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Effects of Ascorbic Acid and Pre-packaging on Shelf-life and Quality of Raw and Cooked Okra (*Hibiscus esculentus*)

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ABSTRACT

Fresh okra fruits were dipped in aqueous solutions containing 250 and 500 ppm ascorbic acid (AA) or 1000 ppm Tween-20 for 5 min, air-dried, packaged and stored at 2 °C. Blackening of the fruits dipped in the Tween-20 solution occurred within 2–4 days of storage while the AA-treated samples showed signs of deterioration after 20 days. Weight loss was greatly reduced in the AA-treated okra samples.

The total chlorophyll, oxalate, fibre (hot-water-insoluble materials), ash and moisture contents of all the treated samples remained fairly constant. The maintenance of good quality by AA-treated samples packed in 'cellophane' bags was reflected in all aspects of sensory evaluation for cooked okra, even after 29 days of storage. It is concluded that a postharvest dip in 500 ppm ascorbic acid can be beneficial in maintaining texture and greenness of okra.

INTRODUCTION

Okra (*Hibiscus esculentus*) is abundantly available to consumers in the southern part of West Africa, mostly in the rainy seasons. In order to extend the availability of fresh vegetables in the market, it is essential to extend the shelf-life of such products beyond the production periods. Controlled atmospheres (Leberman *et al.*, 1968; Wang, 1979) and the use

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of natural or synthetic cytokinins (Dedolph *et al.*, 1962; Fuller *et al.*, 1977) have been suggested as means of improving the shelf-life of vegetables.

Quality of appearance of fresh vegetables has been maintained by preservation of chlorophyll content (Dedolph *et al.*, 1962; Fuller *et al.*, 1977; Wang, 1979), retardation of ethylene production (Wang, 1979) and reduction or inhibition of respiration (MacLean *et al.*, 1963; Leberman *et al.*, 1968). Reduced temperatures, in particular, slow down respiration and help maintain the natural equilibrium of enzymic systems. If the temperature is too low, enzymic reactions may become abnormal and the fruits may begin to deteriorate (Czyhinciw, 1969).

It was the intention of this study to investigate the use of ascorbic acid (AA) in enhancing the storability of raw okra at 2 °C. Also examined were the maintenance of quality and variation in sensory quality of the cooked, AA-treated okra fruits when compared with the cooked fresh fruits.

MATERIALS AND METHODS

Source of materials and treatment

Healthy okra fruits (9·5 g average weight) were harvested from seven fields with uniform cultural treatments and transported under crushed ice to the Department of Food Science and Technology Processing Laboratory (The Polytechnic, Owo). The nearest field was 5 km from the laboratory, the farthest was 8 km.

The treatment of the fruits was carried out within 2 h of collection. The okra fruits were divided into three approximately equal groups. Two groups (500 fruits each) were dipped in sterile distilled water containing 250 and 500 ppm ascorbic acid (AA_{250c} and AA_{500c}), respectively, and the other group (500 fruits) was dipped in water containing 1000 ppm Tween-20 for 5 min (water treatment—control).

The fruits were later drained, air-dried at 30 °C for 15 min and packaged in paper (WT_p) and impermeable 'cellophane' (WT_c) bags after the water treatment. The AA-treated okra were packaged in the 'cellophane' bags only. Seventy grammes of fruit were packaged in each bag, heat sealed by an Impulse Sealer (Clamco Corp., London) and stored at 2 °C. The experiment included ten replicates containing about eight fruits per sample for each of the three dips.

Sensory evaluation

Samples from each treatment were evaluated for quality at intervals of 5 days. Subjective evaluation of colour, aroma, flavour, texture and general acceptability was made by ten trained and ten untrained panellists from the Department of Food Science and Technology and the Department of Catering and Hotel Management (The Polytechnic, Owo). Before each evaluation, the fruits were washed in three successive changes of distilled water and cut both longitudinally between their axes and laterally along four or five planes, depending on their length. The fruits were cooked for 5 min at between 95 and 98 °C in water containing 9 g sodium chloride/litre. Freshly harvested fruits were used as a control.

A 9-point hedonic scale (9 = excellent; 5 = borderline; 1 = very poor) was used for judging each quality attribute. The following analytical procedures were used to determine the oxalate, fibre, moisture, ash and chlorophyll contents.

Analytical procedures

Oxalate

The total oxalate content was estimated using Oke's method (1966) whereby 2 g of sample were digested with 190 ml of hot distilled water, filtered into a conical flask and diluted to 250 ml. To a 50 ml portion of the extract were added 10 ml 6N HCl; the solution was then filtered and the precipitate washed with hot water. The filtrate and the wash were combined and titrated against 6N NH_4OH, using methyl red indicator. The solution was heated to about 90 °C and 10 ml of 5% w/v $CaCl_2$ solution were added to precipitate oxalate. The precipitate formed overnight was washed free of calcium with distilled water and then put, along with 10–15 ml hot 25% H_2SO_4, into a 50 ml conical flask, and diluted with distilled water. The resultant solution was finally heated to about 80 °C and titrated against 0·05N $KMnO_4$. The calculation was made as recorded by Vogel (1961).

Fibre

Using the method of Kramer *et al.* (1949), about 50 g of vegetable and 100 ml of water were homogenized for 2 min at the high speed setting in a Waring blender. The homogenate was heated at 100 °C for 1 h. It was later washed on a 60-mesh screen for 5 min, transferred to a dry, pre-weighed filter and dried at 110 °C for 2 h, cooled and weighed.

Moisture

The moisture content of the samples was calculated from the weight loss after 5 g of okra fruits had been maintained in a ventilated oven at 105 °C for 4 h.

Ash

The ash content was determined by heating the samples in a muffle furnace at 550 °C for 2 h.

Chlorophyll

Twenty grammes of okra were blended with 60 ml acetone at low speed for 1 min in an explosion-resistant blender (a modification of the method of Leberman *et al.* (1968)). The mixture was filtered through glass wool. The residue was returned to the blender and extracted with 40 ml 80% (aqueous) acetone for 2 min, filtered and eventually washed with 80% acetone. The combined extracts were diluted to 250 ml. A portion of the extract was diluted with 80% acetone (5 ml extract to 5 ml 80% acetone) and the absorption at 645 and 663 nm read on a Spectronic 70 spectrophotometer. About 10 ml 80% acetone were used as a blank.

RESULTS AND DISCUSSION

Blackening of Tween-20-treated samples in the paper bags occurred within 2–3 days of storage while similar samples packed in the 'cellophane' bags blackened by the third or fourth day of storage (Table 1). The 250 ppm ascorbic acid-treated fruits showed signs of discoloration

TABLE 1

Effects of Ascorbic Acid and Pre-packaging on Days to Blackening and Chlorophyll Content of Raw Okra Stored at 2 °C

Okra samples (treatment designations)	*Days to blackening*	*Total chlorophyll (mg/litre)*
Water + Tween-20 in paper bag (WT_p)	2–3	4·30
Water + Tween-20 in 'cellophane' bag (WT_c)	3–4	4·31
250 ppm AA in 'cellophane' bag (AA_{250c})	20–22	4·18
500 ppm AA in 'cellophane' bag (AA_{500c})	28–31	4·04

TABLE 2
Effects of Ascorbic Acid and Pre-packaging on Moisture Content and Weight Loss of Okra

Okra samples (evaluation day)	*Moisture (%)*	*Average weight loss*
WT_p (3 days)	89·84	0·520 g
WT_c (3 days)	91·25	0·504 g
AA_{250c} (21 days)	90·63	0·230 g
AA_{500c} (29 days)	90·66	0·110 g
Fresh okra	90·76	—

after 20 days. However, samples treated with 500 ppm ascorbic acid were fresh for at least 28 days. Moisture loss was greatest in those samples packed in the paper bags, which became soaked with watery exudates from the fruits after the second day of storage.

Meanwhile, the average weight loss of AA-treated samples was much less than in the Tween-20 samples throughout the storage period (Table 2). These observations may be due to the antioxidizing nature of ascorbic acid (Czyhinciw, 1969; Singh & Dhankhar, 1981) which suggests there is a beneficial effect in reducing moisture loss through respiration and as such preserving the greenness of the fruits.

The colour, aroma, flavour, texture and general acceptability of cooked okra treated with AA were rated higher, especially for those samples treated with 500 ppm AA (Table 3). The ratings for 500 ppm AA-treated fruits and fresh okra were: colour (7·8, 7·9), aroma (7·6, 7·9), flavour (7·3, 7·6), texture (7·6, 7·7), and general acceptability (7·4, 7·8),

TABLE 3
Sensory Evaluation of Cooked Okra Fruits

Okra samples (evaluation day)	*Colour*	*Aroma*	*Flavour*	*Texture*	*General acceptability*
WT_p (3 days)	5·7	5·8	5·9	5·6	5·6
WT_c (3 days)	6·1	5·9	6·0	6·2	6·0
AA_{250c} (21 days)	7·2	6·9	6·8	7·0	7·0
AA_{500c} (29 days)	7·8	7·6	7·3	7·6	7·4
Fresh okra	7·9	7·9	7·6	7·7	7·8

respectively. However, ratings for the sensory attributes of the cooked samples progressively decreased between 0 and 29 days, except for the texture which was fairly irregular (Fig. 1). This result was expected since all the attributes would vary with the duration of storage. The scoring differences between the sensory attributes of the AA_{500c}-treated samples compared with those of the cooked fresh okra were very slight.

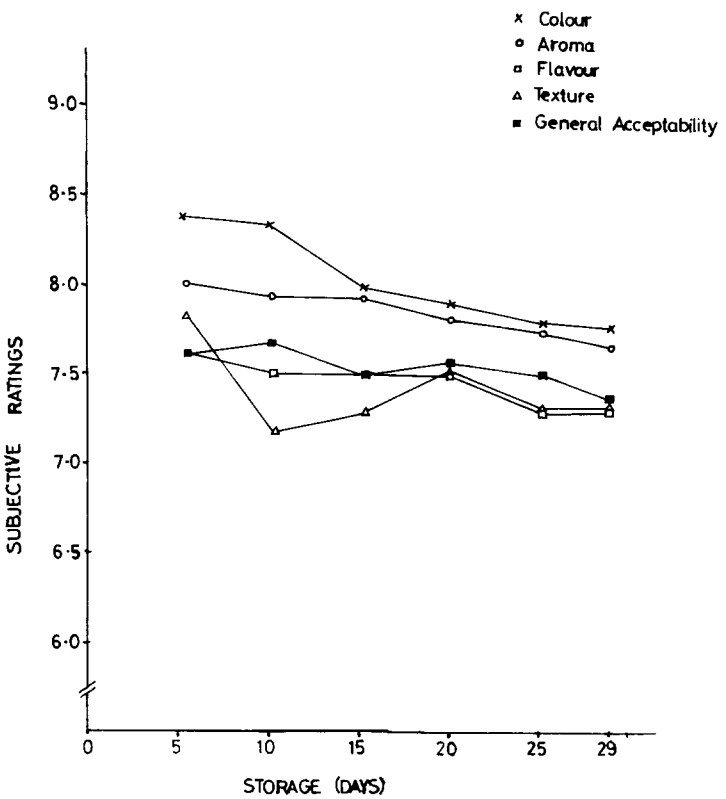

Fig. 1. Sensory evaluations for cooked AA_{500c} treated okra during 29 days of storage.

Table 4 shows the oxalate, crude fibre and ash contents of okra expressed as percentages of the dry matter. The oxalic acid content was used as an index of toxicity in vegetables (Oke, 1966; Ogundana and Fagade, 1982). It is interesting to note that the oxalate contents of the okra samples investigated were low. The value recorded for the crude fibre of the fresh okra when compared with that of the AA-treated sample

TABLE 4
The Oxalate, Fibre and Ash Contents of Okra Fruits

Okra samples (evaluation day)	*Total oxalate* (%)	*Crude fibre* (%)	*Ash* (%)
WT_p (3 days)	1·95	3·55	1·55
WT_c (3 days)	1·96	3·56	1·58
AA_{250c} (21 days)	1·98	3·75	1·67
AA_{500c} (29 days)	1·99	3·72	1·63
Fresh Okra	1·95	3·80	1·55

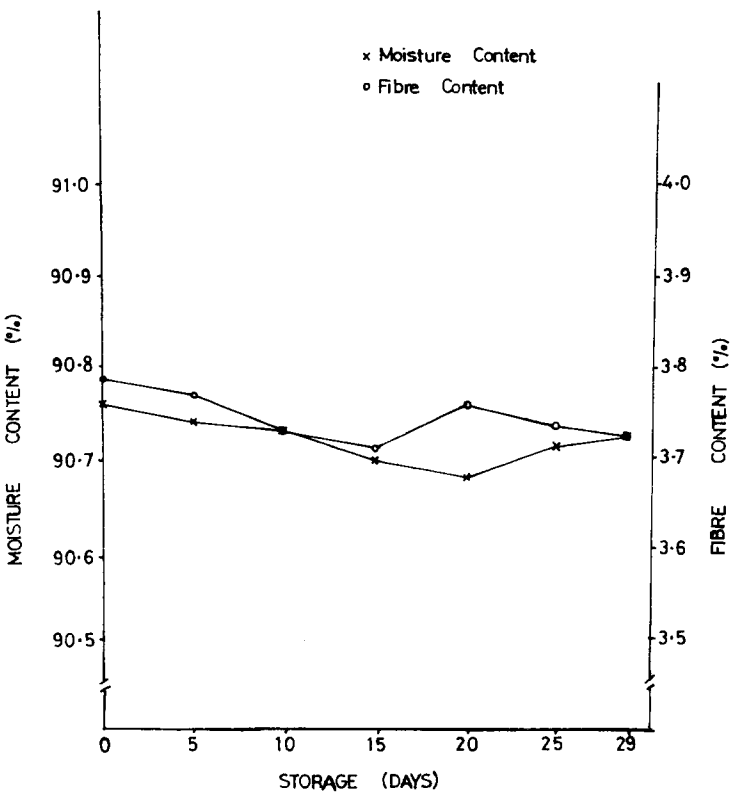

Fig. 2. Effect of 500 ppm ascorbic acid on the fibre and moisture contents of raw okra.

stored for over 29 days is only slightly higher. The fibre content was quite regular and showed a consistent pattern; it decreased slightly for about 15 days and then increased (Fig. 2). A similar pattern was exhibited by the moisture content. In general, the fibre content appeared to be closely related to loss of turgidity during the storage period.

There was little difference in the moisture content over the storage period (Fig. 2) while the ash content was fairly stable (Table 4). The total chlorophyll content decreased in the AA-treated samples between the tenth and twentieth day of storage and increased slightly until discoloration occurred. This is probably due to the decreased effective concentration of ascorbic acid during the storage period.

Based on this experiment, the 500 ppm treatment, as a postharvest dip, can be concluded to be beneficial in maintaining the 'greenness', aroma, texture, and general acceptability of okra for at least 29 days in storage at 2 °C. However, turgidity becomes a limiting factor when storage is extended beyond 30 days.

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