractions from latex, seed, leaf, root, stem bark and fruit. However, crude extracts of different parts of papaya have been used as traditional medicine for the treatment of various diseases. However, apart from these, there are several reports on the therapeutic properties and pharmacological actions of papaya based on modern scientific investigations. Some have been discussed below.

Antifungal

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 (as indicated by transmission electron microscopy observations) [23]. Latex alone is statically effective on *C. albicans* when added to a culture during the exponential growth phase and approximately 60% was achieved. This fungistatic effect is the result of cell wall degradation due to a lack of polysaccharides constituents in the outermost layers of the fungal cell wall and release of cell debris into the culture medium [24].

Antimalarial Activity

The petroleum ether extract of the rind of raw papaya fruit exhibits significant antimalarial activity. There may be significant commercial potential in extracting the active element from this plant, which grows abundantly throughout the tropics and the rind of which is discarded as waste, can be exploited for antimalarial activity [25].

Antihelmenthic activity

The latex of papaya has anthelmintic efficacy against *Heligmosomoides polygyrus* in experimentally infected mice, which suggests its potential role as an anthelmintic against potent intestinal nematodes of mammalian hosts [26]. It also has anthelmintic activity against natural infection of *Ascaris suum* in pigs and found to be 100% effective at the dose of 8g/kg body weight [27]. The plant extracts of papaya possesses a dose dependent significant effect on the egg, infective larvae and adult worms of *Trichostrongylus colubriformis* [28]. Alcoholic extracts of papaya shows potential in vitro anti-parasitic action, which affects eggs, infective larvae and adult *Haemonchus contortus* [29].

Antimicrobial activity

The seed of papaya has antimicrobial activity against *Trichomonas vaginalis* trophozoites. The report suggests the use of papaya seed in urinogenital disorder like trichomoniasis with care to avoid toxicity [30]. The seed and pulp of papaya was shown to be bacteriostatic against several enteropathogens such as *Bacillus subtilis, Enterobacter cloacae, Escherichia coli, Salmonella typhi, Staphylococcus aureus, Proteus vulgaris, Pseudomonas aeruginosa* and *Klebsiella pneumoniae* by the agar cup plate method [31]. Purified extracts from ripe and unripe fruits also produces very significant antibacterial activity on *S. aureus, Bacillus cereus, E. coli, P. aeruginosa* and *Shigella flexneri* [32].

Anti-amoebic actitvity

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

Male antifertility

Seed extract showed pronounced hypertrophy and hyperplasia of pituitary gonadotrophs. Whereas the male rats treated with seed extract revealed gradual degeneration of Germ, Sertoli and Leydig cells as well as germinal epithelium, which confirmed its antifertility activity [34]. Aqueous extract of papaya seeds, 3 weeks after commencement of administration showed that the lumina of the somniferous tubules were more prominent and empty in the experimental animals with no evidence of spermatids and spermatozoa [35].

Diuretic

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 [36].

Female antifertility

Sharma and Mahanta have reported that the composite root extract containing papaya root extract as one of the constituent, induces morphological changes in the endometrial surface epithelium in albino rat uterus. The characteristic smooth regular pattern of normal epithelium appears to have changed at places by haphazardly oriented groups of cells and loss of microvilli indicating a disorganized picture [37].Where as seeds aqueous extract has shown abortifacient properties on female Sprague Dawley rats [38] and the petroleum ether, alcoholic and aqueous extracts inhibits ovulation in rabbits [39].

Immunomodulatory activity

Fermented papaya preparation exerts both immunomodulatory and antioxidant activity in the macrophage cell line RAW 264 and it is a macrophage activator, which augments nitric oxide synthesis and TNF-alpha secretion independently of lipopolysaccharides [40]. The antioxidant cocktail derived from fermentation of unpolished rice, papaya and sea weeds with effective microorganisms of lactic acid bacteria, yeast and photosynthetic bacteria has shown inhibition of lipid peroxidation in vivo, a point dependent on the concentrations of bioactive flavonoids [41].

Nephroprotective activity

Maximum nephroprotection was offered by the extract at 400 mg/kg/day CP*E* which lasted up to 3 hours post-CCl4 exposure and these biochemical evidences were corroborated by improvements in the renal histological lesions induced by CCl4 intoxication. Studies showed that CP*E* has nephroprotective effect on CCl4 renal injured rats, an effect which could be mediated by any of the phyto components present in it via either antioxidant and/or free radical scavenging mechanisms. *Carica papaya* plant has the nephroprotective activity [42].

Antisickling activity

The antisickling properties of fermented dried unripe fruit pulp of *Carica papaya* have been reported. The extract got from the materials incubated for 5 days indicated as SP5, was found to have the highest antisickling properties with 93% inhibitory and 84% reversal activities. The concentration of the day 5 extract was further varied. 0.2 ml was found to be the optimum volume of the test extracts [43].

Anti-tumor activity

Aqueous extract of *Carica papaya* leaves exhibits anti-tumor activity and it has been reported. In PBMC, the production of IL-2 and IL-4 was reduced following the addition of *Carica papaya* extract, where as that of IL-12p40, IL-12p70, IFN-γ and TNF-α was enhanced without growth inhibition [44].

4. Conclusion

Papaya plant is mainly used as the food ingredient throughout the world because of its fruits and its nutritive values. From the above studies about the papaya plant shows that the plant's leaves, stem, fruits and seeds also contains different chemical constituents such as Alkaloids carpain, pseudocarpain, dehydrocarpaine I and II, choline, carposide, vitamin C and E. Carposide and an enzyme myrosin , sinigrin, Carpaine, benzylisothiocyanate, benzyl glucosinolate, glucotropacolin, benzylthiourea, hentriacontane, β-sitosterol, caricin, leaves related alkaloids, flavonoids, saponins, tannins, cardiac glycoside, anthraquinones and cardinolodes etc. many of the pharmacological activities has been done on the papaya plants. But hence extensive investigations on its pharmacodynamics, kinetics, proper standardization and clinical trials are needed to exploit their therapeutics utility to cure many diseases.

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