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# Nutrient Losses During and After Processing of Pineapples and Oranges

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*ABSTRACT*

*Samples of pineapples and oranges processed into various products at the Lafia Canning Factory, Ibadan, were obtained and analyzed for their ascorbic acid, pH, total titratable acidity, total solids, ash and contents of calcium, magnesium, sodium and potassium. The sugars present in the samples were estimated both quantitatively and qualitatively. Samples of the pasteurized pineapple pieces, pasteurized pineapple juice and pasteurized orange juice were stored at room temperature for 3 months followed by chemical analyses.*

*Ascorbic acid content of the fresh fruit juices was reduced considerably with processing and storage. Both the pasteurized and unpasteurized orange juice were acidic as evidenced by the pH and total titratable acidity values obtained in this study. The pineapple products were, however, less acidic. Total solids, ash and the selected minerals were present in appreciable amount in the fruit products and were not significantly affected by processing and storage.*

*Qualitatively, pasteurized pineapple juice and pieces contained glucose, fructose and sucrose in appreciable amounts while pasteurized orange juice contained only glucose and fructose with traces of maltose but no sucrose.*

## INTRODUCTION

The seasonal variation in fruit production is a constraint to its availability all the year round, and therefore canning is used to spread the supply throughout the year. Canning minimizes fruit spoilage and wastage and in most industrialized nations fruit canning is routine. In Nigeria, however, fruit canning is not widespread and its acceptability is still limited

to the upper and middle social status. Most of the population, belonging to the lower classes, consume fruits which have been transported from one part of the country to another and which are in various stages of decay. Considerable economic loss results since most of the fruits produced in Nigeria are still distributed through this channel.

The sources of the fruits canned are wide and varied, hence the nutritional and keeping qualities of the canned products are usually affected. There is a dearth of information on the composition of canned fruit products in Nigeria. Available information on vitamin C contents showed that it was significantly affected by the method of processing (Oke, 1966, 1967; Alase, 1973; Akinyele & Keshinro, 1980).

The present report provides additional information on the effect of processing and storage on some constituents of canned orange and pineapple products.

## MATERIALS AND METHODS

The processing of pineapple into canned pineapple juice (PJ) and canned pineapple pieces (PPS) and oranges into canned orange juice (OJ) was followed at the Lafia Canning Factory, Ibadan. Standard factory operations were followed from the time the fruits arrived at the factory until the finished products were obtained. Samples of fresh unpasteurized pineapple juice (PJu), fresh unpasteurized pineapple pieces (PPJu) and fresh unpasteurized orange juice (OJu) were obtained after the peeling, decoring, washing, slicing and crushing operations of the processes.

The pineapples crushed for PJ making were very ripe while those for making PPS were firmer and of standard grade. Samples of the pasteurized pineapple juice (PJp), pasteurized pineapple pieces (PPJp) and pasteurized orange juice (OJp) were also obtained at the end of the respective processes.

The pineapple series were pasteurized at 210°F for 17 min while the orange juice was pasteurized at 180°F for 4 min. Samples once obtained were taken to the laboratory where analyses were carried out for total solids, total titratable acidity, pH, ascorbic acid content, qualitative and quantitative estimation of sugars, per cent ash as well as the determination of calcium, magnesium, sodium and potassium.

Total solids was determined using the methods of analysis of the AOAC (1980). The dried samples were ashed in a muffle furnace at 450°C for 6 h followed by dissolution of the ash in 2 ml concentrated nitric acid being made up to mark in 100 ml volumetric flasks with deionized water. Two millilitres of 5% Lanthanum chloride was added to prevent cation–anion interference during determination. The selected minerals were determined

using a Perkin–Elmer Atomic Absorption Spectrophotometer model 305B and the appropriate hollow cathode lamps.

Total titratable acidity was determined by the AOAC (1980) method and pH by the use of a pH meter (Pye Unicam). The fruits were qualitatively analysed for individual sugars using paper chromatography with *n*-butanol, acetic acid and water (4:1:1 v/v/v) as irrigant. The sugars were identified using silver nitrate in acetone and ethanolic sodium hydroxide (Travelyan *et al.*, 1970).

The sugars were quantitated using the phenol–sulphuric acid method of Dubois *et al.* (1956) and the appropriate sugar standard curve. Ascorbic acid content was determined using an adaptation of the method described by Roe (1954) as adopted by the Association of Vitamin Chemists (1966) based on the oxidation of ascorbic acid to dehydro-ascorbic acid and its subsequent transformation to diketogulonic acid followed by coupling with 2,4-dinitrophenyl-hydrazine under carefully controlled conditions to produce red coloured osazones.

A comparison of the colour produced in samples and ascorbic acid solutions is then used to determine the ascorbic acid content. This method is accurate for anti-scorbutic assay of many fresh foods when ascorbic acid and dehydro-ascorbic acid occur in the foods and diketogulonic acid has not been formed in appreciable amounts. It is, therefore, a valuable method for determining total ascorbic acid content of foods at the time of harvesting.

Separate samples of the pasteurized canned fruit products were also obtained and stored at room temperature for 3 months before being analysed for the constituents described above. The same methods of analysis described earlier were used.

### Statistical analysis

Means and standard deviations were calculated for the data obtained during chemical analyses of the samples and differences were tested using the Students' *t*-test.

## RESULTS AND DISCUSSION

The results of the various chemical analyses previously described are presented in Tables 1, 2, 3 and 4. These results show the effects of processing and storage on the various constituents of the fruit products and standard deviations.

The ascorbic acid contents of the various products (Table 1) were found to be significantly ($P < 0{\cdot}01$) affected by processing and storage. The ascorbic

**TABLE 1**
Means with Standard Deviation for the Vitamin C Content of Processed Pineapple and Orange Products Before and After Storage

| *Item* | *Ascorbic acid content (mg/100 g)* | |
|---|---|---|
| | *Before storage* | *After storage* |
| PJu | 16·9 ± 0·4 | |
| PPSu | 14·5 ± 0·2 | |
| OJu | 54·0 ± 5·0 | |
| PJp | 1·0 ± 0·01 | 0·0 |
| PPSp | 1·0 ± 0·01 | 0·0 |
| OJp | 52·2 ± 4·3 | 32·4 ± 0·3 |

PJu, unpasteurized pineapple juice; PPSu, unpasteurized pineapple pieces; OJu, unpasteurized orange juice; PJp, pasteurized pineapple juice; PPJp, pasteurized pineapple pieces; OJp, pasteurized orange juice.

acid content of PJu was 16·9 ± 0·4 mg per 100 g edible portion whilst the ascorbic acid content of the PJp was less than 1 mg per 100 g edible portion. The same trend was observed for the PPSu which had an ascorbic acid content of 14·5 ± 0·01 mg per 100 g edible portion and the PPSp having a value of less than 1 mg per 100 g edible portion. This ascorbic acid loss indicates that the process technique needs to be modified to prevent the oxidation of the ascorbic acid when the temperature is raised during pasteurization.

These findings agree with the reports from Komarova and Navrat (1968), and Alase (1973) who reported lower ascorbic acid content in canned fruits

**TABLE 2**
pH and Mean Total Titratable Acidity of Processed Pineapple and Orange Products Before and After Storage

| *Item* | *pH* | *Total titratable acidity before storage (mg citric acid per 10 g edible portion)* | *pH* | *Total titratable acidity after storage (mg citric acid per 10 g edible portion)* |
|---|---|---|---|---|
| PJu | 3·9 | 75·0 ± 3·2 | | |
| PPSu | 3·9 | 46·0 ± 0·9 | | |
| OJu | 3·2 | 132·0 ± 7·0 | | |
| PJp | 4·1 | 65·0 ± 1·8 | 4·1 | 61·0 ± 2·5 |
| PPSp | 3·9 | 36·0 ± 1·2 | 3·9 | 36·4 ± 1·4 |
| OJp | 3·1 | 137·0 ± 6·2 | 3·1 | 127·0 ± 4·6 |

**TABLE 3**
Mean Total Solids, Ash and Selected Mineral Contents of Processed Pineapple and Orange Products Before and After Storage

| *Item* | *Total solids* (*g/100 g*) | *Ash* (*g/100 g*) | *Ca* | *Mg* | *Na* | *K* |
|---|---|---|---|---|---|---|
| | | | (*mg/100 g edible portion*) | | | |
| *Initial* | | | | | | |
| PJu | 16·4 ± 0·04 | 0·61 ± 0·01 | 20·0 | 10·0 | 2·0 | 50·0 |
| PPSu | 10·9 ± 1·8 | 0·21 ± 0·01 | 6·0 | 5·0 | 3·0 | 12·0 |
| OJu | 11·5 ± 0·01 | 0·38 ± 0·06 | 3·25 | 4·0 | 6·0 | 54·0 |
| PJp | 13·8 ± 0·8 | 0·41 ± 0·01 | 10·0 | 11·0 | 3·0 | 24·0 |
| PPSp | 17·5 ± 0·5 | 0·35 ± 0·02 | 8·0 | 8·0 | 6·0 | 30·0 |
| OJp | 12·2 ± 0·7 | 0·68 ± 0·03 | 2·50 | 4·0 | 3·0 | 48·0 |
| *After storage* | | | | | | |
| PJp | 13·8 ± 0·03 | 0·41 ± 0·02 | 10·0 | 11·0 | 3·0 | 24·0 |
| PPSp | 18·0 ± 0·05 | 0·35 ± 0·01 | 8·0 | 8·0 | 6·0 | 30·0 |
| OJp | 12·1 ± 0·08 | 0·68 ± 0·03 | 22·50 | 4·0 | 3·0 | 48·0 |

than in raw fruits. The losses of ascorbic acid could be reduced by lowering the pasteurization time and temperature to prevent oxidation since the initial ascorbic acid content of the pineapple is not very high. Pasteurization had no significant effect on the ascorbic acid content of OJu but when the final product OJp was stored for 3 months, there was a significant ($P < 0·01$) reduction in the ascorbic acid content from 52·2 ± 4·3 to 32·4 ± 0·3. This is an indication that losses of ascorbic acid content of stored fruit products are high, especially when stored under uncontrolled conditions.

The pHs of the PJu, PJp and PPSp (Table 2) were found to be constant after processing and during storage. Similar observations were made for the

**TABLE 4**
Mean Sugar Contents of Processed Pineapple and Orange Products Before and After Storage

| *Item* | *Glucose* | *Fructose* | *Sucrose* |
|---|---|---|---|
| | (*mg per 100 g edible portion*) | | |
| *Initial* | | | |
| PJp | 11·3 ± 0·07 | 24·9 ± 0·60 | 8·29 ± 0·22 |
| PPSp | 14·0 ± 0·71 | 12·7 ± 0·25 | 18·8 ± 0·13 |
| OJp | 13·0 ± 0·10 | 17·5 ± 0·35 | 0·0 |
| *After storage* | | | |
| PJp | 22·4 ± 1·55 | 20·9 ± 1·16 | 16·8 ± 0·90 |
| PPSp | 13·7 ± 0·50 | 6·0 ± 0·4 | 23·1 ± 0·96 |
| OJP | 9·64 ± 0·03 | 11·3 ± 0·7 | 0·0 |

OJu and OJp. Total titratable acidity, expressed as mg citric acid per 10 g edible portion (Table 2), were found in all cases to be significantly ($P < 0.05$) affected by both processing and storage. The PJus decreased from a value of 75·0 mg to 65·0 mg after processing in PJp and 61·0 mg after storage of the PJp. A similar decrease was found for the PPSu after processing but not after storage whilst the decrease for the OJu was for both processing and storage (Table 2). These decreases were significant ($P < 0.01$).

Total solids content of the fruits were also affected by both processing and storage (Table 3). The per cent solids in PJu was $16.4 \pm 0.04$ and this decreased to $13.8 \pm 0.05$ after processing and storage. The per cent solids in PPSu was $10.9 \pm 1.8$ which became $17.6 \pm 0.5$ after processing and $28.0 \pm 0.05$ after storage (Table 3). The main reason for this significant ($P < 0.01$) increase in total solids content of PPS could be traced to the syrup added during processing. Although this syrup was drained off before analysis the PPSp had probably absorbed a considerable amount of the syrup during processing and storage.

The ash content of the fruits ranged from $0.21 \pm 0.06\%$ in PPSu to $0.88 \pm 0.03\%$ in OJp (Table 3). The ash contents of the fruits were not significantly affected by processing or storage. Calcium was highest in PJu and was reduced by 50% after processing (Table 3). Calcium, magnesium and sodium contents of all samples were generally low; however, all samples contained significantly ($P < 0.01$) higher amounts of potassium than PPSu. Processing reduced the potassium content of PJp by 50% whilst that in PPSp increased (Table 3). The potassium content of OJp was only slightly affected by processing and storage had no effect on the potassium content of these products.

The sugar contents of the fruit products were significantly affected by storage (Table 4). The glucose content of the PJp was $11.3 \pm 0.07$ mg per 100 g edible portion before storage and this increased by almost 50% to $22.4 \pm 1.55$ mg per 100 g edible portion after storage. The glucose content of PPSp and OJp, however, decreased with storage from $14.0 \pm 0.71$ and $13.0 \pm 0.10$ mg per 100 g edible portion to $13.7 \pm 0.51$ and $9.64 \pm 0.05$ per 100 g edible portion, respectively. The fructose contents of all products showed significant decreases ($P < 0.01$) in all cases with storage. The values of PJp, PPSp and OJp were $24.9 \pm 0.60$, $12.7 \pm 0.0$ and $17.5 \pm 0.01$ mg per 100 g edible portion, respectively, before storage. These became $20.9 \pm 1.16$, $6.00 \pm 0.4$, and $11.3 \pm 0.7$ g per 100 g edible portion, respectively, after storage. The sucrose content of the pineapple products increased with storage (Table 4). PJp and PPSp both contained, initially, $8.29 \pm 0.22$ and $18.8 \pm 0.13$ g sucrose per 100 g edible portion, respectively, before storage, which increased by 100% for the PJp to $16.8 \pm 0.90$ mg per 100 g edible portion and by about 20% for the PPSp to $23.1 \pm 0.96$ mg per 100 g edible

portion. OJp contained no sucrose and its maltose content was less than 1 mg per 100 g edible portion.

The results obtained and reported here are for products processed within a short span of the process cycle of the factory. As such, other batches of products might give different results in terms of absolute values. This would be due primarily to the agronomic conditions under which the processed fruits were grown, the stage of ripeness, together with the storage and handling conditions in the factory before processing.

The nutritional implication of the ascorbic acid loss during processing and storage is far-reaching since consumption of these products in the hope of meeting daily ascorbic acid requirements would be ineffective. The losses of other nutrients reported here during processing and storage would also serve to reduce the nutritional quality of the fruits canned.

The indication, from the data obtained in this study, is that the processing techniques used for processing pineapples need to be modified to prevent the loss of the nutritionally important ascorbic acid, thereby increasing the value of the fruits as good sources of ascorbic acid.

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