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# Effect of Low Dose Gamma Irradiation on Tristimulus Color and Carotenoid Stability of Seedless Kishu Mandarins (Citrus *kinokuni mukakukishu*) During Postharvest Storage

Maria Belen Meza
*Chapman University*, meza116@mail.chapman.edu

J. Ornelas-Paz
*Centro de Investigación en Alimentación y Desarrollo*

Anuradha Prakash
*Chapman University*, prakash@chapman.edu

# Effect of low dose gamma irradiation on tristimulus color and carotenoid stability of seedless Kishu mandarins (Citrus *kinokuni* mukakukishu) during postharvest storage


**Meza, M.B., Ornelas- Paz, J.J[1]. Prakash, A[2].**

**Schmid College of Science and Technology, Chapman University, Orange, CA**

[1] Centro de Investigación en Alimentación y Desarrollo, A.C, Cuauhtemoc, Chihuahua,, México

[2]Chapman University, Orange, CA, United States


## Abstract

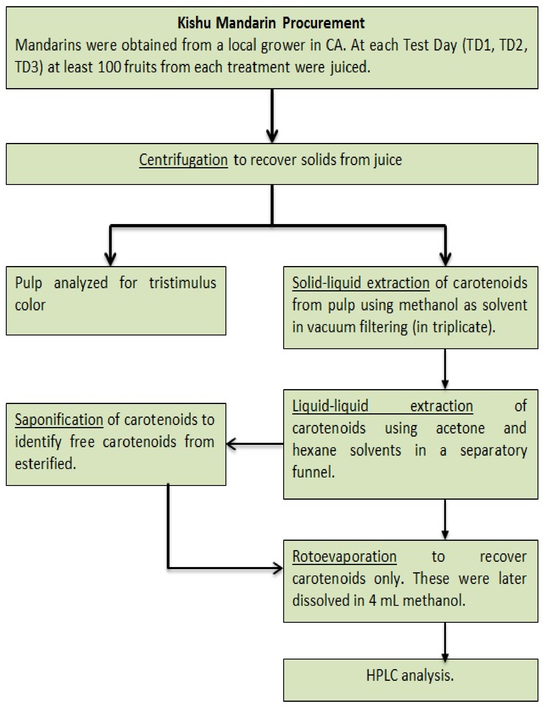

The following research seeks to identify the most appropriate irradiation dose at which carotenoids can be preserved in Kishu mandarins. Irradiation serves as a potential quarantine treatment for imported commodities into the U.S. California grown mandarins *kinokuni* mukakukishu were treated using gamma irradiation at 0, 150 Gy, 400 Gy and 1000 Gy. The carotenoids in mandarin were evaluated for 3 test days following irradiation: after two days, after 3 weeks at 6 ° C and after 3 week storage at 6 ° C plus 1 extra week at 20 ° C. These storage conditions simulate the sea shipment conditions of imported mandarins from China to U.S. Samples were subject to extraction, separation and saponification in order to obtain a pure carotenoid solution. Carotenoid identification was done based on order of elution, UV-VIS spectral data and retention times through HPLC-DAD analysis. The major carotenoids found were β-cryptoxanthin and β-carotene. The results show that the major carotenoids were sensitive to all irradiation doses immediately upon treatment, however exposure to room temperature for a week increased their concentrations. Irradiation caused a decrease in color a* and b* values only in the third week of storage. There did not appear to be a clear correlation between changes in carotenoid content and color values.


## Introduction

The U.S. is considering the importation of various species of citrus fruit from China, including Kishu mandarins (Citrus *kinokuni* mukakukishu). This fruit would be subject to quarantine treatment. In 1986 USDA approved irradiation as a non-chemical treatment on imported fruits (1), which can substitute for methyl bromide fumigation. Food irradiation is highly effective against invasive insect pests (2), however it may impact compounds of nutritional value such as carotenoids which serve as antioxidants and precursors of Vitamin A. Carotenoids are isoprenoid compounds and highly susceptible to degradation by radical species (3). Therefore the objective of this research is to determine the effect that irradiation has on carotenoids in Kishu mandarins.

## Experimental Design

Mandarins (Citrus *kinokuni* mukakukishu) were obtained from a local grower in California. The fruit was treated with 0, 150, 400 and 1000 Gy. The fruit was evaluated for quality after irradiation application (TD1), after 3 weeks at 6 ° C (TD2) and after 3 weeks at 6 ° C + 1 week at 20 ° C (TD3). These storage conditions simulated the sea shipment of fruit from China to USA. Identification and quantification of carotenoids was analyzed by HPLC-DAD, according to Ornelas-Paz et al (2007).




## Key Findings

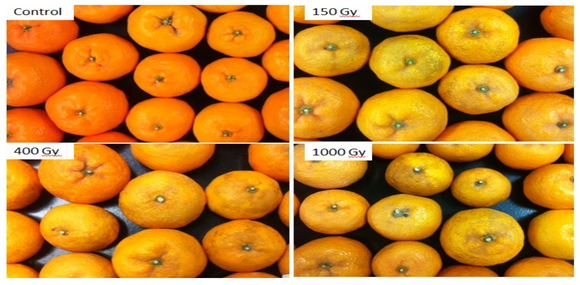



**Fig. 1. External appearance** of control and irradiated seedless Kishu mandarins after 3 weeks at 6 ° C

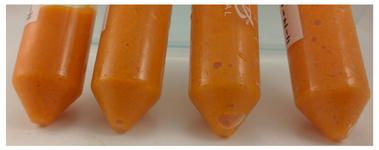


**Fig. 2. Appearance of pulp** of control and irradiated seedless Kishu mandarins after 3 weeks at 6 ° C

- Major carotenoids in Kishu mandarin are β- carotene and β- cryptoxanthin, which are pro-vitamin A carotenoids.
- There was a dose dependent decrease in carotenoid concentration.
- Carotenoid concentration remained stable during three weeks of storage at 6° C.
- However, when samples were placed under ambient conditions during the fourth week, there was an increase in β- carotene and β- cryptoxanthin.
- Significant decrease in a* and b* tristimulus color values of samples irradiated at 400 Gy and 1000 Gy in the third week indicate a loss of redness and yellowness of the pulp.
- The change in color values did not correlate with the change in carotenoid concentration.
- The increase in carotenoids during the fourth week at room temperature did not correlate with the change in color values

## Key Findings (Cont'd)

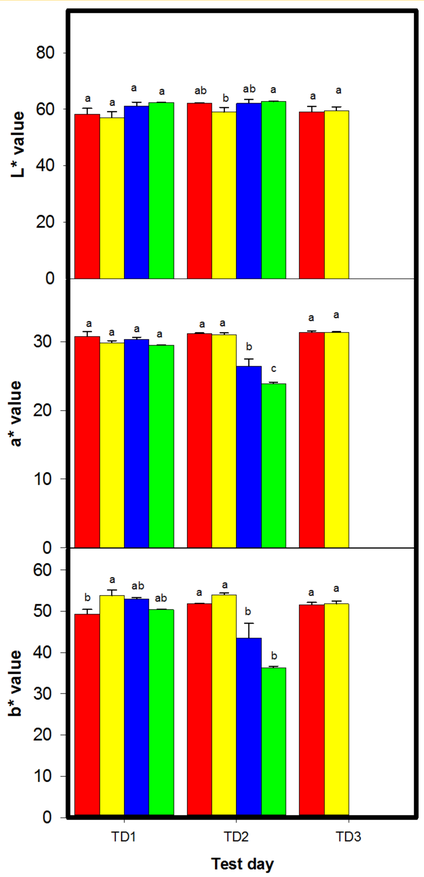



**Fig. 3. Tristimulus color of pulp** from control and irradiated seedless Kishu mandarins at each test days. A, B, C indicate significant differences (p<0.05) among treatments on the same test day

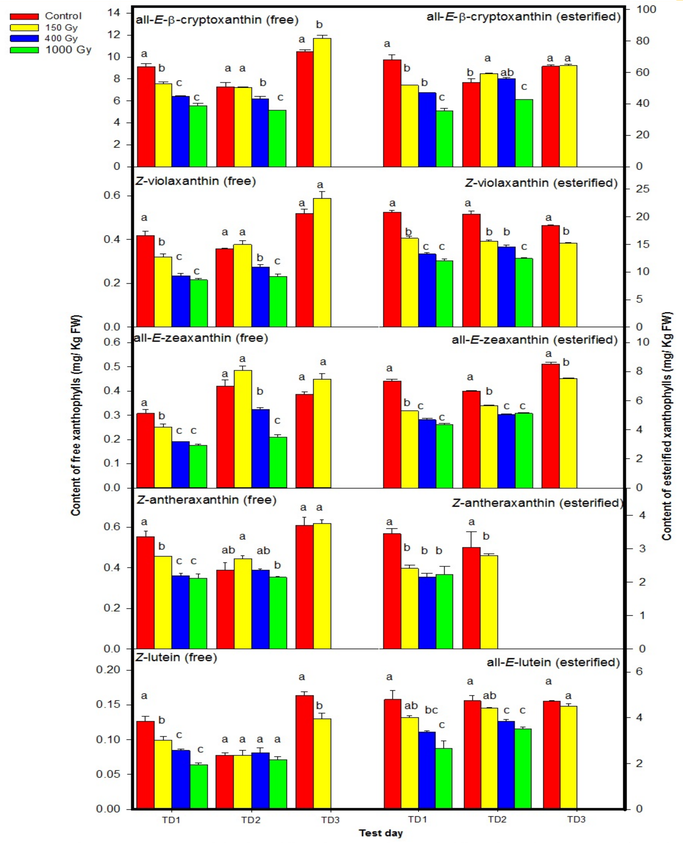



**Fig. 4. Carotenoid Identification and Quantification** from control and irradiated seedless Kishu mandarins at the test days. A, B, C indicate significant differences (p<0.05) among treatments on the same test day.

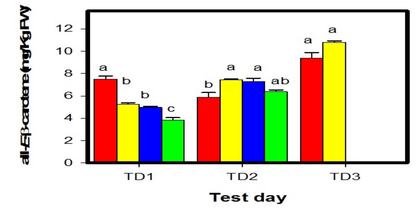



**Fig. 5. All trans β- carotene** from control and irradiated seedless Kishu mandarins at each test days

## Conclusion

Although carotenoid concentrations decreased as an immediate response to irradiation dosage, color change was observed only in the third week, thus color change is not a good indicator of changes in carotenoid content in mandarins.

## References


(1) Perishables Handling Quarterly 99 (1999) 19-21; (2) Irradiation For Fresh Produce (2007) 4; (3) *Tree and Forestry Science and Biotechnology* (2008); (4) Critical Reviews in Food Science and Nutrition 50 (2010) 515-532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