JOURNAL OF PURE AND APPLIED MICROBIOLOGY, Sept. 2015. Vol. **9**(3), p. 2145-2152

Analysis of Nutritional Quality of Peach to Increase Shelf Life by using Gamma Radiation (COBALT-60)

Uzma Waheed* and Shagufta Naz

Department of Biotechnology, Lahore College for Women University, Lahore, Pakistan.

(Received: 04 April 2015; accepted: 20 June 2015)

Present study was conducted to examine the effect of gamma radiation on nutritional quality and shelf life extension of peaches. Peach "Swat local variety No. 4" samples were radiated with Cobalt-60 Doses 0.25, 0.5 and 0.75 kGy and different parameters such as % age of weight loss, moisture loss, ash content, crude fiber, crude fat, total soluble solids (TSS), pH and titratable acidity were studied. It was found that 0.75 kGy was an effective dose to increase the shelf life of peaches to three weeks at refrigerated temperature. It was expected that this technique affect's the Pakistan economy in a positive sense. Moreover, it could help to overcome quarantine barriers by enhancing lifespan of peaches.

Key words: Nutritional quality, Peach, Shelf life, Gamma radiation.

The peach (*Prunus persica L.*) is indigenous to China, and reached the world by the route of Persia therefore its Latin name means "Persian plum". In Pakistan, it is the second most vital stone fruit and produces 52.6 tons of peaches among which 30.8 tons in Khyber Pakhtoonkhwa, 0.4 tons grown in Punjab and 21.4 tons in Balochistan (Pakistan Bureau of Statistics, 2011). Peach is enriched with vitamin, fiber, potassium, niacin, organic acids, aromatic (volatiles) sugar and phenolics. Almost 100 volatile compounds have been known in peaches including alcohol, alkanes, esters, ketones, and terpenes. Lactones are organoleptically important in peach flavor (Jiang and Song, 2010).

The post harvest losses of peaches are mainly occur due to non removal of field heat, unhygienic issues, mismanagement during packaging, improper transport and storage conditions, distant and time consuming market distribution (Kader, 2002). Other quarantine barriers are susceptiblily of peaches to microbial spoilage such as pest *Grapholita molesta* and fungi e.g., *Rhizopus stolonifer, Monilinia fructicola, Botyris cinerea, Alternaria alternate, Penicillium expansum, Aspergillus niger, Mucor priformis.* The major physiological causes of deterioration are chilling injury manifest as mealy, soft textured fruit, flesh bruising, flesh dryness, woolly, leatheriness, pit cavity browning and Inking (black staining) which occurs as a consequence of abrasion harm in combination with heavy metal (copper, iron and aluminum) contagion. In NWFP, it is estimated that 18 % age to 31 % age losses occur due to lack of postharvest treatment; from bulk of the total losses 77 % age at picking stage and 23 % age during transportation (Khan *et al.*, 2013).

FAO/IAEA/WHO declared that gamma radiation can be used for preservation if maintaining nutritive values of foods (WHO, 1999). As gamma radiation has effect on cellular

* To whom all correspondence should be addressed.
E-mail: uzma.waheed22@yahoo.com

metabolism. It delays the ripening of peaches by decreasing respiratory activity and ethylene synthesis (Solano *et al*., 2004). In International trade the alternative method to methyl bromide to overcome quarantine barriers is radiation. (McDonald et al., 2012; Hong *et al*., 2008; Teets et al., 2008; Hallman 2000; Lacroix and Ouattara 2000). According to McDonald et al. (2012), commercial scale radiation of six peach varieties (Encore, Blaze Prince, July Prince, Red Globe, Flame Prince and August Lady) at targeted dose of 0.4 kGy increase the shelf life and enhanced the ripening process; however, this was thought as encouraging change by the consumers. Kim *et al.* (2009) reported that peach varieties respond differently to radiation, but the greatest impact seems to be on firmness. Hussain *et al*. (2008) observed a dose dependent loss of firmness and enhancement in anthocyanin accumulation of Elberta peaches radiated at doses between 1and 2 kGy.

So, the aim of present study was to reduce the post harvest losses by using gamma radiation Cobalt-60 and comparison of nutritional quality of control and radiated peach samples.

MATERIALS AND METHODS

The facility of gamma radiation Cobalt-60 was provided by Pakistan Radiation Services (PARAS); a subsidiary organization of Pakistan Atomic Energy Commission and further experiment of Proximate analysis was conducted at Biotechnology Laboratory of Lahore College for Women University, Pakistan.

Raw material preparation:

Fresh mature peach fruit was collected from Lahore Whole sale Market. The fruit was cooled at 2°C for 24 hours in a cold storage chamber. The precooled fruit was manually graded and packed in polythene bags each containing 10 fruit.

Gamma Radiation

The precooled and packaged fruit was subjected to gamma radiation in the range of 0.25 - 0.75 kGy using a PANBIT radiator having Co-60 as the gamma-ray source. The fruit was radiated at a mean dose rate of 195 Gy/h. The dose rate was determined by Fricke dosimetry. After radiation, the fruit was kept under refrigerated (temp.3 ± 1 °C, RH 80%) storage condition and periodically evaluated for physico-chemical parameters.

Sensory Evaluation

Control and radiated Peach samples were placed on white sheet. Texture firmness and flavor observed on weekly basis with the help of 9-Hedonic scale by trained panel of 5 judges. The values of Texture firmness is obtained from 9-hedonic scale such as: Dislike extremely (1). Dislike very much (2). Dislike moderately (3). Dislike slightly (4). Neither like nor dislike (5). Like slightly (6). Like moderately (7). Like very much (8). Like extremely (9). The testing was done in a place free from irrelevant odour and sound. The Panel was restricted from talking during procedure.

Determination of Moisture Content

5 grams of peach (flesh) sample was taken in a pre-weighed petriplate and placed in hot air oven at 70 °C for 4 hour. The method was repeated until obtained a constant weight.

% age Moisture = (Weight of sample lost / Total weight of sample taken) x 100

Ash test

Five gram of peach sample was taken in a pre-weighed crucible and then placed in Muffle furnace for 5 hours. The temperature was set at 550 °C temperature. The heating was continued till obtaining white ash. After achieving constant weight, the amount of ash was determined by the following formula:

Ash % age = weight of ash / weight of sample x 100

Total soluble solids (TSS)

The Total soluble solids was determined with the help of digital ATAGO hand refractometer (°Brix meter). (A.O.A.C.,1996) method no. 932.12

Titratable acidity

In a beaker 10 g of Peach sample was taken, it was blended and diluted with 40 ml of distilled water. After dilution, shift the sample solution in a flask and titrated against 0.1 N sodium hydroxide (NaOH) solution till pH stabilized to 8.2. The reading of volume of base used was noted. The acidity was calculated by the following equation.

% age Titratable acidity = $[V_b \times N_b \times E_a] / [V_a \times V_s] \times 100$

V_b = volume of base used,

N_b = normality of base,

E_a = equivalent weight of malic acid,

V_a = volume of aliquot taken,
V_s = weight of sample taken
(A.O.A.C., 1996) method no. 942.15.

TSS / acid ratio

TSS / acid ratio was estimated by typical method as described in AOAC (1984).

TSS/acid ratio = Total soluble solids / Total acidity

Determination of Crude Fat (Soxhlet Method)

Two to three grams of Peach dried sample was taken into a pre-weighed thimble. In a soxhlet apparatus the extraction was carried out for 6 hours with 500 ml of ethanol.

Fat % age = [loss in weight (g) / weight of sample] x 100

Determination of Crude Fiber

1 g of Peach defatted sample was taken in reflux flask and 100 ml of 1.25 % age H_2SO_4 was added in sample and refluxed for half an hour. The sample solution was filtered with silky cloth and washed with 200 ml of hot distilled water. Then the filtrate was again refluxed with 1.25 % age NaOH for half an hour. Sample solution was washed with 200ml of hot distilled water on pre-weighed Whatman filter paper. The filtrate was dried in an oven and weighed it. After drying, filtrate was ignited at low flame & then placed in muffle furnace at 500 to 550°C until filtrate become ash.

% age of fiber = weight of sample (g) - loss in weight (g) / weight of sample.

pH determination

The pH was monitored by using a digital pH meter. In order to determine the pH of sample its juice was prepared in a blender. The electrode was dipped in a juice and when the reading get stabilized it was noted from the pH meter.

(A.O.A.C., 1996 method no. 981.12)

Fruit decay percentage

In each treatment, the decayed fruits were counted to calculate decay percentage. Decay percentage was calculated as:

Decay percentage = $N_d / N_t \times 100$

Where N_d = number of decayed peaches; N_t = total number of peaches

Percent weight loss

Recorded the data of initial weight of peach fruit and compared it with weight of peaches at each interval on weekly basis.

% age Wt loss = [(Initial weight - Weight at specific interval / Initial weight) x 100

Statistical Analysis

The data generated from this study were analyzed through one way analysis of variance (ANOVA) and the treatment's means were compared for significance by Duncan's new multiple range test (DNMR) at 0.05 % age using COSTAT computer software (Chase and Brown, 1997).

RESULT AND DISCUSSION

Sterilization by using gamma radiation was a technique used to maximize safety and quality standard of fruits. Low doses delay the ripening process and extend the shelf life whereas high doses effective for disinfestations and reduces microbial spoilage as well as pathogens.

World health organization (WHO) and United state Food and Drug Administration (USFDA) considered it as "SAFE AND WHOLESOME". It had also been approved by FDA for more than 50 years that gamma radiation below 1 kGy for fruit was not harmful. Most commonly used radionuclide was cobalt-60. According to literature, ash and moisture contribute in the mass of fruit (Ranganna, 1986).

The sensory attributes in Table 1 (a) were decided according to the size, color, shape of peach, flesh type, flesh firmness and stone shape. Similar qualities of peaches were also mentioned in (Daniel *et al.*, 2013) in detail. The trend of Moisture content in Table 1 (b) moved towards decreasing direction

Table 1(a). Peach Sensory Attributes

Ground color	Extend of over color	Peach Size	Peach shape	Flesh type	Flesh color	Anthocyanin coloration of flesh	Stone shape	Stone relief of surface	Flesh to stone adherence
Orange yellow	Slight to medium	Medium	Ovate	Melting	Yellow	Faint in the whole flesh	Round	Pits and grooves	Clingstone

Table 1 (b). Parameters for Proximate Analysis of Peach Samples

Doses of Gamma Radiation	Parameters Moisture g /100 g	Ash g /100 g	Fat g /100 g	Fiber g /100 g	TA g /100 g	TSS (Brix°)	pH
Control							
Week- 1	90.8 ± 0.006 [d]	0.2 ± 0.006 [b]	0.20 ± 0.004 [a]	0.60 ± 0.006 [b]	0.70 ± 0.006 [c]	7.3 ± 0.06 [a]	4.11 ± 0.009 [a]
Week- 2	89.09 ± 0.006 [c]	0.34 ± 0.02 [d]	0.1 ± 0.006 [c]	0.5 ± 0.004 [b]	0.65 ± 0.008 [b]	7.0 ± 0.07 [a]	4.12 ± 0.003 [a]
Week- 3	83.0 ± 0.2 [d]	0.4 ± 0.008 [d]	0.07 ± 0.005 [c]	0.32 ± 0.006 [d]	0.34 ± 0.01 [c]	6.0 ± 0.02 [c]	4.13 ± 0.006 [a]
0.25 kGy							
Week- 1	91.6 ± 0.03 [b]	0.2 ± 0.01 [b]	0.15 ± 0.006 [c]	0.62 ± 0.002 [a]	0.89 ± 0.01 [a]	5.2 ± 0.01 [b]	3.85 ± 0.003 [b]
Week- 2	90.96 ± 0.07 [b]	0.4 ± 0.01 [c]	0.12 ± 0.01 [bc]	0.49 ± 0.002 [b]	0.75 ± 0.01 [ab]	6.0 ± 0.006 [b]	4.04 ± 0.003 [b]
Week- 3	85.0 ± 0.05 [c]	0.6 ± 0.02 [c]	0.08 ± 0.004 [bc]	0.37 ± 0.009 [c]	0.71 ± 0.006 [ab]	8.4 ± 0.01 [a]	4.11 ± 0.009 [b]
0.5 kGy							
Week- 1	91.2 ± 0.04 [c]	0.4 ± 0.02 [a]	0.20 ± 0.006 [a]	0.61 ± 0.005 [b]	0.85 ± 0.008 [ab]	4.0 ± 0.02 [c]	3.80 ± 0.008 [c]
Week- 2	88.85 ± 0.008 [d]	0.6 ± 0.008 [b]	0.14 ± 0.004 [ab]	0.57 ± 0.006 [a]	0.81 ± 0.02 [a]	5.3 ± 0.03 [c]	4.02 ± 0.007 [c]
Week- 3	88.0 ± 0.01 [b]	0.72 ± 0.01 [b]	0.10 ± 0.006 [ab]	0.49 ± 0.002 [b]	0.77 ± 0.02 [a]	7.5 ± 0.006 [b]	4.08 ± 0.002 [c]
0.75 kGy							
Week- 1	92.2 ± 0.06 [a]	0.4 ± 0.008 [a]	0.17 ± 0.008 [b]	0.62 ± 0.008 [a]	0.76 ± 0.02 [bc]	2.9 ± 0.03 [d]	3.68 ± 0.006 [d]
Week- 2	92.0 ± 0.01 [a]	0.8 ± 0.006 [a]	0.16 ± 0.002 [a]	0.58 ± 0.009 [a]	0.70 ± 0.06 [ab]	4.0 ± 0.02 [d]	3.76 ± 0.006 [d]
Week- 3	91.4± 0.006 [a]	1.0 ± 0.006 [a]	0.12 ± 0.01 [a]	0.50 ± 0.04 [a]	0.65 ± 0.008 [b]	5.5 ± 0.04 [d]	3.93 ± 0.006 [d]

in all the control and irradiated samples. This loss in moisture content was responsible for shrinkage. similar trend was also observed in this article (Rodríguez *et al.*, 1999). Increase value of ash content was responsible for less microbial attack. Similar trend of increase in the ash content was also found in (Zaman *et al*, 2013). The decrease in titratable acidity in Table 1 (b) was due to the use of organic acid as respiratory substrate. Results were same as described by (McDonald *et al.*, 2012). In radiated samples, increase in TSS value was due to slow ripening process. The ratio of total soluble solid /titratable acidity was responsible for specific flavor and ripeness of peaches. During ripening stage TSS/ TA ratio was low. The reason was at the ripening stage it had high acidity and low sugar content So, the fruit had tartness in its flavor. As the storage period increases, the TSS / TA ratio reached to higher level because peach acidic flavor started degrading. Over ripe peach had low level of acids and therefore lack characteristic flavor (Tavarini *et al.*, 2008).

TSS was responsible for physiological change due to respiration and production of ethylene such as softening of pulp, dissolution of starch, ingredient of solubility solidity, increase of sweet taste and volatile flavor components, decrease of organic acid, etc. Table 1 (b) parameter shows that contents of total soluble solid are directly proportional to after ripening. Analysis indicated that TSS content of peaches showed a linear trend in irradiation dose level and storage time (Kim *et al.*, 2009). According to Table 1 (b) the fiber content in Peaches was decreases because carbohydrate burns out with the increase in storage period.

The decay percentage in Fig 3 of control sample was 16 % in week 1 while 0.25, 0.5 and 0.75 kGy treated samples showed no decay in this week. In week 2, control samples were 50 % decayed while 0.75 kGy exhibited minimum decay of 10 %. Moreover, this Decay % of 0.25, 0.5 and 0.75 kGy peach samples remained on increasing in third week expressing the values as 80, 60 and 30 %

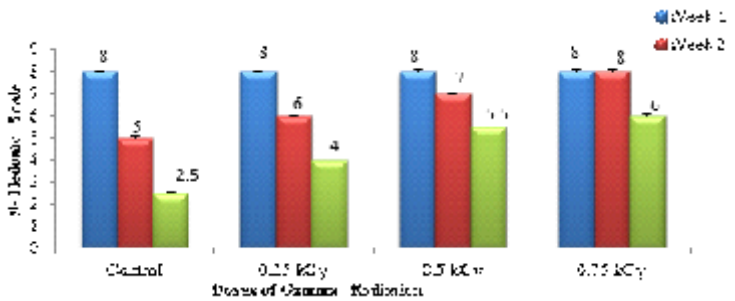

Fig. 2. The values of Texture firmness is obtained from 9- hedonic scale such as: Dislike extremely (1). Dislike very much (2). Dislike moderately (3). Dislike slightly (4). Neither like nor dislike (5). Like slightly (6). Like moderately (7). Like very much (8). Like extremely (9).

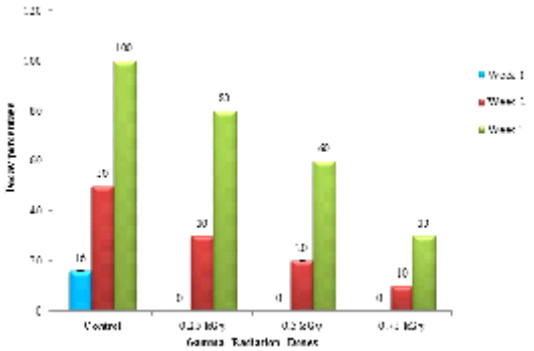

Fig. 3. Decay % age of peaches during storage at refrigerated temperature

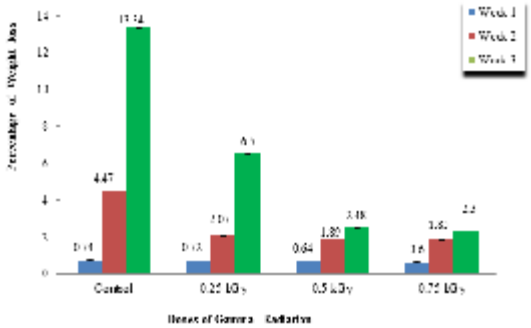

Fig. 4. Percentage of weight loss of Peaches

respectively, whereas the Control peach samples were fully harmed by microbial spoilage. The results were similar to the literature (Hussain *et al.*, 2011).

The % age weight loss of peaches as shown in **Fig 4** of 0.25, 0.5 0.75 kGy radiated peach samples slightly increases with the passage of time due to combined effect of respiration and transpiration according to the literature (McDonald *et al.*, 2012). This reduction of weight loss in peaches was treated with radiation because of the effect of treatment on the respiration rate and in delaying the process of senescence (Hussain *et al.*, 2010; Lester and Whitaker, 1996).

The softness and shrinkage in texture as shown in Fig 2 (a) , (b) , (c) and (d) was occurred as protopectinase degrade macromolecules i.e., cellulose, hemicelluloses and lignin etc that reduces the cohesive forces between cells.

Fig 2 (a) Week 3 Texture Analysis of Control Sample (b) Week 3 Texture Analysis of 0.25 kGy Radiated sample
(c) Week 3 Texture Analysis of 0.5 kGy Radiated Sample (d) Week 3 Texture Analysis of 0.75 kGy Radiated sample

Fig 3 (a) Week 3 % age Decay of Control Sample (b) Week 3 % age Decay of 0.25 kGy Radiated sample
(c) Week 3 % age Decay of 0.5 kGy Radiated Sample (d) Week 3 % age Decay of 0.75 kGy Radiated sample

(Somogyi and Romani, 1964) also described that decrease in firmness was due to decrease in protopectin content and increase in pectin and pectate fractions of the fruit. Texture analysis also showed that 0.75 kGy high dose gamma radiated peaches remained firm for longer time as compared to control sample and exhibited the shelf life of three weeks.

CONCLUSION

The present study demonstrates a simple and efficient method for sterilization of peaches and 0.75 kGy was considered as an ideal dose because shelf life extend up to a period of three weeks. Moreover, it could overcome the quarantine barriers associated with peach export from Pakistan.

ACKNOWLEDGEMENTS

I have the honor to express my heartiest tribute to my research supervisor Prof. Dr. Shagufta Naz, Head of Biotechnology Department, Lahore College for Women University, Lahore. I am also thankful to Pakistan Radiation Services (PARAS); a subsidiary organization of Pakistan Atomic Energy Commission for radiating my peach samples during my research.

REFERENCES

1. A.O.A.C., Official Methods of Analysis. 14th ed. Association of Official Analytical Chemists, Washington, 1984: D.C, U.S.A
2. A.O.A.C. Association of Official Agricultural Chemists. Official Methods of Analysis. Benjamin Franklin Station, Washington, 1996: D.C., U.S.A.
3. Daniela, G., Alessandro, L., Daniele, B., and Marc, L., ECPGR Priority Descriptors for Peach (*Prunus persica*) *Draft Version*, 2013: **1**.
4. Somogyi, L. and Romani, R. Irradiation induced textural change in fruits and its relation to pectin metabolism. *Food science and technology international*, 1964; **29**: 366-371.
5. Chase, W., Brown, F., Gosavi, A. and Das, T. General Statistics. *IIE Transactions*, 1997; **29**: 799.
6. Hallman, G., Expanding radiation quarantine treatments beyond fruit flies. *Agric Forest Entomo*, 2000; **2**: 85–95.
7. Hong, Y. H., Park, J. Y., Park, J. H., Chung, M. S., Kwon, K. S., Chung, K., Inactivation of Enterobacter SakaZakii, Bacillus cereus and Salmonella typhi- murium in powdered weaning food by electron beam irradiation. *Rad Phy Chem*, 2008; **77**: 1097–1100.
8. Hussain, P. R., Meena, R. S., Dar, M. A. and Wani, A. M. Radiation Processing of Temperate Fruits of Kashmir Valley, 2011; 1-9.
9. Jiang, Y. and Song, J. Fruits and Fruit Flavor: Classiûcation and Biological Characterization. *Handbook of fruit and vegetable flavors*, 2010; **1**.
10. Kader, A. Standardisation and inspection of fresh fruits and vegetables. *Postharvest Technology of Horticultural Crops*, 2002; 287–299
11. Khan, A., Shaukat, S. and Khatoon, N. Phytonematodes associated with peach (*Prunus persica L.*) seedlings in Balochistan, Pakistan. *Pakistan Journal of Nematology*, 2013; **31**: 153-156.
12. Kim, K.-H., Kim, M.-S., Kim, H.-G. and Yook, H.-S. Inactivation of contaminated fungi and antioxidant effects of peach (Prunus persica L. Batsch Danger) by 0.5–2 kGy gamma irradiation. *Radiation Physics and Chemistry*, 2009; **79**: 495-501.
13. Kim, M. S., Kim, K. H., Yook, H. S., The effects of gamma irradiation on the microbiological, physicochemical and sensory quality of peach (*Prunus persica* L. Batsch Cv. Dangeumdo). *J Korean Soc Food Sci Nutr*, 2009; **38**: 364 – 371.
14. McDonald, H., Caporaso, M., Winborne, I., Oubichon, M., Rakovski, C., Parakash, A. and Commer, Y. Commercial scale irradiation for insect disinfestation preserves peach quality. *Radiation Physics and Chemistry*, 2012; **81**: 697-704
15. Peach. Pakistan Bureau of Statistics, *Agricultural Statistics of Pakistan, Government of Pakistan Statistics Division.*, 2011; **95**.
16. Rodríguez, M.-J., Villanueva, M.-J. and Tenorio, M.-D. Changes in chemical composition during storage of peaches (*Prunus persica*). *European Food Research and Technology*, 1999; **209**: 135-139.
17. Solano, M., Bel, S., Olmos, E., Hellin, E., Romojaro, F. and Madrid, M. Ionization of Fruits and Vegetables for Fresh Consumption, Springer, 2004; pp.69-70.
18. Ranganna, S. Handbook of analysis and quality control for fruit and vegetable products, Tata McGraw-Hill Education, 1986; pp. 1
19. Tavarini, S., Degl'Innocenti, E., Remorini, D., Massai, R. and Guidi, L. Preliminary characterisation of peach cultivars for their

antioxidant capacity. *International journal of food science & technology*, 2008; **43**: 810-815.

20. World Health Organization (WHO). High-dose irradiation: wholesomeness of food irradiated with doses above 10 kGy. Report of a Joint FAO/IAEA/WHO Technical Report Series N_890; 1999.

21. Zaman, A., Ihsanullah, I., Shah, A., Khattak, T., Gul, S. and Muhammad zai, Combined effect of gamma irradiation and hot water dipping on the selected nutrients and shelf life of peach. *Journal of Radioanalytical and Nuclear Chemistry*, 2013; 1-8.