Changes of Sugar and Starch Levels in Ambient Stored Potato Derived from TPS

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Abstract- The experiment was conducted at the Laboratory of Agronomy Department, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during March to August 2013 to study the influence of variety and date of harvesting on changes of sugar and starch levels of potato derived from TPS at ambient storage condition. Potato variety and time of harvest had significant effect on nutritional aspects. Reducing sugar, total sugar increased with advancing storage period, whereas specific gravity, non-reducing sugar and starch content decreased with increasing storage period. Among the varieties HPS 364/67 was the best in respect of nutritional aspects. At harvest and 100 days after storage, the highest total sugar (0.61% and 0.82%) was observed from Lady Rosetta and harvest at 110 days after planting, while the lowest total sugar from HPS-364/67 and harvest at 80 days after planting. The results revealed that HPS 364/67 showed superior nutritional quality than other varieties when harvested at 100 days after planting.

Index Terms- TPS, sugar, starch, specific gravity and ambient condition

I. INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important vegetable crops of the world (Solomon and Barker, 2001). It is consumed almost absolutely as a vegetable in Bangladesh. It contributes as much as 55% of the total vegetable demand in Bangladesh (BBS, 2011). Potato is not only a vegetable crop but also an alternative food crop against rice and wheat. Potato is a rich crop of nutrient substances so it is consumed in very large quantities. Each 100 g of potato tuber contains 79.8 g water, 76 calories, 2.1 g protein, 0.1 g lipids, 17.1 g carbohydrates, 0.5 g fibers and 0.9 g ash as well as it contains a little quantity of nutrient elements and some vitamins(C and B). It contains 0.1 mg thiamin, 0.4 mg Riboflavin, 1.5 mg Niyasin and 20 mg Ascorbic acid (Hassan, 2003). Potato is a highly nutritious, mild flavored, easy to blend food that has possibilities for "building in" desired nutrients (Arvanitoyannis et al., 2008). True Potato Seeds (TPS) is sexual seed of potato crop, which is produced through open pollination as well as artificial pollination for producing hybrid seeds in between two known parents as male and female. Recently, the use of TPS for the production of high quality seed potatoes has been well established as an acceptable technology instead of tuber seeds in many countries including Bangladesh. The use of TPS for potato production has increased recently in Europe, North America and Asia, especially in the developing countries (Burton, 1989; Devaux, 1984; Wiersema and Cabello, 1987). This is due to low transmission of disease, high multiplication rate and good tuber yield (Siddique and Rashid, 2000). In Bangladesh, this technology has been highly promising (Renia and Hest. 1998; Roy et al., 1999; Siddique and Rashid, 2000). However, knowledge on TPS progenies and appropriate harvesting period for keeping quality under storage condition is not sufficient in our country. But the information of the ambient storage and its mechanism is of great importance for the selection of TPS progenies having good keeping quality. Knowledge of proper storage environment obviously helps to maintain the quality, extend the storage period and increases the value of stored potato. In Bangladesh, the use of TPS for potato production has increased recently but very few reports are available regarding different TPS variety and their lifting period which can play an important role on natural storage of potato. The purpose of the present research is to provide the information on lifting period for different TPS variety under natural storage condition to meet the produced demand. In the context of the mentioned above situation the present piece of research work was carried out to study the quality assessment of some TPS variety and non-TPS cultivar under natural storage condition.

II. MATERIALS AND METHODS

The experiment was conducted at the Laboratory of the Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. It was located in 24.09^0N latitude and 90.26^0E longitudes during the period from March to August 2013 to study the influence of variety and date of harvesting on changes of sugar and starch levels of potato derived from TPS at ambient storage condition.

The temperature and relative humidity of the storage room were recorded daily basis during the study period with a digital thermo hygrometer (TERMO, TFA, Germany). The minimum and maximum temperature during the study period of the storage room was 26.4^0C to 33.6^0C, respectively. The minimum and maximum relative humidity was 54% and 83%, respectively.

The tubers used for the experiment were BARI TPS-1, BARI TPS-2, HPS-364/67 and Lady Rosetta, and were collected at harvest from Sher-e-Bangla Agricultural University farm using uniform cultural practices. The collected tubers were free of any visible defects, disease symptoms and insect infestations and transported to the Laboratory with careful handling to avoid disease and injury. Tubers were randomly selected after harvest from the experimental field and placed on the floor of the

Laboratory at natural condition to find out the better harvesting period as affected by different variety/genotypes under quality observation. The potatoes were harvested as per the experimental requirements.

The experiment was laid out in a 2 factors Completely Randomized Design (CRD) with 3 replications. The experiment consisted of 2 factors: Factor A: Potato variety (4 varieties) as- V_1: BARI TPS-1, V_2: BARI TPS-2, V_3: HPS-364/67 and V_4: Lady Rosetta; Factor B: Time of harvest (4 times) as- D_1: 80 DAP (Days after planting), D_2: 90 DAP, D_3: 100 DAP and D_4: 110 DAP.

There were 16 (4×4) treatment combinations of the collected potato tubers. Thirty tubers (10 for each replication) for specific treatment combination were selected for conducting the experiment. The selected tubers of each combination with 3 replications were kept in netted plastic basket and were stored in a well ventilated room under diffused light condition.

Starch, reducing sugar, non-reducing sugar and total sugar were determined by Nelson-Somogyi (1944).

The mean values of all the recorded characters were evaluated and analysis of variance was performed by the 'F' (variance ratio) test. The significance of the difference among the treatment combinations of means was estimated by Duncan's Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

III. RESULTS AND DISCUSSION

1.1. Specific gravity

Specific gravity of potato showed significant variation for different variety. At harvest and 100 DAS, the highest specific gravity was recorded from V_3 whereas the lowest was observed from V_1 (Table 1). Statistically significant variation was also recorded for specific gravity of potato for different time of harvest. Table 1 showed that specific gravity gradually increased with increasing harvesting time. Jeong et al. (1996) reported gradual increase in specific gravity until 100 days after planting, and showed a decrease thereafter. Combined effect of different variety and time of harvest also varied significantly for specific gravity. Data revealed that at harvest and 100 DAS, the highest specific gravity (1.13 and 1.16) was observed from V_3D_1 (HPS 364/67 and harvest at 80 DAP), while the lowest (1.06 and 1.09) was recorded from V_1D_4 (BARI TPS-1 and harvest at 110 DAP), respectively for same data recording days (Table 1). Results revealed that specific gravity decreased with increasing storage period is due to metabolism of starch (Thornton, 2002).

1.2. Reducing sugar

Different variety showed statistically significant variation for reducing sugar of potato under the present trial. At harvest and 100 DAS, the lowest reducing sugar was observed from V_3, whereas the highest was recorded from V_4, respectively for same data recording days (Table 1). Reducing sugar of potato also showed statistically significant variation for different time of harvest. At harvest and 100 DAS, the lowest reducing sugar was recorded from D_1, while the highest was observed from D_4 due to increasing concentration of glucose and fructose respectively for same data recording days (Table 1). Similar trend of increasing reducing sugars in tubers has been reported by Kibria (1983) and Boyed and Duncan (1982). This was might be due to breakdown of sucrose and starch. The combined effect of different variety and time of harvest was also significant for reducing sugar. At harvest and 100 DAS, the lowest reducing sugar (0.23% and 0.43%) was recorded from V_3D_1 (HPS-364/67 and harvest at 80 DAP), while the highest (0.32% and 0.62%) was observed from V_4D_4 (Lady Rosetta and harvest at 110 DAP), respectively for same data recording days (Table 1).

1.3. Non reducing sugar

Significant variation was recorded for non reducing sugar of potato for different variety under the present trial. Data revealed that at harvest and 100 DAS, the utmost non reducing sugar was recorded from V_4, whereas the lowest was observed from V_3, respectively for same data recording days (Table 1). Different time of harvest also showed statistically significant variation for non reducing sugar. At harvest, the maximum non reducing sugar was observed from D_4, while the minimum was recorded from D_1. At 100 DAS, the highest non reducing sugar was observed from D_2, while the lowest was recorded from D_4 (Table 1). Combined effect of different variety and time of harvest showed statistically significant variation for non reducing sugar of potato. At harvest, the highest non reducing sugar (0.32%) was observed from V_3D_4 (HPS-364/67 and harvest at 110 DAP), while the lowest (0.19%) was recorded from V_1D_1 (BARI TPS-1 and harvest at 80 DAP). At 100 DAS, the highest non reducing sugar (0.24%) was observed from V_1D_1 (BARI TPS-1 and harvest at 80 DAP), while the lowest (0.17%) was recorded in V_1D_3 (BARI TPS-1 and harvest at 100 DAP) (Table 1).

1.4. Total sugar

Total sugar of potato varied significantly for different variety. At harvest and 100 DAS, the highest total sugar was recorded from V_4, whereas the lowest was observed from V_3, respectively for same data recording days (Table 2). Statistically significant variation was also recorded for total sugar of potato for different time of harvest. At harvest and 100 DAS, the highest total sugar was observed from D_4, while the lowest was recorded from D_1, respectively (Table 2). The total sugar increased with increasing storage period. This might be due to enzymatic hydrolysis of starch to sugar (Cochrane et al., 1991; Nielsen et al., 1997). Combined effect of different variety and time of harvest showed significant variation for total sugar of potato. At harvest and 100 DAS, the highest total sugar (0.61% and 0.82%) was observed from V_4D_4 (Lady Rosetta and harvest at 110 DAP), while the lowest (0.44% and 0.63%) was recorded from V_3D_1 (HPS-364/67 and harvest at 80 DAP), respectively (Table 2).

1.5. Starch content

Different variety showed significant differences for starch content of potato. At harvest and 100 DAS, the highest starch content was recorded from V_3, whereas the lowest from V_2, respectively (Table 2). Rainys and Rudokas (2005) recorded the highest starch were recorded for Lady Rosetta (17.0-17.9%). Statistically significant variation was also recorded for starch content of potato for different time of harvest. At harvest and 100 DAS, the highest starch content was observed from D_1, while the lowest was recorded from D_4, respectively for same data recording days (Table 2). Jeong et al. (1996) reported gradual increase starch content until 100 days after planting, and showed a decrease thereafter. Starch content of potato showed statistically significant variation due to the combined effect of

different variety and time of harvest. At harvest and 100 DAS, the highest starch content (21.12% and 19.50%) was observed from V_3D_1 (HPS-364/67 and harvest at 80 DAP), while the lowest (18.50% and 16.97%) was recorded from V_2D_4 (BARI TPS-2 and harvest at 100 DAP), respectively for same data recording days (Table 2).

Table 1: Effect of different variety and/or time of harvest of potato at different days after storage on specific gravity, reducing sugar, non reducing sugar in potato

Treatment	Specific gravity at		Reducing sugar at		Non reducing sugar at	
	Harvest	100 DAS	Harvest	100 DAS	Harvest	100 DAS
Variety						
V_1	1.04 c	1.07 c	0.28 b	0.53 b	0.26 b	0.20 ab
V_2	1.05 b	1.08 b	0.27 b	0.52 b	0.27 a	0.20 ab
V_3	1.06 a	1.09a	0.24 c	0.49 c	0.25 c	0.19 b
V_4	1.06 a	1.08 ab	0.29 a	0.55 a	0.28 a	0.21 a
SE	0.015	0.024	0.012	0.005	0.016	0.018
Level of significance	0.01	0.01	0.01	0.01	0.01	0.05
Time of harvest						
D_1	1.07 a	1.09 a	0.25 d	0.45 d	0.21 d	0.23 a
D_2	1.07 a	1.09 a	0.27 c	0.47 c	0.25 c	0.22 a
D_3	1.05 b	1.08 b	0.28 b	0.58 b	0.28 b	0.19 b
D_4	1.03 c	1.06 c	0.29 a	0.59 a	0.30 a	0.18 b
SE	0.015	0.024	0.012	0.005	0.016	0.018
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01
Variety × Time of harvest						
V_1D_1	1.01 d	1.04 f	0.26 f-h	0.46 gh	0.19 f	0.24 a
V_1D_2	1.04 c	1.06 de	0.28 c-e	0.48ef	0.23 d	0.23 a
V_1D_3	1.05 bc	1.08 bc	0.29 b-d	0.59 bc	0.26 c	0.17 c
V_1D_4	1.05 bc	1.08 bc	0.29 bc	0.59 bc	0.29 b	0.18 c
V_2D_1	1.02 d	1.05 ef	0.25 g-i	0.45 h	0.22 de	0.23 a
V_2D_2	1.04 c	1.07 cd	0.27 d-f	0.47 fg	0.26 c	0.22 a
V_2D_3	1.07 a	1.09 ab	0.28 c-e	0.58 c	0.29 b	0.18 bc
V_2D_4	1.07 a	1.09 ab	0.29 b-d	0.59 bc	0.31 a	0.18 bc
V_3D_1	1.04 c	1.07 cd	0.23 j	0.43 i	0.21e	0.20 b
V_3D_2	1.06 ab	1.09 ab	0.24 ij	0.44 hi	0.26 c	0.20 b
V_3D_3	1.07 a	1.10 a	0.25 hi	0.55 d	0.29 b	0.19 bc
V_3D_4	1.08 a	1.11 a	0.25 hi	0.55 d	0.32 a	0.20 b
V_4D_1	1.05 bc	1.07 cd	0.27 e-g	0.47 fg	0.21 e	0.20 b
V_4D_2	1.06 ab	1.08 bc	0.29 b-d	0.49 e	0.25 c	0.23 a
V_4D_3	1.07 a	1.09 ab	0.30 b	0.60 b	0.28 b	0.20 b
V_4D_4	1.07 a	1.09 ab	0.32 a	0.62 a	0.29 b	0.20 b
SE	0.047	0.030	0.024	0.010	0.031	0.035
Level of significance	0.05	0.05	0.01	0.01	0.01	0.01

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

V_1: BARI TPS-1, V_2: BARI TPS-2, V_3: HPS-364/67, V_4: Lady Rosetta. D_1: Harvest at 80 DAP, D_2: Harvest at 90 DAP, D_3: Harvest at 100 DAP, D_4: Harvest at 110 DAP.

Table 2: Effect of different variety and/or time of harvest of potato at different days after storage on total sugar and starch content in potato

Treatment	Total sugar at		Starch content at	
	Harvest	100 DAS	Harvest	100 DAS
Variety				
V_1	0.52 c	0.73 b	19.12 b	17.33 b
V_2	0.54 b	0.73 b	19.11 b	17.32 b
V_3	0.51 d	0.69 c	20.51 a	18.89 a
V_4	0.55 a	0.75 a	19.14 b	17.35 b
SE	0.014	0.016	0.415	0.315

Level of significance	0.01	0.01	0.01	0.01
Time of harvest				
D_1	0.46 d	0.67 d	20.03 a	18.22 a
D_2	0.52 c	0.69 c	19.74 b	17.92 b
D_3	0.56 b	0.76 b	19.26 c	17.51 c
D_4	0.59 a	0.78 a	18.86 d	17.25 d
SE	0.014	0.016	0.415	0.315
Level of significance	0.01	0.01	0.01	0.01
Variety × Time of harvest				
V_1D_1	0.45 g	0.69 g	19.74 b	17.79 e
V_1D_2	0.51 e	0.71 f	19.47 bc	17.52 f
V_1D_3	0.55 c	0.76 cd	18.77 de	17.02 gh
V_1D_4	0.58 b	0.77 c	18.92 c-e	17.00 gh
V_2D_1	0.47 f	0.68 gh	19.53 b	17.78 e
V_2D_2	0.53 d	0.69 g	19.28 b-d	17.53 f
V_2D_3	0.57 b	0.76 cd	18.75 de	17.00 gh
V_2D_4	0.60 a	0.77 c	18.50 e	16.97 h
V_3D_1	0.44 g	0.63 i	21.12 a	19.50 a
V_3D_2	0.50 e	0.64 i	20.72 a	19.10 b
V_3D_3	0.54 cd	0.74 e	20.72 a	18.97 c
V_3D_4	0.57 b	0.75 de	19.50 bc	18.00 d
V_4D_1	0.48 f	0.67 h	19.75 b	17.80 e
V_4D_2	0.54 cd	0.72 f	19.49 bc	17.54 f
V_4D_3	0.58 b	0.80 b	18.78 de	17.03 g
V_4D_4	0.61 a	0.82 a	18.52 e	17.02 gh
SE	0.028	0.031	0.890	0.630
Level of significance	0.05	0.01	0.05	0.01

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

V_1: BARI TPS-1, V_2: BARI TPS-2, V_3: HPS-364/67, V_4: Lady Rosetta. D_1: Harvest at 80 DAP, D_2: Harvest at 90 DAP, D_3: Harvest at 100 DAP, D_4: Harvest at 110 DAP.

IV. CONCLUSION

For different varieties, at harvest and 100 DAS, the highest specific gravity, lowest reducing sugar, lowest total sugar and maximum starch content were recorded from HPS-364/67. Specific gravity decreased with increasing storage period but the reducing sugar, total sugar increased with advancing storage period irrespective of varieties. From the nutritional point of view the variety HPS-364/67 showed best performance compared to those of other varieties when harvested at 80 days after planting.

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