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GAMMA RADIATION EFFECTS ON THE VISCOSITY OF GREEN BANANA FLOUR

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ABSTRACT

Banana ***(Musa sp)*** is a tropical fruits with great acceptability among consumers and produced in Brazil in a large scale. Bananas are not being as exploited as they could be in prepared food, and research could stimulate greater interest from industry. The viscosity characteristics and a product consistency can determine its acceptance by the consumer. Particularly the starch obtained from green banana had been studied from the nutritional point of view since the concept of Resistant Starch was introduced. Powder RS with high content of amylose was included in an approved food list with alleged functional properties in Brazilian legislation. Ionizing radiation can be used as a public health intervention measure for the control of food-borne diseases. Radiation is also a very convenient tool for polymer materials modification through degradation, grafting and crosslinking. In this work the influence of ionizing radiation on the rheological behavior of green banana pulp was investigated. Samples of green banana pulp flour were irradiated in a ^{60}Co Gammacell 220 (AECL) with doses of 0kGy,1kGy, 3kGy, 5 kGy and 10 kGy in glass recipients. After irradiation 3% and 5% aqueous dilution were prepared and viscosity measurements performed in a Brooksfield, model DVIII viscometer using spindle SC4-18 and SC4-31. There was a reduction of the initial viscosity of the samples as a consequence of radiation processing, being the reduction inversely proportional to the flour concentration. The polysaccharide content of the banana starch seems to be degraded by radiation in solid state as shown by the reduction of viscosity as a function of radiation dose.

1. INTRODUCTION

Banana is mainly produced in tropical and subtropical developing countries. Brazil is the second world producer and the variety Nanicão (***Musa cavendischii***) is one of the most important crops in this country [1] and [2]. The banana composition changes dramatically during ripening [3]. Starch is the principal component of green bananas, which undergoes important changes during ripening. The average starch content drops from 70 to 80% in the pre-climateric (prior to starch breakdown) period to less than 1% at the end of the climacteric period, while sugars, mainly sucrose, accumulate to more than 10% of the fresh fruit weight. [4].

Large quantities of fruits are lost during commercialization as a consequence of deficient postharvest handling. About one-fifth of all banana harvested is wasted and the rejected are normally disposed improperly. New economical strategies are now considered for banana use, such as banana flour production. Banana flour can be a low-cost ingredient for food industry and it preparation is an alternative to minimize banana wastes [3].

Starch and cellulose are the most important biopolymers of D-glucose in the biosphere. Starch occurs in two forms, α-amylose, a long unbranched chains and amlylopectin that are highly branched. Both yield colloidal or micellar solutions in water. Starch granular structure owes much of its functionality and physical organization to these macromolecules [5].

Native raw banana starch is known to be resistant to the attack of α-amylase and glucoamylase, with in vivo results showing that 75–84% of the starch granules ingested reached the terminal ileum [6]. The extent of starch gelatinization and retrogradation which takes place during processing is an important factor in the undigested starch formation, and its subsequent metabolic responses. The starch fraction which escapes digestion in the small intestine but which is later fermented in the large intestine is known as resistant starch (RS). As the RS microbial degradation result in the colon, an increase in short-chain fatty acids, especially butyrate, takes place, which seems to stabilize colonic cell proliferation as a preventive mechanism for colon cancer [7][8]. Several studies suggested that unripe banana consumption confers beneficial effects for human health, a fact often associated with high resistant starch (RS) content, which ranges between 47% and 57% [9][10][11][12].

The RS was categorized into four classes, according to the mechanism that prevents its enzymatic digestion. Among these four types, RS type III seems to be particularly interesting due to thermal stability in most normal cooking operations, and enables uses as an ingredient in a wide variety of conventional foods [13] and [14]. RS formed during processing is associated with amylose retrogradation [15][16][17].

Radiation technology from ^{60}Co or electron beam is gaining more and more acceptance from national authorities, producers, and consumers as one of the top options for ensuring the food safety of foods. It has been approved for commercial use in many countries, Brazil among them.

A basic rheological understanding is necessary to properly control the processing of food materials. Viscosity is the principal parameter that characterizes the flow properties of fluids. In this paper, preliminary results on the rheological behavior of irradiated green banana flour are presented.

2. MATERIAL AND METHODS

2.1. Material

Samples of green banana pulp flour (lot 012) were obtained as a courtesy from Nutraceutica Indústria Comércio Produtos Alimentícios Ltda. Limeira-SP

2.2. Irradiation

Samples irradiation took place in glass recipients using a ^{60}Co Gammacell 220 (AECL). Doses of 1kGy and 3kGy were employed with dose rate about 2 kGy/h certificated IDAS-IAEA with $\pm$ 1,7% uncertainty.

2.3. Viscosimetry

Viscosimetric measurement were done with 3% (w/v) and 5% (w/v) green banana pulp flour dissolved in 50 mL of distilled water in a water bath at 70°C and then stirred vigorously. The radiation effects were measured following viscosity changes at 70°C using a Brookfield viscometer; model LV-DVIII, spindle SC4-18 and SC4-31 with Rheocalc software with an adapter ULA and a Neslab water bath model RTE-210, precision ± 0,1°C.

3. RESULTS AND DISCUSSION

All fluids have a viscosity/temperature relationship, so a working temperature of 70°C was chosen for this study. Figure 1 shows the viscosity at 70°C of the 3% and 5% solutions prepared with green banana pulp flour irradiated with 0 and 3kGy and with 0, 1, 3, 5 and 10 kGy respectively. The viscosity of the samples diminished with the increase of the gamma radiation dose. The viscosity was dependent of the solution concentration but both samples presented similar pattern of radiation dependence.

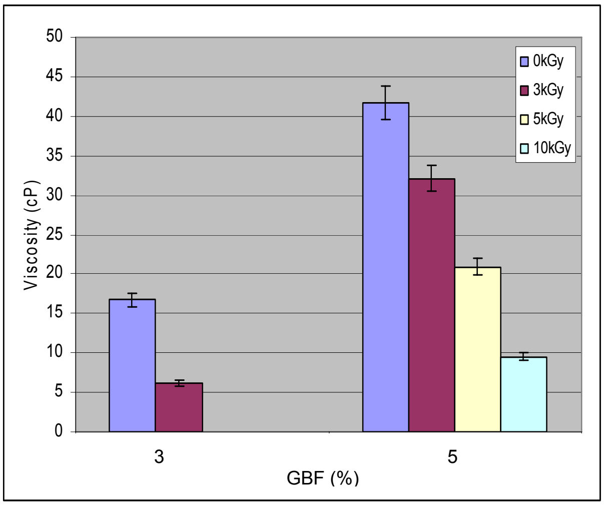

Figure 1. Viscosity at 70 °C versus radiation dose of green banana pulp flour solutions at two concentrations (3% (w/v) and 5% (w/v).

Ionizing radiation acts on polysaccharides by breaking C-C bonds and forming acid and reductive groups [18]. In irradiated dilute aqueous solution, the solvent absorbs practically all the radiation energy and the water radicals generated by the absorption of ionizing radiation interact with the solute. Then, radiation effects are caused by the water radicals •OH, hydrated electrons, e-aq, and H atoms [19]. 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 biopolymer studied in this work, chain scission seems to play the main role and a decrease of viscosity could be observed for both samples, suggesting a high radiosensitivity of this polysaccharide. Some data from the literature also described that different polysaccharides are differently affected by radiation [20].

IZIDORO [21] studied the rheological behavior of the green banana flour gel in the temperature range of 10-60°C and described that the samples presented pseudoplastic behavior for all the temperatures, i.e., fluids which decrease in viscosity as shear rate increases. According to Izidoro [22] initial shear stress values had significantly decreased with the increase of the temperature for all the formularizations. In accordance with some authors [23] during the food processing, the increase of the temperature makes the structure becomes weak. Similar results also had been shown for purees of fruits [24][25].

Other studies also showed a decrease in banana pulp viscosity with temperature. Apparent viscosity of green banana pulp mayonnaise decreased with the increase of the it shear rate being the hydrodynamic forces that will cause the separation of aggregates, diminishing viscosity.

4. CONCLUSIONS

The increase of radiation dose caused a decrease in the viscosity of green banana pulp flour solutions and the viscosity values are depending of the solution concentration. This result is in agreement with the behavior of other polysaccharides upon radiation.

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