Bima Journal of Science and Technology, Vol. 7 (4) Dec, 2023 ISSN: 2536-6041

DOI: 10.56892/bima.v7i4.548

Determination of Different Storage Techniques and shelf life on ONION *(Allium sepa L.)* bulbs

[1]Lanzai H. A., [1]Abubakar A. and [1]*Mohammed U. A.

Department of Biological Sciences, Bauchi State University, Gadau, P.M.B 65 Bauchi State, Nigeria.

Correspondence Author: uaminumohmmed@basug.edu.ng;

ABSTRACT

Onion *(Allium cepa L.)* is the most economically important *Allium* crop. Estimates of post-harvest loss in onions exceeds 30 percent, significantly reducing farmer's income. This research evaluates the effectiveness of some low-cost farm storage technologies. Doum Palm Fruit Storage Techniques (DPFST), Neem leave and riverbed sand were evaluated for loss in weight (LW %), rotting %, sprouting %, damage of black moulds and healthy onios. These parameters were taken at intervals of 15, 30, 45, 60, 75 and 90 days after storage (DAS). The mean LW% of the bulbs irrespective of storage condition increased from 3.00 percent at 15 DAS to 13.60 percent at 90 DAS. The mean percentage rotting of bulbs irrespective of storage methods increased from 0.6 at 30 DAS to 8.25 at 90 DAS. Minimum per cent black mould was noticed in bulbs stored in riverbed sand. No sprouting was recorded in all treatments until 30 days after storage. Maximum percent of healthy bulbs were recorded in bulbs stored in DPFST. The results obtained revealed that both DPFST and riverbed sand storage structure are highly effective and significantly prolong the shelf-life of onions, hence recommended for use to farmers.

Keywords: Storage, Techniques, Onions, Postharvest, and Bulbs

INTRODUCTION

Allium cepa L. commonly called onion belongs to the family of *Alliaceae.* It is commonly found in the tropical region (Edet *et al.,* 2015), and is the second most cultivated vegetable crop in the world. It is called Ayo (Ibo), Ayim (Ibibio), Albasa (Hausa), and Alubosa (Yoruba) in Nigeria. It is an evergreen bulb that grows up to about 0.5 meter in height. The bulbs are used as spice in the preparation of virtually all meals in Nigeria (Pamplona *et al*., 2009). Besides being used as a vegetable, several studies have reported its medicinal properties. The antioxidant present in onion reduce the levels of free radicals involve in gastric ulceration is well reported (Michael and Smith, 2005). Pharmacological properties like ant-hypertensive and anti-convulsant have also been attributed to this spice (Pamplona *et al*., 2009).

Onion and other members of the genus *Allium* are commonly consumed by humans and other ruminant animals such as camel and sheep. Although, onions might not be edible to animals such as dogs, cats, guinea pigs, monkeys and other animals alike (Wissamann, 2016).The toxicity is caused by the sulfoxides present in rows and cooked onions which many animals are unable to digest. This results in anemia, due to the distortion and rupture of red blood cell (Edet *et al*., 2015). The sick pets are sometimes fed with tinned badly foods that contain such. The presence of phytochemicals such as tannins, saponins, steroids and cyanogenic glycosides has been reported in *Allium cepa* L. (Nwinuka *et al*., 2005). The bulb is considered to be anthelmintic, anti-inflammatory, antiseptic,

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antispasmodic, carminatic, diuretic, expectorant, and tonic (Lust *et al*., 2016). When used regularly in the diet, it reduces the chances of arteriosclerosis and heart attack (Chevalier, 2016). It is useful in preventing oral infection and tooth decay, and back onion can be used as a poultice to remove pus from sores (Lust *et al*., 2016).

Fresh onion juice is useful as a first aid treatment for bee and wasp stings, bites, grazes or fungal skin complaints (Allardice, 2016). Warm onion juice can be dropped in to the ear to treat ear-ache. It also aids the formation of scar tissue on wounds, thus speeding up the healing process (Chiej, 2016). Mature bulbs of red cultivars are harvested in summer season and used to make a homeopathic remedy for the treatment of running eyes and nose in human (Ogbonna *et al.*, 2016). This study was carried out to determine the effect of different storage methods of onion (*Allium cape* L.) due to the plants economic importance.

MATERIALS AND METHODS

Study Area

The research was carried out in Bauchi State University, Gadau Main Campus, Biological sciences Herbarium. Bauchi State has Sudan savanna type of vegetation with two major seasons. The dry season lasting from (October to May) and raining season from (June to September). Bauchi State (Latitude and Longitude coordinates are:10.30100 N,9.82370E), with a weather variation, the wet season is oppressive and overcast, the dry season is partly cloudy, and it is hot year round. Over the course of the year, the temperature typically varies from 13.9°C to 37.8°C and is rarely below 10.6^{oC} OR above 40^{oC}. Bauchi aggregates up to 492mm (19.37”) of precipitation.

Storage Techniques

Different storage techniques as listed, below were used as treatments. All the storage techniques were kept at the herbarium, Department of Biological sciences, Bauchi State University, Gadau

Riverbed Sand Techniques

In this method, the onions were stored on riverbed sand spread on concrete floor as commonly practiced by most farmers.

Doum Palm Fruit Storage Techniques

DPFST is the first onion storage structure developed by this study. Here the doum palm fruit was spread on the onions

Neem Leaves Techniques

Neem leave storage structure is also the second onion storage structure developed by this study. Here the Neem leaves was spread on top of onion

Experimental Design

The Completely Randomized Design (CRD) was used for this research, as the experimental unit (onions) is homogenous (Laxman, 2005).

Data collection

Data was recorded on the bulbs during the period of storage. Initial observations were recorded before imposing treatments. The Data recorded were;

Loss in Weight percentage (LW%)

The weights of the bulbs were recorded at 15, 30, 45, 60, 75 and 90 days after storage(DAS) using a weighing balance. The cumulative loss in weight of bulbs was calculated and expressed as per cent loss in weight using the formula given below (Laxman, 2005).

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$$LW\ (\%) = \frac{P0 - P1 \text{ or } P2 \text{ or } P3 \text{ or } P4 \text{ or } P5 \text{ or } P6}{P0} \times 100$$

Where P0 = initial weight P1 = weight after 15 days
P2 = weight after 30 days P3 = weight after 45 days
P4 = weight after 60 days P5 = weight after 75 days and
P6 = weight after 90 days

Sprouting Percentage

For determination of the sprouting percentage on stipulated days after storage, the bulbs showing a sprout were separated and weighed on a balance. The sprouting percentage, which indicated the weight of the bulbs sprouted on 15, 30, 45, 60, 75 and 90 DAS was calculated by using the formula given below (Laxman, 2005).

$$\text{Sprouting percentage} = \frac{\text{Weight of the sprouted bulbs}}{\text{Initial weight of bulbs}} \times 100$$

Rotting Percentage

The weight of the rotted bulbs at the end of 15, 30, 45, 60, 75 and 90 (DAS) was recorded under each storage condition and the rotting percentage was calculated by using the formula below (Laxman, 2005).

$$\text{Rotting percentage} = \frac{\text{Weight of the rotted bulbs}}{\text{Initial weight of the bulbs}} \times 100$$

Damage of Black Mould (%)

The damage of black mould, a major storage disease caused *by Aspergillus niger* was recorded at 15, 30, 45, 60, 75 and 90 DAS. And the damage of black mould expressed as percentage of bulbs affected out of 100 bulbs.

Healthy Bulbs (%)

At the end of storage period (90 DAS), the rotted and sprouted bulbs were separated and the weight of healthy bulbs were recorded. The recovery of healthy bulbs was calculated by using the following formula (Laxman, 2005).

$$\text{Healthy bulbs (\%)} = \frac{\text{Weight of the healthy bulbs obtained}}{\text{Initial weight of bulbs stored}} \times 100$$

Data Analysis

Data obtained from the treatments: Loss in weight, Sprouting percentage, Rotting percentage, Damage of post-harvest diseases (black mould) at different intervals were analyzed using analysis of variance (ANOVA). Means that were significantly different ($P<0.05$) where separated with Tukey using Minitab version 16.

RESULTS

Loss in Weight (LW %)

The results of the loss in weight (LW %) of the onion bulbs are presented in Table1.

Significant differences were observed among the storage methods in the LW of the bulbs throughout the storage period. Minimum LW (2.24, 4.22, 5.68, 7.00 and 10.08%) was recorded in the bulbs stored in Doum palm fruit storage techniques (DPFST).

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Table 1: Effect of different storage conditions on loss in weight (%) of onion

Treatment	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
DPFST	2.24[a]	4.22[a]	5.68[a]	7.00[a]	8.50[a]	10.80[a]
RBS	3.10[b]	5.24[c]	7.80[d]	9.40[c]	10.08[b]	12.40[b]
Neem leave	3.22[c]	5.22[c]	6.90[b]	8.64[b]	10.20[b]	12.70[b]
Control	3.16[b]	5.06[b]	6.98[b]	9.56[d]	12.10[c]	14.60[d]

Values sharing the same superscript in the same column are not significantly different ($p<0.05$).
DAS- Days After Storage.
DPFST- Doum Palm Fruit Storage Techniques.
RBS- Riverbed Sand.

Rooting Percentage

The different storage conditions showed significant differences with respect to per cent rotting during all the stages of storage period. Among the storage conditions experimented, minimum rotting was observed in the Riverbed sand (0.20, 0.65, 1.55, 4.8 and 6.85%) as shown in Table.2.

Table 2: Effect of different storage conditions on rotting (%) of onion

Treatment	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
DPFST	0.25[a]	1.86[c]	3.62[b]	5.66[b]	7.61[b]
RBS	0.20[a]	0.65[a]	1.55[a]	4.80[a]	6.85[a]
Neem leave	0.20[a]	1.80[b]	3.60[b]	5.20[b]	8.10[c]
Control	0.60[b]	1.80[b]	3.90[c]	5.78[c]	8.25[c]

Values sharing the same superscript in the same column are not significantly different ($p<0.05$).
DAS- Days After Storage.
DPFST- Doum Palm Fruit Storage Techniques.
RBS- Riverbed Sand.

Black Mold Percentage

Minimum per cent black mould was noticed in bulbs stored in River bed sand, DPFST and Neem leave as shown in table 3.

Table 3: Effect of different storage conditions on damage of Black mould of onion

Treatment	45 DAS	60 DAS	75 DAS	90 DAS
DPFST	1.00[a]	2.00[a]	3.00[a]	5.00[a]
RBS	1.00[a]	2.00[a]	4.00[b]	5.00[a]
Neem leave	2.00[b]	4.00[c]	5.00[c]	6.00[b]
Control	2.00[b]	3.00[b]	5.00[c]	8.00[c]

Values sharing the same superscript in the same column are not significantly different ($p<0.05$).
DAS- Days After Storage.
DPFST- Doum Palm Fruit Storage Techniques.
RBS- Riverbed Sand.

Sprouting Percentage

The sprouting percentage was significantly influenced by recorded different methods of storage during all the stages of observations. Among the different methods of storage, storing onions in RBS and Neem leave structure has the lowest sprouting percentage at 90 DAS. Results are shown in table 4.

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Table 4: Effect of different storage conditions on sprouting percentage of onions

Treatment	45 DAS	60 DAS	75 DAS	90 DAS
DPFST	0.66[b]	1.10[a]	2.30[b]	3.80[b]
RBS	0.56[b]	0.96[a]	2.22[a]	3.30[a]
Neem leave	0.47[a]	1.08[a]	2.27[b]	3.49[a]
Control	0.87[c]	2.06[b]	3.10[c]	4.12[c]

Values sharing the same superscript in the same column are not significantly different ($p<0.05$)
DAS- Days After Storage.
DPFST- Doum Palm Fruit Storage Techniques.
RBS-Riverbed Sand.

Percentage of Healthy Bulbs

Maximum healthy bulbs at the end of storage period (90 DAS) were found in DPFST (74.90%) which is followed by Riverbed sand structure (73.20%). This is shown in Table 5.

Table 5: Effect of different storage conditions on percentage of healthy bulbs of onions.

Treatment	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
DPFST	94.80[a]	90.60[b]	84.40[b]	80.95[c]	74.90[b]
RBS	94.30[a]	9.10[b]	83.30[a]	79.82[b]	73.20[b]
Neem leave	94.13[a]	88.70[b]	83.80[a]	78.78[b]	72.17[b]
Control	93.54[b]	88.10[b]	82.94[a]	70.41[a]	67.30[c]

Values sharing the same superscript in the same column are not significantly different ($p<0.05$)
DAS- Days After Storage.
DPFST- Doum Palm Fruit Storage Techniques.
RBS- Riverbed Sand.

DISCUSSION

In results of the loss in weight (LW, %) of the onion bulbs, The mean LW% of the bulbs irrespective of storage condition increased from 3.00 % at 15 DAS to 13.60% at 90 DAS. Significant differences were observed among the storage methods in the LW of the bulbs throughout the storage period. Minimum LW (2.24, 4.22, 5.68, 7.00 and 10.08%) was recorded in the bulbs stored in Doum palm fruit storage techniques (DPFST). The minimum weight loss under DPFST may be due to less transpiration and respiration due to low temperature and high relative humidity as reported by Kaul and Mehta (1999).

In rotting percentage, there was no loss of bulbs due to rotting in all storage methods at 15 days after storage. The mean per cent rotting of bulbs irrespective of storage methods increased from 0.6 at 30 DAS to 8.25 at 90 DAS. The different storage conditions showed significant differences with respect to per cent rotting during all the stages of storage period. Among the storage conditions experimented, minimum rotting was observed in the Riverbed sand (0.20, 0.65, 1.55, 4.8 and 6.85%), Microbial spoilage is a major constraint in improving storability of onion bulbs. Microbes multiply and infect the bulb surface when congenial conditions prevail. Onion bulbs are commonly affected by various post-harvest diseases like black mould, neck rot, white rot and soft rot. Among these, the major post-harvest disease that was responsible for black mould in onions is caused by *Aspergillus niger.* Apart from damage of black mold, the mean per cent of black mould occurrence in the bulbs irrespective of storage condition increased from 1.67 per cent at 45 DAS to 6.8 per cent at 90 DAS. There was no black mould

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recorded at 15 and 30 DAS in all the storage conditions. Minimum per cent black mould was noticed in bulbs stored in River bed sand, DPFST and Neem leave. This is in conformity with the work of Srivastava *et al*., (1997) where fungicides were used to reduce rotting percentage.

In terms of sprouting, the mean sprouting percent of the bulbs increased from 0.72 % at 45 DAS to 3.86 % at 90 DAS irrespective of storage condition. There was no sprouting up to 30 days in all the storage conditions. The sprouting percentage was significantly influenced by recorded different methods of storage during all the stages of observations. Among the different methods of storage, storing onions in RBS and Neem leave structure has the lowest sprouting percentage at 90 DAS. This was attributed to the low relative humidity and also to the increased ventilation rates result in the reduced sprouting percentage which is in agreement with what was reported by (Sharma and Kamalesh, 2000; Laxman, 2005)

At the end of this research, the mean percentage of healthy bulbs decreased from 96.35 per cent at 15 DAS to 71.45 per cent at 90 DAS irrespective of storage conditions. Maximum healthy bulbs at the end of storage period (90 DAS) were found in DPFST (74.90%) which is followed by Riverbed sand structure (73.20%). This may be due to the structures having lowest PLW %, rotting per cent and sprouting. These findings are in confirmation with the result of Laxman (2005), Srivastava et al. (1997) and Sharma and Kamalesh (2000) in onion.

CONCLUSION

The storability of onions is greatly influenced by post-harvest physiological factors such as loss in weight, sprouting, rotting and the incidence of black mould throughout the storage (30, 45, 60 and 90 days after storage). These post-harvest parameters are among the major determinants of onion profitability during storage. Prices obtained during the study year revealed an escalation of about 75% market value of the onions from initial storage to the end of this study. This proves the profitability of onion storage.

Based on the findings of this research, the DPFST onion storage structure and the Riverbed sand techniques is best recommended for use by farmers as they are proven to have the highest marketable bulbs at the end of this study.

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