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Study of some physicochemical and rheological properties of irradiated honey

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Abstract. Honey is a sweet substance produced by bees, well appreciated in many places and its consumption has been increased either as raw material or as a food ingredient. Its use as food by the consumer, or even for exportation, implies safety inherent in its quality and processing control. Gamma radiation can be applied in food or ingredients for many objectives like pathogens microorganisms' reduction, disinfestations, and sterilization. The aim of this work was to verify some physicochemical modifications, as well as rheological evaluation of honey submitted to irradiation at 10 kGy. The physicochemical parameters analyzed were: moisture, HMF, free acidity, pH, sugars and ash. The rheological behavior was measured at different temperatures. The results indicated that few changes occurred; the rheological behavior was not impaired and did not present any significant physicochemical alteration.

Key words: gamma radiation • honey • rheology • physicochemical properties

Introduction

Honey is a nectar constituted of a complex mixture of high concentrated sugars, essentially by fructose and glucose, and in less quantity, sucrose. The exact composition depends on the region, mainly the flora, from which they derive [9] and on several factors like weather conditions, botanical species, soil nature, bee breed, honey maturation and physiology status of the hive [1, 7, 8].

Honey is a very important product for Brazilian exportation, which attained a new record in May, 2008 with foreign sales equivalent to US$ 4.15 million, the highest value in the last four years [4]. Several efforts have been undertaken in order to accomplish international requirements for honey market. Gamma irradiation process, among different purposes, can be used to reduce microorganisms' load in food. Migdal *et al*. [10] applied this process on seven honey samples and demonstrated that the amount of aerobic and anaerobic bacteria and fungi decreased. Indeed, several studies have been focusing the inhibitory activity of honeys against food-borne pathogens and studies showed that the factors contributing to this inhibitory activity have clearly not been fully defined. Further work is needed to separate the effects of peroxide and other components in honeys on survival and growth pathogenic and non-pathogenic food-borne microorganisms [13]. The use of honey in products that receive no, or limited, heat treatment may require additional tests besides total plate count [12].

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Table 1. Physicochemical and viscosity results for honey, control and irradiated, and official limits for these parameters

Type of analysis	Treatment		
	Control	10 kGy irradiated	Official limits**
Humidity (%)	17.0*	17.0*	max. 20%**
Total soluble solids (%)	81.0*	81.0*	–
pH	4.16*	4.06*	3.2 to 4.5**
Ash (%)	0.32 ± 0.0003 a	0.31 ± 0.0002 a	max. 0.6%**
Acidity (mEq)	5.53 ± 0.06 a	6.25 ± 0.07 b	max. 50 mEq**
HMF (mg/Kg)	39.0 ± 0.1 a	31.1 ± 0.1 b	max. 60 mg/Kg**
Sugars (mg/Kg)	78.6 ± 0.5 a	78.2 ± 0.8 a	min. 60 mg/Kg**
Sucrose (mg/Kg)	2.2 ± 0.7 a	1.7 ± 0.0 a	max. 6 mg/Kg**
Viscosity (cP) at 25°C	11,268 ± 140 a	11,213 ± 018 a	10,000***
Viscosity (cP) at 35°C	3955 ± 111 a	3446 ± 010 b	–

* As there were no errors for these results, the Tukey test was not performed.
** Brazilian regulation [5].
*** Honey viscosity at 20°C [3].
For the same type of analysis (same line), the means followed by the same lowercase letter are not significantly different ($p \leq 0.05$).

When some treatment is applied to food, more specifically to honey, several parameters must be controlled to assure the safety inherent to its quality and processing control. Rheological properties are very important for honey as its viscosity is unique [3]. The aim of this paper was to verify some physicochemical modifications, as well as rheological evaluation of honey submitted to irradiation at 10 kGy.

Materials and methods

Samples were poly floral honeys from different regions. Immediately after collection the samples were treated. They were irradiated in closed flasks, in normal atmosphere and at room temperature. Irradiation was performed in a ^{60}Co Gammacell 220 (AECL), at a dose of 10 kGy. Dosimetry was done using an Amber routine dosimeter (Harwell, United Kingdon) and the dose rate was established using a Fricke reference dosimeter to plot calibration curves. The whole dosimetry system is in International Dosemeter Assurance Service (IDAS) from the International Atomic Energy Agency.

Humidity, total content of soluble solids, hydroxymethylfurfural (HMF), and acidity were measured by AOAC methods [2]. Ash, sugar and sucrose content was measured by Codex Alimentarius methods [6].

Rheology measurements were carried out using a Brookfield viscometer, model LV-DVIII, spindle SC4-34, as described previously [11], at temperatures of 25°C and 35°C (± 0.1°C), employing a Neslab water bath. Viscosity values were carried out in three replicates, in different days and each rheogram was measured at different shear.

All physicochemical data were measured in triplicate. The set of obtained data was submitted to statistical treatments (analysis of variance, post hoc tests and t-tests) using Statistica (5.1 from StatSoft, 1998).

Results and discussion

Physicochemical results are shown in Table 1. Humidity, total soluble solids and pH presented equal values with no error terms and consequently post hoc test (Tukey) was not performed. Ashes, sugars and sucrose contents for control and irradiated honeys were not statistically different ($p \leq 0.05$). The only differences between irradiated sample and its respective control noted were for HMF and acidity (Table 1). Acidity increased significantly ($p \leq 0.05$) with absorbed dose, while HMF content had a decrease for 10 kGy irradiated honey. Even with those differences the values obtained were within official limits (Table 1).

Rheology behavior for the irradiated honey measured at 25°C and 35°C was coincident with the control one, as can be seen in Figs. 1 and 2. Rheogram was dependent on the temperature that can be observed through comparisons between Fig. 1 with Fig. 2 and independent of irradiation. All rheograms resulted in linear trend with a good linear coefficient that varied from 0.99 to 1 (Figs. 1 and 2). The results indicated that honey is a Newtonian fluid and gamma radiation did not modify this behavior. Viscosity values measured at 25°C presented no statistical difference and were close to a typical value from the literature, as shown in Table 1. Viscosities measured at 35°C were slightly lower ($p \leq 0.05$) for the irradiated honey compared to control. This difference can be attributed to temperature fluctuations, once measured at 25°C remained not changed, independently of irradiation.

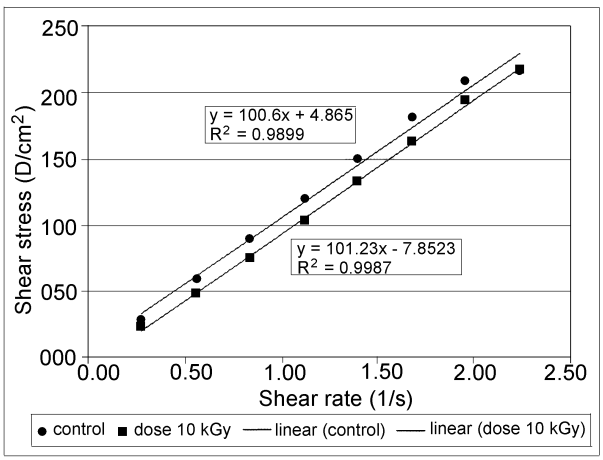

Fig. 1. Rheogram of honey samples at 25°C.

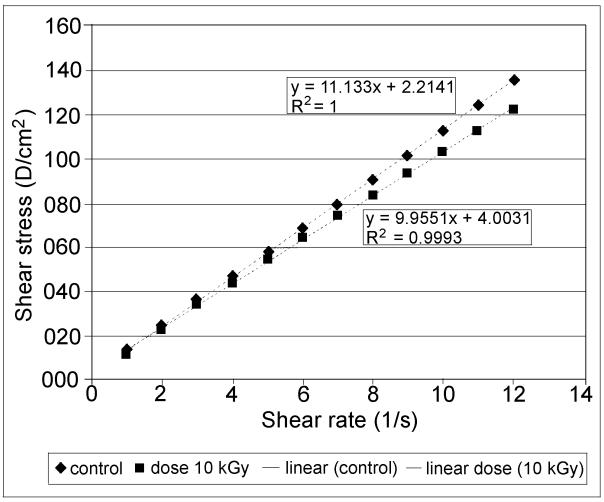

Fig. 2. Rheogram of honey samples at 35°C.

Conclusions

Gamma radiation had a small influence on physicochemical parameters of honey as well as on its rheological properties, demonstrating that irradiation process can be applied to honeys. All results remained within the official limits of quality.

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