Storage performance of naturally ventilated structure for onion bulbs

Wolelaw Endalew[1], Abaye Getahun[2], Ayalew Demissew[3], Tesfa Ambaye[4]

(1. *Bahir Dar Agricultural Mechanization and Food Science Research Center, P.O.Box 133, Bahir Dar, Ethiopia*;
2. *KU Leuven, Belgium*;
3. *Bahir Dar Institute of Technology, School of Chemical & Food Eng., Bahir Dar, Ethiopia*;
4. *Amhara Design & Supervision Works Enterprise, Bahir Dar, Ethiopia*)

Abstract: A comparative study of naturally ventilated onion bulb storage structure and traditional in house floor storage was conducted in Fogera plain, Ethiopia to determine their performances. Onion bulb of Bombay Red cultivar was stored for 90 days in naturally ventilated storage structure and in house floor. The study was conducted from end of April to Jun 2011. Hourly temperature and relative humidity of ambient and storage environment were monitored and the physiological weight loss, sprouting percentage, rotting percentage and percentage of marketable bulbs on stored bulb were recorded every ten days interval. The observation has shown that the temperature profile of naturally ventilated storage structure has followed similar pattern with the ambient environment. Total percentage of bulb loss increases with storage period in both storage methods and lower values were observed in naturally ventilated structure than in house floor storage method. On the 50th day after storage, the overall bulb losses in naturally ventilated structures and in house floor storage were found to be 68.51% and 78.56% respectively.

Keywords: Physiological loss, relative humidity, sprouting loss, temperature, weight loss

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1 Introduction

Onion (*Allium cepal L.*) is one of the major commercial vegetable crops grown in most parts of Ethiopia. It forms part of a daily diet in almost all households throughout the year. The mature bulbs are usually used as condiment for the preparation of traditional dishes either in fresh form or dried and mixed with other spices that are shelved for extended use. It is the most important source of incomes for smallholder farmers, women and young people including all actors engaged in the production-consumption chain.

Although onion is considered as a semi perishable crop yet it is a delicate product to store due to its high water content. Depending on cultivar type and pre harvest as well as post harvest treatments, onion bulbs can be stored at low temperature (0-5°C) or high temperature (25-30°C) maintaining the relative humidity in the range of 55%-70% (Chope, 2006 and Kukanoor, L. 2005). The overall storage losses under these storage conditions are high and generally increase with the increase in storage period. Bulb sprouting and rooting are reported as the main reasons for storage loss (Milenkovic, I.Z., *et.al*, 2009). S.K. Biswas *et.al*, (2010) reported that 46% to 56% bulb storage losses are found under different kinds of storage structures.

The onion production during the dry season is surplus in Ethiopia. During this bulk production period, onion growers either sell their produce at throw out price in fear of high storage loss or store for a few days using traditional methods under ambient environment. In both

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*** Corresponding author: Wolelaw Endalew,** Bahir Dar Agricultural Mechanization and Food Science Research Center, P.O.Box 133, Bahir Dar, Ethiopia. Email: en_woelawl@yahoo.com.

cases, dealers have more control of onion price in favor of them than growers. Improved onion bulb storage facilities such as cold storage are not available and beyond the reach of small holder farmers. Significant onion bulb quality can be retained until market is secured using mud structures that can be locally built under natural ventilation (Ghulam Nabi, *et.al*, 2013). There is scanty information with regards to performance of naturally ventilated structures for onion bulbs. Lord Abbey *et al* (2000) reported high rate of physiological weight loss in the first four weeks under naturally ventilated stored bulbs. Such results vary with the type of cultivar and physical property of the environment under study. This study was therefore, undertaken with the view to determine the storage performance of naturally ventilated structure for onion bulbs.

2 Materials and method

The investigation was carried out around river *Ribb* areas in *Fogera* district, Ethiopia during April to end of June 2011. The area is located at 11°58 latitude and 37°41 longitudes with an altitude of 1,750 meters above sea level which has an average annual rainfall of 1,150 mm. Bombay Red cultivar bulb onion which had been freshly harvested (24 March 2011) were obtained from the experimental area. The bulbs used for the study were grown at farmers' fields. Both the pre harvest and post harvest treatments, which have immense contribution on the effect of storage, were done according to farmers' practice. To hasten bulb maturity the field was trampled by human beings when 10% leafs have fallen and then left for about ten days. Then after, bulbs were harvested with local plow and piled in partial shed. The bulb necks were manually trimmed using sickle at a height of 3-2 cm as practiced by farmers in the area. These bulbs were allowed to dry in partial shed for four days under ambient environment so as to remove any traces of water on the surface of the bulb. Sorting was carried out to remove bulbs having marked defects and only marketable bulbs were filled in to the storage.

The storage methods used for this study were naturally ventilated bulb onion storage structure (NVBOSS) and storing bulbs in house floor that is the traditional method often used by farmers in the study area. The foundation of NVBOSS was constructed as raised platform 70 cm above the ground level with down ventilation. This is because the experimental area is flooded during the rainy season up to a height of 70 cm. The wall material was made from 40 cm × 20 cm × 15 cm mud block and the roof was covered with 10 cm thick thatched grass. The storage was provided with bottom and top shelves for storing the bulbs where these shelves were constructed 25 cm and 125 cm above the plenum respectively. Shelf width was 90 cm and the bulb storage capacity of each shelf was estimated to be 0.35 t. Access door was provided to fill and take out the bulb onion. Even though the constructed storage capacity of NVBOSS was 1.4 t, only 0.6 t onion bulbs was filled for the test. The floor storage method used for this study was farmer's house. Its roof was covered with corrugated iron on a plinth area of 43 m^2 and a slated wall plastered with mud at the interior side. The first 40 days of storage period in the area was warm and low humid. During this storage period two liters of water was sprayed every two days at the base of naturally ventilated bulb onion storage structure in order to improve relative humidity of the storage environment (Figure 1).

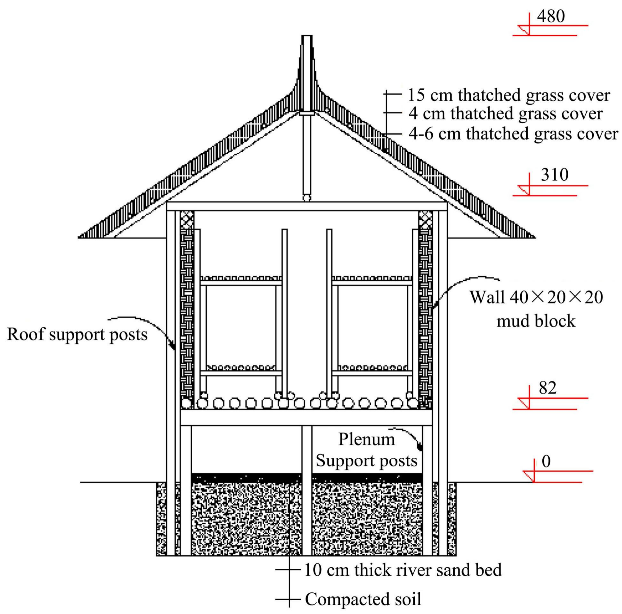

Figure 1 Naturally ventilated bulb onion storage structure

Known weight and number (n=70) of randomly selected sample bulbs were kept in grated plastic tray in three locations of each storage at two host farmers. These sample bulbs were visually assessed and weight data on rotting, physiological loss, sprouting and marketable bulb were recorded at each ten days interval. A bulb was considered to have started rotting when there is any sign of decay around the neck area and considered sprouted when the sprout leaves had emerged from the neck. The rotted and sprouted bulbs were sorted from the sample container tray after recording so as to avoid double counting (Kebede, L., and S.Aklilu.2007). The physiological weight loss was measured using sensitive balance (OHAUS Corporation, USA, with an accuracy of ±1 gm). The temperature and relative humidity of both the storage and ambient condition was monitored on hourly basis throughout the storage period using data loggers (WatchDog data logger, Spectrum Technologies, Inc.).

While determining the physiological response of bulb onion during storage, initial sample weights were the base for all calculations. The resulting data were subject to t-test using SAS statistical package (SAS Institute, 1999-2000) and graphs were plotted using MATLAB and Microsoft Excel.

3 Results and discussion

3.1 Temperature

The hourly temperature of ambient environment, NVBOSS and in house floor storage during the storage period have been monitored and the daily mean values are plotted to compare as shown in Figure 2.

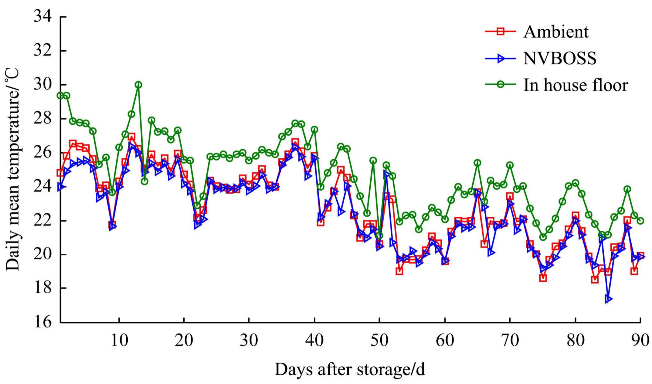

Figure 2 Variation of daily mean temperature of ambient and storage environments

The temperature records inside both storage methods follow a similar pattern with the prevailing ambient condition. Temperature records of in house storage method were higher than both the prevailing ambient condition and NVBOSS, which showed significant (P<0.05) variations throughout the storage period. The daily mean temperature of in house floor storage method in most occasions remained 0.4°C to 3.3°C higher than the ambient and NVBOSS temperature records. The higher temperature record of in house storage is due to high thermal conductivity of corrugated iron roofing and heat coming from dwellers beings living in it as well as kitchen fire as the house environment is a heat sink. There was no significant (P>0.05) variation of temperature records between the ambient condition and NVBOSS. The temperature values in both environments for the first 45 days after storage were nearly in the optimum temperature range (22-30°C) for bulb onion storage. After mid of May, the ambient and storage daily mean temperature record has decreased below 22°C, which is lower than the optimum temperature for bulb onion storage.

3.2 Relative humidity

The daily mean relative humidity results of both ambient and storage environments during the storage period have been recorded and plotted as shown in Figure 3.

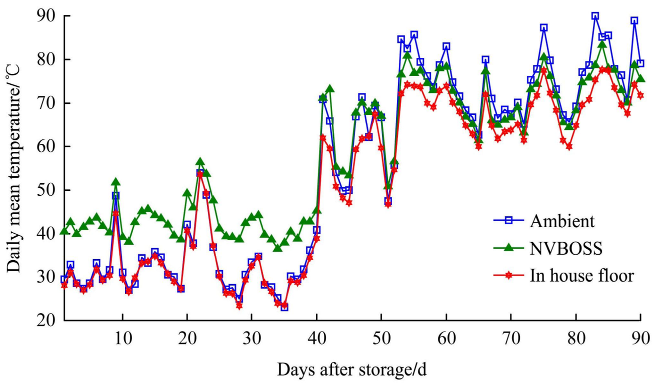

Figure 3 Variation of daily mean relative humidity of ambient and storage environments throughout the storage period (t-test at P<0.05)

The ambient relative humidity value in the area was very low until 40 days after storage (mid of May 2011). During this storage period, the daily mean relative humidity values for ambient environment and traditional storage method were occasionally recorded below 30%. The relative humidity during this period in NVBOSS was around 40%, which was still below the recommended optimum value (55%-70%) for bulb onion storage.

After the onset of the rainy season, the relative humidity of ambient as well as storage environment has increased and higher values than the desired limit were recorded in ambient and NVBOSS for a few days.

3.3 Physiological loss in weight

The t-test showed significant (P<0.05) variation between storage methods with regards to overall percentage of physiological loss in weight of stored bulbs within 80 days after storage. The physiological loss in weight of stored bulbs increases progressively with increase in days after storage in both storage methods (Figure 4).

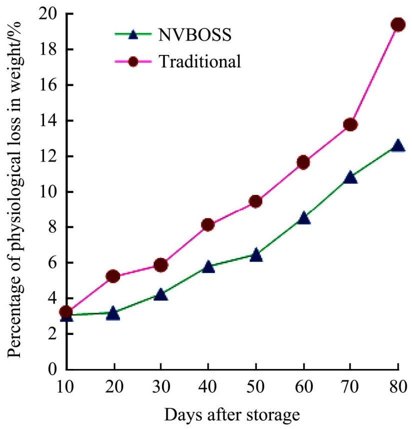

Figure 4 Effect of storage method and period on percentage of physiological loss in weight of stored bulbs

The percentage of physiological loss in weight for bulbs stored in house floor (traditional) method was higher than bulbs stored in NVBOSS. This is attributed to the lower relative humidity records in the traditional storage method during the first 40 days after storage. The initiation of sprouting after this time also contributes to increase in physiological loss in weight for bulbs stored in both storage methods.

3.4 Sprouting loss

Sprouting in stored bulbs is a result of physiological change in which storage can only affect its rate. A perusal of data plotted on Figure 5 revealed that sprouting has not been observed until 30 days after storage in both storage methods. The first visible sprout was observed on the 40th day of storage in both storage methods and this presumably shows that it is the physiological rest period of the onion cultivar under test at the recorded temperature value and the pre harvest as well as post harvest treatments made on the bulb.

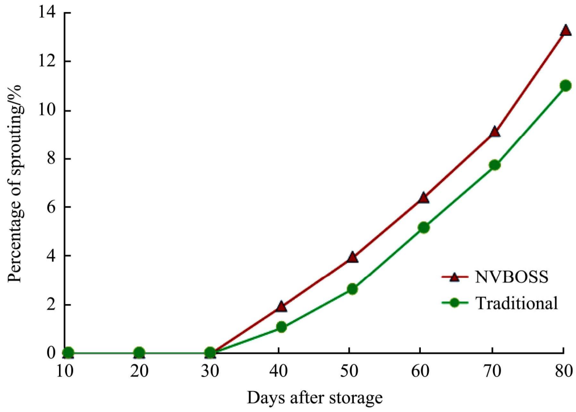

Figure 5 The effect of temperature and days after storage on percentage of bulb sprouting

The percentage of sprouting in NVBOSS was higher than in house floor (traditional) method as the traditional storage method exhibits higher temperature records than NVBOSS. However, the overall sprouting percentage between storage methods throughout the storage period did not show significant (P>0.05) variation.

3.5 Percentage of rotting

Rotting was observed in the first 10 days in both storage methods (Figure 6). It was not observed for the rest period until 50 days after storage. The percentage of rotting on 50th day was 2.41% and 3.31% for NVBOSS and traditional method respectively. It has shown an increasing trend with increase in storage periods for both methods and the values observed on the 80th day was 10.62% and 11.16% for the respective storage methods. The percentage of rotting in traditional storage was higher when compared to NVBOSS. However, the overall value did not show significant (P>0.05) variation.

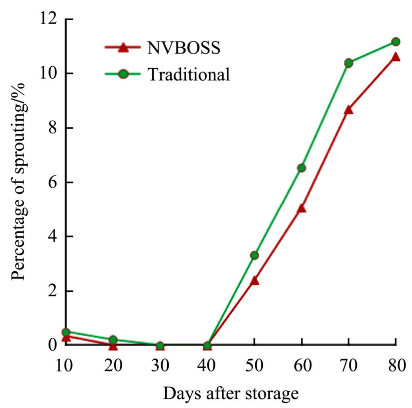

Figure 6 Rotting of stored bulb onion

The occurrence of rotting during the first storage periods is attributed to availability of some moisture traces on the surface of bulb onion. Rotting after 40 days of storage was mainly due to higher relative humidity as this aggravates rotting.

3.6 Percentage of marketable bulbs

The percentage of marketable bulbs in NVBOSS was higher from traditional storage throughout the storage period and the overall values show significant (P<0.05) variation. It has decreased with increase in storage time in both storage methods (Figure 7).

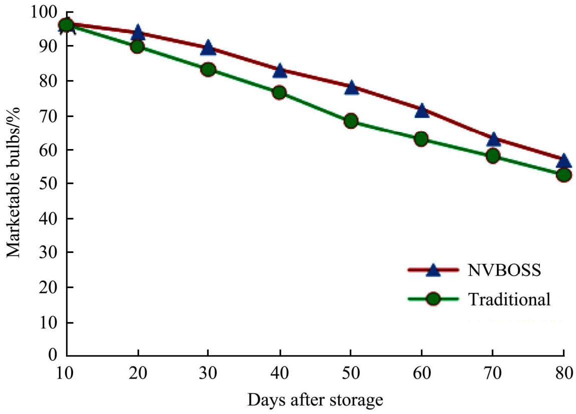

Figure 7 Percentage of marketable bulb

The maximum percentage of marketable bulbs on 10th day after storage was 96.93% and 96.3% for NVBOSS and traditional method respectively. This value has decreased to 78.56% and 68.51% on 50th day after storage for the respective storage methods and storage after this time is uneconomical as percentage of marketable bulbs showed a remarkable decrease with increase in storage time.

4 Conclusion and recommendations

Based on this study, overall loss of bulb onion in traditional storage is higher than NVBOSS. This is due to lower relative humidity records than optimum for bulb onion storage. This indicates that Bombay Red onion can be stored using naturally ventilated bulb onion storage structures at river *Ribb* area up to two months with a tolerable loss until market is secured. The structure can be built from locally available materials and skill with a reasonable cost.

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