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EFFECT OF STORAGE METHODS ON THE QUALITY OF ONION BULBS

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ABSTRACT

An experiment was carried out to determine the effect of storage methods on quality of onion bulbs. The fresh bulbs of Nasarpuri variety free from defects and of uniform in size were purchased from local market and were properly cured. The bulbs were stored under three different storage methods including (i) wooden packed structure on raised platform fully ventilated having bottom and sides covered with rice straw, (ii) nylon net bag and (iii) open ground fully ventilated from all sides. The parameters studied were physiological loss in weight (%), sprouting (%), sprout length (cm), pathogen/fungi (%), rotting (%) and black mold (%). Dry and wet bulb thermometers were installed for measuring ambient temperature and relative humidity during the study. The onions were stored for three months and data were recorded at an interval of 15 days. The results revealed that the highest physiological weight loss (10.40%) was observed under open ground method, followed by nylon net bags (8.54%), while lowest physiological weight loss (4.19%) was recorded under wooden packed structure ventilated from all sides. The maximum % age of pathogen/fungi was observed under open ground (16.25%), followed by nylon net bags (11.24%), while minimum % age of pathogen/fungi was witnessed under wooden packed structure (7.91%). Minimum black mold (%) was observed under wooden packed structure (3.23%), while maximum black molds were recorded under open ground (17.50%), followed by nylon net bags (13.33%) during 90 days of storage. It was also observed that during 90 days of storage, sprouting and rotting didn't occur under any of three storage methods. It is concluded that the wooden packed structure ventilated from all sides on raised platform proved better in providing the desired environment to onion bulbs during 90 days of storage. Therefore, this study suggested that the wooden packed structure ventilated from all sides on raised platform is more effective in reducing the deterioration of onion bulbs during three months of storage.

Keywords: black mold, fungi, storage losses

INTRODUCTION

Onion (*Allium cepa* L.) is one of the most important vegetable crops in the world. It is consumed in green state, mature state and as dehydrated slices. It contains carbohydrates, protein, vitamin A, thiamine, riboflavin, niacin and ascorbic acid

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(Hanen *et al.,* 2012) and is an important component of folk medicines (Marwat *et al.,* 2011). Its importance is also mentioned in the Holy Quran and Bible (Shah *et al.,* 2012).

Global production of onion is about 64 million tons and in Pakistan, its production is about 2.015 million tons, which is 8th largest production in the world (Nabi *et al*., 2011). The major onion producing countries are China, India, USA, Pakistan, Turkey, Russia, Iran, Brazil, Mexico and Spain. Onion is a perishable crop; therefore onion bulbs are usually stored until next harvest of the crop or for a longer period due to seasonal glut in the market.

During storage periods, the onion bulbs are deteriorated due to rotting, sprouting, black mold and physiological loss in weight. These losses could be as high as 66% (Biswas *et al*., 2010), which have been a major problem for the onion growers. The losses in the onion bulbs may be reduced to a certain level through opposite storage methods. The bamboo made structures (single tier or two tier) with better aeration from sides and bottom may help in removing heat and humidity and minimize the decay and sprouting losses from 8-15% over conventional storage structures (Yadav and Yadav, 2012). Imoukhuede and Ale (2015) constructed a storage structure with different roofs and found that basket kept at room temperature is the best option for onion storage than those of asbestos, thatched and iron roof. The onions stored in conventional storage structures have no aeration at bottom, which results in bruising and decaying of onions. However, onions stored in full ventilated conditions at bottom and sides with raised structure above ground reduce the storage losses from 70.0 to 99.2% during five months of storage (Ranpise *et al.,* 2001). Similar results have been also reported by Jamali *et al.* (2012), who attributed that the physiological weight loss after 60 days of storage at raised platform under ambient condition was 7.74%, 8.86 % and 10.89% in Nasarpuri, Phulkara and Indian White bulb varieties, respectively The losses in bottom and sides ventilated structures are much lower (35.17%) than other methods (Tripathi and Lawande, 2003).

Production of onions in Pakistan is adequate, but due to storage losses under conventional storage methods; onion growers cannot get their modest demand (Ahmed *et al*., 2005). In addition the losses decrease the quality of product (Milenkovic *et al*., 2009). Therefore a study was designed to investigate the effect of storage methods on the quality of onion bulbs.

MATERIALS AND METHODS

This experiment was conducted at Latif Experimental Farm of Sindh Agriculture University Tandojam. Approximately 90 kg of onion bulbs (Nasarpuri) variety purchased from local market were included in the study. The onions were stored under three different storage methods including (i) wooden packed structure on raised platform fully ventilated having bottom and sides covered with rice straw, (ii) nylon net bag and (iii) open ground fully ventilated from all sides. These methods were performed in a well-ventilated store. The experiment was arranged in a randomized complete design (RCD) with three replications. Five randomly selected onion bulbs were marked in each storage method and were tested for the changes in the quality of onion bulbs for the period of three months at an interval of 15 days. The following parameters were evaluated to test the quality of onion bulbs:

Physiological loss in weight

The physiological loss in weight (%) was calculated using the formula of Kukanoor (2005):

$$PLW\left(\%\right)=\left(\frac{P_i-P_n}{P_n}\right)\times 100$$

Where,
PLW= Physiological Loss in Weight
P_i = Initial Weight
P_n = Weight, days after storage

Sprouting

To determine sprouting (%) intensity the sprouted bulbs were separated from the experiment and were calculated using the formula of Kukanoor (2005):

$$Sprouting\left(\%\right)=\frac{Number\ of\ \ sprouted\ \ bulbs}{Total\ \ number\ of\ \ bulbs}\times 100$$

Pathogen/Fungi

Onions bulbs infected by Pathogen/Fungi were separated and loss (%) was calculated using of following formula of Kukanoor (2005):

$$Pathogen/Fungi\left(\%\right)=\frac{Number\ of\ \ affected\ \ bulbs}{Total\ \ number\ of\ \ bulbs}\times 100$$

Rotting

Following formula was used to determine the rotting loss (%) (Jamali *et al.,* 2012):

$$Rotting\left(\%\right)=\frac{Number\ of\ \ rotted\ \ bulbs}{Total\ \ number\ of\ \ bulbs}\times 100$$

Black mold

Following formula was used to determine the black mold loss (%) (Jamali *et al.,* 2012):

$$Black\ \ mold\left(\%\right)=\frac{Number\ of\ \ affected\ \ bulbs}{Total\ \ number\ of\ \ bulbs}\times 100$$

Ambient temperature and relative humidity

The ambient temperature and relative humidity were recorded during the storage period. Dry and wet bulb thermometers (Psychrometer) were used to determine the ambient temperature and relative humidity. The ambient temperature was directly calculated from dry bulb, whereas relative humidity was determined by

Psychrometric chart using dry and wet bulb data. During three months of storage period, temperature ranges between 32^{O}C to 40^{O}C, while relative humidity varied from 60% to 93% as can be seen from Figures 1 and 2.

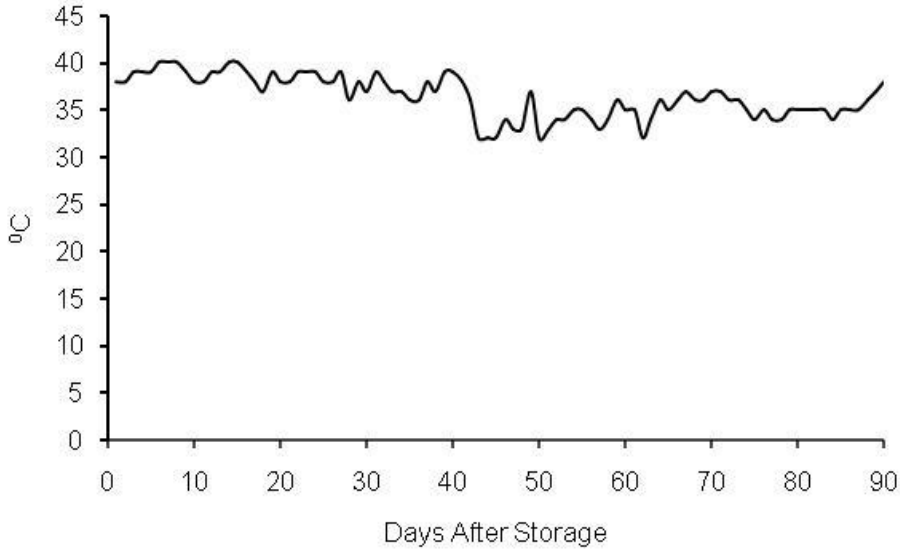

Figure 1. Temperature (^{O}C) recorded during the study

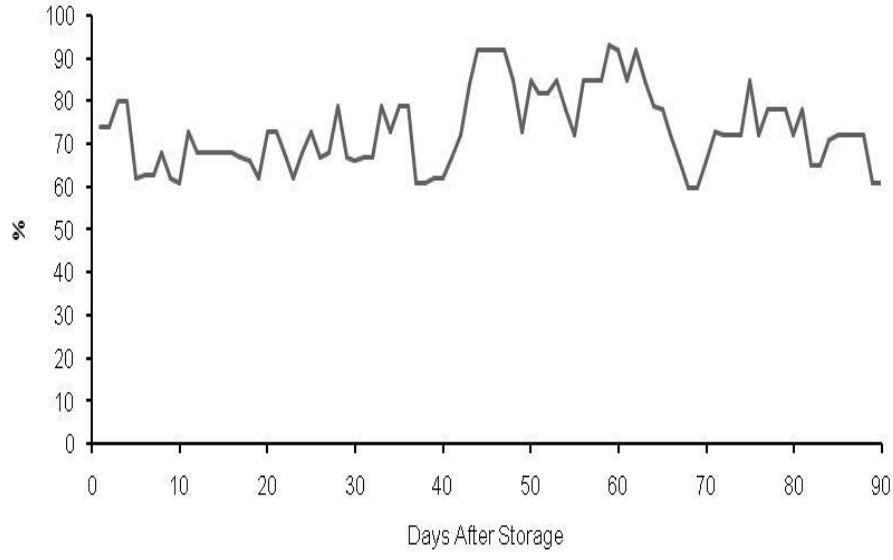

Figure 2. Relative humidity (%) recorded during the study

Statistical analysis

The statistical analysis was performed using factorial analysis (two way ANOVA) by Statistix (Version-8.1).

RESULTS AND DISCUSSION

The physiological loss in weight under different storage methods is shown in Tables 1 and 2. The results showed significant differences ($P< 0.05$) in weight loss during three months. The highest physiological weight loss (10.40% mean) was observed under open ground, followed by nylon net bags (8.54%), while lowest physiological weight loss (4.19% mean) was recorded under wooden packed structure ventilated from all sides. These losses may be due to the moisture loss during respiration of onion bulbs. Similar results were also observed by Bogevska *et al*. (2014), who reported that physiological weight loss in onion bulbs was more under traditional open ground method and nylon bags. Thus wooden packed structure ventilated from all sides provided a sound dormant condition which decreased weight loss of onion bulbs during storage. The statistical analysis of data showed that days, packaging and interaction between days and packaging were significant ($P< 0.05$).

Table 1. Physiological loss in weight under different storage methods

Interval (Days)	Wooden packed structure (%)	Nylon net bags (%)	Open ground (%)
15	1.24	02.78	04.98
30	2.19	04.94	06.10
45	3.14	06.01	07.99
60	5.05	08.16	09.86
75	6.28	12.36	14.10
90	7.24	17.01	19.38
Mean	4.19	08.54	10.40

Table 2. Analysis of variance (ANOVA)

Parameter	Sum of squares	Means Squares	F Value	Significance
Days	846.05	169.210	65.89	0.0000 ***
Packaging	366.11	183.056	71.28	0.0000 ***
Days*Packaging	100.34	010.034	03.91	0.0013 ***

*** = Significant at 5% probability level, NS = Non-Significant

Pathogen/fungi %age under different storage methods is shown in Table 3 and 4. The significant %age of pathogen/fungi was observed during 90 days of storage under different storage methods. No pathogen/fungi were observed under wooden packed structure during first 30 days and under Nylon bags during first 15 days. However, 5.55% Pathogen/Fungi were found under open ground during first 15 days. The maximum % age of pathogen/fungi was observed under open ground (16.25%), followed by nylon net bags (11.24%), while minimum % age of pathogen/fungi was witnessed under wooden packed

structure (7.91%) during 90 days of storage. The statistical analysis of results revealed that the effect of days and packaging was significant at 5 percent level where as the interaction between days and packaging was non-significant. The results are in agreement with Banu Priya *et al*. (2014), who reported that wooden packed storage structure fully ventilated from bottom allowed sufficient ventilation for maintaining the relative humidity.

Table 3. Pathogen/Fungi (%) under different storage methods

Days	Wooden packed structure (%)	Nylon net bags (%)	Open ground (%)
15	00.00	00.00	05.55
30	00.00	05.31	08.98
45	05.37	11.04	14.02
60	10.69	15.60	17.91
75	14.21	20.32	23.00
90	17.20	15.19	28.03
Mean	07.91	11.24	16.25

Table 4. Analysis of variance (ANOVA)

Parameter	Sum of squares	Means Squares	F Value	Significance
Days	3138.15	627.630	112.08	0.0000 ***
Packaging	634.28	317.139	56.63	0.0000 ***
Days*Packaging	58.62	05.862	01.05	0.4277 NS

*** = Significant at 5% probability level, NS = Non-Significant

Table 5. Black Mold% under different storage methods

Days	Wooden packed structure	Nylon net bags	Open ground
15	00.00	01.98	05.32
30	00.00	05.80	10.17
45	00.00	12.00	15.36
60	00.00	15.88	19.36
75	08.19	20.06	24.34
90	11.18	24.27	30.45
Mean	03.23	13.33	17.50

Table 6. Analysis of variance (ANOVA)

Parameter	Sum of squares	Means Squares	F Value	Significance
Days	2487.27	497.453	30.67	0.0000 ***
Packaging	1908.33	954.167	58.82	0.0000 ***
Days*Packaging	282.47	28.247	1.74	0.1113NS

*** = Significant at 5% probability level, NS = Non-Significant

Black mold% in onion bulbs under different storage methods during three months of storage is shown in Tables 5 and 6. It was observed that onion bulbs stored under wooden packed structure were safe and not affected by black molds till 60 days of storage, while after 75 and 90 days 8.19 and 11.18%, respectively black molds were observed. The minimum black mold (%) was observed under wooden packed structure (3.23%), while maximum black molds were recorded under open ground (17.50%), followed by nylon net bags (13.33%) during 90 days of storage. The results are in line with Brice *et al*. (1999), who reported that the storage of onions in well ventilated structure prolongs the storage life. Statistical analysis revealed that the influence of days and packaging was significant at 5 percent level, whereas the interaction between days and packaging was found non-significant for this character.

It was also observed that during 90 days of storage, sprouting and rotting didn't occur under any of three storage methods. The overall results revealed that the quality of onion bulbs was significantly affected by storage methods during the period of three months. Furthermore, the wooden packed structure ventilated from all sides on raised platform proved better in providing the desired environment to onion bulbs during storage period. The results are in line with Ranpise *et al*. (2001); Tripathi and Lawande (2003) and Banu Priya et *al*. (2014), who stated that wooden packed structure ventilated from bottom reduced the storage losses during storage period. This study suggest that the wooden packed structure ventilated from all sides on raised platform is more effective in reducing the deterioration of onion bulbs during three months of storage.

CONCLUSION

It is concluded from the study that the wooden packed structure ventilated from all sides on raised platform provided better results during 90 days of storage period with minimum losses as compared to those of nylon net bags and open ground. The study suggest that the growers should adopt wooden packed structure method ventilated from all sides on raised platform to store onion bulbs to minimize losses.

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