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RADIATION SENSITIVITY OF DIFFERENT CITRIC PECTINS

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ABSTRACT

Pectic substances are important soluble polysaccharides of plant origin of considerable interest for food industry as gelling agent and stabilizer in jams, fruit jellies, yogurt drinks and lactic acid beverages. Polysaccharides can be degraded by ionizing radiation due to the free radical induced scission of the glycosidic bonds. Viscosity methods had been used to determine the efficiency of hydroxyl radical induced chain breaks generation in macromolecules. In the present work samples of pectin with different degree of methoxylation were employed in order to study their radiation sensitivity by means of viscosity measurements. Samples of citric pectin 1% solutions were irradiated with gamma rays at different doses, ranging from 0 to 15kGy, using a ^{60}Co Gammacell 220 (AECL), dose rate about 2kGy/h. After irradiation the viscosity was measured on the viscometer Brookfield model LV-DVIII at 50, 60 and 70ºC within a period of 48h. Pectin viscosity with high degree of methoxylation decreased sharply with the radiation dose remaining almost constant from 10kGy. Pectin with low degree of methoxylation presented initially higher values of viscosity and the radiation induced decrease was also pronounced. Viscosity measurements decreased with the increase of the temperature applied for both kind of samples. The effect of radiation induced chain breaks generation in pectin molecules was evident through the viscosity reduction of irradiated pectin solutions although the viscosity presented diverse values depending of the degree of methoxylation of carboxyl groups in the backbone of polysaccharide macromolecules.

1. INTRODUCTION

Pectin is one of the main components in citrus by-products. Pectin is composed of galacturanoglicans [poli (α-D-acid galactopiranosiluronic)] contained by many methyl ester groups, connected in D-poligalacturonase sequence interrupted with (1-2)-L-ramnose residues [1,2]. Commercially pectin is presented as a colorless or slightly yellow, brittle, practically odorless, tasteless sheets and powder. Their uses include not only food (confectionery, jellies, emulsificants) and pharmaceutical technology but also manufacturing of adhesives, edible films, coating and as a fiber. Prebiotics, usually polysaccharides like pectin exhibit strong bio-activity and the ingestion of them has been shown to reduce the rate of infection and restore health in sick and postoperative patients [3]. Pectin also had shown the capability of being used as internal decontaminant by their property of trapping radionuclides [4].

A wide variety of beneficial effects can be yield by the treatment of food by irradiation, including longer shelf life, destruction of insects and parasites, inhibition of microorganisms, delay of ripening of fruits and vegetables and preventing sprouts of tubercles [5,6,7,8].

Radiation processing can cause a variety of modifications, all of which have found useful industrial applications. These modifications include: cross-linking, in which polymer chains are joined and a higher molecular mass network is formed [9]. Cross-linking usually brings about an improvement in mechanical properties, chemical resistance, thermal stability and

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other important properties [10]. Radiation can also induce polymeric degradation, in which the molecular mass of a polymer is reduced though chain scissioning. With the reduction of molecular mass, the melt flow of the polymer increases and particle size can be reduced.

Ionizing radiation can be applied to improve the safety of foods by reducing or eliminating food borne pathogens [11].

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 [12]. Viscosity measurement can be a powerful tool in product design, as well as quality and engineering applications providing food products with quantifiable attributes [13]. In the present work samples of pectin with different degree of methoxylation were employed in order to study their radiation sensitivity by means of viscosity measurements.

2. MATERIAL AND METHODS

2.1. Material

Citrus h igh methoxyl pectin (HMP), degree of esterification about 72%, was provided as a courtesy from CPKelco do Brasil S/A.- Pectin GENU® type B rapid set-Z (lot: L54013) and low methoxyl pectin (LMP), degree of esterification < 50%, was provided as a courtesy from Plury Química Ltda – Citrus Pectin GENU BTM Type 8002 (lot: L42056). Assays were done with HMP 1% (w/v) and LMP 1% (w/v) dissolved each one in 300 mL of distilled water in a water bath at 60°C and then stirred vigorously.

2.2. Irradiation

Pectin solutions contained in glass recipients were irradiated with doses of: 1; 3; 5; 10 and 15kGy in a ^{60}Co Gammacell 220 (AECL) source, dose rate about 2kGy/h, dose uniformity factor of 1.13.

2.3. Viscosimetry

The radiation effects were measured following viscosity changes at 50, 60 and 70°C using a Brookfield viscometer; model LV-DVIII, spindle SC4-18, with Rheocalc software with an adapter ULA and a Neslab water bath model RTE-210, precision ± 0,1°C. Viscosity measurements were performed according to our previous experience [14] and the results are the means of at least 5 readings.

3. RESULTS AND DISCUSSION

Ionizing radiation acts on polysaccharydes by breaking C-C bonds and forming acid and reductive groups [15]. In irradiated dilute aqueous solution, the solvent absorbs practically all the radiation energy and the water radicals generated by the absorption of ionizing radiation

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interact with the solute. Then, radiation effects are caused by the water radicals •OH, hydrated electrons, e^-_{aq}, and H atoms [16]. Further processes in the system depends to certain extend on the chemical structure of the polymer but can be assume as chain scission, hydrogen transfer as well as inter- and intramolecular recombination.

For the polymers studied in this work, chain scission seems to play an important role and a drastic decrease of viscosity can be observed for both HMP and LMP samples. Citrus pectin with low methoxyl content (LMP) presented initially higher values of viscosity and the radiation induced decrease was pronounced as is shown in the Fig. 1. For pectin with high degree of metoxilation (HMP) initial viscosity values were lower and also decreased sharply with the radiation dose remaining almost constant from 10kGy as shown in Fig. 2, suggesting a high radiosensitivity of this polysaccharide. Some data from the literature also described that different polysaccharides are differently affected by radiation [17].

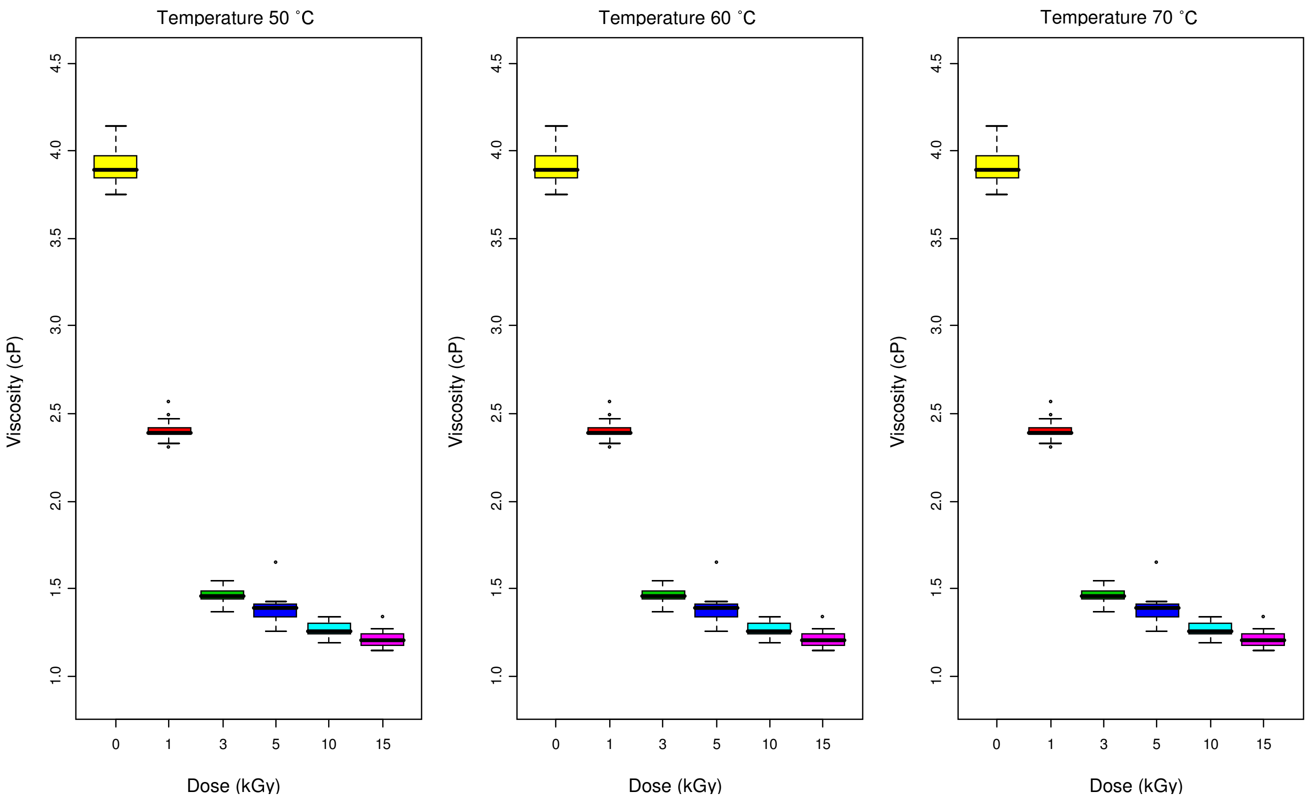

Figure 1. Viscosity vs radiation dose for 1% LM Pectin, at 250 rpm at 50, 60 e 70 °C.

According to Wahba & Massey [18] pectin is essentially a linear polyionic molecule which is sensitive to oxidative and hydrolytic scission by radiation and chemical means. The effect of radiation induced chain breaks generation in pectin molecules was evident in the present work through the viscosity reduction of irradiated pectin solutions although the decrease in viscosity followed a diverse pattern depending of the degree of methoxylation of carboxyl groups in the backbone of polysaccharide macromolecules.

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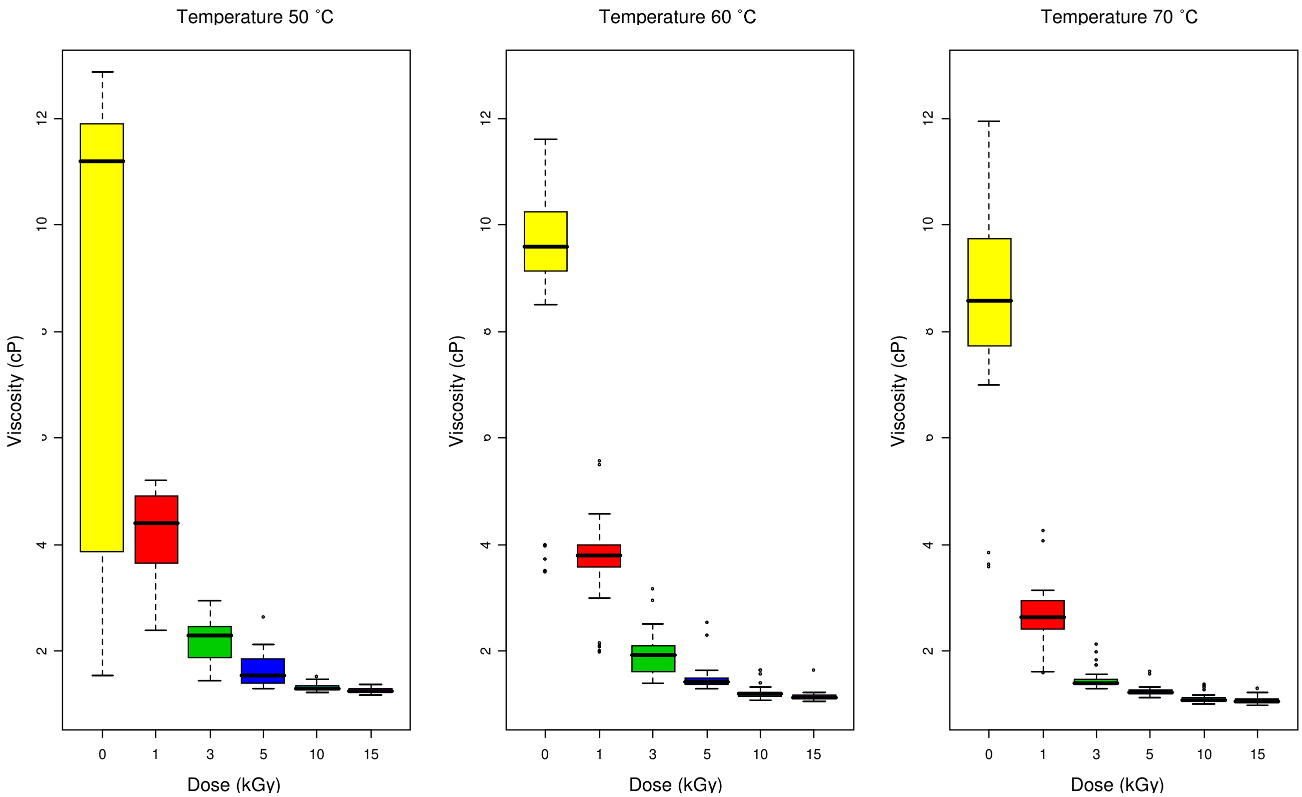

Figure 2. Viscosity vs radiation dose for 1% HM Pectin, at 250 rpm at 50, 60 e 70 °C.

4. CONCLUSION

The increasing of radiation dose caused an exponential decrease of viscosity, although LMP and HMP presented diverse values of viscosity depending of the degree of methoxylation of carboxyl groups in the backbone of polysaccharide macromolecules. Like other polysaccharides [19] the viscosity of pectin solutions showed a slight reduction with the increase of temperature in the range of 50-70°C although no statistical significance could be perceived.

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