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Review

Drug bioavailability and traditional medicaments of commercially available papaya: A review

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Papaya (*Carica papaya* L.) is regarded as an excellent source of ascorbic acid, a good source of carotene, riboflavin and a fair source of iron, calcium, thiamin, niacin, pantothenic acid, vitamin B-6 and vitamin K. Each and every part of papaya plant from root to shoot is used for medicament purposes. Ripe papaya fruit is used in jam, jelly, marmalade, puree, wine, nectar, juice, frozen slices, mixed beverages, ice-cream, powder, baby food, cooked in pie, pickled, sweet meat, concentrated and candied items. Young leaves are cooked and eaten like spinach, animal feed, tenderize meat, stomach trouble, purgative effects and abortion may result from consumption of the dried papaya leaves. The flowers are sometimes candied and used for making sprays. Papaya seeds are rich source of amino acids; scented oil was extracted, used in treatment of sickle cell disease and poisoning related disorders. Papain is used in food processing to tenderize meat, clarify beer and juice, produce chewing gum, coagulate milk, prepare cereals, and produce pet food, also to treat wool and silk before dying, de-hair hides before tanning, adjunct in rubber manufacturing and proteolytic enzymes (papain and chymopapain). In folk medicine, latex is used on boils, warts, freckles, abortion, expel roundworms, salt making, relieve asthma stomach troubles, purgative for horses, treatment for genito-urinary ailments, tumer destroying, making herbal tea, digestive and aid in chronic indigestion, weight loss, obesity, arteriosclerosis, high blood pressure, blood purifier and weakening of heart etc. It has also several antibiotic, allergic, anti-nutritional and toxic properties.

Key words: Pawpaw, drug bioavailability, traditional medicaments, industrial uses, papain, nutritive value.

INTRODUCTION

Papaya (*Carica papaya* L.) belongs to the family Caricaceae, one of the most important fruits cultivated throughout the tropical and subtropical regions of the world (Anonymous, 2000). Papaya known by different names in world *viz*. Arabic (fafay, babaya); Burmese (thimbaw); Creole (papayer,papaye); English (bisexual pawpaw, pawpaw tree, melon tree, papaya); Filipino (papaya, lapaya, kapaya); French (papailler, papaye, papayer); German (papaya, melonenbraum); Indonesian (gedang, papaya); Javanese (kates); Khmer (lhong, doeum lahong); Lao (Sino-Tibetan) (houng); Luganda (papaali); Malaya (papaya, betek, ketalah, kepaya); Sinhala (pepol); Spanish (figuera del monte, fruta bomba, papaya, papaita, lechosa); Swahili (mpapai); Thai (ma kuai thet, malakor, loko); Tigrigna (papayo); Vietnamese (du du). In Australia, red and pink-fleshed cultivars are often known as ‘papaya’ to distinguish them from the yellow-fleshed fruits, known as ‘pawpaw’. In India, locally known as pappaiya (Bengali), papeeta (Hindi), papaya (English) and pappali or pappayi (Tamil). It is native of tropical America and introduced from Philippines through Malaysia to India during 16th Century. It is cultivated in

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Figure 1. Mature pawpaw tree cv. Pusa Dwarf.

Figure 2. Pawpaw tree showing ripe and unripe fruit of cv. Pusa Majesty.

the world in an area of 3.83 lakh ha with a production of 8.05 million tones. Brazil is one of the largest producer worldwide that continues to show rapid growth. In India, it is cultivated in 73,000 ha with a production of 23.17 lakh tones (Singh et al., 2010). Pawpaw has gained more importance owing to its high palatability, fruitability throughout the year, early fruiting and highest productivity per unit area and multifarious uses like food, medicine and industrial input. Being a highly remunerative and short duration fruit crop, it has tremendous impact on economic and nutritional propitiations. It needs plentiful rainfall or irrigation but must have good drainage. Papayas grow and produce well on a wide variety of soils. The tree (Figure 1) often develops a strong taproot shortly after planting. The well-drained or sandy loam soil with adequate organic matter is most important for the papaya cultivation (Anonymous, 2009).

Pawpaw fruit is consumed at unripe and ripe stages (Figure 2). Unripe fruits are cooked and utilized as vegetables, processed products and as a source of papain (Mendoza, 2007). Ripe papaya is consumed as a fresh fruit and is also used for processing. At unripe stage, the fruit is consumed as a cooked vegetable where papaya is widely grown (Mano et al., 2009). In Thailand, unripe fruits are used as ingredients in papaya salad and cooked dishes (Sone et al., 1998). In Puerto Rico, unripe fruits are canned in sugar syrup and sold either in local markets or exported (Morton, 1987). The preserved unripe papaya fruit, which contains high sugar content, is used as an additive in ice cream. Green papaya fruit must be cooked (often boiled) prior to consumption to denature the papain in the latex (Odu et al., 2006). Ripe papaya fruits and papaya products are consumed by humans for their flavour and nutritional value (Saran, 2010). Unripe papaya fruits are consumed both as a cooked vegetable and processed products (Morton, 1987).

NUTRITIVE VALUE

The main constituent of *Carica papaya* fruit is water like other fruits. The dry matter content increases during fruit development from unripe to ripe stages (Chavasit et al., 2002). Agro-climatic conditions or cultivation practices, climate, seasons, site and cultivars all these factors can influence the nutrient content of papaya (Hardisson et al., 2001; Wall, 2006; Marelli de Souza et al., 2008; Charoensiri et al., 2009). Stages of maturity also affect the nutrient content of fruits like the vitamin C content of pawpaw increases with ripening (Bari et al., 2006). Consequently, when comparing the nutrient content of papaya fruits, it is important to compare fruits harvested and stored under similar conditions (Hernandez et al., 2006).

The major components of papaya dry matter are carbohydrates (USDA, 2009). There are two main types of carbohydrates in papaya fruits, the cell wall polysaccharides and soluble sugars. During an early stage of fruit development, glucose is the main sugar. The sucrose content increases during the ripening process and can reach levels up to 80% of total sugars (Paull, 1993). Among the major soluble sugars in ripe fruits (glucose, fructose and sucrose), sucrose is most prevalent. During fruit ripening, the sucrose content was shown to increase from 13.9 ± 5.0 mg/g fresh weight in green fruit to 29.8 ± 4.0 mg/g fresh weight in ripe fruits (Gomez et al., 2002). The total dietary fiber content of ripe fruit varies from 11.9 to 21.5 g/100 g dry matter (Puwastien et al., 2000; Wills et al, 1986; Saxholt et al, 2008). The crude protein content ranges from 3.74 to 8.26 g/100 g dry matter and aspartic acid is the most abundant amino acid in ripe fruits followed by glutamic acid. chemists of Italy and Somalia collaboratively identified 18 amino acids in seeds as given in descending order *viz*., glutamic acid, arginine, proline, and aspartic acid in the endosperm; and proline, tyrosine, lysine, aspartic acid, and glutamic acid in the sarcotesta. The

Table 1. Food value per 100 g of edible portion.

Ingredient	Fruit	Leaves
Calories	23.10-25.80	-
Moisture	85.90-92.60 g	83.30%
Protein	0.081-.34 g	5.60%
Fat	0.05-0.96 g	0.4%
Carbohydrates	6.17-6.75 g	8.3%
Crude fiber	0.50-1.30 g	1.0%
Ash	0.31-.66 g	1.4%
Calcium	12.90-40.80 mg	0.406% (CO)
Phosphorus	5.3-22.0 mg	-
Iron	0.25-0.78 mg	0.0064%
Carotene	0.005-0.676 mg	28,900 I.U.
Thiamine	0.021-0.036 mg	-
Riboflavin	0.024-058 mg	-
Niacin	0.23-555 mg	-
Ascorbic acid	35.5-71.3 mg	38.6%
Tryptophan	4-5 mg	-
Methionine	1 mg	-
Lysine	15-16 mg	-
Magnesium	-	0.035%
Phosphoric acid	-	0.225%

major organic acids found in ripe papaya are citric acid (335 mg/100 g FW) followed by L-malic acid (209 mg/100 g FW), qiunic acid (52 mg/100 g FW), succinic acid (52 mg/100 g FW), tartaric acid (13 mg/100 g FW), oxalic acid (10 mg/100 g FW), and fumaric acid (1.1 mg/100 g FW) (Hernandez et al., 2009).

Pawpaw is regarded as an excellent source of vitamin C (ascorbic acid); a good source of carotene, riboflavin and a fair source of iron, calcium, thiamin, niacin, pantothenic acid, vitamin B-6 and vitamin K (Bari et al., 2006; Adetuyi et al., 2008; Saxholt et al., 2008). Carotenoid content (13.80 mg/100 g dry pulp) of papaya is low compared to mango (50 to 260 mg/100 g dry pulp), carrot and tomato (Saran, 2010). The major carotenoid is cryptoxanthin. Carotenoids are responsible for the flesh colour of papaya fruit mesocarp. Red-fleshed papaya fruits contain five carotenoids, *viz*. beta-carotene, beta-cryptoxanthin, beta-carotene-5-6-epoxide, lycopene and zeta-carotene. Yellow-fleshed papaya contains only three carotenoids, *viz*. beta-carotene, beta-cryptoxanthin and zeta-carotene (Chandrika et al., 2003). Pawpaw is a source of vitamin C with amounts varying between the maturation stages (Bari et al., 2006; Hernandez et al., 2006). The total lipid content in ripe papaya fruit varies between 0.92 and 2.2 g/ 100 g dry matter. Papaya contains a low level of fatty acids. Palmitic acid and linolenic acid are two major fatty acids in papaya. Fatty acid composition change during fruit ripening and no significant difference are observed in lipid composition with maturity of papaya fruits. The minimum and maximum levels of constituents in ripe papaya fruit and current mature leaves were given in Table 1. The edible portion of fruit contains macro-minerals include sodium, potassium, calcium, magnesium and phosphorus. The micro-minerals include iron, copper, zinc, manganese and selenium (USDA, 2009).

HOME CONSUMPTION

Fruit

Ripe papaya fruit is most commonly consumed like a melon. It can be peeled, the seeds removed, cut into pieces and served as a fresh fruit. It can also be cut into wedges and then served with lime or lemon. Ripe pawpaw is also used in jam, jelly, marmalade and other products containing added sugar. Other processed products include puree or wine, nectar (Matsuura et al., 2004;), juice, frozen slices or chunks, mixed beverages, papaya powder, baby food, concentrated and candied items (OECD, 2005; OGTR, 2008). Papaya puree is prepared from fully ripe peeled fruit with the seeds removed. Papaya flesh is pulped, passed through a sieve and thermally treated. Papaya puree is an important intermediate product in the manufacture of several products such as beverages, ice cream, jam and jelly (Brekke et al., 1972). Papaya nectar is prepared from papaya puree and consumed either alone or with other fruit juices such as passion fruit juice and pineapple juice (Brekke et al., 1972). It should be stored at or below 24°C to maintain acceptable quality (Brekke et al., 1976). Ripe papayas are most commonly eaten fresh, merely peeled, seeded, cut in wedges and served with a half or quarter of lime or lemon. Sometimes a few seeds are left attached for those who enjoy their peppery flavor but not many should be eaten because the seed extract of papaya causing sterility in mammals also. The flesh is often cubed and served in fruit salad or fruit cup. Firm-ripe papaya may be seasoned and baked for consumption as a vegetable. Ripe flesh is commonly made into sauce for short cake or ice cream sundaes, or is added to ice cream just before freezing; or is cooked in pie, pickled, or preserved as marmalade or jam. Papaya and pineapple cubes, covered with sugar syrup, may be quick-frozen for later serving as dessert. Half-ripe fruits are sliced and crystallized as a sweet meat for consumption. Unripe papaya is never eaten raw because of its latex content. Raw green papaya is frequently used in Thai and Vietnamese cooking. Even for use in salads, it must first be peeled, seeded, and boiled until tender, then chilled. Green papaya is frequently boiled and served as a vegetable. Cubed green papaya is cooked in mixed vegetable soup. Green papaya is commonly canned in sugar syrup in Puerto Rico for local consumption and for export. Green papayas for canning in Queensland must be checked for nitrate levels. High nitrate content causes damage of ordinary cans, and all papayas with over 30 ppm nitrate must be packed in cans lacquered on the inside. Australian growers are hopeful that the papaya can be bred for low nitrate uptake. A lye process for batch peeling of green papayas has proven feasible in Puerto Rico. The fruits may be immersed in boiling 10% lye solution for 6 min, in a 15% solution for 4 min, or a 20% solution for 3 min. They are then rapidly cooled by a cold water bath and then sprayed with water to remove all softened tissue. Best proportions are 0.45 kg of fruit for every 3.8 L of solution.

Drying and freeze drying are used to reduce the moisture content of papaya chunks and slices. Powdered or dried papaya can be used as a flavoring agent, meat tenderizer or as an ingredient in soup mixes (Sing field, 1998). Papaya seeds are a good source of 18 amino acids and edible oil. Seeds are sometimes also used to adulterate with whole black pepper (Morton, 1987).

Leaves, pomace and fruit skin

Young leaves are cooked and eaten like spinach in the East Indies. Mature leaves are bitter and must be boiled with a change of water to eliminate much of the bitterness. Crushed leaves may be used to tenderize meat; however, stomach trouble, purgative effects and abortion may result from consumption of the dried papaya leaves (Morton, 1987). Pawpaw leaves contain the bitter alkaloids; carpaine and pseudocarpaine, which act on the heart and respiration like digitalis, but are destroyed by heat. In addition, two previously undiscovered major piperideine alkaloids, dehydrocarpaine I and II, more important than carpaine, were reported. Papaya pomace, skins, leaves, and other by-products of papaya processing may find use in animal feed applications (Babu et al., 2003; Fouzder et al., 1999; Munguti et al., 2006; Reyes and Fermin, 2003; Alobo, 2003; Ulloa et al., 2004).

Flower and stem

Sprays of male flowers are sold in Asian and Indonesian markets and in New Guinea for boiling with several changes of water to remove bitterness and then eating as a vegetable. In Indonesia, the flowers are sometimes candied. Young stems are cooked and served in Africa. Older stems, after peeling, are grated, the bitter juice squeezed out, and the mash mixed with sugar and salt.

INDUSTRIAL USES

Many biologically active phytochemical from different parts of papaya tree (latex, seed, leaf, root, stem, bark and fruit) have been isolated from papaya and studied for their potency (Table 2). Some of these parts are known to be analgesic, amoebicidic, antibacterial, cardiotonic, cholagogue, digestive, emenagogue, febrifuge, hypotensive, laxative, pectoral, stomachic and vermifugic (Boshra and Tajul, 2013).

Seed

Papaya seeds are rich source of amino acids especially in the sarcotesta. A yellow to brown, faintly scented oil was extracted from the sundried, powdered seeds of unripe papayas at the Central Food Technological Research Institute, Mysore, India. White seeds yielded 16.1% and black seeds 26.8% and it were suggested that the oil might have edible and industrial uses. The seeds are used in treatment of sickle cell disease. Air dried papaya seeds with honey showed significant effect on human intestinal parasites without significant side effect. Consumption of papaya seed is cheap, natural, harmless, readily available, mono-therapeutic, and prevent against intestinal parasitosis especially in tropical communities.

In India, the fruit is widely classified as harmful in pregnancy, hence pregnant women are strictly forbidden from eating it for fear of its teratogenic and abortifacient effects (Adebiyi et al., 2003). Chinoy et al. (2006) proved the anti-fertility, anti-implantation and abortifacient properties of extracts from papaya seeds. It has been established in males that the seeds of *C. papaya* are potential anti-fertility drugs (Lohiya et al., 2005). Pawpaw seeds are used to produce an indigenous Nigerian food condiment called ‘daddawa’, the Hausa word for a fermented food condiment (Dakare, 2004). Fermented seeds have no effects on litters of rats (Abdulazeez et al., 2009), whereas, those effects were apparent when the unfermented extract was administered (Abdulazeez, 2008). Normal consumption of ripe papaya during pregnancy may not be dangerous, however unripe or semi-ripe papaya (which contains high amount of latex that produces marked uterine contraction) could be unsafe for consumption during pregnancy (Krishna et al., 2008). Antihelmintic activity of papaya seed has been predominantly attributed to carpaine (an alkaloid) and carpasemine (later identified as benzyl thiourea). Carpaine has an intensively bitter taste and a strong depressant action on health. It is present not only in papaya fruit and seed but also in its leaves. Benzylisothiocyanate (BITC), the main bioactive compound in *C. papaya* seeds (Kermanshai et al., 2001) has been shown to be responsible for the anti-fertility effect (Adebiyi et al., 2003). BITC is capable of damaging the endometrium, making the uterus non-receptive and, thus, affecting adversely the implantation (Adebiyi et al., 2003).

Green fruit

Papaya latex is obtained by cutting the green fruit surface

Table 2. Constituents and medicinal uses of different parts of the papaya tree (Krishna et al., 2008; Boshra and Tajul, 2013).

Part	Constituents	Medicinal uses
Fruits		
Ripe fruits	Protein, fat, fiber, carbohydrates, mineral: calcium, phosphorous, iron, vitamin-C, thiamine, riboflavin, niacin and carotene, amino acids.	Stomachic, digestive, carminative diuretic, dysentery and chronic diarrhoea, expectorant, sedative and tonic, relieves obesity, bleeding piles, wound of urinary tract, ringworm and skin disease psoriasis
Unripe fruits	Citric and malic acids.	Laxative, diuretic, dried fruit reduces enlarged spleen and liver, use snakebit to remove poison, abortifaciant, anti- implantation activity and antibacterial activity.
Juice	N-butyric acids, n-hexanoic and n-octanoic acids, lipids, myristic, planets, stars, linolec, linolenic, *cis*-vaccenic and oleic acid	Flower: Jaundice, emmenagogue, febrifuge and pectoral properties
Seed	Fatty acids, crude protein, crude fiber, papaya oil, carpaine, benzylisothiocynate, benzylglucosinolate, glucotropacolin, bemzylthiourea, hentriacontane, ß-sitostrol, caressing and enzyme myrosin.	Seed: Carminative, emmenagogue, vermifuge, abortifaciant, counter irritant, as paste in the treatment of ringworm, pasoriasis and anti-fertility agent.Seed juice: Bleeding piles and enlarged liver and pectoral properties
Root	Carposide and enzyme myrosin	Abortifacient, diuretic, checking irregular bleeding from the uterus, piles, antifungal activity.
Leaves	Alkalodis carpain, pseudocarpain and dehyrocarpaine, choline, carposide, vitamin C and E.	Young leaves as vegetable, Jaundice (fine paste), urinary complaints, gonorrhoea (infusion) dressing wound fresh leave and antibacterial.
Bark	ß-sitosterol, glucose, fructose, sucrose and xylitol.	Jaundice, anti-haemolytic activity, STD, store teeth (inner bark) and anti-fungal activity.
Latex	Proteolytic enzymes, papain, chemopapain, glutamine, cyclortransferase, chymopapains A, B, C, peptidase A, B and lysozymes.	Anathematic, relieves dyspepsia, cures diarrhoea, pain of burn, topical use, bleeding haemorrhoids, stomachic and whooping cough.

with containers over a couple of days. The latex is then sun dried or oven dried, and ground into powder. A proteolytic enzyme, papain, is purified from papaya latex and used in the food and feed industries, as well as the pharmaceutical and cosmetic industries (OGTR, 2008). Papain is used in food processing to tenderize meat, clarify beer and juice, produce chewing gum, coagulate milk, prepare cereals, and produce pet food (Morton, 1987). The latex of the papaya plant and its green fruits contains two proteolytic enzymes, papain and chymopapain. The latter is most abundant but papain is twice as important. The latex is obtained by making incisions on the surface of the green fruits early in the morning and repeating every 4 or 5 days until the latex ceases to flow. The tool is of bone, glass, sharp-edged bamboo or stainless steel (knife or razor blade). Ordinary steel stains the latex. Tappers hold a coconut shell, clay cup, or glass, porcelain or enamel pan beneath the fruit to catch the latex, or a container like an "inverted umbrella" is clamped around the stem. The latex coagulates quickly and, for best results, is spread on fabric and oven-dried at a low temperature, then ground to powder and packed in tins. Sun-drying tends to discolor the product. One must tap 1,500 average-size fruits to gain 680 g of papain. The lanced fruits may be allowed to ripen and can be eaten locally, or they can be employed for making dried papaya "leather" or powdered papaya, or may be utilized as a source of pectin. Because of its papain content, a piece of green papaya can be rubbed on a portion of tough meat to tenderize it. Sometimes a chunk of green papaya is cooked with meat for the same purpose. One of the best known uses of papain is in commercial products marketed as meat tenderizers, especially for home use. A modern development is the injection of papain into beef cattle a half-hour before slaughtering to tenderize more of the meat than would normally be tender. Papain treated meat should never be eaten but should be cooked sufficiently to inactivate the enzyme. The tongue, liver and kidneys of injected animals must be consumed quickly after cooking or utilized immediately in food or feed products, as they are highly perishable.

Papain has many other practical applications. It is used to clarify beer, also to treat wool and silk before dying, to de-hair hides before tanning, and it serves as an adjunct in rubber manufacturing. It is applied on tuna liver before extraction of the oil which is thereby made richer in vitamins A and D, It enters into toothpastes, cosmetics and detergents, as well as pharmaceutical preparations to aid digestion. Carpaine, an alkaloid found in papaya leaves, has also been used for medicinal purpose (Sankat and Maharaj, 2001).

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 and a liquid portion has been used to reduce enlarged tonsils. In addition, the juice is used for warts, cancers, tumors, corns and skin defects while the root is said to help tumors of the uterus. Root infusion is also used for syphilis, and the leaf is smoked to relieve asthma attacks. The papaya eating prevents rheumatism and the latex is used for psoriasis, ringworm and the removal of cancerous growth (Nwofia et al., 2012).

Papain has been employed to treat ulcers, dissolve membranes in diphtheria, and reduce swelling, fever and adhesions after surgery. With considerable risk, it has been applied on meat impacted in the gullet. Chemopapain is sometimes injected in cases of slipped spinal discs or pinched nerves. Precautions should be taken because some individuals are allergic to papain in any form and even to meat tenderized with papain.

ANTIBIOTIC ACTIVITY

The extracts of ripe and unripe papaya fruits and of the seeds are active against gram-positive bacteria. Strong doses are effective against gram-negative bacteria. The substance has protein-like properties.

The fresh crushed seeds yield the aglycone of glucotropaeolin benzyl isothiocyanate (BITC) which is bacteriostatic, bactericidal and fungicidal. A single effective does is 5 g seeds (25-30 mg BITC) for the same. Papaya also found effective in curing post-operative infection in a kidney-transplant patient by strip laid on the wound and left for 48 h.

Allergens

The flowers pollen has induced severe respiratory reactions in sensitive individuals (Blanco et al., 1998). Papaya pollen in papaya cultivating areas can contribute to aeropollen and aeroallergen loads as reported by Chakraborty et al. (2005). Papaya contains four cysteine endopeptidases including papain, chymopapain, glycyl endopeptidase and caricain. Papain is commonly found in papaya latex (Azarkan et al., 2003). The recorded level of papain in papaya latex is 51,000 to 135,000 mg/kg (OGTR, 2008). Papain can also induce IGE-mediated allergic reactions through oral, respiratory or contact routes of exposure. The typical symptoms include bronchial asthma, rhinitis or both (Van Kampen et al., 2005). One case of a life threatening anaphylaxis due to occupational exposure to papain was also reported (Freye, 1988). Thereafter, such people react to contact with any part of the plant and to eating ripe papaya or any food containing papaya, or meat tenderized with papain. Skin irritation in papaya harvesters because of the action of fresh papaya latex, and of the possible hazard of consuming undercooked meat tenderized with papain.

Anti-nutrients

Peel and pulp of ripe papaya fruits contains low amounts of anti-nutrients like tannin (10.16 mg/100 g of dry matter), phytate (3.29 mg/100 g of dry matter) and oxalate (1.89 mg/100 g of dry matter) creating incopatability problems as reported by Onibon et al. (2007).

Toxicants

Carpaine is a major alkaloid found in various parts of papaya, but is primarily found in leaves (Morton, 1987; Duke, 1992; Krishna et al., 2008). The major natural toxicants found in papaya are benzylglucosinolate (BG), benzyl isothiocyanate (BITC) and alkaloids. Fruit and seed extracts have pronounced bactericidal activity. The seeds of unripe fruits are rich in benzyl isothiocyanate, a sulphur containing chemical that has been reported to be an effective germicide and insecticide. These substances are important for plant natural defense mechanisms (El Moussaoui et al., 2001). Although both BG and BITC are found in papaya peel, pulp and seed, the highest levels of BG and BITC are found in seeds, 1269.3 and 461.4 μmol/100 g fresh weights, respectively. The levels of BG and BITC in papaya pulp were <3.0 μmol/100 g fresh weight (Nakamura et al., 2007). The concentration of BITC decreases in pulp and increases in seeds during fruit ripening (Tang, 1971).

FOLK USES

In folk medicine, the fresh latex is smeared on boils, warts and freckles and given as a vermifuge in African countries. In India, it is applied on the uterus as an irritant to cause abortion. The unripe fruit is sometimes hazardously ingested to achieve abortion. Seeds, too, may bring on abortion. The root is ground to a paste with salt, diluted with water and given as an enema to induce abortion. A root decoction is claimed to expel roundworms. Roots are also used to make salt.

Crushed leaves smeared around tough meat will tenderize it in overnight. The leaf also functions as a vermifuge and a primitive soap substitute in laundering. Dried leaves have been smoked to relieve asthma or as a tobacco substitute. It also infusion is taken for stomach troubles in Ghana and they say it is purgative and may cause abortion. Packages of dried, pulverized leaves are sold by "health food" stores for making tea, despite the fact that the leaf decoction is administered as a purgative for horses in the Ivory Coast. It is also used as treatment for genito-urinary ailments. The leaf tea or extract has reputation as tumor destroying agent (Walter, 2008). The fresh green tea is act as antiseptic and dried leaves are best as a tonic and blood purifier (Nwofia et al., 2012). The tea also promote digestive system and aid in chronic indigestion, weight loss, obesity, arteriosclerosis, high blood pressure and weakening of heart (Mantok, 2005).

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