Starch and Sugar Content of Some Selected Potato Varieties as Influenced by Vermicompost

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Article Info

ABSTRACT

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The experiment was implemented at Sher-e-Bangla Agricultural University, Bangladesh to assess the effect of variety and vermicompost on the starch and sugar content activity of potato and their performance under ambient storage condition. The experiment consisted of two factors, i.e., factor A:- Potato varieties (V-4): V₁: BARI TPS-1, V₂: BARI Alu-28 (Lady Rosetta), V₃: BARI Alu-25 (Asterix) and V₄: BARI Alu-29 (Courage); factor B:-Vermicompost level (M-4): M₁: 0 t ha⁻¹ (Control), M₂: 2 t ha⁻¹, M₃: 4 t ha⁻¹ and M₄: 6 t ha⁻¹. Inferior quality is a major problem for potato production in Bangladesh. The application of vermicompost may enhance the processing quality of potato. The research revealed that vermicompost had a remarkable effect on most of the processing quality contributing parameters. Results also exhibited those processing parameters improved with increasing vermicompost level. Among the sixteen treatment combinations, Asterix with vermicompost at 6 t ha⁻¹ showed the highest glucose, sucrose content. These two combinations also showed a little bit higher concentration of glucose and sucrose compared to those of other combinations. In case of ambient storage condition; starch decreased with increasing storing period while total soluble solids, glucose and sucrose increased with increasing duration up to 60 days after storage (DAS). Lady Rosetta and Asterix may keep under ambient storage condition up to 60 days after storage without decreasing any significant quality degradation just prior to tuber sprouting. The potato growers of Bangladesh may use Vermicompost on their potato field @ 6 t ha⁻¹ for maintaining preferable good processing standard.

INTRODUCTION

Potato (*Solanum tuberosum* L.) belonging to the Solanaceae family is produced in nearly 150 countries and is the world's single most major tuber crop with an essential part in the global food network and security (Singh 2010). It is the world's 4th largest cultivated crop after wheat, rice and maize. The total world potato production was estimated 376.83 million metric tons in 2016 (FAOSTAT 2017). In the world top ten potato producing countries, Bangladesh ranks 7th position (FAOSTAT 2017). In Bangladesh, it positions 2nd

after paddy in production (FAOSTAT 2013). The total area under potato crop, per ha yield and total production in Bangladesh were 499,725 hectares, 22.53 t ha⁻¹ and 10,215,957 metric ton, respectively during the fiscal year 2017-18 (FAOSTAT 2017). The total production is increasing day by day because of an alternative food crop against rice and wheat, and as a nutrient-rich crop consumption also rapidly increasing in Bangladesh (BBS 2013).

The nutritive benefit of potato is comparatively high, because of protein content and composition high proportion of essential amino acids such as lysine, leucine, threonine, phenylalanine and valine (Gumul et al. 2011). It is also characterized by a high percentage of starch content and lower portion of sugar content. Due to the increasing demand of consumers and foreign importers on this important crop, special attention should be given to increase its quality. Storage shortage is also a serious problem in Bangladesh. Storage conditions make several differences in the

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physiochemical properties of the tubers and textures. Sugar and starch are important components of carbohydrates in case of potato. Potato is a perishable product and mainly three variables control storage losses in potatoes: quality of the tuber at the beginning of the storage, storage conditions, and duration of storage (Burton et al. 1992).

Storage losses are often defined as weight loss and quality degradation of potatoes which are caused by respiration (Basker 1975); sprouting (Amoros et al. 2000); water evaporation from the tubers (Kabira and Lemaga 2006); which accelerate chemical composition and physical property degradation of the tuber (Cronk et al. 1974; Maga and Fitzpatrick 1980) and damage by high temperatures (Linnemann et al. 1985). It is because too high sucrose level produces black coloration during frying of the potato which is not acceptable. In domestic consumption also a high amount of sucrose is not desirable. Recently, gradual shortage of organic matter in soil has reduced yield and quality of crop; which becomes an alarming issue in Bangladesh. The cost of inorganic fertilizers is very high but the organic manure is inexpensive compared to that of chemical fertilizers and easily available to the farmers. Vermicompost is an excellent source of various macro and micronutrients particularly N, P, K and S. It also improves microbial activity that increases of soil phosphorus and nitrogen availability to plant. Vermiculture is the method of growing of earthworms for mass production of organic wastes under the semi-natural condition and vermicomposting is the bioconversion of organic waste materials through the composting process by using different earthworm species (Senapati 1992). It is a controlled, aerobic, biological process and able to convert biodegradable humus-like organic substances and suitable for the application of soil amendment (Senesi et al. 1996).

Vermiculture is a cost-effective method for environmentally safe waste management (Banu et al. 2001; Asha et al. 2008). Earthworms are the essential drivers of the method, as they function in aerate condition and remove the fragment of the substrate and thereby extremely change the microbial activity and their biodegradation capacity (Fracchia et al. 2006; Lazcano et al. 2008). From

the inner quality point of view, potatoes are mainly valued for its starch, reducing sugar and non-reducing sugar (Asghari-Zakaria et al. 2009).

Sometimes potato produced in Bangladesh is not good quality enough in respect of starch, reducing sugar and non-reducing sugar content etc. which are not present at optimum level in the produced product (Keijbets 2008). So, using a different amount of vermicompost materials may put contribution to improving the quality of potato in Bangladesh condition. The objective of this experiment was to find out the influence of Vermicompost on starch and sugar contents of potato varieties under ambient storage condition.

MATERIALS AND METHODS

Research Location

The research was implemented at the Agronomy Research Field of Sher-e-Bangla Agricultural University (SAU), Dhaka-1207, Bangladesh throughout the duration from November 1, 2016 to April 30, 2017. The research area was located at 23°77' N latitude and 90°33' E longitude at an altitude of 8.6 m above the sea level. Topsoil was silty clay in texture, olive-gray with common fine to medium distinct dark yellowish-brown mottles. Soil pH was 5.6 and organic carbon was 0.45%. The selected plot was medium high land. Plenty of sunshine and moderately low temperature prevails during the experimental period, which is suitable for potato growing in Bangladesh. The weather data chart during the study time are presented in Table 1 (Meteorological Centre, Climate Division, Agargaon, Dhaka).

Experimental Design

The experiment consisted of two factors. Factor A: Potato varieties (V-4) - V₁:BARI TPS-1, V₂:BARI Alu-28 (Lady Rosetta), V₃: BARI Alu-25 (Asterix), V₄:BARI Alu-29 (Courage); Factor B: Vermicompost levels (M-4) - M₁: 0 t ha⁻¹ (control), M₂: 2 t ha⁻¹, M₃: 4 t ha⁻¹, M₄: 6 t ha⁻¹. The experiment was provoked in a split-plot design with three replications. The variety was assigned to the main plot and vermicompost to the subplot. Distance between row to row was 50 cm and plant to plant distance was 25 cm. Distance between plot to the plot was 75 cm. The size of the unit plot was

Table 1. Monthly meteorological information during the period from November 2016 to April 2017

Year	Month	Air temperature (°C)		Relative humidity (%)	Total rainfall (mm)
		Maximum	Minimum		
2016-2017	November	28.10	11.83	58.18	47
	December	25.00	9.46	69.53	0
	January	23.98	10.47	73.86	Trace
	February	26.45	14.83	75.38	Trace
	March	30.45	18.36	69.44	59
	April	35.93	42.35	73.92	103

2 m × 2.5 m.

Crop Management

Collected all varieties of seed potatoes were certified seed and individual weight of seed potato was 60-70 g. The experimental soil was fertilized with Urea (250 kg ha⁻¹), Triple Super Phosphate (150 kg ha⁻¹), Muriate of Potash (250 kg ha⁻¹), Gypsum (120 kg ha⁻¹), Zinc Sulphate (10 kg ha⁻¹) and Boric Acid (10 kg ha⁻¹) as recommended by Mondal et al. (2011). The total amount of vermicompost was applied at 7 days before planting as per treatment. The completely sprouted vigorous and uniform sized potato tubers were planted according to 4-5 cm depth in the soil. Different intercultural operations such as irrigation, weeding, mulching, earthing up and plant protection measures were done as per when needed. Haulm cutting was done at 85 days after planting (DAP), when 40-50% plants exhibited senescence and the tops started drying. For skin hardening the tubers were kept under the soil for 10 days after haulm cutting. The potatoes of each plot were separately harvested, bagged and tagged and brought to the laboratory.

Recording of Data

The harvested potatoes were stored in a well-ventilated ambient storage condition. Data were taken at 0, 20, 40 and 60 days after storage (DAS).

Total Soluble Solids (TSS)

TSS of harvested tubers was measured in a drop of potato juice by using Hand Sugar Refractometer "ERMA" Japan, Range: 0-32% according to (AOAC 1990) and recorded as percentage (%) Brix from an immediate reading of the instrument.

Reducing Sugar and Non-reducing Sugar

Extraction of sugar

For the analysis of sugar contents like reducing sugar (glucose) and non-reducing sugar (sucrose), potato flesh was extracted from each treatment. Sugars were extracted using 5 ml of 80% ethanol heated at 80°C for 30 min in a dry block heat bath and the extracts were centrifuged at 5000 rpm for 10 min and decanted the supernatant and it was repeated 4 and 5 times in total. All the supernatants were mixed properly and the final volume was made 25 ml using 80% ethanol. For starch analysis the residue was used.

Reducing Sugar Determination (Glucose)

Reducing sugar content was measured by the photometric adaptation of the Somogyi technique (Nelson 1944) with some modification. Copper solution, Nelson reagent and standard glucose solution (0.5 ml) were used. 3 ml sample solution

was completely dried up on an electric heater then added 3 ml distilled water and mixed properly. Then 0.5 ml solution was taken in a test tube and added 0.5 ml copper solution and boiled (100°C) for 10 min. After boiling, immediately the test tube was cooled in tap water then added 0.5 ml Nelson reagent and mixed properly. After 20 min, 8 ml distilled water was added and mixed properly (total volume was 9.5 ml). After that the absorbance was measured at 660 nm and the reducing sugar content was calculated as mg g⁻¹ FW.

Non-reducing Sugar Determination (Sucrose)

In a test tube 0.5 ml solution was taken which was left while reducing sugar determination. Then 0.5 ml diluted invertase solution (20 Unit/0.5 ml) was added and incubated for 30 min at ambient condition. After incubation 0.05 ml copper solution was added and boiled (100°C) for 10 min. After boiling, immediately the test tubes were cooled in tap water, added 0.5 ml Nelson reagent and mixed properly. After 20 min, 8 ml distilled water was added and mixed properly (total volume was 9.5 ml). After that the absorbance was measured at 660 nm and the non-reducing sugar content was calculated as mg g⁻¹ FW.

Measurement of Starch in Potato Tubers

After extraction of sugar, the remained residue was washed for several times with water to ensure that there was no more soluble sugar in the residues. After that using tap water marked up to 250 ml in a beaker and stirred properly by using a magnetic stirrer. During the stirring, 0.5 ml solution was taken from the beaker and boiled for 10 min at 100 °C. Then 1 ml Amyloglucosidase solution was added and mixed properly and heated at 50-60°C for 2 hrs in hot water. After cooling, a 0.5 ml copper solution was added and mixed properly, heated at 100C for 10 min. Then cooled in tap water, added 0.5 ml nelson solution, mixed properly and added 7 ml distilled water (final volume was 9.5 ml) and measured the absorbance at 660 nm. The starch content was calculated using the glucose standard curve and expressed as mg g⁻¹ FW.

Statistical Data Analysis

The data acquired for different parameters were statistically calculated following the analysis of variance (ANOVA) method by using Statistix 10 (2013) computer package program. The significant dissimilarity among the treatment means was compared by Least Significant Difference (LSD) at 5% level of probability (Gomez and Gomez 1984). The correlation was calculated on the basis of data from 0 days of storage *i.e.*, at harvesting day. Correlation graph plotted with the help of Microsoft Excel 2016.

RESULTS AND DISCUSSION

Total Soluble Solid (TSS % Brix)

Significant variation was found among different varieties to TSS of tuber at different ambient storage time. At 0 DAS highest TSS of tuber was found by V₁ (5.125 %) which was statistically similar to V₄ and the lowest was shown by V₂ (4.537 %). At 20 DAS highest was found by V₁ (7.575 %) and lowest was found by V₂ (6.425 %) which was statistically similar to V₃. At 40 DAS highest was found by V₁ (7.475 %) and lowest was found by V₂ (6.625 %) which was statistically similar to V₃ and V₄. At 60 DAS highest was found by V₁ (7.688 %) which was statistically similar to V₄ and lowest was found by V₂ (7.150 %) which was statistically similar to V₃. Profound variation was found among different levels of vermicompost on TSS of tuber at different storage time. At 0 DAS highest TSS of tuber was exhibited by M₂ (5.125 %) which is statistically similar to M₁ and M₄; the lowest was exhibited by M₃ (4.512 %). At 20 DAS highest TSS of tuber was exhibited by M₄ (7.00 %) which was statistically similar to M₃ and M₂; the lowest was exhibited by M₁ (6.60 %). At 40 DAS highest TSS of tuber was exhibited by M₄ (7.063 %) which was statistically similar to M₃ and M₂; the lowest was exhibited by M₁ (6.688 %). At 60 DAS different levels of vermicompost on TSS of tuber was found statistically non-significant. Significant variation was found among different variety and vermicompost levels on total soluble solid of tuber at different ambient storage time. At 0 DAS maximum TSS of tuber exhibited by V₄M₂ (5.50 %) which was statistically similar to V₁M₁, V₁M₂, V₁M₄, V₃M₁, V₄M₁ and V₄M₄; minimum was exhibited by V₂M₁ (3.90 %). At 20 and 40 DAS combined effect of variety and vermicompost levels on TSS of tuber was found statistically non-significant. At 60 DAS maximum TSS of tuber exhibited by V₁M₃ (7.80 %) which was statistically similar to V₁M₂, V₁M₄, V₂M₄, V₄M₂, V₁M₁, V₄M₁, V₃M₂ and V₃M₃; minimum was exhibited by V₂M₃ (6.90 %) which was statistically similar to V₃M₁.

Total soluble solids (TSS) increased with the increase of storage time. TSS increased with the increasing of Vermicompost levels because organic manures contain all micro and macronutrients which are helpful for plant growth (Agrawal et al. 2017).

Glucose Content

Significant variation was found among different varieties to glucose content of tuber at

different ambient storage time. The highest glucose content of tuber was exhibited by V₃ (0.7267 mg, 0.795 mg, 1.592 mg, 1.433 mg) and lowest was exhibited by V₁ (0.5508 mg, 0.605 mg, 1.210 mg, 1.090 mg) at 0, 20, 40, 60 DAS respectively. Profound variation was found among different levels of vermicompost on glucose content of tuber at different ambient storage time. The maximum glucose content of tuber was found by M₄ (0.6942 mg, 0.760 mg, 1.523 mg, 1.372 mg) and minimum was shown by M₁ (0.5375 mg, 0.595 mg, 1.184 mg, 1.067 mg) at 0, 20, 40 and 60 DAS respectively. Significant variation was found among different variety and vermicompost levels on glucose content of tuber at different ambient storage condition. At 0 DAS the maximum glucose content of tuber was contained by V₃M₄ (0.82 mg) which was statistically alike to V₃M₃ and minimum was contained by V₁M₁ (0.43 mg). At 20 DAS the maximum glucose content of tuber was contained by V₃M₄ (0.90 mg) which was statistically close to V₃M₃ and the minimum was contained by V₁M₁ (0.48 mg). At 40 DAS the maximum glucose content of tuber was contained by V₃M₄ (1.80 mg) which was statistically alike to V₃M₃ and the minimum was contained by V₁M₁ (0.95 mg). At 60 DAS statistically data was found non-significant.

Glucose content gradually increased with the increasing storage time up to 40 DAS and then sharply decreased. Different genotypes have various regulation of reducing sugar (glucose) accumulation connected with tuber sprouting and senescence in response storage period (Wiltshire and Cobb 1996). The hydrolysis of sucrose by the invertase enzyme accelerated to the formation of glucose and fructose monomers within potato tubers (Kumar et al. 2004). The significant increase in glucose contents in the storage period due to earlier sprouting and the associated depletion of carbohydrate reserves in the tuber (Blenkinsop et al. 2002). A strong positive correlation ($r = 0.927$) was found between the reducing sugar content and non-reducing sugar content of potato tuber (Figure 1) (Braun et al. 2016).

Figure 1. Relationship between reducing sugar content and non-reducing sugar content of potato tuber

Table 2. Effect of variety to total soluble solid at different days after storage of potato tuber

Variety	Total soluble solid (TSS % Brix)			
	0 DAS	20 DAS	40 DAS	60 DAS
V ₁	5.12 a	7.57 a	7.47 a	7.68 a
V ₂	4.53 c	6.42 c	6.62 b	7.15 b
V ₃	4.82 b	6.57 c	6.65 b	7.17 b
V ₄	5.00 ab	6.90 b	6.95 b	7.55 a
CV (%)	4.73	3.39	6.36	4.31
LSD _{0.05}	0.23	0.23	0.44	0.31
Level of significance	**	**	**	**

Numbers in columns followed by the different letter are statistically different at P_{0.05}.

** = Significant at 1% level of probability. V₁ –BARI TPS-1, V₂ – Lady Rosetta, V₃ – Asterix, V₄ – Courage

Table 3. Effect of vermicompost on total soluble solid at different days after storage of potato tuber

Vermicompost level	Total soluble solids (TSS % Brix)			
	0 DAS	20 DAS	40 DAS	60 DAS
M ₁	4.90 a	6.60 b	6.68 b	7.28
M ₂	5.12 a	6.87 ab	7.05 a	7.45
M ₃	4.51 b	7.00 a	6.90 ab	7.35
M ₄	4.95 a	7.00 a	7.06 a	7.46
CV (%)	6.08	5.00	4.82	3.24
LSD _{0.05}	0.25	0.28	0.28	-
Level of significance	**	*	*	NS

Numbers in columns followed by the different letter are statistically different at P_{0.05}.

** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS = Not significant.

M₁ – 0 t ha⁻¹ (Control), M₂ – 2 t ha⁻¹, M₃ – 4 t ha⁻¹, M₄ – 6 t ha⁻¹

Table 4. Combined effect of variety and vermicompost on total soluble solid at different days after storage of potato tuber

Combination	Total soluble solids (TSS % Brix)			
	0 DAS	20 DAS	40 DAS	60 DAS
V ₁ M ₁	5.50 a	7.30	7.20	7.55 a-c
V ₁ M ₂	5.20 ab	7.60	7.70	7.70 ab
V ₁ M ₃	4.65 b-e	7.80	7.50	7.80 a
V ₁ M ₄	5.15 a-c	7.60	7.50	7.70 ab
V ₂ M ₁	3.90 f	6.10	6.35	7.10 c-e
V ₂ M ₂	5.00 a-d	6.30	6.55	7.00 de
V ₂ M ₃	4.65 b-e	6.60	6.50	6.90 e
V ₂ M ₄	4.60 c-e	6.70	7.10	7.60 ab
V ₃ M ₁	5.10 a-c	6.10	6.10	6.90 e
V ₃ M ₂	4.80 b-e	6.70	6.95	7.40 a-d
V ₃ M ₃	4.50 de	6.90	6.90	7.40 a-d
V ₃ M ₄	4.90 b-d	6.60	6.65	7.00 e
V ₄ M ₁	5.10 a-c	6.90	7.10	7.55 a-c
V ₄ M ₂	5.50 a	6.90	7.00	7.70 ab
V ₄ M ₃	4.25 ef	6.70	6.70	7.30 b-e
V ₄ M ₄	5.15 b-c	7.10	7.00	7.55 a-c
CV (%)	6.08	5.00	4.82	3.24
LSD _{0.05}	0.499	-	-	0.402
Level of significance	**	NS	NS	**

Numbers in columns followed by the different letter are statistically different at P_{0.05}.

** = Significant at 1% level of probability, NS = Not significant.

V₁ –BARI TPS-1, V₂ – Lady Rosetta, V₃ – Asterix, V₄ – Courage; M₁ – 0 t ha⁻¹ (Control), M₂ – 2 t ha⁻¹, M₃ – 4 t ha⁻¹, M₄ – 6 t ha⁻¹

Sucrose Content

Profound variation was found among different varieties to sucrose content of tuber at different ambient storage time. At 0 DAS the highest sucrose content of tuber was exhibited by V₃ (2.170 mg)

and lowest was exhibited by V₁ (1.527mg). At 20 DAS the highest sucrose content of tuber was exhibited by V₃ (2.600mg) and lowest was exhibited by V₁ (1.832 mg) which was statistically similar to V₂. At 40 and 60 DAS the highest

Table 5. Effect of variety to glucose at different days after storage of potato tuber

Variety	Glucose (mg g ⁻¹ FW)			
	0 DAS	20 DAS	40 DAS	60 DAS
V ₁	0.550 d	0.605 d	1.210 d	1.090 c
V ₂	0.592 c	0.650 c	1.303 c	1.173 b
V ₃	0.726 a	0.795 a	1.592 a	1.433 a
V ₄	0.626 b	0.690 b	1.380 b	1.245 b
CV (%)	5.07	4.62	3.26	6.30
LSD _{0.05}	0.031	0.031	0.044	0.077
Level of significance	**	**	**	**

Numbers in columns followed by the different letter are statistically different at P_{0.05}.

** = Significant at 1% level of probability. V₁ –BARI TPS-1, V₂ – Lady Rosetta, V₃ – Asterix, V₄ – Courage

Table 6. Effect of vermicompost on glucose at different days after storage of potato tuber

Vermicompost level	Glucose (mg g ⁻¹ FW)			
	0 DAS	20 DAS	40 DAS	60 DAS
M ₁	0.537 d	0.595 d	1.184 d	1.067 d
M ₂	0.610 c	0.667 c	1.341 c	1.207 c
M ₃	0.654 b	0.717 b	1.438 b	1.293 b
M ₄	0.694 a	0.760 a	1.523 a	1.372 a
CV (%)	4.90	4.05	4.12	7.07
LSD _{0.05}	0.026	0.026	0.046	0.075
Level of significance	**	**	**	**

Numbers in columns followed by the different letter are statistically different at P_{0.05}.

** = Significant at 1% level of probability. M₁ – 0 t ha⁻¹ (Control), M₂ – 2 t ha⁻¹, M₃ – 4 t ha⁻¹, M₄ – 6 t ha⁻¹

Table 7. Combined effect of variety and vermicompost on glucose at different days after storage of potato tuber

Combination	Glucose (mg g ⁻¹ FW)			
	0 DAS	20 DAS	40 DAS	60 DAS
V ₁ M ₁	0.430 h	0.480 h	0.956 g	0.86
V ₁ M ₂	0.566 fg	0.620 fg	1.243 ef	1.12
V ₁ M ₃	0.586 e-g	0.643 e-g	1.290 d-f	1.16
V ₁ M ₄	0.620 d-f	0.676 d-f	1.350 cd	1.22
V ₂ M ₁	0.550 g	0.610 g	1.210 f	1.09
V ₂ M ₂	0.590 e-g	0.640 e-g	1.290 d-f	1.16
V ₂ M ₃	0.600 d-g	0.660 d-g	1.320 de	1.19
V ₂ M ₄	0.630 de	0.690 de	1.390 cd	1.25
V ₃ M ₁	0.610 d-g	0.670 d-g	1.330 c-e	1.20
V ₃ M ₂	0.696 bc	0.760 bc	1.530 b	1.38
V ₃ M ₃	0.780 a	0.850a	1.710 a	1.53
V ₃ M ₄	0.820 a	0.900a	1.800 a	1.62
V ₄ M ₁	0.560 fg	0.620 fg	1.240 ef	1.12
V ₄ M ₂	0.590 d-g	0.650 e-g	1.300 d-f	1.17
V ₄ M ₃	0.650 cd	0.716 cd	1.430 c	1.29
V ₄ M ₄	0.706 b	0.776 b	1.550 b	1.40
CV (%)	4.90	4.05	4.12	7.07
LSD _{0.05}	0.053	0.053	0.092	-
Level of significance	*	**	**	NS

Numbers in columns followed by the different letter are statistically different at P_{0.05}.

** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS = Not significant.

V₁ –BARI TPS-1, V₂ – Lady Rosetta, V₃ – Asterix, V₄ – Courage; M₁ – 0 t ha⁻¹ (Control), M₂ – 2 t ha⁻¹, M₃ – 4 t ha⁻¹, M₄ – 6 t ha⁻¹

sucrose content of tuber was exhibited by V₃ (5.20mg, 4.682 mg) and lowest was exhibited by V₁ (3.66 mg, 3.298 mg) respectively. Significant variation was found among different levels of

vermicompost on sucrose content of tuber at different ambient storage period. At 0 DAS highest sucrose of tuber was contained by M₄ (2.149 mg)

Table 8. Effect of variety to sucrose at different days after storage of potato tuber

Variety	Sucrose (mg g ⁻¹ FW)			
	0 DAS	20 DAS	40 DAS	60 DAS
V ₁	1.527 d	1.832 c	3.66 d	3.298 d
V ₂	1.687 c	2.020 c	4.04 c	3.640 c
V ₃	2.170 a	2.600 a	5.20a	4.682 a
V ₄	1.929 b	2.310 b	4.61 b	4.157 b
CV (%)	5.76	9.79	5.40	3.50
LSD _{0.05}	0.104	0.214	0.236	0.137
Level of significance	**	**	**	**

Numbers in columns followed by the different letter are statistically different at P_{0.05}.

** = Significant at 1% level of probability. V₁ –BARI TPS-1, V₂ – Lady Rosetta, V₃ – Asterix, V₄ – Courage

Table 9. Effect of vermicompost on sucrose at different days after storage of potato tuber

Vermicompost level	Sucrose (mg g ⁻¹ FW)			
	0 DAS	20 DAS	40 DAS	60 DAS
M ₁	1.558 d	1.863 c	3.733 d	3.360 d
M ₂	1.697 c	2.033 c	4.068 c	3.660 c
M ₃	1.909 b	2.289 b	4.577 b	4.120 b
M ₄	2.149 a	2.577 a	5.149 a	4.637 a
CV (%)	3.05	9.30	7.04	5.57
LSD _{0.05}	0.046	0.172	0.259	0.184
Level of significance	**	**	**	**

Numbers in columns followed by the different letter are statistically different at P_{0.05}.

** = Significant at 1% level of probability. M₁ – 0 t ha⁻¹ (Control), M₂ – 2 t ha⁻¹, M₃ – 4 t ha⁻¹, M₄ – 6 t ha⁻¹

Table 10. Combined effect of variety and vermicompost level on sucrose at different days after storage of potato tuber

Combination	Sucrose (mg g ⁻¹ FW)			
	0 DAS	20 DAS	40 DAS	60 DAS
V ₁ M ₁	1.31 l	1.57	3.14 k	2.83 j
V ₁ M ₂	1.38 l	1.66	3.31jk	2.98 ij
V ₁ M ₃	1.68 hi	2.02	4.03 f-i	3.63 f-h
V ₁ M ₄	1.74 h	2.08	4.16 e-i	3.75 fg
V ₂ M ₁	1.50 k	1.79	3.59 i-k	3.23 hi
V ₂ M ₂	1.62 ij	1.94	3.89 g-i	3.50 gh
V ₂ M ₃	1.76gh	2.11	4.22 e-h	3.80 e-g
V ₂ M ₄	1.86 ef	2.24	4.47 d-f	4.03 d-f
V ₃ M ₁	1.87ef	2.24	4.48 d-f	4.04 d-f
V ₃ M ₂	1.95 de	2.33	4.67de	4.20de
V ₃ M ₃	2.18 c	2.61	5.22 bc	4.70 bc
V ₃ M ₄	2.68a	3.22	6.43a	5.79a
V ₄ M ₁	1.55 jk	1.85	3.71 h-j	3.34 hi
V ₄ M ₂	1.84 fg	2.20	4.40 d-g	3.96 d-f
V ₄ M ₃	2.01 d	2.42	4.83 cd	4.35 cd
V ₄ M ₄	2.31 b	2.77	5.53 b	4.98 b
CV (%)	3.05	9.30	7.04	5.57
LSD _{0.05}	0.092	-	0.519	0.369
Level of significance	**	NS	*	**

Numbers in columns followed by the different letter are statistically different at P_{0.05}.

** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS = Not significant.

V₁ –BARI TPS-1, V₂ – Lady Rosetta, V₃ – Asterix, V₄ – Courage; M₁ – 0 t ha⁻¹ (Control), M₂ – 2 t ha⁻¹, M₃ – 4 t ha⁻¹, M₄ – 6 t ha⁻¹

and the lowest was contained by M₁ (1.558 mg). At 20 DAS highest sucrose of tuber was contained by

M₄ (2.577 mg) and the lowest was contained by M₁ (1.863 mg) which was statistically similar to M₂. At 40 DAS highest sucrose of tuber was contained by M₄ (5.149 mg, 4.637mg) and lowest was contained

Table 11. Effect of variety to starch at different days after storage of potato tuber

Variety	Starch (mg g ⁻¹ FW)			
	0 DAS	20 DAS	40 DAS	60 DAS
V ₁	20.36 b	12.27 d	9.210 d	1.43 d
V ₂	21.93 b	13.34 c	10.86 c	1.88 c
V ₃	30.48 a	16.69 a	15.13 a	3.66 a
V ₄	29.03 a	14.38 b	12.87 b	2.48 b
CV (%)	6.66	4.99	7.06	4.81
LSD _{0.05}	1.69	0.70	0.84	0.11
Level of significance	**	**	**	**

Numbers in columns followed by the different letter are statistically different at P_{0.05}.

** = Significant at 1% level of probability. V₁ – BARI TPS-1, V₂ – Lady Rosetta, V₃ – Asterix, V₄ – Courage

Table 12. Effect of vermicompost on starch at different days after storage of potato tuber

Vermicompost level	Starch (mg g ⁻¹ FW)			
	0 DAS	20 DAS	40 DAS	60 DAS
M ₁	21.52 d	11.45 d	9.44 d	1.29 d
M ₂	23.91 c	12.57 c	11.07 c	2.04 c
M ₃	27.05 b	14.77 b	12.71 b	2.38 b
M ₄	29.31 a	17.90 a	14.86 a	3.75 a
CV (%)	4.40	4.71	6.52	5.18
LSD _{0.05}	0.94	0.56	0.65	0.10
Level of significance	**	**	**	**

Numbers in columns followed by the different letter are statistically different at P_{0.05}.

** = Significant at 1% level of probability. M₁ – 0 t ha⁻¹ (Control), M₂ – 2 t ha⁻¹, M₃ – 4 t ha⁻¹, M₄ – 6 t ha⁻¹

by M₁ (3.733 mg, 3.360mg). Significant variation was found among different variety and vermicompost levels on sucrose content of tuber at different ambient storage condition. At 0 DAS

maximum sucrose of tuber contained by V₃M₄ (2.68 mg) and minimum was contained by V₁M₁ (1.31 mg). At 20 DAS different variety and vermicompost levels were found statistically non-significant. At 40 and 60 DAS maximum sucrose

of tuber contained by V₃M₄ (6.43 mg, 5.79 mg) and minimum was contained by V₁M₁ (3.14 mg, 2.83 mg) respectively.

Sucrose content gradually increased with the increasing storage time up to 40 DAS and then sharply decreased. Kumar et al. (2004) reported that sucrose content was increased from harvest till 8 weeks of storage in response to variety.

Table 13. Combined effect of variety and vermicompost on starch at different days after storage of potato tuber

Combination	Starch (mg g ⁻¹ FW)			
	0 DAS	20 DAS	40 DAS	60 DAS
V ₁ M ₁	16.62 i	9.47 g	5.96 j	0.72 i
V ₁ M ₂	17.47 i	10.04 g	8.05 i	1.36 g
V ₁ M ₃	21.90 g	12.78 de	9.85 g	1.47 g
V ₁ M ₄	25.47 ef	16.81 b	12.98 d	2.20 f
V ₂ M ₁	18.32 hi	9.69 g	8.38 hi	1.02 h
V ₂ M ₂	19.75 h	11.63 ef	9.62 gh	2.10 f
V ₂ M ₃	23.73 fg	14.38 c	11.58 ef	2.17 f
V ₂ M ₄	25.91 e	17.64 b	13.88 cd	2.24 f
V ₃ M ₁	27.83 d	15.00 c	13.09 d	2.33 ef
V ₃ M ₂	29.28 cd	15.42 c	13.81 cd	2.59 d
V ₃ M ₃	31.72 ab	17.10 b	16.21 ab	3.38 c
V ₃ M ₄	33.08 a	19.26 a	17.41 a	6.37 a
V ₄ M ₁	23.32 g	11.63 f	10.33 fg	1.10 h
V ₄ M ₂	29.15 cd	13.18 d	12.79 de	2.12 f
V ₄ M ₃	30.85 bc	14.84 c	13.19 d	2.51 de
V ₄ M ₄	32.79 ab	17.88 b	15.18 bc	4.22 b
CV (%)	4.40	4.71	6.52	5.18
LSD _{0.05}	1.88	1.12	1.31	0.206
Level of significance	**	**	**	**

Numbers in columns followed by the different letter are statistically different at P_{0.05}.

** = Significant at 1% level of probability. V₁ – BARI TPS-1, V₂ – Lady Rosetta, V₃ – Asterix, V₄ – Courage; M₁ – 0 t ha⁻¹ (Control), M₂ – 2 t ha⁻¹, M₃ – 4 t ha⁻¹, M₄ – 6 t ha⁻¹

Starch Content

Significant variation was found among different varieties to starch content of tuber at different ambient storage time. At 0 DAS the highest starch content of tuber was found by V₃ (30.48 mg) which was statistically similar to V₄ and lowest was found by V₁ (20.36 mg) which was statistically similar to V₂. At 20, 40 and 60 DAS the highest starch content of tuber was found by V₃ (16.69 mg, 15.13 mg, 3.668 mg) and lowest was found by V₁ (12.27 mg, 9.210 mg, 1.438 mg) respectively. Significant variation was found among different levels of vermicompost on starch content of tuber at different ambient storage time. The maximum starch content of tuber was found by M₄ (29.31 mg, 17.90 mg, 14.86 mg, 3.76 mg) and the minimum was shown by M₁ (21.52 mg, 11.45 mg, 9.44 mg, 1.29 mg) at 0, 20, 40 and 60 DAS respectively. Significant variation was found among different variety and vermicompost levels on starch content of tuber at different storage time. At 0 DAS maximum starch of tuber contained by V₃M₄ (33.08 mg) which was statistically close to V₃M₃ and V₄M₄; minimum was contained by V₁M₁ (16.62 mg). At 20 DAS maximum starch of tuber contained by V₃M₄ (19.26 mg) and minimum was contained by V₁M₁ (9.470 mg). At 40 DAS maximum starch of tuber contained by V₃M₄ (17.41 mg) which was statistically alike to V₃M₃ and minimum was contained by V₁M₁ (5.960 mg). At 60 DAS maximum starch of tuber contained by V₃M₄ (6.370 mg) and minimum was contained by V₁M₁ (0.720 mg).

Starch content decreased with the increase of storage time. Starch content of tuber significantly increased with the increasing of Vermicompost levels (Kmeťová et al. 2013). It reduced during storage for all potato varieties due to increasing metabolism activity, respiration and physiological aging of potato tubers; which accelerated earlier sprouting and higher carbohydrate consumption and breakdown of starch into glucose and fructose at the later part of storage (Wiltshire and Cobb 1996) and also found a direct relationship between dry matter and starch contents of tuber.

CONCLUSIONS

On the basis of the results, it can be concluded that the variety and vermicompost have shown the statistically significant variation among the parameters studied under the experiment. On the basis of storage and processing parameters, it can be said that, V₃: BARI Alu-25 (Asterix) has shown the better performance on most of the varieties and M₄: 6 t ha⁻¹ treatment has also shown the significantly better result on most of the vermicompost levels. Tuber produced from V₃M₄, contained maximum glucose, sucrose, starch, whereas the V₁M₁ exhibited the worst one. In

conclusion, Bangladesh's potato growers may use vermicompost on their potato field at the rate of 6 t ha⁻¹ for better processing quality in combination with Lady Rosetta and Asterix.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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