

COLORIMETRIC EVALUATION OF IRRADIATED RED BEETROOTS

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ABSTRACT

The red beetroot contain antioxidant and anticancer activity and have been consumed all over the world. In order to increase the consumption of beetroot the food industry has created a practical alternative, a beetroot shaped like a small ball, minimally processed with the convenience in meal preparation. Food irradiation is in consonance with the proposal to increase the consumption of beetroot whilst maintaining quality and product safety. The aim of this study was to analyze changes in colorimetric properties in beetroot after the irradiation process. Samples of minimally processed beetroot were purchased at a local supermarket. The samples were exposed to gamma rays with doses of 1.0kGy, 2.0kGy, 3.0kGy and 4.0 kGy and were stored at 5°C. Colorimetric characteristics were analyzed such as L*, a*, b*, C*, h*, ΔE and WI. The results of the colorimetric evaluation showed no significant difference among the samples. The authors concluded that the treatment with low doses of gamma radiation keeps the quality of beetroot.

1. INTRODUCTION

According to Mello *et al.* [1] a vegetable is defined as minimally processed plant that has undergone minimal processing steps, similar to the fresh product. Beetroot minimally processed emerges as a possible alternative because of its shape and convenience. However, after this process plant tissue becomes similar to a vegetable that has suffered stress [2]. The beetroots have an antioxidant compound called Betalaine which give purple-red color [3]. According Kluge *et al.* [4] with minimal processing, more specifically the washing step and rinsing, these compounds lose beet, making the product whitish due to surface discoloration. Gamma radiation is used to improve the quality of fruits and vegetables, which may be combined with other conservation methods [5, 6, 7].

2. MATERIAL AND METHODS

2.1. Fresh raw material and storage conditions

Commercially prepared baby beet root were purchased in local market of São Paulo city. The red beet roots were stored at $5\text{ }^{\circ}\text{C} \pm 1$.

2.2. Gamma radiation treatment

Samples of baby red beet root minimally processed were irradiated using a Multipurpose ^{60}Co Irradiator at Instituto de Pesquisas Energéticas e Nucleares-IPEN/CNEN (São Paulo, Brasil). The applied doses were 0, 1.0kGy, 2.0kGy, 3.0kGy and 4.0 kGy with a mean dose rate of 4.5 kGy h^{-1} . Harwell Gammachrome YR Bath 64-530 nm dosimeters were used for the measurement of radiation dose. The irradiated and control samples were stored at $5^{\circ}\text{C} \pm 1^{\circ}\text{C}$.

2.2. Colorimetric analysis

Colorimetric analysis was performed with the whole minimally processed red baby beetroots. It was performed two repetitions with ten samples each one. The color analysis was determined by reflectance with handheld colorimeter (Minolta Chroma-meter model CR400 Minolta Camera Co., Japan). The measuring aperture diameter was 17.0mm and 2° / D65 was the illuminant and calibrated with the standard black and white tiles and values of CIE color space co-ordinates. The parameters L^* (lightness), a^* (the grade of greenness/ redness), b^* (the grade of blueness/yellowness, ΔE (total color difference) and WI (whiteness index) were calculated [8]. (1991). The parameter C^* (chrome) that measure the saturation and analyze the purity of color, h° (hue angle) were calculated [9].

2.3. Statistical analysis

The results were analyzed by analysis of variance (ANOVA) and mean comparison by Tukey test at 5 % significance in the statistical program *GraphPad Prism 5.0*

1. RESULTS AND DISCUSSION

The lightness of the surface of minimally processed red baby beetroots in this study showed values ranging from 39.07 to 43.47. The vegetables treated with 4 kGy had higher measures of L^* . The control sample showed up slightly darker than irradiated samples; however there was no statistical difference. The results of color analysis are showed in table 1. The analysis of the parameters a^* and b^* showed no significant differences between the irradiated samples. The analysis revealed that the b^* 4 kGy sample was different from the sample 2kGy. Hajare *et al.* [10] did not observe changes in the values of L^* , a^* and b^* .

Table 1. Results of the parameters L^* , a^* , b^* , C^* , h° , ΔE^* of irradiated baby red beet roots minimally processed.

Color parameters	Control	1.0 kGy	2.0 kGy	3.0 kGy	4.0 kGy
L^*	39.07 ± 2.86^a	40.36 ± 4.02^a	40.05 ± 4.03^a	40.44 ± 4.60^a	43.47 ± 4.23^a
a^*	13.39 ± 2.48^a	13.04 ± 3.22^a	11.75 ± 2.15^a	13.95 ± 3.77^a	10.17 ± 3.25^a
b^*	10.02 ± 1.38^a	9.74 ± 1.31^a	9.45 ± 0.98^a	9.99 ± 1.36^a	10.68 ± 1.23^{ab}
C^*	16.72 ± 2.37^a	16.37 ± 2.98^a	15.17 ± 1.66^a	17.28 ± 3.48^a	15.06 ± 2.63^a
h°	36.82 ± 2.34^a	37.5 ± 6.55^a	39.26 ± 6.35^a	36.6 ± 7.09^a	48.46 ± 7.63^a
ΔE^*	$42,50 \pm 2.55^a$	$43,54 \pm 3.21^a$	$42,79 \pm 10.03^a$	43.9 ± 4.25^a	$46,08 \pm 3.57^a$

^{a,b} different letters differ significantly ($p < 0.05$)

The variable C^* (chroma) evaluates the degree of saturation, or chromaticity of color. According to Ferreira [11] the definition of chroma is the color intensity. Values ranged from 15.06 to 17.28 and there was no significant difference. The hue angle (h°) also showed no statistical difference between analyzes. Latorre *et al.* [12] analyzed fresh cut red beet root using doses of 2 kGy 1.0kGy and the color parameters L^* , a^* , b^* , C^* , h° and noted that there was no significant differences between any of the item being cited according to the present work.

No significant difference was observed for ΔE color analysis. The sample that obtained higher values of color was the 4.0 kGy and the sample that obtained lower values was the 2.0 kGy. Kamat *et al.* [13] observed no change in relation to discoloration during storage. Whiteness Index (WI) indicates the development of white surface and the values varied from 36.82 to 41.44 % that represents no significant difference between samples (Figure 1).

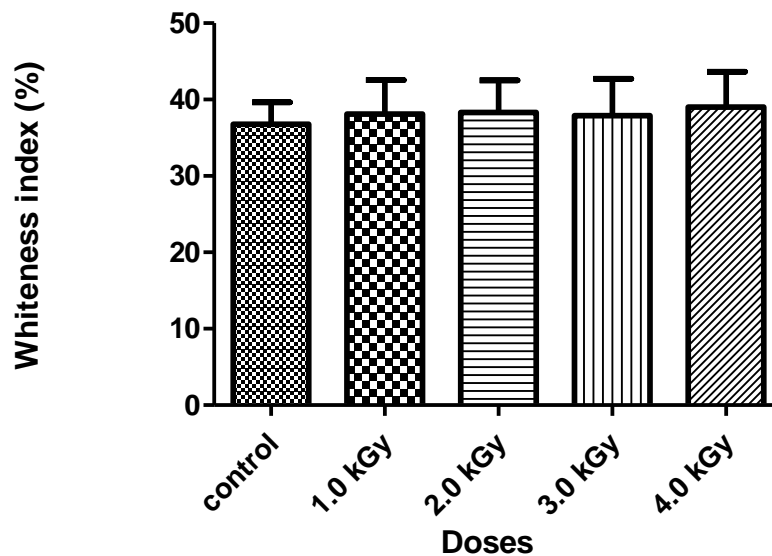


Figure 1. Whiteness index of minimally processed red beetroot.

Some authors have found similar results to those found in this study, with values ranging from 26 to 38 % [14,15,16] The analysis of this parameter is extremely important, because after processing can occur in red beetroot white blush [17], making the product unattractive to the consumer by having an aged appearance [4].

3. CONCLUSIONS

The authors concluded that the treatment with doses up to 4.0 kGy of gamma radiation keeps the color quality of minimally processed red beetroot.

4. ACKNOWLEDGMENTS

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