



RESEARCH ARTICLE

ETHNOMEDICINAL SIGNIFICANCE, MINERAL COMPOSITION AND PHYTOCHEMICAL
CONSTITUENTS OF *CARICA PAPAYA* IN OYO STATE, NIGERIA

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ABSTRACT

Carica papaya is widely cultivated and consumed in Nigeria. However, most Nigerians are not aware of the vast ethnomedicinal significance of various parts of the plant. This study involved the administration of questionnaires to herbalists, herb sellers and old rural dwellers in various parts of Oyo state for complete and comprehensive list of the ethnomedicinal significance of papaya; while information on the mineral composition and phytochemical constituents were obtained through secondary data mining. The results indicated that 22 human ailments can be treated using 46 different herbal formulations involving papaya. The plant parts used include the fruit (ripe and unripe), seeds, roots and leaves (green, yellow and brown/dry). Most frequent in the responses to the questionnaires were the use of the seeds in treating tuberculosis; milky sap to dress wounds, leaves to treat malaria and unripe fruit to treat typhoid fever. Furthermore, the secondary data indicated that the ripe and unripe fruits have wide range of nutrients, vitamins and minerals needed for the normal functioning of the body, thus justifying the necessity for constant eating papaya fruits. The phytochemical composition of the plant include tannins, alkaloids, flavonoids, cardiac glycosides, phytates, steroids, as well as papain and chymopapain found in the milky sap, all with their pharmacological effects on the body. This paper concludes with the call for research for drug development from parts of the plant, as well as more awareness creation on the ethnomedicinal uses of the plant.

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INTRODUCTION

Carica papaya Linn. is one of the major fruit crops cultivated in tropical and sub-tropical zones. It is known by many common names such as papaya and pawpaw among others. In Nigeria, it known as 'ibepe' in Yoruba (South-West Nigeria), 'gwanda' in Hausa (Northern Nigeria), 'ojo', and 'okwere' among the Igbo people (South-East Nigeria), and 'etihibakara' in Efik (South-South Nigeria), indicating a wide range of cultivation and consumption of papaya in Nigeria. Though the plant is called pawpaw in Nigeria, however, for standardization, the author refers *Carica papaya* to papaya throughout this manuscript. It is a fast-growing, semi-woody tropical herb, growing up to 5 – 10m tall (Duke, 1984). The stem is single, branchless, straight and hollow and contains prominent leaf scars. Papaya exhibits strong apical dominance rarely branching unless the apical meristem is removed, or damaged. The leaves are palmately-lobed, usually large, are arranged spirally and clustered at the crown. There several papaya cultivars all over the world, and they 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. The fruit is melon-like, oval to nearly round, somewhat pyriform,

or elongated club-shaped, 15-50 cm long and 10- 20 cm thick and weighing up to 9 kg (Morton 1987). When the fruit is immature, it is rich in white latex and the skin is green and hard. As ripening progresses, papaya fruits develop a light- or deep- yellow-orange coloured skin while the thick wall of succulent flesh becomes aromatic, yellow-orange or various shades of salmon or red. It is then juicy, sweetish and somewhat like a cantaloupe in flavor but some types are quite musky (Morton 1987). *C. papaya* belongs to the family *Caricaceae*. The genus *Carica* was previously classified under various plant families, including *Passifloraceae*, *Cucurbitaceae*, *Bixaceae*, and *Papayaceae*. However it is presently placed under *Caricaceae*, a plant family incorporating 35 latex-containing species in four genera, *Carica*, *Cylicomorpha*, *Jarilla* and *Jacaratia* (Kumar and Srinivasan 1944). *Carica* consists of 22 species and is the only member of the *Caricaceae* that is cultivated as a fruit-bearing plant while the other three genera are grown primarily as ornamentals (Burkill 1966). The mountain papaya (*C. candamarcensis* Hook. f.), is native to Andean regions from Venezuela to Chile at altitudes between 1,800- 3,000 m (Morton 1987). Compared to the well known tropical papaya, *C. papaya*, fruits of the mountain papayas tend to be smaller in size and less succulent. Recently, another taxonomic revision was proposed and supported by molecular evidence that

genetic distances were found between papaya and other related species (Jobin-Décor *et al.* 1996; Badillo 2002; Kim *et al.* 2002). Some species that were formerly assigned to *Carica* were classified in the genus *Vasconcella* (Badillo 2002). Accordingly, the classification of Caricaceae has been revised to comprise *Cylicomorpha*, *Carica*, *Jacaratia*, *Jarilla*, *Horovitzia* and *Vasconcella*, with *Carica papaya* the only species within the genus *Carica* (Badillo 2002). It should be noted that an unrelated plant, *Asimonia triloba* (*Annonaceae*), native to USA, is also called pawpaw in some places; therefore *A. triloba* should not be confused with *C. papaya*, as already noted in some publications.

It is widely believed that papaya originated from the Caribbean coast of Central America, ranging from Argentina and Chile to southern Mexico (Manshardt 1992) through natural hybridization between *Carica peltata* and another wild species (Purseglove 1968), while Nakasone and Paull (1998) reported that papaya originates from the lowlands of eastern Central America, from Mexico to Panama. The history of papaya appears to be first documented by Oviedo, the Director of Mines in Hispaniola (Antilles) from 1513 to 1525, where he describes how Alphonso de Valverde took papaya seeds from the coasts of Panama to Darien, then to San Domingo and the other islands of the West Indies. The Spaniards gave it the name 'papaya' and took the plant to The Philippines, from where it expanded to Malaya and finally India in 1598 (Schery 1952). Villegas (1997) noted that the Spanish explorers in 16th Century were responsible for the spread of the plant, through the seeds, to south-east Asia, from where it spread to India and Africa. By the time papaya trees were established in Uganda in 1874, their distribution had already spread through most tropical and sub-tropical countries. When first encountered by Europeans, papaya was nicknamed 'tree melon'. Papayas are usually grown from seeds (Ellis *et al.*, 1991), while vegetative propagation is possible, but not widely practised except in South Africa where rooting of cuttings is used to eliminate variability in some papaya varieties. Allan (1995) and Allan and Carlson (2007) demonstrated how a female clone can be propagated vegetatively by rooting leafy cuttings for over 40 years. There appears to be paucity of knowledge on the mode of introduction of the plant into Nigeria, but it is interesting to note that Nigeria is the third highest world producer of papaya, producing 765,000 metric tonnes (FAO, 2007). However, apart from eating its fruits, many Nigerians seem to be unaware of some of the ethnomedicinal significance of the plant. This study was conducted to compile and document the various ethnomedicinal uses of the papaya in Southwest Nigeria, as well as the mineral composition and phytochemical constituents.

METHODOLOGY

Study site: Oyo state is located in the South-west region of Nigeria (Fig. 1). The state was established in 1976 from the defunct Western Region, with the total estimated population of 6,617,720 people (Nigerian Population Commission, 2006) mainly Yoruba people. The land area is 28,454km². The indigenes are mainly Oyo, Ibadan, Oke-Ogun and Ibarapa peoples, and notable cities include Ibadan, Oyo, Ogbomosho, Saki, Okeho, Iseyin, Kishi, Eruwa and many others, with Ibadan being the capital city. The state is divided into 33

Local Government areas. The main indigenous occupation of the people is farming, while arts and crafts are popular in Oyo town.

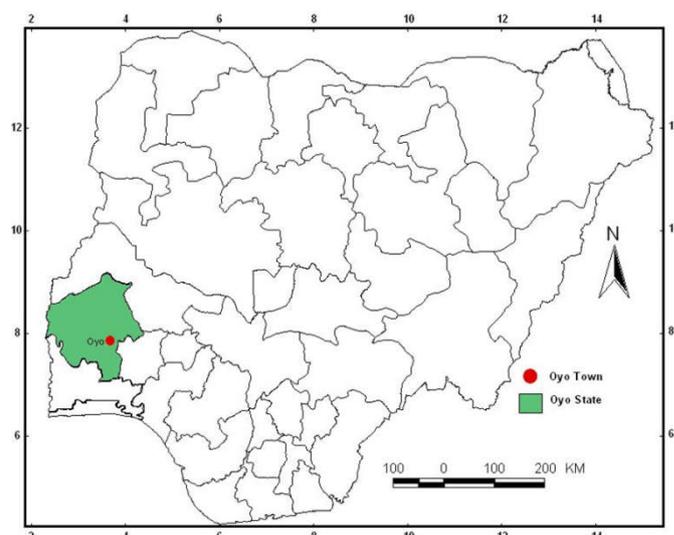


Fig. 1. Map of Nigeria showing Oyo State

Ethnomedicinal Survey: This study involves the administration of semi-structured questionnaires to herb sellers, herb collectors, herbalists and old men and women living in rural areas of Ibadan and Oyo towns of Oyo state, Nigeria between September and December 2011. Information on the mineral composition and phytochemical constituents of the plant were obtained by secondary data mining.

RESULTS AND DISCUSSIONS

Papaya is such a common fruit bearing plant in all parts of Nigeria. While many people eat the fruit, only very few know the medicinal potentials locked in various parts of the plant. This study unravelled these medicinal uses from herbalists and other related people.

Questionnaire administration: The questionnaires were administered to a total of 50 people, of which 15 of them were herbalists, 23 were herb sellers in various herbal markets in Ibadan and Oyo town, and the remaining 12 were old rural dwellers in Ipapo, Fiditi, Oyo, Ilora and Iseyin towns in Oyo State. Thirty-one of them were females, while the remaining 19 were males. Virtually all the herb sellers were females, while only 3 of the herbalists were females. Majority of the respondents were illiterates, with only 8 of them having Primary school education. All of the respondents were Yoruba speaking people of Nigeria. It was difficult to stratify the ages of the respondents, as some of them do not know their actual age. However, 8 of them fall within the age range of 31-40, 13 of them fall within 41-50 age range, 20 fall within 51-60 age range, while the remaining 9 did not know their age, all of which are old rural dwellers and at the same time illiterates.

Ethnomedicinal uses: The results indicate a wide range of the use of papaya for various ethnomedicinal purposes. Similarly, several parts of the plant are employed for herbal preparations. Table 1 shows the ethnomedicinal profile of papaya in Oyo state, Nigeria.

Table 1. Ethnomedicinal significance of papaya in Oyo state, Nigeria

S/N	Disease	Part used	Preparation and dosage
1	Malaria fever	Yellow Leaf	Squeeze some yellow papaya leaves in water. Take a glass cup 3 times daily for 7 days.
		Green leaf	Boil leaves of <i>Azadirachta indica</i> , <i>Psidium guajava</i> , <i>Carica papaya</i> , <i>Cymbopogon citratus</i> and 10 <i>Citrus aurantifolia</i> fruits and <i>Mangifera indica</i> bark in 4 litres of water. Adult to take half a glass cup three times daily. Children to take one-quarter of a cup 3 times daily to treat malaria
		Green Leaf	Boil <i>Cymbopogon citratus</i> leaves, whole unripe <i>Ananas comosus</i> fruit, 2 sliced <i>Citrus paradisi</i> , <i>Carica papaya</i> leaves and 4 tea bags in 4 litres of water. Adult to take a cup full 3 times daily, children to take ½ cup 3 times daily to treat malaria
		Seed	Chew a handful of <i>Carica papaya</i> seeds morning and evening, and take a decoction of unripe <i>Carica papaya</i> fruit, unripe <i>Ananas comosus</i> fruit, <i>Citrus aurantifolia</i> fruit juice, 10cm long <i>Saccharum officinale</i> juice extract, 6 tea bags in 4 litres of water to treat malaria
		Green leaf	Boil <i>Carica papaya</i> leaves for 3 hours and take the extract 3 times daily to treat malaria
2	Tuberculosis	Seed	Blend the inner seed of unripe <i>Carica papaya</i> and <i>Allium sativum</i> rhizomes together, and put it inside a bottle of <i>Citrus aurantifolia</i> fruit juice and add a spoon of salt, and leave for a day. Take 2 spoons 3 times a day after meal to treat tuberculosis
		Seed	Blend the inner seed of unripe <i>Carica papaya</i> and extract the juice. Take 2 spoons 3 times daily after meal to treat tuberculosis
		Seed	Chew <i>Carica papaya</i> seeds to treat tuberculosis
		Seed	Chew a handful of <i>Carica papaya</i> seeds and then eat plenty of <i>Citrus sinensis</i> fruits, <i>Citrus paradisi</i> fruit and <i>Carica papaya</i> fruit before meal. Chew one <i>Allium sativum</i> rhizome raw before going to bed to treat tuberculosis
3	Jaundice	Unripe fruit	Peel matured but unripe <i>Carica papaya</i> fruit remove the seeds and soak inside water for 3 hours with <i>Allium cepa</i> bulbs. Take 1 spoon 3 times daily after meal for 3 weeks to treat jaundice
		Unripe Fruit	Soak unripe <i>Carica papaya</i> fruit in 3 litres of water for 3 hours. Take 1 teaspoon 3 times daily to treat jaundice.
		Yellow Leaf	Squeeze some yellow papaya leaves in water. Take a glass cup 3 times daily for 7 days.
4	Diabetes mellitus	Green Leaf	The green leaves of papaya are squeezed in water and take a glass 3 times daily.
5	Stomach ulcer	Unripe fruit	Cut a big unripe papaya fruit into pieces. Do not remove the peel or seeds. Cut the fruit into cubes; soak in 5 bottles of water for 4 days. Sieve and take ½ a glass cup 3 times daily for 2 weeks.
		Green leaf	Leaf decoction of <i>Carica papaya</i> is taken orally three times daily to treat stomach ulcer
6	Sores	Sap	Cut an unripe papaya to release the white milky sap and use it to dress the wounds
		Unripe fruit	Cut a piece of unripe papaya fruit and tie directly on the wound. Repeat this 4 times daily till the wound is dried.
		Leaf pulp	Roasted leaf pulp of <i>Carica papaya</i> is placed on wound for healing
7	Respiratory infections	Dry leaf	Burn dried papaya leaves and inhale the smoke during an attack of asthma. To prevent an attack, inhale the smoke every night
		Root	Boil some papaya roots, take half a glass cup 3 times daily to treat Bronchitis
		Root	For cough, simply chew a tender papaya root and swallow the juice.
8	Pile	Root	Papaya roots are boiled and take ½ a glass twice daily
		Immature fruit	Cut and eat immature <i>Carica papaya</i> fruit with the peels to treat pile
		Green leaf	A cold infusion of leaves of <i>Ocimum gratissimum</i> and <i>Carica papaya</i> . 1 cup full for adult and half cup for children to treat pile
9	Typhoid fever	Unripe fruit	Boil 6 sachets of tea bags, 25 pieces of <i>Citrus aurantifolia</i> fruits, 2 <i>Citrus paradisi</i> , 2 unripe <i>Carica papaya</i> fruits, 2 unripe <i>Ananas comosus</i> fruits and <i>Mangifera indica</i> tree bark in water for 40 minutes. Drink half a glass cup 3 times a day for 3 weeks to treat typhoid
		Unripe Fruit	<i>Costus afer</i> leaf, 25 <i>Citrus aurantifolia</i> fruits, 2 <i>Citrus paradisi</i> fruits, 2 <i>Ananas comosus</i> fruits, 2 unripe <i>Carica papaya</i> fruits, <i>Allium sativum</i> rhizomes, <i>Alstonia boonei</i> bark are all boiled in 2 litres of water for 30-40 minutes and taken orally twice daily to treat typhoid fever

10	Skin infections	Green leaf Unripe fruit	Squeeze leaf extract in green leaves of papaya and use to bath, act as antibiotic soap Apply the sap from unripe <i>Carica papaya</i> fruit topically to treat eczema
11	Worm expulsion	Seed Seed Sap	Chew 2 tablespoons of the ripe papaya seeds first thing in the morning and last thing at night. Repeat this for 3 days and take fruits only as breakfast and supper on each of these days. Crush ripe <i>Carica papaya</i> seeds and add ripe <i>Carica papaya</i> juice and small honey. Take 2 spoons 5 times daily until treatment is perfected for worm expulsion Take 2 spoonful of the milky sap from the unripe fruit to expel intestinal worms
12	Stomach problems	Green leaf Green leaf Green leaf Ripe fruit	The green leaves of papaya are squeezed in water and take a glass 3 times daily to treat constipation Leaves of <i>Carica papaya</i> and <i>Imperata cylindrica</i> are squeezed in water and taken to treat nausea. Squeeze and take the leaf juice of <i>Carica papaya</i> to treat nausea in pregnant women Eat ripe pawpaw fruit to treat constipation
13	Impotence	Unripe fruit	Cut 2 unripe papaya fruits into pieces (seeds and peel inclusive). Bring to boil in 8 bottles of water. Take ½ a glass cup 3 times daily.
14	Convulsions	Dry leaf	The dry brown papaya leaves are good for convulsions. Pick up the dry, fallen papaya leaves and grind into powder. Add 2 tablespoonfuls of the powder to half a glass of palm kernel oil. Stir well and rub all over the body. It also helps to reduce high temperature for fever.
15	Impotence in men	Unripe fruit	Cut 2 unripe papaya fruits into pieces (seeds and peel inclusive). Bring to boil in 8 bottles of water. Take ½ a glass cup 3 times daily.
16	Hypertension	Green leaf	Crush <i>Carica papaya</i> leaves and add little water and native chalk and leave for 24 hours and take the extract to treat hypertension.
17	Alcohol hangover	Fruit juice	Extract ripe <i>Carica papaya</i> juice and <i>Aloe vera</i> juice in the same proportion and mix them. Take 1 small cup every day to manage alcohol hangover
18	Blood tonic	Unripe fruit	Collect <i>Pentaclethra macrophylla</i> seeds, <i>Solanum aethiopicum</i> leaves (or unripe peeled and sliced <i>Carica papaya</i> fruit with seeds removed), and cook them together till the cooked materials are soft. Eat it for at least 5 days to build the blood (blood tonic).
19	Body pains	Green leaf	Squeeze the leaves of <i>Carica papaya</i> and <i>Anacardium occidentale</i> together in water and take ¼ of a cup once a day to treat pains.
20	Contraceptives	Root	Peel male <i>Carica papaya</i> root downward, add sizeable <i>Xylopiya aethiopicum</i> fruits, little palm oil and cook with catfish and eat it as contraceptive. To restore fertility, carry out the above using female <i>Carica papaya</i> .
21	Baby care	Root Fruit juice	Pound the root of male <i>Carica papaya</i> tree with native soap. Always wash the child's leg kneel downward to enhance child walking Extract <i>Carica papaya</i> fruit juice and mix with water and administer in small quantity (1 tablespoon twice daily after meal) to the baby to treat indigestion
22	Prolonged labour	Root	Collect roots of male <i>Carica papaya</i> and 7 seeds of <i>Aframomum melegueta</i> and soak them in water for 12 hours and taken to stop prolonged labour.

This study discovered that a total of 46 herbal formulations used for the treatment of 25 different health challenges in Oyo state, Nigeria. The plant parts used for the herbal treatments include the unripe and ripe fruit, seeds, roots and green, yellow and brown (dry) leaves, but green leaf is the most widely used (12) plant part observed in this study, followed by unripe fruit (11), seed (7) and root (6). Furthermore, herbalists lay claim to the fact that the papaya fruit resembles the stomach in the body, suggesting that it can be used to treat stomach ailments, which this study confirms. The administration of the herbal preparations include oral administration of specified dose, bathing with it, topical application on affected part, chewing and swallowing and inhalation. Furthermore, the modes of preparation vary, as observed in the study, and include squeezing the leaf, boiling, soaking for some hours, drying and pulverization, blending, passing over fire, decoction, cold infusion, cooking with other recipes as well as pounding. In some of the herbal preparations, papaya plant part is used singly or with other plants. A total of 17 plants used in addition to papaya as

encountered in this study, which include *Citrus aurantifolia*, *Aframomum melegueta*, *Allium sativum*, *Ocimum gratissimum*, *Ananas comosus* and *Mangifera indica* among others, while non-plant materials used include native soap, salt, catfish and others. While the pharmaceutical markets in Nigeria is being flooded with fake drugs, leading to the death of many people, the use of papaya plant parts for primary health care is hereby advocated.

Mineral composition: From secondary data mining of previous studies done and reported on the mineral composition of the ripe fruit, seed and unripe fruit of papaya. Table 2 illustrates the results obtained. Though the use of ripe papaya fruit in ethnomedicine was limited, as observed in table 1, the high mineral composition of the ripe fruits of papaya justifies the need to eat the fruits on daily basis to meet the daily

Table 2. Comparative mineral composition of *Carica papaya* ripe and unripe fruits and other common fruits

S/N	Nutrient/vitamins/ minerals	Mineral composition (value per 100g)				
		Ripe fruit *	Unripe fruit (%)**	Orange*	Banana*	Pineapple*
1	Water	88.83g	10.65			86g
2	Energy	39kcal		47kcal	89kcal	
3	Protein	0.61g	13.63	0.94g	1.09g	0.54g
4	Total lipid (fat)	0.14g	1.29	0.12g	0.33g	0.12g
5	Ash	0.61g	14.12			0.22g
6	Carbohydrate	9.81g	43.28	11.75g	22.84g	13.12g
7	Total Dietary Fibre	1.8g	1.88	2.4g		1.4g
8	Sugars	5.90g	15.15		12.23g	9.85g
9	Calcium	24mg	24.86mg	40mg	5mg	17mg
10	Magnesium	10mg	23.54mg	10mg	27mg	
11	Potassium	257mg	223.0mg	169mg	358mg	125mg
12	Sodium	3mg	4.0mg			1.0mg
13	Zinc	0.07mg	0.056mg	0.08mg	0.15mg	
14	Phosphorus	5mg	12.56mg		22mg	8mg
15	Vitamin C	61.8mg		53.2mg	8.7mg	47.8mg
16	Niacin	0.338mg		0.282mg	0.665mg	
17	Pantothenic acid	0.218mg		0.250mg	0.334mg	
18	Folate	38mcg		30µg	20µg	
19	Choline	6.1mg			9.8mg	
20	Vitamin A	1094 IU (55 RAE)		225 IU	3µg	58 IU (3 RAE)
21	Vitamin E	0.73mg		0.18mg		
22	Vitamin K	2.6mcg				
23	Beta Carotene	276mcg		71µg		35mg
24	Beta Cryptoxanthin	761mcg		11µg		0.5mg
25	Lutein+Zeaxanthin	75mcg		129µg		
26	Manganese		0.008mg	0.024mg		
27	Copper		0.001mg	39mcg		
28	Iron				0.26mg	
29	Riboflavin (Vit B ₂)			0.04mg	0.073mg	
30	Thiamine (Vit. B ₁)			0.1mg	0.031mg	
31	Pyridoxine			0.06mg		
32	Vitamin B ₆				0.4mg	
33	Alpha-carotene			11µg		

*USDA, 2005; **Oloyede, 2005.

requirements of minerals and nutrients for normal body functioning. Comparing mineral composition in papaya with banana, orange and pineapple showed that papaya fruit has the highest amount of Vitamin C and Vitamin A, while calcium content (24mg) is only lower to that of orange (40mg). Likewise potassium content in papaya (257mg) is only lower to that of banana (358mg), while it is higher than in other fruits. Generally, it could be observed from table 2 that papaya fruit compares favourably with other common fruits in terms of the mineral and nutrient contents.

Phytochemical constituents: Furthermore, from previous studies, the phytochemical components of the leaves showed the presence of saponins, cardiac glycosides and alkaloids in the green leaves, yellow leaves and brown (dry) leaves (Ayoola and Adeyeye, 2010). In addition, Okoye (2011) reported the presence of alkaloids, flavonoids, tannins, saponins, phenols, phytates, carbohydrates, HCN, fat, proteins, fibre and steroids in the seeds. In addition, two important compounds, papain and chymopapain are found in the milky sap found in the unripe fruit and leaves (Teixeira da Silva et al. 2007). Likewise the methanol extract of the leaves were found to contain alkaloids, flavonoids, tannins, cardiac glycosides, anthraquinones, phlobatanins and saponins (Imaga et al., 2010); while the unripe fruit contains cardenolides and saponins (Oloyede, 2005). Papain and chymopapain were found to contain active ingredients that help in healing of wounds.

The biological functions of flavonoids include protection against allergies, inflammations, platelets aggregation microbes, ulcer, vaseses and tumours (Okwu and Okwu, 2004). Flavonoids represent the common and widely distributed group of plant phenolics. Flavonoids are free radical scavengers and super antioxidants and potent which prevent oxidative cell damage and have strong anticancer activity (Salah et al., 1995). As antioxidants, flavonoids provide anti inflammatory action (Okwu, 2001). This may be the reason behind the use of seed of *Carica papaya* in herbal medicines. The saponins constituents are responsible for the possession of haemolytic property. Alkaloids are the most efficient therapeutically significant plant substance. Tannins have astringent properties which hasten the healing of wounds and inflamed mucous membrane. The presence of tannins in the seed of *Carica papaya* can support its strong use for healing of wounds, ulcers, hemorrhoids, frost-bites and burns in herbal medicine (Igboko, 1983; Maduyi, 1983).

Conclusions

There is the need to develop research studies to extract the active principles in the plant responsible for the diseases it treats for drug development and commercialization. This is important, especially in the use of the leaves as anti-bacterial soap; the use of the unripe fruit to treat several infections such as Typhoid fever, impotence in men, blood tonic, pile among others; the use of the milky sap to dress wounds and worm

expulsion; as well as the use of the seeds for the treatment of tuberculosis, malaria and other respiratory infections. Furthermore, there is the need to create more awareness with the public on the medicinal importance of papaya in treating many human diseases.

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