Radiation Physics and Chemistry 78 (2009) 583–584

Contents lists available at ScienceDirect

Radiation Physics and Chemistry

journal homepage: www.elsevier.com/locate/radphyschem

Effect of gamma radiation on honey quality control

A. Bera [a], L.B. Almeida-Muradian [b], S.F. Sabato [a,*]

[a] Radiation Technology Center, IPEN-CNEN/SP, A. Lineu Prestes, 2242, 05508-000 São Paulo, Brazil
[b] Av. Prof. Lineu Prestes, 580-Cidade Universitária, São Paulo, Brazil

ARTICLE INFO

Keywords:
Honey
Radiation
Physicochemical analysis
^{60}Co

ABSTRACT

Honey is one of the most complex substances produced by bees, mainly from the nectar of flowers. Gamma radiation is a technique that can be used to decrease the number of microbiological problems associated with food and increase the shelf life of certain products. The objective of this study was to verify the effect of gamma radiation with source of cobalto-60 (10 kGy) on some parameters used in honey quality control. Seven samples of pure honey were obtained from local markets in Sao Paulo, Brazil, in 2007. The methods used are in accordance with Brazilian Regulations. The physicochemical parameters analyzed were: moisture, HMF, free acidity, pH, sugars and ash. The results showed that gamma radiation, in the dose mentioned above, did not cause significant physicochemical alterations.

Published by Elsevier Ltd.

1. Introduction

Honey is produced by mellifera bees from flowers nectar, exuded from plants or sucker insects' excretion. Basically it is a complex mixture of highly concentrated sugars. The chemical composition of honey can be dependent on several factors such as weather conditions, botanical species, soil nature, bee breed, honey maturation and physiology status of the hive (Almeida-Muradian et al., 2007; Crane, 1987, 1975).

In order to reduce microorganisms' contamination different purification techniques can be used but treatments that are traditionally used can impair the product characteristics in some way. Migdal et al. (2000) applied gamma radiation at 10 kGy absorbed dose to reduce the amount of aerobic and anaerobic bacteria and fungi. The results obtained showed little interference in physical–chemical characteristics due to irradiation in honey samples. Based on these results the objective of this work was to verify the use of gamma radiation in Brazilian honeys because the nature, tropical weather and biological diversity found in Brazil is completely different from other regions. This work subjected honeys from different sources to gamma radiation and studied the physical–chemical characteristics of irradiated honeys according Brazilian regulations.

2. Methodology

Seven different types of honeys were collected from apiaries, honey depot and commercial establishments at São Paulo state. Samples in closed flasks were irradiated at 10 kGy in ^{60}Co source (Gammacell 220 AECL from Atomic Energy of Canadá Ltd.), at environmental conditions.

2.1. Physical–chemical analysis

All tests used in this research followed the guidelines from Brazilian regulation (Brazil, 2000).

2.1.1. Humidity and total soluble solids

Total soluble solids content was measured in Abbé refractometer and refraction index was converted into humidity using

Table 1
Averages of humidity, total soluble solids and pH results for honey samples (irradiated at 10 kGy and control).

Sample	Treatment	Humidity (%)	Total soluble solids (%)	pH
1	Control	17.0	81.0	4.20
	Irradiated	17.0	81.0	4.20
2	Control	18.2	80.4	3.87
	Irradiated	16.6	81.2	3.84
3	Control	19.0	79.0	3.90
	Irradiated	19.0	79.0	3.80
4	Control	17.4	80.4	4.08
	Irradiated	17.4	80.4	4.07
5	Control	17.6	80.6	4.06
	Irradiated	17.6	80.6	3.99
6	Control	17.0	81.0	3.99
	Irradiated	17.0	81.0	4.05
7	Control	17.0	81.0	4.16
	Irradiated	17.0	81.0	4.06

* Corresponding author. Fax: +55 11 3133 9852.
E-mail addresses: berale@usp.br (A. Bera), sfsabato@ipen.br (S.F. Sabato).

0969-806X/$ - see front matter Published by Elsevier Ltd.
doi:10.1016/j.radphyschem.2009.03.013

Table 2
Averages of ash, acidity, HMF, reduced sugars and apparent sucrose results for honey samples (irradiated at 10 kGy and control).

Sample	Treatment	Ash (%)	Acidity (mEq)	HMF (mg/kg)	Sugars (mg/kg)	Sucrose (mg/kg)
1	Control	0.35±0.0000[a]a	3.70±0.06[a]a	4.3±0.3[a]a	78.1±0.4[a]a	3.8±0.7[a]a
	Irradiated	0.34±0.0045 a	3.80±0.07 a	3.0±0.3 b	78.8±0.3 a	3.2±0.6 a
2	Control	0.40±0.0263 a	5.03±0.07 a	54.7±0.4 a	78.8±1.0 a	9.4±0.5 a
	Irradiated	0.36±0.0097 a	5.25±0.07 a	43.6±1.3 b	79.3±0.5 a	7.4±0.3 b
3	Control	0.39±0.0366 a	3.43±0.06 a	49.2±1.5 a	77.4±0.9 a	2.3±0.5 a
	Irradiated	0.39±0.0366 a	3.35±0.07 a	42.9±0.8 b	73.0±0.9 b	0.9±0.1 b
4	Control	0.60±0.0003 a	9.07±0.12 a	22.2±0.6 a	75.4±0.6 a	5.0±0.1 a
	Irradiated	0.50±0.0006 a	8.43±0.06 b	27.4±0.3 b	75.5±0.4 a	4.3±0.3 b
5	Control	0.36±0.0041 a	3.10±0.10 a	19.2±0.4 a	78.2±0.4 a	0.5±0.5 a
	Irradiated	0.36±0.0107 a	3.10±0.10 a	11.8±0.6 b	77.4±0.6 a	1.1±0.7 a
6	Control	0.24±0.0002 a	3.43±0.06 a	12.3±1.2 a	77.9±0.7 a	1.7±0.6 a
	Irradiated	0.32±0.0002 b	3.45±0.07 a	11.5±0.2 a	76.8±0.2 b	1.1±0.0 a
7	Control	0.32±0.0003 a	5.53±0.06 a	39.0±0.1 a	78.6±0.5 a	2.2±0.7 a
	Irradiated	0.31±0.0002 a	6.25±0.07 b	31.1±0.1 b	78.2±0.8 a	1.7±0.0 a

For the same type of analysis and same sample, means followed by the same lower-case letter are not significantly different ($p \leqslant 0.05$).
[a] Standard deviation.

Chataway table at 20 °C (AOAC, 1990 #969.38B; Vilhena and Almeida-Muradian, 1999).

2.1.2. Hydroximethylfurfural (HMF)

Honey samples were clarified with 0.2% sodium bisulphite, to avoid interferences. The 5-(Hydroxymethyl)furfural) (HMF) content was measured by spectrophotometry at 284 nm, subtracting the back absorbance at 336 nm according to AOAC (1990; # 980.23).

2.1.3. Sugars and sucrose

Reduced sugar content and apparent sucrose were determined by titration using Fehling reagent (CAC, 1989 #7.1 and 7.2; Bogdanov et al., 1997).

2.1.4. Minerals/ash

Ashes were determined by gravimetric method at 550 °C (CAC, 1989 #7.5).

2.1.5. Acidity

Free acidity was measured by potenciometric titration using 10 g of honey in 75 mL of water (CO_2 free) with NaOH solution. The results were expressed in honey mEq/kg (AOAC, 1990 # 962.19; Bogdanov et al., 1997).

3. Results and discussion

The average for humidity, total soluble solids and pH results are presented in Table 1. Gamma radiation had little impact in the results as there were few differences between irradiated and control samples. Sample 2 showed some differences for the three parameters but these were not significant.

Results related to ash, acidity, reduced sugars and apparent sucrose, in general, were similar for irradiated and control samples as showed in Table 2. Some cases like sugar averages (sample numbers 3 and 6) and sucrose averages (sample numbers 2, 3 and 4) resulted in statistically lower values for irradiated samples when compared to respective controls ($p \leqslant 0.05$). This reduction in sucrose content for irradiated samples compared to the controls indicates there was a glicosidic bond break. This fact contributes to an increase in reduced sugars, glucose and fructose contents which has been reported by Phillips (1961). This paper mentions that irradiation of sucrose solutions could lead to a glicosidic bond break and acid production. All values obtained in Table 2 are in accordance with Brazilian regulations, even though there was a small difference between control and irradiated honeys.

The content of HMF in irradiated samples was significantly different from their respective controls for all samples with an exception of sample number 6 which remained similar. Gamma radiation caused a decrease of all values of HMF for irradiated honeys. The limit established by Brazilian regulations is 60 mg/kg and all of the results are within the official limits (Brazil, 2008).

4. Conclusion

The physical–chemical results obtained for honeys irradiated at 10 kGy were within the official Brazilian regulations for honeys. When compared to their respective control, HMF values for irradiated samples were lower indicating favorable behavior of honey samples when subjected to gamma radiation.

Acknowledgement

The authors are grateful to Conselho Nacional de Pesquisa (CNPq) for a PhD. fellowship for A.B.

References

Almeida-Muradian, L.B., Penteado, M.D.V.C., 2007. Vigilância sanitária: tópicos sobre legislação e análise de alimentos. Guanabara Ed., 203p.
AOAC, 1990. Official Methods of Analysis of the Association of Official Analytical Chemists. Association of Official Analytical Chemists, Arlington, (500p).
Brazil-MAPA. Instrução Normativa n.11, de 20 de outubro de 2000. Regulamento técnico de identidade e qualidade do mel. Disponível em: 〈http://extranet.agricultura.gov.br/sislegis-consulta/consultarLegislacao.do?operacao=visualizar&id=7797〉, accessed at 02/04/2008.
Bogdanov, S., Martin, P., Lüllmann, C., 1997. Harmonised methods of the European Honey Commission. Apidologie, Les Ulis, Supplement, 59.
CAC-Codex Alimentarius Commission, 1989. Codex Standards for Sugars (Honey). FAO, Rome, (21p).
Crane, E., 1975. Honey. Morrison and Gibb, London, (608p).
Crane, E., 1987. O Livro do mel, Second ed. Livraria Nobel, São Paulo, (226p).
Migdal, W., Owczarczyk, H.B., Kedzia, B., Holderna-Kedzia, E., Madajczyk, D., 2000. Microbiological decontamination of natural honey by irradiation. Radiation Physics and Chemistry 57, 285–288.
Phillips, G.O., 1961. Radiation chemistry of carbohydrates. Advances in Carbohydrate Chemistry 16, 13–58.
Vilhena, F., Almeida-Muradian, L.B., 1999. Manual de análises físico-químicas de mel. APACAME, São Paulo, (16p).