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Comparison of γ-radiation and electron beam irradiation effects on gelatin

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Abstract

Gelatin is a heterogeneous mixture of water-soluble proteins of high average molecular weight derived by hydrolytic action from collagen, a protein of mammal external protective tissues. There are many characteristics of a material that can indicate its quality or performance in its intended use. The knowledge of a material's rheological characteristics is valuable to predict its pourability, its performance in a dipping or coating operation or the ease with which it may be handled, processed or used. In this work bovine powder gelatin was submitted to γ-radiation from a ^{60}Co source, dose rate about 7 kGy/h and to electron beam irradiation, dose rate about 11 kGy/s. The doses applied were 5, 10, 20 and 50 kGy. The radiation effects were measured following viscosity changes at 40°C of gelatin powder 10% aqueous solutions. The relationship between the decrease in viscosity of gelatin solutions and radiation dose presented close comparable values for both irradiation processes.

Keywords: Gelatin; Ionizing radiation; Viscosity

1. Introduction

Gelatin is a heterogeneous mixture of water-soluble proteins of high average molecular mass not found in nature but derived by hydrolytic action from collagen, a protein of mammal external protective tissues, by boiling skin, tendons, ligaments, bones, etc., with water. Although rich in glycine, proline and hidroxyproline, gelatin is nutritionally an incomplete protein lacking tryptophan but containing small amounts of other important amino acids. It swells up and absorbs 5–10 times its weight of water to form a gel in solutions below 35–40°C. Commercially gelatin is presented as a colorless or slightly yellow, transparent, brittle, practically odorless, tasteless sheets, flakes or coarse powder. Their uses include not only food (confectionery, jellies, ice cream) and pharmaceutical technology but also manufacturing of rubber substitutes, adhesives, photographic plates and films, matches and clarifying agent (Windholz, 1976; Anonymous, 1980; Jones, 1997; Choi and Regenstein, 2000).

There are many characteristics of a material that can indicate its quality or performance in its intended use. The knowledge of a material's rheological characteristics is valuable to predict its pourability, its performance in a dipping or coating operation or the ease with which it may be handled, processed or used. Viscosity is the principal parameter that characterizes the flow properties of fluids such as liquids, semi-solids, gases, and even solids (Howard, 1991).

Ionizing radiations which can be used for the treatment of foods to preserve quality are: γ-rays from ^{60}Co and ^{137}Cs, accelerated electrons from a machine at an energy of 10 MeV or lower and X-rays from a machine at an energy of 5 MeV or lower (Thayer, 1990; ICGFI, 1992). Wholesomeness of food irradiated even with high doses (above 10 kGy) was confirmed (WHO, 1999).

In this work we compared the effects of ^{60}Co γ-radiation and electron beam (EB) irradiation on the viscosity of gelatin.

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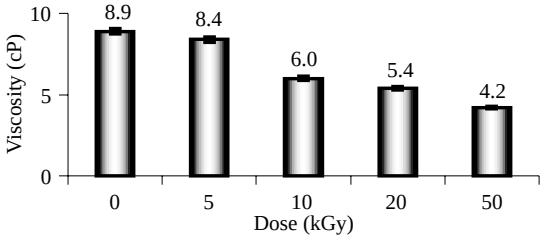

Fig. 1. Viscosity of gelatin vs radiation dose (electron beam).

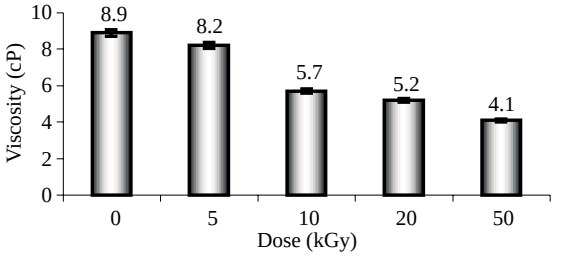

Fig. 2. Viscosity of gelatin vs radiation dose (γ-cell 220).

2. Materials and methods

Bovine powder gelatin (five grams cellophane packaged samples) was submitted to γ-radiation from a ^{60}Co source, dose rate about 7 kGy/h and to EB irradiation, dose rate about 11 kGy/s. The doses applied were 0, 5, 10, 20 and 50 kGy. The radiation effects were measured following viscosity changes at 40°C of gelatin powder 10% aqueous solutions using a Brookfield viscometer, model DVIII, spindle SC4-18, with Rheocalc software. Viscosity measurements were performed according to our previous experience (Aliste and del Mastro, 2000) and the results are the means of at least three experiments.

3. Results and discussion

Although a lot of data are available on the comparative effectiveness of the two types of radiation (Hayashi, 1991), whether or not there is any difference in the effect on foods between γ-rays and accelerated electrons is still controversial. In the present work, the viscosity of gelatin solutions was reduced as a consequence of irradiation in both cases (Figs. 1 and 2). For ^{60}Co- and EB irradiated samples, the results were 8.9, 8.2, 5.7, 5.2 and 4.1 cP and 8.9, 8.4, 6.0, 5.4 and 4.2 cP for the doses of 0, 5, 10, 20 and 50 kGy, respectively. The relationship between the decrease in viscosity of gelatin solutions and radiation dose presented close comparable values for both irradiation processes. It means that no difference on chemical reactions conducting to physical effects between γ-rays and electron beams could be established under our conditions.

While most of the commercial food irradiations are conducted with γ-rays from ^{60}Co, accelerated electrons are increasingly utilized for treating foods. This sort of comparative study on the effects of gamma-rays and electron beams are of great importance for establishing proper irradiation conditions and need to be completed with sensory analysis.

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