



Farmer's Mini Cold Storage: An Innovative CoolBot Technology for Enhancing Shelf Life of Green Chilli under Bangladesh Condition

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Abstract— The study evaluated the effectiveness of a low-cost cold storage condition (CoolBot) in extending the shelf life of Green Chilli under different storage treatments. Six parameters viz., color retention, texture, bruising, rotting, weight loss and total remaining weight were studied across storage condition up to 27 days. Results revealed that the control treatment (T₀) at room temperature exhibited rapid deterioration with complete loss of marketable quality within 9 DAS (days after storage). In contrast, all CoolBot treatments significantly delayed quality loss. Among them, Green Chilli stored under polythene covering (T₄) showed superior color and texture retention up to 18 DAS (scores >4.0). It showed lowest bruising (1.33%) at 12 DAS and 20.67% at 21 DAS. Less rotting percentage (15%) at 18 DAS and (43.67%) at 21 DAS was also noticed in the same treatment. Weight loss was lowest under polythene coverings (T₄) (6.37 kg loss at 27 DAS). The highest remaining Green Chilli weight at 21 DAS was observed in polythene covering (8.25 kg) and the second highest remaining weight was in newspaper coverings (7.73 kg). The findings demonstrate that CoolBot storage substantially prolongs Green Chilli shelf life compared to room temperature storage, with polythene covering (T₄) providing the best short-term quality retention, maximum remaining weight and minimum loss during the study period. This suggests that CoolBot cold storage combined with appropriate packaging can serve as a cost-effective solution for reducing postharvest losses and improving Green Chilli marketability under Bangladesh condition.

Keywords— CoolBot Technology, Green Chilli, Shelf life, Weight loss.

I. INTRODUCTION

Green Chilli (*Capsicum annuum* L.) is one of the most important spice and vegetable crops in Bangladesh, consumed both in green and dry forms. It holds significant economic value, contributing to farmers' income, national spice demand and export potential. However, despite its importance, Green Chilli production faces serious challenges in postharvest handling, resulting in substantial quantitative and qualitative losses. Green Chilli suffers considerable deterioration due to its perishable nature and lack of proper storage facilities (Mandal & Hoq, 2018). In Bangladesh, postharvest losses of fruits and vegetables range between 20–30%. Under ambient conditions in Bangladesh, where high temperature (27–35°C) and low relative humidity prevail, the shelf life of Green Chilli rarely exceeds 3–4 days, making it difficult for farmers to store and market their product efficiently. Texture softening and water loss are intensified at higher temperatures, while bruising accelerates microbial infection, leading to increased rotting percentage. As a result, growers are often forced into distress sales, limiting profitability and weakening the supply chain.

The absence of accessible cold storage facilities is one of the major constraints in preserving Green Chilli quality after harvest. Bangladesh lacks adequate cold chain facilities at the rural and farm-gate level. Consequently, the lack of affordable storage forces farmers to sell immediately after harvest, leading to oversupply in peak seasons, reduced farm-gate prices, and substantial postharvest losses. This situation results in economic losses due to distress sales and contributes to national food and nutritional insecurity. To address these constraints, there is a need for affordable and accessible cold storage technologies that can reduce postharvest losses, extend shelf life, and maintain the quality of Green Chilli.

CoolBot technology is a new innovative technique where temperature and humidity can be controlled at desirable conditions. The device allows a standard air conditioner to function as a refrigeration unit capable of cooling a well-insulated room down to 5–10°C at a fraction of the cost of conventional cold storage (Store It Cold, 2024). This technology is low-cost, energy-efficient, and simple to operate, making it suitable for farmer cooperatives, small traders, and rural entrepreneurs. Previous studies demonstrated that CoolBot-based mini cold rooms can significantly extend the shelf life of vegetables such as tomato, leafy greens, and collards by reducing weight loss, delaying colour change, maintaining texture, and minimizing microbial spoilage (Kathambi et al., 2022; UC Davis Horticulture Innovation Lab, 2022).

In addition to temperature regulation, relative humidity (RH) control is crucial in postharvest storage. High RH (85–95%) helps reduce transpiration, thereby minimizing weight loss and shriveling of Green Chilli (Kitinoja, 2018). For Green Chilli, maintaining cool and humid conditions slows respiration, reduces transpiration-related weight loss, minimizes bruising effects, and lowers rotten percentage, thereby preserving higher marketable yield over extended storage periods (Cheng et al., 2023; Mi et al., 2023). The adoption of CoolBot mini cold storage in Bangladesh can significantly reduce postharvest losses of Green Chilli, thereby improving marketable yield, enhancing farmer profitability, and strengthening the rural economy. By maintaining quality parameters such as colour, texture, and firmness, while reducing bruising, rotten percentage, and weight loss, CoolBot technology provides a viable solution for postharvest loss management in Green Chilli.

'Affordable Cold Storage Technology Extension for Mitigating Climate Change Risk and Increasing Farmers Income' is a Project funded by Environment, Forest and Climate Change Ministry, Government of the People's Republic of Bangladesh. The project was implemented by the Department of Agricultural Extension (DAE), Khamarbari, Dhaka, Bangladesh under the Project Director of Talha Zubair Masror. CoolBot Technology was first time initiated in Bangladesh under this project. This technology can also empower smallholders to delay sales, take advantage of better market prices, and expand into high-value markets such as exports and processing industries.

The overall objective of this study is to evaluate the effectiveness of low-cost mini cold storage using CoolBot technology in reducing postharvest losses of Green Chilli. The specific objectives are:

- To assess the effect of CoolBot storage on key postharvest quality parameters of Green Chilli.
- To compare the performance of CoolBot storage with ambient storage conditions in terms of postharvest loss reduction.
- To provide recommendations for optimizing CoolBot storage conditions (temperature and RH) for Green Chilli in the context of Bangladesh.

II. METHODOLOGY

The experiment was conducted at Horticulture Center, Rajalakh, Savar, Dhaka, Bangladesh. Ready to eat ripe Green Chilli was used as experimental material. Ten kg of Green Chilli was kept in a plastic crate box and considered as a unit of data recording. The experiment was conducted with three replications in a Randomized Complete Block Design (RCBD).

2.1 Treatments:

There were five treatments including control:

T0 = Control (Outside of CoolBot at room temperature)

T1 = Green Chilli in the open condition inside of the CoolBot

T2 = Green Chilli covered with newspaper inside of the CoolBot

T3 = Green Chilli covered with brown paper inside of the CoolBot

T4 = Green Chilli covered with polythene sheet inside of the CoolBot

2.2 CoolBot Setup:

CoolBot has three temperature sensors: the air conditioner's fins, the air conditioner's temperature sensor (heater) and the storage room. When coupled to an air conditioner, the device can trick and override the air conditioner in a well-insulated room and drop the air temperature to as low as 7°C depending on the pre-set temperature (Saran et al., 2013; Rivard et al., 2016; Majubwa et al., 2019). Installation of the CoolBot device (using an air conditioner and CoolBot controller) was done to create a temperature-controlled storage room. The CoolBot was set to maintain a temperature range of 7–8°C. Humidity range was maintained at 80-90% using a humidifier or dehumidifier as necessary. Different modifications were made in the cooling system to control the temperature and relative humidity considering local conditions. A small container with capacity of 6.00 to 7.00 tons was used as a store room. The inner side of the container was totally sealed by air tight sealing materials. The door of the container was made by three layer closing system, so that it is completely air tight and preserves the temperature and relative humidity. A solar panel electricity generation system was also included with general electricity supply system in the CoolBot.

2.3 Preparation of Samples:

Fresh and uniform samples were selected. The experimental materials (Green Chilli) were free from any damage or bruising. Initial data was recorded on weight, color, texture and other morphological characteristics.

2.4 Data Recording:

Data were recorded on the following parameters: (i) Colour of Green Chilli (ii) Texture of Green Chilli, (iii) Bruising percentage of Green Chilli, (iv) Rotten percentage of Green Chilli, (v) Remaining weight of Green Chilli & (vi) Weight Loss of Green Chilli in every 3 days after storage.

Data were recorded using a scoring scale of 1 = Very poor, 2 = Poor, 3 = Average, 4 = Good, 5 = Excellent. Data were recorded at three-day intervals from the initial day to the 27th day of the experiment for each treatment.

Weight measurement: Weight of Green Chilli fruit was measured by a digital scale. Fruit weight loss was measured by subtracting damaged Green Chilli weight from total Green Chilli weight.

2.5 Monitoring:

The temperature, humidity and air circulation inside the CoolBot storage was monitored regularly to ensure stable conditions. Ambient temperature and humidity was checked in the conventional storage room.

2.6 Statistical analysis:

Statistix-10 and other software were used for proper analysis.

III. RESULTS AND DISCUSSION

The postharvest quality of Green Chilli in the low-cost CoolBot cold room was evaluated over 27 days using multiple parameters, including colour, texture, bruising, rotten percentage, weight loss, and total remaining weight. The effects of different covering materials viz., open storage (T1), newspaper (T2), brown paper (T3), and polythene (T4) - were compared with ambient storage (T0). The major findings are given below:

3.1 Colour Retention:

Colour retention of Green Chilli is presented in Table 1. Green Chilli colour, an important visual quality parameter, deteriorated rapidly under ambient storage (T0), with the score dropping from 5.00 at initial time to 1.00 by 6 DAS, reflecting severe loss of freshness. In contrast, CoolBot storage significantly delayed colour change. Open storage (T1) maintained colour scores above 2.00 until 12 DAS, while newspaper (T2) and brown paper (T3) coverings preserved colour longer days and maintained scores above 3.00 until 18 DAS. Polythene wrapping (T4) was most effective, sustaining high colour scores above 4.00 up to 18 DAS and only declining to 1.00 at 27 DAS.

TABLE 1
COLOR OF GREEN CHILLI AT DIFFERENT DAYS AFTER STORAGE (DAS) IN THE LOW COST COLD ROOM (COOLBOT)

Treatment	Colour (1-5)									
	IT	3 DAS	6 DAS	9 DAS	12 DAS	15 DAS	18 DAS	21 DAS	24 DAS	27 DAS
T ₀	5	2.67 b	1.00 b	1	1	-	-	-	-	-
T ₁	5	5.00 a	5.00 a	2.33 c	2.33 c	1.00 c	1.00 c	1.00 c	-	-
T ₂	5	5.00 a	5.00 a	4.67 b	4.00 b	3.67 b	3.33 b	2.33 b	1.00 b	1.00 a
T ₃	5	5.00 a	5.00 a	4.67 b	4.33 b	4.00 a	3.33 b	2.33 b	2.00 a	1.33 a
T ₄	5	5.00 a	5.00 a	5.00 a	5.00 a	4.67 a	4.33 a	3.67 a	1.67 a	1.00 a
LSD _{0.05}	-	1.04	1.22	0.44	0.4	0.4	0.5	0.47	0.5	0.45 ^{NS}
CV(%)	-	7.84	8.72	5.88	6.32	4.72	2.87	3.76	1.32	0.7

3.2 Texture Preservation:

Texture of Green Chilli is presented in Table 2. Texture or firmness of Green Chilli is critical for marketability. Ambient-stored fruits (T₀) softened rapidly with scores declining to 1.00 by 6 DAS. CoolBot storage maintained firmness for longer periods. Open storage (T₁) retained scores above 5.00 until 6 DAS but declined sharply after 9 DAS. Paper coverings (T₂, T₃) preserved firmness more effectively, with scores above 4.00 until 15 DAS. Polythene-wrapped fruits (T₄) maintained the highest firmness, above 4.33 until 21 DAS.

TABLE 2
TEXTURE OF GREEN CHILLI AT DIFFERENT DAYS AFTER STORAGE (DAS) IN THE LOW COST COLD ROOM (COOLBOT)

Treatment	Texture of Green Chilli (1-5)									
	IT	3 DAS	6 DAS	9 DAS	12 DAS	15 DAS	18 DAS	21 DAS	24 DAS	27 DAS
T ₀	5	2.67 b	1.00 b	1.00 d	1.00 d	-	-	-	-	-
T ₁	5	5.00 a	5.00 a	2.67 c	2.33 c	1.33 c	1.00 c	1.00 c	-	-
T ₂	5	5.00 a	5.00 a	4.67 b	4.00 b	3.67 b	3.67 b	2.33 b	1.33 a	1.00 a
T ₃	5	5.00 a	5.00 a	4.67 b	4.33 b	4.00 b	3.33 b	2.33 b	1.67 a	1.33 a
T ₄	5	5.00 a	5.00 a	5.00 a	5.00 a	4.67 a	4.33 a	3.33 a	1.33 a	1.00 a
LSD _{0.05}	-	0.5	0.63	0.22	0.4	0.44	0.49	0.4	0.59 ^{NS}	0.52 ^{NS}
CV(%)	-	6.71	7.34	5.63	7.92	9.27	11.24	8.53	1.36	0.72

3.3 Bruising Percentage:

The bruising percentage of chilli during storage in the low-cost CoolBot cold room across treatments is shown in Fig. 1. Bruising is a major factor affecting marketable quality. Ambient storage (T₀) exhibited rapid bruising, reaching 72.67% by 9 DAS. CoolBot storage substantially reduced bruising. Open storage (T₁) showed minor bruising until 6 DAS but increased to 90% by 21 DAS. Newspaper (T₂) and brown paper (T₃) coverings reduced bruising further, with T₃ performing slightly better than T₂. Polythene wrapping (T₄) was most effective, with bruising remaining negligible up to 12 DAS and increasing only gradually to 45.67% by 24 DAS.

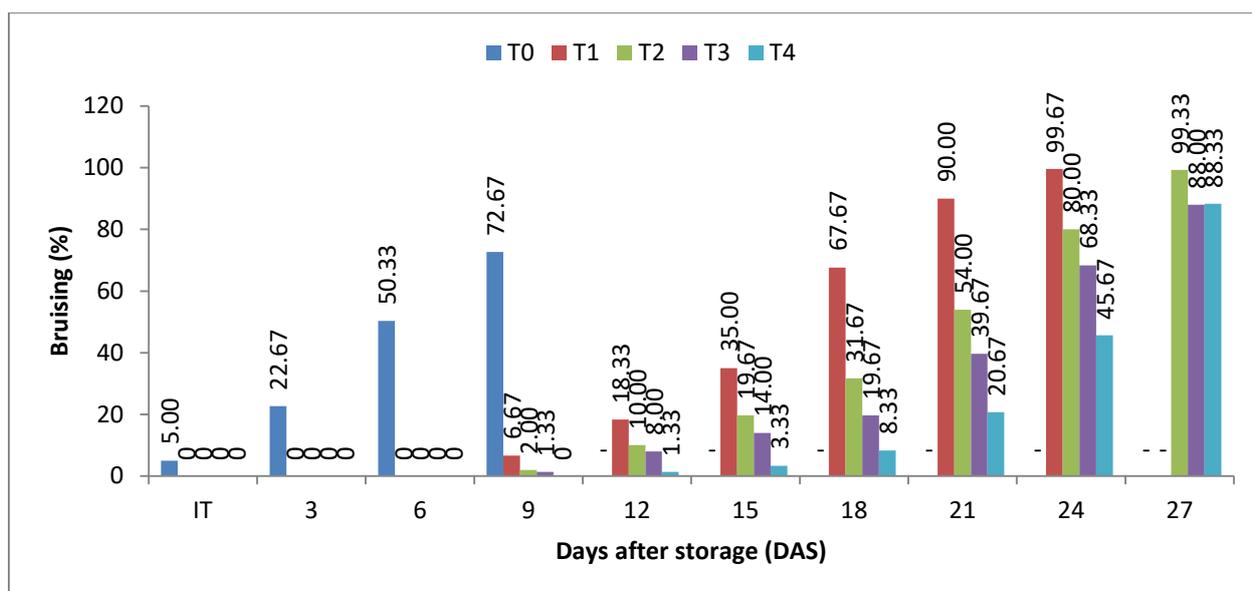


FIGURE 1: Bruising percentage of Green Chilli at different days after storage (DAS) in the low cost cold room (Coolbot)

3.4 Rotten Percentage:

Rotten percentage of Green Chilli is presented in Table 3. Green Chilli decay was significantly higher in ambient storage (T0), with 46.00% rotting by 6 DAS and near-complete spoilage (98.00%) at 9 DAS. CoolBot storage markedly delayed rotting. Open storage (T1) maintained almost zero rot until 6 DAS, but the rotten percentage rose to 63.67% by 27 DAS. Newspaper (T2) and brown paper (T3) further reduced spoilage, whereas polythene-wrapped fruits (T4) showed minimal rotting (1.33–45.67%) throughout the storage period.

**TABLE 3
 ROTTEN PERCENTAGE OF GREEN CHILLI AT DIFFERENT DAYS AFTER STORAGE (DAS) IN THE LOW COST COLD ROOM (COOLBOT)**

Treatment	Rotten percentage of Green Chilli									
	IT	3 DAS	6 DAS	9 DAS	12 DAS	15 DAS	18 DAS	21 DAS	24 DAS	27 DAS
T ₀	0	11.67 a	46.00 a	98.00 a	-	-	-	-	-	-
T ₁	0	0.00 b	0.00 b	0.00 b	1.33 a	6.33 a	11.67 b	42.67 a	61.00 b	74.00 b
T ₂	0	0.00 b	0.00 b	0.00 b	0.00 b	2.33 c	5.67 c	22.67 b	47.67 c	63.67 d
T ₃	0	0.00 b	0.00 b	0.00 b	0.00 b	1.67 c	4.00 c	17.67 c	46.00 c	66.00 c
T ₄	0	0.00 b	0.00 b	0.00 b	2.00 a	5.33 a	15.00 a	43.67 a	70.00 a	86.67 a
LSD _{0.05}	-	1.62	2.44	2.86	0.72	1.22	1.73	2.36	3.11	3.71
CV(%)	-	8.36	10.71	9.73	6.27	5.71	8.36	9.44	10.27	8.47

3.5 Weight Loss:

Weight loss is a key indicator of water loss and dehydration. Ambient storage (T0) showed rapid weight loss, reaching 9.80 kg by 9 DAS. CoolBot storage significantly reduced weight loss (Fig. 2). Polythene cover (T4) showed minimal loss up to 9 DAS, increasing to 6.37 kg by 27 DAS. Covering with Newspaper (T2) effectively maintained moisture with weight loss of 6.60 kg by 27 DAS. Polythene-wrapped fruits (T4) retained moisture all over the experimental period, hence it showed minimum loss.

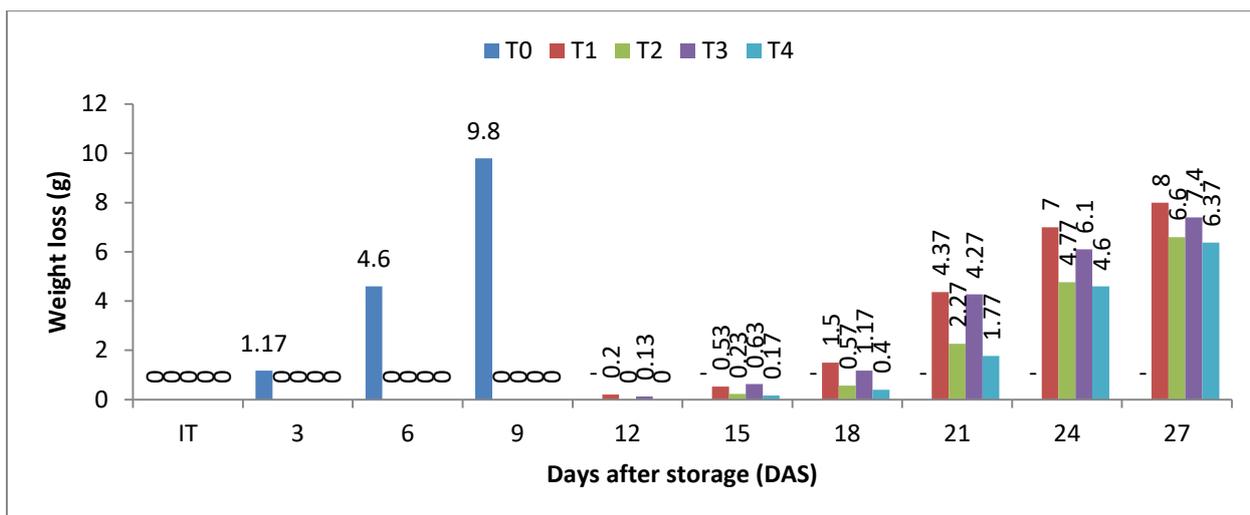


FIGURE 2: Weight loss of Green Chilli at different days after storage (DAS) in the low cost cold room (CoolBot)

3.6 Remaining Weight:

The remaining weight of chilli during storage in the low-cost CoolBot cold room varied significantly across treatments and storage duration, as shown in Table 4. The remaining weight of Green Chilli reflects cumulative effects of water loss, rot and bruising. Ambient-stored Green Chilli (T0) lost almost all weight by 9 DAS (0.20 kg). CoolBot storage maintained significantly higher weight retention. Open storage (T1) preserved 2.00 kg at 27 DAS, newspaper (T2) 3.40 kg, brown paper (T3) 3.1.33 kg and polythene wrapping (T4) 3.63 kg. The results suggest that Polythene coverings combined with low temperature are most effective in preserving cumulative Green Chilli weight and thus marketable yield.

TABLE 4
 TOTAL WEIGHT OF GREEN CHILLI AT DIFFERENT DAYS AFTER STORAGE (DAS) IN THE LOW COST COLD ROOM (COOLBOT)

Treatment	Total weight/remaining weight of Green Chilli (kg)									
	IT	3 DAS	6 DAS	9 DAS	12 DAS	15 DAS	18 DAS	21 DAS	24 DAS	27 DAS
T ₀	10	8.83 b	5.40 b	0.20 b	-	-	-	-	-	-
T ₁	10	10.00 a	10.00 a	10.00 a	9.87 a	9.37 b	8.83 b	5.73 c	3.00 b	2.00 b
T ₂	10	10.00 a	10.00 a	10.00 a	10.00 a	9.77 a	9.43 a	7.73 b	5.23 a	3.40 a
T ₃	10	10.00 a	10.00 a	10.00 a	9.80 a	9.47 b	8.50 c	5.63 c	3.00 b	1.33 c
T ₄	10	10.00 a	10.00 a	10.00 a	10.00 a	9.83 a	9.60 a	8.23 a	5.40 a	3.63 a
LSD _{0.05}	-	0.22	0.24	1.21	0.25	0.22	0.24	0.2	0.52	0.3
CV(%)	-	1.25	1.3	1.27	0.5	0.7	1.1	5.72	6.12	4.37

IV. DISCUSSION

Across all parameters, CoolBot storage significantly improved postharvest quality compared to ambient conditions. Protective coverings enhanced storage outcomes, with polythene maintaining colour, texture, and minimizing bruising in the early to mid-storage period, while paper coverings better preserved total weight and reduced rot in later stages. Maintaining low temperature (around 6–8°C) and high relative humidity (80–90%) is critical for extending shelf life, reducing postharvest losses, and improving marketable yield of Green Chilli in Bangladesh. These findings are consistent with international studies on low cost cold storage and protective packaging for capsicum and Green Chilli (Cheng et al., 2023; Costa et al., 2018; Mi et al., 2023; Sreeramulu et al., 2015).

In Green Chilli, losses occur primarily through physiological deterioration, weight reduction, microbial decay and physical damage during the storage and marketing chain. Such losses reduce both farmers' profitability and consumers' access to quality product (Kitinoja, 2018). Postharvest deterioration of Green Chilli is manifested in several quality parameters, including rapid colour change, softening of texture, mechanical bruising, microbial spoilage, weight loss, and reduced marketable yield (Cheng et al., 2023).

These results indicate that low temperature combined with controlled humidity slows pigment degradation, consistent with previous findings on capsicum and Green Chilli fruits (Costa et al., 2018; Martínez et al., 2019). The result is similar with the finding of Kader (2002), Mahajan & Goswami (2004) and Sreeramulu et al. (2015), who reported that the retention of turgor and reduced water loss in CoolBot, particularly with protective coverings, delays enzymatic softening of cell walls. It is mentioned by Cheng et al. (2023) and Mi et al. (2023) that protective coverings combined with low temperature preserve fruit integrity and reduce mechanical damage, aligning with prior studies. These observations confirm that low temperature and high relative humidity reduce microbial growth and enzymatic decay, prolonging shelf life (Kader, 2002; Sreeramulu et al., 2015; Mi et al., 2023).

V. CONCLUSION

The present study demonstrated that the use of a low-cost CoolBot cold room significantly reduces postharvest losses and preserves the quality of Green Chilli in Bangladesh. Storage under ambient conditions resulted in rapid deterioration of colour, texture, and firmness, with severe bruising, rotting, and weight loss within 9 days. In contrast, the CoolBot system effectively delayed these deteriorative changes by maintaining low temperature and high relative humidity, extending shelf life up to 27 days depending on the type of covering used.

Polythene wrapping (T4) showed superior performance in terms of weight loss and minimum rotting percentage of Green Chilli. Among the CoolBot treatments, protective coverings played a critical role in further enhancing storage quality. Polythene wrapping (T4) was most effective in maintaining colour, texture, and minimizing bruising during the early and mid-storage period. Overall, the combined use of low-cost CoolBot storage and appropriate protective coverings significantly reduced postharvest losses, maintained marketable quality, and improved potential yield and economic return for Green Chilli farmers in Bangladesh.

The findings highlight that CoolBot technology offers a practical, low-cost, and effective solution for smallholder farmers to extend the shelf life of perishable horticultural crops, ensuring better marketability and reduced economic loss

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

- [1] Cheng, H., Yang, S., Wang, W., & Li, Y. (2023). Influence of modified atmosphere packaging and cold storage on the quality and shelf life of green chilli. *Postharvest Biology and Technology*, 200, 112257. <https://doi.org/10.1016/j.postharvbio.2023.112257>
- [2] Costa, L., Civello, P. M., & Chaves, A. R. (2018). Effect of storage temperature on chlorophyll degradation in green chilli pepper. *Scientia Horticulturae*, 241, 164–170. <https://doi.org/10.1016/j.scienta.2018.07.010>
- [3] Kader, A. A. (2002). *Postharvest technology of horticultural crops* (3rd ed.). University of California, Agriculture and Natural Resources.
- [4] Khorshidi, S., Davarynejad, G., & Tehranifar, A. (2010). Effect of different packaging materials on postharvest quality of bell pepper during storage. *Asian Journal of Plant Sciences*, 9(7), 446–450. <https://doi.org/10.3923/ajps.2010.446.450>
- [5] Mahajan, P. V., & Goswami, T. K. (2004). Extended shelf-life of fresh green chilli under modified atmosphere packaging. *Journal of Food Engineering*, 65(2), 193–200. <https://doi.org/10.1016/j.jfoodeng.2004.01.007>
- [6] Martínez, S., López, M., & Carballo, J. (2019). Postharvest changes in colour and quality of green chilli fruits stored under ambient conditions. *Food Research International*, 121, 778–785. <https://doi.org/10.1016/j.foodres.2019.01.032>
- [7] Mi, J., Zhang, L., Wang, Q., & Chen, J. (2023). Effect of low temperature and humidity-controlled storage on the visual quality of green chilli. *Food Packaging and Shelf Life*, 36, 101024. <https://doi.org/10.1016/j.fpsl.2023.101024>
- [8] Sreeramulu, D., Reddy, C. V. K., & Raghunath, M. (2015). Antioxidant activity and storage stability of capsicum fruits under different packaging conditions. *Journal of Food Science and Technology*, 52(1), 169–175. <https://doi.org/10.1007/s13197-013-0984-2>