Evaluation of naturally ventilated bulb onion storage structure around Ribb river

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Abstract

A comparative study of naturally ventilated bulb onion storage structure and traditional floor storage was conducted around river Ribb area in Fogra district, Ethiopia to determine their performances. Bulb onion of Bombay Red cultivar was stored for 90 days in naturally ventilated storage structure and on floor storage system inside the farmers' house. The study was conducted from end of April to Jun 2011. Hourly temperature and relative humidity of ambient and storage environment were monitored and physiological weight loss, sprouting and rotting percentage, and percentage of marketable bulbs for stored bulb were recorded at ten days interval. Results showed that the temperature profile of tha naturally ventilated storage structure followed similar pattern with the ambient environment. Higher relative humidity was recorded for the ambient and floor storage environment. Physiological weight loss of stored bulbs increased with an increase in storage period for both storage methods and higher values were observed in floor storage method.

Introduction

Bulb onion (*Allium cepa 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 bulbs are used for flavoring of different food stuff which are directly consumed and also used as a preservative for food items that are shelved for quite some time. It is the most important source of incomes to small holder farmers, women and young people including all actors engaged in the production-consumption chain.

Bulb onion is currently produced by smallholder farmers around *Rib*b river of *Fogera* district. High water content and low pungent Bombay Red cultivar is widely adopted in the area. The production is mainly based on irrigation using the river *Ribb* during the warm climate season and the fresh produce is available in market from February to March. In the study area, onion is traditionally stored for a few days using conventional methods. These include: using fiber jute sacks, open shades in the field and floors in a house. Onion, having high water content, is a delicate product to store. It can be stored at low temperature (0-5 ^{O}C) and high temperature (25-30 ^{O}C) and relative humidity of 55-70%. The high perishable nature of bulb onion coupled with poor market and absence of improved storage structures has resulted to high postharvest loss. This has forced farmers to sell onion at any price set by dealers in the chain. Improved farm level storage system is, therefore, required to be evaluated and introduced to extend the shelf life of fresh onion produced, so as to reduce postharvest loss and increase its marketability throughout the year with reasonable price.

Materials and methods

The investigation was carried out around river *Ribb* in *Fogera* district, Ethiopia during April to end of June 2011. The area is located at 11^{0} 58' latitude and 37^{0} 41' longitude with an altitude of 1750 m above sea level which has an average annual rainfall of 1150 mm. Freshly harvested (24 March 2011) bulbs of var. Bombay Red were obtained from the experimental area. The bulbs used for the study were grown at farmers fields. Both the pre harvest and postharvest treatments, which have immense c 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 capacity of each shelf was estimated to be 0.35 tons. Access door was provided to fill and take out the bulb onion. Even though the constructed storage capacity of NVBOSS was 1.4 tons, only 0.6 tons bulb onion 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 less 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.

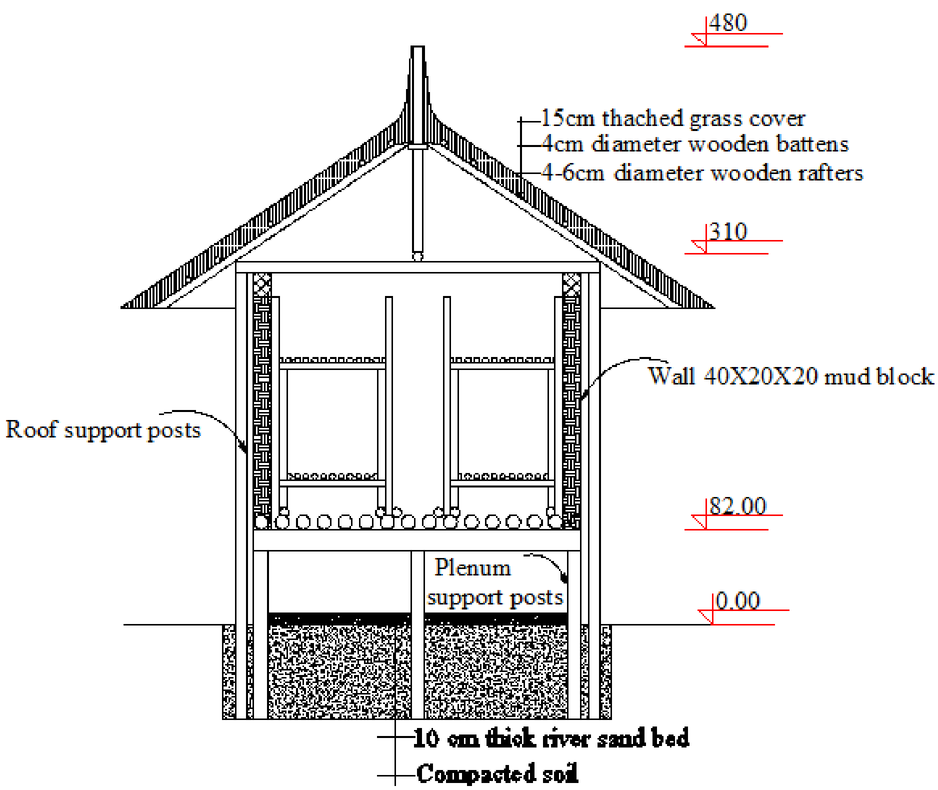

Figure 1. Naturally ventilated bulb onion storage structure.

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 ten days interval. A bulb was considered to have started rotting when there exists any sign of decay around the bulb neck 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 (Laike and Shimelis, 2007). The physiological weight loss was measured using sensitive balance (OHAUS Corporation, USA, with an accuracy of ±1 g). The temperature and relative humidity of both the storage and ambient conditions were 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 weight is the base for all calculations. The resulting data were subject to t-test using SAS statistical package (SAS Institute, 1999-2000).

Results and discussion

Temperature

The hourly temperature of ambient environment, traditional storage and NVBOSS during the storage period have been monitored as detailed earlier and daily mean value is plotted as shown in Figure 2.

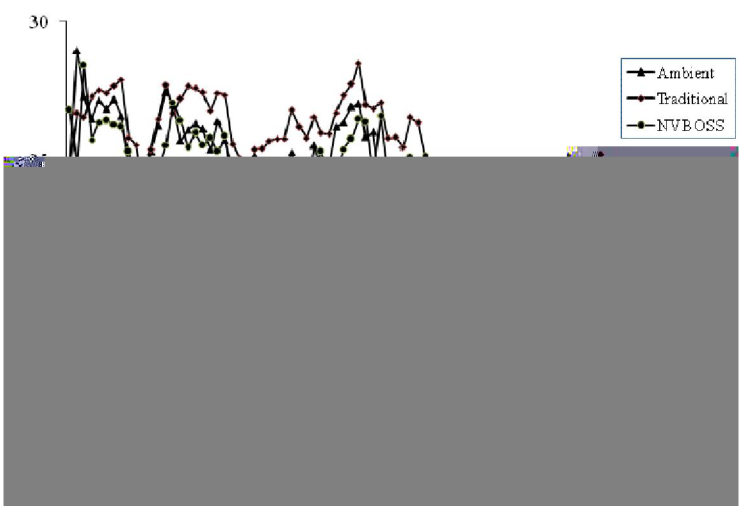

Figure 2. Variation of daily mean temperature of ambient and storage environment throughout the storage period.

The temperature records inside both storage methods follow a similar pattern with the prevailing ambient condition. Temperature records in the traditional storage method was 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 traditional method in most occasions remained 0.4 to 3.3 ^{O}C higher than the ambient and NVBOSS temperature. The higher temperature record of traditional storage is due to high thermal conductivity of corrugated iron roofing and heat coming from dwellers 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 in both environments for the first 45 days after storage was nearly in the optimum temperature range (25-30 ^{O}C) for bulb onion storage. After mid May, the ambient and storage daily mean temperature decreased below 25 ^{O}C, which is lower than the optimum temperature for bulb onion storage.

Relative humidity

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

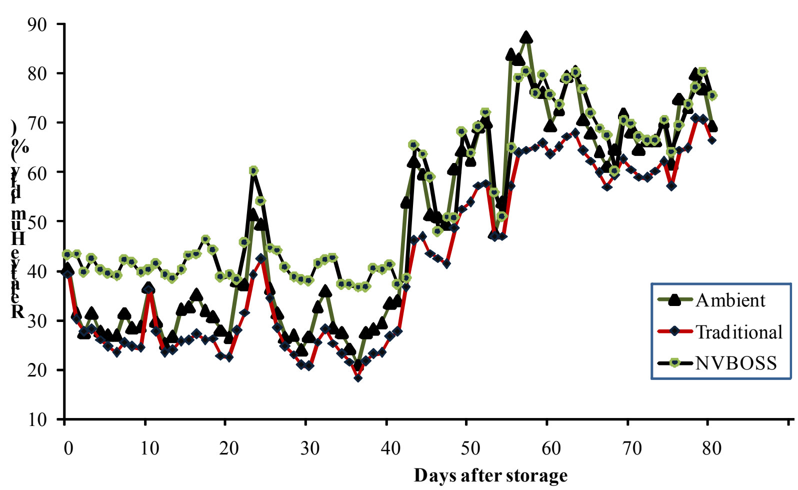

Figure 3. Variation of daily mean relative humidity of ambient and storage environment throughout the storage period (t-test at $P<0.05$).

The ambient relative humidity value in the area was very low until 40 days after storage (mid 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.

Physiological weight loss

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

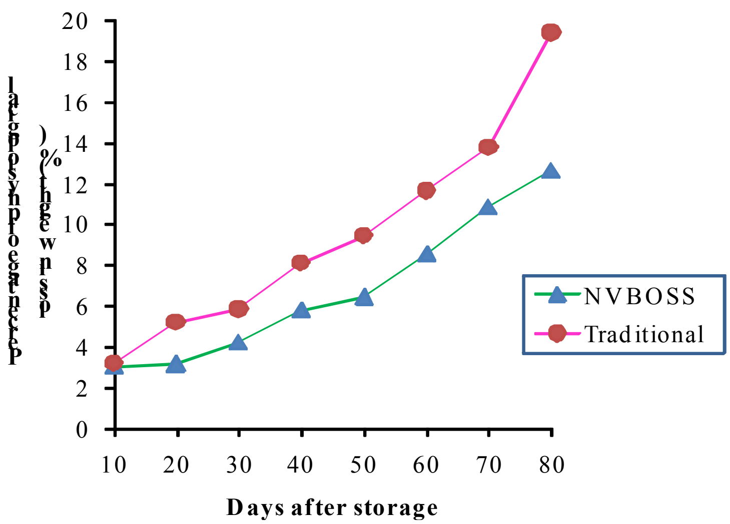

Figure 4. Effect of storage method and period on percentage of physiological weight loss in stored bulbs.

The percentage of physiological weight loss for bulbs stored in 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 contributed to increase in physiological weight loss in bulbs stored in both storage methods.

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 in 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 preharvest as well as postharvest treatments.

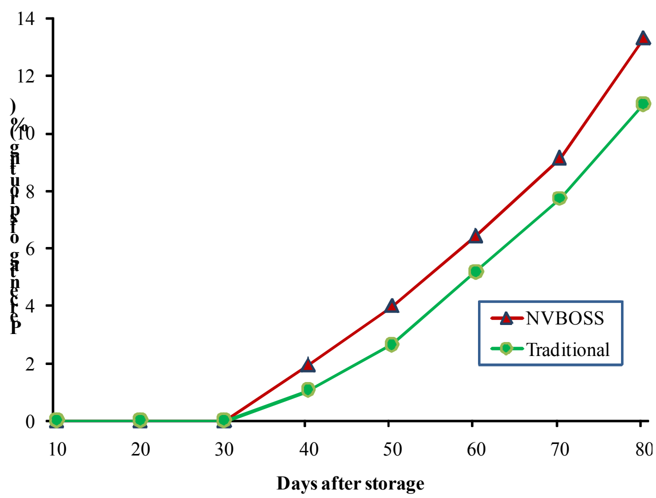

Figure 5. The effect of temperature and days after storage on percentage of bulb sprouting.

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

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. 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.

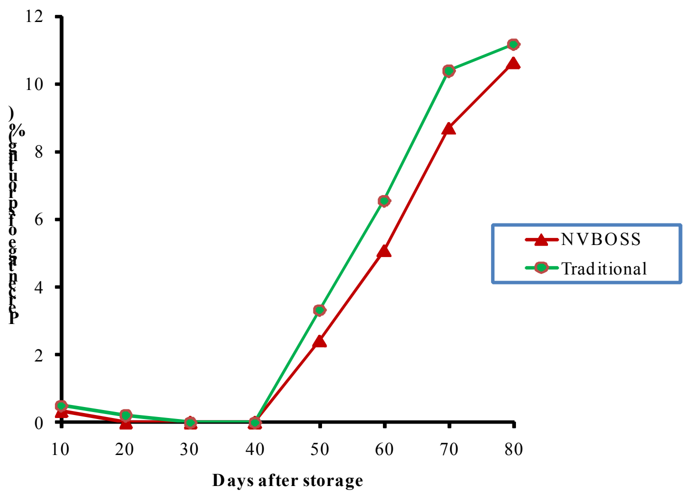

Figure 5. Rotting of stored bulb onion under naturally ventilated and traditional storages.

Percentage of marketable bulbs

The percentage of marketable bulbs in NVBOSS was significantly higher ($P<0.05$) than the traditional storage throughout the storage period. It decreased with an increase in storage time in both storage methods (Figure 6).

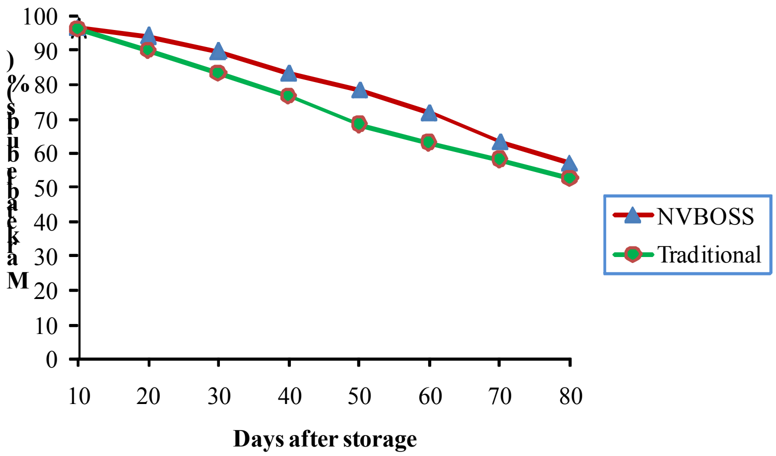

Figure 6. Percentage of marketable bulb under naturally ventilated and traditional storages.

The maximum percentage of marketable bulbs on the 10th day after storage was 96.9% and 96.3% for the NVBOSS and traditional method, respectively. This value has decreased to 78.6% and 68.5% on the 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.

Conclusion and recommendations

Based on this study, overall loss of bulb onion in traditional storage is higher than NVBOSS. This is due to the lower relative humidity which is below the optimum for bulb onion storage. This indicates that Bombay Red 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.

References

Altaf Qadir, Fumio Hashinaga and Md Rezaul Karim. (2007). Effect of Pre-storage Treatment with Ethanol and CO_2 on Onion Dormancy. J. bio-sci. 15:55-62, 2007.

B. Herold; B. Oberbarnscheidt; M. Geyer. (1998). Mechanical Load and its Effect on Bulb Onions due to Harvest and Post-harvest Handling. *J. Agric*. *Engng Res*. (1998) 71, 373-383.

Gemma Amy Chope. (2006). Understanding the mechanism behind onion bulb dormancy in relation to potential for improved onion storage. PhD Thesis submitted to Carnfield University. Cranfield Health Plant Science Laboratory. Retrieved date:04/05/2011. https://dspace.lib.cranfield.ac.uk/.../1826/.../Gemma_Chope_Thesis_ *2006.p.*

Laike Kebede and Shimelis Aklilu. (2007). Development of Naturally Ventilatrd Onion Bulb Storage Structures. P. 128-136. In Firew Kelemu, Omar Taha and Gessessew Likeleh (Eds.) Proceedings of the first National Agricultural Mechanization completed research forum. June 5-7, 2007.

Laxman Kukanoor (2005). Post harvest studies in onion. PhD Thesis submitted to the University of Agricultural Sciences, Dharwad. Retrieved date: 18/04/2011 http://etd.uasd.edu/ft/th8441.pdf

SAS, 1999-2000. Statistical Analysis System User's Guide: Statistics. SAS. Inc. Cary, North Carolina.