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Waxing Effect on the Physical Attributes, Antioxidant and Sugar Contents of Orange (*Citrus sinensis L. osbeek*) Stored at Room Temperature in Nigeria

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Abstract

The objective of this work was to determine the influence of edible wax and non-edible wax on the physical attributes, vitamin C and total phenol of orange stored at room temperature (28 ± 5^{o} C) in Nigeria. The oranges were divided into three lots, viz one was waxed with she-abutter, the second with petroleum wax and the third was left unwaxed. They were subsequently analyzed for physical apperance, weight loss, vitamin C and total phenol. The waxed orange had a better appearance and market appeal than the unwaxed orange. The percentage weight loss in unwaxed orange 5.88% was higher than significantly (P0.05) higher in waxed than the unwaxed orange at every sampling point while there was no significant (P0.05) difference in the total phenol of both waxed and unwaxed orange. It is concluded that oranges should be waxed with sheabutter because it had better qualities than unwaxed and pertoleum waxed orange and also to prevent postharvest losses in these orange.

Key words: Waxed, Unwaxed, Orange, Vitamin C, Phenol

Introduction

Epidemiological evidence relates fruit consumption to the risk of degenerative diseases. In this sense the antioxidant properties of many fruit and vegetables are widely recognized (Biolatto *et al* 2005). Natural antioxidants found in these products include phenolics and nitrogen compound, carotenoids and some vitamins; vitamin C plays several roles in human health (Harris 1996). The requirements of vitamin C are 90mg/day for young women and 75 mg day for men (Levine *et al* 2001). More than 90% of vitamin C in human diets is supplied by fruits and vegetable (Wills *et al* 1984). Citrus fruit is the most important source of vitamin C because of the large quantities consumed (Biolatto *et al* 2005). The sweet orange *Citrus sinensis* L. Osbeck are very tasty and nutritious, containing 5-10% sugar, 1-2% citric acid, along with vitamin C and beneficial fibre and pulp. Most sweet orange have an orange coloured rind when they are ripe as well as an orange interior and juice. Oranges are grown in enormous quantities and are readily available as an inexpensive fruit at anytime of the year (Arthey and Ashurst, 1996). Orange fruit are the most popular ones for consumer throughout the world due to their pleasant flovours and nutritional value (Dhuique-Mayer *et al* 2005). The fruits are both consumed fresh and industrially processed. Orange peels contain abundant fragment substances which are extensively applied for processing into essential oils which are used commercially for flavorign foods, veberages, perfumes, cosmetics (Dhuique-Meyer *et al* 2005). In Nigeria, enormous quantities of fruits and vegetables are produced and staggering figures are sometimes given as estimated annual producation. for example, figures like 15 million tones of plantain, 6 million tones of tomatoes and 35 million of tones of citrus have been quoted as annual production levels for some fruits and vegetables, which are really large quantities of food crops (Oyedrian, 1988, Erinle, 1989). However, it is the amount of the produce available to the consumers rather than the level of production that is more important (Idah *et al* 2007). It is noted that losses as high as 50% are common in fruits and vegetables between rural porduction and town consumption in the tropics (Oyedrian 1988). It is noted that these losses, occured during transportation, storage and marketing (Daramola 1998, Okhuoya 1995). In Nigeria oranges (*Citrus sinensis* L Osbeck) are produced in the south western state and transported to other parts of the country where the consumption is highest and where the orange command better prices. The oranges in Nigeria are packed into an open truck and transported during which they are exposed to high ambient temperature which will result into shriveling due to weight loss and the appearence will be poor. The poor appearance reduces market appeal and contributes to post harvest losses in orange fruit under tropical condition

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(Aworh *et al* 1991). In developed countries mechanical refrigeration, controlled atmospheres, hypobaric storage and other techniques are used to extend storage life (Aworh *et al* 1991) and during transportation of these citrus fruits. In Nigeria, due to poor road network from the outlying villages to the markets (Adetuyi *et al*, 2008a) on the average produce normally spends four to five days in transit, out of which two days are spent on movement from the production site to the market and the remaining days spent at source markets (Idah *et al*, 2007). To our knowledge most of the data on the nutritional status of orange in Nigeria focused on the proximate, mineral and how to prevent microbial spoilage of orange with little information on the effect of postharvest treatement on the nutriotional constituents of orange. The present study was designed to examine the effect of postharvest treatment of waxing orange with edible (shea butter) and non-edible (petroleum wax) wax on the physical attributes, phenol, vitamin C and sugar content of stored orange.

Materials and Methods

Freshly harvested oranges *Citrus sinensis* used for this suudy were yellow with green patches; they were purchased from an orange farm in 'Ago paanu' village in Owo Local Government area of Ondo State. The shea butter and the petroleum wax were purchased form 'Oja Oba' in Akure Ondo State. The chemicals used in this work were of analytical grade.

Sample preparation

The oranges were washed and mixed randomly, thirty (30) orange fruits which were free from physical damage, insect infestation and blemishes were selected and divided into three lots, one lot was waxed with peroleum was, the second one was waxed with shea butter while the third one was left untereated. All the three lots were separately stored in polypropylene bag container at room temperature ($28+5^{o}$ C) for 120 hours. The treatments were replicated twice. Fruit was analyzed immediately on arrival in the laboratory and after treatment using the unreated sample as the control. Fruits were analyzed every 24 hours for the follwoing characteristics (1) external appearance (2) weight loss (3) Vitamin C (4) Total phenol (5) juice total sugar and glucose.

Weight loss and appearance

Weight loss was determined by weighing the fruit in each treatment at 24 hours intervals during the storage period and is expressed as a percentage of the initial weight (Aworh *et al.*, 1991). The appearance of the fruit was visually determined and is expressed as percentage of fruit surface shriveled (Matta *et al.*, 2006).

Sample analysis

The Vitamin C of the orange juice was determined by the iodine titration method as described by Suntornsuk *et al* (2002). The total phenol was determined using the Folin-Ciocalteu's reagent as described by Lim *et al* (2006), and reported as gallic acid equivalent (GAE). Total sugar and glucose, were identified and quantified according to the method of Albuquerque *et al* (2005) by HPLC using a waters R401refractive index detector and a sugar-pack water column.

Statistical analysis

Analysis of variance (ANOVA) was performed on the results of each quality variable to determine the signuificance of the effecrts of waxing on the fruits quality Means were compared by the least signnificance difference LSD test. Significance was set at P<_0.05.

Results and Discussion

The weight loss in both the waxed and unwaxed oranges is presented in figure 1. The percentage weight loss in unwaxed orange (5.88%) was higher then the waxed orange at the end of the storage period. There was no difference in the percentage weight loss of shea butter waxed and petroleum waxed orange, they recorded the least percentage weight loss of 3.18% and 3.06% respectively, and this agreed with the report of Aworh *et al*. (1991) that waxing minimized weight loss in orange and grapefruit during storage at ambient conditions. This could be attributed to the inhibition of moisture loss from the rind of citru fruit by the wax material (Aworh *et al* 1991). The percentage of orange with shriveled surfaces was significantly low in waxed orange than unwaxed orange which means that waxed orange had a better appearance and market appeal than the unwaxed orange (Figure 2). This finding agreed with the earlier observation of Aworh *et al* (1991) that orange and grape waxed had a better appearance than the unwaxed fruit. This was attributed to the reduction of moisture loss from the fruit caused by the waxing agent on the fruit, thus minimizing shriveling and contributing to the better appearance of waxed fruit (Aworh *et al* 1991). Gomez (2000) also observed that the use of wax on passion fruit extend the shelf life of the product, reduced weight losses

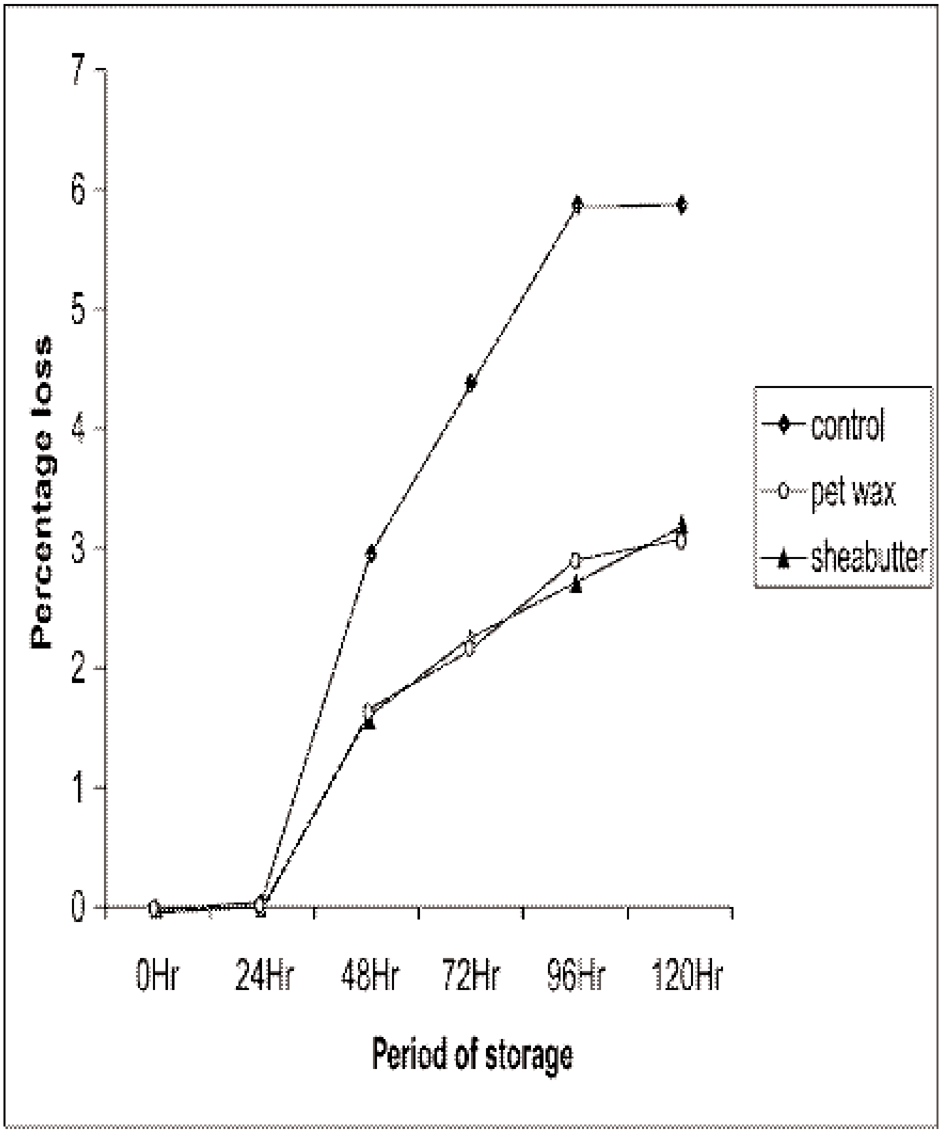

Fig. 1. Percentage weight loss of waxed and unwaxed orange

and maintained an adequate external appearance. The vitamin C and the total phenol of the orange *Citrus sinensis* in storage are shown in Table I. Vitamin C is known to have many biological functions like ion collagen formation, absorption of inorganic iron, reduction of plasma cholesterol level, inhibition of nitrosamine formation, enhancement of the immune system and reaction with singlet oxygen and other free radicals (Lee and Kader 2000). The vitamin C content of orange was found to be 43.46mg/100g. This value was low when compared to the value of vitamin C reported for seed less guava (132mg/100g) and pawpaw (*Carica papaya*) (72.79mg/100g) (Adetuyi *et al* 2008b). Orange could be considered to have high vitamin C content compared to other fruits such as banana, dragon fruit and star fruit with vitamin C content of 4.9mg/100g, 8.0mg/100g and 5.2mg/100g respevtively (Lim *et a*l 2006). During storage the vitamin C content of the orange reduced significantly ($P \leq 0.05$) in both waxed and unwaxed samples. (42.46 to 36.68mg/100g). The loss in vitamin C during storage was in agreement with the report of Evensen (1983) and Albuquerque *et al* (2005) in the storage of musk melon. This result also agree with the observation that fruits and vegetable show a gradual decrease in vitamine C content as the temperature or time at storage time at storage increases (Adisa 1986; Biolaatto 2005). The observed effect ofstorage time on vitamin C degradation could be explained due to indirect degradation through polyphenol

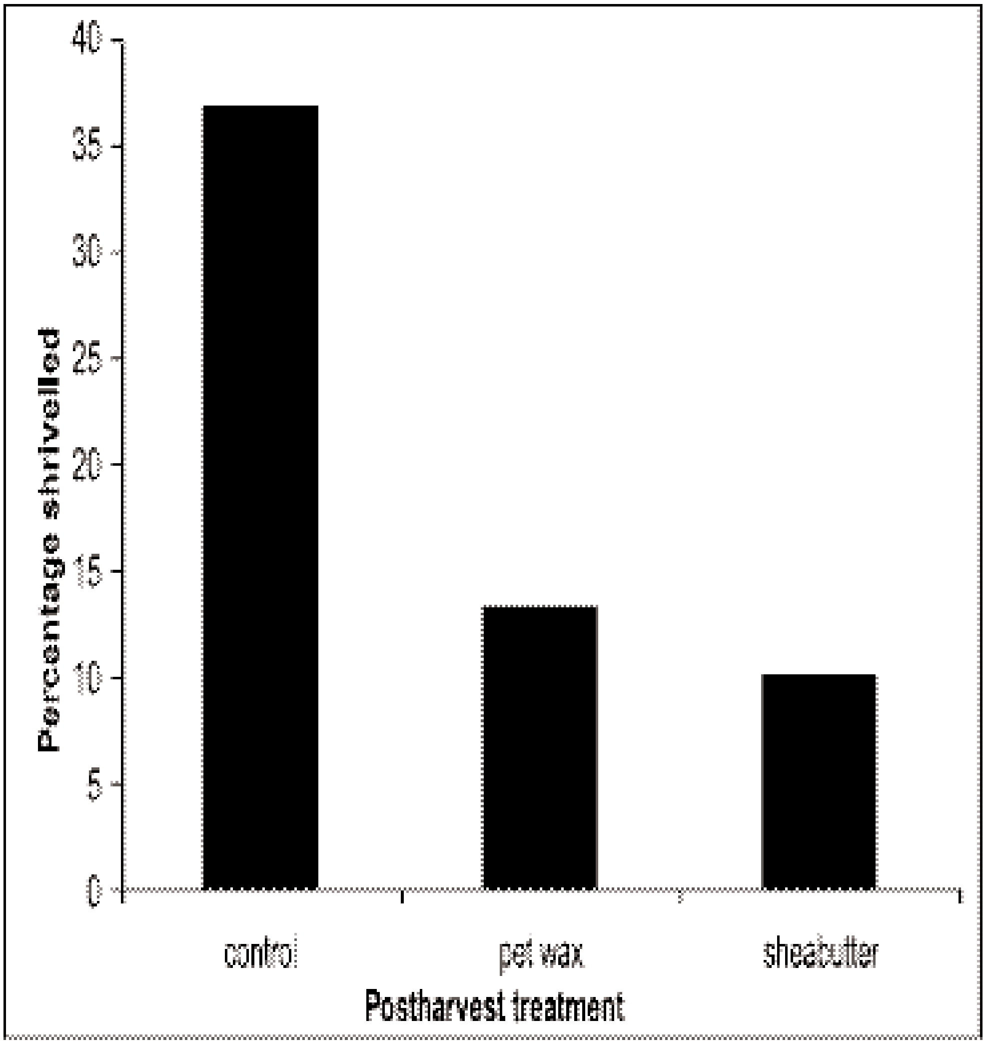

Fig. 2. Percentage of shriveled orange fruit at the end of the storage period (120Hr)

oxidase, cytochrone oxidase and peroxidase activity (Lee and Kader 2000). The orange waxed with shea butter had the highest content of vitamin C of 37.86mg/100g. The reason why the untreated had the least vitamin C may be attributed to increase in the physiological activities in the stored orange which will enhance increase in the activities of the enzymes responsible for vitamin C degradation. Phenolics posses a wide spectrum of biochemical activities

Table I. Vitamin C and total phenol content of waxed and unwaxed orange in storage

Quality	Trmt	0 Hr	24 Hr	48 Hr	72 Hr	96Hr	120 Hr
Vitamin C	Control	43.46±0.1a	42.61±0.02b	41.34±0.01e	38.16±0.02g	37.17±0.01i	36.68±0.021
(mg/100g)	P wax	43.46±0.1 a	42.02±0.01c	41.28±.02e	38.79±0.01f	37.10±0.01k	37.86±0.01k
	S B wax	43.46±0.1a	42.82±0.01b	41.55±0.02d	39.64±0.01f	38.95±0.01h	37.86±0.01j
Total phenol	Control	76.7±0.02a	73.4±0.03b	65.8±0.03c	55.9±0.03d	48.2±0.02e	38.4±0.03f
(mgGAE/100g)	P wax	76.7±0.02a	71.6±0.02b	63.5±0.01c	52.4±0.01d	44.8±0.01e	35.7±0.02f
	S B wax	76.7±0.02a	72.6±0.01b	62.5±0.01c	54.8±0.01d	46.7±0.02e	36.2±0.01f

Value represent mean of triplicate

Values with the same letter along the same column are not significantly different ($p \leq 0.05$).

Trmt-treatment, P wax-petroleum wax, SB Wax-sheabutter wax

Table II. Total sugar and glucose content of waxed and unwaxed orange in storage

Quality	Trmt	0 Hr	24 Hr	48 Hr	72 Hr	96Hr	120 Hr
Total Sugar	Control	12.04±0.12a	11.56±0.11b	10.61±0.12c	9.66±0.14d	8.87±0.12e	7.29±0.13e
(%)	P wax	12.04±0.12a	9.50±0.13d	8.40±0.13e	6.97±0.12f	8.86±0.12f	4.44±0.11h
	S B wax	12.04±0.12a	10.14±0.12c	9.19±0.311d	7.92±0.13e	6.66±0.11f	5.39±0.12g
Glucose	Control	0.087±0.02a	0.074±0.01b	0.062±0.01b	0.050±0.02c	0.042±0.02e	0.032±0.03f
(%)	P wax	0.087±0.02a	0.035±0.01d	0.027±0.02f	0.018±0.02g	0.011±0.03g	0.005±0.02g
	S B P wax	0.087±0.0	0.050±0.02c	0.042±0.01e	0.034±0.03f	0.026±0.01f	0.016±0.02g

Value represent mean of triplicate

Values with the same letter along the same column are not significantly different ($p \leq 0.05$).

Trmt-treatment, P wax-petroleum wax, SB Wax-sheaabutter wax

such as antioxidant, antimutagenic anticarcinogenic as well as ability to modify the gene expression (Marinova *et al* 2005). The total phenol of orange was found to be 76.7 mg GAE/100g (Table I). The value was in the range of total phenolic reported for orange, yellow apple and sweet cherry 75-78.8mg GAE/100g but lower to the value of star fruit seedless guava and blueberries 131-670.9mg GAE/100mg (Lim *et al* 2006 and Marinova *et al* 2005). The total phenol reduced in both waxed and unwaxed orange as the days of storage increased 76.7-35.7mgGAE/100g. This reduction in total phenol agreed with the findings of Ose *et al* (1997) and Lim *et al* (2006) in the study of stored water convolvulus leaves and guava. The loss in total phenol could be attributed to the action of polyphenol oxidase which causes the oxidation of the phenol to quinones (Kays 1991). Though there was reduction in the total phenol of the stored orange but there was no significant difference (P<0.05) in storage (12.04% to 4.44% total sugar, 0.087% to 0.005% glucose). The reduction in sugar could be attributed to natural degradation (Adetuyi *et al* 2008c). In fact they become metabolically consumed in the respiratory chain due to phosphrylated equivalent synthesis (Albuquerque *et al* 2005). At the end of the storage period the sugar content of waxed orange was significantly (P<0.05) lower then the unwaxed orange (0.005% pertoleum wax, 0.016% shea butter). This could be attributed to the conversion of the sugar to ethanol which is primarily due to the inhibitory effect of the coating on gas exchange (Obeland *et al* 2008) of the orange.

Conclusion

This study has shown that the orange waxed are hygienically (P<0.05) better than the unwaxed orange in appearance and the percentage weight loss were also lower. The waxed oranges showed to contain high value of vitamin C when compared with unwaxe at every sampling point; however there was no significant difference in the total phenolic content of the waxed and unwaxed orange. Considering the apperance and weight of the orange, it is therefore concluded that orange transportation in Nigeria should be waxed with shea butter because it had better quality than unwaxed and petroleum waxed orange and also to prevent postharvest losses in these orange.

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