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Identification of gamma-irradiated papaya, melon and watermelon

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Abstract

Ionizing radiation can be used to control spoilage microorganisms and to increase the shelf life of fresh fruits and vegetables in replacement for the treatment with chemical fumigants. In order to enforce labelling regulations, methods for detecting the irradiation treatment directly in the produce are required. Recently, a number of detection methods for irradiated food have been adopted by the Codex Comission. A rapid screening method for qualitative detection of irradiation is the DNA Comet Assay. The applicability of the DNA Comet Assay for distinguishing irradiated papaya, melon, and watermelon was evaluated. The samples were treated in a ^{60}Co facility at dose levels of 0.0, 0.5, 0.75, and 1.0 kGy. The irradiated samples showed typical DNA fragmentation whereas cells from non-irradiated ones appeared intact. In addition to the DNA Comet Assay also the half-embryo test was applied in melon and watermelon to detect the irradiation treatment.

Keywords: Gamma radiation; Detection; DNA comet assay; Half-embryo test; Papaya; Melon; Watermelon

1. Introduction

Food irradiation is a means of preservation, it is used to extend commodity shelf life. Irradiation has been considered as a potential alternative to quarantine treatments for international trade of fresh fruits and vegetables (ICGFI, 1994), so it can be used as a replacement for chemical fumigants such as methyl bromide that is being phased out (Marcotte, 1998). Insects are prevented from maturing or are sterilized or killed by radiation treatment (Johnson and Marcotte, 1999). In the USA, an irradiation phytosanitary treatment of imported fruits and vegetables has recently been authorized by APHIS/USDA (APHIS/USDA, 2002). Worldwide, an International Plant Protection Convention (IPPC) standard for the use of irradiation as a phytosanitary measure has been adopted in 2003 (www.ippc.int/IPP/En/default.htm). Correct and comprehensive information about food irradiation and irradiated food must reach consumers in order to enable them to reach decisions based on well-founded reasons (Delincée, 1998a, b). At present, in Europe a number of standard detection methods have been approved (Delincée, 2002a, b). The DNA Comet Assay is one of them and it detects DNA damage induced by ionizing radiation. This method has been studied in many food items such as meat, fish, grains, and fruits (CEN. EN 13784, 2001). In this paper, the DNA Comet Assay was applied in papaya, melon, and watermelon for

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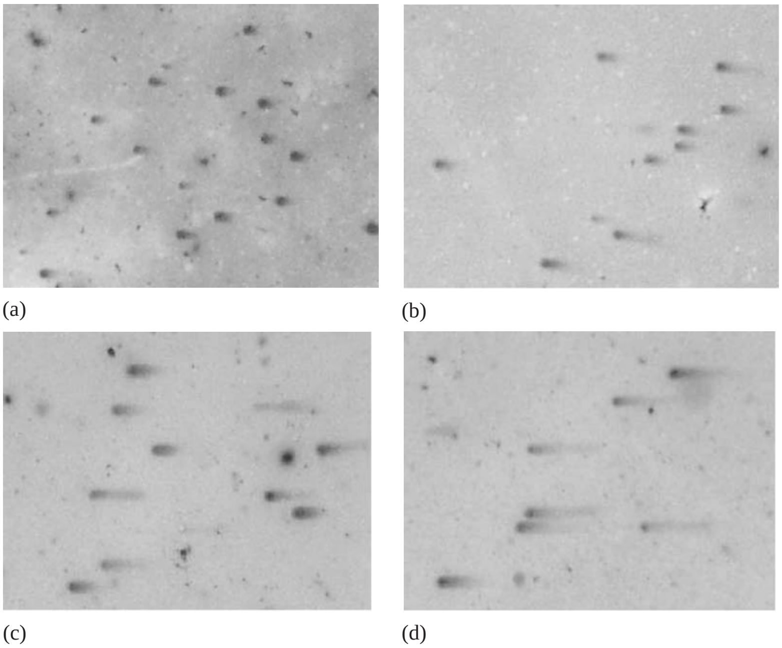

Fig. 1. DNA Comet Assay of papaya. Silver staining; anode to the right: (a) non-irradiated; (b) 0.5 kGy; (c) 0.75 kGy; (d) 1.0 kGy.

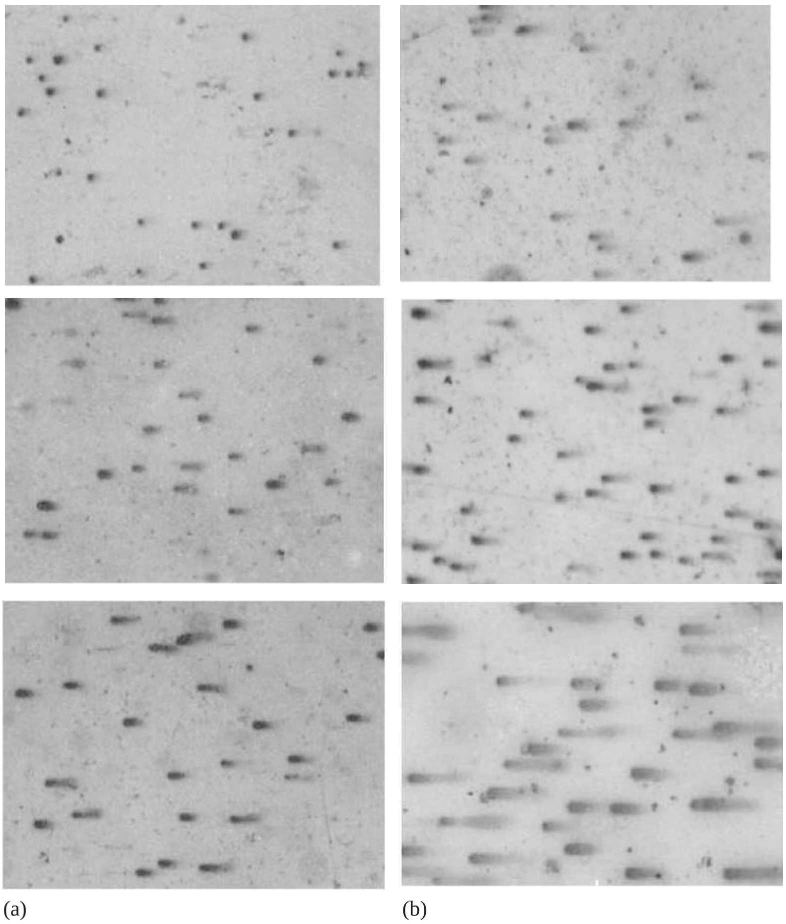

Fig. 2. DNA Comet Assay of melon (a) and watermelon (b). Silver staining, anode to the right. Non-irradiated, 0.5, and 0.75 kGy (top to bottom).

identifying gamma ray treatment. In this study, also a simple germination test was applied in melon and watermelon as a fast method to detect irradiation treatment (Villavicencio et al., 1997).

2. Experimental

2.1. Samples

Three samples of each fruit: papaya, melon, and watermelon were obtained from the local market in São Paulo, Brazil.

2.2. Irradiation

The samples were treated with ionizing radiation using a ^{60}Co gamma ray facility (Gammacell 220, A.E.C.L., dose rate: 5.37 kGy/h) at dose levels: 0.0, 0.5, 0.75, and 1.0 kGy. Harwell Amber 3042 Dosimeters were used for the measurement of radiation dose.

2.3. Methodology

The DNA Comet Assay was carried out as described in the European Standard EN 13784 (CEN. EN 13784, 2001). In the half-embryo test (Kawamura et al., 1996), 12 half-embryos of each melon and watermelon, for each dose level, were incubated at 32°C and germination percentage and root growth were evaluated for 4 days. Experiments were carried out three times.

3. Results and discussion

By a glance at a slide of non-irradiated papaya samples, nearly intact cells and some shorter comets were observed. However, the comets for samples irradiated to up 1.0 kGy were relatively longer as shown in Fig. 1.

The results for melon and watermelon are shown in Fig. 2. It can be observed that irradiated cells show an increased extension of DNA t as compared to control cells. Tails of the comets of watermelon were longer than those of melon.

In fruits analyzed in the present study, the tails of the comets of irradiated samples to up 1.0 kGy increased in length but not in width. Although differentiation may sometimes be difficult at the lowest radiation dose (0.5 kGy) applied, at higher doses the irradiated samples could easily be discerned from the non-irradiated ones. An important characteristic was that irradiated samples did virtually not show intact cells in agreement with the measurements in fresh and frozen rainbow trout, and red lentils (Khan and Delincée, 1998), grapefruits (Delincée, 1998a, b), frozen hamburgers (Delincée, 2002a, b), spices such as poppy seeds, cardamom seeds, caraway seeds, and nigella seeds (Khan et al., 2002).

In the half-embryo test, on the first day after incubation, irradiated samples of melon at doses of 0.5 and 0.75 kGy reached 100% of germination as well as the control. After that day all half-embryos germinated. In watermelon, on the second day after incubation, all irradiated half-embryos to up 0.75 kGy germinated, whereas the germination percentage of the samples irradiated at 1.0 kGy was 92%. With regard to root growth, clear differences between irradiated and non-irradiated samples were observed from the second and third day after incubation for melon and watermelon, respectively, as illustrated in Fig. 3. Roots of irradiated samples were markedly reduced and very limited secondary root elongation was observed. In this method, root elongation inhibition was a good parameter to discern non-irradiated samples from irradiated ones.

In this study, only screening tests were applied in order to have a fast irradiation treatment detection. To confirm those results, other expensive and time consuming methods could be applied, such as the electron spin resonance (ESR) method (EN 1787) and

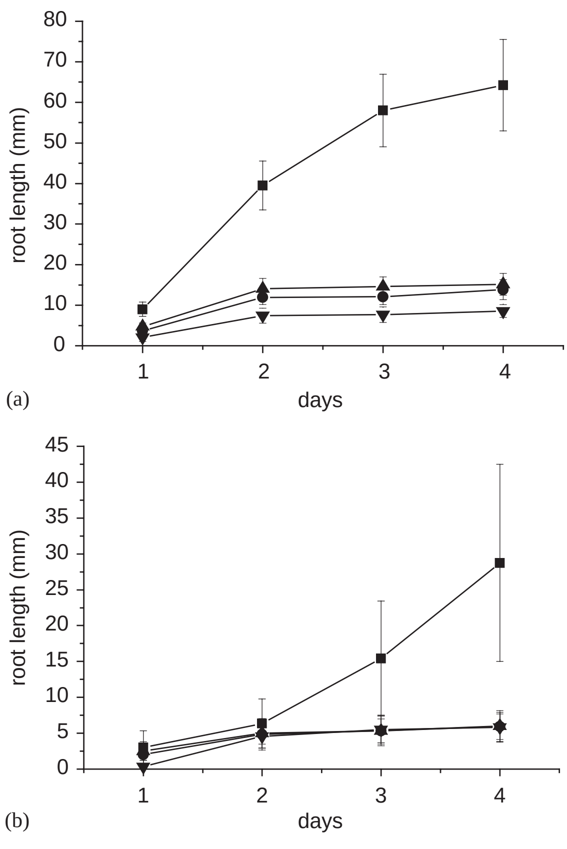

Fig. 3. Effect of gamma radiation on the root growth of half-embryos of melon (a) and watermelon (b) 0.0 kGy (■), 0.5 kGy (▲), 0.75 kGy (●), 1.0 kGy (▼).

Gas Chromatography and Mass Espectrometry (CG-MS) method (EN 1784) (Delincée, 1998a, b).

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