Shelf Life Extension of Mango Fruit by using Non-Preservative Technique

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ABSTRACT

Chemicals are not used safely for the quality retention and optimum storage stability of foodstuffs due to residual problems. Food irradiation is a secure process and can effectively be used to suppress the infestation, sprouting, rate of respiration, and to increase the storage duration of perishable products. This research trial was conducted at Ayub Agricultural Research, Faisalabad, Pakistan. Mango samples of sensation variety were irradiated with three different doses by using a mark-IV irradiator installed at NIAB. Data regarding firmness, Brix, titratable acidity, pH, and Vitamin-C were calculated after a one-week interval. The mango samples were placed in cold storage where temperature and relative humidity were monitored regularly during the storage period 10°C and 85–90% relative humidity. The dose of 300 Gy showed better results as compared to the other two doses, i.e., 150 and 225 Gy due to the concentrated level of rays, however, the ray level higher than 300 imparted adverse effects. Irradiation technology can successfully be applied to improve the storage life and reduce post-harvest losses.

KEYWORDS

Mango; irradiation; quality retention attributes; shelf life

Introduction

Mango fruit (Mangifera indica L.) is very nutritious and mostly harvested in equatorial regions with maximum carotene content. According to a survey, India contributes 41% of the total mango production of the world, (10,800,000 MT), tracked by China, Thailand, Mexico, Pakistan, Indonesia, the Philippines, Nigeria, and Brazil (Kim et al., 2009). Mangos are commonly utilized after different operations in form of achaar, condiment, preserved or dehydrated goods, juices, and squashes (Dube et al., 2004). Fruits are primarily used for fresh utilization, and considered as the best food for the poor, however, most of the fruit is comprised of pulp, peel, and seed (Ambika et al., 2019; Aslam et al., 2019).

If we discuss the standard of mango, on a daily basis quality parameter of mango varies so the customer is unable to recognize it when buying. Quality factors of fruit including mass, shape, visual appearance, or taste conceal about the actual value of mango fruit. In the maturation process of mango fruits, the value of sugar concentration, alkalinity, sugar to acid ratio, and phytochemical enhanced while bitterness, carbohydrates, and ascorbic acid reduced out (Ueda et al., 2001).

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Moreover, due to the continuity of the maturation process after harvesting, and the sudden attack by microbes causing rot disease, the shelf life of mango fruit is reduced (Martínez et al., 2012). Although usage of the cooling system and adjusted environment help to avoid these above problems (Jerônimo and Kanesiro, 2000). Twelve-degree celsius is the suggested temperature for mango fruit (Alves et al., 1998). Calore and Vieites (2003) explained that to reduce the attack of pathogens that could exist less storing temperature can be applied in combination with an adjusted environment (Iqbal et al., 2020). To enhance the storage life and commercialization duration of fruits and vegetables appropriate treatment is applied in conjunction with food conservation techniques after harvesting (Jerônimo and Kanesiro, 2000). Furthermore, any type of coating applied on mango fruit can improve the value of total soluble solids (TSS), vitamin C, acidity, and it decreases the wastage of water and sensory parameters (PoJung Chien et al., 2007; Aslam et al., 2019). Ionizing radiation has been successfully employed to upsurge the storage life of a diversity of perishable foods. Biochemical and physiological studies revealed that these effects are brought about by controlling respiration in the case of fruits. The irradiation technique has also been employed as an alternative non-chemical method to control the post-harvest diseases. (Srimartpirom et al., 2018)

To control the propagation of microbe’s, gamma ray emitter’s specially Co-60 and Cs-137 were used out more above than 50 years (Käferstein and Moy, 1993). Chitarra and Chitarra (2005) described that all infections and injuries of fruits and vegetables after harvesting can be reduced by applying different radiation methods. Though it is a well-known protective procedure because it extends the storing duration by stopping the maturation process of fruit items. Moreover, its application has some drawbacks, such as toasting, lessen, the overall appearance of depressions, irregular ripening, and loss of odor and taste of the fruit items (Khaliq et al., 2018; Nagajata, 2007). The extent of variation in quality parameters depends on variety, arrangement, and dose of radiations applied. The visualization and ability of fruit items can be improved by applying gamma rays which change out the physical constituents of fruit. A lower intensity of gamma rays are used to remove water from fruit and enhance its storage life, it also converts carbohydrates into glucose (Lima et al., 2001). Those fruits that are not treated with radiations are less sweet in taste than those which are treated by radiations (Thomas and Moy, 1986). Throughout the maturation of mango fruit, the amount of carbon-based acid diminishes, and the dissolved sugar amount enhances, which results in a predominance of sugariness in the mature fruit (Bernardes-Silva et al., 2003). Observing these variations plays a role as a base to evaluate if the electron rays affect the maturation of mango. Mangoes treated with radiations expose no significant variations in High-Performance Liquid Chromatography profile but it retards the maturation process than untreated. If treatment is done with rays of dose more than 1.5 kGy it causes skin depressions due to the death of cells of that place which is not preferred by customers.

The major aim of the work was to investigate the effect of irradiation along with cold storage on the post-harvest shelf life of mango cultivar (sensation) and to estimate its effect on the quality retention parameters during the storage period.

**Material and Methods**

**Collection of Samples**

Mango variety, namely, sensation, one of the most important commercial varieties of mango was collected, and for this aim unripe, mature, greener mango with equal mass was collected from the orchard of Horticulture Research Institute AARI, Faisalabad, Pakistan.

**Washing and De-sapping**

After harvesting, the mango fruit samples were cleaned with freshwater to get off dirt, soil, pesticide residues, and to expel the ground heat. De-sapping and antifungal treatment were done by dipping the
harvested mango fruits in 0.5% Ca (OH)\textsubscript{2} solution for 5 minutes. Then, removed the washed and desaped mango fruits and drying was carried out.

**Irradiation Treatment**

The study was a joint and collaborative in its nature. The nuclear institute for agriculture and biology (NIAB) had provided technical facilities for irradiation. The equipment used for irradiation purposes was mark-iv having $^{60}$Co metal source with a dose of 150, 225, and 300 Gy per hour which is closed type. The total quantity of fruits used in this experiment was randomized and divided into four treatments of 5 kg of fruits in each treatment. Three treatments were irradiated, respectively, with 150, 225, and 300 Gy, one treatment, as control (without irradiation) with three replications for each treatment including the control as shown in Table 1. (Kalyani and Manjula, 2014).

**Storage Conditions**

The irradiated mango fruits were put in a storage compartment at 10°C with 85–90% RH up to a maximum acceptable period. The impact of storing period on storage duration and quality retention properties in terms of overall variations such as firmness, sugar concentration, bitterness, pH, vitamin C, and physical estimation such as peel physical appearance, pulp color, shape, flavor, and overall acceptability was examined afterward a storage duration of 7 days for each treatment up to maximum acceptable storage period (Table 1).

**Overall Evaluation**

**Peel Strength**

The strength was determined with a fruit firmness meter, manufactured by Tr di turonil Co. Snc. Italy. This equipment procedure included to catch the sample strongly in the opposite hand; grip the fruit meter among two fingers of another hand, placed the needle (with thickness 7.9 mm) was used above the sample, and push with enhancing power till the needle slope is punctured into the sample up to the mark. Gradually puncture of the needle is necessary for precise determination. The estimated values were expressed in (Kg).

**Sugar Concentration**

The sugar concentration was examined by Brix meter. A standardized specimen was made by crushing the skinned mango pulp in the crusher. The specimen was carefully stirred and little droplets were took on the spectrum of the brix meter and value was taken by reading the display meter as discussed in AOAC (2006).

**Titrated Bitterness**

The bitterness of the specimen was found by taking a 10 mL sample into a 100 mL gravimetric vessel and capacity were brought up with pure water. Then, 10 mL of the specimen was brought into funnel-shaped vessel was standardized in contradiction of base like 0.1 N sodium hydroxide mixture described by A.O.A.C (2006). The % age of bitterness was determined as: -

\[
\text{Acidity} \% = \frac{1}{10} \times \text{equivalent weight of tart} \times \text{value of titer used} \times 100 / \text{mass of the samples.}
\]
pH

10 g of specimens was blended to calculate pH amount by using a numerical pH meter (InoLab 720, Germany) by following the standard method of A.O.A.C (2006).

Vitamin C

The vitamin C amount was examined by applying operative color (2, 6-dichlorophenolindo phenol) giving by the quality procedure of A.O.A.C (2006).

Physical Estimation

Physical estimation, established on skin and flesh physical appearance, aroma, relish, and total suitability properties was done after 7 days by the procedure defined by Lee et al. (2003). Using a 9-point hedonic rule from 1 to 9, here “1” signified really hated and “9” signified very favorite. The 9 point hedonic scale is given as Appendix II.

Statistical Analysis

The material found was statistically studied for Analysis of Variance (ANOVA) by applying (CRD product) to compare the mean values to obtain the significance level among the treatment Steel and Torrie (1997).

Consequences and Conversation

Impact of Storing on Physio-Chemical Factors

Firmness

The statistical analysis proved that the firmness significantly increased with treatment however, it momentarily decreased with time. Mean values regarding the firmness of irradiated mango (Table 2) revealed that firmness ranged from 1.40 to 2.97. The results showed that maximum firmness (17.00) was found in T4 at 0 days whilst, the minimum (1.40) was reported in treatment without radiation (T1) at the last of storage work. A decreasing movement was examined in firmness of irradiated mango (Table 2) from 15.50, 7.00, 4.76, 3.15, 1.40 in T1, 14.00, 10.00, 5.67, 3.92, 2.39 in T2 (150 Gy irradiation), 16.00, 11.00, 4.32, 3.45, 2.89 in T3 (225 Gy irradiation), and 17.00, 12.00, 6.14, 4.25, 2.97 in T4 (300 Gy irradiation) at 0, 7, 14, 21, and 28 days, respectively.

| Treatment | Irradiation doses (Gy) | Storage Conditions       |
|-----------|------------------------|--------------------------|
| T1S       | Without irradiation    | 10°C with 85–90% RH      |
| T2S       | 150                    | 10°C with 85–90% RH      |
| T3S       | 225                    | 10°C with 85–90% RH      |
| T4S       | 300                    | 10°C with 85–90% RH      |

Table 1. Treatment plan.

Table 2. Effect of storage on firmness (kg) of irradiated mango (Sensation).
Mango fruit ripening is closely associated with structural and compositional changes in cell walls resulting in textural softening. According to a study conducted by Penta et al., 2019 mango fruit exposed to 11.7 kJ m\(^{-2}\) UV-C light and stored in air containing less than 0.005 μL L\(^{-1}\) ethylene resulted in notably firmer fruit. In comparison to that, fruit stored in the air with ethylene concentration 0.1 μL L\(^{-1}\), exhibit differential results. However, significantly firm fruit is obtained after treating it with UV-C intensities of 8.3 to 11.7 kJ m\(^{-2}\) than untreated fruits after 6\(^\text{th}\) day of storage.

Liu et al., 2011 in his study also reported that delay in the softening process in tomato fruit treated with UV-C at the intensity of 4 kJ m\(^{-4}\). The study showed that the treated fruit firmness is associated with natural plant tissue defense mechanism. Ultraviolet ray treatment activates the natural defense mechanism of plant tissues resulting in the production of phytoalexin, due to biological stress, a higher concentration of phytoalexin compounds triggers other inducible defense systems like cell wall modification.

**Brix**

Similar to firmness, it was proved with statistical modeling that the brix of irradiated mango increased with the time duration; however, with the treatment the brix content varied differently. Mean values revealed that treatment T\(_1\) (without radiation) for mango irradiation exhibited the maximum score of Brix (18.10 at 28 days) and the minimum flavor score (10.80 at 0 day). Moreover, the values of Brix for irradiated mango were 10.80–18.10 (T\(_1\)), 11.90–17.40 (T\(_2\)), 11.5–16.8 (T\(_3\)), and 12.0–16.5 (T\(_4\)), respectively, from 0 to 28 days of storage period as shown in Table 3.

**Acidity**

At the same time the acidity content of mangoes decreased accordingly with the time interval whilst, it showed non-significant effect within treatments, mean values regarding the acidity of irradiated mango (Table 4) revealed that acidity ranged from 0.13 to 0.25. The results showed that maximum acidity (0.25) was found in T\(_1\) and T\(_4\) at 0 day whilst, the minimum was reported in irradiated mango at the end of the storage study among all treatments. A decreasing trend was observed in the acidity of irradiated mango (Table 4) from 0.25 in T\(_1\) to 0.13 and 0.17 in T\(_4\). During storage, values for acidity decreased from 0.23, 0.22, 0.21, 0.19, 0.15 in T\(_2\) at 0, 7, 14, 21 and 28 days and 0.24, 0.22, 0.20, 0.18, 0.16 in T\(_3\) at 0, 7, 14, 21 and 28 days.

Brix and UV-C intensities show an inverse relation during storage. However, the acidity level follows an entirely opposite pattern, as acidity increase with increasing UV-C intensities. Initially, the acidity level of fruit was 0.626% (citric acid). After 3 days of storage, acidity levels of controlled fruit

| Evaluation | 0   | 7   | 14  | 21  | 28  |
|------------|-----|-----|-----|-----|-----|
| T\(_1\)S   | 10.80 | 13.40 | 15.20 | 17.20 | 18.10 |
| T\(_2\)S   | 11.90 | 13.00 | 14.80 | 16.60 | 17.40 |
| T\(_3\)S   | 11.50 | 12.90 | 14.00 | 15.60 | 16.80 |
| T\(_4\)S   | 12.00 | 13.40 | 14.00 | 15.10 | 16.50 |
| **Mean**   | 11.55 | 13.17 | 14.50 | 16.12 | 17.20 |

| Evaluation | 0   | 7   | 14  | 21  | 28  |
|------------|-----|-----|-----|-----|-----|
| T\(_1\)S   | 0.25 | 0.20 | 0.19 | 0.15 | 0.13 |
| T\(_2\)S   | 0.23 | 0.22 | 0.21 | 0.19 | 0.15 |
| T\(_3\)S   | 0.24 | 0.22 | 0.20 | 0.18 | 0.16 |
| T\(_4\)S   | 0.25 | 0.23 | 0.21 | 0.18 | 0.17 |
| **Mean**   | 0.24 | 0.21 | 0.20 | 0.17 | 0.15 |
were lowest indicating a rapid ripening process. Fruit stored at higher UV-C intensities maintained higher acid concentration. Mango fruit treated with 11.7 kJ m⁻² UV-C intensity during storage exhibited the highest acid concentrations. This study concluded that UV-C treatment has does dependant effect on brix and acidity level Penta et al., 2019.

A study conducted on Tommy Atkins mangoes by González-Aguilar et al., 2001, showed contrasting results; mango fruit after 20 min exposure to UV-C radiation, followed by 14 day storage at 5 °C showed amicably higher sucrose concentration. These contrasting results were due to the intensity of treatment, storage conditions, and maturity level of the fruit, and assessment method of sugar levels.

**pH**

The statistical analysis depicted that the pH content of mango increased with the time duration of 28 days however, the pH decreased with the change in dose as mentioned in treatments Table 5 indicates that the mean values regarding pH range of irradiated mango are from 3.63 to 4.10. The results showed that maximum (4.10) and the minimum (3.63) pH were found in T₁. A marked increase in pH of irradiated mango were observed (Table 4) from 0 day to 28 days of storage. During storage, values for pH increased from 3.63, 3.77, 3.80, 3.94, 4.10 for T₁ at 0, 7, 14, 21, and 28 day of storage, similarly, the same trend was observed in T₂ from 3.65, 3.72, 3.78, 3.92, 4.08 at 0, 7, 14, 21, and 28 day. Interactive effect of treatment and storage revealed that the highest pH was recorded in T₁ (4.10) at 28 days of storage period.

**Vitamin C**

The statistical analysis revealed that the vitamin C content of irradiated mangoes decreased momentously with storage interval as well as within treatments. Mean values revealed a decreasing trend in the content of vitamin C in all treatments from 1st to last day. According to mean values of all treatments for mango irradiation, the highest content (50.00 mg/100 g) of vitamin C was in T₁ at 0 day whilst the lowest content (36.66 mg/100 g) of vitamin C was in T₁ at 28 days. Moreover, in T₂, T₃, and T₄, levels of vitamin C were 49.21, 46.42, 43.62, 40.81, 38.00; 48.33, 46.31, 44.26, 42.25, 40.23; 48.26, 47.29, 45.03, 43.53, 41.71 mg/100 g at 0, 7, 14, 21 and 28 days, respectively(Table 6).

A study by Bagel et al., 2005, supports the current research as the highest ascorbic acid concentration 43.05 was recorded in the treatment T₁ – 0.4 kGy + GA₃ 50 ppm, followed by second treatment T₂ – 0.4 kGy + GA₃ @ 100 ppm with ascorbic acid concentration 42.75. The controlled samples T₅ showed the lowest ascorbic acid concentration 41.80. Throughout the storage period, Vitamin C levels decreased due to multiple factors including the presence of enzyme ascorbinase which converts...

**Table 5.** Effect of Storage on pH of irradiated mango (Sensation).

| Evaluation | 0   | 7   | 14  | 21  | 28  |
|------------|-----|-----|-----|-----|-----|
| T₁S        | 3.63| 3.77| 3.80| 3.94| 4.10|
| T₂S        | 3.65| 3.72| 3.78| 3.92| 4.08|
| T₃S        | 3.67| 3.69| 3.74| 3.89| 4.05|
| T₄S        | 3.69| 3.70| 3.77| 3.85| 4.00|
| Mean       | 3.66| 3.72| 3.77| 3.90| 4.05|

**Table 6.** Effect of Storage on Vitamin C (mg/100 g) of irradiated mango (Sensation).

| Evaluation | 0   | 7   | 14  | 21  | 28  |
|------------|-----|-----|-----|-----|-----|
| T₁S        | 50.00| 46.65| 42.34| 39.98| 36.66|
| T₂S        | 49.21| 46.42| 43.62| 40.81| 38.00|
| T₃S        | 48.33| 46.31| 44.26| 42.25| 40.23|
| T₄S        | 48.26| 47.29| 45.03| 43.53| 41.71|
| Mean       | 48.95| 46.66| 43.81| 41.64| 39.15|
ascorbic acid into dehydro-ascorbic acid and a high rate of evapotranspiration and respiration (Table 6.)

**Effect of Storage on Sensory Characteristics (Mean Tables of 5 Replicates)**

**Skin Color**
The statistical modeling regarding the sensation of the skin color of irradiated mango proved that the skin color changed significantly with the treatment at the start of the storage interval however with time the treatments did not impart significant color changes. Although the skin color within the same treatment decreased momentously with storage timings of 28 days. Mean values exhibited that the color score of irradiated mango in all treatments was 7.00–3.40, 7.40–3.80, 7.20–3.40, and 7.40–3.60 for T1, T2, T3 and T4 respectively at 7 to 28 days. The maximum score of color (7.40) was recorded in T2 and T4 at 0 day and the minimum color score (3.40) was observed in T1 and T3 at 28 days. Moreover, the mean values of color scores of all treatments for irradiated mango showed a decreasing trend from 7 to 28 days as shown in Table 7.

**Flesh Color**
The statistical analysis depicted that the flesh color of irradiated mangoes increased momentously in treatment however, it significantly changed during storage time. Mean values revealed that treatment T4 exhibited the maximum score of flesh color (8.60) at 0 day and the minimum flesh color score (6.80) was observed in T1 at 28 days. Moreover, color scores of irradiated mango were 7.60–6.80 (T1), 7.80–7.00 (T2), 8.20–7.40 (T3), and 8.60–7.80 (T4) at 0 and 28 days as shown in Table 8.

**Taste**
According to statistical tools, the taste attributes significantly increased by the treatments; however, it decreased within 28 days of storage time, correspondingly. Mean values regarding the taste of irradiated mango (Table 9) revealed that taste scores ranged from 6.20 to 8.40. The results showed that maximum taste (8.40) was found in T4 at 0 day whilst, the minimum taste (6.20) was reported in T1 at 28 days in irradiated mango among all treatments. A decreasing trend was observed in the taste of irradiated mango (Table 9) in all treatments from 0 to 28 days. During storage, values for taste decreased from 7.00 to 6.20 in T1, 7.40 to 6.60 in T2, 8.20 to 7.40 in T3, and 8.40 to 7.60 in T4 at 0 and 28 days, respectively.

| Table 7. Impact of Storing on the skin color of irradiated mango (Sensation). |
|---------------------------------|
| Evaluation | Storing duration (days) |
|          | 0     | 7     | 14    | 21    | 28    |
| T1S      | 8.55  | 7.00  | 5.80  | 4.60  | 3.40  |
| T2S      | 8.70  | 7.40  | 5.20  | 4.00  | 3.80  |
| T3S      | 8.65  | 7.20  | 5.00  | 4.80  | 3.40  |
| T4S      | 8.95  | 7.40  | 5.20  | 4.00  | 3.60  |
| Mean     | 8.71  | 7.25  | 5.30  | 4.35  | 3.55  |

| Table 8. Impact of storing on flesh color of irradiated mango (Sensation). |
|---------------------------------|
| Evaluation | Storing duration (days) |
|          | 0     | 7     | 14    | 21    | 28    |
| T1S      | 7.60  | 7.40  | 7.20  | 7.00  | 6.80  |
| T2S      | 7.80  | 7.60  | 7.40  | 7.20  | 7.00  |
| T3S      | 8.20  | 8.00  | 7.80  | 7.60  | 7.40  |
| T4S      | 8.60  | 8.40  | 8.20  | 8.00  | 7.80  |
| Mean     | 8.05  | 7.85  | 7.65  | 7.45  | 7.25  |
Table 9. Effect of Storage on the taste of irradiated mango (Sensation).

| Evaluation | Storing duration (days) |
|------------|------------------------|
|            | 0          | 7          | 14         | 21         | 28         |
| T1S        | 7.00      | 6.80      | 6.60      | 6.40      | 6.20      |
| T2S        | 7.40      | 7.20      | 7.00      | 6.80      | 6.60      |
| T3S        | 8.20      | 8.00      | 7.80      | 7.40      | 7.40      |
| T4S        | 8.40      | 8.20      | 8.00      | 7.80      | 7.60      |
| Mean       | 7.75      | 7.55      | 7.35      | 7.10      | 6.95      |

**Texture**

The statistical analysis resulted that the texture of irradiated mango improved significantly in treatments; however, it gradually decreased with the time interval. Mean values exhibited that the texture of irradiated mango was decreased from 0 to 28 days in all treatments. The maximum texture score (8.60) was recorded in T4 at 0 and 7 days and the minimum texture score (6.80) was observed in T1 at 28 days. A decreasing trend was observed in texture of irradiated mango (Table 10) from 7.60, 7.40, 7.20, 7.00, 6.80 in T1, 7.60, 7.40, 7.20, 7.00 in T2, 8.20, 8.20, 8.00, 8.00, 7.80 in T3, and 8.60, 8.60, 8.40, 8.20, 8.00 in T4 at 0, 7, 14, 21 and 28 days, respectively.

**Overall Acceptability**

It was proved by statistical analysis that the treatments showed the significant acceptance toward the overall acceptability of irradiated mango that momentously decreased with the storage time period. Mean values exhibited that the maximum overall acceptability score was recorded in T4. Maximum score of overall acceptability (8.60) in T4 and the minimum overall acceptability score (6.80) was observed in T1 at 0 and 28 days, respectively. Moreover, overall acceptability scores of all treatments for irradiated mango were observed which were ranged from 7.60 to 6.80 in T1, 7.80 to 7.00 in T2, 8.20 to 7.40 in T3, and 8.60 to 7.80 in T4 at 0 and 28 days, respectively (Table 11). Conclusively, the trend of overall acceptability in all treatments was decreasing from 0 to 28 days.

Ambika, et al., 2019 studied the combined effect of γ-radiations and post-harvest treatment on sensory characteristics i.e. appearance, color, flavor, taste, texture, and overall acceptability of custard apple. The highest score in respect to color and appearance was of T1-0.40 kGy + GA3 @ 50 ppm (8.43), followed by T2- 0.60 kGy + GA3 @ 100 ppm (8.13), whereas controlled sample T5 (6.68) had the lowest scores. The highest score of textual characteristics was of T1-0.40 kGy + GA3 @ 50 ppm (8.25), followed by T2-0.60 kGy + GA3 @ 100 ppm (8.03) controlled sample T5 (6.70) exhibited the lowest scores. Values of remaining samples had a significant difference.

Table 10. Effect of Storage on the texture of irradiated mango (Sensation).

| Evaluation | Storing duration (days) |
|------------|------------------------|
|            | 0          | 7          | 14         | 21         | 28         |
| T1S        | 7.60      | 7.40      | 7.20      | 7.00      | 6.80      |
| T2S        | 7.60      | 7.40      | 7.20      | 7.00      | 7.00      |
| T3S        | 8.20      | 8.00      | 7.80      | 7.40      | 7.40      |
| T4S        | 8.60      | 8.40      | 8.20      | 8.00      | 8.00      |
| Mean       | 8.00      | 7.90      | 7.70      | 7.60      | 7.40      |

Table 11. Effect of Storage on overall acceptability of irradiated mango (Sensation).

| Evaluation | Storing duration (days) |
|------------|------------------------|
|            | 0          | 7          | 14         | 21         | 28         |
| T1S        | 7.60      | 7.40      | 7.20      | 7.00      | 6.80      |
| T2S        | 7.80      | 7.60      | 7.40      | 7.20      | 7.00      |
| T3S        | 8.20      | 8.00      | 7.80      | 7.60      | 7.40      |
| T4S        | 8.60      | 8.40      | 8.20      | 8.00      | 7.80      |
| Mean       | 8.05      | 7.85      | 7.65      | 7.45      | 7.25      |
Highlights

Irradiation technology can make a significant impact in extending the shelf-life of foods and in controlling food-borne diseases in developing and other nations of the world. It can be used to delay ripening in mangos, disinfect, decontaminate grains and spices, and inhibit sprouting in tuber crops. Irradiation can enhance the bioavailability of food, increase exports, and reduce foodborne diseases, adding to the economies and social status of the people in developing countries, in particular, and the world over in general. The use of chemical preservatives could be stopped. Irradiation can enhance the quality and shelf life of the perishable products.

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Disclosure statement

Authors declare that they have no conflict of Interest.

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**APPENDIX II**

**9 POINT HEDONIC SCALE**

**PRODUCT NAME: IRRADIATED MANGO**

**NAME OF JUDGE: ________________________________**

| Sample name | Skin color | Flesh color | Taste | Texture | Overall acceptability |
|-------------|------------|-------------|-------|---------|-----------------------|
| T1S         |            |             |       |         |                       |
| T2S         |            |             |       |         |                       |
| T3S         |            |             |       |         |                       |
| T4S         |            |             |       |         |                       |

**REMARKS (IF ANY) __________________________________________**

**KEY FOR RANKING:**
Dislike extremely1
Dislike very much2
Dislike moderately3
Dislike slightly4
Neither dislikes nor like5
Like slightly6
Like moderately7
Like very much8
Like extremely9