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Radiation effects on viscosimetry of protein based solutions

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Abstract

Due to their good functional properties allied to their excellent nutritional value, milk protein isolates and soy protein concentrates have gained a crescent interest. These proteins could have their structural properties improved when some treatments are applied, such as gamma irradiation, alone or in presence of other compounds, as a plasticizer. In this work, solutions of those proteins were mixed with a generally recognized as safe plasticizer, glycerol. These mixtures (8% protein (w/v) base) at two ratios 1:1 and 2:1 (protein:glycerol) were submitted to a gamma irradiation treatment (^{60}Co), at doses 0, 5, 15 and 25 kGy, and their rheological performance was studied. As irradiation dose increased viscosity measurements decayed significantly ($p<0.05$) for mixture soy/glycerol and calcium caseinate/glycerol. The mixture sodium caseinate/glycerol showed a trend to form aggregation of macromolecules with dose of 5 kGy, while the apparent viscosity for dispersions containing whey/glycerol remained almost constant as irradiation dose increases. In the case of soy protein isolate and sodium caseinate, a mixture of 2:1 showed a significant higher viscosity ($p<0.05$) than a mixture of 1:1. © 2002 Elsevier Science Ltd. All rights reserved.

Keywords: Viscosimetry; Soy protein; Whey protein; Caseinates; Gamma irradiation

1. Introduction

The two major types of proteins in milk are caseins and the whey proteins. Due to their high cost, individual casein fractions have not been extensively studied in the past. Commercially available caseinates have been explored instead. Soy protein isolate (SPI) is a mixture of proteins with different molecular properties. Most soy proteins (90%) are storage proteins (globulins). These kinds of ingredients have gained a crescent interest owing to their excellent nutritional value and their numerous functional properties.

Protein solutions mixed with glycerol have been studied related to their moist and plasticizer functions (Stuchell and Krochta, 1994). Plasticizer added in protein based solutions and combined to the gamma irradiation process showed a better cohesion force (Brault et al., 1997).

Food is submitted to gamma irradiation process for different purposes. Among the several benefits, a food or an ingredient is irradiated to assure a chemical change in such a way a specific characteristic could be improved or its processability be facilitated.

Envisioning future developments evolving these kind of mixtures, this preliminary study was aimed to verify the effects of gamma irradiation (^{60}Co) on the rheological behaviour of mixtures of proteins (soy, caseinates and whey) and glycerol. The studies were conducted without heating treatment in order to examine only the effect of the irradiation process.

2. Experimental

2.1. Materials

Sodium caseinate (Alanate 185), calcium caseinate (Alanate 385) and whey protein concentrate (Alacen 392) were provided by New Zealand Milk Products, New Zealand. Soy protein isolate (Samprosoy 90MP) was kindly supplied by Santista-Ceval, SP, Brazil.

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Glycerol, 99.5%, was from CAAL, SP, Brazil. Dispersions containing proteins and glycerol at ratios (1:1 and 2:1, protein:glycerol) were prepared in distilled water with a total protein concentration of 8% (w/v). The pH values were between 6.8 and 7.2. The solutions were kept at 4°C until irradiation and measuring.

2.2. Irradiation

Irradiations were performed in a ^{60}Co Gammacell 220 (AECL), at a mean dose rate of 8.2 kGy/h and dose uniformity factor of 1.13, with doses of 0, 5, 15 and 25 kGy.

2.3. Viscosimetry

Viscosity measurements were carried out using a Brookfield viscometer, model LV-DVIII, spindle SC4-18 and SC4-31, as described previously (Bernardes and Del Mastro, 1994), at temperature at 10.0°C±0.1°C, employing a Neslab water bath. For each measurement, five replicates were carried out.

3. Results and discussion

The rheological behaviour of dispersions containing proteins (whey, caseinates and soy) and glycerol is presented in Figs. 1–4, where viscosity measurements are plotted against irradiation doses. The irradiation was conducted in the natural atmosphere and the solutions were solubilized without thermal treatment in order to verify the irradiation effect isolated.

The viscosity measurements diminished with the irradiation dose for the dispersions of soy and glycerol at ratios 1:1 and 2:1 (Fig. 1). These reductions were of 12%, 53% and 66% for dispersions at ratio 2:1 and 19%, 58% and 70% for dispersion at ratio 1:1, as the irradiation dose increases (5, 15 and 25 kGy, respectively). A recent work presents reductions around 51% and 66% for agar, carrageenan and alginate, when submitted to an irradiation dose of 10 kGy (Aliste et al.,

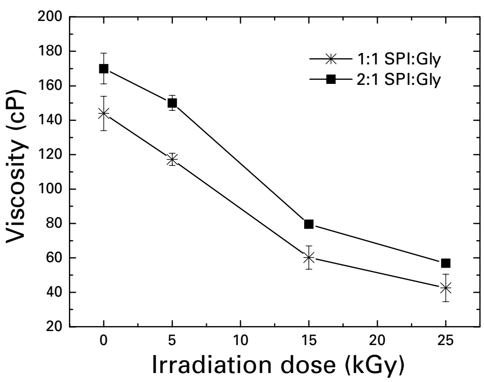

Fig. 1. Viscosity of soy protein isolate and glycerol solution vs. irradiation dose.

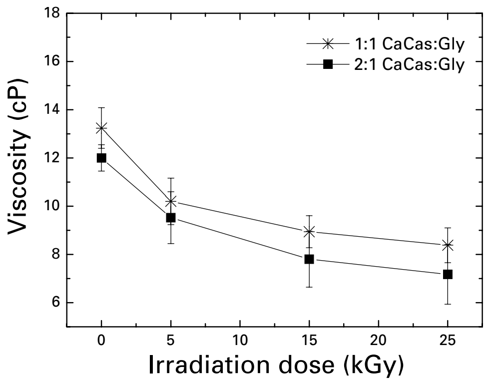

Fig. 2. Viscosity of calcium caseinate and glycerol solution vs. irradiation dose.

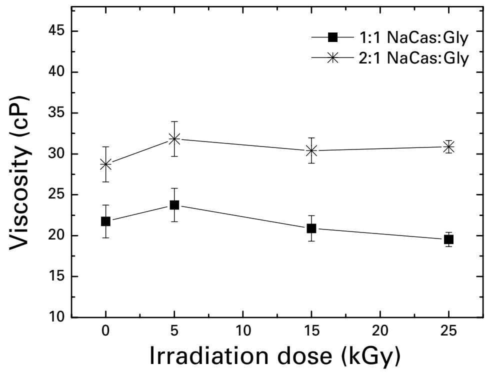

Fig. 3. Viscosity of sodium caseinate and glycerol solution vs. irradiation dose.

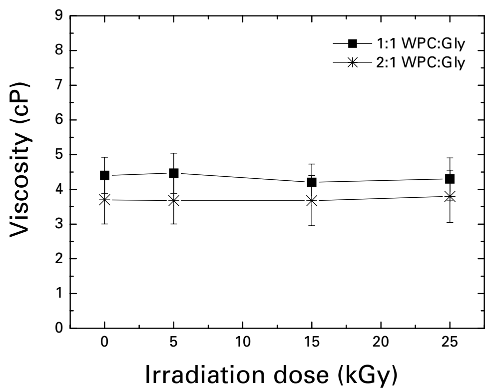

Fig. 4. Viscosity of whey protein concentrate and glycerol solution vs. irradiation dose.

2000). In fact, polysaccharides are more radiosensitive than proteins. The viscosity values for dispersions containing less glycerol (2:1) were higher than the dispersions with protein and glycerol at the same level (ratio 1:1).

Similar behaviour is found for dispersions containing calcium caseinate and glycerol, i.e., as irradiation dose increases the viscosity diminishes (Fig. 2). For the ratio 2:1, reductions of 21%, 35% and 40% were found for irradiation doses of 5, 15 and 25 kGy, respectively; for the ratio 1:1, the values were 23%, 33% and 37%, respectively.

The apparent viscosity for dispersions containing either sodium caseinate with glycerol, or whey with glycerol remained almost constant (Figs. 3 and 4, respectively) when irradiation dose increased. Sodium caseinate showed a trend to form aggregation of macromolecules at a dose of 5 kGy, as can be observed by the increase of viscosity at this dose for both ratios (1:1 and 2:1) studied.

4. Conclusion

Dispersions containing soy with glycerol and calcium caseinate with glycerol had their viscosity diminished and this degradation can be attributed to the irradiation process, once no thermal treatment was applied. Recent works have been demonstrated that the aggregation of proteins solutions is possible when combined treatments (thermal and irradiation) are applied (Mezgheni et al., 1998). Further studies will consider combined treatments to verify the rheological performance of protein-based mixtures in order to compare with the present study.

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