

EFFECT OF POSTHARVEST RIPENING STAGES ON THE NUTRITIONAL COMPOSITIONS OF PAWPAW (*Carica papaya*) VARIETIES

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ABSTRACT

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Climacteric class of fruits exhibits an increase in respiration and ethylene production during ripening. This study was carried out to evaluate the nutritional composition of pawpaw at different stages of postharvest ripening (mature unripe, semi ripe and ripe). The evaluation was carried out on four varieties of pawpaw (red lady, solo sunrise, maradol and Taiwan disco). The fruit pulp was evaluated in terms of sugar, proximate, vitamin and mineral composition. The highest sugar content was found at ripe stage with increased level (14.30%) in red lady variety. Highest moisture content was observed among the varieties at the ripe stage. Crude protein, crude fat, crude fibre and carbohydrate content levels were low in all pawpaw varieties at different stages of ripening. Vitamin C content of the pawpaw pulp was high at mature unripe stage levels in all varieties with red lady variety showing highest content (118.50 mg per 100g). These values decreased as storage ripening progressed. A high content level of calcium was observed at semi ripe stage in all the varieties with the highest content in red lady variety (60.03 mg/100g). Sodium content level was highest at the ripe stage while magnesium content was lowest in all the pawpaw varieties.

Keywords: *Pawpaw, Ripening, Sugar, Varieties, Pulp, Vitamin C*

INTRODUCTION

Pawpaw (*Carica papaya*) is cultivated throughout the tropical and subtropical regions of the world. Botanically, pawpaw plant belongs to the *Caricaceae* family of flowering plant, in the genus *Carica*. It is a berry fruit developed from syncarpous ovary with parental placentation (Kochhar, 1986; Rice *et al.*, 1987). The fruit is generally melon-like, oval to nearly round, pyriform or elongated club-shaped. It is 15 to 50 cm long, 10 to 20 cm thick and could weigh up to 9 kg. The skin is waxy and thin but fairly tough. When the fruit is green and hard it is rich in white latex. As it ripens, it becomes light or deep yellowish externally. Its thick wall of succulent flesh becomes aromatic, yellow, orange or various shades of salmon or red colourations (Fuggate *et al.*, 2010). It is normally juicy, sweetish and somewhat like a cantaloupe in flavour, in some types quite musky. Attached lightly to the wall by soft, white, fibrous tissue, are usually numerous small, black, ovoid, corrugated, slippery seeds about 5 mm long, each coated with a transparent gelatinous aril (Morton, 1987).

Pawpaw is largely cultivated in Nigeria and its fruit widely consumed raw as dessert, and also processed into different products like jam, jelly and marmalades. Its green peels are boiled and consumed for medicinal purposes and the seeds possess significant antioxidant activities (Sofoware, 1997; Jaime *et al.*, 2007; Zhou, 2011). It is a source of papain, a proteolytic enzyme that hydrolyses protein and as such it is used industrially as meat tenderizer. The fruit is rich in carotenoids, vitamins, lycopene and minerals. These nutrients can be influenced by agro climatic conditions, cultivation practices, varieties and the level of maturity (Marelli de Souza *et al.*, 2008; Charoensiri *et al.*, 2009). Pawpaw belongs to the climacteric class of fruits where physico-chemical changes take place very quickly and are triggered by differential gene expression, enzyme activation and plant hormone (ethylene) during ripening (Chong *et al.*, 2009; Fabi *et al.*, 2009; Fabi *et al.*, 2010). This postharvest deterioration creates problem of storage and eventual availability at off season. This study therefore aimed at determining the effect of postharvest ripening stages on the nutritional composition of four varieties of pawpaw.

MATERIALS AND METHODS

Collection of sample and preparation

Red lady (oblong shaped), solo sunrise (pear shaped), maradol (round shaped) and Taiwan disco (convex shaped) varieties of mature unripe pawpaw fruits were harvested from a local farm at Uyo, Nigeria. The fruits were divided into three groups, the first group (mature unripe) was analysed immediately and the second and third groups were allowed to attain semi ripe and ripe stages, respectively, at ambient storage temperature (30±2°C). The fruits were peeled, seeds removed and the fruit sliced into pieces for ease of blending using Kenwood blender (Model FP 505, Kenwood Britain, UK).

Methods of analysis

Total sugar content was determined according to the method described by Nielsen (2009). Moisture, crude fibre, ash and crude protein were carried out according to the method described in AOAC (2005). Carbohydrate content was obtained by difference method according to Ihekoronye and Ngoddy (1985). Two (2) grams of samples were ashed at 550 °C for 4h. The ash was boiled with 10 ml of 20% HCl in a beaker and then filtered through a

Whatman No. 1 ashless filter paper into a 100 ml standard flask. The filter digest was made up to the mark with deionized water and used for the mineral analysis. Calcium (Ca) and Magnesium (Mg) were determined using atomic absorption spectrophotometer (UNICAM, Model 939, UK) while sodium (Na) was determined using the standard flame emission photometer. Vitamin C content of the sample was carried out using indophenol method according to AOAC (2005).

Statistical analysis

Determinations were carried out in triplicate. Data obtained were subjected to analysis of variance (ANOVA) using SPSS version 20.0 software. The statistical significance ($p < 0.05$) of the observed differences among the means of values reported was separated with Duncan's New Multiple Range Test (DNMRT).

RESULTS AND DISCUSSION

Total sugar content of pawpaw fruit

Table 1 shows the total sugar content of four varieties of pawpaw pulp at postharvest ripening stages. Red lady variety had significantly ($p < 0.05$) higher total sugar content (14.30%) than those of solo sunrise (10.31%), maradol (10.58%) and Taiwan disco (12.46%) varieties at their ripe stage level. A similar result has been reported by Zaman *et al.* (2006) for Indian pawpaw and Othman (2009) for Tanzania pawpaw. Sugar content increased as the ripening stages progressed. The largest quantitative change associated with ripening is usually the breakdown of carbohydrate polymers during the total conversion of starch into sugars.

Table 1: Total sugar content (%) of pawpaw pulp varieties at postharvest ripening stages

Stage of ripening	Pawpaw varieties			
	Red lady	Solo sunrise	Maradol	Taiwan disco
Mature unripe	8.29±0.16a	5.17±0.12c	4.25±0.17d	7.17±0.15b
Semi ripe	11.13±0.47a	9.28±0.17c	9.67±0.29c	10.34±0.30b
Ripe	14.30±0.35a	10.31±0.21c	10.58±0.15c	12.46±0.22b

Values are mean ± SD (n=3). Mean value of samples with different letters along the rows are significantly ($p < 0.05$) different according to DNMRT.

Proximate composition of pawpaw fruit

Proximate composition of four varieties of pawpaw pulp at postharvest ripening stages is presented in Table 2. The moisture and carbohydrate content were the highest nutrients in pawpaw fruit irrespective of varieties and stages of ripening. Moisture content ranged from 84.6-87.6%, 84.8-89.3%, 80.4-87.7% and 70.8-86.3% for red lady, solo sunrise, maradol and Taiwan disco, respectively, with the highest content found in ripe stage. Solo sunrise variety had the highest moisture content (89.3%) while the lowest was found in Taiwan disco (70.8%) at mature unripe stage. This high moisture content in ripe fruit pulp makes the fruit a good source of hydration for the body as well as possessing the ability to quench thirst (Ogbonna *et al.*, 2013).

Table 2: Proximate composition (%) of pawpaw pulp varieties at postharvest ripening stages

Varieties	Ripening stage	Proximate composition (%)					
		Moisture	Crude fibre	Ash	Crude protein	Crude fat	Carbo Hydrate
Red lady	MUS	84.61±0.47b	1.33±0.15a	0.76±0.03c	0.57±0.06c	0.22±0.03fg	12.51±0.49c
	SRS	85.26±0.11b	1.05±0.04c	0.86±0.03a	0.55±0.03cd	0.20±0.03g	12.08±0.43f
	RS	87.60±0.14ab	0.76±0.03fg	0.36±0.03j	0.48±0.03ef	0.19±0.02g	10.60±0.47i
Solo sunrise	MUS	84.80±0.58b	1.19±0.26b	0.44±0.04hi	0.56±0.05cd	0.36±0.02cd	12.65±0.43d
	SRS	85.30±0.07b	0.82±0.05ef	0.49±0.01fg	0.56±0.04cd	0.35±0.02cd	12.48±0.43e
	RS	89.29±0.26a	0.71±0.02g	0.42±0.04i	0.50±0.03e	0.33±0.04d	8.75±0.47j
Maradol	MUS	80.40±0.12c	0.88±0.06de	0.49±0.02fg	0.58±0.05c	0.28±0.02e	17.37±0.47c
	SRS	87.26±0.22ab	0.56±0.05h	0.54±0.03e	0.52±0.02de	0.27±0.02e	10.85±0.40h
	RS	87.71±0.05ab	0.53±0.02h	0.46±0.02gh	0.47±0.02ef	0.24±0.02f	10.59±0.40i
Taiwan disco	MUS	70.81±0.16e	0.96±0.02d	0.59±0.01d	0.68±0.07a	0.43±0.02a	26.53±0.43a
	SRS	75.10±0.07d	0.87±0.08e	0.81±0.03b	0.63±0.02b	0.40±0.02b	22.19±0.41b
	RS	86.27±0.19ab	0.80±0.02ef	0.52±0.01ef	0.45±0.01f	0.38±0.02bc	11.58±0.49g

MUS = Mature Unripe Stage, SRS = Semi Ripe Stage, RS = Ripe Stage. Values are mean ± SD (n=3). Mean value of samples with different letters within the columns are significantly ($p < 0.05$) different according to DNMRT

The result is in agreement with the report of Nwofia *et al.* (2012) that recorded high moisture content also for ripe pawpaw pulp. Carbohydrate content decreased from 12.51-10.60%, 12.65-8.75%, 17.37-10.59% and 26.53-11.58% for red lady, solo sunrise, maradol and Taiwan disco, respectively. Maradol and Taiwan disco were two varieties with higher carbohydrate content at mature unripe stage. This increase in moisture content drastically reduces the other nutritive factors of the fruit such as, crude fat, ash, crude protein and crude fibre. It therefore

indicates that fruits are not good sources of crude protein and crude fat (Nnam and Njoku, 2009; Ogbonna *et al.*, 2013). The crude fibre content levels were low in all the pawpaw varieties which ranged from 0.53 to 1.33%. The ash content varies among the varieties. Red lady, solo sunrise, maradol and Taiwan disco had the increase values 0.86, 0.49, 0.54 and 0.81%, respectively at mature unripe stage.

Vitamin C and mineral compositions of pawpaw fruit

Table 3 shows the vitamin C and some mineral compositions of different varieties of pawpaw pulp at different stages of ripening. Vitamin C content ranged from 30.46-118.50 mg per 100g for solo sunrise variety at semi ripe stage and red lady variety at mature unripe stage, respectively. It was observed that all the pawpaw varieties (red lady, solo sunrise, maradol and Taiwan disco) have high vitamin C content (118.51, 93.94, 73.26 and 114.63 mg per 100g), respectively, at mature unripe stage. Vitamin C is required for the prevention of scurvy and maintenance of health skin, gums and blood vessels. As an antioxidant, it reduces the risk of arteriosclerosis, cardiovascular diseases and some form of cancers (Harris, 1996).

Table 3: Vitamin C and mineral composition (mg per 100g) of pawpaw varieties at postharvest ripening stages

Varieties	Sample code	Vitamin C	Mg	Ca	Na
Red lady	MUS	118.50±0.45a	10.85±0.02b	47.24±0.07d	25.48±0.02bc
	SRS	78.49±0.28d	13.04±0.05a	60.03±0.14a	26.18±0.05c
	RS	55.50±0.31f	6.40±0.08cd	14.70±0.12e	28.15±0.03a
Solo sunrise	MUS	93.94±0.25c	10.41±0.02a	46.73±0.07d	25.32±0.02bc
	SRS	44.63±0.17j	12.82±0.02b	52.72±0.14c	25.69±0.04c
	RS	30.46±0.38h	7.28±0.03c	14.28±0.12e	27.80±0.03b
Maradol	MUS	73.26±0.14e	10.29±0.02b	46.70±0.05d	24.86±0.01d
	SRS	33.53±0.22i	12.73±0.02a	57.97±0.20ab	25.72±0.04c
	RS	30.65±0.33j	6.32±0.02cd	14.52±0.12e	26.72±0.01b
Taiwan disco	MUS	114.63±0.28b	9.72±0.01b	46.52±0.05d	24.94±0.01d
	SRS	55.54±0.31f	12.90±0.02a	56.80±0.23b	25.75±0.04c
	RS	52.52±0.16g	5.29±0.02d	14.65±0.20e	27.20±0.03ab

MUS = Mature Unripe Stage, SRS = Semi Ripe Stage, RS = Ripe Stage. Values are mean ± SD (n=3). Mean value of samples with different letters within the columns are significantly ($p<0.05$) different according to DNMR T

Red lady pawpaw has the highest vitamin C content in all the ripening stages when compared with other varieties. Similar results have been reported by Adetuyi *et al.* (2008) and Othman (2009). Gradual reduction in vitamin C content was observed in all pawpaw varieties as the storage ripening progressed. This trend is similar to the observation of Bello and Henry (2015) in the study of African star apple during storage but contrary to the findings of Wurochekke *et al.* (2003) who reported increase in the vitamin C content as ripening stages progressed. The reduction in vitamin C level in all pawpaw varieties could be attributed to the activity of the enzyme ascorbate oxidase which converts ascorbic acid to dehydroascorbic acid in stored produce. Significant ($p<0.05$) differences occurred among the varieties in the selected mineral determined as the ripening stages progressed. The magnesium content of the pawpaw varieties ranged from 5.29-13.04 mg/100g for Taiwan disco at ripe stage and red lady at semi ripe stage, respectively. There was general increase in magnesium content from mature unripe to semi ripe stage while reduction in content was observed at ripe stage level in all the varieties. These values are lower than the report of Bari *et al.* (2006). The calcium content ranged from 14.28-60.03 mg/100g. Red lady variety had the highest content at semi ripe stage compared with other varieties and it was the highest in all the mineral contents determined under this study. This increase could be due to low level of oxalic acid and phytic acid being the major chelators of calcium, hence releasing calcium for biological activities. The sodium content of pawpaw varieties increased significantly ($p<0.05$) from mature unripe stage to ripe stage in all the varieties. However, highest content (28.15 mg/100g) was observed in red lady variety. The obtained values for the mineral content of pawpaw pulp in the present study were similar to the findings of Chukwuka *et al.* (2013). Magnesium supports healthy immune system, helps regulate blood glucose level and aids in the production of energy and protein. Calcium helps to building strong bones and teeth while sodium helps control blood pressure and plays a large role in fluid balance with different variations determining the shift of water by osmosis from one area of the body to another.

CONCLUSION

The ripening stages had effect on nutritional composition of the four different varieties of pawpaw fruit. The chemical analyses indicate high level of moisture content, appreciable increase in sugar and carbohydrate level. It is also observed that fruit are low in crude fat, crude protein and crude fibre content. However, pawpaw fruits, especially red lady variety, are good source of vitamin C and excellent source of calcium which offer a nutritional benefit to human health.

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