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RHEOLOGICAL BEHAVIOR OF GAMMA-IRRADIATED CASSAVA (*MANIHOT ESCULENTA* CRANTZ) STARCH

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ABSTRACT

Cassava starch is the by-product of the process of pressing water out of cassava to make cassava meal. The juice has a fine starch, similar to rice or potato starch that, when dried, yields *polvilho doce* (sweet manioc starch); from the fermented juice comes *polvilho azedo* (sour manioc starch). Cassava starch can perform most of the functions where maize, rice and wheat starch are currently used. The aim of the present work was to determine the influence or ionizing radiation on the rheological behavior of aqueous preparations of gamma-irradiated cassava starch at different concentrations. Samples of polvilho doce and polvilho azedo were obtained at the local market and irradiated in plastic bags in a Gammacell 220 with doses of 1, 3 e 5 kGy, dose rate ~1.2 kGy h-1. A Brooksfield viscometer was employed for the viscosity measurements. The results showed a strong dependence of the viscosity with the concentration of the starch solutions. In most of the cases there was a decrease of viscosity with the increase of the radiation dose usually seen in irradiated polysaccharides. Nevertheless, the dose response relation of the two kind of starch was different.
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1. INTRODUCTION

Cassava starch is a typical food ingredient from some South American countries, produced mainly in Brazil and Colombia. This powdery, flour-like ingredient comes from the cassava (also known as manioc, yucca or mandioca). In many tropical countries, this root vegetable gets pressed in order to make cassava meal, thereby releasing starchy juices that, when dried, is called manioc starch. The difference among sour manioc starch (*povilho azedo*) and manioc starch (also known as sweet manioc starch or *poviho doce*) is that sour manioc starch undergoes a natural fermentation process. As a result, manioc starch (the sweet one) has a much finer consistency and more delicate texture than sour manioc starch. You can't substitute one for the other, as they bring different flavors and textures to baked goods [1]. According to Sriroth et al. [2] starches extracted from cassava roots harvested at different times are characterized by unique starch granule structure and function. Granule size distribution is affected by age of the root, and the integrity and crystalline structure of starch granules also depends on the environmental conditions, evidenced as a change in peak profile obtained by thermal analysis. This can result in the difference in water uptake of starches, and their consequent swelling power and gelatinization.
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The aim of the present work was to determine the influence or ionizing radiation coming from a gamma source on the rheological behavior of aqueous preparations of irradiated cassava starch at different concentrations.

2. MATERIAL AND METHODS

2.1. Material

Samples of edible *polvilho doce* (sweet manioc starch) and *polvilho azedo* (sour manioc starch) were purchased at the local market.

2.2. Methods

Samples of sweet and sour manioc starch were irradiated with doses of 0, 1 and 3 kGy in a fully self-contained research irradiator Gammacell 220 (AECL), dose rate ~1.2 kGy h-1. With the irradiated starches, 50 ml samples of 2% and 3% w v-1 aqueous solutions were prepared in distilled water. Viscosity measurement was performed using a Brookfield viscometer coupled to a Neslab water bath, using a small sample adaptor and a spindle SC4-16. A Rheocalc V1.1 Engineering Laboratories program was employed for datum management. The presented results were the means of two independent experiments and samples were measured 27 times each time.

3. RESULTS AND DISCUSSION

When measuring viscosity of starch preparations is important to report the methods used to prepare the samples as well as the way rheological parameters were determined, as differences can be observed among the gelatinization temperatures and rheological parameters by the diverse methods [3,4]. Figure 1 displays the variation of viscosity with the γ irradiation dose obtained at 40 °C for the samples diluted at 2% for both sweet and sour manioc starch. Figure 2 presents the data obtained by similar samples but at 3% concentration.

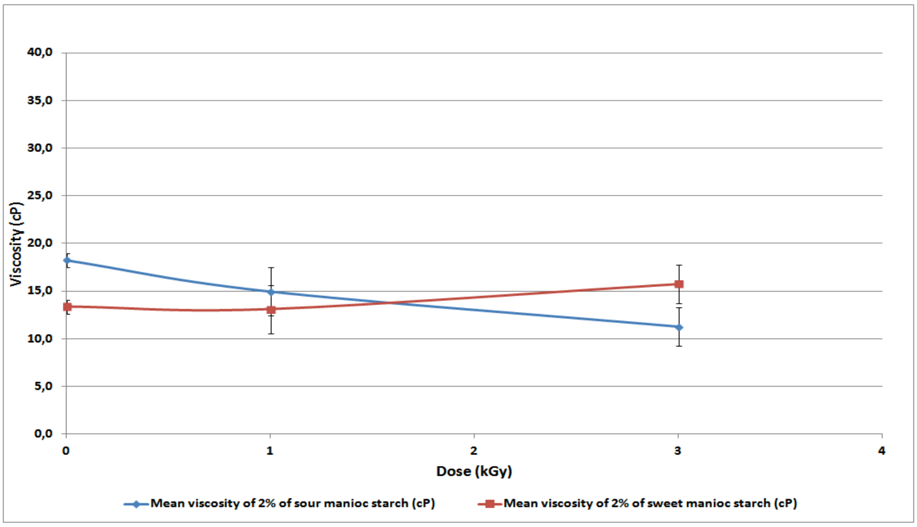

Figure 1: Apparent viscosity of 2% aqueous solutions of sweet and sour manioc starch as a function of γ-radiation dose.

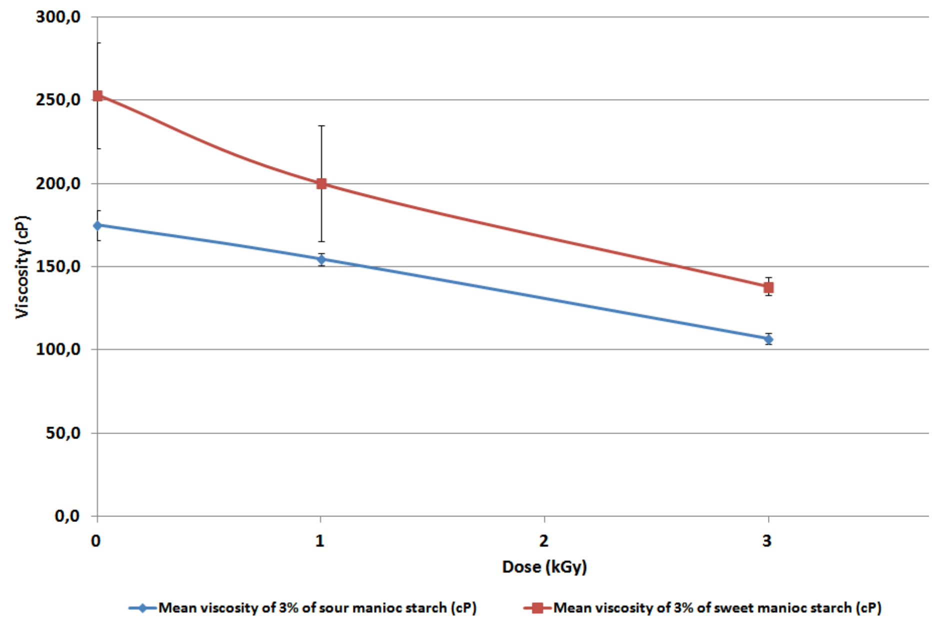

Figure 2: Apparent viscosity of 3% aqueous solutions of sweet and sour manioc starch as a function of γ-radiation dose.

Samples of sweet manioc starch when prepared at 2% remained almost unchanged with the increase of the radiation dose. All other samples presented a reduction of viscosity with the dose. These results corroborate some works from the literature where ionizing radiation seemed to induce depolymerization of the polysaccharide macromolecules affecting rheological properties [5,6]. Bertolini et al. [7] used UV to irradiate cassava starch and found that paste viscosity of cassava, but not corn starch was reduced after UV irradiation and depolimerization was found to occur. Gani et al. [8] studied the modification of bean starch by gamma-irradiation (doses up to 20kGy) and found that it was a positively correlation of radiation doses with water absorption capacity and solubility index and negatively correlated with swelling index, peak viscosity, trough viscosity, breakdown and final viscosity.

4. CONCLUSIONS

The results of the present work show the influence or ionizing radiation on the rheological behavior of aqueous preparations of sweet and sour cassava starch at 2% and 3%. The dose response relation of the two kind of starch was different when a 2% concentration was used. This discrepancy can be attributed to the molecular changes suffer by the cassava starch through the fermentation process. Present data corroborate other works where the decrease of polysaccharide viscosity was observed. This fact is important to be considered in further applications of cassava starch in the food industry.

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REFERENCES

1. Demiate, I.M.; Dupuy, N.; Huvenne, J.P.; Cereda, M.P.; Wosiacki, G. "Relationship between baking behavior of modified cassava starches and starch chemical structure determined by FTIR spectroscopy". *Carbohydrate Polymers,* **42**, n. 2, p. 149-158 (2000).
2. Sriroth, K.; Santisopasri, V.; Petchalanuwat, C.; Kurotjanawong, K.; Piyachomkwan, K.; Oates, C.G. "Cassava starch granule structure–function properties: influence of time and conditions at harvest on four cultivars of cassava starch". *Carbohydrate Polymers*, **38**, n. 2, p. 161-170 (1999).
3. Pérez, E.E.; Breene, W.M.; Bahnassey, Y.A. "Variations in the Gelatinization Profiles of Cassava, Sagu and Arrowroot Native Starches as Measured with Different Thermal and Mechanical Methods". *Starch – Stärke*, **50**, n. 2-3, p. 70-72 (1998).
4. Huang, Z.Q.; Lu, J.P.; Li, X.H.; Tong, Z.F. "Effect of mechanical activation on physico-chemical properties and structure of cassava starch". *Carbohydrate Polymers*, **68**, n. 1, p. 128–135 (2007).
5. Aliste, A.J.; Mastro, N.l.d. "Anomalous Rheological Behavior of Gelatin-Carrageenan-Water System Induced by Ionizing Radiation". Molecular Crystals and Liquid Cristals, 448 (III), 179/781-185/787 (2006).
6. Tissot, C.; Grdanovska, S.; Barkatt, A.; Silverman, J.; Al-Sheikhly, M. "On the mechanisms of the radiation-induced degradation of cellulosic substances". *Radiation Physics and Chemistry*, **84**, p. 185-190 (2013).
7. Bertolini, A.C.; Mestres, C.; Colonna, P. "Rheological Properties of Acidified and UV-Irradiated Starches". *Starch – Stärke*, **52**, n.10, p. 340-344 (2000).
8. Gani, A.; Bashir, M.; Wani, S.M.; Masoodi, F.A. "Modification of bean starch by gamma-irradiation: Effect on functional and morphological properties". *LWT-Food Sc. and Technol.*, **49**, n. 1, p. 162-169 (2012).