PJN
ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
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Pakistan Journal of Nutrition 7 (5): 652-657, 2008
ISSN 1680-5194

Effect of Postharvest Storage Techniques on the Nutritional Properties of Benin Indigenous Okra *Abelmoschus esculentus* (L) Moench

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Abstract: In Nigeria, okra *Abelmoschus esculentus* are packed and stored in polypropylene bag when moved from outlying villages to the city market. The study aims at assessing other storage method for Benin indigenous okra other than polypropylene bag with respect to nutrients, antinutrients and antioxidants. In this study fresh harvested Benin okra were harvested and divided into three parts. One part was stored in 100% RH at the temperature of 10°C±2°C, another at the temperature of 10°C±2°C and the last part in polypropylene bag. The nutrients, antinutrients (Phytate and Saponin) antioxidants (Vitamin C and Total Phenol) and the Viscosity were subsequently determined. The result of the study indicates that the nutrient, antinutrient and antioxidant content reduces significantly ($p>0.05$) in the three storage methods: Moisture (88.73-84.62)%, fibre (10.63-7.22)%, protein (14.87-12.84)%, fat (9.67-7.96)%, phytate (3.84-1.18)%, saponin (0.612-0.284)%, vitamin C (46.28-14.39) mg/100g, total phenol (0.095-0.059)% and the viscosity (58.16-53.42)cp. The method of storage of 100%RH recorded the least percentage loss in moisture, fibre antioxidant and viscosity content of the okra while the least % loss was recorded for protein and fat in the polypropylene bag method. The highest loss of the antinutrient was recorded at the storage method of temperature of 10°C ±2°C. On the average the storage method of 100%RH at temperature of 10°C ±2°C shows to be better method than the others.

Key words: Nutrients, anti-nutrient, antioxidant, benin okra, relative humidity

Introduction

Okra *Abelmoschus esculentus* (L) moench is a tall annual dicotyledonous plant related to cotton and thought to be of African origin. It is still found growing wild along the river Nile in Egypt as well as Ethiopia (Kochhar, 1986) French colonialist carried okra to the new world soon after 1700. Now it is a widely grown vegetable crop in the tropics and sub tropics and also in the warmer temperate areas (Kochhar, 1986).

Young pods may be harvested 60-180 days from sowing about 5-10 days after flowering depending on the cultivar grown. Successional harvesting of young pods is generally recommended. The pods are harvested by detaching using a slight twist to break the stalk (Tindall, 1986).

The fresh and green tender fruits are used as vegetable. Tender and edible fruit is easily cut by the kitchen knife and set into mucilaginous consistency after cooking (Sowumi and Chukwudebe, 1979).

Okra mucilage has medicinal applications; when used as a plasma replacement or 'blood-volume expander'. The mucilage of Okra not only binds cholesterol but the bile acid carrying toxins dumped into it by the filtering liver. It also has industrial applications; when added as size to glaze paper and used in confectionary (Siemonsma and Kouame, 2004; Kochhar 1986; Shalau, 2002).

In Nigeria fresh okra is preferred to dried Okra by the Majority of people and as such consumption is highest in the raining season when production is highest. The site of production of these okra are always very far to the market and where they are been consumed, therefore post-harvest deterioration of fresh okra result in loss of produce due to the poor storage and transport conditions employed by farmers in bringing the produce from the farms in outlying villages to the city markets.

In Nigerian Okra are packed and stored in a bag called polypropylene bag when moved from the outlying villages to the city markets which may be up to 520km, and it may get to the city market after 48hours to 72hours due to transportation problem.

The aim of this study is to exploit other method that can be use in storing Benin indigenous Okra for utilization and transportation other than polypropylene bag with respect to nutrients, antinutrients and antioxidants.

Materials and Methods

Fresh Benin Okra was harvested from a pilot farm in Benin City Nigeria. The chemicals were analytical grade while the water used in the analysis was glass distilled. The freshly harvested okra was randomly divided into three parts. One part was stored at the relative humidity of 100% at the refrigerated temperature of 10°C±2°C prepared by putting 100ml of distilled water in a

Table 1: Nutrient composition of Benin Okra in %

Parameters	Day	Polypropylene bag	100% R.H	10°C ±2°C
Moistur	0	88.73±0.044a	88.73±0.044a	88.73±0.044a
Content	2	88.06±0.035b	88.61±0.044a	88.01±0.035b
	4	86.42±0.044c	88.53±0.035a	87.53±0.044b
	6	85.76±0.044c	88.27±0.044a	87.00±0.035b
	8	85.00±0.044c	88.06±0.035a	86.81±0.044b
	10	84.62±0.044c	87.82±0.044a	86.03±0.044b
	%Loss	4.63	1.03	3.04
Crude	0	10.63±0.015a	10.63±0.015a	10.63±0.015a
Fiber	2	10.41±0.021b	10.60±0.053a	8.76±0.017c
	4	10.04±0.053bc	10.56±0.047a	8.52±0.017c
	6	9.82±0.026b	10.41±0.017a	8.21±0.044c
	8	9.61±0.017bc	10.26±0.040a	7.68±0.017bc
	10	9.02±0.035c	10.17±0.017a	7.22±0.036b
	%Loss	15.13	4.32	32.05
Crude	0	14.87±0.010a	14.87±0.010a	14.87±0.010a
Protein	2	14.36±0.027ab	13.94±0.026b	13.89±0.026c
	4	14.14±0.026a	13.88±0.028c	13.74±0.026c
	6	13.88±0.028a	13.62±0.026b	13.43±0.021c
	8	13.74±0.026a	13.17±0.045c	13.06±0.026c
	10	13.04±0.026a	12.84±0.026a	12.84±0.033a
	%Loss	12.26	13.6	13.6
Fat	0	9.67±0.023a	9.67±0.023a	9.67±0.023a
	2	9.28±0.044a	9.21±0.035bc	9.17±0.017cd
	4	9.21±0.036a	9.18±0.017a	9.05±0.015b
	6	9.08±0.017a	9.05±0.017a	8.86±0.017c
	8	8.91±0.026a	8.26±0.026c	8.33±0.017bc
	10	8.52±0.036ab	8.06±0.026b	7.96±0.017b
	%Loss	11.89	16.65	17.68

Value represent mean of triplicate. Values with the same alphabet along the same row are not significantly different (p> 0. 05)

dessiccator and covered for 72 hours (Wiston and Bate,1960) another part at the refrigerated temperature of 10°C±2°C while the last in polypropylene bag.

Sample analysis: Freshly harvested Benin Okra was analyzed. Stored samples of Benin Okra were analyzed on alternate days with regard to the nutrient, antinutrient and antioxidant content. The Okra were sliced and dried in the oven at 45°C to a constant weight and analyzed as follows:

The nutrient composition, (moisture, fat and crude fibre) of the fresh and stored Benin Okra were determined using the standard AOAC (1990) method and the protein content was determined using the micro-kjeldhal method (Nx6.25). 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 Okra.

The Saponin was determined using the spectro-photometric method of Brunner, 1984. in which the mixture of okra and Isobutyl alcohol (2g in 250ml isobutyl l alcohol) was filtered into 20ml 40% saturated solution of magnesium carbonate. The mixture is filtered to get a colorless solution, 2ml of 5% iron (iii) chloride is added to 1m of the colorless solution and made up to 50ml mark with distilled water and the absorbance was measured after 30minuties at 380nm.

The viscosity was measured using the ostwald viscometer as described by AOAC (1990).

The vitamin C content of the Benin Okra were determined by AOAC (1990) method, described thus 5g of the sample was extracted by 100ml H_2O, 25ml of 20% glacial acetic acid was added to 10ml of the sample extract and titrated against standardized 2,6 dichloroindophenol (0.05g / 100ml) solution.

The total phenol was determined by mixing 0.2ml phenolic extract (0.2g of the Okra extracted by 20ml 70% Acetone) with 0.8ml folin – ciocalteu reagent and 2ml of 7.5% sodium carbonate. The mixture was diluted to 7ml distilled water and the absorbance was measured after 2hours at 765nm, the result was calculated as gallic acid equivalent. (Iqbal *et al.*, 2004).

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

Results and Discussion

Juvenile products such as Okra or lettuce are harvested when they are activity growing and often contain 85% or more of water and they have little protection against water loss (Kays, 1991).

Therefore appropriate storage can minimize moisture loss, slow respiration rate and inhibit the development

Table 2: Vitamin C content in mg/100g and Total phenol content in % of Benin Okra

Parameters	Day	Polypropylene bag	100%R.H	10°C ±2°C
Vitamin C	0	46.28±0.026a	46.28±0.026a	46.28±0.026a
Content	2	18.36±0.035c	22.54±0.017a	19.72±0.052b
	4	17.28±0.026c	21.46±0.035a	18.36±0.035b
	6	16.48±0.026c	20.54±0.010a	17.74±0.026b
	8	15.26±0.026c	19.72±0.026a	17.13±0.010b
	10	14.39±0.035c	19.04±0.035a	16.58±0.017b
	%Loss	63.78	54.48	59.4
Total Phenol	0	0.095±0.004a	0.095±0.004a	0.095±0.004a
	2	0.082±0.003ab	0.086±0.003a	0.085±0.003a
	4	0.076±0.003c	0.084±0.003a	0.081±0.003ab
	6	0.068±0.003bc	0.081±0.003a	0.078±0.003a
	8	0.062±0.003bc	0.079±0.003a	0.076±0.003a
	10	0.059±0.003b	0.073±0.002a	0.072±0.003a
	%Loss	37.87	23.14	24.19

Value represent mean of triplicate. Values with the same alphabet along the same row are not significantly different (p > 0. 05)

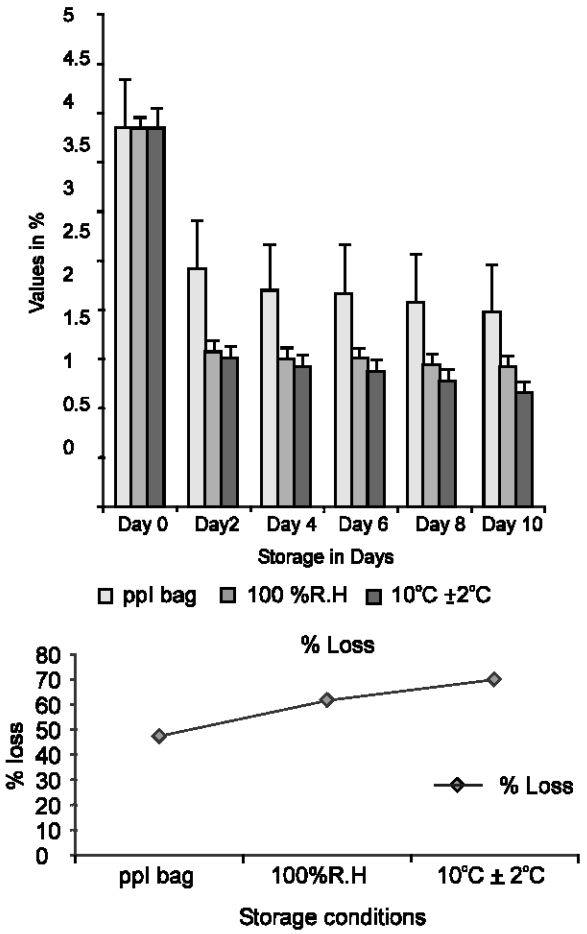

Fig. 1: Viscosity Content of Benin Okra in Cp and its percentage loss in storage

of microorganism. Commodities vary widely in their requirement and in their tolerance of non-optimal conditions (Anonymous, 1979, Munoz-Delgado, 1979). It show from Table 1 that the moisture content of Benin Okra decrease significantly (P>0.05) as the day of storage increases from day 0 to day 10 in the storage methods. (88.73 - 84.62%) the losses in moisture content of the Okra during Storage agrees with the findings of Gupta and Mukherjee (1982) in the storage of Okra waxed with morphactin reported moisture loss when they were stored for 7days.

The rate of loss was least when okra was stored at 100% R.H and recorded the lowest percentage (1.03%) followed by temperature of 10°C (3.04%) while polypropylene bag recorded the highest loss (4.63%).

The lowest percentage loss in 100% R.H at 10°C ±2°C may be as a result of a decrease in the metabolic water which are not been release since they have been arrested by the cold temperature and the high relative humidity might have not allowed for moisture migration from the fruit to its immediate environment which has been already saturated.

Dietary fibres are constituents of many fruits and vegetables, though dietary fibre cannot be digested by man but provides roughage that aids digestion (Eva, 1983). The fibre were decreasing significantly (P>0.05) as the storage days increase. The least rate of reduction and the least percentage loss were recorded at the relative humidity of 100% at 10°C ±2°C (4.32%). This decrease in crude fibre does not conform to the findings of Ketiku (1973) that crude fibre of banana fruit increase as the storage period increases. The reduction in fibre may be as a result of the conversion of the fibre which is cellulose to carbohydrate and used during respiration and at the relative humidity of 100% at 10°C ±2°C all respiratory and metabolic activities were retarded.

Protein are extremely important components of living cells in that they regulate metabolism and in some produce represent storage form of carbon and nitrogen (Kays, 1991)

The crude protein of Benin Okra were decreasing significantly (P>0.05) when stored using these storage methods over a period of 10days. This reduction in protein conform with the findings of Agbor-Egbe and Rickard (1990) that the crude protein content of aroid

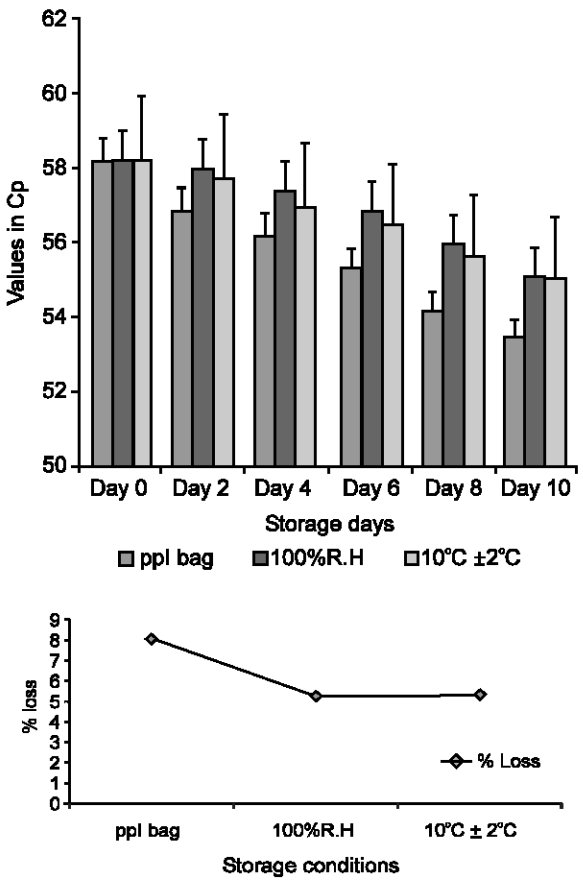

Fig. 2: Phytic acid Content of Benin Okra in % and its percentage loss in storage.

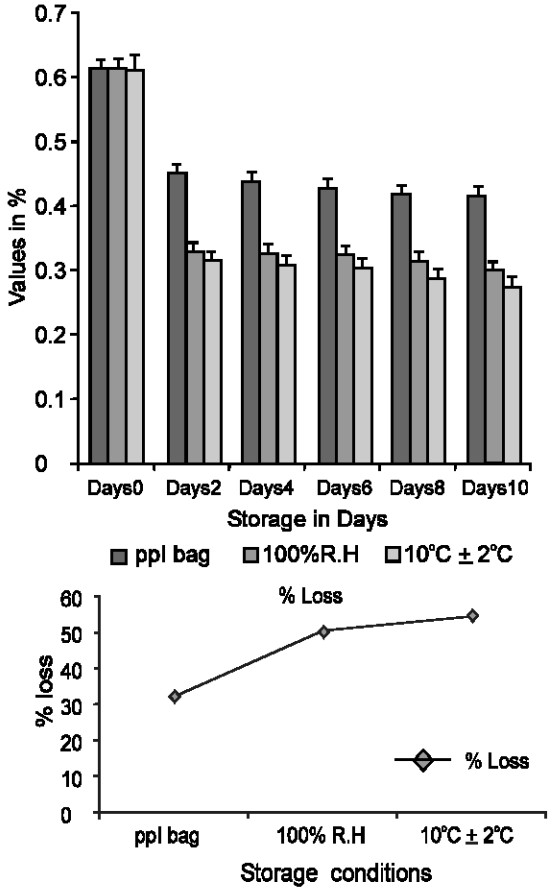

Fig. 3: Saponin Content of Benin Okra in % and its percentage loss in storage.

stored for 14days decrease as the storage period increase. The least rate of decease and percentage loss was recorded at the storage method of polypropylene bag (12.26%). This decrease in protein may be attributed to the physiological and metabolic activities within the cells of the Okra pod and at the same time due to proteolysis which is the breakdown of protein.

The fat content of this Benin Okra decrease in storage significant ($P>0.05$) as the storage period increases. The storage method of polypropylene bag recorded the least percesntage loss of fat (11.89%) the percentage loss of fat in Okra stored in 100% R.H and in temperature of 10°C±2 ℃ are close (16.65% and 17.68%). The reduction in the fat content can be as a result of the recycling of the carbon stored as triacylglycereols in lipids through the action of the enzyme lipase.

The viscosity of Benin Okra as shown in Fig. 1 shows that the viscosity is decreasing as the storage day's increase. Relative humidity of 100% and temperature of 10°C±2°C recorded the following percentage loss of 5.30% and 5.35% respectively while polypropylene bag has 8.05% loss. The reduction in viscosity could be attributed to the utilization of carbohydrate during metabolic process in the stored Okra because mucilage is a polysaccharide which is carbohydrate.

The complexing of phytic acid with nutritionally essential minerals are suggested as responsible for the antinutritional activity. Phytic acid interferes with Ca, Fe, Mg, and Zn absorption because of its ability to chelate divalent cationic minerals (Oboh, 2005).

The phytic acid of this Okra reduces in storage, fig. 2, the storage method that experience the highest loss of phytic acid is the temperature of 10°C ±2°C of 69.79% closely followed by the storage method of 100% R.H 61.72% the least is polypropylene bag 47.66%.This decrease in phytic acid agree with the report of Hernandez-Unzon and Ortega - Delgado (1989) that there was a decrease of 4% in phytic acid of stored common been seeds (*Phaseolus vulgarie* L).

Saponin are characterized by either bitter or astringent taste, foaming properties and their hemolytic effect on red blood cells .They are widely distributed in the plant kingdom (Agarwal and Rastogi 1974; Osagie 1998).

The saponin content of Benin okra in storage as shown in Fig. 2, shows that the saponin decreases significantly

as the storage period increases over a period of 10 days. The trend of decrease of saponin is closely related to that of phytate in that polypropylene bag recorded the least percentage loss 32.03%,the highest percentage loss took place in the storage method of temperature of 10°C ±2°C closely followed by relative humidity of 100% (50.00%).

Vitamin C contributes to the antioxidant properties of vegetables by protecting the membrane erythrocyte, maintaining the blood vessel flexibility and improving blood circulation in the arteries of smokers as well as flexibility the absorption of iron in the body (Oboh, 2005). As shown in Table 2, the vitamin C of the okra in storage reduces significantly ($p>0.05$) over the period of storage. The storage method of 100% R.H recorded the least percentage loss in vitamin C (58.85%), temperature of 10°C ±2°C recorded a percentage loss of 64.17% while the highest loss was recorded at the storage method of polypropylene bag (68.90%) . It has been reported by Albuquerque *et al.* (2005) that the Vitamin C content in water melon decreased with increasing time of storage. This decreased in vitamin C could be as a result of the activity of the enzyme ascorbate oxidase which convert vitamin C to dehydroascorbic acid in stored produce.

Phenols have antioxidant capacities that are much stronger than those of vitamin C and E (Amic *et al.,* 2003). The total phenol of Benin okra reduces in storage with the storage method of polypropylene bag recording the highest loss of 37.89% while the storage method of 100% R.H and temperature of 10°C ±2°C recorded 23.16% and 24.21% respectively. This decrease is in agreement with the finding of Ose *et al.* (1997) that the total phenol content of water convolvulus leaves decreases in storage. This reduction could be attributed to the fact that phenols are susceptible to oxidation by phenolase which convert them to quinones that are extremely reactive and therefore short lived.

Conclusion: In conclusion, it is shown that the storage method of 100%R.H at the temperature of 10°C ±2°C is the best method to store this Benin indigenous okra when transporting them from the outlying villages to the market and its final destination since it recorded the least percentage loss.

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