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Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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Comparative Study of Quality Changes in Shea Butter Coated Pawpaw *Carica papaya* Fruit During Storage

F.O. Adetuyi[1], T.A. Ayileye[1] and I.B.O. Dada[2]
[1]Department of Food Science and Technology, Rufus Giwa Polytechnic, Owo, Nigeria
[2]Department of Science Laboratory Technology, Rufus Giwa Polytechnic, Owo, Nigeria

Abstract: The storage of shea butter coated pawpaw *carica papaya* fruit at different storage temperature was investigated as regard the nutrients, sugars and minerals. Freshly harvested just ripe fruit of pawpaw *carica papaya* was coated with shea butter and stored at room temperature (27°C±1°C), refrigeration temperature (10°C±1°C)and freezing temperature (-5°C±1°C) for 8 days. The proximate, sugar (glucose, fructose and galactose) and minerals (Ca, Mg, Fe and Zn) were subsequently determined. The result of the study shows that the moisture content increases significantly ($P \leq 0.05$) (85.25-95.25%) while other nutrients reduce significantly ($P \leq 0.05$) in storage, the sugar and the minerals content also reduce significantly ($P \leq 0.05$) in storage. The storage temperature of freezing temperature recorded the highest mineral content (Ca-113.33mg/100g, Mg- 53.33mg/100g, Fe- 2.33mg/100g and Zn- 7.00mg/100g) at the end of the storage period which was significantly ($P \leq 0.05$) higher than other storage temperatures. At the end of the storage period, there was no significant difference ($P \leq 0.05$) in the glucose and fructose content of the pawpaw at the different storage temperatures.

Key words: Nutrient, pawpaw, storage temperature, sugar, minerals

Introduction

Pawpaw *carica papaya* is a small tropical tree native to South America. It normally grows with a single and branched trunk which may reach 10m in height but is more commonly 4-5m tall. (Rice *et al*., 1987). The pawpaw plant is wide spread throughout tropical Africa. It belongs to the group (*Caricaceae*). It is a berry developing from syncarpous superior ovary with parietal placentation (Kochhar, 1986; Rice *et al*., 1987).

Fruit is harvested at the first sign of the yellowing if it is to be sent to distant markets, it may remain on the tree a day or two longer if intended for local markets (Rice *et al*., 1987).

Pawpaw fruit soften rapidly at room temperature after harvest and indicated a 2 - to - 3 day shelf life was to be expected (Archbold *et al*., 2003). If the fruit are not very quite ripe, they may be refrigerated for about two weeks and they ripened at room temperature for several days. Pawpaw is favored by the people of the tropic as breakfast and as ingredients in jellies, preservers or cooked in various ways (Oloyede, 2005). The juice makes a popular beverage; young leaves shoot and fruits are cooked as vegetables. Papain, the proteolytic enzymes has a wealth of industrial uses. It is used for meat tenderizers and chewing gum (Oloyede, 2005).

In Nigeria, pawpaw thrives in the southern part but the product is not yet in commercial quantities (Kochhar, 1986). Pawpaw fruit is one of the most nutritional and cheapest fruits grown and consumed in Nigeria. However in the average, fruits are increasingly becoming popular in the Nigerian diet, but the production of these crops remain low and inadequate (Baiyewu and Amusa, 2005). The flavour of pawpaw is very distinctive and needs to be preserved for the consumer (Archbold *et al*., 2003). In Nigeria, very little research has been done on the storage potential of pawpaw since they are not yet in commercial quantity though in some area in Ondo state of Nigeria pawpaw is been coated with palm oil and store on the shelf. It is therefore the aim of this study to determine the proximate, minerals and the sugar content of pawpaw and during storage at the room, refrigeration and freezing temperature.

Materials and Methods

The pawpaw used for this work was a freshly harvested just ripe pawpaw with slight appearance of yellow colour and shea butter obtained from "oja oba" market in Akure.

Sample preparation: The pawpaw was coated with the melted shea butter and divided into three lots. One was stored on the bench in the laboratory, another one was stored in the fridge and the last one was stored in the freezer.

Sample analysis: The nutrient composition, (moisture, crude fibre, ash and fat) of the pawpaw *carica papaya* were determined using the standard AOAC (1990) method, the protein content was determined using the micro-kjeldhal method (Nx6.25) and the carbohydrate was determined by difference. Sugars (glucose, fructose and galactose) were identified and quantified according to the method of Albuquerque (2005) by HPLC using a

Table 1: Nutrient content of shea butter coated pawpaw carica papaya in storage (%)

Nutrients	St.Temp.	Day 0	Day 2	Day 4	Day 6	Day 8
Dry	Rm T	14.74±0.74a(a)	12.85±0.03b(b)	10.95±0.03b(b)	8.94±0.02b(c)	4.74±0.03c(c)
matter	Rf T	14.74±0.74a(a)	14.12±0.07a(a)	13.43±0.02a(a)	12.05±0.03a(b)	10.26±0.04b(b)
	Fr T	14.74±0.74a(a)	14.60±0.02a(a)	13.95±0.03a(a)	12.71±0.95a(a)	11.09±0.05a(a)
Moisturecontent	Rm T	85.25±0.72a(a)	89.15±0.04b(b)	89.05±0.03b(b)	91.06±0.02b(b)	95.25±0.02c(c)
	Rf T	85.25±0.72a(a)	85.88±0.07a(a)	86.57±0.03a(a)	87.24±0.04b(a)	87.68±0.04b(a)
	Fr T	85.25±0.72a(a)	85.39±0.02a(a)	86.07±0.03a(a)	87.26±0.95b(a)	88.91±0.05c(b)
Carbohydrate	Rm T	7.85±0.35a(a)	5.76±0.16c(b)	6.76±0.11b(b)	5.58±0.18c(c)	2.02±0.23d(c)
	Rf T	7.85±0.35b(a)	8.09±0.14a(a)	8.29±0.13a(a)	6.20±0.22d(b)	7.87±0.16c(a)
	Fr T	7.85±0.35b(a)	8.14±0.16a(a)	8.21±0.18a(a)	7.66±0.20b(a)	6.79±0.21c(b)
Protein	Rm T	2.33±0.16a(a)	1.58±0.25b(b)	0.99±0.16c(b)	0.53±0.24d(b)	0.23±0.33e(b)
	Rf T	2.33±0.16a(a)	2.04±0.16a(a)	1.57±0.24b(a)	1.23±0.24b(a)	0.82±0.16c(a)
	Fr T	2.33±0.16a(a)	2.16±0.16a(a)	1.87±0.16b(a)	1.69±0.16b(a)	1.17±0.32b(a)
Ash	Rm T	1.95±0.02a(a)	1.80±0.03a(a)	1.58±0.03a(b)	1.46±0.02b(b)	1.24±0.01c(b)
	Rf T	1.95±0.02a(a)	1.82±0.04a(a)	1.74±0.02b(a)	1.62±0.03b(a)	1.54±0.03b(a)
	Fr T	1.95±0.02a(a)	1.67±0.05b(b)	1.74±0.07b(a)	1.62±0.03b(a)	1.54±0.03b(a)
Fiber	Rm T	2.02±0.02a(a)	1.55±0.04b(b)	1.41±0.04b(a)	1.21±0.03b(b)	1.14±0.01b(b)
	Rf T	2.02±0.02a(a)	1.76±0.03b(a)	1.59±0.02b(a)	1.51±0.02b(a)	1.32±0.02b(a)
	Fr T	2.02±0.02a(a)	1.91±0.01a(a)	1.66±0.02b(a)	1.45±0.02b(a)	1.33±0.02b(a)
Fat	Rm T	0.60±0.07a(a)	0.29±0.08b(a)	0.21±0.01b(a)	0.16±0.02b(a)	0.12±0.01b(a)
	Rf T	0.60±0.07a(a)	0.41±0.02a(a)	0.24±0.04a(a)	0.20±0.04a(a)	0.09±0.02b(a)
	Fr T	0.60±0.07a(a)	0.53±0.02a(a)	0.45±0.01b(a)	0.32±0.01b(a)	0.24±0.01b(a)

Rm T- Room temperature, Rf T- Refrigeration temperature and Fr T- Freezing temperature. Value represent mean of triplicate and standard deviation. Values with the same letter along the same Column are not significantly different ($p > 0.05$) while values with the same letter inside brackets along the row are not significantly different ($p > 0.05$).

waters R401 refractive index detector and a sugar-pack water column. The minerals were determined on aliquots of the solutions of the ash by established flame atomic absorption spectrophotometry method using atomic absorption spectrophotometer (model 372) (Perkin Elmer, 1982).

Analysis of data: Data Collected were subjected to the analysis of variance (SAS, 2002). Mean separation were done where there is significant differences using Duncan multiple range test procedure as described in the SAS soft ware. Significance was accepted at $P \leq 0.05$.

Results and Discussion

Fruits form integral part of African diet and are consumed as relishes and snacks. Fruits are found to be rich in vitamins, especially vitamin C minerals, fat and sugars (Achinewhu, 1983; Ogbonna, 1991). Despite this, fruits have not been given a pride of place in the diet of the Nigeria people. The main reason for the neglect is ignorance of the nutritive values of most of the fruits which abound in our environment (Umoh, 1998). Fruits are usually recommended for weight reducing formulas as well as for providing energy for convalescing patients who most often lack appetite during the period of ill-health (Umoh, 1998).

The result of the nutrient, minerals and sugar content of shea butter coated pawpaw in storage is highlighted as follows:

The result of proximate analysis of pawpaw *carica papaya* fruit as shown in Table 1 revealed that the fruit has 85.25% moisture. However, at the various storage temperature the moisture content increases significantly ($P \leq 0.05$) (85.25 - 95.25%) with the least increase at the storage temperature of refrigerator. The value reported in this work for just ripe pawpaw was lower to what was reported by Umoh (1995) for just ripe papaya 88.87% but higher than the value of ripe *dennetia tripatela* 82% (Udoessien and Ifon, 1984). It is worth noting that in all the storage temperatures observed the nutrient content of pawpaw reduces significantly ($P \leq 0.05$) as the days of storage increases but reduces non significantly ($P \leq 0.05$) except for carbohydrate with respect to each day of storage.

Carbohydrates contain mainly the elements carbon, hydrogen and oxygen; they are usually synthesized by green plants from water and carbondioxide with the aid of sunlight. They are a source of calories or energy (Enwere, 1998; Ihekoronye and Ngoddy, 1985). The carbohydrate content of pawpaw decreases (dry weight basis) significantly ($P \leq 0.05$) in the three storage temperatures at the end of the storage period (7.85-2.02%). The reduction in carbohydrate does not conform with the finding of Umoh (1995) who reported increase in the carbohydrate content of pawpaw as it ripen. The storage method of refrigeration temperature recorded the highest carbohydrate content in day 8 (7.87%) which was significantly higher ($P \leq 0.05$) than other storage temperatures. The decrease in carbohydrate could be attributed to the breaking down of the carbohydrate to sugars as the pawpaw ripens in storage.

Proteins are macromolecules containing one hundred to one thousand amino residue linked together by peptide bonds (Clucas, 1981). They are extremely important components of living cells in that they regulate metabolism, act as structural molecules and in some products represent storage forms of carbon and nitrogen (Kays, 1991).

Table 2: Mineral content of shea butter coated pawpaw carica papaya fruit in storage (%)

Minerals	St.Temp.	Day 0	Day 2	Day 4	Day 6	Day 8
Ca	Rm T	243.33±8.8a(a)	170.0±4.14b(b)	126.67±8.8c(c)	86.67±8.0d(b)	36.67±8.8e(c)
	Rf T	243.33±8.8a(a)	193.3±5.56a(a)	136.67±8.8b(b)	70.00±8.8c(b)	56.67±8.8d(b)
	Fr T	243.33±8.8a(a)	213.3±9.42a(a)	193.3±8.8a(a)	153.3±8.8b(a)	113.3±23.5c(a)
Mg	Rm T	160.0±21.2a(a)	103.3±9.42b(b)	73.33±9.42c(b)	43.3±8.85d(b)	16.67±23.5e(b)
	Rf T	160.0±21.2a(a)	123.3±9.42b(a)	76.67±8.8c(b)	56.67±8.85d(a)	20.00±4.14e(b)
	Fr T	160.0±21.2a(a)	133.3±9.42b(a)	103.33±9.5c(a)	76.67±9.42d(a)	53.33±9.42e(a)
Fe	Rm T	9.00±1.41a(a)	4.67±0.94b(b)	2.67±0.94b(c)	1.33±1.32c(b)	0.00±0.00d(b)
	Rf T	9.00±1.41a(a)	6.67±0.94b(a)	3.67±0.09c(b)	2.00±±1.41c(b)	0.00±0.00d(b)
	Fr T	9.00±1.41a(a)	6.67±0.94b(a)	5.67±0.94b(a)	4.00±1.41c(a)	2.33±0.94c(a)
Zn	Rm T	18.0±4.24a(a)	9.00±1.41b(c)	5.67±1.88c(c)	2.67±0.94d(c)	0.33±0.94e(b)
	Rf T	18.0±4.24a(a)	12.33±1.88b(a)	8.33±1.88c(b)	5.33±1.88d(b)	1.00±1.41e(b)
	Fr T	18.0±4.24a(a)	15.67±0.94b(a)	13.67±0.94b(a)	9.67±0.94c(a)	7.00±1.41c(a)

Rm T- Room temperature, Rf T- Refrigeration temperature and Fr T- Freezing temperature. Value represent mean of triplicate and standard deviation. Values with the same letter along the same Column are not significantly different (p> 0.05) while values with the same letter inside brackets along the row are not significantly different (p> 0.05).

The protein of pawpaw reduces significantly (P≤0.05) on dry weight basis as the days of storage increases in all the three storage temperatures (2.33-0.23%) though there was no significant (P≤0.05) difference in the three storage temperatures on daily basis. The protein content recorded for just ripe pawpaw was higher than what was observed for papaya by Umoh (1995) 0.41%, it was in the same range of the protein value of *terminalia* catappa fruits pulp 2.30% (Jeremiah, 1992) but was far lower to the protein value of the fruit of *tetrapleura tetraptera* (Essien *et al.*, 1994) and mango *magnifera indica* 18.3% (Ibiyemi *et al.*, 1990). The reduction in protein was in agreement with the findings of Umoh 1995 that protein content of papaya reduces as they ripen. Agbor - Egbe and Rickard (1990) also reported decrease in the crude protein of avoid stored for 14days. However, this decrease does not agree with the findings of Amusa *et al.* (2002) who reported increase in the protein content of breadfruit in storage. The decrease in the protein content could be attributed to proteolysis which is the breakdown of proteins and it begins fairly rapidly after harvest.

The ash content reduces significantly (P≤0.05) as the storage period increases (2.02-1.41%) though with respect to days in storage temperatures, there was no significant (P≤0.05) difference. Dietary fibres are constituent of many fruits and vegetables; although dietary fibres cannot be digested by man but have useful roles in providing roughage that aids digestion (Eva, 1983). The fibre reduces significantly (P≤0.05) as the storage period increases (1.95-1.24%) though with respect to days in storage temperatures, there was no significant (P≤0.05) difference. Umoh (1995) reported decrease in fibre of papaya as they ripen. This decrease is not in agreement with the report of Amusa *et al.* (2002) who reported increase in crude fibre of bread fruit in storage. This decrease in fibre could be due to the conversion of the fibre, a cellulose, to carbohydrate and used during respiration.

Fats and oils in the unrestricted sense are macromolecules that are highly soluble in organic

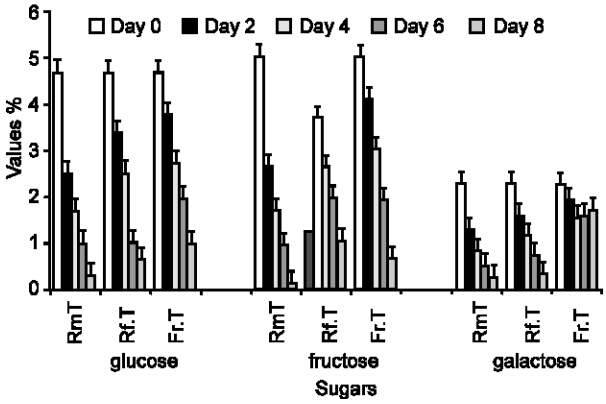

Fig. 1: Sugar content of shea butter coated pawpaw *carica papaya* in storage. Rm T- Room temperature, Rf T- Refrigeration temperature and Fr T- Freezing temperature.

solvents and only sparingly soluble in water (Davidson *et al.*, 1975). Fats and oils are generally called lipids; they provide a convenient and concentrated source of energy in the diet (Ononogbu, 1988). The fat content decreases significantly (P≤0.05) as the storage time increases (0.60-0.09%) but with respect to days in the different storage temperatures, there was no significant (P≤0.05) difference. the fat content obtained was higher than the value obtained by Umoh (1995) 0.46% for just ripe papaya but lower to the value recorded for Africa star apple pulp 15.1% (Edem *et al.*, 1984). The decrease in fat content of pawpaw could be attributed to the recycling of the carbon stored as tricyglycerols in lipids through the action of the enzyme lipase. At the end of the storage period, the freezing temperature recorded the highest value of fat 0.28% which was significantly (P≤0.05) higher than other storage temperatures.

Glucose and fructose are found abundantly in nature occurring free in some foodstuffs and combined with each other. Glucose is the sugar normally found in the blood, it therefore, has an important medical application as a substance that can be administered as a source of

carbohydrate for patients unable to take nourishment by mouth (Ihekoronye and Ngoddy, 1985). The result of the sugar content is shown in Fig. 1, the result revealed that the sugar of just ripe pawpaw to be glucose 4.64%, fructose 4.99% and galactose 2.26%. The sugar are lower to the values reported by Umoh (1995) for pineapple but higher than the values reported by Ladele *et al.* (1984) for unripe and just ripe plantain. However, the value of these sugars reduces significantly ($P \leq 0.05$) as the storage period increases glucose (4.64-0.29%), fructose (4.99-0.13%) and galactose (2.26-0.23%). The reduction in sugar could be attributed to natural degradation. In fact they become metabolically consumed in the respiratory chain due to phosphorylated equivalent synthesis (Albuquerque *et al.*, 2005). When the storage temperatures were analyzed with respect to days, it shows that there was a significant ($P \leq 0.05$) difference in the sugar content with the freezing temperature having the highest value of 1.12% glucose, 1.65% fructose, 1.71% galactose at the end of the storage period which was significantly ($P \leq 0.05$) higher than other storage temperature.

Minerals are classified into major and minor elements, with the major been calcium, potassium, phosphorus, magnesium, sodium, sulphur and iron, all are required in large quantities. (Davidson *et al.*, 1975). Mineral content of (Ca, Mg, Fe and Zn) of pawpaw fruits are shown in Table 2, the result shows that Ca (243.33mg/100g) and mg (160.00mg/100g) were high while Zn (18.00mg/100g) and Fe (9.00mg/100g) were low. The minerals were in the same range with the values reported by Jeremiah (1992) for *T.* catappa fruits pulp but higher than the values reported by Oloyede (2005) for unripe pawpaw. During the storage of pawpaw fruits, the fruits ripen and the colour changes from green to yellow with the formation of carotenoids which could require minerals, this could account for the reduction in the minerals as the storage period increases. However, when the storage temperatures were analyzed with respect to days, it shows that there was a significant ($P \leq 0.05$) difference in the mineral content with the freezing temperature having the highest value of 113.33mg/100g calcium, 53.33mg/100g magnesium, 2.33mg/100g iron and 7.00mg/100g zinc at the end of the storage period which was significantly ($P \leq 0.05$) higher than other storage temperature.

Conclusion: It is therefore advocated that pawpaw after coated should not be stored at the room temperature since this recorded the lowest values of nutrients, sugar and minerals which were significantly ($P \leq 0.05$) lower to other storage temperatures and it makes these nutrients, sugar and minerals not available to the consumer.

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