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PHYSICOCHEMICAL ANALYSES OF JUTE MALLOW *CORCHORUS OLITORIUS* BUNCHING STORED IN THREE STORAGE MEDIA FOR SHELF-LIFE EXTENSION

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ABSTRACT

Green leafy vegetables (GLVs) are rich sources of many nutrients and form a major category of vegetable group that are rich in health promoting phytochemicals, however they are highly perishable due to high moisture content. The effect of bunching on *Corchorus olitorius* was evaluated in the present study. *Corchorus olitorius* were harvested with roots, washed, and stored in three types of storage media and control was set up. Three storage media were prepared and labeled B1, B2, B3 and the roots of the vegetables were dipped in the storage medium, weight loss, physicochemical properties and nutritional compositions were monitored and evaluated for twelve days. No significant weight change in the stored vegetables was observed in sample B2. The moisture content of initial was 84% while the experimental ranged between 79 to 81%. Titratable acidity increased with reduction in pH level. Vitamin C and chlorophyll content was not significantly ($p>0.05$) different in all the tested groups as B1 maintains its colour after 12 days of storage. β - Carotene decreased significantly ($p<0.05$) after the experiment. This trial provided good media for growth, storage and keeping quality of *Corchorus olitorius.* It stored for 12 days with significant retention of vitamin C. This study should be recommended for market women for preserving vegetables for days.

Key words: Chlorophyll, *Corchorus olitorius*, Shelf life, Vitamin C.

INTRODUCTION

Green leafy vegetable are shrubs or herbaceous annuals or bi annuals which may be leaves, shoots, roots, seeds, fruits or inflorescences of plants. In Nigeria vegetables are supplementary food side dishes (raw) or as soup with condiments with other main staple dishes. (Adekalu; (1999). Some common leafy vegetables are *Amanrathus caudatus* (spinach/tete.), *Corchorus olitoris* (Ewedu), *Veronia amyadalina* (Bitter leaf/ewuro), *Talinum triangulare* (water leaf/gbure), *Telfaria occidentalis* (fluted pumpkin/Ugu) and Celosia *argentea* (shokoyokoto). All leafy vegetables possess good nutritional contents vital for growth, health and good skin. They contain many different types of vitamins, minerals, small amounts of protein, crude fibre, ash, carbohydrate, oil and moisture (<80%) (Ambuko *et al.*, 2017). Previous research findings indicated that edible species of *Corchorus* are very good source of proteins, vitamins (A, C, E) and they are also rich in mineral nutrients like calcium and iron (Steyn *et al.*, 2001; Dansi *et al.*, 2008). Moreover, *Corchorus olitorius* is known to contain high levels of iron and folate which are useful for the prevention of anaemia (Steyn *et al.*, 2001).

Transpiration water loss is one of the physiological processes that results in deterioration of leafy vegetables. It results in loss of freshness as evidenced by wilting, shriveling, and loss of firmness, crispness, and succulence, which all are components of freshness. If leafy vegetables lose more than 3% of the original fresh weight, they are rendered unsalable (Ben-Yehoshua and Rodo, 2002).

Leafy vegetables deteriorate very rapidly after harvest and therefore require proper postharvest handling to preserve the quality at harvest. Lack of knowledge on appropriate quality preservation practices and technologies can result in high qualitative and quantitative losses in vegetables. High postharvest losses (over 50%) in leafy vegetable are attributed to various biological and environmental factors (Kinyuru *et al.*, 2012). Loss of quality and deterioration in harvested leafy green vegetables is manifested through yellowing because of loss of chlorophyll; wilting and loss of textural properties; and decay from pathological breakdown, among others. In addition to deterioration and loss of physical component of quality, vitamin C which is a major micronutrient in vegetables is known to decline rapidly after harvest and this loss is often used as an indicator of quality deterioration during postharvest handling because it is highly susceptible to chemical and enzymatic oxidation and is highly water soluble (Ambuko *et al.*, 2017).The rate of deterioration of leafy vegetables is determined by the storage environment where temperature and relative humidity are key components.

There is need for a suitable way that will allow market women keep their vegetables fresh to boost their income, to keep the freshness and maintain quality. This study therefore aimed at addressing the short life span of vegetables after twenty-four hours (24hr).

MATERIALS AND METHODS

Experimental set up

The vegetables (*Corchorus olitorius*- Ewedu) were harvested from a vegetable farm in fufu area of Ilorin, Nigeria. It was then transported to the processing centre of Nigerian Stored Products Research Institute (NSPRI), where the sand associated with the stalks and root were gently shaken off and the leaves close to the roots were removed so as to avoid contact with storage medium. Three storage media were used for this study. Storage medium 1 was distilled water, storage medium 2 composed of distilled water (1lt), sugar (0.55g) and sodium hypochlorite (10ml), while storage medium 3 was made up of distilled water and soda (3:1), sugar (0.55g) and sodium hypochlorite (3 drops). The vegetables were grouped into three. The roots of group 1 were immersed in storage medium 1 and tagged B1, group 2 in storage medium 2 and tagged B2 while group 3 were dipped in medium 3, labeled B3 and each of the groups were cover with uniformly perforated transparent polyethylene. The set up were kept at ambient while data logger was installed to monitor the relative humidity and temperature while the storage media were changed at 2 days interval.

Plate 1: Experimental set up

Plate 2: *Corchorus olitorius* after 12 days of storage

Determination of Moisture Contents

The moisture content was determined with AOAC, (2000) method. A weighed portion (5g) of homogenized vegetable sample was dried to a constant weight first at 80ºC (for 4h) and subsequently at 105ºC for 2h and the moisture content is calculated as follows.

$$Moisture\ content(\%) = \frac{W2 - W0}{W1} \times 100\%$$

where;
W0=weight of empty can
W1=weight of sample
W2=weight after drying

Measurement of pH and Titratable Acidity (%)

The pH and titratable acidity were determined using the method described by Sharoba (2009) with little modification as follows; 10g of sample was homogenized and centrifuged with (Model of the centrifuge) (5000rpm for 20min), at 4°C. The supernatant was recovered for pH and titratable acidity measurements. The pH was measured at 20°C with a pH meter (SEARCHTECH PHS-3C). Titratable acidity was determined by titration with 0.1N NaOH until pH 8.1 was reached (rose pink colour) and reported as gram citric acid/100g fresh weight.

Determination of ash content

The ash content of samples was determined using methods of AOAC (2000), where weighed portion (2g) of homogenized vegetable sample was dried to a constant weight at 600ºC (for 4h) in the blast furnace and data computed for ash contents as follow.

$$Ash\ content(\%) = \frac{W2 - W0}{W1 - W0} \times 100\%$$

where;
W0=weight of empty crucible
W1=weight of crucible + sample (before blasting)
W2=weight of crucible + ash (after blasting)

Determination of vitamin C content (mg/100g)

The 2, 6-dichlorophenol indophenol titration method described by Ndawula *et al*. (2004) was adopted for the determination of ascorbic acid content. This method was slightly modified and used as follow: 2g of sample was homogenized in a mortar containing 10ml of 0.5% oxalic acid (extraction solution) and the content transferred into 100ml volumetric flask. More extraction solution was added up to the mark. The content being mixed thoroughly, filtered immediately (Whatman No. 4) and aliquots (10ml) of extract were titrated against standardized 2, 6-dichlorophenol indophenol solution. An equivalent amount of the extraction solution was titrated against standardized 2, 6-dichlorophenol indophenol solution as blank at the same time. Data was computed for determination of Vitamin C content as follow.

$$\boldsymbol{Vitamin}C(mgper100g) = \frac{V1 \times VE \times D \times 100}{W}$$

where;
V_1 = Volume of 2, 6-dichlorophenolindophenol (DCPIP) that neutralized 10ml of sample extract
V_E = 0.002g/V_2, where V_2 = Volume of DCPIP for Standard
D = Dilution factor = 10
W = weight of sample

Carotenoids determination

The vegetable samples were homogenized using mortar and pestle dipped in ice water bath. Exactly 16mL of acetone-hexane (4:6) solvent was added to 1.0g of homogenized sample and mixed in a test-tube to extract the carotenoids, an aliquot was taken from the upper solution from the two phases formed and its optical density (OD) was measured at 663, 645, 505, and 453 nm in a UV-VIS spectrophotometer (SEARCHTECH INSTRUMENTS; UV1902PC, ENGLAND). Values from these measurements were used to compute the β-carotene content, according to the Nagata and Yamashita equations below as reported by Sharoba (2009).

$$Beta\ Carotene(mg/100mL) = 0.216 \times OD663 - 1.22 \times OD645 - 0.304 \times OD505 + 0.452 \times OD453$$

where;
OD= Optical density (absorbance)

Determination of physiological weight loss

Weights of the vegetables during the experimental period were determined using a top-loading digital balance (CAMRY ACS-30-JE11) and data was computed for physiological change in weight.

Determination of chlorophyll

Chlorophyll content was estimated using standard operating procedure (1994). 0.1 g of fresh leaf and 10 ml of 80% acetone were added, the chlorophyll was extracted by thoroughly grinding it in a pesto-mortar, the sample was then filtered, and the absorbance was read for photosynthetic pigments at 645 and 663 as soon as possible before chlorophyll starts to disintegrate and the chlorophyll content was calculated as follows;

$$\text{Chlorophyll a } \left[\frac{\text{milligrams}}{\text{milliliter}}\left(\frac{\text{mg}}{\text{mL}}\right)\right] = 12.7\ \text{A663} - 2.69\ \text{A645}$$

$$\text{Chlorophyll b (mg/mL)} = 22.9\ \text{A645} - 4.68\ \text{A663}$$

$$Total\ chlorophyll = Chlorophyll\ a + Chlorophyll\ b$$

where:

A645 = absorbance at a wavelength of 645 nm;

A663 = absorbance at a wavelength of 663 nm.

Total Chlorophyll (mg/mL) = Chlorophyll a + Chlorophyll b.

Statistical analysis

Data obtained were subjected to analysis of variance (ANOVA) and tested for significance difference among treatments by New Duncan's Multiple Range F-Test (DMRT) at ($p<0.05$) using SPSS software package version 20.0.0

RESULTS AND DISCUSSION

Moisture content of stored Jute Mallow

The initial moisture contents (MC) of *Corchorus olitorius* sample was 84.11% and the final MC ranged from 79.59–80.61% in all the groups (B1, B2 and B3) (Figure 1). There was no significant difference ($p>0.05$) in the moisture content after 12 days of storage. The main cause of deterioration in vegetables is high moisture content. The vegetables remain fresh if they retain water (Ambuko *et al.*, 2017). The decrease in the moisture content of vegetables as the storage time increases could be due to transpiration, evaporation, and respiratory activities of vegetable samples to attain equilibrium with the ambient. This agrees with the findings of Ngure *et al.*, (2009) who reported that storage of fresh Okra at a temperature between 10 – 20°C reduces the microbial activities, as moisture of leaf vegetables are mostly affected by temperature. This agrees with Santi *et al*. (1992).

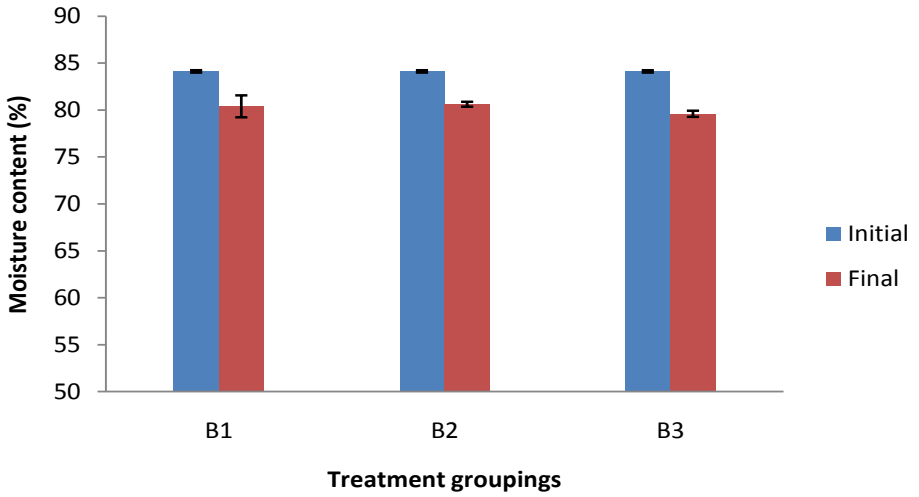

Figure 1: Effect of bunching on the initial and final moisture content of *Corchorus olitorius.*

Key: B1= roots in water; B2= roots in water + hypochlorite (10:1) + sugar (0.55g); B3 = roots in water+ soda (3:1) + sugar (0.55g) + hypochlorite (3 drops). Each bar represents mean of triplicate readings (n=3). Error bars represent standard error (SE) of the mean.

Ash content of stored Jute Mallow

The effect of bunching on the ash content of *Corchorus olitorius* is shown in figure 2. The initial ash content was 4.037% which reduced to 2.841%, 3.533% in B1 and B2 respectively and increased significantly ($p<0.05$) to 4.058% in B3 after 12 days of storage. The increase in the ash content of group B3 could be due to the constituents of the storage medium, which helps in stabilizing the colour of the vegetables as shown in plate 2, thus indicating high mineral content in the samples. The high ash content might not be unconnected with the findings of *Duke (1981)* that the leaves are rich in potassium and iron which became visibly increased in groups B2 and B3.

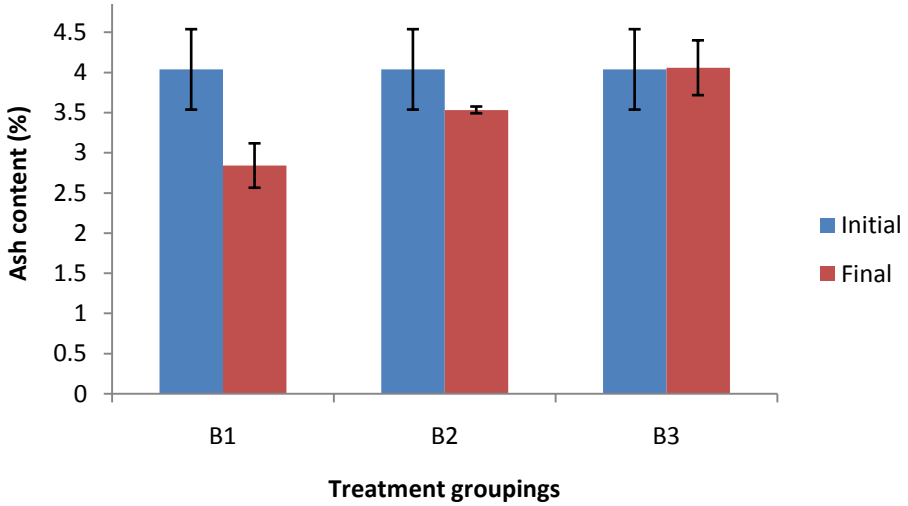

Figure 2: Effect of bunching on the initial and final ash content of *Corchorus olitorius*

Key: B1= roots in water; B2= roots in water + hypochlorite (10:1) + sugar (0.55g); B3 = roots in water+ soda (3:1) + sugar (0.55g) + hypochlorite (3 drops). Each bar represents mean of triplicate readings (n=3). Error bars represent standard error (SE) of the mean.

Vitamin C content of stored Jute Mallow

The effect of bunching on the Vitamin C content of *Corchorus olitorius* is shown in figure 3. The initial vitamin C content was 0.787 mg/100g while it was 0.757, 0.779 and 0.781 mg/100g for B1, B2 and B3 respectively after the storage period. There was no significant difference ($p>0.05$) in the initial and final vitamin C content for the experimental period considered in this study. The slight decrease in all the groups could be because vitamin C is a less stable nutrient due to its high sensitivity to oxidation under the influence of light therefore it degrades rapidly after harvest and during storage. Research indicates that if fresh products undergo minimal storage and are handled at proper temperatures, they are superior to processed products in terms of vitamin C content (Barrett, 2007). Equally the storage of leafy vegetables in cool environment increases its shelf life and could be helpful in retention of vitamin C (Mathiventhan and Ramiah, 2015).

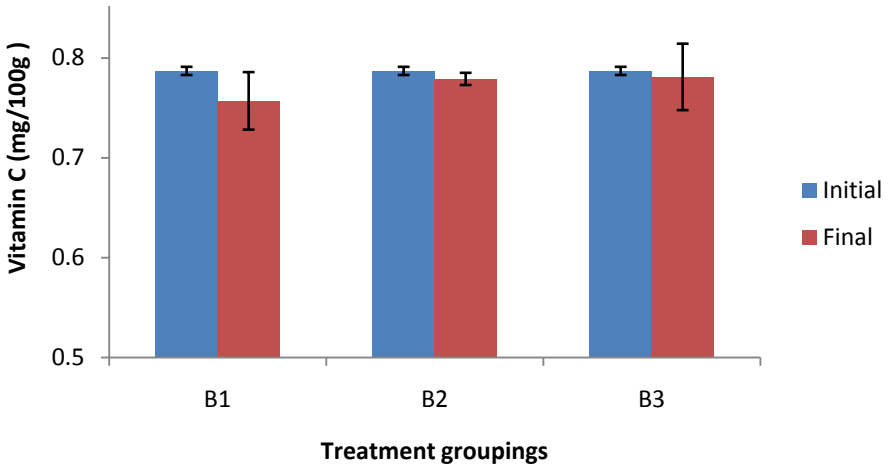

Figure 3: Effect of bunching on the initial and final Vitamin C content of *Corchorus olitorius*

Key*:* B1= roots in water; B2= roots in water + hypochlorite (10:1) + sugar (0.55g); B3 = roots in water+soda (3:1) + sugar (0.55g) + hypochlorite (3 drops). Each bar represents mean of triplicate readings (n=3). Error bars represent standard error (SE) of the mean

β–Carotene of stored Jute Mallow

The effect of bunching on the β-Carotene content of *Corchorus olitorius i*s shown in Figure 4. The final β-Carotene content was 0.496, 0.532 and 0.352 mg/100g (after 12 days of storage) for B1, B2 and B3 respectively which showed significant ($p<0.05$) decrease from the initial value (0.602 mg/100g). There was also significant difference ($p<0.05$) in the final β-Carotene content among the test groups. The decrease in β-Carotene content may be because leafy vegetables are prone to wilting after harvesting thereby losing more than half of their carotene when held at or near room temperature. This observation is similar to Balan *et al.* (2015) report where a decrease in β-Carotene was observed in vegetables (broccoli, peas, and green beans) stored under chilled condition.

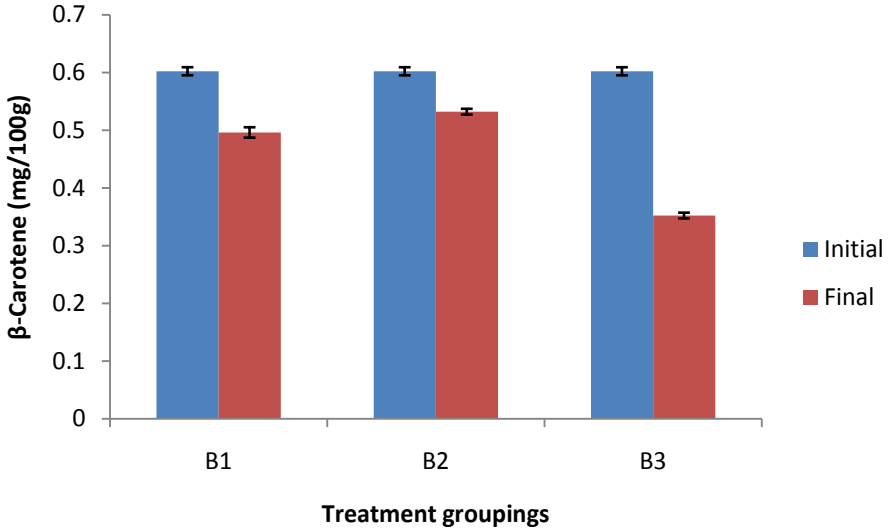

Figure 4: Effect of bunching on the initial and final β-Carotene content of *Corchorus olitorius.*

Key; B1= roots in water; B2= roots in water + hypochlorite (10:1) + sugar (0.55g); B3 = roots in water+ soda (3:1) + sugar (0.55g) + hypochlorite (3 drops). Each bar represents mean of triplicate readings (n=3). Error bars represent standard error (SE) of the mean

Total chlorophyll of stored Jute Mallow

The effect of bunching on the initial and final value of chlorophyll in *Corchorus olitorius* is presented in Figure 5. The initial chlorophyll content was 0.0044mg/100g for all the groups. There was no significant difference ($p>0.05$) in the final total chlorophyll content of B2 and B3 as well as the initial value of chlorophyll, however group B1 value (0.0862 mg/100g) was significantly different ($p<0.05$) from the other groups (0.0033, 0.0036 for B2 and B3 respectively) The increase in the final chlorophyll content of B1 could be due to the green colour that became more intense after 12 days of storage as there was no external interference in the storage medium; equally the decrease in the values for B2 and B3 after 12 days of storage could be attributed to wilting which is a major postharvest problem of leafy vegetables. The reduction could be due to the fact that the shelf life of leafy vegetables is usually 5-6 days (Ferrante *et al.*, 2004).

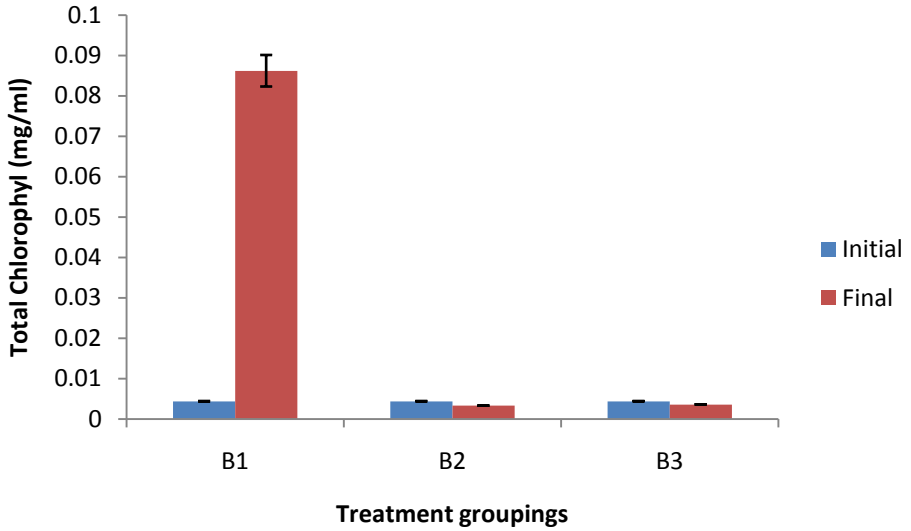

Figure 5: Effect of bunching on the initial and final Total Chlorophyll content of *Corchorus olitorius.*

Key; B1= roots in water; B2= roots in water + hypochlorite (10:1) + sugar (0.55g); B3 = roots in water+ soda (3:1) + sugar (0.55g) + hypochlorite (3 drops). Each bar represents mean of triplicate readings (n=3). Error bars represent standard error (SE) of the mean.

Titratable Acidity of stored Jute Mallow

The initial titratable acidity (TTA) was 0.138 while the final titratable acidity for B1, B2 and B3 were 1.353%, 0.418% and 0.761% respectively (Figure 6). There was significant difference ($p<0.05$) in the final TTA among the three groups with the final TTA for B1 having the highest value of 1.353%. The titratable acidity of the vegetable increased significantly ($p<0.05$) after 12 days of storage; this could be potentially attributed to more organic acids being produced during the storage period, it could be that the storage medium increases the acidity of *Corchorus olitorius* during the storage period. The sugar added to the storage medium B2 supplied energy and ensure stabilization of the medium pH, equally hypochlorite

reduce microbial attack thus the acidity of vegetables in groups B2 and B3 are maintained after 12 days of storage

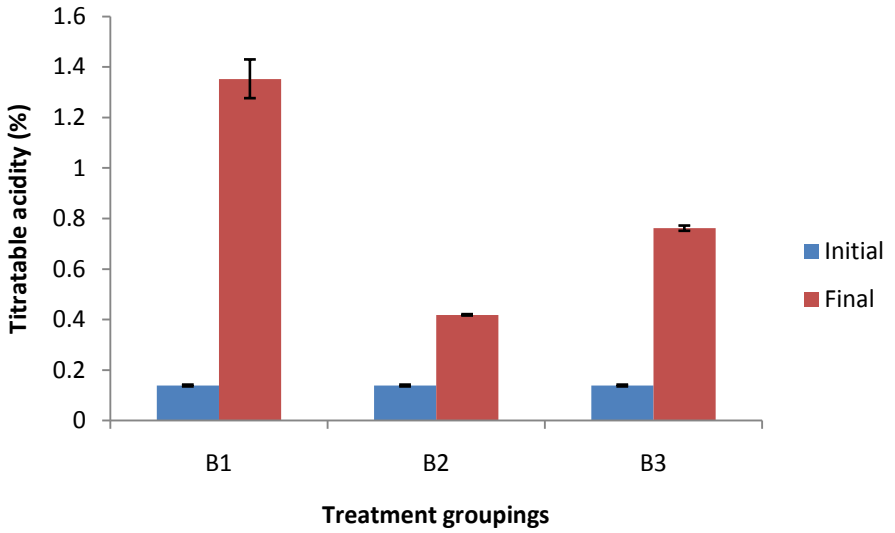

Figure 6: Effect of bunching on the initial and final Titratable acidity of *Corchorus olitorius.*

Key: B1= roots in water; B2= roots in water + hypochlorite (10:1) + sugar (0.55g); B3 = roots in water+ soda (3:1) + sugar (0.55g) + hypochlorite (3 drops). Each bar represents mean of triplicate readings (n=3). Error bars represent standard error (SE) of the mean.

Change in pH of stored Jute Mallow

The effect of bunching on the pH of *corchorus olitorius* is shown in figure 7. The initial pH was 6.6 while the final value showed a significant ($p<0.05$) reduction of 5.81, 6.20 and 6.15 for B1, B2 and B3 respectively. The reduction in pH after 12 days of storage could be due to accumulation of acid from the storage medium by the plant.

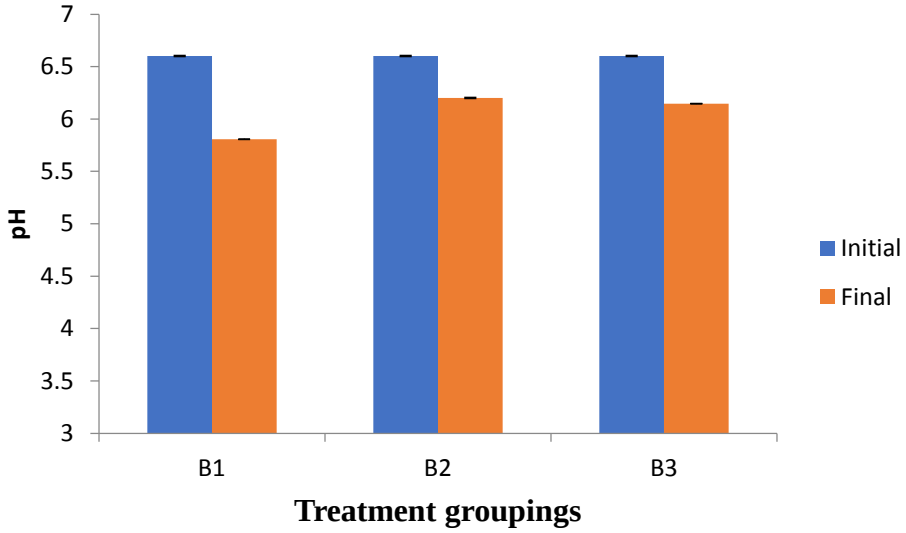

Figure 7: Effect of bunching on the initial and final pH of *Corchorus olitorius.*

Key: B1= roots in water; B2= roots in water + hypochlorite (10:1) + sugar (0.55g)**;** B3 = roots in water+ soda (3:1) + sugar (0.55g) + hypochlorite (3 drops). Each bar represents mean of triplicate readings (n=3). Error bars represent standard error (SE) of the mean

Weight changes in stored Jute Mallow

The loss in weight in *corchorus oliterius* as storage days increase was as presented in Figure 8. There was no change in weight of groups B1 and B2 at day 4 while the weight of group B3 increase by 0.02g. However, the weight of B1 reduced by 0.01g at day 8 and remains unchanged after 12 days of storage, equally B2 reduce by 0.04g at day 8 which further decrease by 0.01g at day 12, also B3 decrease 0.02g to return to the initial weight which later reduced by 0.02g at the end of the experiment. The reduction in weight of the three groups at day 8 could be due to wilting/yellow coloration of the leaves closer to the root. The vegetables lost some weight during storage irrespective of the storage medium, at the 12th day of storage, the vegetables in group B1 at ambient conditions present the lowest incidence of weight loss at the end of the experiment.

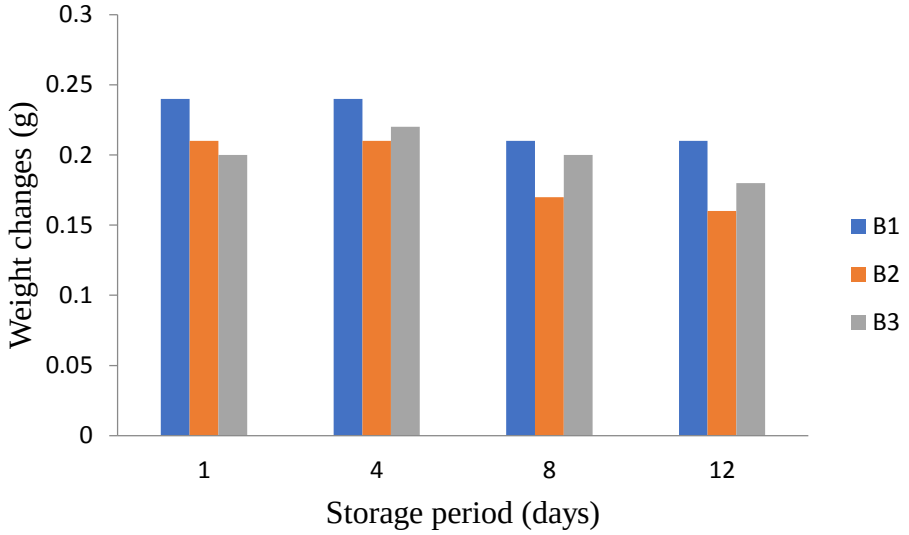

Figure 8. Loss of weight in *Corchorus olitorius* in different treatment groupings.

Key: B1= roots in water; B2= roots in water + hypochlorite (10:1) + sugar (0.55g); B3 = roots in water+ soda (3:1) + sugar (0.55g) + hypochlorite (3 drops).

CONCLUSION

The nutritional quality and acceptability of *corchorus olitrius* leaves of experimental trials were preserved for longer days compared to the control which dried up after 48hrs of storage. The vegetables retained a near farm-fresh state for twelve (12) days more than control (stored without the storage medium) at ambient conditions which dried up after 48hrs of the experiment. The lower temperature (26.2°C) and high relative humidity (77.3%) slowed down the deteriorative processes including wilting and yellowing. The results of the study were very encouraging as it stored for 12 days with significant retention of vitamin C.

REFERENCES

Adekalu, O. A. (1999). Preservation of leafy vegetables: A paper presented at the monthly technical review meeting of the Agricultural development authority Oko – Oba Agege Lagos 21st October 1999.

Ambuko, J., Wanjiru, F., Chemining'wa, G. N., Owino, W. O. and Mwachoni E. (2017). Preservation of postharvest quality of leafy amaranth (Amaranthus spp.) vegetables using evaporative cooling. *Journal of Food Quality*. Volume, Article ID 5303156, 6 pages https://doi.org/10.1155/2017/5303156.

AOAC international (2000). *Official Methods of Analysis of AOAC International* 17th Ed., Arlington, Virginia: AOAC International

Balan, D., Israel-Roming, F., Luta G. and Evelina G. (2016). Changes in the nutrients content of some green vegetables during storage and thermal processing**.** *Romanian Biotechnological Letters*, 21(5):2016

Barrett, D. M. (2007). Maximizing the nutritional value of fruits & vegetables. *Food Technology*, 61(4): 40–45.

Ben-Yehoshua, S and V. Rodov, V. (2002). Transpiration and water stress in postharvest physiology and pathology of vegetables, J. A. Bartz and J. K. Brecht, Eds., pp. 111–159, Marcel Dekker, New York, NY, USA, 2nd Edition.

Dansi, A., Adjatin, A., Adoukonou-Sagbadja, H., Faladé, V., Yedomonhan, H., Odou, D. and Dossou, B. (2008). Traditional leafy vegetable and their use in the Benin republic. *Genetics Resources Crop Evolution*, 55: 1239-1256.

Duke, James (1981). Handbook of legumes of world economic importance. Plenum press, New York. 345pp (LEG).

Ferrante, A., Incrocci, L., Maggini, R., Serra, G. and Tognon E. (2004). Colour changes of fresh cut leaf vegetables during storage. *Journal of Food Agriculture and Environment*, 2:40-44

Kinyuru, J. N., Konyole, S. O., Kenji G. M., Onyango, C. A., Owino, V. O., Owuor, B. O., Estambale, B. B., Friis, H. and Roos, N. (2012). Identification of traditional foods with public health potential for complementary feeding in western Kenya," *Journal of Food Research*, 1:148–158.

Mathiventhan, U. and Ramiah, S. (2015). Vitamin C content of commonly eaten green leafy vegetables in fresh and under different storage conditions. *Journal of Tropical Plant Research*, 92652(3): 240–245

Ndawula, J., Kabasa, J. D., Byaruhaanga, Y. B. (2004). Alteration in fruit and vegetable β-carotene and vitamin C content caused by open sun drying, visqueen-covered and polyethylene-covered solar dryers. *African Health Science*; 4(2):125-130.

Ngure, P. K., Tonui, W. K., Ingonga, J., Mutai, C. H., Kigondu, E., Ng'ang'a, Z., Rukunga, G. and Kimutai, A. (2009). In vitro antileishmanial activity of extracts of Warburgaugandens_sp (Canellaceae), a Kenyan medicinal plant. *Journal of Medicinal Plants Research*, 3:61-66.

Santi, R., Bhowmilk, S. R. and Jung C. P. (1992). Shelf life of mature green tomatoes stored in controlled atmosphere and high humidity. *Journal of Food Science*, 57: 948-951

Sharoba, A.M. (2009). Producing and evaluation of red pepper pastes as new food product. *Annals of Agricultural Science Moshbohor*, 47(2):151-165.

Steyn, N. P., Olivier, J., Winter, P., Burger, S. and Nesamvuni, S. (2001). A survey of wild, green, leafy vegetables and their potential in combating micronutrient deficiencies in rural populations. *South African Journal of Science*, 97: 276-279.