DOI : 10.5958/0974-0112.2016.00087.6

Indian J. Hort. 73(3), September 2016: 410-415

Effect of gamma irradiation and refrigeration on extending shelf-life of gherkin (*Cucumis anguria* L.)

Y. Bindiya[*], D. Srihari[**] and J. Dilip Babu[**]

College of Agriculture, Acharya NG Ranga Agricultural University, Rajendranagar, Hyderabad 500 030, Telangana

ABSTRACT

An experiment on gherkin (*Cucumis anguria* L.) was carried out at Post Harvest Technology Laboratory and Department of Horticulture, College of Agriculture, Rajendranagar, Hyderabad to study the effect of gamma irradiation and refrigeration with reference to shelf-life and quality. Benzyl adenine (BA) 50 ppm treated gherkin fruits were irradiated with different doses (0.1, 0.2, 0.3, 0.4, 0.5 and 0.6 kGy) of gamma rays and were kept in 100 gauge polythene bags of 0.25 per cent ventilation and stored at low temperature (10°C). The studies revealed that irradiation dose at 0.2 kGy recorded lower PLW and per cent of spoilage. The shelf-life was extended for 4 days when compared to control (BA 50 ppm treated fruits packed in 100 gauge polythene bag with 0.25 per cent ventilation without irradiation). The fruits of 0.2 kGy treatment were free from spoilage and retained good quality (TSS, titratable acidity, total sugars and ascorbic acid) and higher organoleptic score with a maximum shelf-life of 25.50 days.

Key words: Gamma irradiation, gherkin, low temperature storage, quality, shelf-life.

INTRODUCTION

Gherkin (*Cucumis anguria* L.) (2n = 24), commonly called as 'pickling cucumber' is an important cucurbitaceous vegetable crop. It is a monoecious, annual, trailing or climbing vine, which branches freely with slender, rough hairy, angled stems and tendrils. The fruits are 3 to 5 cm in length and oval to oblong in shape and born on long slender stalks. They are light green and turn yellowish when fully matured with or without spiky surface covered with long sharp glistering hairs. The immature fruits are used for the preparation of pickles, eaten as a cooked vegetable and are used in curries.

Irradiation is one of the important and recent processing technology, which has gained attention as an effective tool for assuring food safety by extending the shelf-life of many fruits and vegetables. Balock *et al.* (3) first introduced the idea of post harvest irradiation of fruits and its potential for disinfectations and prolongation of shelf-life. Irradiation proved to be extremely beneficial in terms of prolonging the fruit and vegetable shelf-life by 3-5 times (Arvanitoyannis *et al*., 2; Fan *et al*., 5). The present investigation was conducted to find out optimum dose of irradiation for extending shelf-life of gherkin fruits under cold storage conditions.

MATERIALS AND METHODS

The present study was conducted in the Post Harvest Technology Laboratory and Department of Horticulture, College of Agriculture, Rajendranagar, Hyderabad. The experiment was designed in completely randomized design with factorial concept and each treatment was replicated thrice. Same treatments were repeated for destructive sampling, for physiological and biochemical studies and all the treatments were conducted twice for confirmation of the results. The irradiation treatments (kGy) studied in the experiment were T_1 = 0.1, T_2 = 0.2, T_3 = 0.3, T_4 = 0.4, T_5 = 0.5, T_6 = 0.6 kGy & T_7 = control (no irradiation).

The fruits (5 cm in length) treated with BA 50 ppm were packed in 100 gauge polythene bag of 0.25 per cent ventilation and were subjected to different irradiation treatments. The experiment was carried out at low temperature (10°C). The shelf-life was studied at six day intervals. Observations such as physiological loss in weight, percentage of spoilage, shelf-life (days), total soluble solids, titrable acidity (%), total sugars (%), ascorbic acid (mg/100 g) and organoleptic score were recorded.

RESULTS AND DISCUSSION

The physiological loss in weight increased with increase in storage period (Table 1). The increase in PLW may be attributed to increased respiration and loss of water through transpiration. Further high humidity and relatively low temperature resulted in lower PLW. Among different irradiated treatments, fruits subjected to 0.2 kGy irradiation recorded the lowest PLW (5.83), while maximum was recorded

*Corresponding author's E-mail: bindiyaphdhort@yahoo.com
**Dr YSRHU, Venkataramannagudem 534 101, Tadepalligudem, West Godavari, Andhra Pradesh

Table 1. Effect of gamma irradiation on physiological loss in weight (%) of gherkin during storage.

Treatment (kGy)	1st year						2nd year					
	Days 1	7	13	19	Mean	25	1	7	13	19	Mean	25
0.1	0.31	4.18	8.27	11.16	5.98	13.88	0.28	4.20	8.38	11.28	6.04	13.96
0.2	0.24	4.00	8.05	10.91	5.80	13.52	0.22	4.02	8.15	11.03	5.86	13.60
0.3	0.27	4.07	8.14	11.04	5.88	13.64	0.24	4.10	8.26	11.15	5.94	13.73
0.4	0.36	4.26	8.40	11.22	6.06	14.97	0.33	4.31	8.47	11.35	6.12	14.05
0.5	0.40	4.42	8.46	11.36	6.16	*	0.39	4.49	8.51	11.48	6.22	*
0.6	0.43	4.50	8.52	11.56	6.25	*	0.42	4.53	8.57	11.63	6.29	*
Control	1.17	4.74	8.74	12.22	6.72	*	1.10	4.67	8.72	12.15	6.66	*
Mean	0.45	4.31	8.37	11.35			0.43	4.33	8.44	11.44		
$CD_{0.05}$												
Days (D)			0.053						0.045			
Treatment (T)			0.070						0.059			
D × T			0.140						0.119			

*Indicates termination of storage

with control (6.74). The lower PLW of irradiated fruits might be due to impairment of cellular functions and therefore decreased the respiration rate. The greater loss in weight of control fruits might be due to higher respiration. Beyond 0.2 kGy there was increase in PLW with increase in irradiation dose. From the present study, it was clear that 0.2 kGy is the optimum dose of irradiation. The results are in conformity with the findings of Hussain *et al*. (6).

The spoilage in gherkin due to gamma irradiation was found minimum in irradiated fruits over control (Table 2). Irradiation at higher doses beyond 0.3 kGy increased spoilage percentage. Among different irradiation treatments 0.2 kGy (5.71) recorded the minimum spoilage over the higher doses and maximum with control. This might be due to decrease in microbial load and reduced respiratory rate with the irradiation. Similar results were reported by Barkai-Golan (4), Silva *et al*. (10) and Hussain *et al*. (6). The shelf-life of the irradiated fruits was higher by 4 days compared with control (Table 3). Among different irradiation treatments, 0.2 kGy recorded

Table 2. Effect of gamma irradiation on percentage of spoilage of gherkin during storage.

Treatment (kGy)	1st year						2nd year					
	Days 1	7	13	19	Mean	25	1	7	13	19	Mean	25
0.1	0.00	0.00	0.00	25.33	6.33	65.33	0.00	0.00	0.00	25.66	6.42	65.66
0.2	0.00	0.00	0.00	22.66	5.67	62.33	0.00	0.00	0.00	23.00	5.75	62.33
0.3	0.00	0.00	0.00	24.66	6.17	64.33	0.00	0.00	0.00	25.00	6.25	64.66
0.4	0.00	0.00	0.00	30.33	7.58	73.33	0.00	0.00	0.00	31.33	7.83	72.33
0.5	0.00	0.00	0.00	36.00	9.00	83.66*	0.00	0.00	0.00	37.00	9.25	84.66*
0.6	0.00	0.00	0.00	42.00	10.50	84.33*	0.00	0.00	0.00	43.33	10.83	85.33*
Control	0.00	0.00	23.66	50.33	18.50	87.33*	0.00	0.00	25.33	52.66	19.50	88.33*
Mean	0.00	0.00	3.38	33.04			0.00	0.00	3.62	34.00		
$CD_{0.05}$												
Day (D)			0.306							0.308		
Treatment (T)			0.405							0.407		
D × T			0.811							0.815		

*Indicates termination of storage

Table 3. Effect of gamma irradiation on shelf-life (days) of gherkin during storage.

Treatment (kGy)	Shelf-life (days)	
	1st year	2nd year
	24.33	24.33
0.1	25.33	25.66
0.2	24.66	24.66
0.3	23.00	23.33
0.4	22.33	22.66
0.5	22.00	22.33
0.6	21.00	21.33
$CD_{0.05}$	0.396	0.400

highest shelf-life (25.50 days) over the higher doses. This might be due to decrease in microbial load and reduced respiratory rate with the irradiation. The results were in consonance with the findings of Barkai-Golan (4), Hussain *et al*. (6), Silva *et al*. (10) and Majeed *et al*. (8).

The total soluble solids (TSS) increased initially upto 13 days and later on decreased as the storage progressed (Table 4). The increase in TSS during the initial stages may be attributed to the conversion of starch and other polysaccharides into sugars. Ripening is normally accompanied by an increase in TSS with the increase in production of ethylene in fruits. Decrease in TSS at later stages may be due to high relative humidity and low temperature maintained in the cold storage unit results in rapid utilization of soluble fraction as respiratory substrate. Fruits subjected with gamma rays recorded higher TSS over control. The maximum TSS was recorded in fruits treated with 0.2 kGy (4.88). These findings are in accordance with Hussain *et al*. (7) in pear and Singh and Sudhakar Rao (11) in papaya. Contrary to this, Serranosintes *et al.* (9) in mandarin reported that with increase in irradiation dose there was decrease in TSS compared to control.

The titrable acidity in gherkin as influenced by gamma irradiation during storage are presented in Table 5. Decrease in acidity after treatment was observed during storage. The decrease in acidity in fruits might be due to utilization of organic acids in respiration and conversion of acids to sugars. Further changes in acidity may be connected with changes in the mechanism of respiratory process and ripening. However, the fruits subjected to irradiation retained more acidity over control during storage. The higher titrable acidity recorded with 0.2 kGy irradiated fruits may be because of delay in the fruit ripening. Similar results were reported by Vieites *et al.* (12) in melon fruits. Contrary to the above findings no significant alteration in titrable acidity was observed due to irradiation as reported by Serranosintes *et al.* (9) in mandarin. Total sugars decreased as the storage period increased (Table 6). The decrease in total sugars may be attributed to their utilization in respiration. Among all irradiated treatments, 0.2 kGy dose recorded the highest (1.92) total sugars over all the other treatments. Irradiation of fruits might have resulted in increase in sugars by conversion of starch to sugar by hydrolysis. Concurrent results were obtained by Hussain *et al*. (10), and Singh and Sudhakar Rao (11).

Table 4. Effect of gamma irradiation on total soluble solids (°Brix) of gherkin during storage.

Treatment (kGy)	Day	1st year						2nd year					
		1	7	13	19	Mean	25	1	7	13	19	Mean	25
0.1		4.67	4.77	4.87	4.77	4.77	4.53	4.70	4.83	4.93	4.80	4.82	4.60
0.2		4.73	4.87	4.97	4.87	4.86	4.67	4.77	4.90	5.00	4.90	4.89	4.70
0.3		4.70	4.83	4.93	4.83	4.82	4.57	4.77	4.90	4.97	4.87	4.88	4.63
0.4		4.70	4.80	4.83	4.60	4.73	4.33	4.77	4.87	4.90	4.67	4.80	4.40
0.5		4.67	4.77	4.80	4.53	4.69	*	4.73	4.83	4.90	4.63	4.77	*
0.6		4.63	4.73	4.80	4.53	4.67	*	4.70	4.80	4.87	4.60	4.74	*
Control		4.63	4.70	4.73	4.40	4.61	*	4.70	4.77	4.80	4.49	4.69	*
Mean		4.68	4.78	4.85	4.65			4.73	4.84	4.91	4.71		
$CD_{0.05}$													
Day (D)				0.023						0.030			
Treatment (T)				0.030						0.039			
D × T				0.060						0.078			

*Indicates termination of storage

Table 5. Effect of gamma irradiation on titrable acidity (%) of gherkin during storage.

Treatment (kGy) Day	1st year						2nd year					
	1	7	13	19	Mean	25	1	7	13	19	Mean	25
0.1	0.242	0.233	0.230	0.223	0.232	0.215	0.248	0.238	0.235	0.229	0.238	0.221
0.2	0.242	0.238	0.236	0.231	0.237	0.224	0.248	0.242	0.239	0.235	0.241	0.229
0.3	0.242	0.237	0.235	0.227	0.235	0.220	0.248	0.240	0.238	0.233	0.240	0.226
0.4	0.242	0.233	0.229	0.222	0.232	0.214	0.246	0.237	0.233	0.227	0.236	0.219
0.5	0.242	0.232	0.228	0.219	0.230	*	0.246	0.236	0.231	0.225	0.235	*
0.6	0.242	0.232	0.226	0.218	0.230	*	0.246	0.236	0.230	0.223	0.234	*
Control	0.242	0.228	0.220	0.212	0.226	*	0.246	0.232	0.224	0.219	0.230	*
Mean	0.242	0.233	0.229	0.222			0.247	0.237	0.233	0.227		
$CD_{0.05}$												
Day (D)	0.0010						0.0009					
Treatment (T)	0.0013						0.0012					
D × T	0.0027						0.0025					

*Indicates termination of storage

Table 6. Effect of gamma irradiation on total sugars (%) of gherkin during storage.

Treatment (kGy) Day	1st year						2nd year					
	1	7	13	19	Mean	25	1	7	13	19	Mean	25
0.1	2.25	1.91	1.67	1.39	1.81	1.05	2.32	1.98	1.74	1.47	1.88	1.13
0.2	2.25	1.97	1.77	1.48	1.87	1.18	2.33	2.05	1.87	1.59	1.96	1.29
0.3	2.25	1.91	1.65	1.37	1.80	1.01	2.33	2.00	1.80	1.46	1.90	1.10
0.4	2.25	1.89	1.63	1.36	1.78	0.98	2.32	1.96	1.70	1.44	1.86	1.06
0.5	2.25	1.86	1.61	1.34	1.77	*	2.32	1.93	1.68	1.43	1.84	*
0.6	2.25	1.85	1.59	1.35	1.76	*	2.32	1.92	1.66	1.42	1.83	*
Control	2.25	1.70	1.44	1.20	1.65	*	2.32	1.80	1.50	1.30	1.73	*
Mean	2.25	1.87	1.62	1.36			2.32	1.95	1.71	1.44		
$CD_{0.05}$												
Day (D)	0.014						0.016					
Treatment (T)	0.020						0.021					
D × T	0.040						0.042					

*Indicates termination of storage

The ascorbic acid content of fruits decreased significantly during storage (Table 7). The decrease in ascorbic acid content in storage might be due to degradation of ascorbic acid to dehydroascorbic acid by oxidative enzymes. In the present experiment, the highest content of ascorbic acid was recorded with 0.2 kGy (5.63) and lowest with control. The ascorbic acid content increased upto 0.2 kGy and further increase in dose of irradiation decreased the ascorbic acid content. This could be due to sensitivity of ascorbic acid to ionizing radiation and the ascorbic acid converted to dehydro-ascorbic acid, which is highly unstable. The results are in consonance with the findings of Wong and Kitts (13) and Vieites *et al*. (12). In contrary result was noted by Serranosintes *et al*. (9) on mandarin. With the progress in the storage period, there was decrease in the organoleptic score in all the irradiated treatments (Table 8). The highest organoleptic score was observed in fruits treated with 0.2 kGy (8.96). It might be due to retention of moisture, which prevented shriveling and ripening of gherkin fruits. Further the irradiation beyond 0.2 kGy decreased organoleptic score due to browning and also due to decrease in quality parameters.

Table 7. Effect of gamma irradiation on ascorbic acid content (mg/100 g) of gherkin during storage.

Treatment (kGy) Day	1st year						2nd year					
	1	7	13	19	Mean	25	1	7	13	19	Mean	25
0.1	5.89	5.70	5.35	5.07	5.50	4.84	5.96	5.78	5.44	5.18	5.59	4.94
0.2	5.89	5.74	5.48	5.20	5.58	5.02	5.96	5.83	5.59	5.32	5.68	5.11
0.3	5.89	5.72	5.40	5.11	5.53	4.91	5.96	5.79	5.48	5.21	5.61	4.99
0.4	5.89	5.68	5.27	4.94	5.45	4.80	5.96	5.75	5.35	5.04	5.53	4.79
0.5	5.89	5.66	5.23	4.87	5.41	*	5.96	5.73	5.30	4.96	5.49	*
0.6	5.89	5.64	5.19	4.82	5.39	*	5.96	5.72	5.28	4.93	5.47	*
Control	5.89	5.61	5.11	4.72	5.33	*	5.96	5.66	5.16	4.79	5.39	*
Mean	5.89	5.68	5.29	4.96			5.96	5.75	5.37	5.06		
$CD_{0.05}$												
Day (D)	0.029						0.038					
Treatment (T)	0.039						0.051					
D × T	0.079						0.101					

*Indicates termination of storage

Table 8. Effect of gamma irradiation on organoleptic score of gherkin during storage.

Treatment (kGy) Day	1st year						2nd year					
	1	7	13	19	Mean	25	1	7	13	19	Mean	25
0.1	10.00	9.00	8.33	7.00	8.58	6.00	10.00	8.66	8.00	7.00	8.42	6.00
0.2	10.00	9.33	8.66	7.66	8.91	6.33	10.00	9.66	8.66	7.66	9.00	6.66
0.3	10.00	9.00	8.33	7.33	8.67	6.00	10.00	9.00	8.00	7.00	8.50	6.33
0.4	10.00	8.33	7.66	6.66	8.16	5.33	10.00	8.33	7.33	6.33	8.00	5.66
0.5	10.00	8.00	7.33	6.33	7.92	*	10.00	8.33	7.00	6.00	7.83	*
0.6	10.00	8.00	7.00	6.00	7.75	*	10.00	8.00	7.00	6.00	7.75	*
Control	10.00	7.33	6.00	5.00	7.08	*	10.00	7.33	6.33	5.00	7.17	*
Mean	10.00	8.43	7.62	6.57			10.00	8.47	7.47	6.43		
$CD_{0.05}$												
Day (D)	0.077						0.154					
Treatment (T)	0.102						0.203					
D × T	0.205						0.406					

*Indicates termination of storage

In conclusion, the present study revealed that Gamma irradiation at 0.2 kGy recorded lower PLW, spoilage percentage, higher shelf-life (25.50 days), higher values of biochemical parameters (TSS, titrable acidity, ascorbic acid, total sugars) and organoleptic scores.

REFERENCES

1. Anon, 1975. Gherkins (*Cucumis sativus* L.). *Farm Digest,* **1-3**: 6-8.

2. Arvanitoyannis, I.S., Stratakos, A.C. and Tsarouhas, P. 2009. Irradiation applications in vegetables and fruits: a review. *Critical Rev. Food Sci. Nutr.* **49**: 427-62.

3. Balock, J.W., Chistenson, L.D. and Burr, G.O. 1956. Effect of gamma rays from cobalt 60 on immature stages of oriental fruitfly (*Dacus doralisttindel*) and possible application to commodity treatment problems. *Acad. Sci.* pp. 18.

4. Barkai-Golan, R. 2001. *Postharvest Diseases of Fruits and Vegetables: Development and Control*, Elsevier Science BV, 418 p.

5. Fan, X.T., Niemira, B.A. and Prakash, A. 2008. Irradiation of fresh fruits and vegetables. *Food Tech. Chicago*, **62**: 36-42.

6. Hussain, P.R., Meena, R.S., Dar, M.A. and Wani, A.M. 2008. Studies on enhancing the keeping quality of peach (*Prunus persica* Bausch) cv. Elberta by gamma irradiation. *Radiat. Phys. Chem*. **77**: 473-81.

7. Hussain, P.R., Meena, R.S., Dar, M.A. and Wani, A.M. 2010. Carboxymethyl cellulose coating and low-dose gamma irradiation improves storage quality and shelf-life of pear (*Pyrus communis* L. cv. Barlett/William). *J. Food Sci.* **75**: 586-96.

8. Majeed, A., Muhammad, Z., Majid, A., Shah, A.H. and Hussain, M. 2014. Impact of low doses of gamma irradiation on shelf-life and chemical quality of strawberry (*Fragaria* x *ananassa*) cv. 'Corona'. *J. Animal Plant Sci.* **24**: 1531-36.

9. Serranosintes, G., Garcia Arteage, A., Gorcia Yanez, M., Smapere Diaz, E., Fernandez Miranda, J. and Castillo Rodriguez, E. 1990. Stability of vitamin C content and some chemical indicators in gamma irradiated mandarins. *Revista Cubuna de Alimentaction Y Nutrition*, **4**: 7-14.

10. Silva, J.M., Correia, L.C.S.A., Moura, N.P., Salgado, P.L., Maciel, M.I.S. and Villar, H.P. 2009. Sensorial analysis of strawberry submitted to the technology of ionizing radiation. *Acta. Hort.* **842**: 863-66.

11. Singh, S.P. and Sudhakar Rao, D.V. 2005. Quality assurance of papaya by shrink film wraping during storage and ripening. *J. Food Sci. Tech.* **42**: 523-25.

12. Vieites, R.L., Evangelista, R.M. and Silva, A.P., da. 2000. Gamma radiation for retaining quality in minimally processed melon. *Cultura Agron.* **9**: 101-14.

13. Wong, P.Y.Y. and Kitts, D.D. 2001. Factors influencing ultraviolet and electron beam irradiation induced free radical damage of ascorbic acid. *Food Chem*. **74**: 75-84.

Received : January, 2014; Revised : April, 2016;
Accepted : June 2016