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Enhancing Shelf Life and Marketability of Orange-Fleshed Sweet Potato using Low-Cost Storage Methods

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Abstract

Malnutrition remains a significant public health concern in Bangladesh, with vitamin A deficiency posing a major public health issue. Orange-fleshed sweet potato (OFSP) is a nutrient-dense crop rich in provitamin A and other essential micronutrients and minerals, offering strong potential to combat this issue. However, its short shelf-life limits year-round availability and market access. This study, conducted in Gaibandha, Bangladesh during the 2020–2021 season, aimed to evaluate low-cost storage methods for extending shelf-life, reducing postharvest losses, and improving the marketability of sweet potato roots. Four storage methods—zero-energy cool chamber (T1), pit storage (T2), clamp storage (T3), and sand storage (T4) were tested using five sweet potato varieties: BARI SP 4 (V1), BARI SP 8 (V2), BARI SP 12 (V3), BARI SP 15 (V4), and a local variety (V5). The findings revealed that the zero-energy cool chamber (T1) and clamp storage (T3) were the most effective, particularly for BARI SP 12 (V3) and BARI SP 4 (V1), maintaining root quality with minimal losses, enhancing marketability and extending shelf-life up to three months.

Keywords: Marketability, Orange-fleshed sweet potato, Post-harvest losses, Shelf-life extension, Storage methods

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Introduction

Sweet potato (*Ipomoea batatas* L.) is a critical crop for food security and economic stability in Bangladesh, where it is predominantly cultivated under rain-fed conditions. During the harvest season, the abundance of sweet potato roots often results in rapid consumption or sale due to the lack of proper storage systems, leading to low market prices. In contrast, the off-season is characterized by scarcity and high prices, posing significant challenges for both farmers and consumers (Sugri *et al.*, 2017). The short shelf-life of sweet potato roots, attributed to their high moisture content (60-75%), low mechanical strength, and susceptibility to microbial decay. Postharvest losses, driven by factors such as respiration, microbial attack, weevil damage, and sprouting, significantly reduce the nutritive value and marketable quality of the roots (Shila *et al.*, 2017; Suhag *et al.*, 2006; Chagonda *et al.*, 2014).

In Bangladesh, traditional storage methods, such as storing roots in heaps or sand, are widely practiced but often prove inadequate for long-term preservation under ambient conditions. As a result, postharvest losses in sweet potato can reach up to 65%, leading to fresh weight loss, disease spread, and quality deterioration (Prathiksha & Naik, 2019; Ray & Ravi, 2005). While cold storage is effective in developed countries, it is not a viable option for smallholder farmers due to its high cost.

From the above points of view this study aims to identify suitable storage methods that can extend the shelf-life of sweet potato roots, thereby reduce postharvest losses and increase marketability.

Materials and Methods

The experiment was conducted in 2021 at the GUK Agricultural Farm in Nashratpur, Gaibandha, Bangladesh to evaluate the storage performance of five sweet potato varieties- BARI SP-4, BARI SP-8, BARI SP-12, BARI SP-15 (orange-fleshed varieties released by BARI), and a local variety- under four low-cost storage system: Zero Energy Cool Chamber (ZECC), Pit Storage, Clamp Storage, and Sand Storage. Vines of four orange fleshed sweet potato varieties were collected from BARI, Gazipur, while the local variety was sourced from a farmer's field in Gaibandha. The storage systems were constructed using locally available materials such as bricks, bamboo, straw, and sand to ensure cost-effectiveness and suitability for smallholder farmers. The study followed a two-factor Completely Randomized Design (CRD) with three replications, where Factor A comprised the four storage methods (T1: Zero Energy Cool Chamber (ZECC), T2: Pit Storage, T3: Clamp Storage, T4: Sand Storage), and Factor B included the five sweet potato varieties (V1: BARI SP-4, V2: BARI SP-8, V3: BARI SP-12, V4: BARI SP-15, V5: Local Variety).

Procedure for storage

Zero Energy Cool Chamber (T1): The Zero Energy Cool Chamber is a low-cost, electricity-free storage solution designed to extend the shelf-life of sweet potato roots. Commonly promoted in India and Sub-Saharan Africa, maintains at a temperature 10-15°C cooler than the ambient environment and about 90% relative humidity. Constructed using locally available materials like brick, sand, bamboo, and straw, the chamber relies on evaporative cooling. Key construction steps include building a double-wall structure with a sand-filled cavity and maintaining moisture through regular watering, ensuring optimal storage conditions for fresh sweet potatoes.

Pit Storage (T2): Pit storage involves digging a hole in a dry area, lining it with dry grass or straw, and carefully placing fresh sweet potato roots inside. The roots are covered with more grass or straw, then sealed with dry soil. A bamboo pole is used for ventilation, and a raised, sloping roof provides shade and rain protection. A drainage channel is also created to prevent water accumulation, reducing the risk of rot.

Clamp Storage (T3): Clamp storage involves creating a raised mound covered with dry grass, on which sweet potatoes are piled. The roots are then covered with more grass and a thick layer of dry soil. A thatched roof provides sun and rain protection, with ventilation gaps, and a drainage channel is added to prevent water accumulation.

Sand Storage (T4): Sand storage involves placing sweet potatoes on a 10 cm layer of dry sand and covering them with another 10 cm of sand. The structure is protected by a thatched roof with ventilation gaps, and a drainage channel is added to prevent water accumulation.

Parameters Studied

Sprouting Incidence (%): Sprouting incidence was monitored at 30-day intervals during storage. The number of sprouted roots was counted and expressed as a percentage of the total number of roots using the formula:

$$\text{Sprouting Incidence (\%)}= \frac{Number\ of\ tuber\ sprouted}{Total\ number\ of\ tubers} \times 100 \ldots\ldots\ldots\ldots\ldots\ (1)$$

Rotting (%): The percentage of rotting was determined by counting the number of rotten tubers, both externally and by cutting them open to assess internal decay. The rotting percentage was calculated as follows:

$$\text{Rotting (\%)}= \frac{Number\ of\ rotten\ tubers}{Total\ number\ of\ tubers} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ (2)$$

Weevil Incidence (%): Weevil incidence was evaluated at 30-day intervals by recording the number of tubers affected by weevils. The percentage was calculated using the formula:

$$\text{Weevil Incidence (\%)}= \frac{Number\ of\ tubers\ affected\ by\ weevil}{Total\ number\ of\ tubers} \times\ 100 \ldots\ldots\ (3)$$

Weight Loss of Tuberous Roots (%): Weight loss was measured at 30-day intervals during storage. The initial weight of the tubers was recorded at the start, and the final weight was measured on each observation date. The percentage weight loss was determined using the following equation (Seweh *et al.*, 2016):

$$\text{Weight loss of tuberous root (\%)} = \frac{Initial\ weight - Final\ weight}{Initial\ weight} \times 100 \quad \ldots\ldots\ldots(4)$$

Marketable root (%): Storage roots that were free from damage, uninfected by insect pests, and had good physical appearance were considered marketable (Yohannes, 2007). The following formula was used for the calculation.

$$\text{Marketable tuber (\%)} = \frac{Weight\ of\ marketable\ tuber\ at\ Different\ DAS}{Initial\ Weight\ of\ marketable\ tuber} \times 100 \quad \ldots\ldots(5)$$

Statistical analysis: Data on different parameters was recorded and statistically analyzed by using Statistix-10 software (Trial version released on Saturday May 25, 2013). Mean separation was done following Least Significant Difference (LSD) test at 0.05 level of significance.

Results and Discussion

Sprouting (%): Sprouting significantly contributes to storage losses and post-harvest deterioration in sweet potatoes (Ezeocha and Irokwe, 2017; Ravi and Aked, 1996). Variations in sprouting percentages were noted across different storage methods, sweet potato varieties, and their interactions at 30, 60, 90, and 120 days after storage (DAS). The T2 treatment had the highest sprouting at 30 DAS (1.37%) and 60 DAS (1.83%), while T3 had the lowest at 30 DAS (0.71%) and T1 at 60 DAS (1.08%). At 90 and 120 DAS, T4 showed the highest sprouting (10.59% and 21.92%), with T1 recording the lowest (3.41% and 13.23%) (Table 1). Regarding variety, at 30 DAS, no sprouting occurred in V1, V3, and V4, while V5 had the highest sprouting (3.36%). At 60 DAS, V5 again showed the highest sprouting (3.11%), with no sprouting in V1. By 90 and 120 DAS, V3 had the highest sprouting (8.87% and 21.58%), while V2 had the lowest (5.18% and 12.76%) (Table 2). Regarding the interaction effect, the highest sprouting rates were observed in T2V2 at 30 DAS (4.66%) followed by T4V3 at 60 DAS (9.01%), T3V5 at 90 DAS (14.15%), and T4V3 at 120 DAS (33.25%) respectively (Table 3). Overall, sprouting rates increased with longer storage durations and varied based on storage method, variety, and their interaction, consistent with Ezeocha and Irokwe (2017).

Table 1. Effect of storage method on sprouting (%) of sweet potato at different day after storage

Treatment	Sprouting at 30 DAS	Sprouting at 60 DAS	Sprouting at 90 DAS	Sprouting at 120 DAS
T1	0.82 b	1.08 c	3.41 c	13.23 d
T2	1.37 a	1.83 a	3.58 c	14.97 c
T3	0.71 c	1.20 b	9.91 b	16.09 b
T4	0.72 c	1.80 a	10.59 a	21.92 a
LSD	0.07	0.10	0.27	0.55
CV (%)	10.74	9.51	5.45	4.53

T1 = Zero energy cool camber storage, T2 =Pit storage, T3= Clamp storage and T4= Sand storage; DAS=Day After Storage; In a column, means having similar letter (s) are statistically similar and those dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

Table 2. Effect of variety on sprouting (%) of sweet potato at different storage time

Treatment	Sprouting at 30 DAS	Sprouting at 60 DAS	Sprouting at 90 DAS	Sprouting at 120 DAS
V1	0.00 c	0.00 e	5.81 d	14.90 c
V2	1.17 b	0.84 d	5.18 e	12.76 d
V3	0.00 c	2.25 b	8.87 a	21.58 a
V4	0.00 c	1.19 c	6.46 c	14.33 c
V5	3.36 a	3.11 a	8.04 b	19.18 b
LSD	0.08	0.11	0.30	0.61
CV (%)	10.74	9.51	5.45	4.53

V1=BARI SP 4, V2=B V1=BARI SP 4, V2=BARI SP 8, V3=BARI SP 12, V4= BARI SP 15 and V5=local variety; DAS=Day After Storage; In a column, means having similar letter (s) are statistically similar and those dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

Table 3. Interaction effect of storage method and variety (T×V) on sprouting (%) of sweet potato at different day after storage

Interaction (T×V)	Sprouting at 30 DAS	Sprouting at 60 DAS	Sprouting at 90 DAS	Sprouting at 120 DAS
T1 V1	0.00 e	0.00 g	4.62 hi	11.94 i
T1 V2	0.00 e	3.37 e	3.64 j	6.13 k
T1 V3	0.00 e	0.00 g	4.38 hi	16.08 g
T1 V4	0.00 e	0.00 g	2.39 k	19.47 cd
T1 V5	4.09 b	2.04 f	2.00 k	12.50 i

Interaction (T×V)	Sprouting at 30 DAS	Sprouting at 60 DAS	Sprouting at 90 DAS	Sprouting at 120 DAS
T2V1	0.00 e	0.00 g	2.60 k	14.55 h
T2V2	4.66 a	0.00 g	2.08 k	10.37 j
T2V3	0.00 e	0.00 g	3.63 j	19.93 c
T2V4	0.00 e	4.78 c	5.55 g	12.33 i
T2V5	2.17 d	4.36 d	4.04 ij	17.64 ef
T3V1	0.00 e	0.00 g	8.73 e	20.21 c
T3V2	0.00 e	0.00 g	7.76 f	16.81 fg
T3V3	0.00 e	0.00 g	13.97 ab	17.06 efg
T3V4	0.00 e	0.00 g	4.95 gh	7.22 k
T3V5	3.57 c	6.02 b	14.15 a	19.16 cd
T4V1	0.00 e	0.00 g	7.29 f	12.91 i
T4V2	0.00 e	0.00 g	7.24 f	17.73 ef
T4V3	0.00 e	9.01 a	13.51 bc	33.25 a
T4V4	0.00 e	0.00 g	12.92 c	18.28 de
T4V5	3.59 c	0.00 g	11.98 d	27.43 b
LSD	0.16	0.23	0.61	1.23
CV (%)	10.74	9.51	5.45	4.53

T1 = Zero energy cool camber storage, T2 =Pit storage, T3= Clamp storage and T4= Sand storage; V1=BARI SP 4, V2=BARI SP 8, V3=BARI SP 12, V4= BARI SP 15 and V5=local variety; DAS=Day After Storage; In a column, means having similar letter (s) are statistically similar and those dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

Rotting (%): Rotting significantly impacts the marketability of fresh sweet potato roots and is a major cause of post-harvest losses. The data revealed significant differences in rotting across storage methods, varieties, and their interaction at 30, 60, 90, and 120 days after storage (DAS). T4 had the highest rotting at 30 DAS (1.70%) and 90 DAS (8.01%), while T2 had the highest at 60 DAS (1.82%) and 120 DAS (8.60%). On the contrary, T1 showed the lowest rotting at 60 DAS (0.00%), 90 DAS (0.60%), and 120 DAS (2.63%), except at 30 DAS, where T2 had the lowest (0.32%) (Table 4). Regarding variety, the highest rotting percentages were observed in variety V2 (4.50% at 30 DAS, 1.61% at 60 DAS, 8.62% at 90 DAS, and 8.97% at 120 DAS). No rotting occurred in V1, V3, and V5 at 30 DAS. The lowest rotting was recorded in V3 at 60 DAS (0.00%) and 120 DAS (4.62%), and in V5 at 90 DAS (3.08%) (Table 5.). Tuber rotting was significantly influenced by storage methods (Bhattarai *et al.*., 2021), with pathogenicity varying by storage method and location (Sugri *et al.,* 2017).

Table 4. Effect of storage method on rooting (%) of sweet potato at day after storage

Treatment	Rotting at 30 DAS	Rotting at 60 DAS	Rotting at 90 DAS	Rotting at 120 DAS
T1	0.47 c	0.00 d	0.60 d	2.63 c
T2	0.32 d	1.82 a	7.63 b	8.60 a
T3	1.52 b	0.68 b	4.31 c	5.80 b
T4	1.70 a	0.46 c	8.01 a	8.17 a
LSD	0.12	0.09	0.30	0.69
CV (%)	17.02	18.10	8.01	15.52

T1 = Zero energy cool camber storage, T2 =Pit storage, T3= Clamp storage and T4= Sand storage; DAS=Day After Storage; in a column, means having similar letter (s) are statistically similar and those dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

Table 5. Effect of variety on rotting (%) of sweet potato at different day after storage

Treatment	Rotting at 30 DAS	Rotting at 60 DAS	Rotting at 90 DAS	Rotting at 120 DAS
V1	0.00 c	0.65 c	4.89 c	5.73 c
V2	4.50 a	1.61 a	8.62 a	8.97 a
V3	0.00 c	0.00 d	3.84 d	4.62 d
V4	0.51 b	0.78 b	5.26 b	6.32 bc
V5	0.00 c	0.67 c	3.08 e	6.61 b
LSD	0.14	0.11	0.33	0.77
CV (%)	17.02	18.10	8.01	15.52

V1=BARI SP 4, V2=BARI SP 8, V3=BARI SP 12, V4= BARI SP 15 and V5=local variety; In a column, means having similar letter (s) are statistically similar and those dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

Regarding the interaction effect, rotting percentages varied significantly at 30, 60, 90, and 120 days after storage (DAS) (Table 6). The lowest mean spoilage (0.00%) after four months was observed in T_1V_3 and T_4V_3, while the highest was in T_2V_2 (12.91%). Similar findings were reported by Dandago and Gungulam (2011) and Maalekuu *et al.* (2014). Table 6 shows that rotting percentages generally increased over time, consistent with Bhattarai *et al.* (2021).

Table 6. Interaction effect of storage method and variety (T×V) on rotting (%) of sweet potato at different day after storage

Interaction (T×V)	Rotting at 30 DAS	Rotting at 60 DAS	Rotting at 90 DAS	Rotting at 120 DAS
T1 V1	0.00 f	0.00 g	3.00 hi	2.37 h
T1 V2	0.00 f	0.00 g	0.00 k	5.18 g
T1 V3	0.00 f	0.00 g	0.00 k	0.00 i
T1 V4	0.00 f	0.00 g	0.00 k	0.75 i
T1 V5	0.00 f	0.00 g	0.00 k	4.83 g
T2V1	0.00 f	1.07 e	2.60 ij	5.26 g
T2V2	0.00 f	5.64 a	12.38 c	12.91 a
T2V3	0.00 f	0.00 g	13.06 b	8.11 de
T2V4	0.00 f	2.37 c	9.47 e	10.72 bc
T2V5	0.00 f	0.00 g	0.65 k	5.97 fg
T3V1	0.00 f	0.00 g	2.53 ij	5.83 fg
T3V2	0.00 f	0.00 g	7.74 f	10.11 bc
T3V3	0.00 f	0.00 g	2.30 j	2.38 h
T3V4	0.00 f	0.74 f	3.31 h	2.41 h
T3V5	0.00 f	2.66 b	5.70 g	8.28 de
T4V1	1.61 e	1.52 d	11.45 d	9.44 cd
T4V2	2.04 d	0.79 f	14.35 a	7.67 e
T4V3	2.36 c	0.00 g	0.00 k	0.00 i
T4V4	6.45 b	0.00 g	8.27 f	11.40 ab
T4V5	7.59 a	0.00 g	5.98 g	7.34 ef
LSD	0.28	0.22	0.67	1.54
CV (%)	17.02	18.10	8.01	15.52

T1 = Zero energy cool camber storage, T2 =Pit storage, T3= Clamp storage and T4= Sand storage; V1=BARI SP 4, V2=BARI SP 8, V3=BARI SP 12, V4= BARI SP 15 and V5=local variety; DAS=Day After Storage; in a column, means having similar letter (s) are statistically similar and those dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

Weevil Infestation (%): The sweet potato weevil (*Cylas spp*.) is a major storage pest in the tropics and subtropics, causing losses of 60-100% (Chalfant *et al.*, 1990; Tomlins *et al.,* 2010). Infested roots produce terpenoids, making them inedible. Even low weevil densities can lead to significant crop losses and impact trade. The data shows that storage methods, varieties, and their interactions significantly affected weevil infestation percentages. Table 7 reveals that storage methods had minimal impact on weevil infestation in sweet potato, ranging from 0.00% to 1.80% during the entire storage period. Among the storage methods, T1 performed the best, followed by T4, across all storage durations. Regarding varieties, no weevil infestation was found in variety V3. Variety V4 showed the highest weevil infestation at 30 DAS (1.22%) and 60 DAS (0.41%). At 90 DAS and 120 DAS, the highest weevil infestation was observed in V1 (0.61%) and V2 (0.66%), respectively (Table 8).

Table 7. Effect of storage method on weevil infestation (%) of sweet potato at different day after storage

Treatment	Weevil infestation at 30 DAS	Weevil infestation at 60 DAS	Weevil infestation at 90 DAS	Weevil infestation at 120 DAS
T1	0.33 c	0.00 b	0.00 c	0.00 c
T2	1.80 a	0.00 b	0.49 a	0.00 c
T3	0.53 b	0.32 a	0.31 b	0.66 a
T4	0.00 d	0.00 b	0.00 c	0.52 b
LSD	0.08	0.01	0.01	0.02
CV (%)	17.66	16.36	12.44	9.25

T1 = Zero energy cool camber storage, T2 =Pit storage, T3= Clamp storage and T4= Sand storage; DAS=Day After Storage; In a column, means having similar letter (s) are statistically similar and those dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

Table 8. Effect of variety on weevil infestation (%) of sweet potato at different day after storage

Treatment	Weevil infestation at 30 DAS	Weevil infestation at 60 DAS	Weevil infestation at 90 DAS	Weevil infestation at 120 DAS
V1	0.27 c	0.00 b	0.61 a	0.42 b
V2	1.17 a	0.00 b	0.00 c	0.66 a
V3	0.00 d	0.00 b	0.00 c	0.00 c
V4	1.22 a	0.41 a	0.39 b	0.42 b
V5	0.67 b	0.00 b	0.00 c	0.00 c
LSD	0.09	0.01	0.02	0.02
CV (%)	17.66	16.36	12.44	9.25

V1=BARI SP 4, V2=BARI SP 8, V3=BARI SP 12, V4= BARI SP 15 and V5=local variety; DAS=Day After Storage; In a column, means having similar letter (s) are statistically similar and those dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

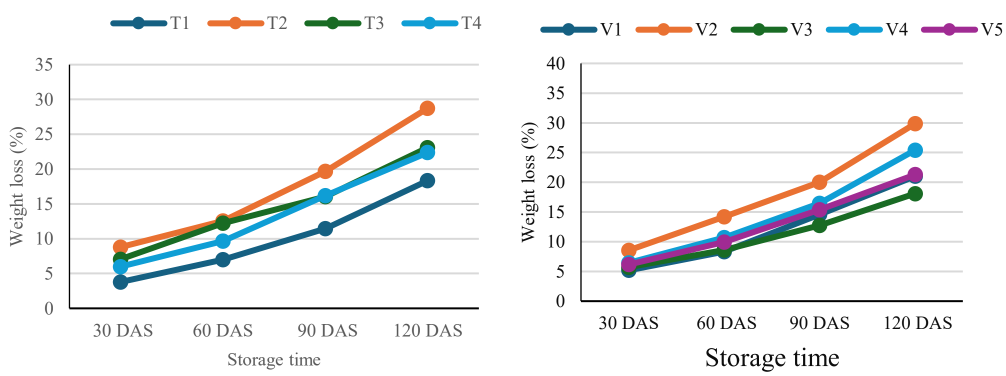
Regarding interaction effect, most treatment combinations had no weevil infestation, and where observed, it remained below 4.66% throughout storage (Table 9). The low temperatures during the study likely hindered infestation, as higher temperatures promote insect population growth (Ladányi and Hufnagel, 2006; Gomi *et al.,* 2007). Atuna *et al.* (2017) also found no significant differences in weevil damage among sweet potato cultivars during storage.

Table 9. Interaction effect of storage method and variety (T×V) on weevil infestation (%) of sweet potato at different day after storage.

Interaction (T×V)	Weevil infestation at 30 DAS	Weevil infestation at 60 DAS	Weevil infestation at 90 DAS	Weevil infestation at 120 DAS
T1 V1	0.00 f	0.00 b	0.00 c	0.00 c
T1 V2	0.00 f	0.00 b	0.00 c	0.00 c
T1 V3	0.00 f	0.00 b	0.00 c	0.00 c
T1 V4	1.64 d	0.00 b	0.00 c	0.00 c
T1 V5	0.00 f	0.00 b	0.00 c	0.00 c
T2V1	1.08 e	0.00 b	2.45 a	0.00 c
T2V2	4.66 a	0.00 b	0.00 c	0.00 c
T2V3	0.00 f	0.00 b	0.00 c	0.00 c
T2V4	3.24 b	0.00 b	0.00 c	0.00 c
T2V5	0.00 f	0.00 b	0.00 c	0.00 c
T3V1	0.00 f	0.00 b	0.00 c	1.67 b
T3V2	0.00 f	0.00 b	0.00 c	0.00 c
T3V3	0.00 f	0.00 b	0.00 c	0.00 c
T3V4	0.00 f	1.64 a	1.57 b	1.67 b
T3V5	2.66 c	0.00 b	0.00 c	0.00 c
T4V1	0.00 f	0.00 b	0.00 c	0.00 c
T4V2	0.00 f	0.00 b	0.00 c	2.63 a
T4V3	0.00 f	0.00 b	0.00 c	0.00 c
T4V4	0.00 f	0.00 b	0.00 c	0.00 c
T4V5	0.00 f	0.00 b	0.00 c	0.00 c
LSD	0.19	0.02	0.04	0.04
CV (%)	17.66	16.36	12.44	9.25

T1 = Zero energy cool camber storage, T2 =Pit storage, T3= Clamp storage and T4= Sand storage; V1=BARI SP 4, V2=BARI SP 8, V3=BARI SP 12, V4= BARI SP 15 and V5=local variety; DAS=Day After Storage; In a column, means having similar letter (s) are statistically similar and those dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

Weight loss (%): Weight loss is a key indicator of sweet potato deterioration during storage and affects quality and shelf-life. Significant effects of storage methods, variety, and their interaction on weight loss were observed (Appendix IV). Cumulative weight loss increased significantly with storage time across all treatments (Figure 1(a)), consistent with Bhattarai *et al.* (2021). After 120 days, the lowest weight loss was in T1 (18.34%), followed by T4 (22.37%), while T2 had the highest loss. Among varieties, V1 had the lowest weight loss in the first 60 days (5.19% at 30 DAS and 8.24% at 60 DAS), and V3 continued to show the least weight loss at 90 DAS and 120 DAS (12.75% and 18.10%, respectively). V2 had the highest weight loss (29.86% at various intervals) (Figure 1 (b)).



1(a) **1(b)**

Fig. 1(a). Effect of storage method on weight loss (%) of sweet potato at different day after storage; 1(b) Effect of variety on weight loss (%) of sweet potato at different day after storage. T1 = Zero energy cool camber storage, T2 =Pit storage, T3= Clamp storage and T4= Sand storage; V1=BARI SP 4, V2=BARI SP 8, V3=BARI SP 12, V4= BARI SP 15 and V5=local variety; DAS=Day After Storage

The interaction effects in Table 10 reveal that the T_1V_3 combination had the lowest weight loss (14.58%) after 120 days, making it the most effective storage method compared to other combinations.

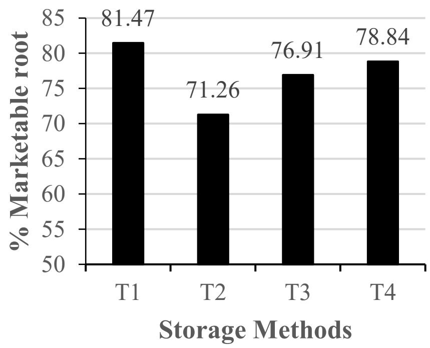
Table 10. Interaction effect of storage method and variety (T×V) on weight loss (%) of sweet potato at different day after storage.

Interaction (T×V)	Weight loss at 30 DAS	Weight loss at 60 DAS	Weight loss at 90 DAS	Weight loss at 120 DAS
T1 V1	3.38 l	5.97 i	11.22 k	19.18 k
T1 V2	4.44 jk	9.40 fg	12.72 j	22.77 fgh
T1 V3	3.64 kl	5.52 i	9.80 l	14.58 m
T1 V4	4.02 kl	7.84 h	12.07 jk	19.18 k
T1 V5	3.47 l	6.26 i	11.49 k	15.97 l
T2V1	6.48 fgh	9.37 fg	14.49 hi	21.27 ij
T2V2	13.47 a	16.07 a	28.95 a	45.95 a
T2V3	7.50 de	9.62 f	17.20 e	23.69 efg
T2V4	8.69 bc	14.81 b	22.11 b	31.98 b
T2V5	7.88 cd	12.93 c	15.77 fg	20.80 j
T3V1	5.32 ij	9.39 fg	14.10 hi	22.08 hij
T3V2	8.15 bcd	16.88 a	17.51 e	27.54 c
T3V3	6.00 fghi	10.96 e	11.46 k	16.90 l
T3V4	9.06 b	12.02 cd	16.62 ef	25.59 d
T3V5	6.78 ef	11.92 de	20.49 c	23.34 fgh
T4V1	5.57 hi	8.62 gh	18.59 d	22.58 ghi
T4V2	8.16 bcd	14.53 b	20.90 c	23.17 fgh
T4V3	5.71 ghi	8.29 h	12.56 j	17.23 l
T4V4	4.03 kl	8.22 h	15.07 gh	24.88 de
T4V5	6.51 fg	8.57 gh	13.91 i	23.97 ef
LSD at 5%	0.93	0.97	1.05	1.34
CV (%)	8.82	5.68	4.03	3.52

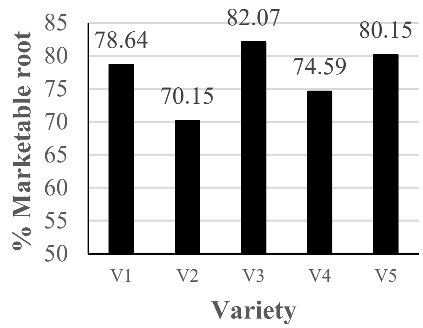
T1 = Zero energy cool camber storage, T2 =Pit storage, T3= Clamp storage and T4= Sand storage; V1=BARI SP 4, V2=BARI SP 8, V3=BARI SP 12, V4= BARI SP 15 and V5=local variety; DAS=Day After Storage; in a column, means having similar letter (s) are statistically similar and those dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

Marketable root (%): The study revealed a significant effect of storage methods, varieties, and their interaction on the percentage of marketable sweet potato roots at 120 DAS. The impact of storage methods and varieties on marketable roots at 120 DAS is depicted in Figure 2. The highest percentage of marketable roots was recorded in the T1 treatment (81.47%), followed by T4 (78.84%), while the lowest percentage was observed in the T2 treatment (71.26%) (Figure 2(a)). Among the varieties, V3 consistently showed the highest marketable root percentage (82.07%) at 120 DAS, followed by V4 (80.15%), with V2 exhibiting the lowest (70.15%) (Figure

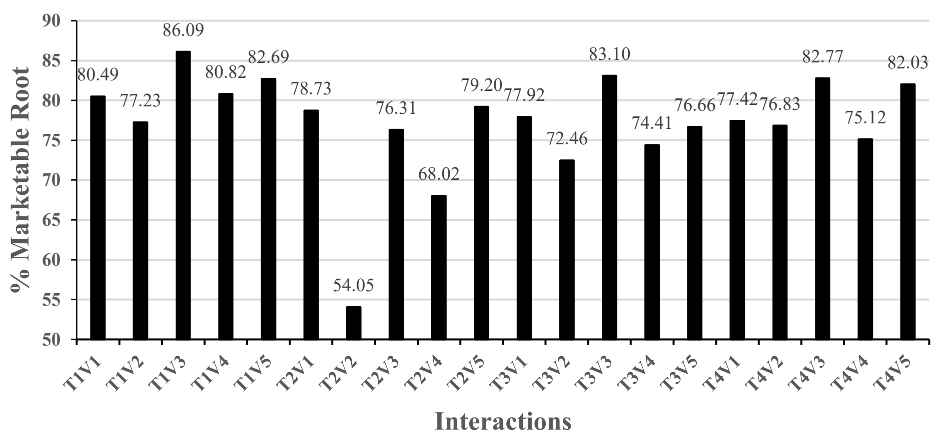
2(b)). The interaction effect of storage methods and varieties is shown in Figure 2 (c). The highest percentage of marketable roots (86.09%) was recorded in the T1 V3 combination, while the lowest percentage (54.05%) occurred in the T2V2 combination.



2(a)



2(b)



2 (c)

Fig. 2 (a). Effect of storage method on marketable root (%) of sweet potato at 120 DAS; 2(b) Effect of variety on marketable root (%) of sweet potato at 120 DAS; 2(c) Interaction effect of storage method and variety on marketable root (%) of sweet potato at 120 DAS. T1 = Zero energy cool camber storage, T2 =Pit storage, T3= Clamp storage and T4= Sand storage. V1=BARI SP 4, V2=BARI SP 8, V3=BARI SP 12, V4= BARI SP 15 and V5=local variety; DAS=Day After Storage.

Over the 120-day storage period, the percentage of marketable roots decreased progressively with prolonged storage period. Regarding storage methods, consistently high percentages of marketable roots (above 80%) were recorded up to 90 DAS, after which a significant decrease was observed, except for T1 (Figure

3(a)). Regarding varieties, all varieties, except for V2, showed above 80% marketable roots at 90 DAS, after which a significant decrease observed in all varieties except for V3 and V5 at 120 DAS (Figure 3(b)).

The results suggest that different storage methods significantly affect the marketability and shelf life of sweet potatoes. Similar findings were reported by Sugri *et al.* (2017), who noted that these methods help maintain optimal quality, reduce spoilage, and enhance the overall market availability of sweet potatoes. Additionally, the studied varieties exhibited significant differences in root quality parameters and the percentage of marketable roots during storage, a trend also reported by Atuna *et al.* (2017).

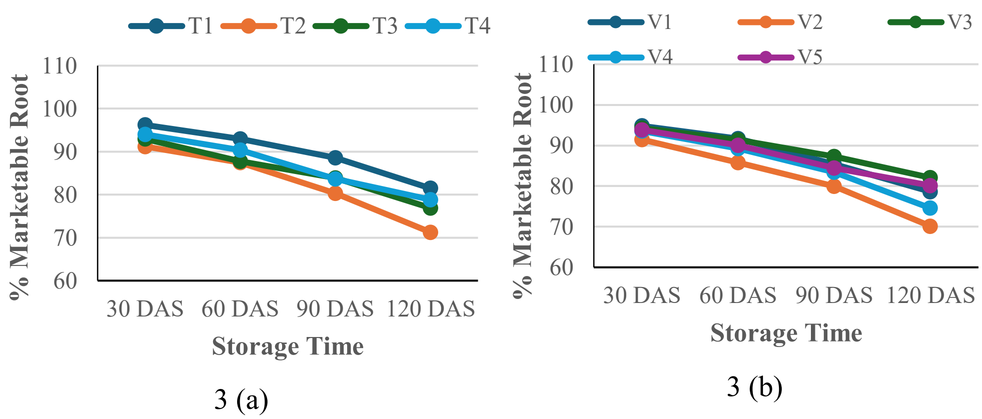


Fig. 3 (a). Effect of storage method on marketable root (%) of sweet potato at different days after storage; 3(b). Effect of variety on marketable root (%) of sweet potato at different day after storage

Conclusion

The study concludes that T1 (Zero energy cool camber storage), followed by T3 (Clamp storage) is most effective in minimizing sprouting, rotting, and weight loss in orange-fleshed sweet potatoes (OFSP). Among the tested varieties, V3 (BARI SP 12) and V1 (BARI SP 1) demonstrated superior root quality with minimal postharvest losses. These results underscore the effectiveness of T1 (Zero energy cool chamber) and T3 (Clamp storage) storage methods, particularly for V3 (BARI SP 12) and V1 (BARI SP 4), in extending shelf life up to three months, improving availability, and enhancing the marketability of OFSP in resource-constrained regions.

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