Quantification of some Quality Changes in Dried Okro Stored in Sealed Polythene and Traditional Storage Systems

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***Abstract*Studies were conducted to quantify the changes in quality attributes of dried okra during storage using High Density Polythene Film (HDPF) and normal open storage systems (traditional). 300g of the dried okra fruits were packaged in each of the six (6) high-density polythene film (HDPF) bags while similar quantities were in open bowls as practiced by the rural processors. Periodic assessment of some quality parameters such as microbial loads, moisture content, color, vitamins A and C, and phosphorus were carried out for a period of three months to ascertain how these two storage systems influence the changes in these quality attributes. The results show that the fungal load counts of the dried samples prior to storage were 3.3×10^3 cfu/g. After three months of storage, the counts were 1.7×10^3 cfu/g and 5.7×10^3 cfu/g for the samples stored in HDPF and open systems respectively. These were significantly different at 5% level of confidence. Vitamin A of the samples changed from the initial value of 28.6μg prior to storage to 16.4 μg and 19.4 μg after three months of storage in open and HDPF systems respectively. Vitamin C content changed from 4.97 mg/ 100g prior to storage to 3.22 mg/100g and 3.57 mg/100g in the samples stored in Open and HDPF systems respectively after three months. The moisture content of the dried sample prior to storage was 3.7 %. After three months of storage, the values were 6.20% and 5.42% respectively for samples stored in open and HDPF systems and these were not significant at 5% level of confidence. The HDPF method gave better results compared to the traditional method of storage in Nigeria as far as these quality parameters assessed are concerned.**

Key words: dried okra, quality, sealed, polythene film, open-storage.

I INTRODUCTION

Vegetables, particularly okra are of great importance in human nutrition as they supply essential vitamins and minerals (which are necessary to maintain good health) to the diet. Unfortunately, they are not only seasonal but highly perishable and deteriorate very fast few days after harvest, losing almost all the required quality attributes in them and some may likely result to total waste. It has been shown that as high as 50% of these produce are lost between rural production and town consumption in the tropical areas (Oyeniran, 1988). Studies have also recorded that 20 to 40 % of harvested vegetables are not eaten because they are made unavailable through some forms of spoilage (Anne *et al.*, 1968)

Though the production figures for okra in Nigeria are hard to come by in the literature, substantial quantities of this vegetable is produced annually. Okra which usually appears bright green, firm, free of blemishes soon deteriorates, losses color and good texture after harvest unless cooled and kept below 15°C (Anita, 1999). Very little considerations and attention are however, given to preservation aspect of this important agricultural produce in Nigeria. The increase in the production of these vegetables usually results in gluts at harvest time and very low price, while few months after, scarcity sets in resulting in high prices.

One major means of preserving okra is by drying. Drying is one of the oldest techniques of preserving agricultural products. Drying as a process for food conservation and preservation seems to be an adequate method under most conditions in the developing economies

(Ali and Sakr, 1981). New drying techniques had increased demand for dried foods than in the past due to improved quality and researchers are of the opinion that if more attention is given to food quality during drying, there would even be more significant boost to its demand (McCarthy, 1986)

Kordylas (1990) revealed that food processing, (in particular; drying) is essential to human civilization because it provides advantages in respect of food hygiene, distribution and storage. A study also revealed that dehydrated products have advantages over other forms of preserved foods in that they are easily packaged and stored at ambient temperature conditions (Holdsworth, 1971).

It is also noted that a good drying method must be followed by a good storage method if the quality attributes are to be maintained (Anon, 1997). At present, majority of the rural populace (especially women) is engaged in vegetable drying particularly tomatoes. However, the dried products are hardly packaged before storage. The products are thus exposed to the open air thereby predisposing them to further contamination and subsequent deterioration.

It is revealed that the shelf life of a packaged food is controlled by the physical characteristics of the products such as water activity, pH value, susceptibility to enzymatic or microbial deterioration, mechanism of spoilage, requirement for sensitivity to oxygen, light, carbon dioxide and moisture (Fennema and Tannencbaum, 1985). Moisture loss or uptake is one of the most important factors that control shelf life of foods. There is a microclimate within a package, which is determined by the food at the temperature of storage. Ability of packaging material to retain food sensory characteristics and properties throughout the storage period cannot be understressed in the choice of any material to package a type of food (Williams, 1981). Williams (1982), stated that a number of factors determine a good and effective packaging of dried food products. Food safety is related to packaging in two ways: (Robertson, 1993).

1. The packaging material must provide a suitable barrier around the food to prevent microorganisms from contaminating the food
2. Such material must not contain toxic substances that make the food unsafe.

Rozis (1997) noted that the choice of packaging material depends on several factors such as the kind of foodstuff, the storage conditions, the material's protective qualities and the materials availability and cost. Polythene films are good materials widely used in packaging due to their relatively low cost, good moisture and gas barrier properties. They are either described as low density (LDPF) or high density (HDPF) depending on their thickness (Williams, 1981).

As stated earlier, the quality of dried food products especially okra is of utmost importance and should be able to reach a certain level of acceptance in terms of appearance, taste, moisture content, extractable constituents, microbial quality, flavor, nutritive value,

and degree of contamination (Williams, 1981). The current practice by the processors in some states in Nigeria whereby the dried products are stored without packaging of any sort leaves much to be desired. It is therefore necessary to investigate the level of changes taking place in the quality of the stored products. In this study a comparative assessment of two methods of storage of dried okra was carried out with a view to quantifying the level of the changes in some of these quality attributes of the dried produce during the period of storage. The two systems were the sealed high-density polythene film and the traditional open storage system.

M II MATERIALS AND METHODS

Fresh samples of Okra (*Hibiscus esculents*) were purchased from Minna Central Market. The samples were first sorted to remove infested ones and then washed. Three kilograms of the sorted samples were randomly selected from the baskets.

The moisture content of the fresh samples was determined using the oven dry method. The samples were dried at 65°C and weighed at interval until there was no change in the weight of the dried samples. The samples were sliced using stainless steel knife. The sliced Okra samples were then dried using a tray drier to a moisture content of 3.7% (wet basis) which was within the range considered to be safe enough for storage (Hall, 1986).

Prior to packaging and storage, the following quality attributes of the dried Okra samples were assessed: Vitamins C and A, Moisture content, Color, Texture, Calcium and Phosphorus contents and Microbial load counts (Fungi and bacteria).

The standard methods as adopted by AOAC (1970) were used to determine the following: - Vitamin C, phosphorus and calcium contents. Vitamin A was determined using a spectrophotometer. The fungal and bacterial loads were enumerated using the nutrient agar method (Atlas *et al.*, 1984).

300g of the dried samples were then packaged in the 6 packs of $0.950 g/cm^3$ (high density) Polythene films (15cm X 10cm) and then sealed. Similar quantities of the dried samples were put in 3 bowls and the two groups were stored ithe laboratory under ambient temperature and relative humidity (with the average values being 23 ^{o}C during the period of storage).

The same sets of quality parameters were assessed every month for a period of 3 months to ascertain the level of changes in these parameters under the two methods used.

The sensory evaluation method was used to assess the color and texture of the samples. A ten-man panel chosen from students, laboratory technicians, lecturers and other workers were constituted to evaluate the color and texture of the dried samples of okra using the eight- point hedonic scoring scale method (Derosier, 1977).

The panelists who recorded their assessment/ evaluation on a descriptive graduated scale assessed coded samples for color and texture that best described the assessment scoring, given an indication of the size and direction of differences of variation from the standard sample, which is the fresh okra

The categories on the scale were assigned numerical value (1-8). The data collected were transferred and analyzed using the chi-square statistical method with the formula stated by Kwanchai et al, (1984)

$$\chi^2 = \sum\left\{\frac{o-E}{E}\right\}^2 \quad \text{Kwanchai } et\ al.,\ 1984 \qquad (1)$$

where, O = observed value, E = expected value

III RESULTS AND DISCUSSION

The results of the microbial load counts (cfu / g) for the dried okra samples, using the two storage systems are presented in table 1. The microbial loads counts obtained from the fresh sample prior to drying were $4.2x10^5$ cfu/g and $3.6x10^3$ cfu/g for bacteria and fungi respectively. This load generally reduced to $7.5x10^4$ cfu/g and $3.3 x10^3$ cfu/g for bacteria and fungi respectively after drying

After three months of storage in the two systems, the fungi loads decreased form the initial value of $3.3 x10^3$ c f u/g to $1.7 x 10^3$ c f u/g in the samples stored in the sealed HDPF.

The bacterial counts on the other hand decreased from the initial value of $7.5 x 10^4$ cfu/g to $0. 54 x 10^4$ cfu/g after 90 days of storage in the sealed HPDF. The decline noted in those stored in HDPF could be due to the exhaustion of the nutrients on which these microbes thrive (Adebanjo and Shopeju , 1993).

TABLE 1 AVERAGE MICROBIAL LOAD COUNTS (CFU/G) IN STORED DRIED OKRA SAMPLES IN THE TWO SYSTEMS.

Period of storage(Days)	Sealed HDPF System		Open Storage System	
	Bacterial loads	Fungi loads	Bacterial loads	Fungi loads
1	7.5×10^4	3.3×10^3	7.5×10^4	3.3×10^3
30	1.2×10^4	2.3×10^3	1.5×10^5	9.8×10^3
60	0.64×10^4	2.1×10^3	8.5×10^5	6.3×10^3
90	0.54×10^4	1.7×10^3	7.2×10^5	5.7×10^3

C F U/ g = colony forming units/ gram

TABLE L A: ANOVA FOR FUNGI LOAD COUNTS OF THE SAMPLES STORED IN THE TWO SYSTEMS.

Source of var.	df	Sum of squares	Mean square	F-value
Storage system	1	30.811×10^6	30.811×10^6	9.378*
Error	7	22.998×10^6	3.285×10^6	

* Highly significant at $\alpha = 0.05$

TABLE 2: AVERAGE VALUES OF MOISTURE CONTENT OF DRIED OKRA SAMPLES STORED IN SEALED HDPF AND OPEN STORAGE SYSTEMS.

Period of Storage (days)	Moisture content variation (wet basis)	
	Open storage system	Sealed HDPF
1	3.7	3.7
30	4.7	4.1
60	5.4	4.32
90	6.2	5.42

The results however, showed that the microbial load counts increased tremendously from the initial values of 7.5×10^4 cfu/g to 7.2×10^5 cfu /g (bacteria) and 3.3×10^3 c f u /g to and 5.7×10^3 cfu/g (fungi) in the samples stored in the open storage system.

In particular, the fungi load count of the samples stored in the open system increased tremendously within the 90 days. There is therefore a significant difference between the two systems as far as the fungi load count is concerned (Table l a). This increase could be attributed to secondary infection resulting from exposing the produce to the atmosphere: Though the differences were not statistically significant at 5 % level in the case of the bacteria load count, it can however be noted from the figures that the sealed packaging system provides better quality products than the open storage system.

The results, however showed that the bacteria load counts of the samples were generally lower than the level of contamination observed in Nigerian dried food condiments revealed by Obuekwe and Ogbimi

(1989) .The assessment also showed that the microbe's species identified. agreed with earlier studies (Ijah. 1999)

A Moisture Content

The fresh samples were dried from the initial moisture content of 73.8 % (wet basis) to 3.7% which falls within the values recommended for safe storage of dried product to prevent microbial growth during storage (Hall,1988). The results of the monitored moisture content during the storage period using the two systems are shown in Table 2. The results showed that there were no significant differences between the moisture content of the samples stored in the two systems at 5 % confidence level statistically. The attained moisture content remained fairly constant for the samples of the product stored in the sealed HDPF storage system throughout the 90 days period of storage. Those stored in the open system however increased from the initial 3.7% prior to .storage to 6.2% after 90 days of storage.

This increase showed that the sample absorbed moisture from the surrounding atmosphere. Since moisture is one of the critical factors influencing the shelf life of any stored product, it can be inferred from these results that the sealed HDPF is better in terms of long term storage of dried okra samples. The increase could have influenced the results of the microbial loads in the open storage system as discussed earlier.

B Sensory Analysis

The results of the sensory analysis carried out to ascertain the changes in color of the stored dried Okra sample are presented in Table 3.

TABLE 3: SUMMARY OF THE CHI-SQUARE STATISTICAL ANALYSIS OF THE COLOR VARIATION DURING THE STORAGE PERIOD UNDER THE TWO SYSTEMS OF STORAGE

Period of storage (days)	Storage Systems		X^2- Values	
	Sealed HDPF	Open storage	5%	1%
1	6.88	6.88		
30	8.13	10.25	16.92*	21.7*
60	9.38	17.38		
90	13.00	25.63		

*Highly significant at both 5% & 1% levels.

Table 4 Means values of the nutritional parameters of the dried okra in the two storage systems

Period (days)	Parameters			
	Vitamin C (mg/100g)	Vitamin A(μg/100g)	Calcium (mg/100g)	Phosphorus (mg/100g)

	Sealed	Open	Sealed	Open	Sealed	Open	sealed	Open
1	4.97	4.97	28.60	28.60	60.62	60.62	36.22	36.22
30	4.27	4.27	26.40	24.80	57.63	52.33	35.12	35.34
60	4.10	3.15	23.00	20.20	57.40	49.12	37.40	29.97
90	3.57	3.22	19.40	16.40	57.20	55.12	30.20	24.57

The results (Table 3) showed that the changes in color of the dried okra samples stored in the two systems were highly significant at both 5% and 1% levels of confidence after three months of storage. Color is one of the important quality attributes normally used by consumers in accepting or rejecting food products especially vegetable products.

It can be seen from these results that the sealed HDPF storage system gave a better keeping color quality as far as these two systems are concerned. The current practice whereby the dried products are left in the open without any form of protection calls for serious enlightenment of the processors. It is this color change that makes the locally dried okra unattractive and this normally discourages consumers.

C Nutritional Analysis

The results of the assessments of some nutritional contents of the samples are presented in Table4. The mean value of vitamin C content of the fresh samples was 11.57 mg/100g. After drying this value reduced to 4.97 mg/100g. After 90 days of storage, the value decreased by 28.17 % for those stored in the HDPF while for those stored in the open system, 35.21 % of the vitamin C content were lost after 90 days of storage. In terms of food value, 35 % reduction in nutrient in 90days is substantial; hence the traditional means of storage leaves much to be desired.

A similar trend was observed in the results obtained for vitamin A content of the samples. The value of vitamin A was 32.5 μ g/100g for the fresh samples. After drying the average value was 28.6 μ g/100g. There was a 32.17 % reduction in the samples stored in the HDPF, while the samples stored in the open recorded a 42.66 % reduction after 90 days of storage. In other words almost half of the value of the vitamin A was lost in the open storage system after three months. Though these values were not significantly at 5% level of probability, the results indicate that comparing the two systems, the HDPF is still better than the traditional method.

As regards the calcium content there was a slight reduction from the initial value of 60.62 mg/100g to 57.20 mg/100g in the samples stored in the sealed HDPF while that of open system reduced to 55.12 mg/100g after 90 days of storage. Phosphorus content decreased from 36.22 mg/100g prior to storage to 30.20 mg/100g and 27.32mg/100g in samples stored in sealed and open systems respectively after 90 days.

The fast depletion in the values this useful quality attributes of the dried samples in the open system may be due to the exposure of these samples to the atmosphere which predispose the products to interplay of various agents of deterioration. This more so as the moisture content of the products shows a significant increase in this open system of storage. The increase in the microbial growth could as well influence other reactions and changes in these parameters.

CONCLUSION

The aim of this study was to quantify the changes in some quality attributes in dried Okra stored under two different storage techniques namely, the sealed high density polythene film (HDPF) and the traditional open storage system used by the rural processors in Nigeria.

The results of the assessment showed that the loss in the values of the assessed quality of the product is greater and faster in the open system of storage than the sealed HDPF. In other words, the sealed HDPF provides better keeping quality of the product compared to the traditional open system.

Since quality of this product cannot be compromised, it is advised based on the findings from this study that the HDPF should be encouraged in the storage of dried Okra in order to retain some of these quality attributes during the storage period and also reduce the level of infestation by microbes.

The sealed HDPF is also a means of package, which can also assist in the marketing of the product.

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