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EFFECT OF GAMMA IRRADIATION AND MODIFIED ATMOSPHERE PACKAGING ON POSTHARVEST BEHAVIOR OF DRAGON FRUIT

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Abstract

The experiment was conducted at the Postharvest Laboratory of the Department of Horticulture, Bangladesh Agricultural University, Mymensingh during, the period of September to October 2022 to find the effects of gamma irradiation and modified atmosphere packaging on postharvest behavior of dragon fruit. The experiment was laid out in completely randomized design with three replications. There were four treatments, viz. T_0: Control, T_1: gamma irradiation at 1000 Gy, T_2: 1000 Gy irradiated fruits wrapped in a non-perforated PP bag (25µ) containing $KMnO_4$, T_3: 1000 Gy gamma irradiated fruits wrapped in 25µ perforated PP bag containing $KMnO_4$. Data were recorded on weight loss, firmness, color, flavor, shrinkage, freshness, appearance, total soluble sugar (TSS), disease severity and shelf life at different days after storage. The longest shelf life (7.7 days) was recorded in 1000 Gy irradiated fruits and the shortest shelf life (5.3 days) was found in untreated control. The minimum weight loss (0.01%) was found in 1000 Gy gamma irradiated fruits wrapped in non-perforated PP bag containing $KMnO_4$ and maximum weight loss (3.44%) in untreated control at 7th day after storage. The findings would greatly contribute in reducing postharvest loss of dragon fruit and maintaining their quality during storage and marketing at ambient conditions.

Key words: Dragon fruit, gamma irradiation, MAP, $KMnO_4$, polypropylene.

Introduction

Dragon fruit is a rustic plant that belongs to the family Cactaceae and is an exotic fruit. There are several species of dragon fruit, with three groups of commercial value, such as red peel and white pulp *(Hylocereus undatus),*; red peel and red pulp (*Hylocereus costaricensis*) and yellow peel with thorns and white pulp (*Selenicereus megalanthus*) (Cordeiro *et al*., 2015). However, fruits with red pulp have conquered the preference of consumers due to their sweet taste and more vivid color (Bonewati *et al.*, 2017). The dragon fruit deteriorates easily when stored under ambient conditions, with a short shelf life since it has a highwater content, which favors the short postharvest period of approximately 6 to 10 days. The global demand for fresh and nutritious fruits has been steadily increasing due to the growing awareness of the importance of a healthy diet (Smith, 2021). However, the perishable nature of dragon fruit poses significant challenges in maintaining quality,

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extending shelf life and reducing loss during storage and transportation. As a result, there is a need to explore innovative and sustainable preservation techniques that can enhance their postharvest life without affecting their nutritional attributes. Postharvest losses of fresh fruits and vegetables are thought to range from 30 to 40% globally, while this number may be far higher in developing nations due to a lack of technology and proper sanitation. Currently in Bangladesh, the postharvest losses of fruits and vegetables have been assessed across marketing channel and system for 17-32% (Hassan *et al*., 2021). Several techniques have been researched to maintain the quality and increase the shelf life of fruits and vegetables. These techniques, alone or in combination, are used to reduce the metabolic activity of fruits, mainly the respiratory rate and water loss (Carvalho *et al.*, 2015). Thus, the use of gamma irradiation has become popular as it is an innovative ionizing technique and a physical method that has been adopted in the food industry for air disinfection, microbial decontamination of surfaces and packaging, and postharvest of fruits and vegetables (Nunes, 2015). Therefore, the present study was undertaken to determine the suitable doses of gamma irradiation for extending shelf life of dragon fruits.

Materials and Methods

The experiment was conducted at the Postharvest Laboratory of the Department of Horticulture, Bangladesh Agricultural University, Mymensingh. The storage room temperature was 22.0-27.6°C and relative humidity was 83-68%, respectively. Fully matured, fresh red fleshed dragon fruits (*cv*. BAU Dragon Fruit 2) were used as experimental materials that were collected from BAU-GPC. This experiment was conducted during the month of September to October 2022. The single-factor experiment comprised the following treatments T_0:Control (without any treatment),T_1: Dragon fruits irradiated with 1000 Gy, T_2: 1000 Gy irradiated fruits held in 25μ non-perforated polypropylene (PP) bag containing $KMnO_4$, T_3: 1000 Gy irradiated fruits were wrapped in 25μ perforated polypropylene (PP) bag containing $KMnO_4$. The experiment was laid out in a completely randomized design with three replications. A total of 12 fruits of uniform shape and size were used as experimental materials. The postharvest treatments were assigned randomly to the selected fruits. Data were analyzed using analysis of variance (ANOVA) by Statistix 10 (Version 10.0 Analytical Software USA). The means for all the treatments were calculated and ANOVA for all parameters was performed by F-test. Statistically significant differences among the different doses were identified by LSD at the 1% and 5% levels of significance as described by Gomez and Gomez (1984). Qualitative evaluations of external and internal characteristics of fruits and storage behavior were observed during the period of the study. The data were recorded every day during storage on different characteristics and shelf life of dragon fruit.

Parameters investigated

Estimation of total weight loss (%)

The fruits of each treatment were individually weighed using an electric weighing balance and kept for storage. The percent total weight loss was calculated every day during storage by using the following formula:

$$\text{Weight loss (\%)} = \frac{IW - FW}{IW} \times 100$$

Where, IW = Initial fruit weight (g); FW = Final fruit weight (g)

Firmness

Days required to reach different stage of firmness during storage and ripening were determined objectively using numerical rating scale of 1-4, where, 1= Firm, 2 = Sprung, 3 = Soft. 4 = Over ripe.

Freshness

Days required to reach different stages of freshness during storage were determined objectively using numerical rating scale of 1-4, where, 1=Excellent, 2=Good, 3=Fare, 4=Poor.

Shrinkage

Days required to reach different stages of shrinkage during storage were determined objectively using a numerical rating scale of 1-4, where, 1= no shrinkage, 2= slightly shrinked, 3= moderately shrinked, 4= shrinked.

Color

Days required to reach different stage of color during storage and ripening were determined objectively using numerical rating scale of 1-3, where 1 = Red, 2 = Deep red, 3 = Rotten/Dark purple.

Flavor

Days required to reach different stages of dragon fruits flavor during storage were determined objectively using numerical rating scale of 1-4, where 1= Excellent, 2 = Slightly odor, 3 = Moderately odor, 4 = Off odor.

Appearance

Days required to reach different stages of freshness during storage were determined objectively using numerical rating scale of 1-4, where 1= Excellent, 2= Good, 3= Fare, 4= Poor.

Disease severity

Disease severity represents the percent diseased portion of the infected fruit. The infected fruits were selected to determine percent fruit area infected. The percentage of fruit area diseased was measured based on eye estimation.

Total Soluble Solids (TSS)

Total soluble solid content of dragon pulp was estimated by using hand refractometer. A drop of dragon fruit juice was squeezed from the fruit pulp on the prism of the refractometer. Total soluble solid content was recorded as % Brix from direct reading of the instrument.

Shelf life

Shelf life is the period of time (days) which started from harvesting and extends up to the start of rotting of fruits. Shelf life of dragon fruits as influenced by different postharvest storage treatments was calculated by counting the number of days required to ripe fully so as to retain optimum marketing and eating qualities.

Results and Discussion

The results are presented and discussed in the following heads:

Total weight loss (%)

The main effect of packaging used in the present investigation showed a significant impact on percent weight loss (Table 1). The highest weight loss (3.4%) was found in control T_0 and the lowest weight loss (0.1%) was observed in other packaging at the 7^{th} day of storage. In comparison, Nerd *et al.* (1999) reported water loss of 4.4% for non-treated dragon fruit stored for 14 days at 14 °C. The weight loss is a natural feature of horticultural crops during storage, and it is attributed to respiration, transpiration and other biological changes taking place in the fruit. Higher weight loss is associated with bad appearance of fruit, which tends to wilt, and thus, lose consumer's acceptance. Several authors reported a reduction in weight loss of mangoes by using Modified Atmosphere Packaging (MAP) technique for fruit conservation. The total weight loss (%) differed significantly over the storage period irrespective of postharvest treatment and modified atmosphere packaging. Wavhal and Athale (1989) reported that inclusion of a bag of vermiculite, saturated with $KMnO_4$, in the polythene bag gave a reduction of weight loss and storage disorders. Bidyut *et al.* (2009) also observed that 1-2% $KMnO_4$, reduced weight loss. Similarly, Rahman *et al.* (2016) reported that weight loss from the strawberries gradually increased over time and was affected by the stages of maturity.

Disease severity

The disease severity of dragon fruits differed significantly to postharvest treatments, packaging and their interaction during the storage period (Table 1). Disease severity was increased with the progress of storage time. Disease severity changes were found to be faster in fruits of the control treatment. While, disease severity change was slower in 1000 Gy gamma irradiated fruits without any packaging. The faster rate of appearance change was found in the control fruits (66.67) and the slowest rate of appearance changes occurred in fruits under T_1 (18.33), T_3 (36.67) and T_2 (46.67) at the 7th day of storage, respectively (Table 1).

Table 1. Effect of gamma irradiation and MAP on percent weight loss and disease severity of dragon fruit at different days after storage (DAS)

Treatments	Weight loss (%) of fruits at different DAS)								Disease severity (%) of fruits at different DAS				
	2	3	4	5	6	7	8	9	5	6	7	8	9
T_0	1.1	1.3	1.8	1.3	2.7	3.4	-	-	6.7	20.0	66.7	-	-
T_1	1.4	1.7	2.1	1.2	1.9	1.9	2.7	3.7	1.7	11.7	18.3	25.0	34.0
T_2	0.1	0.1	0.1	0.1	0.5	0.2	-	-	5.0	18.3	46.7	-	-
T_3	0.1	0.1	0.2	0.1	0.5	0.1	-	-	2.7	8.3	36.7	-	-
$LSD_{0.05}$	0.4	0.5	0.60	0.45	1.0	1.0	0.9	1.2	4.5	18.8	36.0	-	-
$LSD_{0.01}$	0.5	0.8	0.9	0.7	1.4	1.4	1.3	1.8	6.57	27.39	52.3	-	-
Level of significance	**	**	**	**	**	**	**	**	*	NS	*	-	-

** = Significant at 1% level of probability. T_0: Control (without any treatment), T_1: Dragon fruits gamma irradiated at 1000 Gy, T_2: 1000 Gy gamma irradiated fruits held in 25μ non-perforated polypropylene (PP) bag containing $KMnO_4$, T_3: 1000 Gy gamma irradiated fruits were wrapped in 25μ perforated polypropylene (PP) bag containing $KMnO_4$.

Appearance

The appearance of the fruits decreased over the storage period irrespective of postharvest treatments, packaging and their interactions (Table 2). However, there was a significant difference between the postharvest treatments, packaging and interactions. Appearance changes were found to be faster in fruits of the control treatment. On the other hand, appearance changes were slower in 1000 Gy gamma irradiated fruits without any packaging. The fastest rate of appearance change was found in the control fruits (3.67) and the slowest rate of appearance change occurred in fruits under T_1 (2.33), T_3 (2.67) and T_2 (3.33) at the 7th day of storage, respectively (Table 2). The appearance of dragon fruit observed stored in ambient condition is likely due to an elevated relative humidity that favored growth and development of pathogens in the fruit, especially with high storage temperatures, as has been previously shown in other studies (Lurie *et al*., 2010). The rapid shriveling of dragon fruit after harvest reduces visual quality, storage life, and marketability (Jiang *et al*., 2002).

Firmness

Dragon fruit firmness is affected by fruit size, stage of maturity (Schmitz and Lenz, 1985) and is composed of two factors: skin toughness and the firmness of the underlying flesh (Büttner *et al*., 1987). The firmness of the dragon fruit was differed significantly over the storage period irrespective of the postharvest treatment, packaging and their interactions (Table 2). This could be due to the increase in the rate of physiological processes like transpiration and respiration. However, softening can limit shelf life, and further studies are needed to determine the maximum shelf life of irradiated dragon fruit. Other non-climacteric fruits had minimal (blueberries) to substantial (cherries, oranges and rambutans) softening at doses 1000 Gy or less. (Boylston *et al*., 2002; Ladaniya *et al*., 2003). The highest rate of firmness change was found in the control fruits T_0 (3.67) and the lowest rate of firmness changes occurred in fruits under T_1 (2.33), T_3 (3.33) and T_2 (3.67) at the 7th day of storage, respectively (Table 2).

Freshness

The highest rate of freshness change was found in the control fruits T_0 (3.67) and the lowest rate of freshness changes occurred in fruits under T_1 (2.33), T_2 and T_3 (3.67) at the 7th day of storage, respectively (Table 3). Results also revealed that the minimum shrinkage throughout the storage period was found in the fruits treated with 1000 Gy gamma irradiated fruits (without any packaging) (2.33) followed by 1000 Gy gamma irradiated fruits are kept in 25µ perforated poly propylene bags containing $KMnO_4$ with perforation (3.0) at the 7th day of storage, 1000 Gy gamma irradiated fruits are kept in 25µ poly propylene bags containing $KMnO_4$ without perforation and also fruits in control (3.67) at 7th day of storage, respectively. Similar findings were also reported by Kumar *et al*. (2013) and Bruno *et al*. (2021) in pomegranate and Amulya *et al.* (2016) in mango.

Shrinkage

Among postharvest treatments, the minimum shrinkage throughout the storage period was found in the fruits treated with 1000 Gy gamma irradiated fruits (without any packaging) (2.33) followed by 1000 Gy gamma irradiated fruits kept in 25µ perforated polypropylene bags containing KMnO4 with perforation (3.0) at the 7th day of storage, 1000 Gy gamma irradiated fruits kept in 25µ poly propylene bags containing KMnO4 without perforation and also fruits in control (3.67) at the 7th day of storage, respectively (Table 3).

Color

The color of the fruits differed significantly over storage period irrespective of the postharvest treatments, packaging and their interaction (Table 4). Color change was found to be faster in fruits of the control treatment. On the other hand, color changes were slower in 1000 Gy gamma irradiated fruits without any packaging. The faster rate of color changes was found in the control fruits (2.33) and the slowest rate of color changes occurred in fruits under T_1 (1.0), T_3 (1.0) and T_2 (1.33) at the 7th day of storage, respectively (Table 4).

Table 2. Effect of gamma irradiation and MAP on appearance and firmness of dragon fruit at different days after storage (DAS)

Treatments	Appearance [a] of fruits at different DAS									Firmness [b] of fruits at different DAS								
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
T_0	1.0	1.0	1.0	1.0	2.0	2.7	3.7	-	-	1.0	1.0	1.0	1.0	2.0	2.7	3.7	-	-
T_1	1.0	1.0	1.0	1.0	1.7	2.0	2.3	2.3	3.0	1.0	1.0	1.0	1.0	1.3	1.7	2.3	2.3	3.
T_2	1.0	1.0	1.0	1.0	2.0	2.7	3.3	-	-	1.0	1.0	1.0	1.0	1.7	2.7	3.7	-	-
T_3	1.0	1.0	1.0	1.0	1.3	1.7	2.7	-	-	1.0	1.0	1.0	1.0	1.0	2.0	3.3	-	-
$LSD_{0.05}$	-	-	-	-	0.8	1.3	1.1	-	-	-	-	-	-	0.8	1.3	1.1	-	-
$LSD_{0.01}$	-	-	-	-	1.1	1.9	1.6	-	-	-	-	-	-	1.1	1.9	1.6	-	-
Level of significance	-	-	-	-	NS	NS	*	-	-	-	-	-	-	NS	NS	*	-	

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

[a] = Appearance scale: 1 = Excellent, 2 = Good, 3= Moderate and 4 = Poor; [b] = Firm scale: 1 = Firm, 2 = Sprung, 3 = Soft, 4 = Over ripe; T_0: Control (without any treatment), T_1: Dragon fruits gamma irradiated at 1000 Gy, T_2: 1000 Gy gamma irradiated fruits held in 25μ non-perforated polypropylene (PP) bag containing $KMnO_4$, T_3: 1000 Gy gamma irradiated fruits were wrapped in 25μ perforated polypropylene (PP) bag containing $KMnO_4$.

Table 3. Effect of gamma irradiation and MAP on freshness and Shrinkage of dragon fruit at different days after storage (DAS)

Treatments	Freshness[c] of fruits at different DAS									Shrinkage[d] of fruits at different DAS								
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
T_0	1.0	1.0	1.0	1.0	2.0	3.0	3.7	-	-	1.0	1.0	1.0	1.0	2.0	3.0	3.7	-	-
T_1	1.0	1.0	1.0	1.0	2.0	2.3	2.3	2.3	3.0	1.0	1.0	1.0	1.0	2.0	2.3	2.3	2.3	3.0
T_2	1.0	1.0	1.0	1.0	2.0	2.7	3.7	-	-	1.0	1.0	1.0	1.0	2.0	2.7	3.7	-	-
T_3	1.0	1.0	1.0	1.0	1.7	2.0	3.7	-	-	1.0	1.0	1.0	1.0	1.7	2.0	3.0	-	-
$LSD_{0.05}$	-	-	-	-	0.5	1.2	1.1	-	-	-	-	-	-	0.5	1.2	1.3	-	-
$LSD_{0.01}$	-	-	-	-	0.8	1.8	1.6	-	-	-	-	-	-	0.8	1.8	1.9	-	-
Level of significance	-	-	-	-	NS	NS	*	-	-	-	-	-	-	NS	NS	*	-	-

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

[c] = Freshness scale: 1 = Excellent, 2 = Good, 3 = Fair, 4 = Poor. [d] = Shrinkage scale: 1 = No shrinkage, 2 = Slightly shrinked, 3 = Moderately and 4 = Shrinked. T_0: Control (without any treatment), T_1: Dragon fruits gamma irradiated at 1000 Gy, T_2: 1000 Gy gamma irradiated fruits held in 25µ non-perforated polypropylene (PP) bag containing $KMnO_4$, T_3: 1000 Gy gamma irradiated fruits were wrapped in 25µ perforated polypropylene (PP) bag containing $KMnO_4$.

Table 4. Effect of gamma irradiation and MAP on colour and flavour of dragon fruit at different days after storage (DAS)

Treatments	Color[e] of fruits at different DAS									Flavour[f] of fruits at different DAS								
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
T_0	1.0	1.0	1.0	1.3	1.7	2.0	2.3	-	-	1.0	1.0	1.0	1.0	2.0	3.0	3.7	-	-
T_1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.3	1.7	1.0	1.0	1.0	1.0	2.0	2.3	2.3	2.3	3.00
T_2	1.0	1.0	1.0	1.0	1.0	1.0	1.3	-	-	1.0	1.0	1.0	1.0	2.0	2.7	3.3	-	-
T_3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-	-	1.0	1.0	1.0	1.0	1.3	1.7	2.7	-	-
$LSD_{0.05}$	-	-	-	0.5	0.5	0.9	1.2	-	-	-	-	-	-	0.5	1.3	1.1	-	-
$LSD_{0.01}$	-	-	-	0.8	0.8	1.4	1.8	-	-	-	-	-	-	0.8	1.9	1.6	-	-
Level of significance	-	-	-	NS	*	*	*	-	-	-	-	-	-	*	*	*	-	-

* = Significant at 5% level of probability, NS = Not significant. [e] = Color scale: 1 = Red, 2 = Deep red, 3 = Black/Rotten and [f] = Flavor scale: 1 = Excellent, 2 = Good, 3 = Fair and 4 = Poor.

T_0: Control (without any treatment), T_1: Dragon fruits gamma irradiated at 1000 Gy, T_2: 1000 Gy gamma irradiated fruits held in 25μ non-perforated polypropylene (PP) bag containing $KMnO_4$, T_3: 1000 Gy gamma irradiated fruits were wrapped in 25μ perforated polypropylene (PP) bag containing $KMnO_4$.

Flavor

The flavor of the fruits was decreased over the storage period irrespective of postharvest treatments, packaging and their interactions (Table 4). However, there was a significant difference between the postharvest treatments, packaging and interactions. Overall fruit flavor trended to be increased with the progress of storage duration. Flavor changes were found to be faster in fruits of the control treatment. On the other hand, flavor changes were slower in 1000 Gy gamma irradiated fruits without any packaging. The highest rate of color changes was found in the control fruits (3.67) and the slowest rate of color changes occurred in fruits under T_1 (2.33), T_3 (2.67) and T_2 (3.33) at the 7^{th} day of storage, respectively (Table 4). Our results concerning the behavior of dragon fruit postharvest are consistent with previous reports on dragon fruit by Nerd *et al*. (1999) in mango.

Total soluble solids (TSS)

TSS have been shown to increase during ripening and then remain constant with over-maturity (Gautier *et al.*, 2008). The results confirm those of Prakash *et al.* (2002), that there were no significant differences (P >0.05) in TSS as a result of irradiation. The significant change in TSS that was observed in the unirradiated samples (Fig. 1), however, was different from the results by Akter and Khan (2012) in control tomato fruits stored at 25°C, this may be due to the slight change in the temperature regimes used for this study.

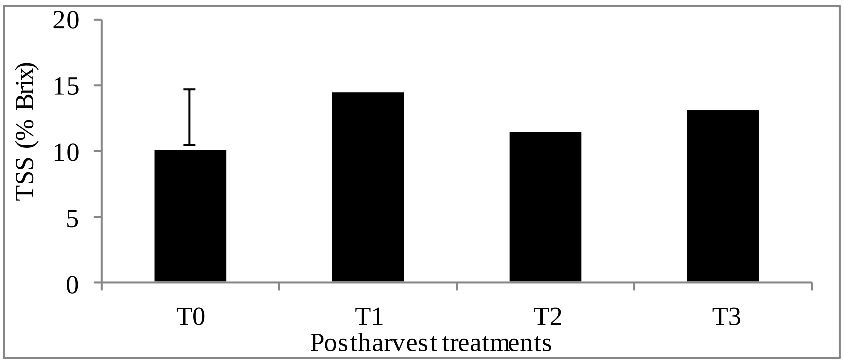

Fig. 1. Effect of postharvest treatments on TSS of dragon fruit. The vertical bar represents LSD at 5% level of significance.

T_0: Control (without any treatment), T_1: Dragon fruits gamma irradiated at 1000 Gy, T_2: 1000 Gy gamma irradiated fruits held in 25µ non-perforated polypropylene (PP) bag containing $KMnO_4$, T_3: 1000 Gy gamma irradiated fruits were wrapped in 25µ perforated polypropylene (PP) bag containing $KMnO_4$.

Soluble solids content of mangoes gradually increased in all treatments during storage, as an effect of fruit ripening and bagged fruit had lower TSS content when compared to un-bagged ones (Akhther *et al.*, 2023). This effect occurs due to the low oxygen concentration around the fruit promoted by MAP, which reduces the starch breakdown into glucose with the inhibition of amylase and maltase activities (Singh *et al.*, 2013). The maximum TSS content (14.47% Brix) was found in 1000 Gy gamma irradiated fruits without any packaging at the 9th day of storage, while the minimum TSS content (10.03% Brix) was found in control treatment at the 7th day of storage (Fig. 1). The increase in soluble solid contents may be due to hydrolysis of sucrose to invert sugars (Salama *et al.*, 2013). Similarly, This observation is somewhat similar to Caner *et al.* (2009).

Shelf life

Postharvest treatments exerted significant effects in extending shelf life of dragon fruits. Among the postharvest treatments, 1000 Gy gamma irradiated fruits without packaging showed the longest shelf life (7.66 days) followed by 1000 Gy gamma irradiated fruits were kept in 25µ polypropylene bag containing $KMnO_4$ with perforation (6 days) (Fig. 2). 1000 Gy gamma irradiated fruits were kept in 25µ polypropylene bag without perforation (5.33 days). However, the shortest shelf life of fruits was recorded in fruits without any treatment and 1000 Gy gamma irradiated fruits were kept in 25µ polypropylene bag without perforation (3 days) (Fig. 2).

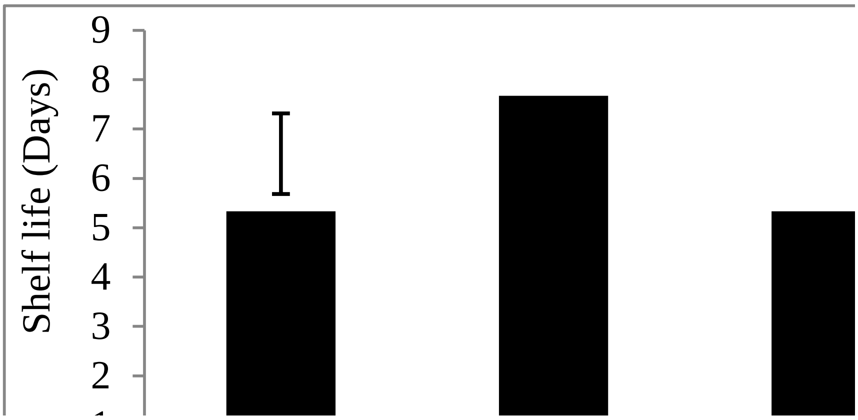

Fig. 2. Effect of gamma irradiation and MAP on shelf life of dragon fruit. The vertical bar represents LSD at 5% level of significance.

T_0: Control (without any treatment), T_1: Dragon fruits gamma irradiated at 1000 Gy, T_2: 1000 Gy gamma irradiated fruits held in 25µ non-perforated polypropylene (PP) bag containing $KMnO_4$, T_3: 1000 Gy gamma irradiated fruits were wrapped in 25µ perforated polypropylene (PP) bag containing $KMnO_4$.

The most striking result of the present study was that dramatic extension of shelf life of dragon fruit, a highly perishable fruit, was achieved at ambient condition when treated with 1000 gamma radiation without any packaging materials. This result was in support of Akhther *et al.* (2023), who reported that shelf life of mango was significantly extended due to the application of gamma irradiation. The high CO_2 and low O_2 atmosphere inside the package result in the decrease in respiration rate, ethylene production, and other metabolic processes in addition to its effect on improved moisture retention (Mir and Beaudry, 2016).

Conclusion

It was observed that the result of this experiment would be useful to prolong shelf life and maintain better quality of dragon fruit. 1000 Gy gamma irradiated dragon fruits kept at ambient temperature, would be an effective tool to store dragon fruit promoted almost all morphological traits of fruits as well as disease severity, appearance, freshness, shrinkage, flavor, texture, color, firmness, TSS and shelf life. 1000 Gy gamma irradiated fruits without packaging showed the longest shelf life (7.66 days).

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