



Effect of phytosanitary irradiation on the quality of Chandler Pummelo (*Citrus maxima* (Burm.) Merr.)



Jain, A. Paz, J. Rodriguez, K. Prakash, A.

Food Science Program, Schmid College of Science and Technology, Chapman University, Orange, CA

Abstract

Gamma Irradiation is increasingly being considered as an alternative to chemical phytosanitary treatments, such as methyl bromide. In this study, the chemical and physiological effect of low-dose gamma irradiation on the post-harvest quality of Chandler Pummelos (*Citrus maxima* (Burm.) Merr.), an emerging crop of interest in the U.S. was evaluated. Chandler pummelos from a local grower in California were irradiated at target doses of 150 Gy and 1000 Gy. Irradiated and untreated pummelos were stored at 12° C for 3 weeks and at 20° C for the 4th week to reflect temperature conditions during three weeks of sea shipment and an additional week of retail under ambient conditions. Color, titratable acidity, total sugars, juice content, weight loss and concentrations of organic acids were not different for the irradiated fruit in comparison to the untreated pummelos. Irradiation reduced hardness of the pummelo peel and firmness of the flesh. The external appearance of pummelos was negatively impacted by higher irradiation dose, longer storage time and higher temperatures as pitting and mold growth were evident on pummelos treated at 1000 Gy and following storage at 20° C. The results suggest that Chandler pummelo quality is compromised at 20° C and 1000 Gy treatment but irradiation with 150 Gy can serve as a potential phytosanitary treatment for Chandler pummelos.

Introduction

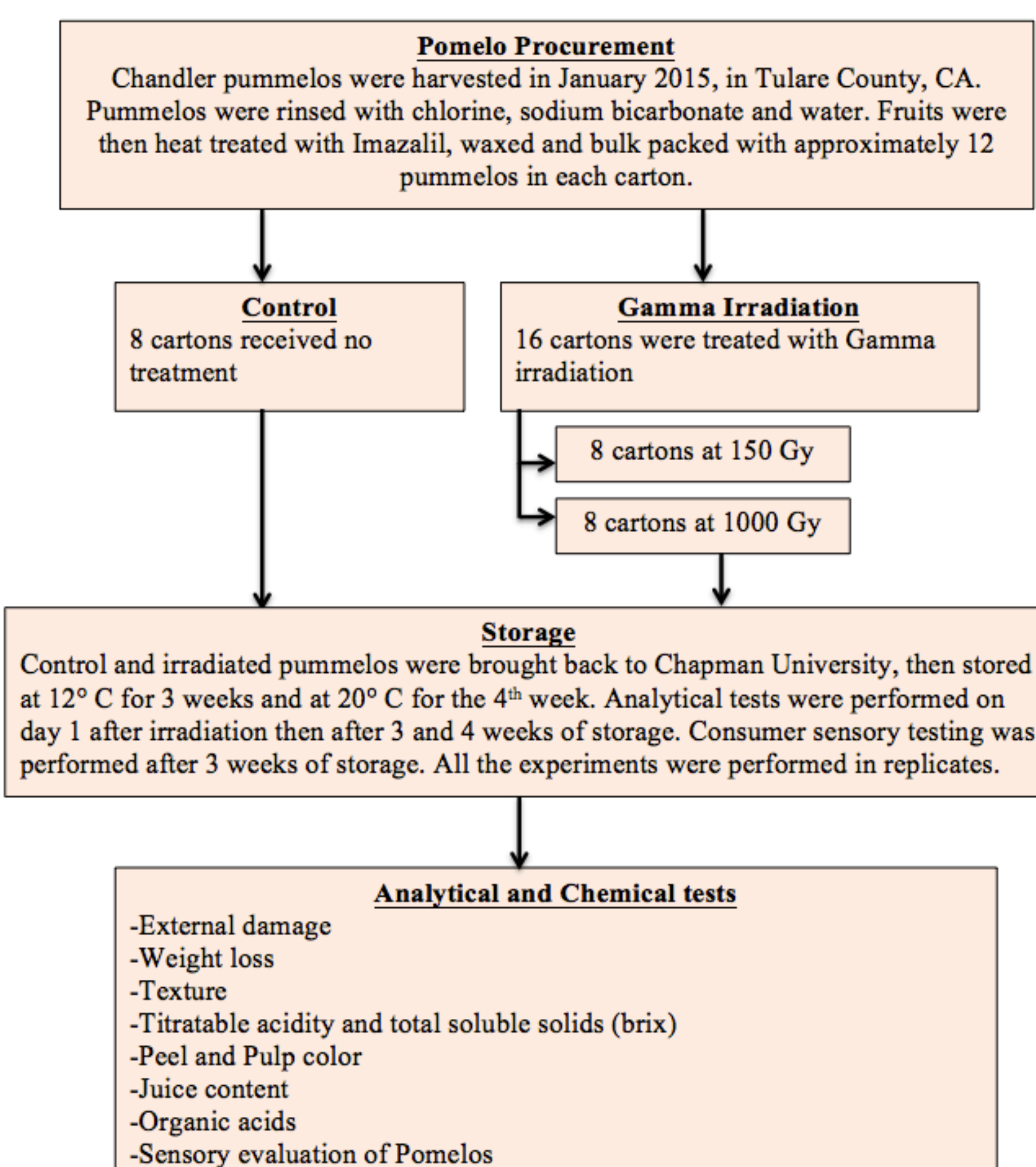
Pummelos (*Citrus maxima* or *Citrus grandis*) are popular in Asia for their desirable taste, flavor and juicy texture. Pummelo is one of the largest citrus fruits and is becoming commercially important in the U.S due to emerging consumer interest. USDA-APHIS is considering importing Pummelos from China. However, a phytosanitary treatment is needed to destroy insect pests such as moths, thrips, and fruit flies.

Approved phytosanitary treatments include chemical control (fumigation), irradiation, cold and hot treatments (McDonald and others 2013), of which methyl bromide (MeBr) fumigation is most commonly used in the U.S. However, due to its harmful effects on the ozone layer MeBr has been banned under the 1987 Montreal protocol and efforts are underway to phase out MeBr completely (EPA 2014). The Methyl Bromide Technical Options Committee under The United Environmental Programme has recognized irradiation as one of the potential phytosanitary alternatives to MeBr fumigation (Patil and others 2004).



Citrus fruits differ tremendously in their tolerance to radiation (McDonald and others 2013; Ladaniya and others 2003; Miller and others 2000). The effect of low-dose gamma irradiation on post harvest quality of pummelos is not known. Therefore, the objective of the research was to observe the effects of low-dose gamma irradiation (150 Gy and 1000 Gy) on the post harvest quality of Chandler pummelos during storage at 12° C for 3 weeks and at 20° C for the 4th week to simulate 3 weeks of shipment from Asian countries and one week of storage at retail at ambient temperature.

Experimental Design



Key Findings



Figure 1. Control, 150 Gy and 1000 Gy pummelos after 4 weeks of storage; 3 weeks at 12° C and 4th week at 20° C. 1000 Gy pummelos had maximum damage

- No differences in external damage were observed after 3 weeks of storage at 12° C. But after storage at 20° C for an additional week, external damage increased significantly for the 1000 Gy fruit. Peel injury and peel pitting were significantly higher for the 1000 Gy fruit, whereas the intensity of damage was similar (p>0.05) for control and pummelos treated with 150 Gy.
- Consumers rated the pummelos no differently for overall liking, overall flavor, sweetness, bitterness and juiciness.

Key Findings (Cont'd)

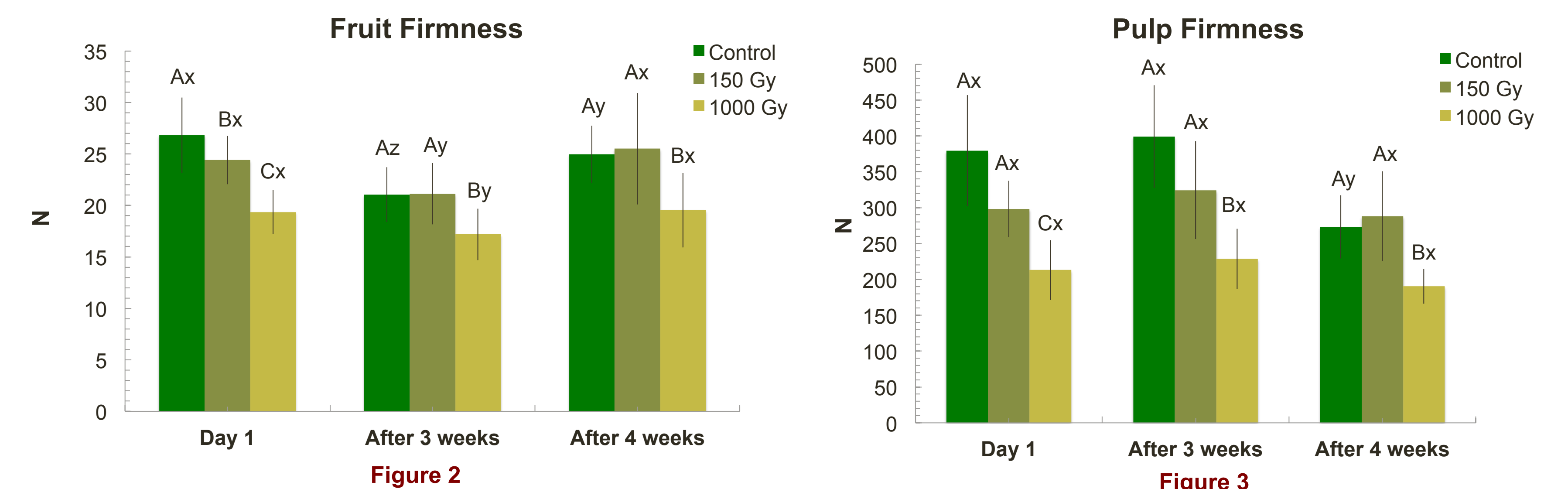
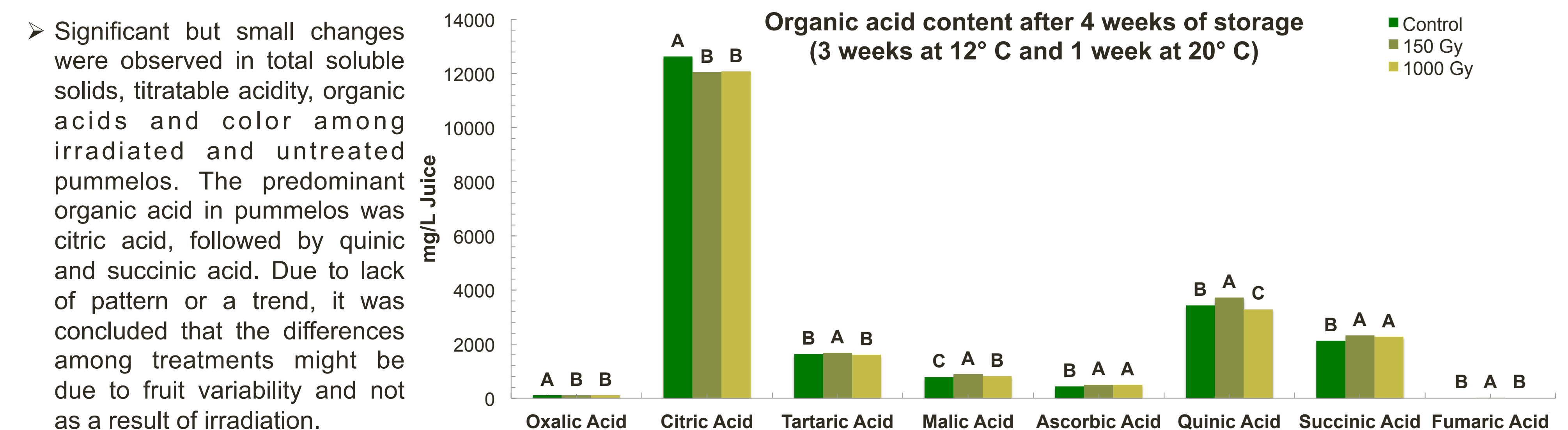


Figure 2. Maximum force required to shear through a whole pummelo using a puncture probe; Figure 3. Maximum force required to shear through 150 g of pummelo segments using a Kramer Shear. Means with the same letter are not significantly different (p<0.05). A, B, C indicate differences among treatment on the same test day, whereas x, y, z indicate differences among test days for the same treatment.

- Gamma irradiation resulted in softening of the peel and flesh. After 3 weeks, the control fruit and 150 Gy pummelos had similar peel and flesh texture, whereas the 1000 Gy pummelos were significantly softer. After 1 week at 20° C, the peel became firmer most likely due to dehydration.

- Weight of the fruit decreased over storage period of 4 weeks, the loss was attributed to fruit respiration and dehydration during storage. No significant changes were observed in juice content.



Conclusion

Gamma irradiation at 1000 Gy negatively impacted the quality of Chandler pummelos. However, pummelos irradiated at 150 Gy can maintain quality similar to non-treated pummelos when stored at appropriate storage conditions and thus can serve as a potential phytosanitary treatment for Chandler pummelos.

Acknowledgement



The Authors are thankful to United States Department of Agriculture for providing funds for the research

References

1. APHIS -. 2014. USDA (United States Department of Agriculture)-Treatment Manualonline]. Available from (APHIS) http://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/treatment.pdf.
2. Citrus Profile. Agricultural marketing resource center; 2013 [Accessed 2014 06/12/2014] Available from: http://www.agmrc.org/commodities_products/fruits/citrus/citrus-profile/
3. Bustos RME, Mendieta RC. 1988. Physiological evaluation of Valencia oranges treated with cobalt 60 gamma radiation. Radiat Phys Chem 31:215-23.
4. McDonald H, Arpaia ML, Caporaso F, Obenland D, Were L, Rakovski C, Prakash A. 2013. Effect of gamma irradiation treatment at phytosanitary dose levels on the quality of 'Lane Late' navel oranges. Postharvest Biol Tec 86:91-9
5. Nagai NY, Moy JH. 1985. Quality of gamma irradiated California Valencia oranges. J Food Sci.
6. Miller WR, McDonald RE, Chaparro J. 2000. Tolerance of Selected Orange and Mandarin Hybrid Fruit to Low-dose Irradiation for Quarantine Purposes. Hortscience 35:1288-91.