International Journal of Food Science and Nutrition
ISSN: 2455-4898; Impact Factor: RJIF 5.14
Received: 23-06-2019; Accepted: 25-07-2019
www.foodsciencejournal.com
Volume 4; Issue 5; September 2019; Page No. 134-138

Changes induced by storage method variability on the mineral composition and some selected phytochemicals content of red and white onion (*Allium cepa*). bulbs

Sanusi Shamsudeen Nassarawa[1*], Salamatu Ahmad Sulaiman[2]
[1, 2] Department of Food Science and Technology, Faculty of Agriculture, Bayero University Kano. P.M.B. Kano State, Nigeria

Abstract
Purpose: The influence of different storage conditions (ambient temperature, refrigeration storage and Wooden Cabinet storage) in minimising the postharvest losses of onions was investigated. The fresh onions varieties (red and white) were obtained from Modibbo Isah Farms, Bichi, Kano State, Nigeria. The experiment followed a completely randomized design in a factorial 3 x 2 x 8, with a total of 48 treatments, corresponding to three storage temperature conditions, two onion varieties and eight-week storage duration. The storage temperature conditions were ambient temperature (30±2 ºC), refrigeration storage (5-7 ºC) and hot air wooden cabinet storage (45-50 ºC) while the two onion varieties were white and red types. The prevailing relative humidity during the storage period ranged between 70 and 95 %. During the storage period of onion bulbs the red onion showed less damage when compared with white onion. The result showed that some nutritional components of the stored onions decreased with increase in the storage period including sodium content (12.13-11.77mg/kg) and *ascorbic acid (9.62-3.87mg/100g*. Other parameters such as potassium content (30.00-72.12mg/kg), calcium content (55-105mg/kg) and *flavonoid content (1.25-2.31g/100g)*, increased with an increase in the storage period. . It may be concluded that the different storage conditions to which the onions were subjected led to diverse responses of onion components to such conditions while ambient storage condition may be regarded as the best of the three storage conditions investigated.

Keywords: Ambient temperature (30 ± 2 ºC), Hot air wooden cabinet storage (45-50 ºC Refrigeration storage (5-7 ºC),), Red Onion and White Onion

1. Introduction

Onion (*Allium cepa* L) has been described as the dynamite of natural foods (Rune, 2007) [16]. The outstanding characteristic of onion is its pungency, which is due to the volatile oil known as allyl-propyl disulfide. Onions contains vitamin B, vitamin C and traces of iron and calcium. Onions when compared with other fresh vegetable are relatively high in food energy, intermediate in protein content and rich in calcium and riboflavin (Rune, 2007) [16]. Onion cultivation in Nigeria is confined to the Semi-Arid, Northern Guinea and Savanna zones. The bulk of onion production is from the dry season cropping system particularly under irrigation in the Northern States (Amans, 2001) [10]. In this light, the greater part of onion production in Nigeria is undertaken in the north of the country specifically in Kaduna, Kano, Jigawa, Katsina, Sokoto, Plateau and Bauchi States. The natural features of these regions, especially the presence of flood prone plains and river basins and above all the development of very large irrigated lands, create a condition that greatly favour the development of this crop (Ojo *et al.*, 2009) [13]. In comparison with other fresh vegetables, onions are relatively high in food value of antioxidant and phytochemicals (Hussaini *et al.*, 2000) [10]. The crop is the second only to tomatoes in importance among the vegetables in Nigeria and fifth in the world market (Hussaini *et al.*, 2000) [10]. The trace metals may enter the food chain from soil through mineralization by crops or environmental contamination as the application of agricultural inputs, such as pesticides, fertilizers, herbicides or use of polluted river (from industrial effluents) for irrigation (Cramer, 2000) [7]. Apart from its nutritional value, the common onion is one of the most outstanding higher plants recommended by United States Environmental Protection Agency (USEPA) and the American Society for Testing and Materials (ASTM) in 1982 and 1994 respectively for use as an excellent and alternative first–tier indicator for safety evaluation of cytogenetic and mutagenic effects of drinking water and environmental pollutants (Cramer, 2000) [7]. The use of A. cepa for root length inhibition and chromosome aberration bioassay as a sensitive, cost effective and valid indicator of toxicity test for the routine monitoring of water pollution is due to the important activation enzymes of the root tip cells (Fiskesjö *et al.*, 2011) [8]. These have shown good correlation with other test systems involved in genotoxicity (Fiskesjö *et al.*, 2011) [8].The objective of this study was to determine the most suitable storage method(s) and changes in the nutritional composition of two varieties of onions during storage and also this work is designed to prolong the shelf life of onion, that are stored under three different storage conditions which include (refrigeration at 5-7 ºC, ambient temperature at 30 ± 2 ºC and Hot air wooden cabinet storage at 45 ºC-50 ºC).

2. Materials and Methods

2.1 Plant Materials

Fresh samples of red and white onion varieties (Walla Walla) were obtained from Modibbo Isa farm, Kano State, Nigeria in Bichi Local Government areas, at the longitude of 12º 14’ 8” North and latitude of 8 º 14’ 21” East. The onions were harvested in the early morning and collected in a traditional basket, the samples were cured (air dried) for two weeks immediately after harvesting, cultivation of red and white onions was the same. After harvesting the onions was then cured under 25ºC temperature and 70% relative humidity until further analysis.

2.1.1 Chemical and Reagents

All chemicals and reagents used were of analytical grade and purchased from Sigma-Aldrich (St. Louis, Missouri, United States).

2.1.2 Methods

The Cured onions were stored for two months January and February during which the sample was replicated three times i.e 2 by 3 Factorial, which include: Ambient temperature of 30 ± 2 ºC, refrigeration at 5 - 7 ºC and Hot air wooden cabinet storage at 45 - 50 ºC. The prevailing relative humidity during the storage period ranged between 70 and 95 %.

2.1.2 Ambient temperature

In ambient storage, the cured onions were stored in two different storage cupboards at 30 ± 2 ºC. One cupboard was made to contain 45 bulbs of red onions, and other cupboard 45 bulbs of white onions. The cupboards were made from plywood material and all the sides were covered with wire gauze, the dimensions of which were 2 m length, 1.5 m height and 1 m breadth.

2.1.3 Refrigeration storage

In refrigeration storage, the cured onions were stored in two different fridges at 5 - 7 ºC. One fridge was made to store 45 bulbs of red onions and the other fridge 45 bulbs of white onions at the same storage temperature.

2.1.4 Hot air Wooden Cabinet storage

In the controlled temperature cupboards, the fresh onions were stored at 45-50 ºC. One cupboard contained 45 pieces of red onions and the other, 45 pieces of white onions. The cupboards were constructed with plywood materials having some holes by the sides to allow gaseous exchange within the produce. The temperature of 45 - 50 oC were maintained with electric filaments or bulbs and the temperatures were measured by thermometers. The dimension of each of the two cupboard were 2 m length, 1.5 m height and 1 m breadth.

2.1.5 Determination of mineral content of onion sample

According to the method outlined by AOAC, (1990) mineral (calcium, sodium and potassium) content was determined by Atomic Absorption Spectrophotometry (Model 6800 series Shimazo Corp). The mineral content of the sample was determined by weighing (5g) of the sample. The ash obtained from the muffle furnace (product of the ash content determination) was dissolved in 10 ml of 10% HCl. The mixture was heated on a steam bath to effect complete dissolution and the dissolved ash, all the organic matters were filtered into a 100 ml volumetric flask and made up to volume with distilled water. The mineral content was determined using an Atomic Absorption Spectrophotometer (Alpha 4-Chem. Tech Analytical, USA)

2.1.6 Determination of phytochemicals

2.1.7 Determination of flavonoid content of stored onions

Total flavonoid determination was conducted according to the AOAC, (1990). About 5g of onion sample was boiled in 50ml of 2M HCl solution for 30min under reflux. It was allowed to cool and then filtered through what man No 42 filter paper. A measured volume of the extract was treated with equal volume of ethyl acetate starting with a drop. The flavonoids precipitated were recovered by filtration using weighed filter paper. The result weight difference gives the weight of flavonoids in the sample.

2.1.8 Determinition of Ascorbic acid content of stored onions

Ascorbic acid was determined by the 2, 6- dichlorophenol indophenol (DCPIP) titration based on the method described by AOAC (1990). About 5 g of onion sample were extracted with 20 ml of 4% oxalic acid. The resulting solutions was centrifuged at 10,000 rpm for 30 min. Ten (10) ml of sample and 10 ml of 4% oxalic acid was titrated against 2, 6-dichlorophenol indophenol dye (v2) until the appearance of a faint pink colour that persisted for a few minute was obtained. Another 5 ml of 100 ppm solution of ascorbic acid and 10 ml of 4% oxalic acid was titrated against dye (v1). The ascorbic acid content (mg/g) was determined by using the formula:

Amount of ascorbic acid (mg/g) = $(0.5 \times V2 \times 20)/V1 \times 10 \times 0.1$

Where V1 = dye consumed by 0.5 mg ascorbic acid,

V2 = dye consumed by 10ml of test solution.

2.1.9 Statistical Analysis

All analyzes were carried out in triplicates and the data were analysed and presented as means ± standard deviation (SD). The results obtained were presented in charts, graph and tables, where applicable. The results were subjected to statistical analysis with MINITAB software package using one-way ANOVA and Fisher LSD methods at $p<0.05$ and 95% confidence limit.

3 Results and Discussion

3.1 Selected Mineral Content of Onions Subjected to Three Storage Conditions As Affected by Storage Duration.

Figure 1 shows the sodium content of onions stored subjected to three different storage conditions. The onions showed that samples WO-AT, WO-HT, RO-AT and RO-HT exhibited an increase in the sodium content with respect to the final values which is higher than the fresh values at the end of storage period although oscillating changes in sodium content was experienced during the storage period. In the case of WO-RT and RO-RT which exhibited a decrease in the sodium content, the final sodium content at the end of the storage period was lower than the fresh values. For example, in the case of RO-AT samples, the sodium content increased up to the 5th week of storage (17.77%) and thereafter decrease up to the 6th week (15.68%) before it started to increase again up to the 8th week of storage (19.02%). The decrease in sodium content this may be as a result of water absorption in the refrigeration storage. The values obtained in sodium content of fresh harvested onions were similar to the value reported by Rodrigues Galdon *et al*. (2008) which observed increase in the sodium content of onions under ambient storage and a decrease under refrigeration storage.

Figure 2 shows the potassium content of stored onions subjected to three different storage conditions. The stored onions exhibited an increase in the potassium content across the storage period in all the storage conditions. The WO-HT, WO-RT, RO-HT and RO-RT samples exhibited a high increase in potassium content when compared with WO-AT and RO-AT samples which exhibited a slight increase in potassium content at the end of the storage period. The changes in the potassium content within the eight - week's storage duration were observed as: 30.00-39.27 mg/kg (WO – AT), 59.10-70.11 mg/kg (WO – RT), 59.01-72.12 mg/kg (WO –HT), 30.00-38.70 mg/kg (RO – AT), 58.00-69.09 mg/kg (RO –RT), 57.01-72.12 (RO –HT). Both the samples showed an increase in potassium content across the storage period. The increase in refrigerated onions may be due to the fungal attack in onions bulb and the increase of potassium content in others storage may be due to the effect of storage temperature. The increase in the potassium content of stored onions under ambient storage and refrigeration storage was observed across the storage period which is similar to the observation of Asanja *et al*. (2015) [5].

Figure 3 shows the calcium content of stored onions subjected to three different storage conditions. The onions observed an increase in calcium content across the storage period in all the samples with respect to the final values at the end of the storage period. But in the case of WO-AT samples, exhibited an oscillating changes during the storage period, the calcium content decrease in 1st week of storage up to (50 mg/kg) and thereafter got an increase in 2nd and 3rd week of storage and then got decreased on the 4th week of storage before it started to increase again up to the 8th week of storage (59 mg/kg). Both the samples increase in calcium content across the storage period. The increase in calcium content across the storage period may be due to the effect of storage temperature which increases the rate of water loss during the storage period. The results obtained in studied stored onions was similar to the report of Yahaya *et al*. (2010) [18] which shows an increase in the calcium content of onions under refrigeration storage condition while Anju *et al*. (2010) [18] contrary observed a decrease under refrigeration and ambient storage.

The analysis of mineral composition of the *Allium cepa* bulb extracts revealed the presence of sodium, potassium and calcium. These mineral elements are considered critical for the normal functioning of the human body.

3.1 Influence of Storage Duration on the Ascorbic Acid of Onions Subjected to Three Storage Conditions

Figure 4. shows the value of ascorbic acid content of stored onions in three different storage conditions. All the onions exhibited a decrease in ascorbic acid content when compared with the values of fresh samples. However, during the course of storage, the onions showed an oscillating trend of changes in the ascorbic acid values. Both the samples exhibited a decrease in ascorbic acid content across the storage period. For example, in the case of RO-RT samples, the ascorbic acid content decreased up to 6th week (5.16 mg/100g), got constant up to the 7th week (5.16 mg/100g) and then started to decrease up to the 8th week (3.03 mg/100g). The decrease in ascorbic acid across the storage period may be due to the effect of water activity and temperature of storage. Hellmann and Rembialowska (2006) [9] reported that there is a decrease in the ascorbic acid content of onions under ambient storage while Biezanowska-kopec *et al*. (2011) [6] observed an increase in the ascorbic acid content of onions under refrigeration storage.

The result of vitamin composition revealed that onion contains ascorbic acid. Presence of ascorbic acid in the bulb extract of *Allium cepa* may explain its use in treating itching, skin infections, eczema and psoriasis. According to a previous study (Okwu *et al*., 2004) [14], onions can be used in the treatment of prostrate cancer and common cold and also act as antioxidant for dietary material.

3.3 Flavonoid Content of Onions Subjected to Three Different Storage Conditions as Influenced by Storage Duration

Figure 5: shows the value of flavonoid content of stored onions in three different storage conditions. It was generally observed from the stored onions that there was no specific pattern of changes in the flavonoid content during the storage period as increase and decease in flavonoid content were exhibited at different storage duration. In the case of WO-AT samples, the flavonoid content increased up to the 4th week of storage (1.67%) and thereafter got decreased up to the 5th week (1.18%) before it started to increase again up to the 8th week of storage (2.0%). The decrease in flavonoid content may be due to the effect of water activity and temperature of storage. Some previous researchers suggested a similarly observation in the decrease in flavonoid content of onions under refrigeration storage and an increase under ambient storage (Andlauer *et al*., 1999 and Lombard *et al*., 2002) while Slimestad *et al*. (2007) had a contrary observation particularly an increase in the flavonoid content for all the storage conditions.

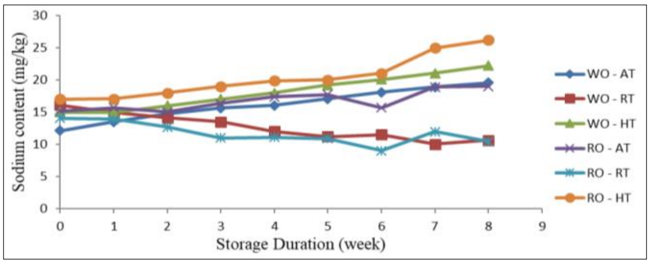

Fig 1: Changes in the sodium content of onions with storage duration

Key:

WO–AT = White onion stored at Ambient Temperature (30 ± 2 ºC)

WO–RT = White onion stored at Refrigeration Temperature (5 -7 ºC)

WO–HT = White onion stored at wood cabinet (45 -50 ºC)

RO–AT = Red onion stored at Ambient Temperature (30 ± 2 ºC)

RO–RT = Red onion stored at Refrigeration Temperature (5 -7 ºC)

RO – HT = Red onion stored at wood cabinet (45-50 ºC)

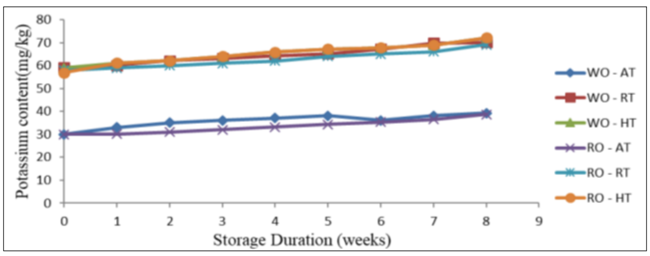

Fig 2: Changes in potassium content of onions with storage duration

Key:
WO–AT = White onion stored at Ambient Temperature (30 ± 2 ºC)
WO–RT = White onion stored at Refrigeration Temperature (5 -7 ºC)
WO–HT = White onion stored at High Temperature (45 -50 ºC)
RO–AT = Red onion stored at Ambient Temperature (30 ± 2 ºC)
RO–RT = Red onion stored at Refrigeration Temperature (5 -7 ºC)
RO–HT = Red onion stored at Refrigeration Temperature (45-50 ºC)

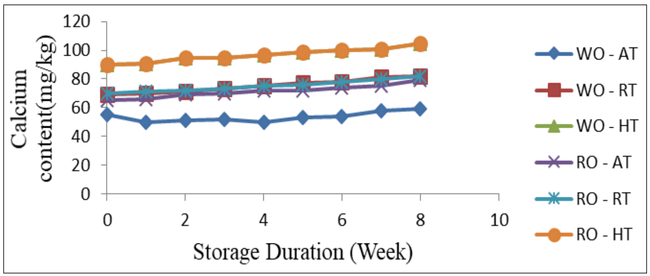

Fig 3: Change in calcium content of onions with storage condition

Key:
WO–AT = White onion stored at Ambient Temperature (30 ± 2 ºC)
WO–RT = White onion stored at Refrigeration Temperature (5 -7 ºC)
WO–HT = White onion stored at wood cabinet (45 -50 ºC)
RO–AT = Red onion stored at Ambient Temperature (30 ± 2 ºC)
RO–RT = Red onion stored at Refrigeration Temperature (5 -7 ºC)
RO–HT = Red onion stored at wood cabinet ((45 -50 ºC)

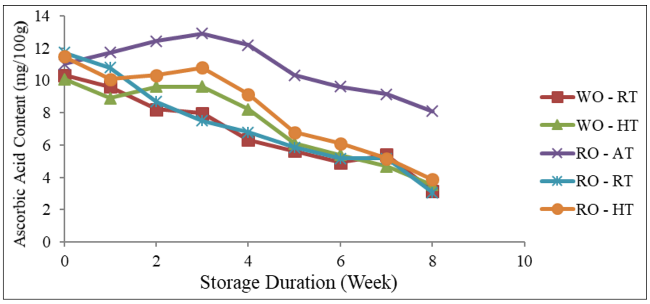

Fig 4: Changes in ascorbic acid content of onions with storage duration

Key:
WO–AT = White onion stored at Ambient Temperature (30 ± 2 ºC)
WO–RT = White onion stored at Refrigeration Temperature (5 -7 ºC)
WO-HT = White onion stored at wood cabinet (45 -50 ºC)
RO–AT = Red onion stored at Ambient Temperature (30 ± 2 ºC)
RO–RT = Red onion stored at Refrigeration Temperature (5 -7 ºC)
RO–HT = Red onion stored at wood cabinet (45 -50 ºC)

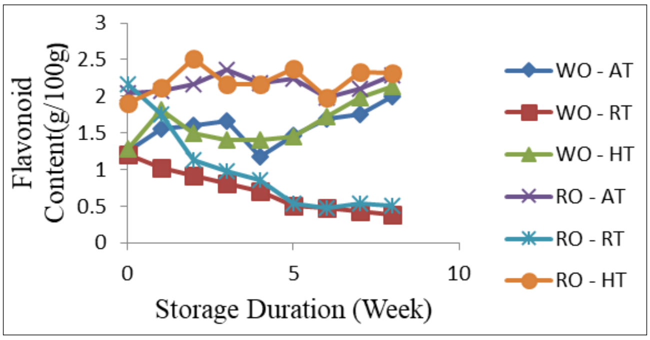

Fig 5: Changes in flavonoid content of onions with storage duration

Key:
WO–AT = White onion stored at Ambient Temperature (30 ± 2 ºC)
WO–RT = White onion stored at Refrigeration Temperature (5 -7 ºC)
WO–HT = White onion stored at wood cabinet (45 -50 ºC)
RO–AT = Red onion stored at Ambient Temperature (30 ± 2 ºC)
RO–RT = Red onion stored at Refrigeration Temperature (5 -7 ºC)
RO–HT = Red onion stored at wood cabinet (45 -50 ºC)

Conclusion
Different storage conditions caused diverse effects on the nutritional quality of onion varieties (red and white) thereby causing postharvest losses or reduction in marketable values. Ambient and elevated temperature storage was found with less deleterious effects on the nutritional quality of stored onions during the storage period. Lastly, it may be concluded that onions could be stored at ambient temperature and elevated temperature for a maximum of two months.

Acknowledgement
The authors wish to acknowledge the assistance of Modibbo Isah Farm who provide the two onion varieties.

Conflict of interest
The authors declare no conflict of interest.

References
1. Amans EB. Effect of plant spacing nitrogen on early and late-sown dry season onion (*Allium cepa*) in the Sudan Savanna of Nigeria. Growth, maturity and bulb yield. Ph.D. Thesis, Ahmadu Bello University, Zaria, Nigeria, 2001.
2. Andlauer W, Martena MJ, Furst P. Determination of selected phytochemicals by reversed-phase high-performance liquid chromatography combined with ultraviolet and mass spectrometric detection. Journal of Chromatography Analyst. 1999; 849:341-348.
3. Anju S, Kawatra A, Salil S. Nutritional Evaluation of Onion powder dried using different Drying Methods. Journal of Drying Food and H.S. 2010; 29(2):151-153.
4. AOAC. Association of official analytical chemist. Ash and animal feed (942:05). Official method of analysis, 15th edition, 1990.

5. Asanja E, Lorunfemi O, Ekanem A. Anti-nutrients composition and mineral analysis of *Allium cepa* (onion) bulbs. African journal of pharmacy and pharmacology. 2015; 9(13):456-459.
6. Biezanowska-kopec R, Galas K, Leszeznska T. Effect of heat treatment on the basic chemical composition of onion (*Allium cepa*). Designed Food. 2011; 3:7-15.
7. Cramer CS. Breeding and Genetics of Fusarium basal rot resistance in onion. Euphytica. 2000; 115:159-16.
8. Fiskesjö G. The Allium test in waste water monitoring. Environmental Toxicology and Water Quality. 2011; 8:291-298.
9. Hellmann E, Rembialowska E. Antioxidant compounds content in selected onion bulbs from organic and conventional cultivation. Journal of Research and Application in Agricultural Engineering. 2006; 51:42-46.
10. Hussaini MA, Amans EB, Ramalan AA. Yield, bulb size distribution and storability of onion (*Allium cepa* L.) under different levels of nitrogen fertilization and irrigation regime.Tropical Agriculture. 2000; 77:145-152.
11. Jurgiel-Maleck G, Gibczynska M, Nawmeua-pezik M. Comparison of Chemical Composition of Selected Cultivars of White, Yellow and Red Onions. Bulgarian Journal of Agricultural Science. 2014; 21(4):736-741.
12. Lombard KA, Geoffriau E, Peffley E. Flavonoid quantification in onion by spectrophotometric and high performance liquid chromatography analysis. Hortscience. 2002; 37: 682-685.
13. Ojo MA, Mohammed US, Adeniji B, Ojo AO. Profitability and technical efficiency in irrigated onion production under Middle Rima valley irrigation project in Goronyo, Sokoto State Nigeria. Continental Journal of Agricultural Science. 2009; 3:7-14.
14. Okwu DE, Okwsu ME. Chemical Composition of Spondaic Mobbing Plant. Journal of Sustainable Agriculture and Enviroment. 2004; 6:140-147.
15. Rodrigues G, Bonzalez ER, Rodrigues C, Diaz-Romero C. Composition of mineral and trace element content in onion cultivars (*Allium cepa*). Journal of the Science of Food and Agriculture. 2008; 88:1554-1561.
16. Rune S, Torgils F, Ingunn MV. Onion (*Allium cepa*) – Ethnomedicinal and therapeutic properties. Journal of Agricultural Food Chemistry. 2007; 55:10067-10080.
17. Slimestad R, Fossen T, Vagen IM. Onions: a source of unique dietary flavonoids. Journal of Agricultural and Food Chemistry. 2007; 55:10067-10080.
18. Yahaya Y, Birnin YUA, Badu do BU. Study of nutrient content variation in bulb and stalk of onions (*Allium cepa* L.) cultivation in Aliero, Kebbi State Nigeria. Bulgarian Journal of Basic and Applied Science. 2010; 18(1):83-89.