CHANGES IN SOME NUTRITIONAL AND SENSORY PROPERTIES OF TREATED AND STORED FLUTED PUMPKIN LEAF

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Abstract
This study investigated the influence of processing methods on some chemical and sensory properties of treated and stored fluted pumpkin leaf. Fluted pumpkin leaves were blanched separately with solutions of ethylene diamine tetraacetic acid (EDTA; 0.003%), sodium chloride (NaCl; 0.5%), sodium benzoate (0.05%) and a mixture of the three preservatives solutions (EDTA, NaCl and sodium benzoate). The fifth portion was the control and was blanched with only water. Each of these was divided into two portions and one portion was dried and the other portion was not dried. The dried portion was stored at room temperature and the wet sample was stored at refrigerated temperature. Samples were analysed for changes in moisture content, mineral contents, ascorbic acid content and sensory characteristics every two weeks. Results of the analysis showed that samples stored at refrigerated temperature could not be stored beyond six weeks. The moisture content varied between 6.69 to 11.30% and 82.70 to 93.80% for the dry and wet samples respectively, across the storage period. The vitamin C content and the mineral contents also reduced with storage period but the reduction was lowered in samples blanched with salt solutions. Sensory evaluation of the samples showed that after the storage period of eight weeks, the dried samples were accepted by the panellists while the samples stored at refrigerated conditions decayed after sixth weeks. The study concluded that the shelf life of fluted pumpkin leaves could be extended for more than a month using appropriate processing methods.

Keywords: Leafy vegetable, Blanching, Mineral contents, Refrigerated storage, Vitamin C

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1. INTRODUCTION

Literature facts abound that different types of leafy vegetables are cultivated in the Sub-Sahara Africa, which are of immense health benefits to the body. These vegetables include but not limited to Amaranth *viridis*, *Telfaria occidentalis*, *Solanum macrocarpon*, *Vernonia amygdalina*, *and Brassica oleracea*, to mention but a few. Among these vegetables, more attention has been paid to fluted pumpkin (*Telfaria occidentalis*), in terms of cultivation and consumption especially in Nigeria. This is so because it is nutritionally important and contains some vital phytochemical constituents (Lisiewska *et al*., 2009). Fluted pumpkin has been regarded as a major economic source to poor resource populace and also a veritable source of micronutrient intake (Gupta *et al*., 2011). The vegetable is usually made into vegetable soup, locally called *efo riro* among Yoruba tribe of Nigeria. It is usually prepared with melon and it is a delicacy in many homes in Nigeria.

Post-harvest losses are one of the major hindrances to the cultivation of fluted pumpkin leaf in Nigeria. This is because the vegetable is highly perishable due to high water content and huge losses are recorded yearly due to high volume of cultivation and production, coupled with non-availability of sufficient storage, transport and proper processing facilities (Gupta *et al*., 2011). Therefore, the need to device approaches to prevent post-harvest losses of this vegetable while still retaining the essential nutrients is long overdue.

Fluted pumpkin leaf at harvest has over 70% water content and after which it begins to undergo high rates of respiration, quality deterioration and potential microbial spoilage (Rickman *et al*., 2007). Furthermore, other biological reactions such as dehydration, rapid wilting and the senescence lead to their quality deterioration. To extend the shelf-life of this all-important vegetable, with minimal loss in important nutrients, different preservation methods such as water and chemical blanching, drying, refrigeration can be employed.

One major household method of preserving vegetable is blanching. Blanching is a process of immersing vegetable into warm, hot water or steam for a timed period and rapidly cooling to prevent further cooking (Barrett *et al*., 2000; Severini *et al*., 2016). Blanching is practically carried out using various methods in order to maintain the quality of the stored produce. This include: hot water blanching, steam blanching and microwave blanching etc. One major blanching method being practiced among household in Nigeria is hot water blanching with salt. The commonly used salt is the table salt (NaCl). The choice of NaCl is because of its accessibility and affordability. Other salts such as ethylene diamine tetra acetic acid (EDTA) and sodium benzoate can also be used to ensure the extension of shelf life and the quality of stored vegetables.

Literatures have revealed efforts on the use of different methods at preserving the vegetable by drying and freezing methods (Awogbemi *et al*., 2009) but these methods have not been effective in maintaining the wholesomeness and nutritional characteristics of pumpkin leaves as many of the nutritional values were lost. Information on the changes in the nutritional qualities of fluted pumpkin leaf treated with chemical preservatives is still scanty in the literature and this formeds the basis of this study.

2. MATERIALS AND METHODS

Collection and Preparation of Raw Materials

Fresh leaves of fluted pumpkin (*Telfairia occidentalis*) were purchased from Teaching and Research Farms of Obafemi Awolowo University, Ile-Ife, Nigeria. The leaf samples were prepared using the described by Gbadamosi*et al*. (2018). The fresh vegetable leaves were de-stalked, sorted manually and washed under clean tap water to remove sand and other unwanted materials. The cleaned vegetables were sliced (approx. 1.2x 1.5 mm) using steel knife.

Treatment of the raw materials

The sliced fluted pumpkin leaves were divided into five portions of equal weight (100 g) and each portion was blanched separately at 70^0C for 3 min with solutions of ethylenediamine tetra-acetic acid (0.003%), sodium chloride (0.5%), sodium benzoate (0.05%) and a mixture of the three preservative solutions (ethylenediamine tetra-acetic acid, sodium chloride and sodium benzoate) at 0.003%, 0.5 % and 0.05% respectively. The fifth portion was blanched without any preservative and labelled as control of the experiment.

Each of the treated samples described above was divided into two portions. The first portion was packaged and stored wet (refrigerated storage at 4^0C), drained and air-dried before storage while the second portion was dried at 50^0C for 8 h and stored at room temperature. Samples were taken out every two weeks for analysis to assess quality changes in the stored samples with respect to the treatments. The duration of storage was eight weeks.

Chemical Analysis during Storage

During storage of the samples, changes in the moisture content, mineral contents and vitamin C (ascorbic acid) of the stored samples were evaluated.

Moisture content

Moisture content of the stored samples was determined by the standard method described by AOAC (2005).

Minerals Analysis

The analyses for essential mineral were investigated using atomic absorption spectrophotometric method described by Fashakin *et.al.* (1991). Five hundred milligram (500 mg) of each of the samples was treated with 10 ml of HCl and HNO_3. The mixture was digested until colourless and allowed to cool. The digest was loaded on the atomic absorption spectrophotometric and flame photometer for the mineral analysis.

Determination of ascorbic acid content

Ascorbic acid content in the samples was estimated by titrimetric method described by Gbadamosi *et al*. (2018). Five millilitres (5 ml) of standard ascorbic acid (100 µg/mL) was measured into a conical flask containing 10 mL 4% oxalic acid. The mixture was titrated against the 0.0005M of 2, 6-dichlorophenol indophenols dye. The appearance and persistence of pink colour for 30 seconds was taken as the end point. The amount of dye consumed V_I (mL) is equivalent to the amount of ascorbic acid. Five millilitres of sample (extracted by taking 5 g of sample in 100 mL 4% oxalic acid and filter with WHATMAN No 1 filter paper) was measured inside a conical flask containing 10 mL 4% oxalic acid in a conical flask and titrated against the dye (V_{ii}

mL). The amount of ascorbic acid was then calculated using the formula:

Asscorbic acid (mg/g) = x

$$Ascorbic\ acid\ (mg/g) = \frac{x\ mg}{Vi}\ x\ \frac{V\ ii}{15\ ml}\ x\ \frac{100\ mL}{mL\ of\ sample\ used\ for\ analysis}$$

$x(mg)$ = quantity of ascorbic acid dissolved in a known volume of oxalic acid

$Vi\ (ml)$ = volume of dye consumed by the sample

$Vii\ (ml)$ = volume of dye consumed by the sample

$15\ mL$ = total volume of sample and oxalic titrated

$100\ mL$ = volume of oxalic acid solution used in dissolving the sample

Sensory Evaluation

Sensory properties of wet (fresh leaves stored in refrigerated condition) and dried samples (dried leaves stored at ambient temperature) were carried out using 9-point hedonic scale. Stored samples were used to prepare soup every two weeks. The dry samples were re-constituted with warm water before soup preparation while the fresh samples were used directly. Semi-trained panellists that were familiar with fluted pumpkin leaf soups (*ugu soup*) participated in the sensory evaluation. The soups were prepared by reconstituting the processed leaves in water (100 g of leaf in 100 ml of water) and the water was later decanted. The reconstituted leaves were made into vegetable soup by adding salt, red oil, fish and onion in their right proportions and heated inside cooking pot and heated for fifteen minutes. Samples prepared from each vegetable sample were presented in coded white plastic plates. The order of presentation of samples to the panel was randomized. The panellists were instructed to evaluate the coded samples for aroma, colour, turgidity, flavour, taste and overall acceptability. Each sensory attribute was rated on a 9-point Hedonic scale (1 = disliked extremely while 9 = liked extremely).

Statistical Analysis

The data obtained in the analysis were subjected to analysis of variance (ANOVA) and the means were separated using Duncan multiple range test. Significance was taken at $p<0.05$.

3. RESULT AND DISCUSSION

Changes in moisture content of stored samples

The changes in the moisture contents of the treated fluted pumpkin leaf at storage for dry and wet samples is presented in Tables 1a and 1b, respectively. The values of the moisture contents of the dry leaves stored at room temperature ranged from 6.69 to 9.90%, 7.50 to 10.50%, 9.08 to 10.80%, 9.8 to 10.80% and 9.80 to 11.30 % for week zero, second, fourth, sixth and eighth week respectively. For the wet samples, the moisture contents ranged between 86.72 to 89.00%, 90.0 to 92.00 %, 92.40 to 93.60 % and 92.90 to 93.80 for week zero, second, fourth, sixth and eighth week respectively across different blanching treatments. These changes in moisture were significantly ($p<0.05$) different from one another. There was progressive increase in the moisture content of both the wet and the dry samples as the storage days increased, irrespective of the blanching treatments. However, the rate of moisture absorption of the samples varied. The wet samples absorbed water from the environment faster than the dry samples. This might be due to the storage condition (refrigerated storage) the samples were subjected to. After sixth week, the wet samples got spoilt. The vegetables were smelly and very soft and therefore could not be used for analysis. The spoilage of the samples might be due to the continued activities of the enzymes in the wet environment. Emebu and Anyika (2011) revealed that high moisture content of food samples predisposes food materials to spoilage, because micro-organism causing food spoilage are known to thrive well in food having high moisture contents. Contrary to the submission of Armel *et al.* (2015), that leafy vegetable can only be stored for seven days under refrigerated condition, all the vegetable samples in this study were wholesome after a month. The antimicrobial activities of the salts used in blanching the samples might have extended the shelf life of the fluted pumpkin vegetables.

Changes in Mineral Content of the Stored Fluted pumpkin Leaf

Mineral analysis of the samples was carried out on the dry samples at zero, fourth and eighth week. In the case of wet samples, analyses were carried out at zero, fourth and sixth week. Analysis at eighth week on wet samples was not possible because of spoilage.

Changes in the calcium content of stored fluted pumpkin leaf

The calcium contents of the treated fluted pumpkin leaf during storage are as presented in Figures 1(a) and (b). The calcium content for the wet samples at fourth week ranged from 266.0- 308.0 mg/100 g and 202.0-304.0 mg/100 g at sixth week. Also, the calcium contents for the dry samples at fourth week ranged from 266-288 mg/100g and 202.0-280.0 mg/100g at eight weeks. These values were significantly ($p<0.05$) different from one another. The results indicated that calcium contents of the samples for both the wet and the dry leaves decreased as the storage period increased. Also, irrespective of the salts used in blanching, the calcium content decreased, though at different rates, depending on the salts used. This study revealed that the rate of calcium loss in FPED, FPNB, FPNC and FPCM was slower both in wet and dry storages when compared with FPCT. This implied that blanching with salt solutions actually played significant roles in retaining the calcium content of the samples. The perceived preservative properties of the salts solutions might be responsible for this observation. The decrease in the calcium contents as the storage days increased agreed with the observation of Armel *et al*. (2015) on the residual calcium content on the dried and refrigerated sample of *Abelmoschus esculentus*. The recommended dietary allowances (RDA) as mg/day/person for calcium is 1000mg (FAO, 2004). However, the results revealed that the stored dry leaf could supply about 20-27% at eighth week and wet fluted pumpkin leaf could contribute 20-30% at sixth week to the recommended daily allowance for calcium.

Table 1(a): Changes in moisture content (%) of differently treated fluted pumpkin dried leaf

	Week 0	Week 2	Week 4	Week 6	Week 8
FPED	$9.90±0.29^a$	$10.5±0.72^a$	$10.8±0.29^a$	$10.8±0.19^a$	$11.0±0.19^b$
FPNB	$6.73±0.71^d$	$7.1±0.71^f$	$10.3±0.09^b$	$10.5±0.39^c$	$10.5±0.73^c$
FPNC	$6.69±0.89^d$	$8.2±0.79^e$	$9.6±0.39^d$	$9.8±0.70^e$	$9.8±0.39^e$
FPCM	$9.83±0.30^b$	$10±0.73^b$	$10.7±0.80^b$	$10.7±0.39^b$	$11.3±0.74^a$
FPCT	$6.72±0.29^d$	$8.9±0.29^d$	$10.1±0.20^c$	$10.2±0.26^d$	$10.2±0.69^d$
FPUB	$8.98±0.29^c$	$9.01±0.09^c$	$9.08±0.28^e$	$9.81±0.34^f$	$9.91±0.73^f$

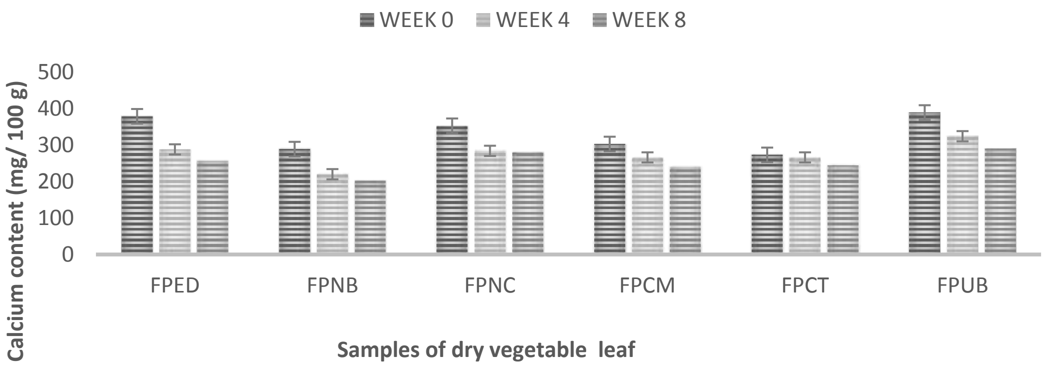
Table 1(b): Changes in moisture content (%) of differently treated fluted pumpkin wet leaf

	Week 0	Week 2	Week 4	Week 6
FPED	89.90±0.29[a]	92.00±0.28[a]	93.60±0.31[a]	93.80±0.24[a]
FPNB	86.73±0.71[c]	90.30±0.49[d]	92.70±0.55[c]	93.10±0.39[c]
FPNC	86.69±0.89[d]	90.00±0.69[e]	92.40±0.39[e]	93.10±0.25[c]
FPCM	89.83±0.30[b]	91.20±0.22[b]	93.10±0.21[b]	93.30±0.99[b]
FPCT	86.72±0.29[c]	90.00±0.25[c]	92.60±0.09[d]	92.90±0.59[d]

Values reported are means ± standard deviation of triplicate determinations. Mean values with different superscript within the same column are significantly ($P < 0.05$) different

FPED: Fluted pumpkin sample blanched with ethylenediamine tetra acetic acid (EDTA) solution, **FPNB**: Fluted pumpkin sample blanched with sodium benzoate solution, **FPNC**: Fluted pumpkin sample blanched with sodium chloride (NaCl) solution, **FPCM**: Fluted pumpkin sample blanched with combination of EDTA, NaCl and sodium benzoate solutions,
FPCT: Fluted pumpkin sample blanched without preservative, **PFUB**: Unblanched fluted pumpkin.

(a)



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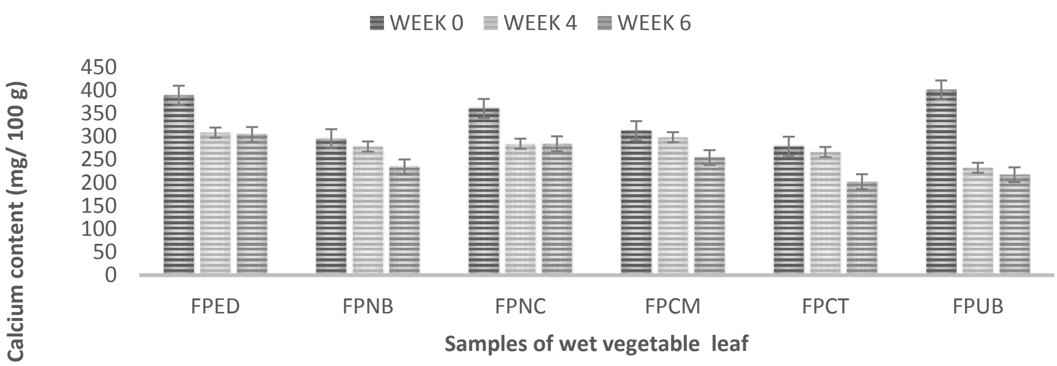

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Figure 1: Effect of different blanching treatments on the calcium content of stored (a) dry fluted pumpkin leaf (b) wet fluted pumpkin leaf.

Changes in the copper content of stored fluted pumpkin leaf

The copper contents of the stored fluted pumpkin leaf during storage are shown in Figure 2 (a) and (b). The copper contents ranged between 3.2 to 12.0 mg/100g, 2.8 to 14.1mg/100g for wet samples at fourth and sixth week while1.1 to 11.4mg/100g, and 1.1 to 12.1mg/100g were the values obtained for dry samples at fourth and eighth week, respectively. The results showed that there was decrease in the copper contents of the samples as storage weeks increased. This decrease was irrespective of the salt solutions used in blanching, though some were not significantly (p>0.05) different from each other, depending on the salts used in blanching. Some salt solutions such as the sodium chloride and combined salts solutions slowed down the rate of depletion of copper in the samples both in the dry and wet samples. The residual copper content in the FPCT was approximately 1.0 mg/100g at the end of the storage period both in the wet and dry form, which is lower than the quantity of copper retained by samples blanched with salt solutions.

Changes in the Iron content of stored fluted pumpkin leaf

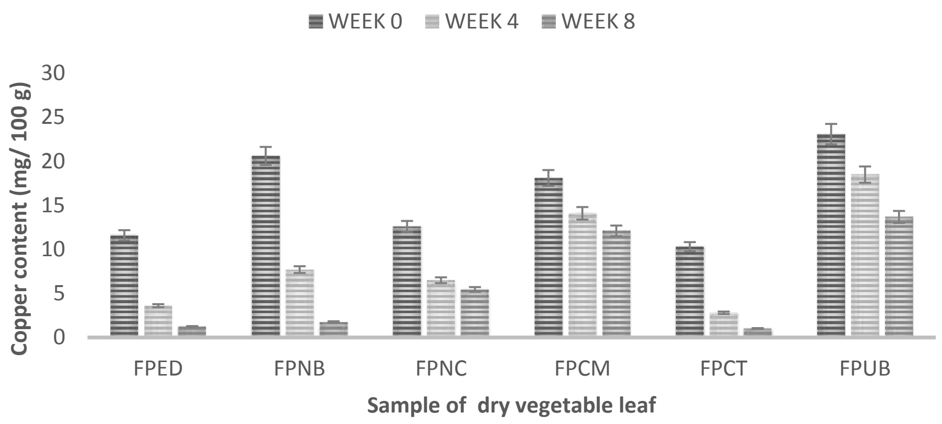
The iron content in the stored treated fluted pumpkin leaf samples during storage is shown in Figures 3(a) and (b). The values obtained were between 398-613 mg/100 g and 488-639 mg/100g for wet and dry samples, respectively. In the sixth week, the iron content for wet samples ranged from 305-594 mg/100g while 361-610 mg/100g was obtained for dry samples in the eighth week. The results indicated that wet samples did not retain much samples compared to the dry samples.

Among the samples blanched with salts solutions for the two treatments, sodium benzoate and EDTA retained the highest value of iron. This decrease in the iron content as storage time increasedagreed with the observations of Armel *et al*. (2015) on the reduction in iron content during the storage of*Abelmoschus esculentus*, *Celosia argentea*, *Ipomea batatas*, *Manihot esculenta* and *Myrianthus arboreus* vegetables. The recommended dietary allowances (RDA) as mg/day/person for iron is 8mg (FAO, 2004). The level of residual iron in the samples after the storage period in the samples could meet RDA intake and contribute substantially to improving human diet (FND, 2005).

Changes in the sodium content of stored fluted pumpkin leaf

The results of the sodium content of stored fluted pumpkin leaf samples during storage period are shown in Figure 4 (a) and (b). The values obtained for sodium content varied between 1089 to 1128 mg/100g and 1091 to 1120 mg/100g for wet and dry samples in the fourth week of storage, respectively. In the sixth week of storing the wet sample, the sodium content varied between 1000-1123 mg/100g while values ranging between 1066-1093mg/100g was obtained in the eighth week of storing the dry sample. These results showed that the rate of sodium loss as the storage weeks increased were almost the same for both the wet and dry leaves. This revealed that, storing fluted pumpkin leaves in dry and wet forms would not lead to a significant loss in sodium content for a specific length of time. Among the samples evaluated, sample FPCT had the lowest sodium content as the storage period increased. This observation was as expected as sample FPCT was not blanched with any salt solutions. With regard to the potency of the solutions used in blanching, the study revealed that all the salts solutions used in blanching retained the sodium content in the samples at almost equal rates. The trend observed in thisstudy on the decrease in the sodium content as storage increased agreed with

(a)



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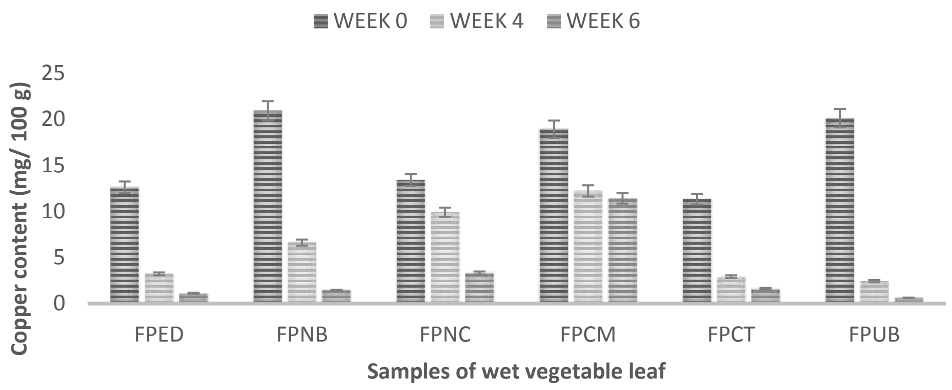

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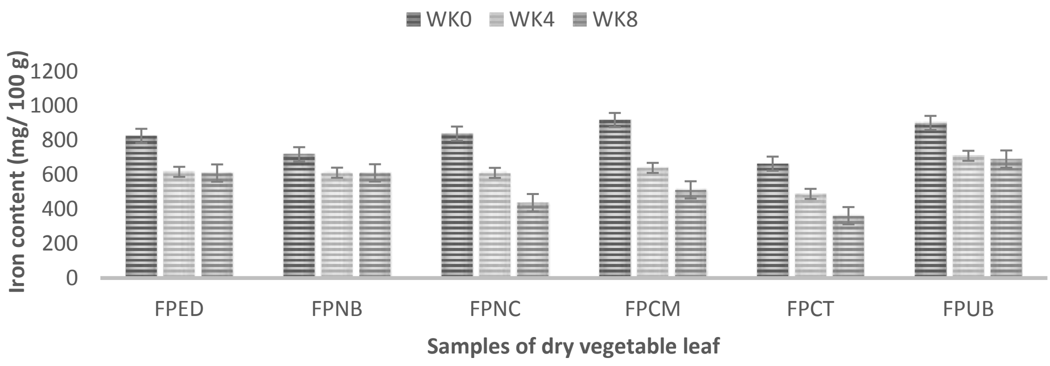
Figure 2: Effect of Different Blanching Treatments on the Copper Content of Stored (a) Dry Fluted Pumpkin Leaf (b) Wet Fluted Pumpkin Leaf

(a)



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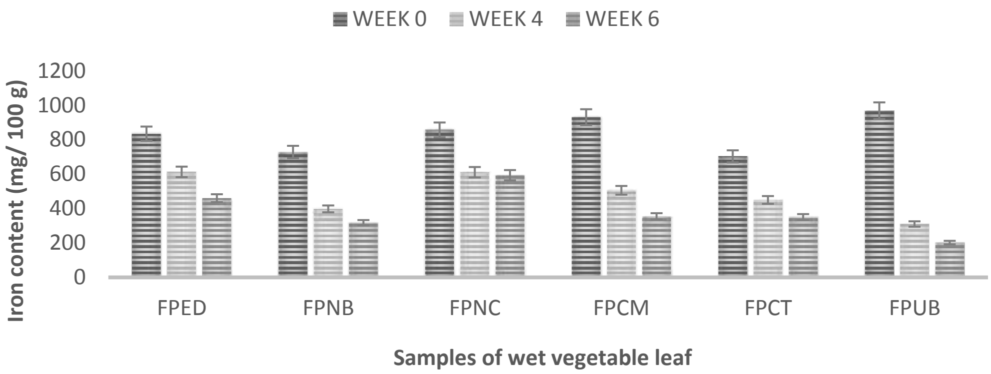

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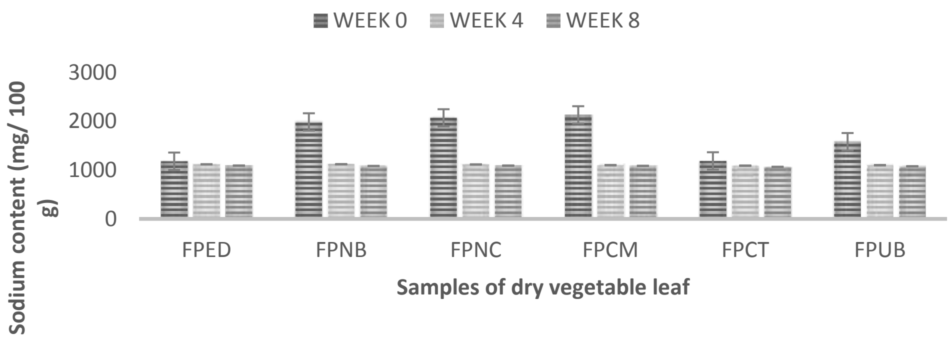
Figure 3: Effect of Different Blanching Treatments on the Iron Content of Stored (a) Dry Fluted Pumpkin Leaf (b) Wet Fluted Pumpkin Leaf

(a)



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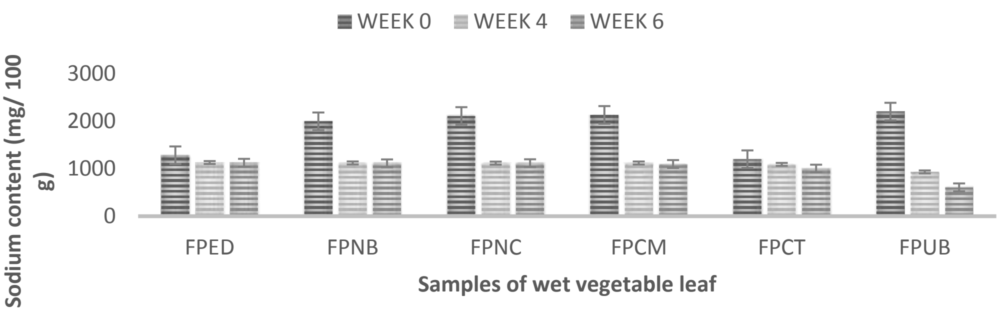

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Figure 4: Effect of Different Blanching Treatments on the Sodium Content of Stored (a) Dry Fluted Pumpkin Leaf (b) Wet Fluted Pumpkin Leaf

The pattern of results in this study was similar to the submission of Zoro *et al*. (2015) on the refrigerated and ambient storage on the residual sodium content of *A. esculentus* after fifteen days. Sodium is the principal cation in extracellular fluids. It regulates plasma volume and acid-base balance, involved in the maintenance of osmotic pressure of the body fluids (Soetan *et al*., 2010). Sodium intake of less than 2g/day increases calcium loss in urine and high intakes can contribute to hypertension in some people (Solanke and Awonorin, 2002). Therefore, the level of residual sodium content in both the wet and dry forms can satisfy the sodium requirement for sodium depleted diets.

Changes in the zinc content of stored fluted pumpkin leaf

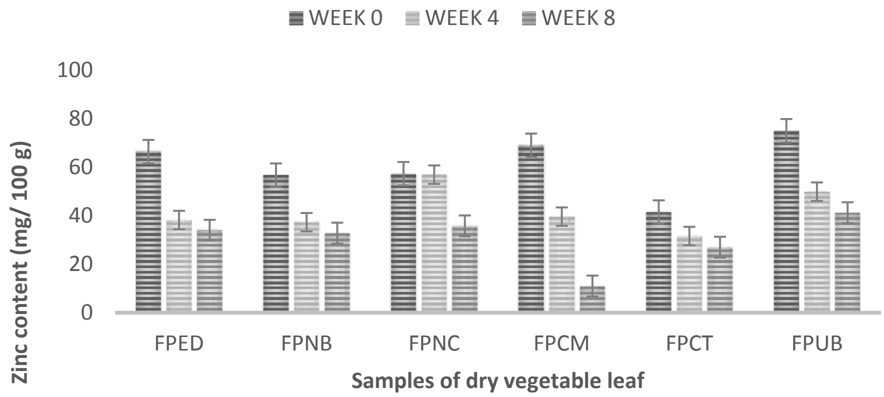
Zinc content in the treated fluted pumpkin samples during storage was evaluated and presented in Figure 5 (a) and (b). The results showed that the zinc content ranged between 19.2-54.4 mg/100g and 31.6-56.9 mg/100g for wet and dry samples in the fourth week of storage. In the sixth week of storing the wet samples before spoilage, the zinc content was 13.2-44 mg/100g while the values for the dry samples in the eight weeks of storage ranged from 11.0-35.8 mg/100g. The results showed that the rate of zinc loss in the wet samples was faster than the dry samples. The salt solutions used in blanching also helped in preventing excessive depletion of the zinc contents of the samples. However, EDTA and sodium chloride were found to prevent high depletion of the zinc during storage, both in the wet and dry samples. The observations in this study agreed in line with the submissions of Armel *et al*. (2015) on the residual zinc when *Abelmoschus esculentus*, *Celosia argentea*, *Ipomea batatas*, *Manihot esculenta* and *Myrianthus arboreus* were stored.

Zinc is very useful in protein synthesis, cellular differentiation and replication, immunity and sexual functions. The recommended dietary allowances (RDA) for zinc are 6.0mg/day/person (FAO, 2004). The level of zinc in the samples could assist in meeting up RDA and contribute substantially for improving human diet (FND, 2005).

Changes in the potassium content of treated fluted pumpkin

The level of potassium during the storage of treated fluted pumpkin leaf samples under different conditions is presented in Figures 6 (a) and (b). The potassium content of the wet samples varied from 1992 to 2969 mg/ 100 g in the fourth week of storage while the values in the sixth week of storage reduced and varied from 1085 to 2959 mg/ 100 g. For the dry samples, the potassium content ranged from 1965 to 2394 mg/100g and 1383-1826 mg/100g in the fourth and eighth week of storage, respectively. The results showed that the loss of potassium was faster in the dry samples than in the wet samples during storage. Also, sample blanched without salt solution had the highest rate of potassium loss during storage. This shows that the salt solution used in blanching reduced the rate of potassium loss during storage period. This -observation agreed with the submission of Mbemba *et al*. (2012) on the potassium content of stored *Cuervea isangiensis* leaf. Generally, the decrease in mineral contents of the leaf during storage might be connected to gradual depletion of chlorophyll in the stored samples, since most of the minerals are chemically bonded with chlorophyll. The daily body need of potassium ranged between 500 to 3000 mg (Kleiner and Greenwood-Robinson, 2000). In this study, the potassium content fell within this range throughout the storage period, indicating that stored fluted pumpkin leaf could be used to meet the daily potassium need of the body.

(a)



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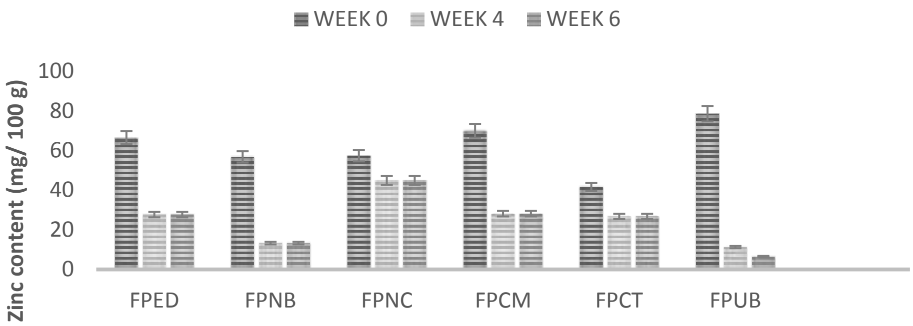

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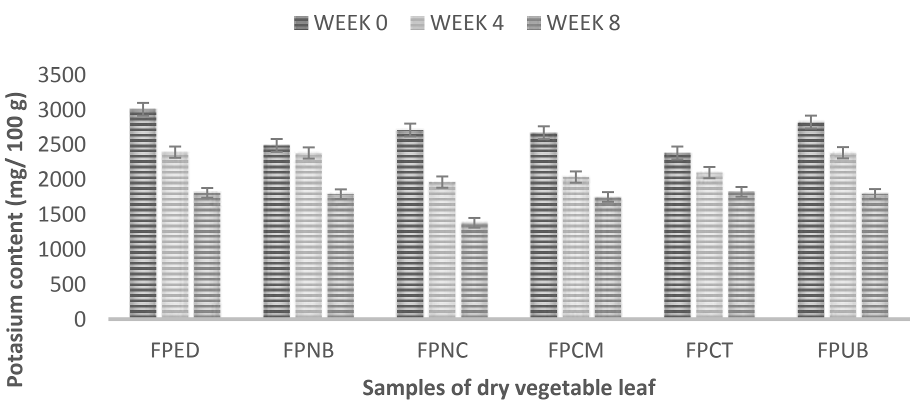
Figure 5: Effect of Different Blanching Treatments on the Zinc Content of Stored (a) Dry Fluted Pumpkin Leaf (b) Wet Fluted Pumpkin Leaf

(a)



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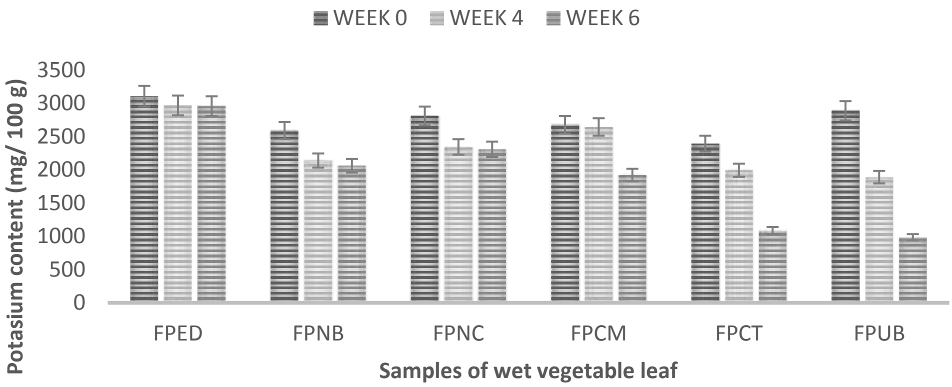

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Figure 6: Effect of Different Blanching Treatments on the Potassium Content of Stored (a) Dry Fluted Pumpkin Leaf (b) Wet Fluted Pumpkin Leaf

Changes in Vitamin C Content of Stored Fluted Pumpkin Leaf

The changes in vitamin C content of the stored fluted pumpkin leaf are presented in Figures 7 (a) and (b). The values ranged from 81 to 112 mg/100g, 64 to 97 mg/100g and 34 to 66mg/100g for wet samples at second, fourth and sixth week of storage, respectively. For the dry samples, the values obtained for the dry leaf samples ranged from 94 to 110 mg/100g, 87 to 106 mg/100, 84 to 103mg/100g and 74 to 93mg/100gfor the second, fourth, sixth and eighth week of storage, respectively. The results showed that the vitamin C content of both the wet and dry samples decreased as the storage period increased. The rate of loss of vitamin C was higher in the wet samples than in the dry samples. This might be due to auto-oxidation and enzymatic degradation occurring in the stored environment of the wet samples. The trend in this study partly agreed with the submission of Armel *et al.* (2015)in which 75% of the ascorbic acid was loss in the storage of leafy vegetables for fifteen days. However, in the present study, 58% of ascorbic acid was loss in the wet samples and 43% was loss in the dry samples at the end of the storage period. Blanching of the leaves with salt solutions might be responsible for reducing the rate of ascorbic acid loss in the leaf.

Vitamin C is required for healthy skin, bones, and muscles. It plays an important role in the manufacture of collagen, which is the connective tissue that holds bones together. In this study, all the salts used in blanching, the storage methods and other processing treatment were to be effective in retaining significant quantity of vitamin C at the end of the storage period.

Sensory Evaluation of Stored Fluted Pumpkin Leaf

The soups prepared using the stored fluted pumpkin leaf were subjected to sensory evaluation and tested for appearance, aroma, taste, turgidity and general acceptability.

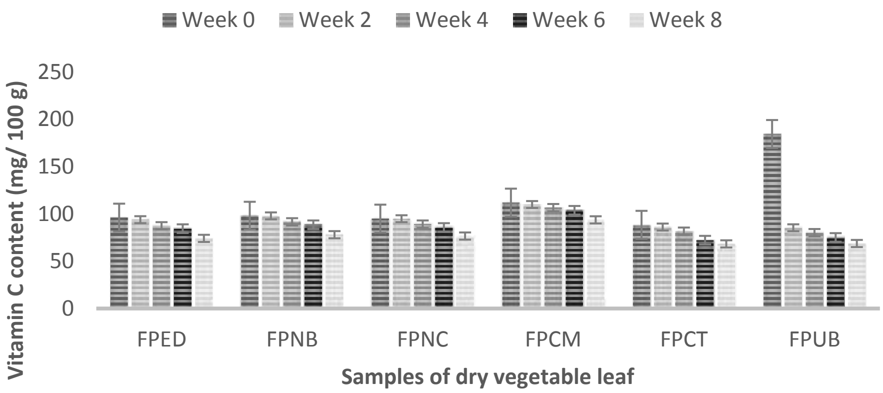
Appearance

The results of the appearance of the soups for the dry and wet samples as evaluated by the panellist is presented in Table 2 (a) and 2 (b) respectively. The results showed that the preference for the soups decreased as the storage days of the samples increased. Panellists preferred the dry samples more that the wet samples, judging from the scores awarded to the samples. The scores ranged from 5.1 to 9.00 and 4.8 to 7.30 for the dry and wet samples respectively. Also, with respect to the salt solutions used in blanching the samples, the appearance of the samples blanched with EDTA was preferred most by the panellists. Some other samples were tending towards black colour especially the wet samples. This observation might be attributed to the ability of EDTA (as a chelating agent in foods) to minimize free radical associated reactions (Girgih *et al*., 2014) such as change in colour and loss in turgidity in leaves.

Aroma

The quality of the soups prepared using the treated and stored fluted pumpkin samples in terms of the aroma is presented in Table 3(a) and (b) for dry and wet samples, respectively. The results showed variations in the preference of the aroma of the samples by the panellist. From the scores awarded by the panellists, the preference decreased as the storage period increased both in the dry and the wet samples. Results also revealed that the aroma of the soups prepared with the dry samples were more preferable to the wet samples. There were significant (P<0.05)

(a)



(b)

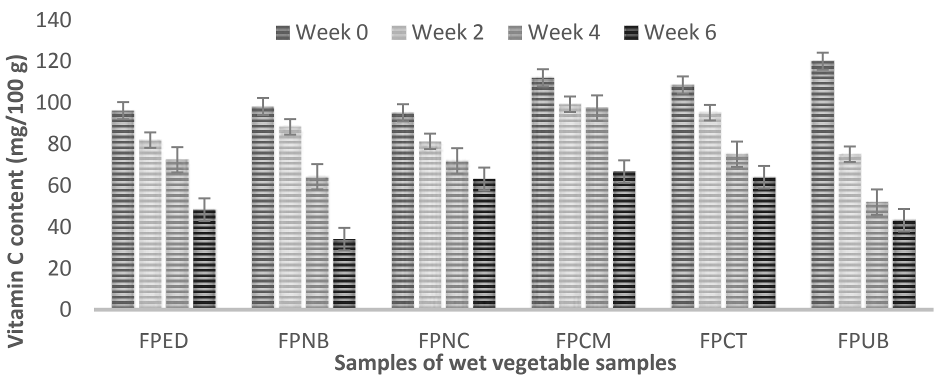


Figure 7: Effect of Different Blanching Treatments on the Potasium Content of Stored (a) Dry Fluted Pumpkin Leaf (b) Wet Fluted Pumpkin Leaf

FPED: Fluted pumpkin sample blanched with ethylenediamine tetra acetic acid (EDTA) solution; **FPNB**: Fluted pumpkin sample blanched with sodium benzoate solution; **FPNC**: Fluted pumpkin sample blanched with sodium chloride (NaCl) solution **FPCM**: Fluted pumpkin sample blanched with combination of EDTA, NaCl and sodium benzoate solutions; **FPCT**: Fluted pumpkin sample blanched without preservative, **PFUB**: Unblanched fluted pumpkin

Table 2(a): Appearance of the Soup prepared with Stored Fluted Pumpkin Dry Leaf

	Week 0	Week 2	Week 4	Week 6	Week 8
FPED	8.50±0.06^{b}	6.99±0.66^{b}	6.90±0.60^{b}	6.80±0.16^{b}	6.00±0.06^{b}
FPNB	7.24±0.01^{f}	6.50±0.61^{d}	6.30±0.14^{c}	5.30±0.14^{e}	5.10±0.16^{d}
FPNC	7.50±0.01^{e}	6.90±0.16^{c}	6.30±0.25^{c}	5.30±0.21^{e}	5.20±0.36^{d}
FPCM	7.80±0.03^{d}	6.90±0.50^{c}	6.90±0.25^{b}	5.90±0.10^{d}	5.90±0.16^{c}
FPCT	7.89±0.13^{c}	6.30±0.14^{e}	6.70±0.53^{d}	6.00±0.21^{c}	6.00±0.06^{b}
FPUB	9.00±0.00^{a}	8.80±0.03^{a}	8.70±0.12^{a}	9.00±0.00^{a}	9.00±0.00^{a}

Table 2(a): Appearance of the Soup prepared with Stored Fluted Pumpkin Wet Leaf

	Week 0	Week 2	Week 4	Week 6
FPED	8.50±0.06^{a}	7.30±0.03^{a}	7.20±0.03^{a}	6.70±0.11^{a}
FPNB	7.24±0.01^{e}	6.90±0.05^{c}	5.80±0.12^{d}	4.80±0.26^{e}
FPNC	7.50±0.01^{d}	7.30±0.01^{a}	6.30±0.14^{c}	5.30±0.16^{d}
FPCM	7.80±0.03^{c}	7.30±0.06^{a}	6.50±0.04^{b}	5.80±0.05^{b}
FPCT	7.89±0.13^{b}	7.11±0.07^{b}	5.60±0.01^{e}	5.60±0.02^{c}

Values reported are means ± standard deviation of twenty panellist. Mean values with different superscript within the same column are significantly ($P < 0.05$) different

Key:

FPED: Fluted pumpkin sample blanched with ethylenediamine tetra acetic acid (EDTA) solution, **FPNB**: Fluted pumpkin sample blanched with sodium benzoate solution; **FPNC**: Fluted pumpkin sample blanched with sodium chloride (NaCl) solution, **FPCM**: Fluted pumpkin sample blanched with combination of EDTA, NaCl and sodium benzoate solutions, **FPCT**: Fluted pumpkin sample blanched without preservative, **PFUB**: Unblanched fluted pumpkin.

Table 3(a): Aroma of the Soup prepared with Treated and Stored Dry Fluted Pumpkin Leaf

	Week 0	Week 2	Week 4	Week 6	Week 8
FPED	8.70±0.53^{c}	6.09±0.40^{f}	6.00±0.49^{e}	6.00±0.13^{c}	5.80±0.53^{b}
FPNB	7.94±0.43^{d}	6.70±0.41^{c}	6.00±0.33^{e}	6.00±0.23^{c}	5.60±0.49^{c}
FPNC	7.50±0.46^{f}	6.80±0.46^{b}	6.20±0.47^{c}	6.00±0.49^{c}	5.30±0.13^{d}
FPCM	8.80±0.93^{b}	6.70±0.73^{c}	6.30±0.23^{b}	6.10±0.53^{b}	5.60±0.42^{c}
FPCT	7.80±0.23^{e}	6.30±0.93^{d}	6.10±0.35^{d}	6.00±0.43^{c}	5.10±0.90^{e}
FPUB	9.00±0.00^{a}	9.00±0.00^{a}	9.00±0.00^{a}	9.00±0.00^{a}	9.00±0.00^{a}

Table 3(b): Aroma of the Soup prepared with Treated and Stored Wet Fluted Pumpkin Leaf

	Week 0	Week 2	Week 4	Week 6
FPED	8.70±0.53^{b}	7.10±0.49^{b}	5.10±0.23^{d}	4.10±0.42^{c}
FPNB	7.94±0.43^{c}	6.90±0.44^{c}	5.40±0.93^{c}	4.40±0.73^{b}
FPNC	7.50±0.46^{e}	7.30±0.33^{a}	5.60±0.33^{b}	4.60±0.33^{a}
FPCM	8.80±0.93^{a}	5.90±0.63^{e}	6.00±0.93^{a}	4.00±0.47^{d}
FPCT	7.80±0.23^{d}	6.67±0.49^{d}	6.00±0.43^{a}	4.00±0.93^{d}

Values reported are means ± standard deviation of triplicate determinations. Mean values with different superscript within the same column are significantly ($P < 0.05$) different

Key:

FPED: Fluted pumpkin sample blanched with ethylenediamine tetra acetic acid (EDTA) solution, **FPNB**: Fluted pumpkin sample blanched with sodium benzoate solution; **FPNC**: Fluted pumpkin sample blanched with sodium chloride (NaCl) solution, **FPCM**: Fluted pumpkin sample blanched with combination of EDTA, NaCl and sodium benzoate solutions, **FPCT**: Fluted pumpkin sample blanched without preservative, **PFUB**: Unblanched fluted pumpkin.

Differences in the aroma (Table 3b) of the soups prepared with samples blanched with different salt solutions. At the end of the storage period (eight week) for the dry samples, the aroma of the soup prepared with EDTA was mostly preferred while for the wet samples, the aroma of the soup prepared with sample blanched with NaCl was mostly preferred by the panellists at the end of the sixth week. This study revealed that, the aroma of the soups prepared with stored fluted pumpkin leaves was still very pleasant after storage for eight weeks and six weeks for dry and wet storage respectively.

Taste

The preference for taste of the soups prepared using the various treated and stored fluted pumpkin leaf samples is presented in Tables 4(a) and (b). In this study, a decreasing order was observed in the taste of the soups as the storage days increased for the wet and dry samples. The taste of the dry and the wet samples were rated almost the same but differ as the storage period increased. At the end of the storage period for the dry samples, soups prepared with samples blanched with EDTA and NaCl were rated mostly preferred by the panellists. For the wet samples, after sixth week, soup prepared with sample blanched with combined salt solutions was mostly preferred. On the scale of 5-9, all the soups prepared by the samples were wholesome and preferred by the panellists.

Texture

The results of the texture of the stored pumpkin leaves used in making soups are presented in Tables 5 (a) and (b) for the dry and wet samples respectively. The panellists indicated variations in the preference of the texture of the samples. The softness of the stored samples, both the dry and wet leaves increased as the storage period increased and this reflected in the soups. However, wet samples were softer than the dry samples. This pattern of results might be attributed to the gradual loss of turgidity of the wet samples, due to the storage history (refrigerated condition) of the wet samples. Also, on prolonged storage, the storage conditions of the wet samples might have encouraged continued enzymatic activities within the samples and this might lead to loss of turgidity of the wet samples when compared with dried samples. At the end of the storage, soups prepared with samples blanched with EDTA, both in the wet and the dry forms were mostly preferred by the panellists. This might be attributed to the effect of the EDTA, being able to maintain the structure of the stored samples.

Overall acceptability

Overall acceptability is the cumulative effects of each of the sensory characteristics evaluated. In the present study, the scores for the overall acceptability of the soups prepared using the treated and stored dry and wet samples is presented in Table 6(a) and (b) respectively. Like other sensorial properties evaluated, the overall acceptability decreased as the storage period increased. The results also indicated that soups prepared with dry samples were more acceptable, compared with wet samples. However, at the end of the storage period, soups prepared with samples blanched with EDTA were mostly accepted for the dry samples and for wet samples, soup prepared with FPCM and FPCT were not significantly ($p>0.05$) different from each otherand were mostly accepted.

Table 4(a): Taste of the Soup prepared with Treated and Stored Dry Fluted Pumpkin Leaf

	Week 0	Week 2	Week 4	Week 6	Week 8
FPED	7.50±0.32[e]	7.09±0.43[e]	6.50±0.72[d]	6.30±0.49[b]	6.30±0.82[b]
FPNB	7.84±0.48[d]	7.40±0.48[c]	6.50±0.43[d]	6.10±0.22[d]	6.10±0.47[d]
FPNC	7.90±0.32[c]	7.80±0.62[b]	6.60±0.22[c]	6.30±0.52[b]	6.30±0.22[b]
FPCM	7.90±0.82[c]	7.30±0.24[d]	6.80±0.82[b]	6.20±0.12[c]	6.20±0.45[c]
FPCT	8.00±0.22[b]	7.30±0.02[d]	6.50±0.49[d]	6.20±0.02[c]	6.20±0.22[c]
FPUB	9.00±0.00[a]	9.00±0.00[a]	9.00±0.00[a]	9.00±0.00[a]	9.00±0.00[a]

Table 4(b): Taste of the Soup prepared with Treated and Stored Wet Fluted Pumpkin Leaf

	Week 0	Week 2	Week 4	Week 6
FPED	7.50±0.32[d]	7.00±0.42[d]	6.80±0.40[a]	5.20±0.42[c]
FPNB	7.84±0.48[b]	7.20±0.43[c]	6.50±0.44[c]	5.30±0.48[b]
FPNC	7.90±0.32[c]	7.50±0.72[a]	6.30±0.92[e]	5.00±0.49[d]
FPCM	7.90±0.82[c]	7.25±0.92[b]	6.70±0.43[b]	5.40±0.32[a]
FPCT	8.00±0.22[a]	6.80±0.52[e]	6.44±0.32[d]	5.20±0.44[c]

Values reported are means ± standard deviation of triplicate determinations. Mean values with different superscript within the same column are significantly ($P < 0.05$) different

Key:

FPED: Fluted pumpkin sample blanched with ethylenediamine tetra acetic acid (EDTA) solution, **FPNB**: Fluted pumpkin sample blanched with sodium benzoate solution; **FPNC**: Fluted pumpkin sample blanched with sodium chloride (NaCl) solution, **FPCM**: Fluted pumpkin sample blanched with combination of EDTA, NaCl and sodium benzoate solutions, **FPCT**: Fluted pumpkin sample blanched without preservative, **PFUB**: Unblanched fluted pumpkin

Table 5 (a): Turgidityof the Soup prepared with Treated and Stored Dry Fluted Pumpkin Leaf

	Week 0	Week 2	Week 4	Week 6	Week 8
FPED	8.50±0.64[b]	8.00±0.42[b]	6.70±0.47[b]	6.50±0.49[b]	6.00±0.49[b]
FPNB	7.90±0.49[b]	7.24±0.92[c]	6.20±0.84[c]	6.00±0.84[c]	5.00±0.64[e]
FPNC	7.90±0.94[b]	7.50±0.46[c]	6.10±0.48[d]	5.40±0.64[d]	5.20±0.48[d]
FPCM	7.80±0.41[d]	7.60±0.52[c]	6.20±0.94[c]	6.00±0.98[c]	5.40±0.24[c]
FPCT	7.89±0.74[c]	7.00±0.89[c]	5.20±0.44[e]	5.10±0.83[e]	5.00±0.14[e]
FPUB	9.00±0.00[a]	8.90±0.05[a]	9.00±0.00[a]	9.00±0.00[a]	9.00±0.00[a]

Table 5(b): Turgidity of the Soup Prepared with Treated and Stored Wet Fluted Pumpkin Leaf

	Week 0	Week 2	Week 4	Week 6
FPED	8.50±0.64[b]	6.80±0.43[a]	6.40±0.64[a]	5.50±0.94[a]
FPNB	7.90±0.49[b]	6.40±0.24[b]	6.20±0.34[b]	5.30±0.42[b]
FPNC	7.90±0.94[b]	6.30±0.84[d]	5.20±0.94[d]	5.00±0.41[d]
FPCM	7.80±0.41[d]	6.30±0.84[d]	6.20±0.24[b]	5.20±0.92[c]
FPCT	7.89±0.74[c]	6.33±0.94[c]	5.30±0.04[c]	5.00±0.40[d]

Values reported are means ± standard deviation of triplicate determinations. Mean values with different superscript within the same column are significantly ($P < 0.05$) different.

Key:

FPED: Fluted pumpkin sample blanched with ethylenediamine tetra acetic acid (EDTA) solution, **FPNB**: Fluted pumpkin sample blanched with sodium benzoate solution; **FPNC**: Fluted pumpkin sample blanched with sodium chloride (NaCl) solution, **FPCM**: Fluted pumpkin sample blanched with combination of EDTA, NaCl and sodium benzoate solutions, **FPCT**: Fluted pumpkin sample blanched without preservative, **PFUB**: Unblanched fluted pumpkin

Table 6(a): Overall acceptability of the Soup Prepared with Treated and Stored Dry Fluted Pumpkin Leaf

	Week 0	Week 2	Week 4	Week 6	Week 8
FPED	8.60±0.40^{b}	6.64±0.49^{b}	5.90±0.90^{c}	5.30±0.43^{d}	6.20±0.30^{b}
FPNB	8.24±0.90^{c}	6.50±0.80^{c}	5.90±0.40^{c}	5.40±0.90^{c}	5.40±0.49^{e}
FPNC	7.80±0.42^{e}	6.20±0.49^{e}	5.70±0.48^{d}	5.20±0.47^{e}	5.00±0.50^{f}
FPCM	7.50±0.60^{f}	6.40±0.49^{d}	5.40±0.80^{e}	5.20±0.46^{e}	5.60±0.20^{d}
FPCT	7.99±0.70^{d}	5.60±0.60^{f}	6.60±0.92^{b}	6.00±0.49^{b}	5.70±0.49^{c}
FPUB	9.00±0.00^{a}	9.00±0.00^{a}	9.00±0.00^{a}	9.00±0.00^{a}	9.00±0.00^{a}

Table 6 (b): Overall acceptability of the Soup Prepared with Treated and Stored Wet Fluted Pumpkin Leaf

	Week 0	Week 2	Week 4	Week 6
FPED	8.60±0.40^{a}	6.80±0.60^{a}	6.20±0.49^{a}	5.20±0.60^{b}
FPNB	8.24±0.90^{b}	6.15±0.49^{d}	5.20±0.80^{d}	4.50±0.90^{c}
FPNC	7.80±0.42^{d}	6.50±0.60^{c}	5.80±0.79^{b}	5.40±0.43^{b}
FPCM	7.50±0.60^{e}	5.80±0.90^{e}	5.80±0.90^{b}	5.60±0.90^{a}
FPCT	7.99±0.22^{c}	6.66±0.06^{b}	5.66±0.01^{c}	5.60±0.40^{a}

Values reported are means ± standard deviation of triplicate determinations. Mean values with different superscript within the same column are significantly ($P < 0.05$) different.

Key:

FPED: Fluted pumpkin sample blanched with ethylenediamine tetra acetic acid (EDTA) solution, **FPNB**: Fluted pumpkin sample blanched with sodium benzoate solution, **FPNC**: Fluted pumpkin sample blanched with sodium chloride (NaCl) solution, **FPCM**: Fluted pumpkin sample blanched with combination of EDTA, NaCl and sodium benzoate solutions, **FPCT**: Fluted pumpkin sample blanched without preservative, **PFUB**: Unblanched fluted pumpkin

4. CONCLUSION

The study showed significant increase in the moisture content of the stored leaves and this contributed to the deterioration of the samples, especially samples stored under refrigerated conditions. The study also showed that the shelf life of treated fluted pumpkin stored at refrigerated temperature, irrespective of the pre-treatment processes in this study could not be extended beyond six months due to spoilage. The study also found out that although, there was decrease in the vitamin C contents of the treated and stored samples as the storage time increased, yet blanching with salt solutions minimized the extent of loss of vitamin C content in the samples. Generally, all the mineral compositions of the samples evaluated throughout the storage period decreased as the storage period increased, though at different rates depending on the type of salts used during the processing treatments. The chemicals used in preserving the fluted pumpkin leaves were effective in extending the shelf life of the leaves. The sensory characteristics indicated that soups prepared with the stored wet and dried samples were accepted at the end of storage period, though some of the sensory scores for some sensory attributes such as texture such and appearance decreased as the storage period increased and that the samples treated with EDTA solution were found to be wholesome compared with other salt solutions during the storage period.

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Conflicts of Interest
Authors declare that there are no conflicts of interest regarding the writing and publication of this work.

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