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Original Research Article

Postharvest Storage and Shelf Life Potentials among Selected Varieties of Onion (*Allium cepa* L.)

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Abstract: An experiment was conducted to determine the post-harvest storage potentials and shelf-life in eight varieties of onion Namely - Ex-Dutsi; Ex-Huguma; Ex-Kudan; Ex-Kura; Ex-Romi; Wuyan Bijimi; Ex-Kwadon; and Wabe. The study was conducted between March and June 2016 at the Biological Garden of the Department of Biological Sciences, Gombe State University, using a simple and cost effective technology of aerated thatch bed. Data were recorded on bulb rot; weight loss and sprouting, and subjected to analysis of variance using R-statistical v.3.0 software. Ex-dutsi; Wabe and Wuyan Bujimi were the varieties identified to have the highest bulb weight loss (6.6 Kg and 10.0Kg respectively) among the varieties. Similarly, Ex-kudan (22.9 Kg) and Romi (20.5 Kg) recorded the lowest average bulb weight loss. The remaining three varieties have varying initial and final weights. Wuyan Bijimi; Ex-Dutsi and Ex-kwadon, recorded the highest average number of sprouted bulbs (48.9; 38.1 and 30.9) respectively, compared to Ex-kudan and Romi which recorded lowest sprouts of (0.6 and 1.3) respectively. There was no much significance difference observed in Ex-Huguma; Ex-Kura; Ex-Kwadon; and Wabe, which made them to be intermediate in their response to deterioration during storage. 'Romi and Ex-Kudan' recorded the lowest percentage of rot (6.3 and 5.4%) and are therefore determined to be the best varieties for storage and shelf-life.
Keywords: Onions, storage, Post-harvest, loss, deterioration, shelf-life..

INTRODUCTION

Onion (*Allium cepa* L.) belongs to the genus *Allium* of the family *Alliaceae* [1]. Onion is a vegetable crop which is used as a condiment in everyday diet and helps to fight against heart and blood diseases [2]. It is by far the most important of the bulb crops cultivated commercially in nearly most parts of the world. The crop is grown for utilization both in green state as well as in matured bulbs. Onion demonstrates certain diversity in the eastern Mediterranean countries, through Turkmenia, Tajikistan to Pakistan and India, which remain as the most important sources of genetic diversity and thought to be center of origin [3]. In Nigeria, onion is an important food vegetable crop based on utilization and economic value to farmers. The crop is cultivated predominantly in the north, during the dry season it is grown for its bulbs which are used daily in every home for food seasoning and flavoring. It is a valuable ingredient in the diet due to its sugars content, minerals and vitamins [4]. All the plant parts are edible, but the bulbs and the lower stem sections are the most common as seasonings or as vegetables in stews [5].

However, onions contribute significant nutritional values to the human diet and have therapeutic properties [6] they are principally consumed for their unique functional and nutritional values, providing prebiotic fructans, antioxidant flavonoids, organo-sulfur compounds, it also cures diabetes, anti-bacterial, antiviral, anti-allergenic and anti-inflammatory with anticancer, cardiovascular health benefits [3, 7, 4].

Onion farmers in Nigeria virtually continuously store their onions after harvest for one to five months to ensure a persistent supply through seasons when fresh food was un- available. Rots are the common cause of onion loss in storage. Particularly fungi and moulds are essential pathogens of vegetables and fruits predominantly under tropical and sub-tropical conditions [8]. The significance of storage rots includes a decline in the quality and quantity of onion which affects the market value [9]. Appropriate agronomic and handling practices such as cultivation and establishment methods, plant population densities, methods and time of fertilizer application, weeds, soil moisture, and pest and disease control measures, time of harvest, storage

duration, curing regimes and types enhance onion produce sustainability [10-15].

The loss of foods in the post-harvest system is not new; it has always remained a problem for mankind. In these days of rapidly expanding population in the underdeveloped countries in the world where food is short, there is a growing earnestness to do a better job of safeguarding mankind food supply in order to alleviate hunger and malnutrition [16]. Postharvest losses of fruits and vegetables are challenging to forecast; the major agents producing deterioration commonly being attributed to physiological damage and combinations of several organisms [17]. FLORES, 2000 [18] reported that postharvest losses may be grouped largely into food losses after harvesting and food losses due to economic and social reasons. Significant decrease and or results in post-harvest losses are recorded in onions through sustainability of such cultural practices [19-25]. Reduction in post-harvest deterioration will be contributory in market stability and exploiting opportunities to export onion and gross foreign exchange [26-30].

Several recent improvements in postharvest technology in developed countries have been in response to the desire to elude the use of costly labour and the need for desirable produce, these techniques may not be sustainable over time, due to socioeconomic, cultural and/or environmental concerns [14]. Local conditions for small-scale handlers may include labour surpluses, lack of credit for investments in postharvest technology, unreliable electric power supply, lack of transport options, storage amenities, and/or packaging materials, as well as a host of other constraintsc[31, 15]. In spite of economic significance and global culinary, onions research in Nigeria falls behind other major vegetable crops. With respect to Gombe and related ecologies, only few research works have so far been reported [32, 10-12]. In view of this, the present study was carried out to elucidate the onion varieties with high potentials of post-harvest storge shelf life among the eight onion varieties cultivated under the prevailing agro-climatic condition of Gombe.

MATERIALS AND METHODS

Description of the study site

The study was conducted between March to June 2016 at the Biological garden of the Department of Biological Sciences, Gombe State University, Gombe State which is one of the North-eastern stated where a reasonable proportion of onion cultivation and storage take place. Located on latitude $10^0$15'N longitude $11^0$10'E at an altitude 449M elevation above sea level, it falls within the Sudan savannah of West Africa. It is characterized by hot dry season, short duration of rainfall about 4 to 5 months. Annual mean rainfall varies from 857.4-975.5mm while ambient temperature ranges between 25.5 and 35.4ºC and relative humidity ranges from 40.3-51.8% between April and May (2005 to 2009 m.in.weather.com).

Experimental management

A total of five hundred (500) freshly harvested bulbs from eight varieties; Ex-Dutsi; Ex-Huguma; Ex-Kudan; Ex-Kura; Ex-Romi; Wuyan Bijimi; Ex-Kwadon; and Wabe were randomly selected and dried by windrowing for 7 days [13, 33]. They were stored in a simple traditional aerated thatched-bed to assess their potentials of storability and shelf life. The storage time was between the months of March to June at which the average monthly temperature was 20.24° and 21.18°C, respectively and relative humidity of 38 and 37.2%, respectively [35].

Data collection and analysis

Data were collected according to the standard procedures described by [36] Data on bulb weight in each variety, the percentage of rotten bulbs and percentage sprouted bulbs were taken at two weeks interval for the period of four (4) months and were analyzed using R- V 3.0 Statistical package.

RESULTS AND DISCUSSION

Storage and shelf life of onion bulbs

Results on assessment of storage/deterioration rate and shelf life potentials of selected varieties of onion at different weeks indicated that there were variations in the level of deterioration or changes of the bulbs among the varieties such as bulb weight loss, bulb rot and sprouted bulbs. Based on the outcome of this study, it was also observed that there was an advanced increase of loss as the number of weeks increased. Similarly, the findings of this research revealed a significant effect on a number of weeks (storage period) on various response parameters.

Percentage storage rots (%) Based on the findings of this study, significant ($p < 0.05$) differences were observed based on the percentage of rotten bulbs measured at the end of 14 weeks storage period. Changes with respect to rotten bulbs start to appear at two weeks after the bulbs were subjected to storage condition and continue to increase with advance days of storage within the varieties studied. Maximum percentage of rotten bulbs was recorded at week 14^{th} which recorded 33% deterioration after storage, while the lowest percentage (1.5%) of rotten bulbs was observed at two weeks after storage (Figure 1). Proliferation in rotting of the bulbs owing to the increase in the number of weeks in storage have increased geometrically and may be attributed to the fact that higher duration in storage brings about physiological changes in the cells and tissues of the bulbs which make them be predisposed to attack of disease-causing microorganisms and produced rotten

bulbs. Sritavavas & Kumar (2013) [37] and Rajcumar in 1997 [38] reported that the loss of bulbs due to rotting is increasing with the advanced days of bulbs at storage, the losses incurred at the time of storage may be due to the infection rate among bulbs and the loss of individual bulbs was more considerable to decrease yield and quality of the bulbs. Intermittent assessments done by [39] investigated that the number of rotted bulbs increased with increasing time of bulbs during storage. Cho *et al.;* in 2010 [40] justified that larger onions are more susceptible to bruising, disease and other damage than smaller bulbs. 'Wuyan Bijimi and Ex-Dutsi' showed highest rot percentage (30 and 34.4%) and displayed significant differences from the other varieties with respect to the percentage of rotten bulbs which brings about lost of a reasonable number of bulbs within short time of storage. There was no much significant difference observed in Ex-Huguma; Ex-Kura; Ex-Kwadon; and Wabe (Figure 2). This might be as a result of their closeness in genetic makeup which makes them be intermediate in their response to deterioration during storage. 'Ex-Romi and Ex-Kudan' recorded the lowest percentage of rot (6.3 and 5.4%) respectively compared with other varieties that recorded varying degrees of response to storage during the period of storage and that indicates their potentials as varieties that could give a high percentage of healthy and unrotten bulbs for a longer period of time. These findings are in agreement with the finding of Zorn *et al.;* in 2003[41] who reported similar result. Storage life could also be associated with the relationship of the gene controlling such character. This result was in accordance with the report of Rafika *et al.;* 2006 [42] and Mistry *et al.;* 2008 [43] who observed that dry matter was negatively correlated with the level of rotten bulbs, this variability characterized the ability to store of cultivars. Similar results were also reported by Yemane Kahsay in 2013 [3] in onion plant and Roy and Gupta in 2000; Heidari *et al.;* 2005; Farukey in 2001[44, 45] in cereals and Giri and Kachole in 1998 [46] in legumes. The apparent cause of rotting was predicted to be fungal pathogens because symptoms like neck-rot and basal rot were observed. Lee *et al.;* in 2001[47] noticed that larger bulbs had higher incidences of bulb rots than the small ones. He further added that the higher incidence of rotting in large bulbs may be attributed to higher water content.

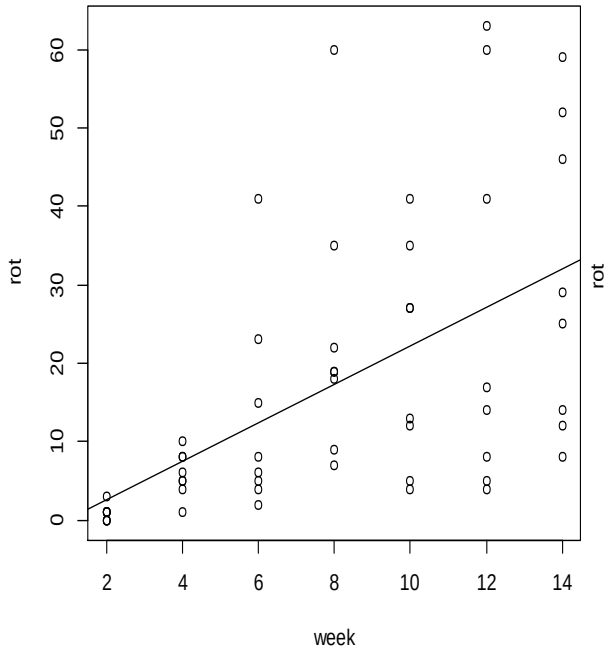

Fig 1: Rot by week

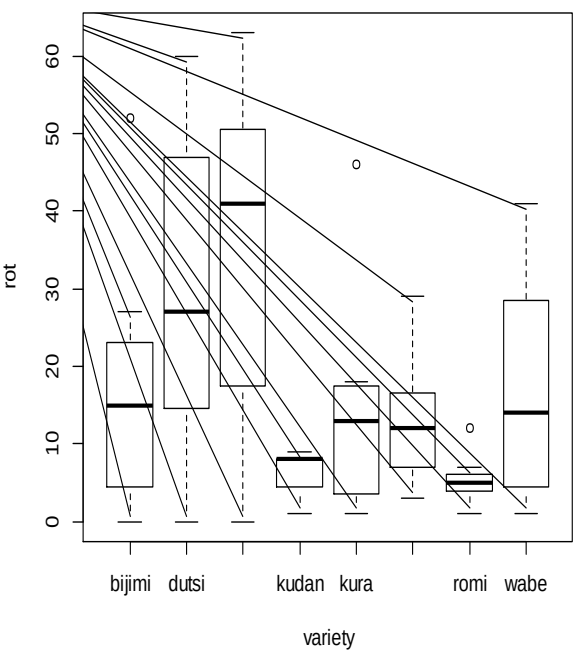

Fig 2: Rot by variety

Percentage bulb sprout

Similar trend was observed in percentage sprouted bulbs at weeks interval, changes in number of sprouted bulbs start to appear at 3rd week after storing the onion bulbs, Wuyan Bijimi; Ex-Dutsi and Ex-kwadon, recorded the highest number of sprouted bulbs (48.9; 38.1 and 30.9) respectively, compared to Ex-kudan and Romi which recorded lowest sprouts of (0.6 and 1.3) respectively (Figure 3). Based on the outcome of this study significant ($p < 0.05$) differences were observed with respect to the percentage of sprouted bulbs encountered at the end of 14 weeks storage period. Also a progressive increase in number of sprouted bulbs seem to increase as storage weeks increases, explosion of sprouted bulbs owing to the increase in the number of weeks in storage have indicated a decline in the weight of the bulbs and also brings about weathering of the bulb shells which also

brings about decrease in water content of the bulbs in storage, it was also observed that smaller bulbs have the highest rate of sprouting compared to bigger size bulbs. Rajcumar in 1997 [38] reported a decrease in terms of the marketable value of bulbs due to sprouting. Figure 4; indicates the percentage rate of sprouted bulbs per variety which indicates a highly significant ($p < 0.05$) differences among the onion varieties studied. As storage weeks increase from 3 to 14 weeks, marketable bulb yield decreased. Largely a trend of decreasing gross marketable bulbs couple with bulb density was observed. Bulb density and vigour have an impact on the value of bulbs after storage. Atanda *et al.;* 2011 [16]; Seck and Baldeh in 2009 [48] Kantona *et al.;* 2003 and Opara in 2003 [14] reported that as bulb density decreased, the number of marketable bulbs decreased significantly. This is in conformity with the present results, Jilani *et al.;* in 2009 [49] observed the similar trend. Bulbs respond inversely under different storage conditions and several varieties of the same species stored even in the same environment often respond differently [50].

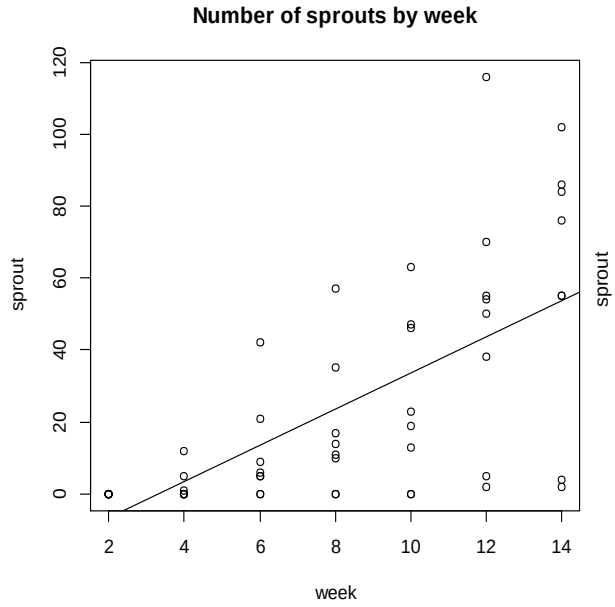

Fig 3: Number of sprouts by week

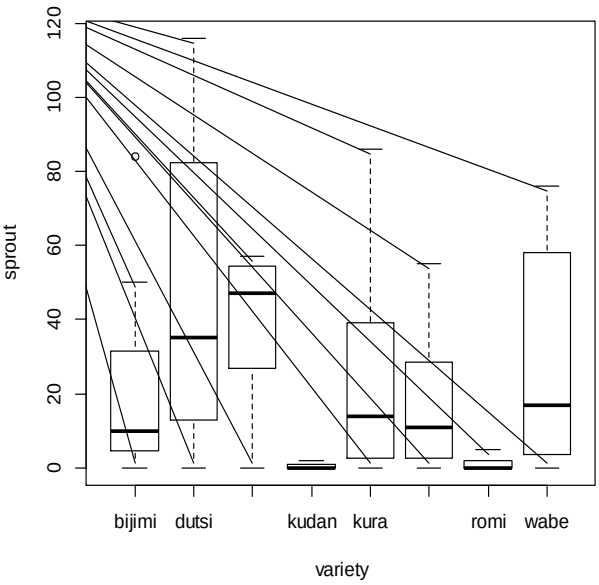

Fig 4: Number of sprouts by variety

Percentage of bulb weight loss

Initial bulb weight was taken before subjecting the onion bulbs to storage condition, percentage of bulb weight loss of onion start to manifest after two weeks of storage which show decline when compared with the initial weight, decline in the weight continue to increase with the increase in the number of weeks of storage up to the last week of the study (Figure 5). A significant difference ($p < 0.05$) was observed with advanced weeks of storage. Varieties display different trends of weight loss throughout the storage period (weeks). However, almost all the varieties show certain level of response to the loss of weight Ex-dutsi; Wabe and Wuyan Bujimi have initial and final weight of 24.3-6.6; 23.3-10.0 and 31.8-10.3 respectively which indicates that they have the highest bulb weight loss among the varieties studied, similarly Ex-kudan and Romi have the initial and final weight of 38.1-22.9 and 34.8-20.5 respectively. The remaining three varieties have varying initial and final weights (Figure 6). The result of this study is in agreement with the findings of [14, 51, 16] who described cultivar specific weight losses of between 2 and 5% per month in an ambient storage condition. They directed that the loss increment occurred from the second week to end of third month storage time. They described the relatively low initial rate to loss of water through the skin and by the low-level of respiration of dormant bulbs that was followed by a change to a steeper slope, indicating more rapid weight loss, due to high respiration rate and senescence of older fleshy scales. Sing and Sing in 2003 [52] also stated that large size of bulb demonstrated the highest weight loss compared to the smaller size of bulbs. The flavour, colour and size as well as keeping the quality of onion bulbs could be determined by the variety [54]. Storage quality is also reported to be negatively correlated with certain bulb morphological traits such as bulb diameter and neck diameter [55]. Medium size bulbs (50 to 60 g) are suitable for long-term storage. So also storing a combination of sizes of bulbs helps longer shelf life. In this study, the storage weight loss throughout all weeks increased where this could perhaps be connected with physiological activities that lead to higher respiration rate. AVRDC (2000), stated that the loss in weight can be uppermost in large size bulbs then followed by small size bulbs and lastly

medium size bulbs. Rajcumar in 1997 [38] Sritavavas & Kumar in 2013 [37] reported that weight loss was found to be associated with the resumption of a higher incidence of sprouting, rotting and percentage of diameter loss most likely through an increase in the rate of respiration.

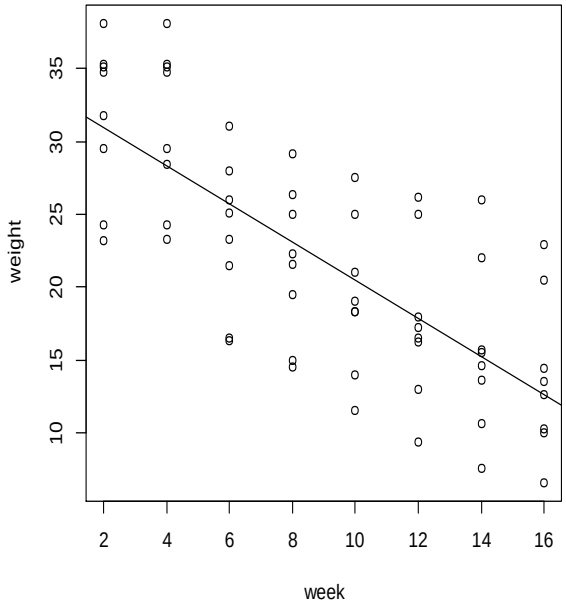

Fig 5: Weight by weeks

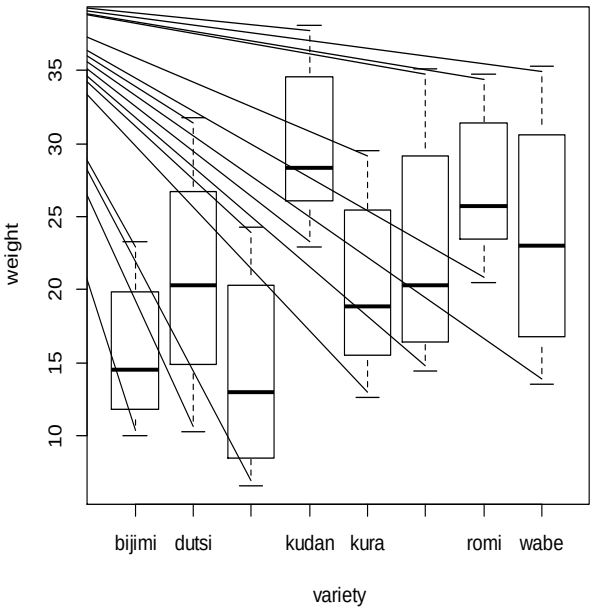

Fig 6: Weight by variety

CONCLUSION

Based on the outcome of this study it was clear that different variety of onions have varied responses to the time taken for storage. Post-harvest deterioration brings about significant losses in stored varieties of onion bulbs which can pose serious damage during storage and affect their market value, it clearly indicates the potentials in some of the varieties that display high level of resistance to factors which pre-dispose bulbs to deterioration and ultimately render them unfit for human consumption and reduces their market value during and after storage. Farmers and growers of onion can make choices from the varieties that have a longer storability and shelf-life potentials when it comes to the selection of variety to be use, also small scale and low-income earners can employ a simple and cost effective technology of aerated thatched bed to store their onions for a long time without deteriorating.

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