Comparative Effect of Storage Materials on Quality of Okra (*Abelmoschus esculentus* L. Moench) in Awka-South Local Government Area, Nigeria

*Iwuagwu, C.C.*and Ezeufoh, U. V.*

Department of Crop Science and Horticulture, Faculty of Agriculture, Nnamdi Azikiwe University, P.M.B. 5025, Awka, Nigeria.

KEYWORDS

Awka
Okra,
Quality,
Storage methods,
Comparison,

***CORRESPONDING AUTHOR**

chrisiwuag@yahoo.com
+2348061156141

ABSTRACT

An investigation was carried out at the research Laboratory of Plant protection of Crop Science and Horticulture, Nnamdi Azikiwe University, Awka to compare effects of storage materials on quality of okra fruits (Abelmoschus esculentus L. Moench). The experimental design was a completely randomized design (CRD) replicated six times. The experiment consisted of storing of freshly harvested okra fruits in two storage media viz: woven baskets (lined with bitter leaves and unlined baskets) and perforated Paper Cartons (lined with bitter leaves and unlined cartons). The baskets and perforated cartons containing the okra fruits were then kept on laboratory benches. Okra fruits in the storage media were covered with white transparent nylon material and observed for 14 days. At the end of the period, the fruits were sorted out into relatively healthy fruits, rotted fruits, green fruits, light green fruits, spotted fruits and shriveled fruits. The weight loss of okra fruits was recorded to an accuracy of 0.01g using mettle balance model (P1200). Results showed that packaging materials had significant effect on physical qualities of Okra fruits after two weeks of storage, where unlined cartons had the highest (38.3%) number of relatively healthy fruits followed by 37.5% in unlined baskets while the least (30.8%) was obtained in lined baskets. The results also showed that packaging materials had significant effect on moisture content of Okra fruits stored in different storage materials where there was lesser moisture loss in Okra fruits stored in lined cartons compared to other storage packages. The results as well showed that 20.55% moisture was lost from Okra fruits stored in lined cartons from the first day to the seventh day while 32.48% moisture loss occurred from the same number of Okra fruits from the seventh day to the fourteenth day. From this study it could therefore be recommended that farmers should adopt the use of unlined perforated cartons for the storage and transportationof their freshly harvested okra fruits since it showed the best extension of shelf-life of Okra fruits.

INTRODUCTION

Okra plant was formerly addedin the genus Hibiscus, Abelmoschus in the family Malvaceae. The Abelmoschus was subsequently proposed to be raised to the rank of distinct genus. Okra is grown in many parts of the world, especially in tropical and sub-tropical countries. This crop can be grown on a large commercial farm or as a garden crop. Okra plants are grown commercially in many countries such as India,

Japan, Turkey, Iran, Western Africa, Yugoslavia, Bangladesh, Afghanistan, Pakistan, Myanmar, Malaysia, Thailand, Brazil, Ethiopia, Cyprus and in the Southern United StatesThe okra production of Nigeria increased from 300,000 tons in 1972 to 1.92 million tons in 2021 growing at an average annual rate of 5.59%.The importance of fruits and vegetable cannot be overemphasized due to the vitamin content of fruit vegetable, 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 detoriation, soon after harvest, therefore they have to be properly packaged and stored if not consumed immediately (Weichman, 1987), traditionally storage materials such as calabash, earthen pots, baskets 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 better quality and extended shelf life for some days (Schippers, 2000). Certain type of containers typically made from paperboard which is sometimes also known as cardboard are used. Many of these cardboards are used in packaging food, pharmaceutical wares, and may other types of products. Inadequate storage of okra results in color fading by oxidation and enzymatic activities which affects the commercial value of fresh okra when stored at a room temperature (lsiong, 1997). Unfortunately, okra belongs to the group of crops commonly referred to as perishables (NSPRI, 2000). In their fresh form under hot tropicalconditions, they suffer extensive deterioration within a short period of time after harvest. Consequently, large amount of the okra is 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 also utilization of okra is necessary to arrest the wastage being experienced during the peak season.Such effort should involve the development of appropriate technologies for processing and preserving okra for high market value. The loss in quality and limited shelf life are the major problems faced in marketing fresh okra in Nigeria due to its high respiration rate at warm temperatures. Therefore, in order to extend the shelf life of okra, it is essential to package it in appropriate packaging materials to reduce the rate of post-harvest spoilage. Okra can be preserved in many ways, either by refrigerating of fresh okra or by canning of okra pods or by freezing of okra pods or by drying. Therefore, the objective of this research was to investigate effects of two storage methods on quality of okra fruits (*abelmoschus esculentus* L. Moench) in Awka-South Local Government Area.

MATERIALS AND METHODS

Twelve small baskets woven with the radius of palm were used. Six (6) of these baskets were lined with bitter leaf (*Vernonia amygdalina*) containing 20 freshly harvested okra fruits. The freshly harvested okra fruits were sourced from a reliable farmer from Asaba, Delta State and transported to the Laboratory same morning in a Sackbag with the mouth properly tied. The other six baskets were not lined with any leaf and also contained twenty okra fruits each, which served as the control. Similarly, twelve small paper cartons, six of which were perforated (small holes of 10 cm diameter) and lined with bitter leaf and the other six were perforated (same number of holes and dimension) and used as control for the cartons. The okra fruits in the baskets and cartons were covered with transparent nylons and were completely randomized on the Laboratory bench in the Crop Science and Horticulture Laboratory, Nnamdi Azikiwe University, Awka. The prevailing temperature and humidity in the laboratory were 34°C and 78%RH respectively. The Okra fruits were observed for two weeks in storage. At the end of the 2 weeks, the fruit were sorted into relatively healthy fruits, rotten fruits, green fruits, light green fruits, spotted fruits, and shriveled fruits. Each of the above character of the fruits in the storage were counted and recorded for in 2 weeks. Data were collected on okra fruits contained in the basket lined with bitter leaf, unlined basket (control), carton lined with bitter leaf, unlined carton (control)The treatments were laid out in Completely randomized design (CRD) replicated six times. Temperature and relative humidity were recorded with Laboratory Thermometer and Hygrometer respectively. 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 (2005).

% Moisture content is given with the relation $\%\ mc_{ab} = \frac{W_w - W_d}{W_w} \times \frac{100}{1}$

where mc is expressed on wet basis (Ww is wet weight and Wd is dry weight).

Statistical Analysis

Data collected were subjected to analysis of variance (ANOVA) in CRD using SPSS the means were compared by the use of New Duncan Multiple Range Test (NDMRT) at 5% level of probability.

RESULTS

Table 1 shows that packaging materials had significant effect on the physical qualities of stored Okra fruits where unlined carton had the highest number (65%) of Okra fruits that were relatively healthy on the seventh day of storage, followed by 55% obtained in lined basket while the least (37%) which occurred in unlined basket. Table 1 also shows that unlined baskets had the highest (20.8%) number of rotten fruits which is significantly higher than 5,0% obtained in lined baskets but statistically same as 7.5% and 13.3% obtained in unlined and lined cartons respectively. The results shows that unlined cartons had the highest colour retention with 64.2% of Okra fruits retaining their green colour followed by 52.5% in lined baskets while the least (42.5%) colour retention occurred in unlined baskets. Table 1 also shows that lined cartons had the least (9.2%) number of shriveled Okra fruits, followed by 11.7% obtained both in lined and unlined baskets while the highest (15.8%) number of shriveled Okra fruits occurred in unlined cartons.

Table 1. Effects packaging materials on Okra fruits at day 7

Packaging materials	RHF	RF	GF	LGF	SPF	SHF
Basket only	37.5[b]	20.8[a]	42.5	21.7[ab]	11.7	11.7
Basket lined	55.0[ab]	5.0[b]	52.5	32.5[a]	11.7	11.7
Carton lined	51.7[ab]	13.3[ab]	51.7	17.5[ab]	8.3	9.2
Carton only	65.0[a]	7.5[ab]	64.2	7.5 [b]	6.7	15.8
SE	3.783	2.205	3.723	3.062	1.409	2.148

Means with same superscripts or means without superscripts are not significantly different from each other. Where: RHF = Relatively healthy fruits, RF = Rotten fruits, GF, = Green fruits, LGF = Light green fruits, SPF = Spotted fruits and SHF = Shriveled fruits.

Table 2 shows that packaging materials had significant effect on physical qualities of Okra fruits after two weeks of storage, where unlined cartons had the highest (38.3%) number of relatively healthy fruits followed by 37.5% in unlined baskets while the least (30.8%) was obtained in lined baskets. Results also shows that lined baskets had the highest number (52.5%) of rotten Okra fruits followed by 48.3% which occurred in lined cartons while the least number of rotten Okra fruits (32.5%) was obtained in unlined baskets. Table 2 also shows that the highest number of green fruits (31.7%) was obtained in unlined cartons followed by 22.5% which occurred in lined cartons while the least (13.3%) occurred in lined baskets. Unlined baskets had the highest (17.5%) number of shriveled Okra fruits followed by 11.7% obtained in unlined cartons while the least (1.7%) occurred in lined cartons. Generally unlined cartons had Okra fruits with better physical qualities than lined cartons and baskets

Table 2. Effects packaging materials on Okra fruits at day 14

Packaging materials	RHF	RF	GF	LGF	SPF	SHF
Basket lined	30.8	52.5	13.3	15.8	6.7	10.0[ab]
Basket only	37.5	32.5	24.2	13.3	12.5	17.5 [a]
Carton lined	36.7	48.3	22.5	10.8	13.3	1.7 [b]
Carton only	38.3	39.2	31.7	7.5	10	11.7ab
SE	2.974	3.769	3.226	2.568	1.356	1.915

Means with same superscripts or means without superscripts are not significantly different from each other. Where: RHF = Relatively healthy fruits, RF = Rotten fruits, GF, = Green fruits, LGF = Light green fruits, SPF = Spotted fruits and SHF = Shriveled fruits.

Table 3 shows that packaging materials had significant effect on moisture content of Okra fruits stored in different storage materials where there was lesser moisture loss in Okra fruits stored in lined cartons compared to other storage packages. The results show that 20.55% moisture was lost from Okra fruits stored

in lined cartons from the first day to the seventh day while 32.48% moisture loss occurred from the same number of Okra fruits from the seventh day to the fourteenth day. This is quite lower than 40.54% moisture loss which occurred in Okra fruits stored in unlined baskets on the seventh day and 44.10% moisture loss that was obtained on the fourteenth day. It is very clear that there was more moisture loss in Okra fruits stored in unlined baskets than any other storage package.

Table 3. showing the weight of okra fruits after storing in different storage media for 14 days

Containers	Day 1	Day 7	Day 14
Basket only	275.83[a]	164	91.67[b]
Basket lined	232.67[b]	181.17	111.00[ab]
Carton only	232.33[b]	165.17	117.33[ab]
Carton lined	228.67[b]	181.67	122.67[a]
SE	6.283	4.523	4.83

SE= Standard error. Means with same superscripts or means without superscripts are not significantly different from each other. Where: RHF = Relatively healthy fruits, RF = Rotten fruits, GF, = Green fruits, LGF = Light green fruits, SPF = Spotted fruits and SHF = Shriveled fruits.

Table 4 shows that Okra fruits stored in different packaging materials had different microbial qualities which include: blackening of fruits, soft rots, slimy mucilage and white mass of mold growth observed in Okra fruits stored in baskets lined with bitter leaves, while massive fungal growth, blackening of fruits and grey mold growth were seen in Okra fruits stored in unlined baskets. The results also shows that there was presence of egg-shaped insect larva and whitish molds in Okra fruits in lined cartons while whitish spots and whitish mold growth were observed in unlined cartons.

Table 4. Effect of Packaging Materials on Microbial Growth and deterioration on the Stored Okra Fruits after 7 and 14 Daysrespectively

Packaging Materials	Symptoms of Disease/Spoilage
Baskets lined with bitter leaves	Blackening of fruits Soft rots Slimy mucilage Black spots and necrotic tissues White mass of mold growth
Baskets only	Massive fungal growth Blackening of fruits Grey mold
Cartons lined with blades bitter leaf	Presence of egg -shaped insect larva
Cartons only	Whitish spot, White mold growth

Where: RHF = Relatively healthy fruits, RF = Rotten fruits, GF, = Green fruits, LGF = Light green fruitsSPF = Spotted fruits and SHF = Shriveled fruits.

DISCUSSION

Effect of storage methods had significant effect on quality of okra fruits after the 14th day storage. This is in agreement to the finding of Indhupriya *et al* (2021), who reported that cold storage gave better performance than ambient condition in shelf- life extension of okra fruits. This could be as a result of slowing down of some physiological processes such as respiration, which leads to deterioration of the stored produce as well as reduction of excessive loss of water occasioned by reduced temperature in cold storage. The result also corroborated with Paulus, *et al* (2021), who reported that packaging materials had significant effect on physiological qualities of okra fruits wrapped with low-density polyethylene (LDPE) compared to other storage materials. Okra fruits storage media showed that unlined perforated cartons had the best relatively healthy fruit (RHF) on 14thday.This is dissimilar to Chukunda and Nwonuala, (2013), who reported that in terms of relatively healthy fruits, rotten fruits, spotted fruits, light green fruits, green fruits and shriveled fruits in cartons lined with bitter leaf retained their quality. This could have been as a result of difference in the size of perforations in the cartoon. While theirs had wider holes, narrow holes were used in the present

study. This is also dissimilar to findings of Iwuagwu *et.al*, (2014), who reported that the physical qualities of fruit vegetables stored in evaporative coolants lined with polythene materials were considerably depressed.

Okra fruits had highest weight retention at day 14 in lined cartons than the other storage methods. This is in agreement Chukunda and Nwonuala, (2013), who found that okra fruits stored in cartons lined with bitter leaves retained up to 86% of their moisture compared to other storage media.

CONCLUSION

The results showed that unlined cartons had the highest (38.3%) number of relatively healthy fruits followed by 37.5% in unlined baskets while the least (30.8%) was obtained in lined baskets on the fourteenth day. But it was observed that it was quite better to store okra fruits in lined cartons since it enhanced more moisture retention than other packaging materials. Also, unlined cartons had fewer microbial deterioration than other storage methods.

RECOMMENDATIONS

From this study it could therefore be recommended that farmers should adopt the use ofunlined perforated cartons for the storage and transportationof their freshly harvested okra fruits since it showed the best extensionof shelf-life of Okra fruits.

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