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EFFECT OF IRRADIATION ON COLOR OF MINIMALLY PROCESSED MELON AND PAPAYA

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ABSTRACT

The access to nutritious food is an essential dimension of food meal. High potential for fresh-cut industry exists and ready-to-eat fruit market has grown rapidly in recent years due to the health benefits associated. Although there is many concerns to food safety other parameters like texture, taste, color and sensory acceptance are fundamental principles of acceptance to any food. Actually the use of instrumental measurements has proven to be a major predictor of sensory responses. According to many authors, the addition of different techniques should always be considered to provide additional information of the sensory aspects. Therefore the objective of this study was to evaluate the influence of irradiation on color of minimally processed melon and papaya. The fruits were purchased in a market of São Paulo, at the same point of ripeness and sent to the IPEN/CNEN-SP. The fruits were sanitized and manually cut into cubes of approximately 2 x 2 cm with the aid of stainless steel knives and packed in polyethylene bags. Melons and papaya were irradiated in a Multipurpose Gamma Source (IPEN – São Paulo – Brazil) and were divided in six groups for color analysis: Control; 0.5 kGy; 1.0 kGy, 1.5kGy, 2.0 kGy and 3.0kGy. After the treatment, the MP fruits were kept in a refrigerator at 4°C ± 1ºC until the end of the analysis. The color of the samples was determined using a Minolta colorimeter CR-400 Chromameter. The parameters L*, a* and b* were evaluated. The results were statistically analyzed by analysis of variance One-Dimensional Analysis of Variance (One-Way-ANOVA) followed by Tukey test. All statistical analysis was performed using the program Graph Pad Prism 5 and adopting a significance level of 5 % ($p < 0.05$), expressed as the mean results ± standard deviation. Samples of papaya and melons showed no statistical difference for the L* parameter of any dose despite the tendency to darkening observed for the group of 3.0 kGy. This fact also occurred for the chromatographic coordinates a* and b* which remained in the same tonality for all treatments ($p<0.05$). Current results indicate that gamma radiation can be used for keeping the color. Doses up to 3kGy were efficient for that. Future studies should consider pretreatments to minimize the darkening effects on fruits. Therefore, the results from this study suggest the use of gamma radiation as a quality alternative for keep the color of minimally processed melon and papaya.

1. INTRODUCTION

Papaya and melon are between the most consummated fruits of Brazil. Besides the consumption, Brazil is the world's largest producer of papaya, with a production of 1.650,000 t/ year, placing it in the major exporting countries, mainly for the European market [1]. Besides it, the country is the first producer of melon in South America, followed by Venezuela, Argentina and Chile [2].

The consumption of fruits has increased not only because their health properties, but due to the facilities to find it processed. Minimally processed (MP) fruits and vegetables are widely available and generally considered safe to eat by consumers. However, the majorities of these

products requires no further treatment and are eaten raw, posing a potential safety problem [3].

The treatment of specific foods by ionizing radiation to improve the microbiological safety and storage capacity is one of the most studied technologies of the twentieth century [4]. It is one of the few technologies which address to food quality and safety by virtue of its ability to control microorganisms without significantly affecting any sensory or other organoleptic attributes of food [5].

Whereas the color is one of the most important properties of food, which determines the acceptability and quality of a product, this work aims to demonstrate and discuss the results of the application of ionizing radiation in minimally processed melon and papaya submitted to different doses of irradiation.

2. MATERIALS AND METHODS

2.1. Materials

The fruits (melon and papaya) were purchased in a market of São Paulo, at the same point of ripeness and sent to the IPEN/CNEN-SP.

2.2. Sampling

The fruits were sanitized and manually cut into cubes of approximately 2 x 2 cm with the aid of stainless steel knives and packed in polyethylene bags.

2.3. Irradiation

The fruits were irradiated in a Multipurpose Gamma Source (IPEN – São Paulo – Brazil) and were divided in six groups for color analysis: Control; 0.5 kGy; 1.0 kGy, 1.5kGy, 2.0 kGy and 3.0kGy.
Gammachrome YR Bath 530 nm dosimeters were used for the routine measurement of radiation dose.
After the treatment, the fruits were kept in a refrigerator at 4°C ± 1ºC until the end of the analysis.

2.4. Colorimetric analysis

The color of the samples was determined using a Minolta colorimeter CR-400 Chromameter. The parameters L*, a* and b* were evaluated. To have a better interpretation of the colorimetric results it is necessary to remember that the L* indicates lightness, while a* and b* represent chromatographic coordinates. (Thus, according to the values are indicated: the higher the L* closer to white and the smaller closer to black, a* positive values: direction of red, negative values of a*: green direction; positive values b*: yellow direction, negative values of b*: blue direction. With increasing values of a* and b*, there is a saturation of color) [6].

2.5. Statistical Analysis

The results were statistically analyzed by analysis of variance One-Dimensional Analysis of Variance (One-Way-ANOVA) followed by Tukey test. All statistical analysis was performed using the program Graph Pad Prism 5 and adopting a significance level of 5 % ($p < 0.05$), expressed as the mean results ± standard deviation.

3. RESULTS AND DISCUSSION

Table 1: Color measurements for minimally processed fruits (melon and papaya) submitted to irradiation.

Fruit	Color Parameters	Irradiation Dose					
		Control	0.5 kGy	1.0 kGy	1.5 kGy	2.0 kGy	3.0 kGy
Melon	L*	65.39 ± 1.10[a]	62.56 ± 2.87[a]	62.01 ± 2.44[a]	64.13 ± 0.58[a]	63.82 ± 2.37[a]	60.32 ± 2.27[a]
	a*	-3.28 ± 0.50[a]	-4.68 ± 0.29[a]	-4.13 ± 1.08[a]	-4.57 ± 2.35[a]	-3.66 ± 0.38[a]	-2.74 ± 0.73[a]
	b*	11.03 ± 1.09[a]	13.97 ± 0.23[a]	12.85 ± 1.57[a]	13.97 ± 4.62[a]	11.38 ± 0.69[a]	9.41 ± 1.14[a]
Papaya	L*	51.64 ± 2.04[a]	51.24 ± 3.94[a]	50.85 ± 3.31[a]	52.43 ± 0.90[a]	49.75 ± 3.03[a]	48.44 ± 0.91[a]
	a*	23.50 ± 0.77[a]	23.96 ± 2.77[a]	25.06 ± 0.78[a]	22.56 ± 2.97[a]	22.74 ± 1.65[a]	25.23 ± 0.75[a]
	b*	41.98 ± 2.36[a]	40.92 ± 0.47[a]	43.51 ± 1.31[a]	40.49 ± 2.97[a]	40.33 ± 2.21[a]	41.80 ± 0.27[a]

*Averages followed by the same letter (line) do not differ at 5% level of significance.

**Average results for colorimetric analysis on minimally processed fruit exposed to different doses of irradiation (n = 12; triplicate).

The L* parameter of a colorimetric analysis indicates brightness. Variations indicate that the closer the value is to zero, blacker hue is the sample, and the closest tonality to100 is white. Despite the 3.0 kGy samples are darker than the others at the time of this analysis showed no statistical difference ($p<0.05$), as shown in Table 1.

Regarding chromatographic coordinate a* (which indicates the variation red-green) melon and papaya samples showed no statistical differences ($p<0.05$) with increasing dose. Some oscillations in the various measurements that can be justified on different points of ripening fruits, as well their response to differently stimulus of irradiation.

The chromatographic coordinate b* indicates the variation of yellow-blue hue. This parameter showed no statistical difference ($p<0.05$), indicating that the yellow color remained constant even at higher doses.

Palekar et al. [7] obtained positive results for the texture and color of melons irradiated to 0.7 kGy and 1.4 kGy and packaged with modified atmosphere. Bibi et al. [8] to perform analysis

and sensory analysis of texture in melon (*Cucumis melo*) concluded that doses up to 2.5 kGy maintaining the sensory qualities and firmness within acceptable limits for seven days storage (5°C). Thus, the results obtained for the color of minimally processed melons maintained a satisfactory coloring stable even with higher doses (3kGy).

D'Innocenzo and Lajolo [9] were able to slow down in two days, the initiation of maturation on irradiated papayas with 0.5 kGy, keeping the color, firmness and sugar content throughout the storage period. Boylston et al. [10] worked with irradiated papayas, rambutans and oranges at 0 (control) and 0.75 kGy and concluded that the effects of irradiation and storage depend on each fruit. Despite the steady decrease as a result of irradiation and storage, this decrease was significant only in rambutans. The color of rambutans and oranges were considerably affected by irradiation.

Color is a critical quality property of fresh-cut fruit and cutting operations may often lead to enzymatic browning [11]. Rico et al. [12] studied some methods for extending the shelf-life quality and safety. The authors concluded that the alternatives for minimally processed foods must meet the consumers and maintain a balance between quality and sensory aspects. The authors indicate that demand for new alternative methods that provide it, is essential. Recent studies [11] [13] [14] [15] have showed many forms to keep the color and the quality of fruits, being the irradiation a good alternative.

In this study, samples of papaya and melons showed no statistical difference for the L* parameter of any dose despite the tendency to darkening observed for the group of 3.0 kGy. This fact also occurred for the chromatographic coordinates a* and b* which remained in the same tonality for all treatments ($p<0.05$). Thus, the results are in agreement with the literature, showing no significant changes in color for all treatments.

4. CONCLUSIONS

Current results indicate that gamma radiation can be used for keeping the color of minimally processed melon and papaya. Doses up to 3kGy were efficient for that. Future studies should consider pretreatments to minimize the darkening effects on fruits. Therefore, the results from this study suggest the use of gamma radiation as a quality alternative for keep the color of minimally processed fruits.

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