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Use of ionizing radiation as a technological and structural improvement in fresh and dehydrated *Diospyros Kaki* strong rama

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Food insecurity is a major concern in the world. The Food and Agriculture Organization (FAO) published the report entitled "The State of Food Insecurity in the World" which stressed the need for economic growth to reduce hunger, in addition to the core issues of food insecurity such as food prices, distribution, and availability. Problems related to food preservation and quality were also addressed. [1]

Commonly called persimmon or Japanese persimmon, it is a deciduous plant native to China, Korea, and Japan, which is currently being cultivated in many East Asian and Southern European countries. Diospyros kaki belongs to the family *Ebenaceae* and is considered one of the most important species of the genus *Diospyros* for exotic fruit production. [2]

The fruit is usually consumed *in natura*. However, in some producing regions of the country where Japanese colonization is present, persimmon is industrialized, being used for the preparation of raisins (dehydrated fruit) and the manufacture of vinegar. [3]

The persimmon culture has been gaining importance in Brazil, both for the planted area and for the increase in production, which has driven the increase in the supply of the product for the domestic market, and consequently, boosting producers so that part of the production is exported. According to FAO (Food and Agriculture Organization of the United Nations) data, the world persimmon production in 2007 was 3.3 million tons. China, the largest producer, produced about 2.3 million tons, followed by the Republic of Korea with 345,000 tons, Japan with 240,000 tons, and Brazil, occupying fourth place in the world ranking, producing about 169,000 tons. [3]

The South and Southeast Brazilian regions are the largest producers, led by the São Paulo state. According to data from the IEA (Institute of Agricultural Economics), only the municipality of Mogi das Cruzes (São Paulo), contributed with the production of 49.7 thousand tons of kaki in 2007. [4]

Fruits and vegetables are highly perishable and there are several problems related to their preservation which arise from the moment they are harvested, when a series of processes begins that influence the quality of the product and its consequent losses before reaching the consumer. Due to the extended shelf life and preservation of food, irradiation technology is considered a viable alternative for food processing as it is can provide food safety with nutritional assurance. [3; 5]

The irradiation process applied in different doses to food is able to improve technological properties also reduce insect infestations. However, it is necessary to analyze and measure the characteristics of food exposed to the irradiation process in order to evaluate whether the process in question was able to maintain the essential characteristics of the food after exposure to irradiation. [4; 6; 7]

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The objective of this work was to evaluate the conservation of fresh and dehydrated persimmon fruits based on the exposure of the fruits to the effects of different doses of ionizing radiation, aiming at the maintenance of their characteristics after the process of technological improvement. The use of the irradiation technique demonstrated its efficacy in the conservation of fresh and dehydrated persimmon fruits.

The fresh and dehydrated fruits properly packed were irradiated in a 60Co source, in the Multipurpose Irradiator of the CTR of IPEN/CNEN-SP (dose rate 3 kGy/hour). The doses of 1.0, 3.0, and 5.0 kGy of irradiation were applied to the fresh fruits and 1.0, 3.0, 5.0, and 10 for the dehydrated fruits.

After irradiation, all fresh samples (control and irradiated) were stored at 3.0 ± 5.0 °C in a cold room and the dehydrated samples were stored at room temperature for the appropriate analyses. The color of the samples was determined by Minolta-Chromameter CR 400 colorimeter A Minolta Chroma Colorimeter CR-400 model was used to perform the instrumental color analysis of the irradiated and control samples. This analysis allowed the evaluation of the color attribute, identifying inconsistencies and showing the numerical results, where the L*, a* and b* values were measured, in triplicates for all fresh and dehydrated persimmon samples.

Texture was analyzed using a Stable Micro Systems TA-XT2 texturometer with a 50 kg compression force mode and running at a test speed of 30 mm/s. The irradiated samples were evaluated with homogenized portions and weighed at room temperature. The analysis considered the attributes of firmness, cohesiveness, and chewiness.

In the study of the fresh persimmon samples, it was observed that the coloration of the fruit was maintained between day 1st and day 7th the control sample showed a lower value than the samples with doses 1 and 3 kGy for the L* and b* parameters. For the a* parameter, the control sample had a higher value than the irradiated samples. On 14th, there was no significant difference between the 3 and 5 kGy doses for L* and a*. However, these samples showed considerably lower values compared to day 1 of analysis for the factors L*, a* and b*.

There was a significant difference for the 1 kGy samples throughout the storage period only in the parameter, where this value decreased on day 14 when compared to day 1. In the 3 kGy sample, the difference was less pronounced, and in the irradiated sample, the change in the L*, a*, and b* parameters became visible only after day 28. The fresh persimmon control sample was discarded on day 21, however, by day 7 the clear degradation in fruit coloration could be seen.

In the study of the dehydrated persimmon samples it was observed that the coloration of the fruits was maintained among all the treatments, the control sample presented the same coloration in relation to the samples with doses 1.0, 3.0, 5.0 and 10 kGy for the parameters L* a*, and b*.

There was no significant difference for the 1.0 kGy and 3.0 kGy control samples throughout the storage period. The irradiated samples changed only slightly in relation to the control sample from the 60th day on for the parameters L*, a* and b*.

The fresh samples irradiated with the 3 kGy dose showed greater maintenance of the firmness, cohesiveness, and chewiness properties than the others. In addition, the treatment with 3 kGy provided a longer shelf life that was able to maintain the original properties of the fruit.

At the end of these tests, the efficient doses were determined for the determination of ripening delay, technological improvement, and shelf life of the fresh and dehydrated strong branch

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persimmon fruit, evidencing, through this study, the effectiveness of the food irradiation process on the persimmon fruit at the presented doses.

The firmness test determined in fruits of Giombo persimmon with the help of a texturometer showed relevant results of firmness for the doses 0.3 and 0.6 kGy. Evidencing, therefore, a similarity in the results of fresh persimmons irradiated at 1 kGy, we can see that irradiation at lower doses can contribute to the maintenance of the firmness of the fruits.[8; 9]

The values obtained through the color analysis were in agreement with those found in the literature, so that we conclude that the exposure of the persimmons to low doses of irradiation was promising in the maintenance of these characteristics.

The methodology used had the objective of studying the effects of ionizing radiation on fresh and dehydrated persimmon fruits and, in parallel, to evaluate the influence of irradiation, verifying the efficiency of the irradiation process on these fruits and the resistance of the final product, analyzing the dehydrated fruits after processing with ionizing radiation in physical aspects.

We conclude from the results obtained after color and texture analysis that fresh persimmons irradiated with a dose of 1kGy remained in perfect condition for consumption after 28 days of technological treatment, while the fruit control sample showed degeneration in its quality after 14 days of storage. The dehydrated persimmons remained in perfect condition for consumption up to 60 days after exposure to the irradiation treatment process, thus in both fresh and dehydrated fruit the exposure to technological treatment for conservation by means of gamma rays proved to be efficient.

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