EFFECT OF IRRADIATION AS QUARANTINE TREATMENT ON CITRUS FRUIT QUALITY

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ABSTRACT

Gamma radiations have been used to improve sanitation treatments without significant effects on fresh fruit quality. The objective of this work was to evaluate the fruit quality characteristics of citrus variety Valencia (Valencia Late), main variety produced and exported in Uruguay. All samples were stored at 3-5 ºC, 80% RH, for 20 and 40 days. Irradiation doses used were 0,35 kGy min. and 0,80 kGy max. (doses that also eliminate the fruit fly). Irradiation experiments were conducted using irradiation equipment from Ezeiza Atomic Center (CAE), year 1968, Co60 source, 800.000 Ci. The effects of irradiation on sensory qualities and physical characteristics were studied. The attributes evaluated were visual appearance (1-4 hedonic scale, expert), overall acceptance (1-9 hedonic scale, consumers), texture (TAB Stevens, speed: 2m/s, distance: 2mm), yield of juice and colour (Hunter values). In general, no significant changes in these parameters were observed after irradiation. Quality was not significantly affected by doses usually applied to decrease the viability of pathogen that cause citrus Scab. This is an important contribution for the protocols that would allow citrus fruit exportation.

Keywords: Irradiated, citric, fungi

INTRODUCTION

Uruguay produces approximately 300 000 tons of citrus fruits per year, 120.000 of which are exported. The subsector of citrus is a highly labor-intensive production; citrus production is mainly destined to export as fresh fruit. Mainly oranges, mandarins and lemons are available in this market; the area cultivated with citrus is 22.000 ha. The total cultivated area is distributed with Valencia and Navel orange (44%); Satsuma mandarin and Ellendale (44%), Clementines and Lemons (10%) and Grapefruit (less than 2%).

Citrus fruit exports require, among others, high quality, minimum chemical residue levels and the compliance with phytosanitary requirements. After harvest fruit begins a critical period, in order to maintain the quality up to the final consumer. At this moment there are several microorganisms as fungi (i.e. Penicillium), causing fruit rots.

These requirements involve pests of quarantine concern for the importing countries, which risks are mitigated by the application of phytosanitary measures. These measures could be the requirement of a pest free area, crop inspections, treatments applied to the consignments or phytosanitary inspection of the product in order to certify it is free from the required pest. The irradiation as quarantine treatment is a phytosanitary measure under the International Plant Protection Convention, approved by an international standard.




MATERIALES AND METHODS

Materials

Citrus variety Valencia (Valencia Late) with post harvest treatment (PHT) was provided by AGRISUR-URUDOR. Size of sample: 30 citrus boxes in two pallets, containing 15 boxes each one. Doses range was established based on the D10 determined for Citrus canker D10= 0,16 KGy. The oranges were irradiated in three blocks and the doses used were 0,35 and 0,80kGy (Table 1).

Table 1: Applied treatments

Code	Doses
VO	Non irradiated
VA	0,35 kGy min.
VB	0,80 kGy max

The results were compared between doses and also between different storage periods. Data were analyzed using two - way analysis of variance (ANOVA).

Treated (irradiated) and control (non irradiated) fruits were stored at 3-5°C and 80% RH right after irradiation for 20 and 40 days. The storage times were chosen in order to simulate the maximum export shipping time. Finally, the samples were intained at room temperature for 7 days for each time of study to simulate gondola storage. All chemical and physical Tests were performed at the end of storage.

Methods of analysis

Irradiation process was performed in a Semi-Industrial Facility from Ezeiza Atomic Center (CAE), year 1968, Co60 source, 800.000 Ci. Dosimetric measurements were carried out by means of Frike. Irradiation doses used were 0,35 kGy min. and 0,80 kGy max (doses that also eliminate the fruit fly).

All analysis were carried out on three blocks with seven samples each. Samples from the different treatments were selected randomly and analyzed as follows:

Analysis of orange's quality

Texture analysis

The firmness was determinate by a Stevens-L FRA Texture Analyser, using a penetrometer the clear plastic 35mm log. 0,35 -0,43mm diameter, speed 2m/s, distance 2mm. The determination was made on 21 samples in duplicated and the data was statistically analyzed by ANOVA.

Colour measurement

Colour of control and treated fruits was measured using a colorimeter based on the standard colour system CIELAB. The illuminant/viewing geometry was D65/10º. A standard white tile was used for calibration prior to colour measurements and a black tile was used for reflectance calibration. The values of L* (lightness), a* (redness to greenness) and b* (yellowness to blueness) were recorded for each sample. The determination was made on 21 samples and the data was statistically analyzed by ANOVA.

Production of juice

Yield of juice was calculated by the ratio between the juice weight and the orange weight. The juice was obtained using an extractor of citric juice with manual alimentation and turn pines mechanize (medium pineapple).

Appearance

Appearance was evaluated by visual observation by an expert. Visual changes of the fruit over time were studied. A 1-4 hedonic scale was used to evaluated the samples in which a score of 1 represented not good and a score of 4 represented very good.

Sensory evaluation

The combined effect of time and irradiation dose level was evaluated on the sensory quality of Valencia oranges juice using 30 un-trained and randomly chosen panelists. Overall acceptance of the juice obtained from the treated and control fruits were evaluated.

Each consumer received a total of six samples (incomplete blocks were presented to obtained 45 senses for sample) identified by three digits and randomly placed. A 1-9 hedonic scale was used to evaluate the samples in which a score of 1 represented extremely dislike and a score of 9 represented extremely liked. The sensory evaluations were conducted at room temperature under normal laboratory light conditions.

Means values were reported, and the differences in the mean values were compared by ANOVA, and differences were declared significant when P≤0,05.

RESULTS

Effect of irradiation on colour (hunter colour values), are presented in Table 2.

Table 2: Effect of dose and storage time on hunter colour values of oranges stored for 20 and 40 days.

Treatment		Storage time					
		20 days			40 days		
Code	kGy	L*	a*	b*	L*	a*	b*
VO	0,0	68,28^{ab}			65,16^{b}	34,89^{bc}	65,81^{b}
VA	0,35 min.	65,62^{bc}	35,46^{b}	65,14^{bc}	65,59^{bc}	34,33^{bc}	65,37^{bc}
VB	0,80 max.	65,63^{bc}	35,42^{b}	65,33^{bc}	66,79^{a}	33,63^{c}	66,54^{a}

#Values with different superscripts in rows and columns are statistically significantly different (P<0,05)

Irradiation affected the lightness (L*values) (P<0,05) of oranges treated as they presented lower values than the control (became darker) at 20-day storage. However exposure to irradiation did not affect (P<0,05) the lightness of the samples over time. Irradiation increased the redness (a* values) (P<0,05) of samples exposed at 20-day storage, but there was no difference between irradiated samples.

Exposure to radiation did not affect the yellowness (b* values) over time. While non irradiated samples had decreased b* values during the storage.

Textures measurements of non irradiated and irradiated samples were analyzed. Table 3 shows that exposure to irradiation did not affect (P<0,05) the textural properties of the orange.

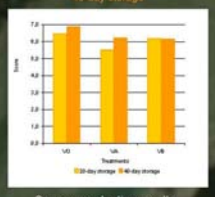
Table 3: Effect of irradiation on textural qualities of orange

Treatment		Storage time	
Code	kGy	20 days	40 days
VO	0,0	1006	998
VA	0,35 min	999	1000
VB	0,80 max	1000	1006

*The force value is expressed in g units

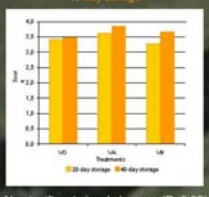
Sensory quality attributes including overall acceptance of juice and visual appearance were evaluated (Fig. 1 and Fig. 2).

Fig. 1: Overall acceptance after 20 and 40-day storage



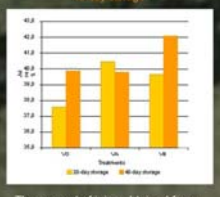
Sensory evaluation results showed that for Valencia variety, irradiation had no significant (P< 0,05) effect on the ratings of the sensory attributes at 20 and 40 days of storage for the different treatments.

Fig. 2: Appearance after 20 and 40-day storage



No significant visual changes (P<0,05) were noted in control and irradiated samples for the same period of storage. However, irradiation did affect appearance (P<0,05) of the exposed samples over time. At 40-day storage, appearance of samples irradiated had higher score (P<0,05) than the control.

Fig. 3: Percentage of juice after 20 and 40-day storage



The amount of juice obtained from the oranges remains equal with increasing irradiation dose. There were no significant differences in the juiciness after 40-day storage (Fig.3).

CONCLUSIONS

The effects of irradiation and storage were not significant (P<0,05) on the visual appearance, texture and juice yield. There were not major changes in colour, however at 40 days of storage irradiated samples showed better appearance that not irradiated ones, so it can be considered that irradiation improved fruit quality. In addition, consumers accepted both, treated and untreated orange juice in the same way.

Therefore gamma irradiation used as a quarantine treatment after routine packing process, did not adversely affect the parameters evaluated of Valencia orange.

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