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Storage Behaviour of Microtuber of Potato Varieties in Relation to Its Weight

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Authors' contributions

This work was carried out in collaboration between all authors. Author MSH designed the study, wrote the protocol, wrote the first draft of the manuscript and performed the statistical analysis. Authors TH and MMH reviewed the study design and all drafts of the manuscript. Author MDS managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The present work was evaluated to assess the storage behaviour of microtuber as affected by its different grades.
Study Design: The experiment was laid out in a completely randomized design with three replications.
Place and Duration of Study: The experiment was conducted in the Tissue Culture Laboratory of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur, Bangladesh during the period of September 2010 to February 2011.

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Methodology: The experiment having two factors: microtuber from the *in vitro* plantlets of three potato varieties; namely- Asterix, Granola and Diamant were evaluated during storage for 3 months in refrigerator at 4 0C by <250 mg, 250-500 mg and >500 mg graded microtuber.
Results: Fresh weight of microtubers as affected by different grades is inversely proportional to their sizes. At 90 days of storing <250 mg size microtubers lost more weight in Granola followed by medium (250-500 mg) and large size (>500 mg) microtubers in Asterix and Diamant. The cumulative fresh weight loss at 90 days of storing was the highest with smaller size (<250 mg) microtubers in all varieties, while statistically it was the minimum with larger microtubers (>500 mg). The percentage of decayed microtuber was minimum quantity with larger size microtuber. Granola showed maximum 14.24% of decayed microtuber followed by Diamant and Asterix.
Conclusion: Microtuber grades is the main factor affecting storage life. Heavier microtuber about >500 mg showed minimum biomass loss during storage. They can be stored for 3 months in refrigerator at 4℃.

Keywords: Storability; microtuber; tuber biomass; tuber size.

1. INTRODUCTION

Potato (*Solanum tuberosum* L.) is a vegetable crop which significantly improves the nutritious value of the diet. In 2008-2009 the total area and production of potato of Bangladesh was 3.96 million acres and 5.29 million tons, respectively [1]. The per capita yearly consumption is only 24 kg in Bangladesh that is very negligible compared to other potato growing countries [2]. Quality seed tubers as well as marketability of potato tubers depend mainly on storage conditions. Generally, after harvest of potato tubers remain dormant for 6-8 weeks under non-refrigerated conditions after that tubers begin to sprout, storage losses increase [3]. Besides to improve storability, several techniques like refrigerator, application of sprouting inhibitors or natural substances and irradiation has been attempted. In Bangladesh, maximum tubers are stored at ambient temperature due to economic reasons of the growers, lack of storage capacity and also, they prefer to store at home environment and for selling conveniently. The total number of cold storage in Bangladesh is only 330 and the capacity is also only 20-22 lac ton of potato [2]. On the other hand, it is a winter crop of Bangladesh, usually tubers harvested in February-March and stored during hot with humidified environment. As a result, tubers turn to break dormancy, shrinkage, weight loss and rot [4]. Microtubers are convenient to handle, can be transported over long distances and like *in vitro* plantlets don't require hardening periods [5]. Fact on this, potato microtubers could become an integral component of healthy seed tuber production programs, particularly in hot, humid tropical countries [6]. Storage of microtubers in ambient condition causes significant weight loss during the first few hours after harvesting [7,8] results in deterioration of seed quality and poor sprout emergence [9]. Biomass loss may also depend on tuber size, because large tuber contains higher surface area and volume ratio. Microtubers have been successfully used in basic seed production at the Central Potato Research Institute, India [10]. Information on storage behavior of microtuber produced from different varities of potao in regards to seed tuber production program is far behind in Bangladesh. Besides dormancy duration, sprout growth might be influenced by tuber size. Therefore, the study was undertaken to assess the biomass loss of different graded microtuber during storage in refrigerator using three potato varieties.

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was conducted in the Tissue Culture Laboratory of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur, Bangladesh during the period of September 2010 to February 2011.

2.2 Seed Source

Diseases free *in vitro* plantlets of three potato varieties namely- Asterix, Granola and Diamant were collected from Bangladesh Agricultural Research Institute and Bangladesh Agricultural Development Corporation Tissue Culture Laboratory which were prepared through meristem culture earlier.

2.3 *In vitro* Multiplication of Plantlets

In vitro plantlets of three potato varieties were multiplied as per routine by sub culturing of

single stem nodes at every three weeks interval for growing the explants upto 6-8 nodes stage to get desired number of plantlets for experimentation. The multiplication medium contained minerals salts and vitamins [11] which was supplemented with 0.1 mg l^{-1} gibberellic acid (GA_3), 0.01 mg l^{-1} Napthal acetic acid (NAA), 4 mg l^{-1} D-calcium pantathonate and 30 g l^{-1} sucrose. The medium was solidified with 8 g l^{-1} agar and pH was adjusted 5.7 prior to autoclaving. Temperature in the growth chamber was 20±1℃ with 16 hours photoperiod and light was supplied by fluorescent tubes at an intensity of 3000 lux.

2.4 *In vitro* Production of Microtuber

2.4.1 Step i

Eight stem segments (each with 3 nodes) of sub cultured *in vitro* plantlets were again cultured in liquid medium in 250 ml Erlenmeyer flasks contained mineral salts and vitamins [11] supplemented with 0. 01 mg l^{-1} GA_3, 0.01 mg l^{-1} NAA, 4 mg l^{-1} D-calcium pantathonate and 30 g l^{-1} sucrose for 28 days.

2.4.2 Step ii

After 28 days, the liquid media were decanted off and 40 ml microtuber induction medium based on MS medium [11] supplemented with 10 mg l^{-1} benzyl adenine (BA) and different concentrations of sucrose (0, 3, 4, 6, 8, 10, 12 and 14%). Then the microtuber induction cultures were incubated in the dark at 20℃ [12]. All cultures in Erlenmeyer flask were closed with cotton cap.

2.5 Harvest and Storage of Microtuber

Cultures with microtuber were kept in full light after 63 days of incubation for greening. After 70 days of incubation, microtuber were harvested aseptically and washed properly, then treated with the bavistin solution very quickly, which were then dried in the clean bench by blowing clean air. The microtubers were then distributed into three grades, <250 mg, 250-500 mg and >500 mg and stored in refrigerator at 4℃ by taking initial weight. Ten tubers of each grade in each replication were stored.

2.6 Treatments and Design of the Experiment

The experiment was laid out in a completely randomized design with three replications having two factors. The first factor was three potato varieties of *viz*., Asterix, Granola and Diamant; the second factor was three grades of microtuber *viz.*, <250 mg, 250-500 mg and >500 mg.

2.7 Data Collection

The data were collected on fresh weight loss of microtuber, fresh microtuber percentage and decayed microtuber percentage.

2.8 Analysis of Data

All the collected data were analyzed by analysis of variance and the means were compared according to Duncan's Multiple Range Test at $P = .05$ level of probability.

3. RESULTS AND DISCUSSION

3.1 Effect of Microtuber Grades

3.1.1 Fresh weight loss

Fresh weight of microtubers as affected by different grades was found to be inversely proportional to their sizes (Table 1). Weight loss increased with time in all sizes of microtubers. Significantly the highest fresh weight loss (%) was obtained from <250 size microtuber and the lowest from >250 mg size microtuber irrespective of DAS. At 90 days of storing <250 mg size microtubers lost more weight followed by medium (250-500 mg) and large size (>500 mg) microtubers. Significantly higher physiological loss in small microtubers and a gradual decrease in weight loss with increasing size of microtubers can be attributed to the larger surface area per unit weight as well as to the immature state of smaller microtubers than larger ones where natural senescence occurs due to respiration and other metabolic processes in the living tissues of microtubers during storage [13]. This result is also in agreement with the earlier findings of [14], [15,16,17].

Table 1. Storage behaviour of different grades of microtuber

Microtuber grade (mg)	Fresh weight loss (%)		
	30 DAS	60 DAS	90 DAS
>500	12.29 c	15.85 c	20.62 c
250-500	18.81 b	23.31 b	29.14 b
<250	28.65 a	33.85 a	40.53 a

Mean followed by same latter(s) in a column are not significantly different by DMRT at 5% level of probability, DAS = Days after storage

3.1.2 Fresh microtuber

The percentage of fresh microtuber was the highest with large size (>500 mg) followed by medium (250-500 mg) and small sizes (>250 mg). After 90 days fresh microtuber was readily in dormant (Fig. 1). [18] reported that microtuber sprouted immediately after a dormant period varying from 60 to 210 days when stored at 4℃ depending on the conditions.

3.1.3 Decayed microtuber

The percentage of decayed microtuber number was lower in larger size (>500 mg), while it was higher in medium (250-500 mg) and small (>250 mg) size microtubers (Fig. 1). [19] reported that decay of microtubers is also very serious problem during storage. More than 45% of the total number of small microtubers was lost in 4 months of storage. The highest percentage (40%) of desiccated microtuber was found with smaller microtuber than larger [20] which supported the present findings.

3.2 Varietal Performance

3.2.1 Fresh weight loss

Fresh weight loss increased with storage period in all varieties (Table 2). At 90 days of storage the maximum weight loss was observed in Granola followed by Diamant and the minimum in Asterix. The result was in agreement with the behaviour of normal potato cultivar where Diamant showed minimum weight loss at 120 days of storage period [21]. Varietal difference on fresh weigh loss was observed by [22]. They reported that the microtubers of Kennebec cultivar showed only about 10% fresh weight decrease even after 4 month storage at room temperature, whereas Daejima showed about 30% fresh weight loss.

3.2.2 Fresh and decayed microtuber

Water content by the variety is major factor for storing of microtuber. Granola showed lowest percentage of fresh microtuber followed by Diamant and Asterix. This may be due higher water content of the variety. Granola showed highest percentage of decayed microtuber. The minimum percentage of decayed microtuber was found in Diamant and Asterix (Fig. 2).

Table 2. Varietal performance during storage of microtuber

Variety	Fresh weight loss (%)		
	30 DAS	60 DAS	90 DAS
Asterix	18.31 b	22.98 b	28.27 b
Granola	20.51 a	24.50 a	31.20 a
Diamant	20.93 a	25.52 a	30.81 a

Mean followed by same latter(s) in a column are not significantly different by DMRT at 5% level of probability, DAS = Days after storage

3.3 Varietal Performance of Microtuber as Influenced by Its Grades

3.3.1 Fresh weight loss

Fresh weight loss of microtubers at the end of every month differed significantly (Table 3). Weight loss increased with storage period in all varieties in combination with different grades. The cumulative fresh weight loss at 90 days of storing was the highest with smaller size (<250 mg) microtubers of Diamant, while it was minimum with larger microtubers (>500 mg) of Asterix.

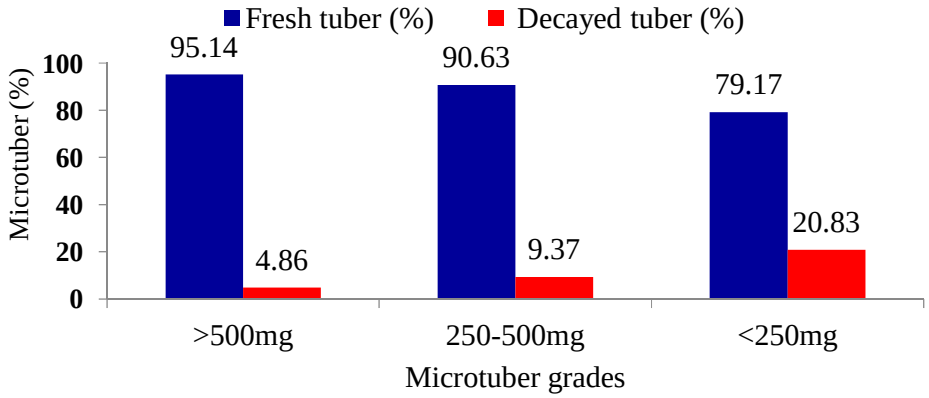

Fig. 1. Effect of microtuber size on percentage of fresh and decayed microtuber at 90 days

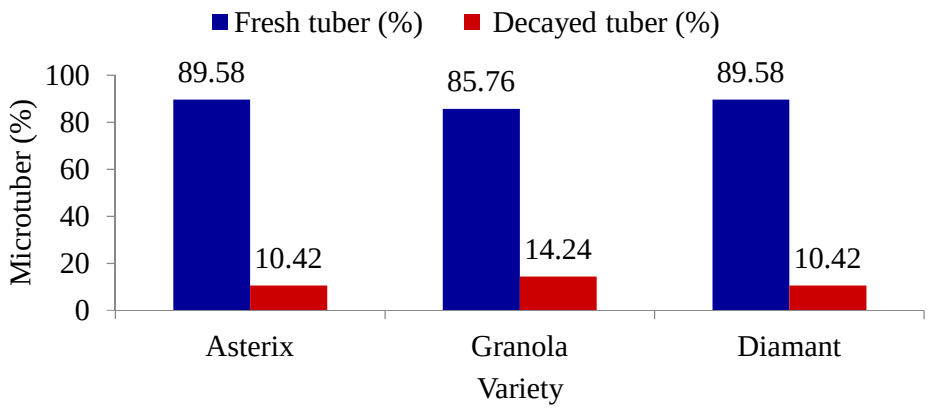

Fig. 2. Effect of variety on percentage of fresh and decayed microtuber stored at 90 days

Table 3. Storage behaviour of microtuber influenced by variety and grades

Variety	Microtuber grade (mg)	Fresh weight loss (%) at			Fresh tuber (%) at 90 DAS	Decayed tuber (%) at 90 DAS
		30 DAS	60 DAS	90 DAS		
Asterix	>500	10.78 f	14.70 d	19.74 d	95.83 a	4.17 f
	250-500	17.10 d	21.19 c	25.77 c	90.63 cd	9.37 cd
	<250	27.06 b	33.04 a	39.29 a	82.29 e	17.71 b
Granola	>500	13.09 e	16.49 d	22.13 d	93.75 abc	6.25 def
	250-500	19.54 c	24.22 b	31.58 b	88.54 d	11.46 c
	<250	28.90 ab	32.79 a	39.91 a	75.00 f	25.00 a
Diamant	>500	13.00 e	16.34 d	19.98 d	95.83 ab	4.17 ef
	250-500	19.80 c	24.50 b	30.07 b	92.71 bcd	7.29 cde
	<250	29.99 a	35.71 a	42.38 a	80.21 ef	19.79 ab

Mean followed by same latter(s) in a column are not significantly different by DMRT at 5% level of probability, DAS = Days after storage

3.3.2 Fresh microtuber

Fresh tuber was the maximum (95.83%) in largest size microtubers of Asterix and Diamant and it was the minimum in smaller microtubers of Granola. This might be due higher water content of the variety Granola (Table 3).

3.3.3 Decayed microtuber

The maximum decayed microtubers were observed in smaller microtubers of Granola and it was the minimum (4.17) in larger size microtubers of Asterix and Diamant. This might be due higher water content of the variety Granola (Table 3).

4. CONCLUSION

Storing of microtuber exerted significant effect on different events of microtuber behaviour. Size of microtuber for all potato varities is the main factors affecting microtuber storage life. Larger tuber had to minimum water loss during storage and can be stored at 4℃ in refrigerator for 3 months.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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