Gamma irradiation improve post-harvest quality of tomato

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1. Introduction

Tomato is an important climacteric fruit, the consumption of which has increased rapidly worldwide [1]. However, tomato have a sensitive tissue structure that is susceptible to microbes and fungi, which can shorten fruit self-life and lead to economic losses due to infections. Therefore, postharvest treatment and storage management is very important for the quality of fresh horticultural [2,3]. Gamma irradiation technology has been using for quarantine of agricultural products to inactivate pathogens and insects. In this study, microbiological changes, decay rate and weight loss of gamma irradiated tomato (0, 150, 400, 600, 1000 Gy) were evaluated during storage (0, 5, 10, 15 days).

2. Methods and Results

2.1 Microbiological analysis

Non-irradiated and gamma-irradiated tomatoes were compared to evaluate the effect of gamma irradiation on microbial load [4]. The total number of aerobic microorganisms, yeasts, and molds were individually estimated by incubating on plate count agar and tartaric acid-supplemented potato dextrose agar.

Horticultural crops are sensitive to humidity and are susceptible to decay, which can easily increase contamination of pathogenic microorganisms [5]. Presence of microorganisms plays a decisive role in determining product marketability, and proper treatment methods are required to minimize the loss of microorganisms after harvest.

Table 1. Total aerobic microorganism populations (log CFU/g) of gamma irradiated tomato during storage

Dose (Gy)	Storage time (days)			
	0	5	10	15
0	ND	2.42 ± 0.35^{A}	2.87 ± 0.17^{AB}	3.28 ± 0.07^{BC}
150	ND	2.26 ± 0.51^{A}	2.72 ± 0.17^{AB}	3.20 ± 0.09^{BC}
400	ND	2.13 ± 0.38^{A}	2.70 ± 0.18^{AB}	3.14 ± 0.13^{BC}
600	ND	1.76 ± 0.66^{A}	2.63 ± 0.12^{AB}	3.12 ± 0.14^{C}
1000	ND	1.60 ± 0.56^{A}	2.50 ± 0.25^{B}	3.04 ± 0.06^{BC}

$^{A\text{–}C}$ The presence of the same letter in the same row means there are not significantly difference by tukey test.(P<0.05)
ND: not detected, detection limit less than <1 log CFU/g.
Measured values are represent as the average standard deviation (n=3).

Although no microorganisms were observed at any doses on the first day, the total number of aerobic microorganisms and yeast and mold increased during storage period. Gamma irradiation significantly reduced microorganism growth dose dependently at all storage time, which indicates gamma irradiation is the effective method to improve shelf-life of tomato. For this reasons, the FDA approved up to 4 kGy irradiation dose to enhance microbial safety and shelf-life of fruits and vegetables [6].

Table 2. Yeast and mold populations (log CFU/g) of gamma irradiated tomato during storage

Dose (Gy)	Storage time (days)			
	0	5	10	15
0	ND	2.59 ± 0.23^{bA}	3.20 ± 0.14^{cB}	3.49 ± 0.04^{bB}
150	ND	2.49 ± 0.19^{bA}	3.08 ± 0.15^{bcB}	3.43 ± 0.14^{bC}
400	ND	2.42 ± 0.14^{bA}	2.88 ± 0.17^{abB}	3.35 ± 0.10^{abC}
600	ND	2.34 ± 0.10^{bA}	2.84 ± 0.19^{abB}	3.27 ± 0.03^{aC}
1000	ND	1.58 ± 0.34^{aA}	2.68 ± 0.19^{aB}	3.26 ± 0.05^{aC}

$^{a\text{–}b}$ The presence of the same letter in the same column means there are not significantly difference by tukey test. (P<0.05)
$^{A\text{–}D}$ The presence of the same letter in the same row means there are not significantly difference by tukey test.(P<0.05)
ND: not detected, detection limit less than <1 log CFU/g.
Measured values are represent as the average standard deviation (n=3).

2.2 Decay

Loss of quality and commercial value due to microbial contamination during distribution and storage post-harvest is the biggest problem with fresh agricultural products. Tomato decay was estimated from the occurrence of necrotic local lesions or molds on the tomato surface [7]. One whole tomato was fixed on a black plate and changes in the surface after gamma irradiation were visualized using a digital camera.

Bacteria, yeasts, and molds cause rotting of tomato after harvest mainly by the fungus *Erwinia chrysanthemi* [8]. No decay occurred at any doses on day 0 of storage. Controls developed mold from the 5th day of storage, and the area of the black lesions around the tomato leaf increased with time. However, tomatoes showed less decay and softening with increase in irradiation dose during the storage period (Fig. 1). Thus, gamma irradiation is considered a safe and suitable treatment technique for controlling tomato decay during storage.

Dose (Gy)	Storage time (days)			
	0	5	10	15
0				
150				
400				
600				
1000				

Fig. 1. Photo of the decay changes of gamma irradiated tomato during storage at different dose.

2.3 Weight loss

Weight loss of tomatoes during 15 days of storage after gamma irradiation was determined using a digital balance and the results were determined [9] and calculated using Eq (1)

$$\text{Weight loss (\%)} = \left(\frac{W_1 - W_2}{W_1}\right) \times 100 \qquad (1)$$

where W1 = weight of tomato before gamma irradiation, W2 = weight of gamma-irradiated tomato after storage

Table 3. Weight loss (%) of gamma irradiated tomato during storage

Dose (Gy)	Storage time (days)			
	0	5	10	15
0	0.41±0.13^{A}	2.12±0.48^{B}	3.07±0.56^{bC}	3.89±0.38^{bC}
150	0.38±0.11^{A}	1.66±0.50^{B}	2.57±0.52^{abC}	3.59±0.27^{abD}
400	0.33±0.03^{A}	1.66±0.18^{C}	2.49±0.31^{abD}	3.50±0.43^{abE}
600	0.38±0.12^{A}	1.64±0.13^{B}	2.43±0.21^{abC}	3.51±0.31^{abD}
1000	0.33±0.04^{A}	1.50±0.15^{B}	2.26±0.21^{aC}	3.21±0.30^{aD}

$^{a-c}$The presence of the same letter in the same column means there are not significantly difference by tukey test. (P<0.05)
$^{A-F}$The presence of the same letter in the same row means there are not significantly difference by tukey test.(P<0.05).
Measured values are represent as the average standard deviation (n=5).

After harvesting, the tomatoes lose weight due to evaporation during storage and the forgery phenomenon (the peel becomes squarish), leading to decrease in freshness. Identical weight loss occurred at all doses on the 0th day of storage, but the weight loss increased at all doses with storage period. However, the weight loss of gamma-irradiated tomatoes was significantly different for all doses after 5 day of storage and decreased significantly with increasing doses.

Gamma irradiation with excessive doses increases the chances of collapse of tomato tissue. Therefore, extension of fruit life, quality, and safety occurs within a limited range of radiation, which does not damage tomato tissue structure after harvest [10]. From our result, up to 1000 Gy gamma irradiation might not affect tomato tissue damage, only decay changes increases the permeability of the outer pericarp, resulting in increased water loss [11].

3. Conclusions

Gamma irradiation was effective in decontaminating total aerobic microbes, yeast and molds, which suggests potential using to improve and maintain fruit hygiene. However, appropriate irradiation doses should be selected so as not to affect the quality of the fruit. Up to 1000 Gy of gamma irradiation to tomato did not collapse its tissue and significantly reduced decay, which lead decreased weight loss of tomato. Therefore, gamma irradiation is very effective methods for postharvest treatment and quarantine of tomato.

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