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Effects of irradiation on natural antioxidants of cinnamon (*Cinnamomum zeylanicum* N.)

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Abstract

Food irradiation to reduce the number of spoilage microorganisms and insects is an ionizing process that induces free radical formation in proteins, lipids, carbohydrates and other molecular structures in food. Antioxidants generally decrease the level of oxidation in such systems by transferring hydrogen atoms to the free radical structure. In the present paper, the effect of ionizing radiation on natural cinnamon antioxidants is studied. Cinnamon samples were purchased from retailers and irradiated with a ^{60}Co source, Gammacell 220 (A.E.C.L.) installed at IPEN (São Paulo, Brazil) using 0, 5, 10, 15, 20, 25 kGy at room temperature. After irradiation 3 kinds of sequential extractions were performed. One was submitted to antioxidant extraction using ethyl ether, the second with ethanol and the last with water. The antioxidant activity was determined by β-carotene/linoleic acid co-oxidation. Irradiation in the dose range applied did not have any effect on the antioxidant potential of the cinnamon compounds. Further studies will be performed to study the possibility to use cinnamon extracts in preserving food from oxidative damage induced by ionizing radiation.

Keywords: Cinnamon; Antioxidants; Phenolic compounds; Irradiation

1. Introduction

Cinnamon tree (*Cinnamomum zeylanicum* N.) is native in South-West Asia, e.g. Sri Lanka, and the bark is sold in powder, scraping and branches.

Phenolic compounds present in spices that show natural antioxidant properties have been studied for substitution of synthetic antioxidants, due to possible side effects of synthetic antioxidants which may in some circumstances act deleterious to animal organisms (Pratt, 1992).

Antioxidants are regarded as compounds that are able to delay, retard or prevent oxidation processes. They can interfere with oxidation by reacting with free radicals, chelating metals and also by acting as oxygen scavengers, triplet as well as singlet form and transferring hydrogen atoms to the free radical structure (Torres et al., 2002).

Food irradiation is the processing of food products by ionizing radiation in order to, control foodborne pathogens, reduce microbial load and insect infestation,

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inhibit the germination of root crops, and extend the durable life of perishable produce. Irradiation of dried food ingredients, particularly herbs and spices, has a great application potential, and has already been implemented in many countries. The amount of spices irradiated commercially has been estimated in 2002 to reach about 1,00 000 tons world-wide. Spice irradiation is performed to increase the hygienic quality of spices by reducing the number of pathogenic and spoilage microorganisms (Farkas, 2001). Radiation doses up to 30 kGy have been authorized for decontamination (www.iaea.org/icgfi). Irradiation replaces previous decontamination processes such as fumigation of spices with ethylene oxide. The toxicity of ethylene oxide and its reactants has led to its ban in various countries, e.g. in the European Community, and irradiation provides an effective residue-free alternative. Although the effect of irradiation on the antioxidant properties of some spices has been studied (Kuruppu et al., 1985; Farag and El-Khawas, 1996; Chatterjee et al., 1999), this has not been the case for cinnamon. The present paper evaluates the effect of ionizing radiation on natural antioxidants of cinnamon (*Cinnamomum zeylanicum* N.) by estimating the antioxidant activities of their extracts.

2. Experimental

2.1. Samples

Cinnamon powder (1 kg) was obtained at the local market in São Paulo.

2.2. Irradiation

The aliquot samples with 50 g each, were irradiated in polyethylene packaging in a ^{60}Co, Gammacell 220 (A.E.C.L.), installed in Instituto de Pesquisas Energéticas e Nucleares — IPEN (São Paulo, Brazil). The applied radiation doses were 0, 5, 10, 15, 20, 25 kGy (dose-rate ~5,41 kGy/h) at room temperature to each one sample. Harwell Amber 3042 Dosimeters were used for the measurement of radiation dose (± 10%).

2.3. Extracts

After irradiation samples were submitted to sequential extraction using as solvents (increasing polarity of the solvent): ether, ethanol and distilled water, using the proportion of 1:5 g/ml to ether and ethanol extracts and 1:25 g/ml to aqueous extracts.The amount of dry material in each extract was determined gravimetrically.

2.4. Antioxidant activity

The antioxidant activity of cinnamon extracts at different radiation doses was evaluated using the β-carotene/linoleic acid system in vitro as described by Marco (1968) and modified by Miller (1971). This system was placed in a water bath at 50°C and absorbance reading at 470 nm every 15 min intervals for 120 min with Spectronic 20 D apparatus (Milton Roy Company).

Different concentrations were tested, based on the amount of dry material in each extract. Two controls were used in the determination of antioxidant activity: one without antioxidant (Blank) and another with the synthetic antioxidant BHT (butylhydroxytoluene) at the same concentrations as the extracts.

3. Results and discussion

Ether, ethanol and aqueous extracts were obtained through sequential extraction. Ether and ethanol extractions were carried out at the ratio 1:5 (g/ml) and aqueous extraction at 1:25 (g/ml). Pectin and other carbohydrates present in cinnamon caused the solution to be of high viscosity. Increasing the radiation doses at 20 and 25 kGy, it was no longer possible to obtain ether extracts. Some lipid drops occurred which affected the sample homogeneity and solubility. In addition, the formation of a precipitate could be observed.

The antioxidant activity was evaluated with the β-carotene/linoleic system. This spectrophotometric method is based on the ability of the different extracts to decrease oxidative losses of β-carotene in an emulsion (Melo and Mancini-Filho, 1991). The antioxidant activity of the extracts, and of BHT as a positive control was calculated as percentage in comparison with the oxidation of linoleic and β-carotene without antioxidant (100% oxidation - Blank) (Moreira, 1999). BHT effectively inhibited lipid oxidation, and antioxidant activities of 84.5%, 88.0%, 90.6%, 91.1%, 91.2% and 94.3% were measured at concentrations of 50, 100, 200, 400, 800 and 1600 ppm.

The highest antioxidant activities were found at 400 ppm concentration of ether extract. Concentrations of 800 and 1600 ppm could not be evaluated, since the solutions were getting too dark for reading the absorbance in the spectrophotometer. For ethanol extracts, the highest antioxidant activities were found at 1600 ppm, however, the percentage of antioxidant activity was less than 50%. Using the aqueous extracts, it was not possible to detect antioxidant activity for concentrations up to 200 ppm. A low antioxidant activity was observed at 400 ppm and the best results were at 1600 ppm.

4. Conclusions

The results indicate that the ether, ethanol and aqueous extracts of irradiated cinnamon possess antioxidant activity that can be measured by the β-carotene/linoleic acid system. The highest antioxidant activities were obtained for the ether extracts. As expected, the antioxidant activities of the cinnamon extracts increased with concentration. Irradiation did not abolish the antioxidant activities of cinnamon to a great extent, although a small decrease was observed at 20–25 kGy.

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