Chemical composition of leaves, fruit pulp and seeds in some Carica papaya (L) morphotypes

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RESEARCH ARTICLE

Chemical composition of leaves, fruit pulp and seeds in some *Carica papaya* (L) morphotypes

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Abstract: The leaves and fruits of five *Carica papaya* morphotypes were harvested from trees in home gardens in Umuahia, Abia state, Nigeria. The morphotypes were based on fruit shape and pulp colour and are oblong red, oblong yellow, pear orange, round orange and round yellow. Seeds were extracted from the fruits and the proximate, mineral and vitamin analysis carried out on the leaves, fruits and seeds. All the determinants were carried out in triplicates. The result showed that there was a highly significant difference ($P < 0.01$) for proximate, chemical and vitamin compositions of theses morphotypes. The leaves had more crude protein, carbohydrate, crude fibre, Ca, Mg, Fe, and K than the fruit pulps and seeds. Beta-carotene was the most abundant vitamin in these *Carica papaya* morphotypes while papain activity was detected only in the leaves.

Keywords: Chemical composition; leaves; fruit pulp; seeds; *Carica papaya*.

Introduction

Carica papaya (family: *Caricaceae*) belongs to the fruits and vegetable class. It is highly abundant and is commonly known as pawpaw in Nigeria. It is an invaluable plant that is prevalent throughout tropical Africa and Nigeria is the third largest producer globally (FAO 2002). Practically every part of the plant is of economic value and its use ranges from nutritional to medicinal. The fruit are popularly used as desert or processed into Jam, puree or wine, while the green fruits are cooked as vegetable (Matsuura et al., 2004; Ahmed et al., 2002; OECD, 2005). The seeds are medicinally important in the treatment of sickle cell diseases (Imaga et al. 2009), poisoning related disorder(Okeniyi et al., 2007). The leaf tea or extract has a reputation as a tumor destroying agent (walter 2008). The fresh green tea is an antiseptic whilst the brown, dried pawpaw leaves are best as a tonic and blood purifies (Atta, 1999). The tea also promotes digestive and aid in treatment of ailment such as chronic indigestion, overweight and obesity, arteriosclerosis, high blood and weakening of the heart (Mantok, 2005).

Nutritionally, the major components of pawpaw fruit pulp dry matter are carbohydrates. The total dietary fibre content of ripe fruit varies from 11.9 to 21.5 g/ 100 g/ dry matter (Puwastien et.al., 2000, Saxholt et.al., 2008 and USDA, 2009) crude protein ranges from 3.74 to 8.26 g/100 dry matter (USDA, 2009). There are two main types carbohydrates in pawpaw fruits, the cell wall polysaccharides and soluble sugars. At the early stage of fruit development, glucose is the main sugar but the sucrose content increases during ripening and can reach up to 80% of the total sugars (Paul, 1993, and OECD, 2010). The edible portion of the ripe pawpaw fruit contains both macro and micro minerals and these Na, K Ca, Mg, P, Fe, Cu, Zn, and Mn (OECD, 2010) *Carica papaya* is a source of carotenoids, vitamin C, thiamin ,riboflavin, niacin, vitamin B-6 and vitamin K (Bari et al., 2006: Adetuyi et al., 2008 and USDA, 2009). The carotenoids are responsible for the flesh color of the fruit mesocarp (fruit pulp).The red-fleshed pawpaw contains five beta carotene: beta-crytoxanthin, beta carotene -5- 6- epoxide, lycopene and zeta-carotene while the yellow fleshed contains only beta carotene, beta-cryptoxantain and zeta-

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carotene (Chandrika et al., 2003). Pawpaw is also a good source of vitamin with amount varying between maturation stages and varieties (Bari et al., 2006, Hernandez et al., 2006 and Wall 2006).

Despite the importance of this crop, not much attention have been paid to the nutritional composition of the leaves, seeds and fruits pulp of the Nigerian morphotypes of *Carica papaya* hence the objective of this study was to determine the nutritional values of the leaf, seeds and fruit pulp among five sunrise solo morphotypes in Nigeria.

Materials and methods

The fruit and leaves of five sunrise solo morphotypes of *Carica papaya* were harvested from home gardens in Umuahia, Abia State, Nigeria and used in this study. The morphotypes were selected based on fruit shape and fruit pulp color and are: oblong red, oblong yellow, pear orange, round orange and round yellow. The seeds were extracted from the fruit and the proximate, mineral vitamin and pawpaw activity carried out on the fruit pulp, leaves and seeds.

Proximate Analysis

Moisture content was determined by the method of Pearson (1976) and James (1995). Crude protein (N x 6.25) was determined by the kjedahl method as described by Chang (2003). The recommended method of association of Official Analytical Chemist (1980) was used for the determination of ash, crude lipid and crude fibre. The carbohydrates content was obtained by difference as the nitrogen free extract.

Mineral Analysis

The mineral content of the samples was determined by the dry ash extraction method described by James (1995) and Kirk and Sawyer (1998). Calcium and magnesium was determined by the versanate EDTA complexiometric titration method while phosphorus was determined by molybdovanadate colorimetric method James (1995). Iron in the samples was determined using atomic absorption spectrophotometer as described by Pearson (1976) and Carpenter and Hendricks (2003).

Vitamin Analysis

Vitamin C was determined according to the method outlined by Kirk and Sawyer (1998), while the B-vitamins was determined by the spectrophotometric method described by Okwu (2004).

Papain Activity Analysis

The colorimetric method described by Arnon (1970) was used to determine the papain activity.

Results and discussion

Highly significant difference ($p<0.01$) was observed in all the proximate trait studied among the morphotypes show that there were variation in the proximate composition of the different plant parts: leaves, fruits pulp and seeds as well as among the morphotypes. Crude protein content in the fruits pulp ranged from 0.47% to 1.17% while in the leaves, it varies from 5.84% to 10.80. the seeds contained 2.34 to 3.15% crude protein . in the morphotypes, the round yellow contained the highest protein in the leaves, fruit pulp and seeds while oblong red have the least in seeds and fruit pulp but not in the leaf. Generally the fruit pulp had low crude protein relative to the leaves and seeds (Table 1). The low protein contents in fruit pulps of these *Carica papaya* morphortypes is at variance from the report of USDA (2009) that gives a range of 3.74 to 8.26g/100g dry matter but it can be due to the climatic conditions, growing seasons, site of cultivation and the varieties of *Carica papaya* used in this study. These factors have been shown to influence the nutrient content of *papaya* (Hardisson et al., 2001; Chavasit et al., 2002; Wall, 2006; Mavelli de Souda et al., 2008 and Chavonensin et al., 2006).

Table 1: Proximate Composition of seeds, leaves and pulp in five Paw paw morphotypes

Morphotypes/ Plant parts	% Ash	% Fat	% Protein	% Crude fibre	% Moisture content	% Carbohydrate
Oblong red						
Seed	4.27[a]	3.04[b]	2.63[b]	2.13[a]	44.33[a]	43.61[c]
Leaf	1.43[e]	1.37[d]	5.84[d]	13.15[a]	83.09[c]	78.22[a]
Pulp	0.37[d]	0.53[b]	0.4[7b]	0.83b[c]	90.33[ab]	7.46[bc]
Pear orange						
Seed	3.91[b]	2.92[c]	2.34[c]	2.02[b]	42.70[b]	46.11[b]
Leaf	1.75[c]	1.27[e]	9.16[b]	12.81[a]	81.27[e]	75.02[c]
Pulp	0.31[e]	0.37[d]	0.9[9a]	0.93[a]	89.74[bc]	7.56b[c]
Round orange						
Seed	3.35[c]	1.33[e]	3.04[a]	1.87[c]	42.01[b]	48.40[a]
Leaf	1.61[d]	2.14[c]	7.24[c]	13.08[a]	83.99[b]	75.94[b]
Pulp	0.45[c]	0.47[c]	0.59[b]	0.77[c]	91.32[a]	6.50[c]
Oblong yellow						
Seed	4.28[a]	3.27[a]	2.57[b]	1.87[c]	39.69[c]	48.31[a]
Leaf	1.92[b]	3.15[a]	9.05[b]	12.38[b]	82.00[d]	73.50[d]
Pulp	0.61a	0.70[a]	0.99[a]	0.87[ab]	88.75[c]	8.07[b]
Round yellow						
Seed	3.84[b]	2.00[d]	3.15[a]	2.09[a]	40.50[c]	48.42[a]
Leaf	2.25[a]	2.88[b]	10.80[a]	11.41[c]	85.17[a]	72.64[e]
Pulp	0.53[b]	0.49[c]	1.17[a]	0.83b[c]	87.47[d]	9.51[a]

Means with different superscript within the same column are significantly different ($P < 0.05$)

The result also showed higher moisture content in the fruit pulp (87.47% to 91.32%) than in the leaves (81.27% to 85.17%) and the seeds (39.69-44.33%). The round yellow colored fruits had less moisture while round orange had more. This high moisture content in the fruit pulp and leaves are in agreement with the report of USDA (2008) that stated that moisture content in papaya fruits ranges from 85-92% while the mean of 83% was reported for leaves. Low crude fiber was observed in the pulp and seeds but the leaves contained relatively high level of crude fiber (11.41%-13.15%). The presence of high crude fiber in the papaya indicates it’s potential for use in animal feeds formulation, since fiber makes for good bowel movement as well as aid nutrient absorption (Onwuka, 2005). The fat and ash content was generally higher in the seeds than in the leaves and fruits pulp. Though percentage fat content of the seeds were higher than that obtained in the leaves and fruit pulp, the seed oil content obtained in this study is quite low compared to the report of Bouanga-kalou et al., (2011).

The leaves and seeds had higher carbohydrates content than the fruit pulp. It varies from 6.50%-9.51% in the fruit pulp, 43.61% - 48.42% in the seeds and 72.02% to 78.22% in the leaves. It has been earlier stated that the major nutritional component of *papaya* is carbohydrate(OECD,2010). A highly significant effect was observed for all minerals except magnesium content in the fruit pulp that was not significant among the morphotypes. Calcium content of the leaves were high (267.20 to 366.07mg/100g) while the seed contained 45.43-54.44 mg /100 g and fruit pulp varies from 21.38 34.73mg/100g (Table 2). The leaves also had more magnesium, iron and potassium. Potassium is an essential nutrient and has an important role in the synthesis of amino acids and proteins (Malik and Srivastava, 1982). Calcium and Magnesium plays significant role in photosynthesis, carbohydrate metabolism, nucleic acids and binding agents of cell walls (Russel 1973) .Calcium also assists in teeth development (Brody, 1994). Magnesium is an essential mineral for energy activity, like calcium and chloride plays a role in regulating the acid -alkaline balance in the body (Bouanga-Kalou *et al.*, 2011).

Table 2: Mineral composition of seeds, leaves and pulp in five morphotypes of Pawpaw

Morphotypes/ Plant part	Calcium(Ca) (mg/100g)	Magnesium(Mg) (mg/100g)	Phosphorus(P) (mg/100g)	Iron(Fe) (mg/kg)
Oblong red				
Seed	46.76[bc]	10.40[ab]	241.50[a]	0.17[bc]
Leaf	313.96[c]	32.00[bc]	221.08[a]	6.34[a]
Pulp	34.73[a]	13.60[a]	16.47[b]	2.52[b]
Pear orange				
Seed	50.77[ab]	11.20[a]	238.83[d]	0.15[c]
Leaf	324.65[b]	37.60[a]	199.47[e]	6.23[b]
Pulp	22.71[b]	11.20[a]	18.37[b]	2.57[a]
Round orange				
Seed	45.43[c]	8.80[abc]	237.15[c]	0.25[a]
Leaf	366.07[a]	32.00[bc]	217.02[b]	6.20[b]
Pulp	22.71[b]	10.40[a]	17.02[b]	2.45[c]
Oblong yellow				
Seed	53.44[a]	6.40[c]	203.38[e]	0.18[b]
Leaf	267.20[e]	33.33[b]	202.72[c]	5.90[d]
Pulp	21.38[b]	12.00[a]	19.45[b]	2.15[e]
Round yellow				
Seed	49.43[abc]	8.00b[c]	239.73[b]	0.23[a]
Leaf	285.91[d]	29.60[c]	201.35[d]	6.00[c]
Pulp	30.73[a]	12.80[a]	29.80[a]	2.31[d]

Means with different superscript within the same column are significantly different ($P < 0.05$)

Significant ($P<0.01$) was observed for vitamin contents in the leaves, seeds and fruit pulp of the *Carica papaya* morphotypes.The water soluble vitamins as well beta- carotene was found to be in the leaves seeds and fruit pulp of the morphotypes. The most abundant vitamin in these morphotypes was beta-carotene (54.36-72.82mg/100g in seeds,644.10-666.67mg/100g in leaves,and 5173.33-6207.18mg/100g in fruit pulp Table 3). Vitamin C was more in the fruit pulp and lowest in the seeds.Papaya is a good source of vitamin c and the amount varies between maturity stages and varieties(Bari et-al.,2006; and Hernandez etal.,2006). Niacin, thiamine and riboflavin also occurred in the three plant part. Significantly it was noted that oblong red had more Beta-carotene than the other fruit shapes and colors. It have been shown that carotenoids are responsible for fruit color and the red-fleshed pawpaw contents five carotenoids: beta-crytoxanthin, beta-carotene-5-epoxide, lycopene and zeta-carotene, therefore, the significantly high Beta- carotene in oblong red is expected. But it is important to note that the orange fleshed pawpaw also had high Beta-carotene (6112.82 and 6182.67 mg / 100 g respectively). The significance of Beta-carotene need not be overemphasized as it is a precursor to vitamin A which in turn is important for good eye sight.

Papain activity was not detected in the seeds and fruit pulp but was detected in the leaves (Figure 1). Significant differences were observed among the morphotypes for papain activity and it ranged from 205.86 to 401.27 enzyme units. The leaves of the round yellow morphotype had higher papain activity than the other morphotypes (infact, its papain activity is almost double that of oblong red). This is an indication that variation exists in the germplasm, for this important trait and selection can be an effective tool in the improvement of this trait in *papaya* germplasm. The non-activity of papain in ripe pawpaw is also an indication that fruit ripening leads to denaturation of papain and is one of nature's way of preparing *Carica papaya* fruits for consumption as a vegetable and fresh fruit.

Table 3: Vitamin composition of seeds, leaves and pulp in five morphotypes of Pawpaw

Morphotypes / Plant part	Vitamin C (mg/100g)	Niacin (mg/100g)	Thiamine (mg/100g)	Riboflavin (mg/100g)	Beta- carotene (IU/100g)
Oblong red					
Seed	11.73^{a}	0.26^{a}	0.05^{bc}	0.05^{b}	65.64^{b}
Leaf	31.09^{c}	0.38^{b}	0.43^{c}	0.14^{ab}	659.47^{ab}
Pulp	41.07^{ab}	0.37^{b}	0.28^{b}	0.04^{b}	6207.18^{a}
Pear orange					
Seed	8.21^{c}	0.24^{bc}	0.05^{bc}	0.06^{ab}	54.36^{c}
Leaf	25.23^{d}	0.35^{c}	0.44^{b}	0.15^{a}	655.38^{b}
Pulp	39.31^{b}	0.39^{a}	0.26^{c}	0.03^{c}	6112.82^{b}
Round orange					
Seed	9.97^{b}	0.23^{c}	0.07^{a}	0.07^{a}	72.82^{a}
Leaf	29.33^{c}	0.40^{b}	0.46^{a}	0.12^{c}	644.10^{c}
Pulp	39.89^{b}	0.32^{c}	0.30^{a}	0.02^{c}	6186.67^{b}
Oblong yellow					
Seed	9.97^{b}	0.20^{d}	0.07^{a}	0.04^{c}	59.49^{c}
Leaf	34.61^{b}	0.39^{b}	0.45^{a}	0.15^{a}	666.67^{a}
Pulp	36.37^{c}	0.36^{b}	0.24^{d}	0.05^{a}	5173.33^{c}
Round yellow					
Seed	12.91^{a}	0.26^{ab}	0.06^{b}	0.03^{c}	66.67^{b}
Leaf	38.13^{a}	0.43^{a}	0.46^{a}	0.13^{bc}	654.36^{b}
Pulp	43.41^{a}	0.33^{c}	0.27^{b}	0.03^{c}	5874.87^{d}

Means with different superscript within the same column are significantly different ($P < 0.05$)

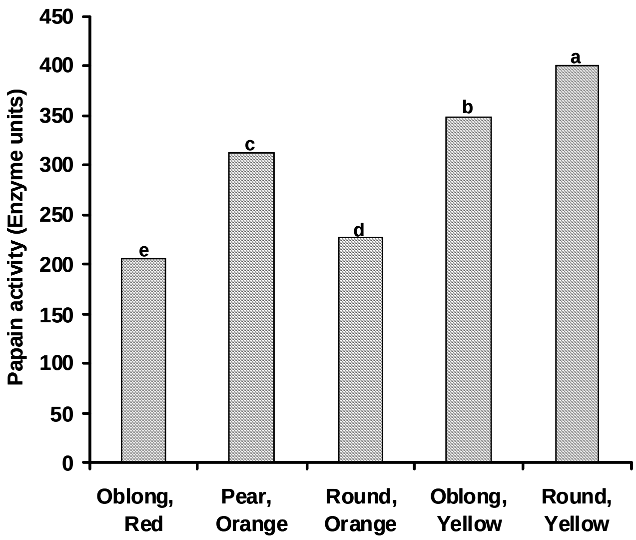

Figure 1: Papain activity (enzyme units) of leaves in five morphotypes of pawpaw. Bars with different letters are significantly different.

In conclusion, the seed, leaves and fruit pulp of *Carica papaya* are beneficial to man and animals and contains the essential nutrients like minerals and vitamin required in the body. Significant variation has been shown to exist in the pawpaw morphotypes for nutritional traits and hence selection can be an effective tool for their improvement.

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