Effect of vermicompost and tuber size on total soluble solids, sucrose and skin color of potato under ambient storage condition

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ABSTRACT

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The research was carried out to assess the effect of vermicompost and tuber size on the changes of TSS (total soluble solids), sucrose (non-reducing sugar) content, and skin color of potato under ambient storage condition. Potato variety BARI TPS-1 was used as an experimental crop. The experiment was consisted of two factors, i.e., factor A:- Vermicompost level (V_{m1-4}): V_{m1} : 0 t ha⁻¹ (control), V_{m2} : 3 t ha⁻¹, V_{m3} : 6 t ha⁻¹ and V_{m4} : 9 t ha⁻¹; factor B:- Tuber size (T_{1-5}): T_1 : 5-10 g, T_2 : 10-20 g, T_3 : 20-30 g, T_4 : 30-40 g and T_5 : >40 g. The research exhibited that vermicompost had a significant effect on most of the quality contributing parameters investigated under the experiment. Results exhibited that processing quality parameters increased with increasing vermicompost level irrespective of tuber size. Among the twenty (20) treatment combinations, vermicompost at the rate of 9 t ha⁻¹ with tuber size >40 g produced the minimum total soluble solids (4.55% Brix), minimum sucrose (0.2947 mg g⁻¹ FW) and maximum skin color (L^* 67.38, a^* 15.38, b^* 26.60). In respect of ambient storage condition total soluble solids (TSS), sucrose slowly increased with increasing storage time up to 40 days after storage (DAS) and finally became non-suitable for both table and processing purpose; while skin color decreased with increasing storage time. Therefore, the study suggests that potato growers may use vermicompost for improving processing quality of potato varieties and can store potato up to 40 DAS at ambient storage condition.

INTRODUCTION

Potato (*Solanum tuberosum* L.) popularly known as "the king of vegetables" belonging to the Solanaceae family is the world's most cultivated and 4th largest tuberous crop following maize, wheat and rice (Rajiv and Kavar 2016; FAOSTAT 2019). During 2017 the total world potato production was estimated 388.19 million metric tons. In the world's top 10 potato producing countries, Bangladesh ranks 7th position (FAOSTAT 2019). Potato is one of the major vegetable crops in Bangladesh (Hoque 2010). In Bangladesh, it positions 2nd after rice in production (Mostofa 2019). The total area under potato crop,

per hectare yield and total production in Bangladesh were 499725 hectares, 22.53 t ha⁻¹ and 10.22 million metric tons, respectively during the fiscal year 2017-18 (FAOSTAT 2019). The total production is increasing day by day because of a substitute food crop against rice and wheat and is a nutrient rich crop as such consumption also quickly increasing in Bangladesh (BBS 2015). Potato is unique compared to other vegetables in that they are exclusively consumed in processed forms. Approximately 60% of the fresh potato is used for industrial processing into different products such as French fries, chips and flakes, whereas the remaining 40% is sold on the fresh vegetable market for home preparation and fresh food service applications (USDA 2014). Due to the increasing demand of consumers and foreign importers on this important crop, special attention should be given to increase its processing quality. Potato tuber quality is one of the most important quality attributes for consumers and industrial demand (Brown 2005). Processing standards of potato tuber are determined by low total soluble solids (TSS) and sucrose (non-

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reducing sugar) content (Kadam et al. 1991; Abong et al. 2009). Higher sucrose content increases dark color and bitter taste of processed products, which negatively influence consumer acceptance (Wiltshire and Cobb 1996; Wang-Pruski and Nowak 2004). In domestic consumption, a high amount of sucrose content and dark colored potato are not also desirable. The skin color of potato is an essential factor for consumer acceptance of fresh potatoes from the market (Jemison et al. 2008). Application of vermicompost singly or in combination with either other chemical fertilizers has been proved useful to enhance quality (Alam et al. 2007). 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 assess the optimum level of vermicompost and tuber size on the biochemical changes of potato under ambient storage condition.

MATERIALS AND METHODS

Research Location

The experimental study was carried out at the experimental agronomy field of Sher-e-Bangla Agricultural University (SAU), Dhaka-1207, Bangladesh during the period from November 1, 2016 to April 30, 2017 in Rabi season (winter season). The soil of the research area was to the common soil type series of shallow red brown terrace soils under Tejgaon series. Upper-level soils were clay loam in texture, olive-gray through general fine to average distinct dark yellowish-brown mottles under the Agro-ecological Zone (AEZ) - 28 and belonged to the Madhupur Tract (UNDP 1988). Soil organic carbon was 0.45% and pH was 5.6. The Rabi season (winter season) is characterized by comparatively low temperature and sufficient sunshine from November to February which is suitable for potato growth and development (SRDI 1991).

Experimental Treatments and Design

The experiment consisted of two factors viz., vermicompost level and tuber size. Factor A: Vermicompost level (V_{m1-4}) - V_{m1} : 0 t ha⁻¹ (control), V_{m2} : 3 t ha⁻¹, V_{m3} : 6 t ha⁻¹, V_{m4} : 9 t ha⁻¹. Factor B: Tuber size (T_{1-5}) - S_1 : 5-10 g, S_2 : 10-20 g, S_3 : 20-30 g, S_4 : 30-40 g, S_5 : >40 g. The research was carried out in a split-plot design with three replications. The vermicompost was assigned to the main plot and tuber size to the subplot. The distance between plot to plot was 75 cm, row to row was 50 cm and plant to plant was 25 cm. Unit plot size was 2 m × 1.5 m.

Planting material

BARI TPS-I (certified seed) was used as planting material. It is easily storable due to its low storage volume and does not transmit virus diseases from one generation to another or soil-borne diseases from one field to another (Almekinders et al. 2009). BARI TPS-I was developed and released by Tuber Crops Research Centre (TCRC), Bangladesh Agricultural Research Institute (BARI) in 1997. Collected seed tubers were graded according to the size 5-10 g, 10-20 g, 20-30 g, 30-40 g, >40 g and kept in room temperature to assist uniform sprouting. Finally, sprouted seed tubers were planted at 4-5 cm depth in the soil.

Fertilizer Application

After land preparation the experimental soil was fertilized with a recommended dose of Urea 250 kg ha⁻¹, Muriate of Potash (MOP) 250 kg ha⁻¹, Triple Super Phosphate (TSP) 150 kg ha⁻¹, Gypsum 120 kg ha⁻¹, Zinc Sulfate 10 kg ha⁻¹ and Boric acid 10 kg ha⁻¹. The total amount of MOP, TSP, Gypsum, Zinc Sulfate, Boric acid and 50% of the Urea were applied at basal dose during final land preparation. The remaining 50% Urea was side dressed in two equal splits at 35 and 50 days after planting (DAP) during first and second earthing up (Mondal et al. 2011). The total amount of vermicompost was applied at 7 days before planting as per treatment.

Intercultural Operation

All intercultural operations such as earthing up, removal of weed, irrigation, control of insects and diseases were done as per when needed.

Harvesting of Potatoes

Haulm cutting was done when 40-50% plants exhibited senescence and the tops started drying. After haulm cutting the tubers were kept under the soil for seven days to harden the skin. Harvesting of the potato was done manually by hand. The potatoes of each plot were separately harvested, bagged, tagged and brought to the laboratory.

Recording of Data

Harvested potatoes were kept at ambient storage condition with good ventilation facility. Experimental data were recorded from 0 days after storage (DAS) and continued until sprouting occurred in the ambient storage condition.

Total Soluble Solids (TSS)

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

Sucrose (non-reducing sugar)

Extraction of Sugar

For the analysis of sucrose (non-reducing sugar) content, tuber flesh was extracted from each treatment. For each extraction, 1 g fresh chopped sample was taken uniformly from tuber sample and blended properly in a motor. Sugar was extracted using 5 ml of 80% EtOH (ethanol) heated at 80°C for 30 min using a dry block heat bath and the extracts were centrifuged at 5000 rpm for 10 min and decanted the supernatant. It was repeated 4 to 5 times in total and all the supernatants were mixed properly and the final volume was made 25 ml using 80% ethanol.

Sucrose Determination

Somogyi-Nelson method (Nelson 1944) was used to determine the sucrose content of tubers. 0.2 ml Invertase solution (1,000 U/0.1 ml) was diluted with 50 ml distilled water and added one drop of Vinegar. 0.5 ml solution was put into a test tube. Then 0.5 ml diluted Invertase solution (20 Unit/0.5 ml) was added and incubated for 30 min at ambient temperature and then 0.5 ml Copper solution was added and boiled at 100° C for 10 min. After boiling, instantly the test tubes were cooled in tap water. Then 0.5 ml Nelson reagent was added in the test tube and mixed properly. After 20 min, 8 ml distilled water was added, mixed properly through a vortex mixer and finally made the total volume of 9.5 ml. After that the absorbance was measured at 660 nm wavelength and the sucrose content was calculated. The calculated value expressed as mg per g Fresh Weight (mg g⁻¹ FW).

Skin Color Measurement

Color is an important quality attribute which influences the acceptability of fried products (Nourian et al. 2003). The color was determined with a color spectrophotometer NF333 (Nippon Denshoku Japan) using the CIE Lab L*, a* and b* color scale. The 'L*' value (lightness parameter) indicates the degree of lightness of the sample; it varies from 0 = black (dark) to 100 = white (light). The 'a*' value (chromatic redness parameter), whose value means tending to red color when positive (+) and green color when negative (-). The 'b*' value (yellowness chromatic parameter) is corresponding to yellow color when it is positive (+) and blue color when it is negative (-). Each sample consisted of 5 potatoes and measured three times.

Statistical Analysis

The data obtained for different characters were statistically analyzed following the analysis of variance (ANOVA) technique by using Statistix 10 (2013) computer package program. The significant differences among the treatment means were

compared by Least Significant Difference (LSD) at 5% level of probability (Gomez and Gomez 1984). The correlation (Pearson method) was calculated based on data from 0 days of storage condition, i.e., at harvesting day. The available Correlation graphs were plotted using Microsoft Excel 2016.

RESULTS AND DISCUSSION

Total soluble solids (TSS)

Significant variation was found among different levels of vermicompost on TSS of potato tuber at different ambient storage condition. The maximum TSS (5.53% Brix, 5.98% Brix, 6.17% Brix, 6.92% Brix) of tuber was recorded by Vm₁ and the minimum (4.68% Brix, 4.92% Brix, 5.15% Brix, 5.55% Brix) was recorded by Vm₄ at 0, 20, 40 and 60 DAS, respectively (Figure 1).

Figure 1. Response to vermicompost on total soluble solids (TSS) (% Brix) of potato tuber at different days after storage. Vm₁ – 0 t ha⁻¹ (Control), Vm₂ – 3 t ha⁻¹, Vm₃ – 6 t ha⁻¹, Vm₄ – 9 t ha⁻¹

Significant variation was found among different tuber sizes on TSS of tuber at different storage time. At 0 DAS the maximum TSS (5.08% Brix) of tuber was found by T₁ which was statistically similar to T₂ and the minimum (4.86% Brix) was found by T₅. At 20 DAS the maximum TSS (5.47% Brix) of tuber was found by T₁ and the minimum (5.15% Brix) was found by T₅. Similarly, at 40 DAS the maximum TSS (5.69% Brix) of tuber was found by T₁ which was statistically similar to T₂ and the minimum (5.49% Brix) was found by T₅ which was statistically similar to T₄. At 60 DAS the maximum TSS (6.19% Brix) of tuber was found by T₁ which was statistically similar to T₂ and the minimum (5.97% Brix) was found T₅ which was statistically similar to T₄ (Figure 2).

Figure 2. Effect of tuber size on total soluble solids (TSS) (% Brix) of potato tuber at different days after storage T₁ 5-10 g, T₂ – 10-20g, T₃ – 20-30 g, T₄ – 30-40 g, T₅ - >40 g

Table 1. Combined effect of vermicompost and tuber size on TSS at different days after storage of potato tuber

Combinations	Total soluble solids (% Brix) at			
	0 DAS	20 DAS	40 DAS	60 DAS
Vm ₁ T ₁	5.72 a	6.25 a	6.31	7.07
Vm ₁ T ₂	5.66 a	6.19 a	6.24	7.01
Vm ₁ T ₃	5.62 a	5.96 b	6.15	6.90
Vm ₁ T ₄	5.43 b	5.91 b	6.11	6.85
Vm ₁ T ₅	5.23 c	5.61 c	6.06	6.77
Vm ₂ T ₁	4.97 d	5.48 d	5.75	6.19
Vm ₂ T ₂	4.95 de	5.36 e	5.74	6.12
Vm ₂ T ₃	4.93 de	5.24 f	5.62	6.05
Vm ₂ T ₄	4.91 d-f	5.19 fg	5.54	5.96
Vm ₂ T ₅	4.87 d-g	5.15 f-h	5.49	5.91
Vm ₃ T ₁	4.87 d-g	5.13 f-h	5.46	5.88
Vm ₃ T ₂	4.85 e-h	5.11 g-i	5.44	5.85
Vm ₃ T ₃	4.82 f-i	5.08 g-j	5.40	5.81
Vm ₃ T ₄	4.79 g-j	5.07 h-j	5.34	5.75
Vm ₃ T ₅	4.77 g-j	5.04 h-k	5.31	5.71
Vm ₄ T ₁	4.75 h-k	5.00 i-k	5.23	5.63
Vm ₄ T ₂	4.73 i-k	4.98 j-l	5.19	5.60
Vm ₄ T ₃	4.71 jk	4.94 kl	5.15	5.54
Vm ₄ T ₄	4.67 k	4.89 l	5.11	5.49
Vm ₄ T ₅	4.55 l	4.79 m	5.08	5.47
CV (%)	1.32	1.06	0.89	1.12
LSD _{0.05}	0.1030	0.1134	0.0918	0.1254
Level of significance	**	**	NS	NS

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly. ** = Significant at 1% level of probability, NS = Non-significant. Vm₁ – 0 t ha⁻¹ (Control), Vm₂ – 3 t ha⁻¹, Vm₃ – 6 t ha⁻¹, Vm₄ – 9 t ha⁻¹; T₁ 5-10 g, T₂ – 10-20g, T₃ – 20-30 g, T₄ – 30-40 g, T₅ – >40 g

Significant dissimilarity was found among the different combination of vermicompost levels and tuber sizes on TSS of tuber at different ambient storage condition. At 0 DAS the maximum TSS (5.72% Brix) of tuber was recorded by Vm₁T₁ which was statistically similar to Vm₁T₂ and Vm₁T₃; minimum (4.55% Brix) was recorded by Vm₄T₅. At 20 DAS the maximum TSS (6.25% Brix) of tuber was recorded by Vm₁T₁ which was statistically similar to Vm₁T₂ and minimum (4.79% Brix) was recorded by Vm₄T₅. At 40 and 60 DAS due to different combination of vermicompost levels and tuber sizes were found statistically non-significant (Table 1).

TSS (total soluble solids) increased with increasing the ambient storage time, up to 40 DAS; at the beginning of storing it increased slowly but later increased rapidly. TSS was made up of sucrose, glucose and fructose which were converted from starch (Adu-Kwarteng et al. 2013). TSS increased due to provide enough food for sprouting and respiration purposes (Kumar et al. 2004). A positive correlation ($r = 0.8225$) was found between TSS and sucrose of potato tuber (Figure 5) (Braun et al. 2016). TSS decreased with the increasing of vermicompost levels. There was a positive correlation between the amount of vermicompost available for plants and nitrate

concentration in leaves (León et al. 2012). Besides, there was an inverse correlation between nitrate and soluble sugar content (Wanlai et al. 2013). TSS decreased with the increasing of tuber size (Nipa et al. 2013).

Sucrose (non-reducing sugar)

Profound variation was found among different levels of vermicompost on sucrose of tuber at different ambient storage time. The highest sucrose (0.4837 mg g⁻¹ FW, 0.7115 mg g⁻¹ FW, 1.5802 mg g⁻¹ FW, 1.1373 mg g⁻¹ FW) of tuber was observed by Vm₁ and the lowest (0.3112 mg g⁻¹ FW, 0.5097 mg g⁻¹ FW, 0.8177 mg g⁻¹ FW, 0.6197 mg g⁻¹ FW) was observed by Vm₄ at 0, 20, 40 and 60 DAS, respectively (Figure 3).

Figure 3. Response to vermicompost on sucrose (mg g⁻¹ FW) of potato tuber at different days after storage. Vm₁ – 0 t ha⁻¹ (Control), Vm₂ – 3 t ha⁻¹, Vm₃ – 6 t ha⁻¹, Vm₄ – 9 t ha⁻¹

Table 2. Combined effect of vermicompost and tuber size on sucrose at different days after storage of potato tuber

Combinations	Sucrose (mg g ⁻¹ FW) at			
	0 DAS	20 DAS	40 DAS	60 DAS
Vm ₁ T ₁	0.4927 a	0.7310 a	1.6160 a	1.1517
Vm ₁ T ₂	0.4900 a	0.7270 a	1.5900 b	1.1493
Vm ₁ T ₃	0.4830 b	0.7090 b	1.5747 c	1.1367
Vm ₁ T ₄	0.4780 c	0.6963 c	1.5647 d	1.1263
Vm ₁ T ₅	0.4750 c	0.6940 c	1.5557 e	1.1223
Vm ₂ T ₁	0.4647 d	0.6853 d	1.2547 f	0.9140
Vm ₂ T ₂	0.4620 d	0.6780 d	1.2477 f	0.9090
Vm ₂ T ₃	0.4520 e	0.6667 e	1.2340 g	0.8943
Vm ₂ T ₄	0.4463 f	0.6573 f	1.2057 h	0.8787
Vm ₂ T ₅	0.4440 f	0.6463 g	1.1893 i	0.8717
Vm ₃ T ₁	0.3610 g	0.5933 h	0.9773 j	0.7343
Vm ₃ T ₂	0.3577 h	0.5880 h	0.9713 j	0.7307
Vm ₃ T ₃	0.3507 i	0.5777 i	0.9537 k	0.7190
Vm ₃ T ₄	0.3453 j	0.5587 j	0.9460 kl	0.7023
Vm ₃ T ₅	0.3427 j	0.5483 k	0.9393 l	0.6980
Vm ₄ T ₁	0.3303 k	0.5423 k	0.8393 m	0.6413
Vm ₄ T ₂	0.3270 l	0.5260 l	0.8343 m	0.6350
Vm ₄ T ₃	0.3070 m	0.5170 m	0.8170 n	0.6180
Vm ₄ T ₄	0.2970 n	0.4850 n	0.8033 o	0.6047
Vm ₄ T ₅	0.2947 n	0.4780 n	0.7947 o	0.5997
CV (%)	0.46	0.74	0.46	0.44
LSD _{0.05}	0.0010	0.0022	0.0102	0.0019
Level of significance	**	**	**	NS

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly.

** = Significant at 1% level of probability, NS = Non-significant. Vm₁ – 0 t ha⁻¹ (Control), Vm₂ – 3 t ha⁻¹, Vm₃ – 6 t ha⁻¹, Vm₄ – 9 t ha⁻¹; T₁ 5-10 g, T₂ – 10-20g, T₃ – 20-30 g, T₄ – 30-40 g, T₅ – >40 g

Figure 4. Effect of tuber size on sucrose (mg g⁻¹ FW) of potato tuber at different days after storage. T₁ 5-10 g, T₂ – 10-20g, T₃ – 20-30 g, T₄ – 30-40 g, T₅ – >40 g

Figure 5. Relationship between total soluble solids (TSS) and sucrose of potato tuber at harvesting day

Profound variation was got among different tuber sizes to sucrose of tuber at different ambient

condition. The highest sucrose (0.4122 mg g⁻¹ FW, 0.6380 mg g⁻¹ FW, 1.1718 mg g⁻¹ FW, 0.8603 mg g⁻¹ FW) of tuber was recorded by T₁ and the lowest (0.3891 mg g⁻¹ FW, 0.5917 mg g⁻¹ FW, 1.1197 mg g⁻¹ FW, 0.8229 mg g⁻¹ FW) was recorded by T₅ at 0, 20, 40 and 60 DAS, respectively (Figure 4).

Significant dissimilarity was obtained among the different combination of vermicompost levels and tuber sizes on sucrose of tuber at different ambient storage time. At 0 and 20 DAS, the maximum sucrose (0.4927 mg g⁻¹ FW, 0.7310 mg g⁻¹ FW) of tuber observed by Vm₁T₁ which was statistically similar to Vm₁T₂ and minimum (0.2947 mg g⁻¹ FW, 0.4780 mg g⁻¹ FW) was observed by Vm₄T₅ which was statistically similar to Vm₄T₄ respectively. At 40 DAS the maximum sucrose (1.6160 mg g⁻¹ FW) of tuber observed by Vm₁T₁ and minimum (0.7947 mg g⁻¹ FW) was observed by Vm₄T₅ which was statistically similar to Vm₄T₄. At 60 DAS due to different combination of vermicompost levels and tuber sizes was found statistically non-significant (Table 2).

Sucrose (non-reducing sugar) content gradually increased up to 40 DAS after that it reduced rapidly due to provide energy for sprouting (Blenkinsop et al. 2002). Sucrose also converts to glucose (reducing sugar) via invertase enzyme at storage condition (Kumar et al. 2004).

Table 3. Effect of vermicompost on skin color at different days after storage of potato tuber

Vermicompost levels	Skin color at								
	20 DAS			40 DAS			60 DAS		
	L*	a*	b*	L*	a*	b*	L*	a*	b*
Vm ₁	61.44 d	7.67 d	19.48 d	55.98 d	4.79 d	17.55 d	50.34 d	3.37 d	14.37 d
Vm ₂	63.06 c	10.09 c	21.57 c	58.59 c	8.48 c	19.15 c	55.93 c	5.26 c	16.82 c
Vm ₃	64.03 b	12.57 b	24.23 b	60.99 b	11.75 b	22.22 b	58.21 b	8.85 b	19.59 b
Vm ₄	66.47 a	14.94 a	26.49 a	63.30 a	12.58 a	24.79 a	60.54 a	10.39 a	21.47 a
CV (%)	0.27	0.37	0.16	0.58	0.64	0.46	0.47	0.37	0.55
LSD _{0.05}	0.1524	0.0374	0.0335	0.3097	0.0534	0.0859	0.2386	0.0227	0.0887
Level of significance	**	**	**	**	**	**	**	**	**

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly.

** = Significant at 1% level of probability. Vm₁ – 0 t ha⁻¹ (Control), Vm₂ – 3 t ha⁻¹, Vm₃ – 6 t ha⁻¹, Vm₄ – 9 t ha⁻¹

Table 4. Response of tuber size on skin color at different days after storage of potato tuber

Tuber sizes	Skin color at								
	20 DAS			40 DAS			60 DAS		
	L*	a*	b*	L*	a*	b*	L*	a*	b*
T ₁	63.35 d	11.18 d	22.85 d	59.28 d	9.25 d	20.84 d	55.95 c	6.89 d	17.96 c
T ₂	63.46 d	11.20 d	22.87 d	59.39 cd	9.27 d	20.86 cd	55.96 c	6.89 d	17.99 c
T ₃	63.72 c	11.29 c	22.94 c	59.58 c	9.36 c	20.92 bc	56.09 c	6.99 c	18.07 b
T ₄	63.98 b	11.37 b	23.01 b	59.89 b	9.53 b	20.98 ab	56.45 b	7.01 b	18.13 a
T ₅	64.24 a	11.53 a	23.05 a	60.43 a	9.59 a	21.04 a	56.83 a	7.06 a	18.18 a
CV (%)	0.24	0.47	0.11	0.39	0.65	0.42	0.40	0.42	0.35
LSD _{0.05}	0.1290	0.0438	0.0209	0.1936	0.0511	0.0727	0.1865	0.0246	0.0525
Level of significance	**	**	**	**	**	**	**	**	**

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly.

** = Significant at 1% level of probability. T₁ – 5-10 g, T₂ – 10-20 g, T₃ – 20-30 g, T₄ – 30-40 g, T₅ – >40 g

Skin Color

Significant dissimilarity was found among different levels of vermicompost on L* value (lightness), a* value (green-red chromaticity) and b* value (blue-yellow chromaticity) of potato skin color at different storage condition. The highest L* value (66.47, 63.30, 60.54) was found by Vm₄, highest a* value (14.94, 12.58, 10.39) was found by Vm₄ and highest b* value (26.49, 24.79, 21.47) was found by Vm₄; the lowest L* value (67.44, 55.98, 50.34) was found by Vm₁, lowest a* value (7.67, 4.79, 3.37) was found by Vm₁ and lowest b* value (19.48, 17.55, 14.37) was found by Vm₁ at 20, 40 and 60 DAS, respectively (Table 3).

Significant variation was found among different tuber sizes on L* value (lightness), a* value (green-red chromaticity) and b* value (blue-yellow chromaticity) of potato skin color at different storage condition. At 20 DAS the highest L* value (64.24) was found by T₅ and the lowest (63.35) was found by T₁ which was statistically similar to T₂. Highest a* value (11.53) of tuber skin was found by T₅ and the lowest (11.18) was found by T₁ which was statistically similar to T₂. Highest b* value (23.05) was found by T₅ and the lowest (22.85) was found by T₁ which was statistically similar to T₂ (Table 4). At 40 DAS the highest L* value (60.43) was found by T₅ and the lowest (59.28) was recorded by T₁ which was statistically similar to T₂. Highest a* value (9.59) was found by T₅ and the lowest (9.25) was found by T₁ which was statistically similar to T₂. Highest b* value (21.04) was found by T₅ which was statistically similar to T₄ and the lowest (20.84) was found by

T₁ which was statistically similar to T₂ (Table 4). At 60 DAS the highest L* value (56.83) was found by T₅ and the lowest (55.95) was found by T₁ which was statistically similar to T₂ and T₃. Highest a* value (7.06) was found by T₅ and the lowest (6.89) was found by T₁ which was statistically similar to T₂. Highest b* value (18.18) was found by T₅ which was statistically similar to T₄ and the lowest (17.96) was found by T₁ which was statistically similar to T₂ (Table 4).

Noteworthy dissimilarity was found among different interaction of vermicompost level and tuber size on L* value (lightness), a* value (green-red chromaticity) and b* value (blue-yellow chromaticity) of potato skin at different storage condition. At 20 DAS the highest L* value (67.38) was observed by Vm₄T₅ and lowest (61.02) was observed by Vm₁T₁; highest a* value (15.38) was observed by Vm₄T₅ and lowest (7.58) was observed by Vm₁T₁ which was statistically similar to Vm₁T₂ and Vm₁T₃; highest b* value (26.60) was observed by Vm₄T₅ and lowest (19.38) was observed by Vm₁T₁ which was statistically similar to Vm₁T₂ (Table 5). At 40 DAS the highest L* value (64.68) was observed by Vm₄T₅ and the lowest (55.80) was observed by Vm₁T₁ which was statistically similar to Vm₁T₂, Vm₁T₃ and Vm₁T₄; in case of highest a* value (12.89) was observed by Vm₄T₅ which was statistically similar to Vm₄T₄ and the lowest (4.69) was observed by Vm₁T₁ which was statistically similar to Vm₁T₂ and Vm₁T₃; in respect of blue-yellow chromaticity (b*) of potato skin color was found numerically non-significant (Table 5). At 60 DAS the highest L* value (61.74) was taken by

Table 5. Combined effect of vermicompost and tuber size on skin color at different days after storage of potato tuber

Combinations	Skin color at								
	20 DAS			40 DAS			60 DAS		
	L*	a*	b*	L*	a*	b*	L*	a*	b*
Vm ₁ T ₁	61.02 k	7.58 m	19.38 n	55.80 j	4.69 m	17.49	50.17 i	3.30 m	14.23
Vm ₁ T ₂	61.17 jk	7.59 m	19.39 n	55.87 ij	4.69 m	17.49	50.17 i	3.30 m	14.23
Vm ₁ T ₃	61.39 j	7.67 lm	19.45 m	55.94 ij	4.78 lm	17.54	50.31 hi	3.36 l	14.40
Vm ₁ T ₄	61.73 i	7.71 kl	19.58 l	56.10 ij	4.87 kl	17.59	50.48 hi	3.42 k	14.43
Vm ₁ T ₅	61.89 i	7.78 k	19.60 l	56.19 i	4.94 k	17.65	50.55 h	3.44 k	14.52
Vm ₂ T ₁	62.85 h	9.92 j	21.51 k	58.19 h	8.33 j	19.02	55.82 g	5.19 j	16.74
Vm ₂ T ₂	62.94 gh	9.96 j	21.50 k	58.29 h	8.37 ij	19.05	55.84 g	5.20 j	16.77
Vm ₂ T ₃	62.97 gh	10.12 i	21.56 j	58.45 h	8.44 i	19.16	55.89 g	5.25 i	16.80
Vm ₂ T ₄	63.19 fg	10.18 i	21.61 i	58.49 h	8.58 h	19.21	55.93 g	5.30 h	16.83
Vm ₂ T ₅	63.31 f	10.27 h	21.65 h	59.54 g	8.64 h	19.28	56.14 g	5.34 h	16.94
Vm ₃ T ₁	63.79 e	12.48 g	24.08 g	60.78 f	11.62 g	22.12	57.87 f	8.71 g	19.52
Vm ₃ T ₂	63.83 e	12.49 g	24.12 f	60.81 f	11.65 fg	22.14	57.88 f	8.72 g	19.55
Vm ₃ T ₃	63.93 e	12.54 fg	24.26 e	60.89 f	11.74 ef	22.19	57.95 f	8.93 ef	19.59
Vm ₃ T ₄	64.24 d	12.62 ef	24.30 e	61.13 ef	11.83 de	22.27	58.44 e	8.90 f	19.62
Vm ₃ T ₅	64.36 d	12.67 e	24.35 d	61.31 e	11.90 d	22.35	58.88 d	8.97 e	19.69
Vm ₄ T ₁	65.74 c	14.74 d	26.41 c	62.34 d	12.33 c	24.72	59.92 c	10.33 d	21.33
Vm ₄ T ₂	65.89 c	14.76 cd	26.44 c	62.59 d	12.34 c	24.74	59.93 c	10.34 cd	21.38
Vm ₄ T ₃	66.59 b	14.84 c	26.49 b	63.05 c	12.47 b	24.78	60.18 c	10.38 bc	21.45
Vm ₄ T ₄	66.73 b	14.98 b	26.52 b	63.83 b	12.82 a	24.82	60.94 b	10.40 b	21.62
Vm ₄ T ₅	67.38 a	15.38 a	26.60 a	64.68 a	12.89 a	24.88	61.74 a	10.46 a	21.53
CV (%)	0.24	0.47	0.11	0.39	0.65	0.42	0.40	0.42	0.35
LSD _{0.05}	0.2756	0.0866	0.0500	0.4628	0.1055	0.1554	0.4087	0.0493	0.1286
Level of significance	**	**	**	**	**	NS	**	**	NS

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly.

** = Significant at 1% level of probability. NS = Non-significant, Vm₁ – 0 t ha⁻¹ (Control), Vm₂ – 3 t ha⁻¹, Vm₃ – 6 t ha⁻¹, Vm₄ – 9 t ha⁻¹; T₁ 5-10 g, T₂ – 10-20g, T₃ – 20-30 g, T₄ – 30-40 g, T₅ – >40 g

Vm₄T₅ and the lowest (50.17) was observed by Vm₁T₁ which was statistically similar to Vm₁T₂, Vm₁T₃ and Vm₁T₄; in case of highest a* value (10.46) was observed by Vm₄T₅ and the lowest (3.30) was observed by Vm₁T₁ which was statistically similar to Vm₁T₂; in respect of blue-yellow chromaticity (b*) of potato skin was found numerically non-significant (Table 5).

The skin color of potato gradually decreased during storage condition and became darker with the increase of storage time (Martí 2004).

CONCLUSIONS

From this research, it may be concluded that vermicompost is an excellent organic manure. It plays an important role in increasing processing quality. Among the twenty (20) treatment combinations though Vm₄T₅ viz., that is vermicompost 9 t ha⁻¹ and tuber size >40 g exhibited the superior processing quality that is minimum TSS (total soluble solids), sucrose (non-reducing sugar) content and maximum skin color. However, the potato farmers of Bangladesh may be benefited for potato cultivation by using vermicompost; ultimately, they can sell their quality potato to potato processing industry with the high price.

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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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