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EVALUATION OF QUALITY PARAMETERS OF TWO CULTIVARS OF ONIONS (ALLIUM CEPA) DRIED WITH SOLAR TENT DRYER AND AN ELECTRIC OVEN

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ABSTRACT

Onions are perishable commodities, therefore cannot be stored for a long time after harvest in ordinary conditions. Hence, there is a need for processing and value addition into more stable products to prevent losses. In this study, two varieties of onions were taken through pre-processing standard procedures for cleaning and slicing, lots were then dried using two different methods (Solar Tent Dryer = STD and Oven-dried = OD) for evaluation of sensory attributes, physiochemical properties, nutritional composition and microbiological quality of fresh and dried samples and parameters compared drying methods. The Solar Tent Dryer White (WSD) was rated higher in all attributes except for aroma, where the Solar Tent dried red onion was scored higher. The RSD onion had the least moisture and ash contents (10.33% and 3.85% respectively). Titratable acidity and Total soluble solid were lower in the Fresh White onion (at 0.34% and 1.30 ^{o} Brix respectively) while pH was lower in Oven dried White onion flakes (4.92 units). Similarly, the WOD dried sample had the lower protein content (7.09%) while the vitamin C content was lower in the WSD dried onion flakes (16.47 mg/100 g). The microbiological results showed that Total Bacterial and Fungal Counts were within acceptable limits (less than 10^{3}cfu/g) in all the samples. Thus, the study has demonstrated the Acceptably-clean-effective- drying advantage of using STD for drying of onions (Red and White varieties) over the use of Oven dryer.

Keywords: Perishable, preservation, processing, shelf-life

INTRODUCTION

Onion Onion (*Allium cepa*) belongs to the family *leliaceace,* the most commonly used vegetable in the world food preparations especially in the tropics and one of the most important vegetables in Nigeria (Alabi and Adebayo, 2008); it is ranked the second most important vegetable after tomato in Nigeria (Hussaini, *et al*.,2000). In the year 2011 alone, as high as 4,277,647 tons of onions were produced in Nigeria making the country the fifth-largest onion producer in the world (FAO, 2002).Nigeria incurs losses of up to 50% of its onion harvest due to poor post-harvest practices, especially during transit and lack of proper storage facilities, farmers are forced to sell at low prices during glut period hereby reducing income (WVC, 2018). The economic importance of onion cannot be over emphasized; being highly rich in vitamin C, a good source of dietary fibers and folic acid as well. Several antioxidants, mainly polyphenols such as flavonoids and sulfur-containing compounds, have been described in onion and garlic by researchers (Gorinstein, *et al*., 2005; Ly, *et al*., 2005). Onions contains a significant amount of flavonoid called quercetin; although quercetin is available in tea and apples, earlier research proved that absorption of quercetin from onions is

twice that from tea and more than three times that from apples (Singh, 2005).In order to reduce post-harvest loss in onions, it can be processed into a wide variety of products including ready to use or ready to cook fresh onions, onion paste, dehydrated onion flakes, onion powder, onion oil, onion vinegar, onion sauce, pickled onion, onion wine, beverages and others. Dehydrated onions are considered as potential products in world trade and in the form of flakes or powders are in extensive demand in several parts of the world (Mitra, *et al*., 2012). This has several advantages such as the convenience of transportation, storage, simplicity longer shelf life than fresh ones and less prone to microbial contamination (Sangwan, *et al*., 2010).

The objective of this study was to dry two onion varieties using two different drying methods (NSPRI solar tent dryer and hot air oven) as value addition and to evaluate sensory, nutritional, and microbiological properties of the fresh and dry products.

MATERIALS AND METHODS

Two varieties of onion (Red and White) were procured from mandate market Ilorin, Kwara state and brought to Processing Centre at Nigerian Stored Products Research Institute (NSPRI), Ilorin, Nigeria. The onions were weighed, sorted, peeled, re-weighed, washed, drained, and sliced (0.4mm). These were shared into lots, weighed again, and spread on trays before drying in the different dryers. The treatment groups were labeled as follow: Fresh red onion (RFS), Fresh white onion (WFS), Solar Tent dried red (RSD), Solar Tent dried white (WSD), Oven dried red (ROD), Oven dried white (WOD).

Sensory evaluation

Samples were presented to 20 untrained panelist members to evaluate color, texture, appearance, flavour, and overall acceptability using a nine-point hedonic scale as described by Larmond (1977).

Determination of physicochemical and nutritional properties

The moisture and ash contents were determined using AOAC (2000) methods. The Kjeldahl (1994) method was used in the determination of crude protein contents. The method described by Joslyn (1970) was adopted for crude fibre determination. The method described by Onwuka (2005) was adopted in the determination of pH, TTA and TSS while the 2, 6-dichlorophenol indophenol titration methods described by Ndawula*et al*.,2004 was modified and adopted for the determination of ascorbic acid content.

Microbial analysis

The total plate counts in onion samples were determined by the procedure described by IS5402:2012. Total coliform was determined using Macconkey agar medium (Tambekar and Mundhada, 2006). Nutrient agar was used for total bacteria count, using the procedure described by IS5887(1):1976, while potato dextrose agar (PDA) was used for fungi counts, using the method described by Chaturvedi*et al*., 2013

Minerals determination

The mineral content was determined by the procedure described by (Sharoba 2009). The quantitative estimation of K, Fe, Ca, Mn, and Zn was done using an atomic absorption spectrophotometer in accordance with AOAC (2000) and compared with absorption of standards of the elements.

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 (IBM Statistics 20.0).

RESULTS AND DISCUSSION

Effect of drying methods on the sensory attributes of dehydrated onion flakes is as shown in Figure 1, For the color, there was no significant difference between the oven dried sample, while WSD was significantly different from the other samples. There was significant difference between the red and the white solar tent dryer. For texture, the white solar tent sample showed significant difference when compared to the red and white oven dried samples, there was no difference between the white and red solar tent dried samples. For appearance, the white solar dried sample was significantly different from oven dried sample but there was no difference between the red and the white solar tent dried samples. Also for Aroma, there was significant difference between the oven dried sample and solar tent dried samples. Overall Acceptability showed significant difference ($p<0.05$) between the oven dried samples and the solar tent dried samples.

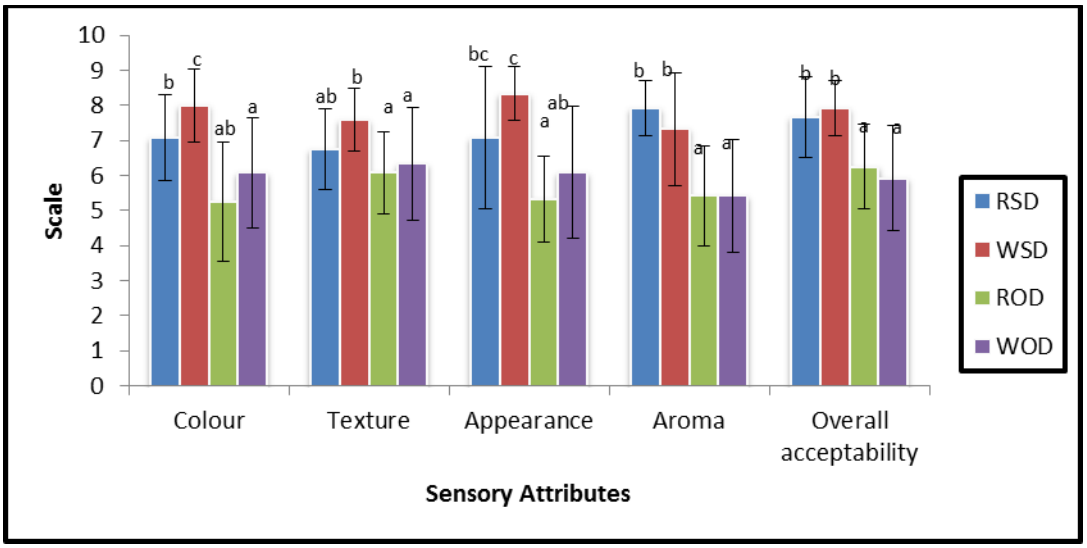

Figure 1: Sensory characteristics of the various dehydrated onion flakes

Each bar represents Mean ± SE of 20 panelist members on 9-pont hedonic scale where 9 indicates excellent and 1 indicates poor. Bars with different alphabets are significantly different ($p<0.05$). RSD=solar tent dried red onion flakes; WSD=solar tent dried white onion flakes; ROD=oven dried red onion flakes; WOD=oven dried white onion flakes.

Physicochemical and nutritional properties

The Effect of drying on the nutritional and physicochemical composition of fresh and dehydrated onion flakes (dry matter basis) is presented in Table 1. Expectedly, moisture content reduced significantly after processing. There was no difference between the two fresh samples (red and white) in their moisture contents. However, the white dried onions (solar tent and oven dried) had significant higher moisture contents compared to red dried onions (solar tent and oven dried). The solar tent dried onion flakes (red and white) and oven dried white onion flakes had significant higherash contents than in fresh samples (red and white) the result suggest that drying caused a significant reduction in protein content generally. Protein content of fresh red onion (RFS) was significantly higher than in the dried flakes samples. Oven dried white onion flakes had significantly lower protein content. On the other hand, fresh white onion had significantly higher ($p<0.05$) crude fibre content compared to red variety while the solar tent dried (red and white) had significantly lower crude fibre content. Table 1 shows effect of the processing on the physicochemical properties of dried onion flakes to the fresh, White: oven dried onion flakes recorded the highest titratable acidity (1.26%) and the lowest pH (4.92) values, and the readings were statistically significant in both cases. On the other hand, fresh white onion variety recorded the lowest titratable acidity (0.34%) and the value was significant while fresh red onion variety had significantly higher pH value. The observed results for pH and titratable acid in the present study agreed with each other because the higher the acidity the lower the pH value. Titratable acidity and soluble solids are two quality indices of fruits and vegetables because the ratio of their proportion in any substance determines the taste (Saltveit 2005). Red fresh onion variety recorded significant higher vitamin C content among all the samples, while the solar tent dried onion flakes (red and white) had the lowest readings of vitamin C content. From the results Vitamin C content of the two varieties of onions significantly reduced, which is due to drying process, similar results were reported by Abdou B.A.*et al*., (2018).

Table 1. Nutritional composition of dehydrated onions flakes (dry matter basis)

Parameter	Fresh Onion (red)	Fresh Onion (white)	Solar tent Dried(red)	Solar tent Dried(white)	Oven Dried(red)	Oven Dried(white)
MC (%)	88.98 ± 0.18^{e}	89.43 ± 0.01^{e}	10.33 ± 0.39^{a}	11.32 ± 0.03^{b}	15.45 ± 0.45^{c}	16.43 ± 0.29^{d}
Ash (%)	2.94 ± 0.43^{a}	2.79 ± 0.04^{a}	3.85 ± 0.76^{b}	4.19 ± 0.01^{b}	3.13 ± 0.01^{a}	4.07 ± 0.21^{b}
Protein (g)	36.52 ± 0.59^{f}	30.53 ± 0.01^{e}	11.35 ± 0.04^{c}	14.85 ± 0.00^{d}	10.83 ± 0.06^{b}	7.09 ± 0.02^{a}
Crude Fiber (%)	8.95 ± 0.14^{b}	19.03 ± 0.10^{d}	5.51 ± 0.02^{a}	5.53 ± 0.000^{a}	9.21 ± 0.05^{c}	8.84 ± 0.02^{b}
Vitamin C (mg/100 g)	157.24 ± 11.89^{c}	111.33 ± 41.27^{b}	21.39 ± 4.03^{a}	16.47 ± 3.21^{a}	25.35 ± 4.19^{a}	40.34 ± 6.71^{a}
TTA (%)	0.45 ± 0.02^{b}	0.34 ± 0.00^{a}	1.07 ± 0.00^{c}	1.12 ± 0.01^{d}	1.21 ± 0.01^{e}	1.26 ± 0.00^{f}
Ph	6.30 ± 0.01^{f}	6.21 ± 0.01^{e}	5.71 ± 0.01^{c}	5.02 ± 0.02^{d}	4.98 ± 0.01^{b}	4.92 ± 0.02^{a}
TSS (^{o}Brix)	1.50 ± 0.00^{b}	1.30 ± 0.00^{a}	4.20 ± 0.00^{e}	2.50 ± 0.00^{c}	4.60 ± 0.00^{f}	4.10 ± 0.00^{d}

Readings show Mean ± SE of triplicate determinations (n=3). Means with different superscripts are significantly different (p=0.05) along the rows

Microbial properties

The result of fungi counts is presented in Table 2, the red onion sample shows a decrease in fungi counts from fresh to oven dried sample and to solar dryer respectively with 1.6×10^{2} cfu/ml, 1.2×10^{2}cfu/ml and 0.2×10^{2}cfu/ml. Also, reduction of fungi count was observed in the white onion sample that was dried with solar and oven heat dryerfrom 6.8×10^{2}cfu/ml to 2.6

$\times 10^2$cfu/ml (solar tent) and 0.4 $\times 10^2$cfu/ml (oven) respectively. Thus, this finding is in accordance with the study done by Acevedo, *et al*., (2001), who isolated fungi from minimally processed vegetables and recorded a reduced fungi count. Total coliform counts as shown in (Table 2), there were no visible reduction in the red onion sample for coliform counts across all dryers.An increase was observed in white onion sample that was treated with solar tent dryer from 0.08×10^2cfu/ml (fresh) to 0.83×10^2cfu/ml (solar). This finding is in agreement with the submission of (Seow J. *et al*., 2011 and Martinez- villalvenga *et al*., 2008). Their submission stated that suitable and favorable condition such as high temperature can make microbes proliferate faster. They also evaluated that amount of thermo tolerant coliform increase approximately by 2 and 3 log cfu/g in their study. Bacterial counts as shown in (Table 2), a decrease in total bacterial count was seen and observed in the red onion sample treated under solar tent heat dryer from 8.8 $\times 10^2$cfu/ml of fresh red onion sample to 0.6×10^2cfu/ml, while a decrease in bacterial count was also recorded in the oven treated red onion sample to be 3.3×10^2cfu/ml. Also, low bacteria count was recorded in the white onion sample treated under oven heat dryer from 5.6×10^2cfu/ml to 1.4 $\times 10^2$cfu/ml. This finding also agrees with the report of (Acevedo *et al*., 2001).

Table 2. Effect of drying on microbiological properties of dehydrated onions flakes

Samples	**Bacterial Counts (10^2cfu/ml)**	**FungalCounts (10^2 cfu/ml)**	**Total Coliform (10^2cfu/ml)**
Fresh onion (red)	8.8	1.6	0.06
Fresh onion (white)	5.6	6.8	0.08
Solar Tent Dried (red)	0.6	0.2	0.07
Solar Tent Dried(white)	1.4	2.6	0.08
Oven Dried (red)	3.3	1.2	0.04
Oven Dried (white)	1.1	0.4	0.08

Mineral determination

The composition of mineral elements found in the fresh and dried onion samples is presented in Table 3. The most abundant elements out of the four minerals determined was potassium which ranged in values from 1.80±0.00 mg/100g for white fresh onions to 4.70±0.00 mg/100g for white oven dried onion. The values were significantly ($p<0.05$) different from each other with values for oven dried onions relatively higher than that of solar dried. Also, the value of the fresh onion was lower than that of dehydrated onions as can be seen in Table 3. Nzikou *et al*. (2009) reported that Potassium is an essential nutrient and plays an important role in the synthesis of amino acids and proteins. Aslam *et al*., (2005) also reported that potassium is important for reducing blood pressure and increasing blood circulation, as well as preventive aid on general health of the heart. The amount of Fe in the samples of onion of RFS, WFS, RSD, WSD, ROD and WOD were found to be 0.10± 0.00mg/100g respectively (Table 3).Therewas no significant ($p<0.05$) difference. The amount of Calcium (Ca) in the sample ranged from 0.30 ± 0.00 to 0.83 ± 0.03 Mg/100g, Highest level of Ca was observed in sample RSD, whereas least amount of Ca was found in RFS. There was no significant difference ($p<0.05$) amongst the dried samples irrespective of the method of dehydration. According to Aslam *et al*. (2005), Ca helps in transporting long chain fatty acid which helps in prevention of heart diseases, high blood pressure and other cardiovascular diseases. Similarly, zinc (Zn) level in the onion bulbs varied significantly ($p<0.05$) and ranged between 0.03 mg/ 100 g DM (WFS) and 0.26 mg/ 100 g DM (RSD). Zinc is essential to all organisms and has an important role in metabolism, growth, development, and general well-being. It is an essential co-factor

for a large number of enzymes in the body. Zinc deficiency leads to coronary heart diseases and various metabolic disorders, (Saraf and Samant, 2013). Generally, the difference in mineral composition can be as a result of compositional differences which exist among the different varieties of onions, and among the varieties grown in different areas in the country (Zebib *et al*., 2015).

Table 3. Effect of processing on the mineral composition of dehydrated onions flakes (dry matter basis mg/ 100 g)

Samples	**K**	**Fe**	**Ca**	**Zn**
Fresh onion (red)	$2.60^{c} \pm 0.00$	$0.10^{a} \pm 0.00$	$0.30^{a} \pm 0.00$	$0.05^{c} \pm 0.00$
Fresh onion (White)	$1.80^{b} \pm 0.00$	$0.10^{a} \pm 0.00$	$0.50^{ab} \pm 0.00$	$0.03^{b} \pm 0.00$
Solar tent dried (Red)	$4.40^{d} \pm 0.00$	$0.10^{a} \pm 0.00$	$0.83^{bc} \pm 0.03$	$0.26^{f} \pm 0.01$
Solar tent dried (White)	$4.57^{e} \pm 0.06$	$0.10^{a} \pm 0.00$	$0.73^{bc} \pm 0.03$	$0.16^{e} \pm 0.00$
Oven Dried (Red)	$4.67^{f} \pm 0.03$	$0.10^{a} \pm 0.00$	$0.60^{bc} \pm 0.00$	$0.13^{d} \pm 0.00$
Oven Dried (White)	$4.70^{f} \pm 0.00$	$0.10^{a} \pm 0.00$	$0.57^{abc} \pm 0.23$	$0.33^{a} \pm 0.00$

Readings show Mean ± SE of triplicate determinations (n=3). Means with different superscripts are significantly different (p=0.05).

CONCLUSION

This study showed the potentiality for effective and acceptable drying of onions (red and white) using solar tent dryer and hot air oven but further demonstrated the advantages of solar tent dryer over the hot air oven for clean drying of onions with significant nutritional quality retention.

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