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EFFECT OF GAMMA RADIATION ON THE COLOR AND PH OF TOMATOES

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ABSTRACT

Tomato (*Lycopersicum esculentum Mill*) is one of the most widely grown vegetables in Brazil. It has great economic importance in view of constant increases in demand, both in the forms of natural or industrialized product. However, the issue that most affects its culture is its short life in post-harvest, because of its susceptibility to various types of pests. Some pest-damaged fruits are even unable to be sold in the market. The control of chemical insecticides, a practice used by most farmers, promotes a reduction in the population of pests. However, there are many pests such as the tomato moth, that are more difficult to control due to their resistance to pesticides. Based on the fact that the energy use of ionizing radiation in food has shown positive results in various fields of application, such as in the control of insect infestation, delay of fruit's ripening and reduction of microbial load, the irradiation can be identified as a potential solution to this problem. Due to these factors, this work aims to study the physic-chemical characteristics of tomatoes, under the effect of different doses of gamma radiation (0.25 kGy, 0.5 kGy , 1.0 kGy and 2.0 kGy).

1. INTRODUCTION

The tomato (*Lycopersicum esculentum Mill*) is a soft fruit protected by a cuticle almost impervious to gases and water [1] and is characterized by a soft pulp, thin skin and many seeds [2]. Currently, it has made great economic importance in the world, being the second most important vegetable after potatoes [3].

There are several methods used to minimize the effects of aging and to prolong the shelf life of tomatoes. Among them is the cooling, which provides efficiency especially in the control of pathogens [4]. However, problems caused by the attack of some pests may shorten its life [5], interfering in its metabolic activity.

Thus, the irradiation can be identified as a potential solution. Used alone or in combination with other technologies of preservation [6], it can bring get various benefits such as: reduction of losses after harvest, control of insect infestation, delay of ripening of fruits, reduction of microbial load, inhibition of sprouting in bulbs and tubers, among others [7].

Therefore, the objective of this study was to evaluate the effect of different doses of gamma radiation on the skin color of tomatoes and on the pH, over a period of time.

2. MATERIALS AND METHODS

2.1. Materials

It was used fruits of tomato (*Lycopersicum esculentum Mill*), belonging to the cultivar of table Débora. Tomatoes were purchased in CEAGESP (Companhia de Entrepostos e Armazéns em Geral de São Paulo) at the point of ripeness note 0 (zero) and sent to the IPEN / CNEN-SP.

2.2. Treatment: Irradiation

The tomatoes were irradiated in a Multipurpose Gamma Source (IPEN, São Paulo – Brazil) and were divided in five groups (treatments): Control (C); dose 0.25 kGy (T1); dose 0.5 kGy (T2); dose 1.0 kGy (T3) and dose 2.0 kGy (T4).

2.3. Storage and Measurements

After the treatment, the tomatoes were kept in a cold chamber at 12°C ± 1ºC and 67% UR until the end of the analysis. This condition is the ideal temperature for the physiology of the fruit during storage.

Physical characteristics of tomato were evaluated over a period of twenty days: the skin color and pH. These parameters were analyzed in the following days after irradiation: 3, 6, 9, 12, 15, and 20.

2.4. Skin Color

The skin color was evaluated subjectively on a scale of notes: note 0 (for green fruit), note 1 (green ripe), note 2 (red) and note 3 (mature red) [1]. For each day of analysis were used six tomatoes from each treatment.

2.5. pH

The pH was measured using a potentiometer (Micronal brand - model B274) from the Laboratory of Food Irradiation – CTR / IPEN-SP.

Two tomatoes of each dose were crushed using a mixer. After grinding, 10g were weighed and placed in a beak for dilution in 100 ml of distilled water.

Subsequently, the electrode and the thermometer from potentiometer were placed in the samples under magnetic stirring to obtain the values [8].

3. RESULTS AND DISCUSSION

3.1. Skin Color

Tomatoes from Treatment 1, presented a delay in ripening in relation to the others, thus maintaining the green color until fifteen days after irradiation, as Table 1.

Table 1. Average of skin color for tomato fruits subjected to different doses of gamma radiation during storage.

	Day 3	Day 6	Day 9	Day 12	Day 15	Day 20
Treatments						
C (control)	1.00 ± 0.58^{ab}	1.17 ± 0.50^{abc}	2.00 ± 0.58^{abcde}	2.17 ± 0.50^{abcde}	3.00 ± 0.00^{e}	3.00 ± 0.00^{e}
T1 (0.25 kGy)	0.83 ± 0.58^{a}	0.50 ± 0.58^{ab}	0.50 ± 0.58^{abc}	0.50 ± 0.58^{abcd}	1.50 ± 0.58^{abcde}	1.75 ± 0.58^{abcde}
T2 (0.5 kGy)	1.00 ± 0.89^{ab}	1.33 ± 0.52^{abcd}	1.50 ± 0.55^{abcde}	1.66 ± 0.52^{abcde}	2.00 ± 0.63^{abcde}	2.17 ± 0.41^{abcde}
T3 (1.0 kGy)	0.83 ± 0.75^{a}	1.00 ± 0.89^{ab}	1.00 ± 0.89^{ab}	1.00 ± 0.89^{ab}	2.17 ± 0.75^{abcde}	2.67 ± 0.52^{cde}
T4 (2.0 kGy)	1.00 ± 0.89^{ab}	1.5 ± 0.55^{abcde}	2.17 ± 0.41^{abcde}	2.50 ± 0.55^{bcde}	2.83 ± 0.41^{de}	3.00 ± 0.00^{e}

Averages followed by the same letter on the line or column do not differ by Tukey test at 5% level of significance.

Treatments 1 and 2, did not significantly in color, but the dose of 0.25 kGy kept the green tomatoes throughout the period and the dose of 0.5 kGy reached the red. Treatment 3 showed statistical difference only at day 20, with the color red. As for treatment 4 showed differences on days 15 and 20 from day 3.

Meanwhile, the tomatoes from Control group had the intense red color (Table 1) fifteen days after irradiation. This can be explained by a possible acceleration in the accumulation of carotenoids, which would have advance the red color of tomatoes [1]. These data confirm that the cooling may assist in the conservation and maintenance of shelf-life of tomatoes, but the irradiation treatments 1, 2 and 3 were more effective in the delay of maturation, and consequently the color of the fruit.

Thus, the gamma radiation had beneficial results in the delay of senescence and in preserving the color during the twenty days of storage of tomatoes, where the most effective was the Treatment 1, as Figure 1.

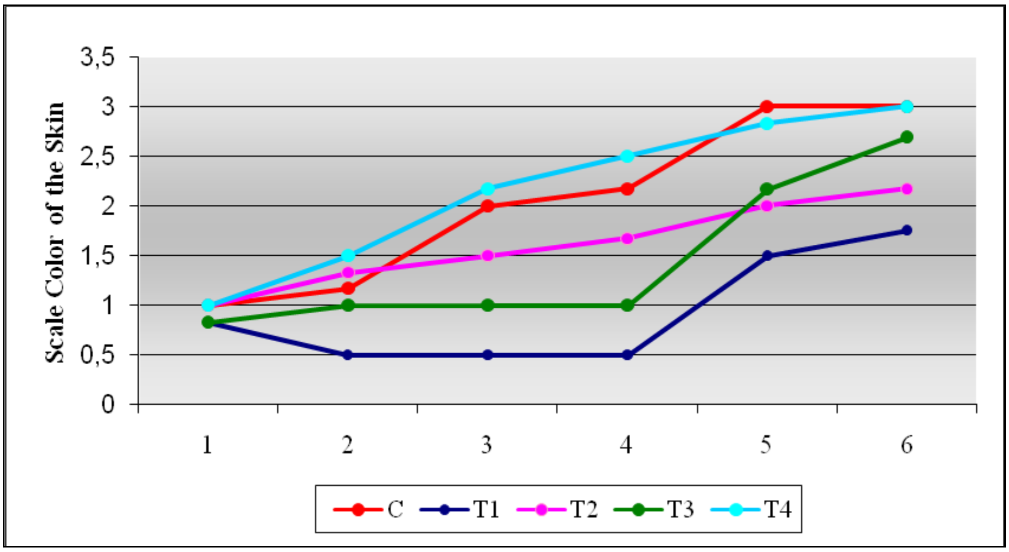

Figure 1. Values of skin color for tomato fruits subjected to different doses of gamma radiation: Control (C) T1 (0.25kGy), T2 (0.5 kGy), T3 (1.0 kGy) and T4 (2.0 kGy).

3.2. pH

The results of pH of tomatoes are presented in Table 2:

Table 2. Averages of pH for tomato fruits subjected to different doses of gamma radiation during storage.

	Day 3	Day 6	Day 9	Day 12	Day 15	Day 20
Treatments						
C (control)	4.70 ± 0.05^{m}	4.58 ± 0.02^{kl}	4.42 ± 0.06^{defg}	4.39 ± 0.08^{bcdef}	4.38 ± 0.03^{bcd}	4.56 ± 0.03^{jkl}
T1 (0.25 kGy)	4.63 ± 0.01^{lm}	4.52 ± 0.09^{ijk}	4.39 ± 0.04^{cdef}	4.42 ± 0.04^{defg}	4.25 ± 0.04^{a}	4.36 ± 0.02^{bcd}
T2 (0.5 kGy)	4.45 ± 0.09^{efghi}	4.46 ± 0.03^{efghi}	4.37 ± 0.06^{bcd}	4.36 ± 0.04^{bcd}	4.32 ± 0.01^{abc}	4.38 ± 0.06^{bcde}
T3 (1.0 kGy)	4.46 ± 0.08^{efghi}	4.50 ± 0.08^{hij}	4.37 ± 0.08^{bcd}	4.46 ± 0.05^{fghi}	4.31 ± 0.04^{ab}	4.36 ± 0.03^{bcd}
T4 (2.0 kGy)	4.38 ± 0.03^{bcde}	4.49 ± 0.03^{ghij}	4.42 ± 0.04^{defg}	4.48 ± 0,04^{ghi}	4.37 ± 0.05^{bcd}	*

Averages followed by the same letter on the line or column do not differ by Tukey test at 5% level of significance.
* data not obtained.

The results indicated a decrease in pH until the ninth day for all treatments and a subtle increase in the twentieth day. This can be explained by the fact that the pH decreases significantly with the signs of aging and increases slightly with the last stage [10]. In fact, at Day 15 the values were the lowest for each treatment considering all dates ($p<0.05$).

The loss of acidity in fruit that has reached maturity is due to the ability to synthesize these organic acids, leading to an increase in pH, as can be observed in Figure 2.

There were also observed oscillations, probably due to intrinsic differences of tomatoes. As this analysis shows low deviation between the measurements, small oscillations in the samples may result in statistical differences that are not necessarily related to treatment or the day of analysis.

Treatment 1 had similar behavior of control group until the twelfth day and since Day 15 they presented significantly differences ($p<0.05$).

However, it is desirable to a pH, values below 4.5 in order to prevent the proliferation of microorganisms [9, 10]. Thus, the gamma radiation has been shown to be effective in T1, T2 and T3. It was not possible to measure the T4 treatment group (2.0 kGy) on the twentieth day, because of lack of the samples for analysis and so a final result on this could not be obtained.

Samples of the control group (C) had a pH around 4.56, slightly undesirable for tomatoes. Thus, the results indicate that the treatments were satisfactory and that the radiation helped to maintain the pH below 4.5.

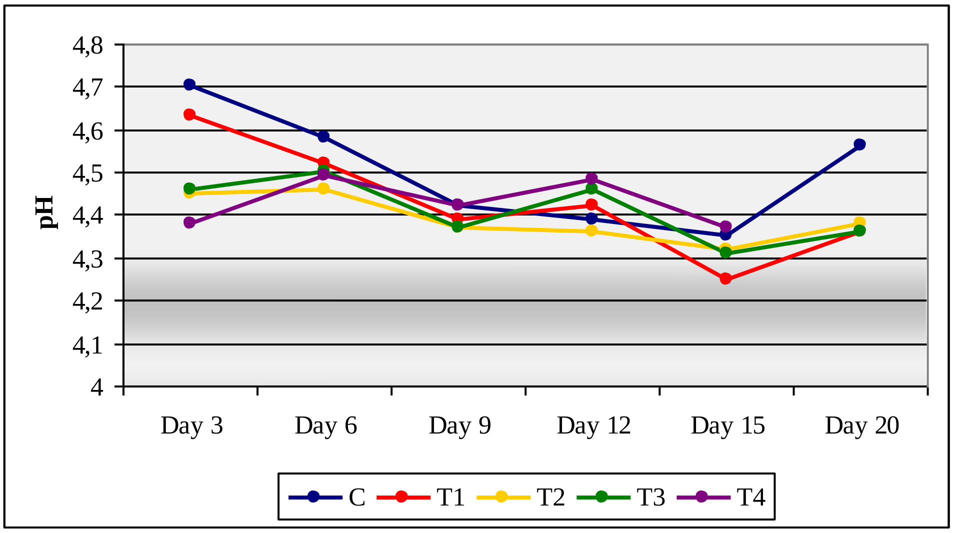

Figure 2. Values of pH for tomato fruits subjected to different doses of gamma radiation: Control (C) T1 (0.25kGy), T2 (0.5 kGy), T3 (1.0 kGy) and T4 (2.0 kGy).

3. CONCLUSIONS

Fruits kept in refrigeration, submitted to four different treatments, showed better results than the control. Treatment 1 (0.25 kGy) proved to be the most effective, both in the extension of skin color of tomatoes (ripening), and in maintaining the pH, which should be kept below 4.5.

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