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Full Length Research Paper

Antinutrient and antioxidant quality of waxed and unwaxed pawpaw C*arica papaya* fruit stored at different temperatures

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The storage of shea butter waxed and unwaxed pawpaw *Carica papaya* fruit at two storage temperatures was investigated with respect to the antinutrient (phytate, oxalate, condensed tannin (CT) and hydrolysable tannin (HT)) and antioxidant (vitamin C, tocopherol, total phenol and carotenoid) properties. Freshly harvested just ripe pawpaw *C. papaya* fruit was divided into two lots; one was waxed with shea butter, the other was not waxed and they were stored at room temperature (27 ± 1°C) and refrigeration temperature (10 ± 1°C) for 8 days. The antinutrients and antioxidants were subsequently determined. The result of the study shows that the antinutrients decreased significantly (P < 0.05) as the storage period increased in both storage temperature regimes; phytate (1.22 to 0.34%), oxalate (0.45 to 0.13%), hydrolysable tannin (0.021 to 0.000%) and condensed tannin (0.062 to 0.006%). The value of antinutrients of unwaxed sample was lower than that of waxed sample though there was no significant difference (p > 0.05) in the CT and HT. Antioxidants also decreased significantly (P < 0.05) as the storage period increased. Waxed pawpaw recorded the highest antioxidant content at the end of the storage period which was significantly (P < 0.05) higher than the unwaxed in the two storage temperatures.

Key words: Antinutrient, antioxidant, pawpaw, *carica papaya*, storage temperature.

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 10 m in height but is more commonly 4 – 5 m 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 plancentation (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 fruits are climacteric exhibiting an increase in respiration and ethylene production during ripening. Within 3 days of harvest, ethylene and respiratory climacteric were clearly evident as the fruit were rapidly softening (Peterson, 1991, Koslanund, 2003).

Pawpaw fruit soften rapidly at room temperature after harvest and a 2 to 3 day shelf life is to be expected (Archbold et al*.,* 2003). If the fruits are not quite ripe, they may be refrigerated for about two weeks and they ripen 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 flavour of pawpaw is very distinctive and needs to be preserved for the consumer (Archbold et al*.,* 2003). The juice makes a popular beverage; young leaves shoot and fruits are cooked as vegetables. Papain, the proteolytic enzyme obtained from the leaves 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 on average, fruits are increasingly becoming popular in the Nigerian diet, but the production of these crops remain

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low and inadequate (Baiyewu and Amusa, 2005). In Nigeria, very few researches have been carried out on the storage potentials of pawpaw since it is not yet in commercial quantity. Although in some areas in Ondo State of Nigeria pawpaw is been coated with palm oil and stored on the shelf. It is therefore the aim of this study to determine the effect of waxing of pawpaw with Shea butter on its antinutrient and antioxidant properties during storage at the room and refrigeration temperatures.

MATERIALS AND METHODS

Materials

The pawpaw used for this work was a freshly harvested just ripe pawpaw with slight appearance of yellow colour, and shear butter were both obtained from "Oja Oba" market in Akure, Ondo state, Nigeria.

Sample preparation

The pawpaw was divided into two lots; one was waxed with melted Shea butter, the other was not waxed and they were divided into two lots. One was stored on the bench in the laboratory at room temperature (27 ± 1°C) and the other one was stored in a refrigerator (10 ± 1°C).

Sample analysis

The antinutrient content, (phytate, oxalate, condensed tannin and hydrolysable tannin) of the pawpaw (*Carica papaya)* were determined as follows: The phytate content was determined by the method of Maga (1982) which depend on the ability of standard ferric chloride to precipitate phytate in dilute HCl extract of the pawpaw. Oxalate content was determined using the AOAC (1990) method. The method of Wang and Hang (1993) was used for the determination of hydrolysable tannin (HT) and condensed tannin (CT). For hydrolysable tannin (HT) the phenolic extract (0.5 ml) was diluted with 2 ml-distilled water in 10 ml flask. 1 ml folin-ciocalteau phenol reagent was added and shaken vigorously. 5 ml of 20% Na_2CO_3 was pipetted into the mixture and made up to the mark with distilled water and shaken vigorously. It was allowed to stand for 20 min for colour development. Absorbance of the sample, standard and the blank were read on spectronic 21D spectrophotometer at a wavelength of 735 nm. For condensed tannin (CT) the phenolic extract (0.1 ml) was pipetted into a 30 ml test tube and covered with aluminium foil. 3 ml of 4% vanillin (w/v) in methanol was added; the tube was shaken vigorously. 1.5 ml concentrated Hcl was added into the tube and was shaken again. It was allowed to stand for 20 min for colour development. Absorbance of the sample, standard and the blank were read on spectronic 21D spectrophotometer at a wavelength of 500 nm. The vitamin C content were determined by AOAC (1990) method, described thus: 5 g of the pawpaw sample was extracted by 100 ml H_2O, 25 ml of 20% glacial acetic acid was added to 10 ml of the pawpaw sample extract and titrated against standardized 2,6 dichloroindophenol (0.05 g/100 ml) solution. Vitamin E (tocopherol) and vitamin A (carotenoid) contents were determined using the AOAC (1990) method. The total phenol was determined by mixing 0.2 ml phenolic extract (0.2 g of the pawpaw extracted by 20 ml 70% Acetone) with 0.8 ml Folin – Ciocalteu reagent and 2 ml of 7.5% sodium carbonate. The mixture was diluted using 7 ml distilled water and the absorbance was measured after 2 h at 765 nm, the result was calculated as garlic acid equivalent (Iqbal et al*.,* 2004).

Analysis of data

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

RESULTS AND DISCUSSION

Results of antinutrient contents of pawpaw (*C. papaya*) fruit as shown in Table 1 revealed that the fruit has 1.22% phytate. However, at the various storage temperatures the phytate content decreases significantly (P < 0.05) (1.22 to 0.34%) with the least decrease in the unwaxed pawpaw. The value reported in this work for just ripe pawpaw was lower to what was reported by Aremu (1989) for plantain (*Musa paradisiaca*; 26.8%) and Eka (1977) for carrot (5.5%) but higher than the value of star apple *Chrysophyllum albidum* (0.8%; Edem et al*.,* 1984) and for avocado fruit (0.14%; Phillippy and Wyatt, 2001). The reduction in phytate could be attributed to the presence of an enzyme phytase which degrade phytate in fruits. The unwaxed pawpaw sample recorded the least phytate content 0.34% at room temperature storage and 0.62% in refrigeration at the end of the storage period. This could be attributed to the reduction in the activity of the enzyme phytase which was caused by the low temperature.

It is worth noting that in all the storage temperatures, the antinutrient content of pawpaw reduced significantly (P < 0.05) as the days of storage increases. This could be as a result of ripening of the pawpaw and the changes in the chemical composition from acidic to neutral.

Oxalate is a concern in fruits and vegetable because higher oxalate diet can increase the risk of renal calcium absorption (Osagie, 1998). Oxalic acid has the ability to bind some divalent metals such as calcium and magnesium and has therefore been suspected to interfere with the metabolism of these minerals (Aletor, 1993). The oxalate content of waxed and unwaxed pawpaw decreased significantly (P < 0.05) in the storage temperatures at the end of the storage period (0.45 – 0.13%). The oxalate content of pawpaw (0.45%) was low when compared to its content in cocoa (*Theobroma cacao*; 0.5 – 0.9%) but high with respect to cashew (*Anacardium occidentale*; 0.231%) and apple (*Malus spp.*; 0.03%) (Noonan and Savage 1999). The unwaxed pawpaw recorded the least oxalate (0.13%) at room temperature and in refrigeration (0.25%), though there was no significant (P > 0.05) difference between the oxalate content of waxed and unwaxed pawpaw at refrigeration temperature at the end of the storage period. This situation made more of the oxalate unavailable.

The tannin content of the waxed and unwaxed pawpaw at the storage temperatures reduced as the storage period increased. The reduction in tannin could be attributed to the action of polyphenol oxidase enzyme which oxidizes tannin to phenol. The hydrolysable tannin (H.T)

Table 1. Antinutrient content of waxed and unwaxed pawpaw *carica papaya* in storage (%).

Antinutrient	Storage days	Room temperature		Refrigeration temperature	
		Waxed	Unwaxed	Waxed	Unwaxed
Phytate	0	1.22a(a)	1.22a(a)	1.22a(a)	1.22a(a)
	4	0.71b(b)	0.49b(c)	0.94b(b)	0.82b(c)
	8	0.46c(c)	0.34c(d)	0.69c(d)	0.62c(e)
Oxalate	0	0.45a(a)	0.45a(a)	0.45a(a)	0.45a(a)
	4	0.25b(b)	0.20b(b)	0.36b(b)	0.32b(b)
	8	0.17c(c)	0.13c(d)	0.29c(c)	0.25c(c)
Condensed	0	0.062a(a)	0.062a(a)	0.062a(a)	0.062a(a)
tannin	4	0.029b(b)	0.016b(c)	0.038b(b)	0.025b(c)
	8	0.010c(d)	0.006c(d)	0.010c(d)	0.013c(d)
Hydrolysable	0	0.021a(a)	0.021a(a)	0.021a(a)	0.021a(a)
tannin	4	0.011b(b)	0.002b(c)	0.009b(b)	0.011b(b)
	8	0.001c(c)	0.000c(c)	0.006c(b)	0.003c(b)

Value represent mean of triplicate.
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).

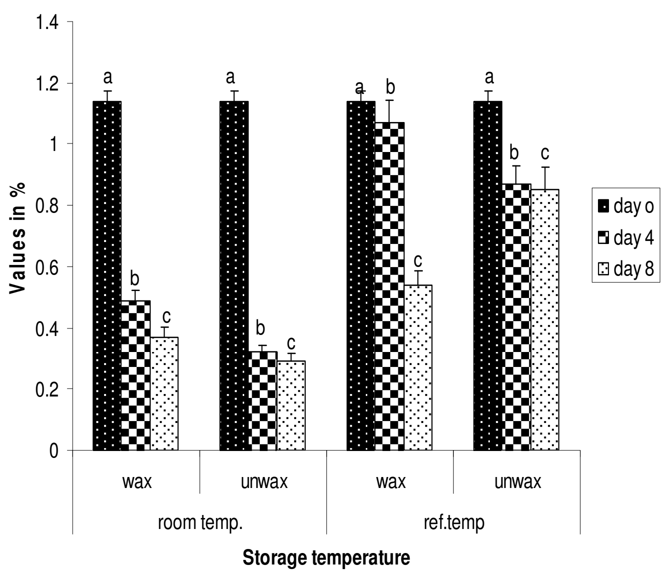

Figure 1. Total phenol content of waxed and unwaxed pawpaw *carica papaya* in storage. Values with the same letter along the same column are not significantly different (p > 0. 05).

is of more importance nutritionally because they may be readily hydrolyzed into a mixture of carbohydrate and phenols (Bullard et al., 1981; Osagie, 1998). The hydrolysable tannin reduced from 0.021 to 0.000%. The condensed tannin (C.T) are complex flavanol polymers. They cannot be hydrolyzed to simple components and they also have limited solubility and extractability and hence may have little nutritional significance (Osagie 1998; Mehansho et al., 1987). The condensed tannin reduced from 0.062 to 0.006%. At the storage temperatures, the tannin content (C.T and H.T) of waxed pawpaw were higher than unwaxed pawpaw though there was no significant (P > 0.05) difference at the end of the storage period. Fleck (1988) reported decrease in tannin level during storage of four acorn species.

The total phenol as presented in Figure 1 shows that the total phenol were reducing as the storage period increased in the two storage temperatures. This reduction in total phenol conforms with the findings of Ose et al. (1997) that the total phenol content of water convolvulus leaves decreased in storage. Also Lim et al. (2006) reported decreases in the total phenol content of guava. The total phenol of the pawpaw reduced from 1.14 - 0.29%. Reduction in total phenol could be attributed to the fact that phenols are susceptible to oxidation by phenolase which convert it to quinones (Kays, 1991). There was a significant difference (P < 0.05) between the waxed and unwaxed pawpaw at the storage temperature of refrigeration with unwaxed pawpaw having a higher value (0.85%). There was no significant (P > 0.05) difference between the waxed and unwaxed pawpaw at the room temperature at the end of the storage period.

The main contribution of fruits and their products to nutrition is undoubtedly their supply of vitamins. Fruits and vegetables are the main sources from which primates derive their vitamins (Umoh, 1998). Table 2 revealed that just ripe pawpaw has 5.33 mg/100 g of vitamin E (tocopherol) and they reduce significantly (P < 0.05) in the two storage temperatures at the end of the storage period. The value of vitamin E in waxed pawpaw was significantly higher (P < 0.05) (1.48 mg/100 g room temperature and 2.53 mg/100 g refrigeration temperature) than the unwaxed at the end of the observation. Vitamin A is present in fruit as carotenes (α, β,γ) which can be converted to the vitamin in the body. Vitamin A deficiency brings about a malfunction in the visual purple

Table 2. Vitamin content of waxed and unwaxed pawpaw *carica papaya* fruit in storage.

Vitamin	Storage days	Room temperature		Refrigeration temperature	
		Waxed	Unwaxed	Waxed	Unwaxed
Vitamin C (mg/100 g)	0	72.79a(a)	72.79a(a)	72.79a(a)	72.79a(a)
	4	34.63b(b)	23.32b(c)	57.95b(b)	50.88b(c)
	8	19.79c(d)	14.84c(e)	40.28c(d)	38.16c(e)
Vitamin E (Tocopherol; mg/100 g)	0	5.33a(a)	5.33a(a)	5.33a(a)	5.33a(a)
	4	2.41b(b)	1.58b(c)	3.47b(b)	2.50b(b)
	8	1.48c(c)	0.64c(d)	2.53c(b)	1.86c(c)
Carotenoid (µg/100 g)	0	321.20a(a)	321.20a(a)	321.20a(a)	321.20a(a)
	4	115.30b(b)	76.92b(c)	287.30b(b)	205.88b(c)
	8	77.00c(c)	42.99c(d)	203.70c(c)	144.80c(d)

Value represent mean of triplicate.
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).

and consequent night-blindness (Umoh, 1998). The value of carotenoid in just ripe pawpaw (321.2 µg/100 g) was low because pawpaw is very low in fat and these are fat soluble pigments.

Carotenoids reduced significantly (P < 0.05) in the two storage temperatures at the end of the storage period.

This reduction conforms to the finding of Umoh (1995) that the carotene in just ripe papaya was higher than that of over ripe papaya. The value of carotenoid in waxed pawpaw was significantly (P < 0.05) higher (77.0 µg/100 g room temperature and 203.7 µg/100 g refrigeration temperature) than the unwaxed at the end of the observation. Vitamin C contributes to the antioxidant properties of vegetables by protecting the membrane erythrocyte, maintaining the blood vessel flexibility and improving the blood circulation in the arteries of smokers as well as facilitating the absorption of iron in the body (Oboh, 2005). The vitamin C content of the pawpaw as shown in Table 2 reduced in storage. The loss in vitamin C has been reported by Evensen (1983) in the study of musk melon during storage and Albuquerque et al. (2005) in the storage of winter melons (C*ucumis melo* L). Vitamin C reduced from 72.79 to 14.84 mg/100 g. The value reported in this work for just ripe pawpaw 72.79 mg/100 g was lower than what was reported by Umoh (1995) for just ripe pawpaw (158.75 mg/100 g), and Edem et al. (1984) for the pulp of African star apple (*Chrisophylum albidum*; 446.0 mg/100 g) but higher than the value of T*erminalia catappa* fruit pulp (33.65 mg/100 g; Adewole and Olowokere, 1986). The reduction in vitamin C could be attributed to the activity of the enzyme ascorbate oxidase which converts ascorbic acid to dehydroascorbic acid in stored produce. At every stage of storage at the storage temperatures there was a significant difference (P < 0.05) between the vitamin C content of the waxed and unwaxed pawpaw with the waxed pawpaw having a higher values.

Conclusion

It is concluded that waxed pawpaw retains more of the antioxidants than the unwaxed pawpaw in the two storage temperatures studied. This trend show that they are available, however the antinutrients are not better preserved in waxed pawpaw. In view of the health importance of antioxidants, pawpaw is better waxed.

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