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Effect of Different Packaging Methods on Shelf Life of Potato Stored at Room Temperature

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A B S T R A C T

The cured tubers of variety Kufri Chipsona-4 were subjected to the sprout inhibiting treatment viz., hot water dip treatment (57.5±0.1^{o}C for 20 min) along with control and were packed in nylon mesh bags, MAP (modified atmosphere packaging) and vacuum packaging. The tubers were stored for 5 weeks at room temperature conditions (32±2^{o}C; RH ~90%)and sampled at 7-day interval. A progressive increase in decay loss and shriveling of potato tubers was observed during storage. Hot water dip treated tubers showed significantly lower decay loss and shriveling than untreated tubers. Among various packaging methods, minimum decay loss was observed in net bag packaging while vacuum packaged tubers had significantly higher decay loss.

Introduction

Potato is an important cash crop and widely grown in different agro climatic regions. It supplements the food needs in a substantial manner, since it produces highest yield per unit area and time. Fresh potatoes are available only for a few months in a year and potatoes need to be stored properly to make them available for vegetable purpose and to the starch processing industry throughout the year (Ezekiel *et al.*, 2010). Indian vegetable basket is incomplete without Potato. Being a short duration crop, it produces more quantity of dry matter, edible energy and edible protein in lesser duration of time than cereals like rice and wheat. Hence, potato may prove to be a useful tool to achieve the nutritional security of the nation. Due to the bumper crop, and lack of post harvest management, glut situations raised in the market for the surplus yield every year which ultimately results in decline the prices drastically. Under tropical and sub-tropical conditions, the losses due to poor handling and storage are reported to be in between 40-50 per cent (Sheibani *et al.*, 2012). The post harvest losses of potatoes are defined as qualitative and quantitative losses. The qualitative losses greatly reduce the price of potatoes. Potato is a perishable commodity and its harvest time (February/March) coincides with a steep rise in temperature in the Indo-Gangetic plains which account for 87% of the production area in the country. From April onwards, temperature in the plains increases rapidly, and produce has either to be consumed within a short period or shifted to cold stores. Due to inadequate, expensive and unevenly distributed refrigerated storage facilities, there are frequent cases of oversupply in the market causing substantial economic loss to the farmers as well as wastage of this food product. Such gluts have occurred every 3 to 5 years, whenever there had been an increase in potato production (Blenkinsop *et al.,* 2002; Mani *et al.,* 2014).

In most countries, only one potato crop can be grown in one year and, therefore, fresh potatoes are available only for a few months. Storage of potatoes is essential to meet the requirements during the rest of the year. Good storage environment should maintain the stored potatoes in good condition by preventing excessive weight loss, spoilage by pathogens, sprout growth and deterioration in quality. Storage conditions depend on the purpose for which potatoes are stored (Kaur *et al.,* 2009). Golmohammadi and Afkari-Sayyah, (2013) found that storage of potatoes in bulk is essential to ensure a continuous supply of raw material for household consumption as well as for the potato processing industry. However, tubers are living entities, even after harvest, it respire and transpire. These processes bring about physiological changes and water loss, which in turn affect the shelf life of tubers. Long-term postharvest cold storage of potatoes (*Solanum tuberosum* L.) is widely used to delay physiological processes (e.g. sprouting) and lengthen the marketing season. The maintenance of low temperatures during the storage period depends on the desired end use of the tubers (Sonnewald, 2001; Kader, 2003).Various methods of storage have been designed to prolong the dormant period and to retard deterioration or inhibit the undesirable changes in potato tubers. Storage conditions are also reported to affect phosphorus, potassium and calcium contents of potato(Ezekiel *et al.,* 2007).

The potato tubers can safely be stored for 12 weeks at either 8 or 18°C without sprouting, if dipped in a 57.5 °C hot water for 20–30 min (Ranganna *et al.,* 1998). From this study, the expected deliverables will be most prominent for the economic condition of the farmers as well as industries. But information on shelf-life and post-harvest losses of commercial potato cultivars under ambient conditions (20-35°C, 44-86% RH) is unavailable. Vacuum packaging with low temperature and Modified atmosphere packaging have been shown to increase the shelf-life of potatoes, retain tuber firmness, reducing sugar content and color(Rocha *et al.,* 2003; Shetty *et al.,* 1989). Use of chemicals like CIPC, irradiation and heat treatments have been shown to inhibit sprouting of tubers and also alter their biochemical properties (Lu *et al.,* 2012; Ranganna *et al.,* 1998).

So this study was carried out with the objective that hot water treated tubers packed by different packing ways increased the shelf life of potato at room temperature. This will help farmers to store potato even if cold storage facility is not available.

Materials and Methods

The present research work was carried out at Centre of Food Science and Technology, CCSHAU, Hisar. Potato(*Solanum tuberosum* L.)of variety Kufri Chipsona-4was procured from Vegetable Farm, CCS HAU, Hisar.Potato tubers were washed thoroughly in distilled water, patted dry and eight tubers per sample were taken. Tubers were immersed for 20 min in a 45 L water bath maintained at

57.5±0.1°C.Tubers were immediately cooled in distilled water at ambient temperature for 10 min and air dried. Washed and untreated tubers were taken as control. Potatoes were packaged in three different packaging: net bags (length 41.4 cm and breadth 29.6 cm), passive modified atmosphere (MA) packaging (LDPE bags having length 31.5 cm, breadth 25.5 cm and thickness 100 micron) and vacuum packaging (LDPE bags having length 31.5 cm, breadth 25.5 cm and thickness 100 micron) with 8 tubers (~1 Kg) each pack. They were packed in LDPE bags with a Multivac machine (1 mBar for 10 s).Packed tubers were placed in corrugated fiberboard boxes and stored at room temperature (32±2°C and RH 90%) for 5 weeks. Sampling was done at 7-day intervals.

Observation recorded

Decay loss percentage

The number of potatoes in each replicate was calculated on the initial day of the experiment (initial number of potatoes). On the day of observation, the decayed potatoes, if any, were counted (final number of decayed potatoes).

$$\text{Deacy loss (\%)} = \frac{\text{Number of decayed potatoes}}{\text{Initial number of potatoes}} \times 100$$

Shrivelling

It was observed visually and score was given to potatoes. The sound and healthy potatoes represented by 0, healthy potatoes by 1, slightly shriveled by 2 and highly shriveled by 3. Average of 8 tubers per treatment was recorded.

Statistical Design

The experiment was laid out in factorial CRD. The data obtained in the present investigation were subjected to statistical analysis of variance (ANOVA). Means were separated by critical difference (CD) at 5% level of significance. For this experiment three factorial CRD was used for analysis using OPStat software, CCSHAU, Hisar.

Results and Discussion

Decay loss

The effect of sprout inhibiting treatment and packaging methods on decay loss (%) of stored potatoes at room temperature is presented in Table 1. There was progressive increase in decay loss (%) with increasing storage period of tubers. There was no decay loss on 0 day, which significantly increased to 100% at 5th week of storage. The increase in decay loss with time can be ascribed to softening of tubers with storage period which makes them susceptible to microbial attack. Storage at room temperature instead of low temperature also aids microbial infestation (Mehta *et al.*, 2006). Hot water dip treated tubers resulted in significantly lower decay loss (40.0%) than untreated tubers (53.0%). In second week the decay loss was 30.6%, whereas in HWT it was only 18.8%. Surface pathogens on tubers were exposed to high temperature which inactivated them leading to less decay loss in HWT treated potatoes. Similar results were reported by Hu *et al.*, (2010) in sweet potato and Ranganna *et al.*, (1998) in potato.

Among various packaging methods, net bag packaging resulted in significantly lower decay loss (42.3%) followed by modified atmosphere (45.7%), while maximum decay loss was observed in vacuum packaging (51.6%). The increased decay loss in vacuum packed potatoes can be due to absence of air in the pack which aided the growth of anaerobic decay microbes, as reported by Beltran *et al.*, (2005).

Table.1 Effect of sprout inhibiting treatment and packaging methods on decay loss (%) of stored potatoes at room temperature

Period of Storage (weeks)	Treatments								
	Control				Hot Water Dip				
	Net Bag	Modified Atmosphere	Vacuum	Mean	Net Bag	Modified Atmosphere	Vacuum	Mean	Overall mean
0	0.0 (2.9)	0.0 (2.9)	0.0 (2.9)	0.0 (2.9)	0.0 (2.9)	0.0 (2.9)	0.0 (2.9)	0.0 (2.9)	0.0 (2.9)
1	12.5 (20.2)	16.7 (23.8)	29.2 (32.4)	19.4 (25.7)	0.0 (2.9)	4.2 (11.5)	10.3 (18.5)	4.8 (11.2)	12.1 (18.4)
2	29.2 (32.4)	25.0 (29.7)	37.5 (37.5)	30.6 (33.4)	14.7 (22.3)	18.3 (25.1)	23.5 (28.7)	18.8 (25.5)	24.7 (29.5)
3	58.3 (49.9)	66.7 (55.9)	79.2 (66.7)	68.1 (56.5)	39.2 (38.4)	43.3 (41.0)	56.3 (48.7)	46.3 (42.9)	57.2 (49.7)
4	100.0 (87.1)	100.0 (87.1)	100.0 (87.1)	100.0 (87.1)	53.3 (47.0)	74.3 (60.1)	82.7 (67.4)	70.1 (58.4)	85.1 (72.7)
5	100.0 (87.1)	100.0 (87.1)	100.0 (87.1)	100.0 (87.1)	100.0 (87.1)	100.0 (87.1)	100.0 (87.1)	100.0 (87.1)	100.0 (87.1)
Mean				53.0 (48.8)				40.0 (37.7)	

Period of Storage (weeks)	Packaging methods			Overall mean
	Net Bag	Modified Atmosphere	Vacuum	
0	0.0 (2.9)	0.0 (2.9)	0.0 (2.9)	0.0 (2.9)
1	6.3 (11.6)	10.4 (17.9)	19.8 (25.7)	12.1 (18.4)
2	21.9 (27.5)	21.7 (27.6)	30.5 (33.3)	24.7 (29.5)
3	48.8 (44.3)	55.0 (48.6)	67.8 (56.1)	57.2 (49.7)
4	76.7 (67.1)	87.2 (73.7)	91.3 (77.4)	85.1 (72.7)
5	100.0 (87.1)	100.0 (87.1)	100.0 (87.1)	100.0 (87.1)
Mean	42.3 (40.1)	45.7 (43.0)	51.6 (47.1)	

CD at 5 %	**Storage (S) = 4.05**	**Treatment (T) = 2.34**	**Packaging methods (P) = 2.87**	
	SxT = 5.7	SxP= NS	TxP = NS	SxTxP = NS

Values in the parenthesis are transformed values; NS – non significant

Table.2 Effect of sprout inhibiting treatment and packaging methods on shriveling* of stored potatoes at room temperature

Period of Storage (weeks)	Treatments								
	Control				Hot Water Dip				
	Net Bag	Modified Atmosphere	Vacuum	Mean	Net Bag	Modified Atmosphere	Vacuum	Mean	Overall mean
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	1.0
2	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	2.0
3	3.0	3.0	3.0	3.0	2.0	2.0	2.0	2.0	3.0
4	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
5	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Mean				2.0				2.0	

Period of Storage (weeks)	Packaging methods			Overall mean
	Net Bag	Modified Atmosphere	Vacuum	
0	0	0	0	0.0
1	0.5	0.5	0.5	1.0
2	1.5	1.5	1.5	2.0
3	2.5	2.5	2.5	3.0
4	3	3	3	3.0
5	3	3	3	3.0
Mean	2.0	2.0	2.0	

Sound & healthy = 0 Healthy = 1 Slightly shriveled = 2 Highly shriveled = 3
*The mean values have been rounded off.

The potato treated with HWT and packed in net bag gave the good shelf life of potato up to third week (39.2% decay at 3rd week), whereas in other interactions like HWT with modified atmosphere (43.3%decay at 3rd week) and HWT with vacuum packaging (56.3% decayat 3rd week), potato tuber lost the shelf life very fast.

Shriveling

The effect of sprout inhibiting treatment and packaging methods on shriveling of stored potatoes at room temperature is presented in Table 2. It increased with increasing storage period. The tubers were highly shriveled by 3rd week of storage. Similar trends in shriveling of potatoes have been reported by Mani *et al.*, (2014) and Sonnewald and Sonnewald (2014). The hot water dip treated tubers did not show any difference in shriveling than untreated tubers. Among various packaging methods also no differences were observed in shriveling of tubers during storage. HWT being an effective treatment to suppress sprouting and control water loss led to less shriveling of tubers with storage (Campbell *et al.*, 2010; Hu *et al.*, 2010). There was a progressive increase in decay loss and shriveling of potato tubers during storage at room temperature. HWT was an effective sprout inhibiting treatment and also a low cost technology which can easily adopted by farmers to treat potatoes before storage. Decay loss among potatoes was lower in net bag packaging, while maximum decay loss was observed in vacuum packaging. Thus, it can be inferred that HWT along with net bag packaging is a low cost method that can be employed by farmers to store potatoes for longer shelf life (2-3 weeks) at room temperature.

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