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COMPARISON OF TWO STORAGE METHODS ON THE QUALITY OF OKRA (*Abelmoschus esculentus* L. Moench)

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ABSTRACT
The effect of two storage packaging materials on the physical quality indices and microbial spoilage of okra (*Abelmoschus esculentus* L.) was carried out in the Department of Crops/Soil Science (Crop Protection Unit) Laboratory to develop a modified packaging system for okra and other vegetables. The experiment was laid out in a Completely Randomized Design (CRD) with five replicates. The results showed that packaging materials had significant ($P<0.05$) effect on the packaging quality of okra stored in carton or basket lined with bitter leaf. These methods of storage reduced number of rotten, spotted, and shrivelled fruits but promoted higher number of green fruits and also some relatively healthy fruits were observed within 5-10 days of storage. The weight loss of okra fruits was in reduced in carton lined with bitter leaf when compared with okra kept in basket lined with bitter leaf. This research holds promise on the use of cartons and baskets for a prolonged shelf life of okra as an alternative to refrigeration method.

KEYWORDS: Packaging materials, Physical quality indices, Microbial spoilage, Okra, Bitter leaf *(Vernomia amygdalina)*

INTRODUCTION

Storage of Okra Using Baskets and Cartons

The importance of fruits and vegetables cannot be overemphasized due to the vitamin content of fruits and vegetables, which is known to be nutritionally superior when compared to many cereals and leguminous crops (FAO, 1992). They are highly perishable due to high water content and thereby susceptible to rapid deterioration soon after harvest, therefore they have to be properly packaged and stored if not consumed immediately (Weichmann, 1987), Traditionally, storage materials such as calabash, earthen pots, and basket have been used for the purposes of extending shelf life of crops few days after harvest (Kordylas, 1991). Okra, when left for more than two days tend to become fibrous and unsuitable for direct use, thus proper packaging and storage allows for a better quality and extends shelf life for some days (Schippers, 2000; Weichmann, 1987). Certain type of containers typically made from paperboard which is also sometimes knows as cardboard. Many of these cardboards are used in packaging food, pharmaceuticals, hardware's, and many other types of products. Inadequate storage of okra results in fading of colour by oxidation and enzymatic activities which affected the commercial value of fresh okra when stored at room temperature (Isiong, 1997). Unfortunately, okra belongs to the group of crops commonly referred to as perishables (NSPRI, 2000). In their fresh form under hot tropical conditions, they suffer extensive deterioration within a short time after harvest. Consequently, large amount of the okra are produced annually, but a great percent is lost through spoilage caused by high respiration and transpiration rates, in addition to bacterial and fungal attack and also lack of hard texture make them bruise easily (NSPRI, 2000). Proper processing, preservation and marketing and utilization of okra is necessary to arrest the wastage being experienced during the peak season, such effort should involved the development of appropriate technologies for processing and preserving okra high market value. The loss in quality and limited shelf life are major problems faced in marketing fresh okra in Nigeria due to its high respiration rate at warm temperature. Therefore, in order to extend the shelf life of okra, it is an essential to package it in appropriate packaging materials to reduce the rate of post harvest.

MATERIALS & METHODS

The experiment was carried out in the Crop Protection Laboratory, Faculty of Agriculture, Rivers State University of Science and Technology, Port Harcourt. Okra fruits used were the Lady's finger variety obtained from Nkpolu-Oroworukwo Market, Diobu, Port Harcourt, Nigeria. The fruits were harvested in the morning of the day of purchase; Ten (10) small baskets woven with the radius of oil palm were used. Five (5) of these basket were lined with bitter leaf (*Vernonia amygdalina*) containing 20 okra fruits and covered with the same leaves and tied with twines. The other five (5) baskets were not lined with any leaf but had twenty (20) okra, which served as the control. Similarly, ten (10) small cartons, five of which were perforated and were used treated as for the basket. The baskets and cartons where completely randomized on the laboratory bench in the plant protection at 20^0C and 78% RH. They were observed for 2 weeks.

At the end of the period, the fruits were sorted out into, relatively healthy fruits, rotted fruits, green fruits, light green fruits, spotted fruits, shrivelled fruits. Each of the

above character of the fruits in the storage structure was counted and recorded for 2 weeks.

Moisture Content Determination

The weight loss of okra fruits was recorded to an accuracy of 0.01g using mettle balance model P1200 and percentage weight loss was calculated using the methods of analysis AOAC, (2004).

$$\% \text{ weight loss} = \frac{\text{AOAC, (2004).}}{\text{[illegible]}} \times \text{[illegible]}$$

Statistical Analysis

The statistical differences were analyzed by the analysis of variance and the means separated by the New Duncan Multiple Range Test (NDMRT) at 5% level of probability and percentage (%)

RESULTS & DISCUSSION

Results on the effects of packaging materials on stored okra fruits after 7 and 14 days are shown in Tables 1a and 1b. The result showed that the physical quality indices of Okra fruits in terms of relatively healthy fruits, rotten fruits, spotted fruits, light green fruits, green fruits and shrivelled fruits in cartons lined with bitter leaf retained their quality when compared to those stored with baskets lined with bitter leaf and control after 7 and 14 days respectively. Generally, okra stored for 7 days retained its quality than those stored for 14 days. The results on the effect of packaging materials on the moisture content of stored okra after 7 days are shown in Table 2.

TABLE 1a: Effect of Packaging Materials on Stored Okra Fruits after 7 Days

Packaging Materials	Physical Quality Indices (%)					
	RHF	RF	GF	LGF	SPF	SHF
Basket lined with better leaf	70^{b}	50^{c}	60^{b}	55^{a}	38^{b}	8^{c}
Basket (Control)	50^{d}	63^{a}	48^{d}	35^{c}	49^{a}	12^{a}
Carton lined with bitter leaf	85^{a}	40^{d}	73^{a}	36^{c}	25^{d}	4^{d}
Carton (control)	62^{c}	54^{b}	56^{c}	42^{b}	32^{c}	10^{b}

NDMRT Figures in each vertical column bearing similar letters are not significantly different at ($p<0.05$)
RHF = Relatively healthy fruits, RF = Rotten fruits, GF, = Green fruits, LGF = Light green fruits, SPF = Spotted fruits and SHF = Shriveled fruits.

TABLE 1b: Effect of Packaging Materials on Stored Okra Fruits after 14 Days

Packaging Materials	Physical Quality Indices (%)					
	RHF	RF	GF	LGF	SPF	SHF
Basket lined with better leaf	54^{b}	30^{c}	42^{b}	25^{a}	38^{b}	15^{c}
basket (Control)	45^{d}	45^{a}	30^{d}	35^{c}	50^{a}	24^{a}
carton lined with bitter leaf	60^{a}	20^{d}	54^{a}	22^{c}	30^{d}	10^{d}
carton (control)	53^{c}	40^{b}	40^{c}	35^{b}	32^{c}	15^{b}

NDMRT Figures in each vertical column bearing similar letters are not significantly different at ($p<0.05$)

TABLE 2: Effect of Packaging Materials on Percentage Moisture Content of Stored Okra Fruit after 7 days

Packaging Materials	% Moisture Content
Basket lined with better leaf	70.0
Basket (Control)	53.2
Carton lined with bitter leaf	86.0
Carton (control)	65.2

TABLE 3: Effect of Packaging Materials on the Microbial Growth on the Stored Okra Fruits after 7 and 14 Days respectively

Packaging Materials	Symptoms of Disease/Spoilage
Basket lined with better leaf	Blackening of fruits
	water-soaked spots on damaged areas of the pod surface (*Rhizopus* soft rot)
Basket only (Control)	Greyish – while mass of mould
	Gray mould with spots
	Blackening of the fruits
	Soft watery
Carton lined with bitter leaf	Light green
Carton only (control)	Blackening of the fruits
	Whitish spots substances

The result showed that carton lined with better leaf retained 86% of moisture compared to those of baskets. However the results, on the effect of packaging material on the microbial growth on the stored okra fruits after 7 and 14 days are shown in Table 3. The result showed the following symptoms of spoilage; blackening of the fruits,

water-soaked spots on damaged areas of the pod surfaces greyish, mass of mould, gray mould with spots, light green and sour odour. Okra fruits are highly perishable due to high water content and thereby susceptible to rapid deterioration soon after harvest, therefore they have to be properly packaged and stored it not consumed immediately Hardenburg, *et al.*(1986); Kadar *et al.* (1985) and Babarinde and Fabunmi (2009). Traditionally, storage materials such as calabash, earthen post and baskets have been used for the purposes of extending shelf life of farm produce (Kordylas, 1991). Schippers, (2000), Majeed (2010) and Gupta and Mukherjee (1982) reported that okra when left for more than two days tend to become fibrous and unsuitable for direct use, thus proper packaging and storage allows for a better quality and extends shelf life for some days this reports is in agreement with the findings of the present research. Similarly, Isiong (1997) reported that in adequate storage of okra results in changes of colour due to oxidation and enzymatic activities which affects fresh okra stored at room temperature. Finger, *et al.* (2008) also observed that poorly packaged okra fruits losses its quality such as yellowing and rupture of the apical pod when twisted with fingers. Santi, *et al.* (1992) and Nguyen, *et al.* (2004) further observed that banana when wrapped in a non-perforated polyethylene bags resulted in less visible symptoms of spoilage when compared with the control fruits. This was due to controlled water loss and food reserved loss from tissues of okra due to transpiration and respiration. This report agreed with the present research on the use of carton lined with better leaf. Batu and Thompson (1998) reported that weight loss in tomatoes stored in films minimized loss of water vapour and this could be associated with lower loses recorded in Okra stored in cartons lined with bitter leaf compared to basket and control. Storage of okra with carton lined with bitter leaf retained moisture better than baskets. This could be attributed to the property of the low density of carton which exhibited good barrier to water vapour loss (Zagory, 1995 and Lee *et al.,* 1995) Decrease in moisture content was more in the control samples of basket and carton which was similar to findings of Amati, *et al.,* (1989) who reported that moisture loss in fruits and vegetables to be due to post-harvest physiological processes such as respiration and transpiration.

CONCLUSION

Okra fruits are highly perishable due to high water content and thereby susceptible to rapid deterioration soon after harvest. Therefore okra fruits have to be properly packaged and stored if not consumed immediately. The result of this work suggested that storage of okra using baskets and cartons had significant effect on the quality of okra. This research showed that okra fruits were better preserved with carton lined with bitter leaf than baskets lined with bitter leaf. This may therefore suggest that okra should be packaged in cartons lined with bitter leaf and stored at room temperature for optimum period of 9-10 days. In conclusion, it is shown from the study that the carton storage method is the best to store okra when transporting them from the outlying villages to the market or to the final destination with minimal percentage loss of moisture. Therefore agriculturist and farmers-alike are encouraged to use cartons lined with bitter leaf to prolong the shelf life of okra fruits.

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