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Enhancing Onion Preservation and Storage through Improved Storage System

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ABSTRACT: The objective of this paper was to assess the influence of traditional and improved storage system for freshly harvested onion bulbs cultivar violet de Galmi widely grown in Northern Nigeria on postharvest losses of onions using standard methods. Data obtained revealed that incidences of rotting (23%) and sprouting (7.8%) onion bulbs were found to be significantly (P> 0.05) lower in Ventilated Onion Safe' compared with the three traditional storage methods with a range of 34 – 61% rotting and 11 – 22% sprouting. Physiological weight loss was highest in Ventilated Onion Safe (22%) and the least in Straw hut (14%). The levels and extent of postharvest losses were found to be influenced by relative humidity, temperature and ventilation. Healthy, undamaged cured onion bulbs can be stored for six months in dry, well ventilated stores under ambient environmental conditions of Northern Nigeria. Farmers should be trained with appropriate skills and tools needed to preserve and store Onions such as harvesting Onions at maturity, proper drying of bulbs before storage and the use of dry, well ventilated storage facilities. The adoption of the improved onion storage facility (Ventilated Onion Safe) developed and patented by a team of researchers in Nigeria for enhanced onion preservation and storage is therefore recommended

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Onion (*Allium cepa* L.) is an important vegetable crop in Nigeria based on consumption and economic value to farmers it is used almost daily in every home. Nigeria is the largest onion producer in West Africa with a total annual production of 1.4 million metric tonnes (FOASTAT, 2022). The country has considerable export trade to Niger, Benin, Ghana, Senegal, Cameroon and Chad (NBS, 2018). The major Onion producing states in Nigeria are Sokoto, Kebbi, Kaduna, Kano, Jigawa and Borno. The main period of production is during the dry season (October to April) under irrigation. The intensive cultivation of Onion crop in Nigeria serves as a source of income generation to farmers, traders and provides employment to a high population of labour force. Nigeria loses as much as 50 percent of its onion harvest annually due to inadequate storage facilities and poor handling practices (FOASTAT, 2022). This reduces both the quantity and quality of onions available for domestic use and export to international markets. Other Consequences often overlooked include mycotoxin contamination of spoiled onions which when consumed are hazardous to humans (Shehu *et al.*, 2020). It is therefore important to store onions successfully with minimal postharvest losses. The high rate of onion losses necessitated the onion farmers to adopt various local methods of storage: Heaping the bulbs on the ground, Storage on wooden racks raised above the ground in straw huts and storing in jute-woven sacks. The practices are conventional and have remained basically the same for centuries. These storage facilities are inadequate to preserve the onions for a long period of time and lead to huge losses during storage. There is therefore a need for

sustainable and effective storage system that can mitigate the huge postharvest losses of onion in Nigeria.

As the leading producer of onion in West Africa, Nigeria has a good potential to reduce postharvest loses and tap from the opportunity presented by the export markets to generate foreign exchange. The objective of this paper was to assess the influence of traditional and improved storage system for freshly harvested onion bulbs cultivar violet de Galmi widely grown in Northern Nigeria

MATERIALS AND METHODS

The study was conducted at the premises of Kebbi State Agricultural Development Authority (KARDA), Birnin Kebbi and Federal University Birnin Kebbi, Kebbi State Nigeria. Freshly harvested onion bulbs of cultivar 'Violet de Galmi' locally known as *Yar Galmi* widely grown in Northern Nigeria were collected using purposive sampling techniques. The onions were cured for 15 days under the shade. Cured onions were stored for 6 months (April – October, 2023) using four (4) storage techniques (Figure 1-4): (1) Heaping the bulbs on the ground and covered with dry grasses of *Imperata cylindrica* (Gamba grass) (2) storage on wooden racks raised above the ground in straw huts, (3) Storing in jute bags and (4) Shelving in an improved storage facility (Ventilated Onion Safe). Data on rotting, sprouting and physiological weight loss were recorded at monthly intervals for 6 months. The incidences of rotting, sprouting and physiological weight loss were computed following a method reported by Shehu and Suberu (2015) with modifications: Incidence of rotting/sprouting/weight loss = Proportion of rotten/sprouted/ dehydrated onions divided by total onions stored in each treatment multiplied by 100.

Fig 1: Heaping on the ground in straw hut

Fig 2: Heaping on wooden racks raised above the ground in straw huts

Fig 3: Storing in jute bags

Fig 4: Shelving in ventilated onion safe

Statistical analysis: Treatments were laid out as a completely randomized design with three replications. Data were analyzed using analysis of variance (ANOVA) technique. Where the treatments are significantly different, means were compared using Duncan's, Multiple Range Test (DMRT). Analysis was performed by using Minitab for Windows, release 16.3 (Minitab Inc., State College, PA).

Fig 5: Dry grass of Gamba (*Imperata cylindrica*) traditionally used for the construction of onion stores

Fig 6: Materials used as wooden support in the construction of onion stores

RESULTS AND DISCUSSION

In the present study, the main causes of postharvest losses of Onion were found to be rotting, sprouting and weight loss. Shelving in ventilated Onion Safe has the least percentage of rotten Onion bulbs (23%) followed by Heaping on wooden racks raised above the ground in straw hut with 34% rotting. The highest percentage of rotten onion bulbs was obtained in Jute bags with 61% (Table 1).The improved storage system had significantly P>0.05 lower incidence of rotting compared with the traditional storage methods: Heaping on the ground covered with dry grasses, heaping on wooden racks raised above ground in straw huts, and storing in Jute bags. The incidence of sprouted Onion bulbs was significantly lower (7.8%) in ventilated onion safe compared to bulking on raised platform above the ground (11%), heaping on the ground (15%), and storing in Jute bags (22%) (Table 2). The result on the effect of storage methods on percentage physiological weight loss of stored onions is presented in Table 3. The highest physiological weight loss (22%) was recorded in Ventilated Onion Safe followed by Onions stored in wooden racks raised above the ground in straw huts (17.3%), with the least percentage weight loss being obtained from Onion stored on the ground and covered with dry grasses (14%)..

Table 1: Incidence of Rotten Onion Bulbs (%) as influenced by Storage Methods

Storage Methods	April	May	June	July	August	September	Total
Shelving in Ventilated Onion Safe	0	0	0	05	10	8	23[a]
Heaping on wooden racks raised above the ground	0	0	5	10	15	10	34[b]
Heaping on the ground in straw hut	0	0	8	10	15	10	42[b]
Bagging in jute sacks	0	2	9	12	18	20	61[c]

Overall (%) Mean with different letters in the same column are statistically different (p < 0.05) according to Duncan's test.

Table 2: Incidence of Sprouted Onion Bulbs (%) as influenced by Storage Methods

Storage Methods	April	May	June	July	August	September	Total
Shelving in Ventilated Onion Safe	0	0	0	2	3	2.8	7.8[a]
Heaping on wooden racks raised above the ground	0	0	1	4	6	4	11[ab]
Heaping on the ground in straw hut	0	0	3	4	7	1	15[b]
Bagging in Jute sacks	0	2	2	6	8	4	22[c]

Overall (%) Mean with different letters in the same column are statistically different (p < 0.05) according to Duncan's test.

There were significant differences in physiological weight loss among the different storage methods evaluated (Table 3). The results obtained from the effects of different storage methods on postharvest losses of onions were presented in Table 4, it shows that Shelving in ventilated onion safe has the lowest percentage of rotten (23%) and sprouted (7.8%) onion bulbs, while heaping on the ground covered with dry grasses had the lowest percentage weight loss (14%). Storing in Jute bags had the highest incidences of rotting and sprouting (P>0.05) in comparison with the storage methods investigated. Onion is stored at ambient storage condition in most of the tropical countries where the storage losses are very high. It is

estimated that 40 to 50% of the stored onion never reaches consumers due to postharvest losses. In this study, the main causes of postharvest losses were rotting (23-61%), sprouting (7-22%), and physiological Weight loss (14-22%). The improved storage system (Ventilated Onion Safe) had the lowest incidences of rotten (23%) and sprouted (7.8%) onion bulbs with a significant difference between the traditional storage methods. The levels of rotting and sprouting were low until the fourth month in storage (July) which falls during the period of rainy season characterized by increase in relative humidity within the range of 70 – 85% and decrease in temperature (22 – 30^{O}C.). The rate of increase in rotting and sprouting was highest during the last three months (August – October) indicating that, the levels and extent of storage losses in terms of rotting and sprouting observed in this study are enhanced by high relative humidity which is correspondingly higher during the rainy season. The findings from this study are in consonance with the reports of many workers that a high ambient relative humidity above 75 – 80%is the prime enemy of good Onion storage and promotes sprouting and the development of storage rots at any temperature (Shehu and Muhammad, 2011; Shehu and Suberu, 2015; Murumkar *et. al*. 2018).

Table 3: The effects of storage methods on physiology weight loss (%) in Stored Onions

Storage Methods	April	May	June	July	August	September	Total
Shelving in Ventilated Onion Safe	2	3	3	5	5	4	22^{b}
Heaping on wooden racks raised above the ground	0	2	2	3	5	5	17.3^{a}
Heaping on the ground in straw hut	2	2	2	3	4	1	14^{a}
Bagging in Jute sacks	0	2	3	8	4	3	20^{b}

Overall (%) Mean with different letters in the same column are statistically different (p < 0.05) according to Duncan's test.

Table 4: Postharvest losses of onions as influenced by different storage methods

Storage Methods	Rotting (%)	Sprouting (%)	Weight Loss (%)
Shelving in Ventilated Onion Safe	23.0^{a}	7.8^{a}	22.0^{b}
Heaping on wooden racks raised above the ground	34.0^{b}	11.0^{ab}	17.3^{a}
Heaping on the ground in straw hut	40.2^{b}	15.0^{b}	14.0^{a}
Bagging in Jute sacks	61^{c}	22^{c}	20^{b}

Overall (%) Mean with different letters in the same column are statistically different (p < 0.05) according to Duncan's test.

The gradual rise in onion deterioration from the fourth to the sixth month could be attributed to cross contamination of the bulked onions especially in the traditional storage methods. The sprouting of onion starts in later part of storage period when the bulb dormancy is over and temperature drops below 25^{O}C.The increase in sprouting towards the end of the storage period (August-October) could be due to the decrease in temperature/loss of dormancy in the bulbs and is one of the principal factors limiting storage life of onion bulbs. Sprouting is a result of normal physiological changes in stored bulbs and the storage condition does not cause sprouting but only affects its rate (Bruce *et al.*, 1997).

The highest physiological weight loss (22%) was obtained in Ventilated Onion Safe after six months of storage under ambient environmental conditions. The high weight loss in Ventilated Onion Safe could be due to exposure of onions to comparatively more ventilation/air circulation in the improved storage facility. Disturbing the stored onions to weigh them may have resulted in more weight loss owing to increased skin cracking and shedding. Well-ventilated storage system has a great impact in reducing postharvest losses of onions by reducing the temperature of the store and humidity of the air around the bulbs due to aeration and higher rate of air flow which affect physiology and pathology of the stored products (Murumkar *et. al.*, 2018, Gulumbe *et. al.*, 2018; Tripathi and Lawande, 2019). Low relative humidity (less than 65%) however, leads to excessive moisture loss from the onion bulbs, resulting in loss in weight. This implies that by ventilating the onion store, the temperature of onions and the humidity of the air around the onion bulbs can be decreased. Other factors in the onion production system, such as varieties, previous damage to the onion bulbs, Improper drying of bulbs, poor storage facilities and methods common with the traditional practices such as bulking on ground, and storing in bags, can also lead to storage losses.

Conclusion: To reduce the huge postharvest losses of onions, farmers should endevour to store mature, cured (2 weeks) and undamaged onion bulbs in dry and well ventilated stores. Adoption of Good Agricultural Practices (GAP) could also offer a

remedy. It is recommended that Shelving in Ventilated Onion Safe could be adopted for onion storage in Nigeria.

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