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PHYSIOLOGICAL LOSS DURING STORAGE OF SWEET ONION IN REPUBLIC OF MACEDONIA

SUMMARY

The local old sweet onion population '*buchinska arshlama'* is mainly grown in the region of Pelagonia, South-West part of the Republic of Macedonia. It is traditionally grown by seedlings during the period of March until the middle of September. Growers commonly store this type of onion in bulk, covered with foil, without any controlled conditions. The aim of this study was to determine the physiological loss of the onion '*buchinska arshlama'* stored traditionally and in cold rooms from October to April.

The results show that although the mass of bulbs decreases, both in the traditional storage and in cold rooms, it was more advanced in traditional storage. Largest losses were measured at the end of storage period. The percentage of sprouted bulbs traditionally stored in all years (2010/2011, 2011/2012 and 2012/2013) was the highest in April and accounted for 32.06%, 10.85% and 40.22%, respectively, due to higher temperatures in that period. In cold room storage the percentage of sprouted bulbs is low and is the highest at the end of storage. The percentage of diseased bulbs depends on the year of production.

This work confirms the existence of significant differences between storage conditions and production years during sweet onion storage, regarding physiological loss during storage period.

Buchinska arshlama is well stored traditionally until the month of February. After that cold room storage is required in order to reduce the progressive physiological loss of bulbs.

Keywords: sweet onion, storage, weight loss, sprouting, diseases.

INTRODUCTION

Onion is grown in 126 countries covering 2.3 million hectares (Lawande, 2001). In Macedonia, the onion is present in food due to the specifics of the Macedonian traditional dishes and it is used throughout the year and in the last ten years is grown on an area of 3.323 ha, with a total production of 34,343 tons and an average yield of 10.47 t / ha and shows an increasing trend (Statistical Yearbook, 2004-2013). Many long there are micro regions with specific in the

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cultivation method of onions in relation to agro-technique and use of local populations.

The local old sweet onion population ’buchinska arshlama’ is mainly grown in the region of Pelagonia, South-West part of the Republic of Macedonia. It is traditionally grown by seedlings during the period of March until the middle of September. In relation to other populations, this population is well stored in winter. A special way of storage in practice (outdoors in yards) in piles of 2-3 m height and 1-1.5 m width and long depending on the amount provided much greater durability of bulbs. That’s why our investigations were focused on loss during this kind of storage and storage in cold rooms.

MATERIAL AND METHODS

To achieve the aim of the research, as the material was chosen the local population buchinska arshlama, grown in the village Vogjani, Prilep. For traditional storage were taken 300 bulbs in three repetitions stored in the yard of individual farmer Igor Veljanoski in the village Vogjani. The same amount was taken for storage in the cold rooms in a firm Altra - Gevgelija. The onion was stored at temperature of 0 to 2°C and relative humidity of 90 to 95%. The research was repeated three years (2010-2011, 2011-2012 and 2012-2013), and storage period was from October to April with two weeks shelf life at temperatures from 14 to 16^{o}C for cold room storage.

During storage physiological changes expressed in percentage of weight loss, the percentage of sprouting and the percentage of diseased bulbs were monitored.

The percentage of physiological loss in weight (quality loss) (%) was formerly set by formula (Kukanoor, 2005, Jamali et al., 2012):

$$PLW(\%)=\frac{P_0-P_n}{P_0}\ x100$$

where: P_0 is the initial mass, P_n mass after n days (in our case 15, 45, 75, 105, 135, 165 and 210 after two weeks shelf life in the cold room).

The percentage of sprouting (%) was calculated according to the formula (Kukanoor, 2005; Jamali et al., 2012):

$$\text{Percentage of sprouting} = \frac{\text{Mass of sprouted bulbs}}{\text{Initial mass of bulbs}}\ x100$$

The percentage of diseased bulbs (%) was calculated according to the formula (Kukanoor, 2005; Jamali et al., 2012):

$$\text{Percentage of diseased bulbs} = \frac{\text{Mass of diseased bulbs}}{\text{Initial mass of bulbs}}\ x100$$

The statistics of the data obtained during the survey was done with base in statistical program SPSS for Windows 13,0. The analyzed parameters are displayed with descriptive statistics or mean values and standard deviation (SD).

To test the significance of differences between the analyzed parameters was used Mann-Whitney U TEST. The percentage of variation was determined by the coefficient of variation (KV). For the level of significance a value of $p < 0,05$ was taken but for a high significance was taken a value of $p < 0,01$.

RESULTS AND DISCUSSION

Weight loss is determined by the change in weight compared with that at the beginning expressed in percentage (Baninasab and Rahemi, 2006). Loss in weight after 15 days of harvest in October in the 2010/2011 amounted to 5.9%, while the passage of time the percentage of weight loss have increased in April after 195 days of harvest and reached 52.24%. In 2011/2012 loss reached a value of 5.03% in October to 23.73% in April, and in 2012-2013 from 10.05% to 42.72% (Table 1).

According to the research of Simonov (1980) when storing buchinskata arshlama in ware houses from October to April total loss of weight amounted 50.1%, which coincides with our research in 2010/2011.

Table 1. Weight loss in traditional storage in %

Day	Period of measurement	2010/2011		2011/2012		2012/2013	
		mean±SD	KV	mean±SD	KV	mean±SD	KV
15	Before loading October	5,9±1,1	18,61%	5,03±0,89	17,69%	10,05±0,82	8,16%
45	November	8,4±0,87	10,36%	6,03±0,91	15,09%	12,53±0,86	6,86%
75	December	9,85±0,76	7,71%	6,56±0,96	14,63%	14,92±2,29	15,35%
105	January	11,33±0,68	6,0%	6,75±0,91	13,48%	18,75±2,93	15,63%
135	February	15,32±3,26	21,28%	7,07±0,95	13,44%	21,36±1,84	8,61%
165	March	24,86±0,51	2,05%	7,75±1,22	15,74%	28,99±1,26	4,35%
195	April	52,24±7,43	14,22%	23,73±5,15	21,7%	42,72±4,31	10,09%

The weight loss of bulbs that were stored in the cold room in 2010/2011 was from 5.93% in October, or before loading, to 27.17% after 2-week storage of bulbs at a temperature of 14 ° C to 16 ° C. In 2011/2012 the average weight loss in October, or when first measurement was done was 6.37%, while 22.1% since the last measurement was done after simulating the bulbs in the market conditions. In the last analyzed year, the average weight loss of 8 84% in October increased to 23,82 (Table 2).

Bulbs that were stored traditionally and in the cold rooms do not differ significantly in terms of average weight loss in the three analyzed years, which indicates that bulbs are equally good stored traditionally as well in the cold room (Table 3).

Table 2. Weight loss in cold room storage in %

Day	Period of measurement	2010/2011		2011/2012		2012/2013	
		mean±SD	KV	mean±SD	KV	mean±SD	KV
15	Before loading October	5,93±1,17	19,33%	6,37±2,71	42,54%	8,84±1,19	13,46%
45	November	6,58±1,33	20,21%	7,14±2,66	37,25%	9,48±1,31	13,82%
75	December	8,33±1,91	22,93%	8,13±3,09	38,01%	10,3±1,35	13,11%
105	January	9,82±1,55	15,78%	9,1±3,0	32,97%	13,95±0,98	7,03%
135	February	11,87±1,94	16,34%	9,95±2,94	29,55%	15,16±1,23	8,11%
165	March	16,42±4,59	27,95%	11,61±3,0	26,01%	18,04±3,04	16,85%
195	April	21,44±5,93	27,66%	15,09±2,63	17,43%	18,76±2,78	14,82%
210	shelf life 2 weeks on 14°C - 16°C	27,17±5,91	21,75%	22,1±3,86	17,47%	23,82±4,2	17,67%

Table 3. Average values of weight loss traditionally and in the cold room

Year	Traditional storage mean±SD	Cold room mean±SD	Test	p-value
2010/2011	18,24±16,22	13,44±7,62	Z=0,23	0,82
2011/2012	8,99±6,56	11,19±5,2	t=0,72	0,48
2012/2013	21,33±11,32	14,79±5,24	t=1,47	0,17

Z (Mann-Whitneu U Test)

One of the physiological changes during storage is sprouting of bulbs which reduces quality and makes product uncompetitive to the market. The bulbs are sprouted once the leaves emerge from the neck (Qadir et al., 2007). These authors suggest that sprouting is driven by two factors: induction of cytokinins and reduction of abcisinic acid, and stress caused by injury, low temperatures or heat shock.

In our research sprouting in traditional storage started with lower intensity in December after 75 days of storage in 2010/2011, later with high intensity in April (after 195 days) in 2011/2012, while the earliest in November (45 days) in the 2012/2013 year. Unlike traditional storage, in cold room storage in year 2010/2011 sprouting started in December (after 75 days) in 2011/2012 in February (after 235 days) and in 2012/2013 in April (after 195 days) (Table 4).

According to the research of Biswas et al. (2010), bulbs began to sprout after 90 days of storage. Earlier sprouting in our research is result of variety specifications and requirements during storage. Sprouting was the greatest at the end of storage both traditionally and in the cold room.

The percentage of sprouted bulbs, which were stored in a traditional way, was the highest in April during the three years examination and accounted for 32.06% in 2010/2011, 10.85% in 2011/2012, and 40.22% in 2012/2013. In cold room storage the percentage of spouted bulbs was low and amounted 3.07% in April in 2010/2011 and 1.39% after shelf life procedure in 2011/2012 and 2012/2013.

Table 4. Sprouted bulbs (%)

Days	Period of measurement	2010/2011		2011/2012		2012/2013	
		T	C	T	C	T	C
0	Harvest						
15	October						
45	November					1,26	
75	December	1,09	0,91			1,24	
105	January	1,09					
135	February	1,94	1,63		1,05		
165	March	18,14	2,65			6,98	
195	April	32,06	3,07	10,85	0,58	40,22	0,52
210	Shelf life 2 weeks on 14°C-16°C	-	2,51	-	1,39	-	1,39
	Total	54,32	10,77	10,85	3,02	49,7	1,91

T- traditional way of storage C- cold room

In our research dominant pathogen in onions were *Botrytis sp.* and saprophytic fungus *Penicillium*. According to Biswas et al. (2010), rotting in bulbs started on 75th day of storage, which coincides with the rotting bulbs that were stored in the cold room in 2012/ 2013.

The percentage of diseased bulbs, which were traditionally stored, in 2010/2011 was the highest in March 4.12%, in 2011/2012 in April for about 17.97%, which is the highest percentage for the entire analyzed period, while in 2012/2013 the highest percentage of diseased bulbs is registered in March 4.25%. In the cold room storage, in 2010/2011 the highest percentage of diseased bulbs is registered in February 3.46%, while in 2011/2012 and in 2012/2013 the highest percentage of infected bulbs was recorded in April 4,64% and 2,74 %, respectively (Table 5).

Table 5. Diseased bulbs (%)

Days	Period of measurement	2010/2011		2011/2012		2012/2013	
		T	C	T	C	T	C
0	Harvest						
15	October						
45	November					0,69	
75	December					2,00	1,28
105	January	2,42	0,99			1,33	
135	February	3,06	3,46		0,88	4,19	2,43
165	March	4,12	1,48	9,96	1,59	4,25	
195	April	3,00	1,05	17,97	4,64	2,07	2,74
210	Shelf life 2 weeks on 14°C-16°C	-	1,89	-	3,13	-	0,62
	Total	12,6	8,87	27,93	10,24	14,54	7,07

CONCLUSIONS

Based on three years research of storing the onion `buchinska arshlama` by traditional way and in cold room, the following conclusions can be specified:

-Average values for weight loss (quality loss) in 2010/2011 in traditional way of storage amounted 18.24% and 13.44% in cold room. In 2011/2012, the average values for weigh loss in traditional storage were 8.99% and 11.19% in cold room, while in 2012/2013 in traditional way of storage 21.23%, and 14.79% in cold room. Bulbs that were traditionally stored in cold room did not differ significantly in terms of average weight loss suggesting that bulbs are well stored both traditionally and in cold room.

-The percentage of spouted bulbs, traditionally stored in all years (2010/2011, 2011/2012 and 2012/2013) was highest in April and accounted 32.06%, 10.85% and 40.22%, respectively, due to higher temperatures in that period. In cold room the percentage of sprouted bulbs was low and amounted 3.07% in April in 2010/2011 and 1.39% after shelf life procedure in 2011/2012 and 2012/2013.

-The highest percentage of diseased bulbs traditionally as well in cold room was observed in 2011/2012 (27.93% and 10.24%, respectively) while the lowest percentage was recorded in 2010/2011 for about 12.6% in traditional storage and 7,07% in cold room in 2012/2013.

-The general conclusion is that buchinskata arshlama can be successfully stored traditionally from October to early February, and then in controlled conditions (cold room) until April or longer.

REFERENCES

Baninasab, B., Rahemi, M. (2006). The effect of high temperature on sprouting and weight loss of two onion cultivars. American Journal of Plant Physiology. Academic Journals Inc., USA. 1(2): 199-204.

Biswas, S. K., Khair, A., Sarker, P. K., Alom, M. S. (2010). Yield and storability of onion (Allium cepa l.) as affected by varying levels of irrigation. Bangladesh Journal of Agricultural Research. 35(2): 247-255.

Jamali, L. A., Ibupoto, K. A., Chattha, S. H., Laghari, R. B. (2012). Study on physiological weight loss in onion varieties during storage. Pakistan Journal of Agriculture. Agricultural Engineering and Veterinary Sciences, 28 (1): 1-7.

Kukanoor, L. (2005). Post–harvest studies in onion Cv. N-53. Doctor thesis. Department of Horticulture. College of agriculture. The University of Agricultural Sciences, Dharwad, Karnataka, India.

Lawande, K.E. (2001). Onion. National Research Centre for Onion and Garlic, Pune. Handbook of herbs and spices. Chapter 21. Woodhead Publishing Limited, 249-259.

Qadir, A., Hashinaga, F., Karim, M. R. (2007). Effects of pre-storage treatment with ethanol and CO2 on onion dormancy. Journal of Bio-Science 15: 55-62.

Simonov, D. (1980). Nekoi morfoloshki, bioloshki i hemisko-tehnoloshki svojstva na povazhnite populacii kromid (Allium cepa L.) vo SRM so ogled na nivnata stopanska vrednost (Some morphological, biological and chemical-technological properties of the major onion populations (Allium cepa L.) in SRM regarding their commercial value) (doctoral thesis). Zemjodelski fakultet. Univerzitet „Kiril i Metodij“. Skopje.

Statistical Yearbook of the Republic of Macedonia. State Statistical Office. 2004-2013