ELSEVIER

Food Chemistry 84 (2004) 499–502

Food Chemistry

www.elsevier.com/locate/foodchem

Characterization of honey produced in Venezuela

Graciela Ojeda de Rodríguez*, Betzabé Sulbarán de Ferrer, Alexis Ferrer, Belkis Rodríguez

Laboratorio de Alimentos, Departamento de Química, Facultad de Ciencias, Universidad del Zulia, Apartado postal 526, Maracaibo, Venezuela

Received 11 July 2002; received in revised form 7 November 2002; accepted 27 November 2002

Abstract

To evaluate the quality of honey produced in Zulia State (Venezuela), moisture content, ash, acidity, pH, diastase activity, 5-(hydroxymethyl)-2-furaldehyde, nitrogen and carbohydrate composition were analysed. Sampling was carried out during dry and rainy seasons in three regions, directly from the honey comb. These samples were found to meet all major national and international honey specifications.

Keywords: Multifloral honey; Sugars; Zulia; Venezuela

1. Introduction

Honey is one of the most complex mixtures of carbohydrates and other minor components produced in nature. It is a very important energy food and is used as an ingredient in hundreds of manufactured foods, mainly in cereal-based products, for its sweetness, colour, flavour, caramelization, pumpability and viscosity (La Grange & Sanders, 1988).

The physical properties and chemical composition of honey from different sources have been published by many scientists (Andrade, Amaral, Isabel, Carvalho, Seabra, & Cunha, 1999; Anklam, 1998; Costa et al., 1999; Esti, Panfili, Marconi, & Trivisonno, 1997; Pérez-Arquillué, Conchello, Ariño, Juan, & Herrera, 1995; Singh & Kaur, 1997; Sporns, Plhak, & Friedrich, 1992; Swallow & Low, 1990; White, Riethof, Subers, & Kushmir, 1962). The composition depends highly on the type of flowers utilized by the bee as well as climatic conditions (Abu-Tarboush, Al-Kahtani, & El-Sarrage, 1993).

Consumption of honey in Zulia state, Venezuela, has increased considerably in recent years. The population is reducing its refined sugar consumption, and people seem to be more aware of honey.

Since there are very little data available on the composition of Venezuelan honey (Bogdanov, Vit, & Kilchenmann, 1996; Vit, 1987; Vit & Tomas, 1998; Vit, Ríos de Salgrado, Novoa, Reinosa, & Camargo, 1994), the purpose of this work was to establish values for authentic Zulia honey, and to determine whether it meets national and international compositional standards of honey specifications. The following parameters were analysed: moisture, ash, acidity, pH, diastase activity, 5-(hydroxymethyl)-2-furaldehyde (HMF), nitrogen and carbohydrate composition, which are considered the basic parameters for characterizing honey.

2. Materials and methods

2.1. Samples

Typical *Apis mellifera* honey samples of multifloral types from Zulia state (western region of Venezuela) were obtained from apiarists and beekeeper associations. The representative regions of Zulia state were: North (N1 and N2), North West (NW) and South (S). Vegetation in N1, N2 and NW is dry tropical forest, where *Citrullus vulgaris*, *Curcubita maxima*, and *Achras sapota* are predominant. Vegetation in S is wet tropical forest, where *Passiflora* sp.*Annona muricare,* and *Persea americana* are predominant. Twenty honey combs were collected from each region and two litres of homogeneous sample were used for the analysis. The honey samples were collected in 1997 during the dry and rainy seasons

* Corresponding author. Tel./fax: +58-261-7598062.
E-mail address: grodriguez@icnet.com (G. Ojeda de Rodríguez).

0308-8146/03/$ - see front matter © 2002 Published by Elsevier Ltd.
doi:10.1016/S0308-8146(02)00517-4

(November–June 1997 and July–October 1997) and stored in amber glass bottles at 4 °C under N_2 atmosphere.

3. Methods

The analytical procedures followed were: moisture by AOAC (1990) method 969.38, diastase, HFM and ash, determined by the methods suggested in the Venezuelan regulations for honey quality COVENIN 2136-84, pH and acidity, by AOAC method 962.19 find nitrogen, by AOAC (1980) method 16.036. All analyses were carried out in triplicate.

3.1. LC carbohydrates analysis

Sugars were determined using an HPLC chromatographic method. The system consisted of a Waters HPLC with a model 600E solvents delivery system, a 410 differential refractometer detector, a Waters 717 autosampler, and Millenium^{2010} software to analyse the data. A Bio-rad column, Aminex HPX-87P 3.9 × 300 mm (Richmond, C.A, USA) at 85 °C, was used. The mobile phase consisted of deionized filtered water (0.45 μm, nylon membranes, Millipore, Ma, USA) at a flow rate of 0.6 ml/min. The operating parameters of the refractometer were set at 20 scale factor and sensitivity 4. All standard sugars (fructose, glucose, sucrose, arabinose) were obtained from (Sigma, St. Louis, Missouri, USA). All honey samples were analysed for carbohydrates in triplicate.

3.2. Statistical analysis

Data were statistically analysed by analysis of variance (Steel & Torrie, 1980) and the differences among the means were determined for significance at the 5% level using Duncan's new multiple range test and SAS computer programmes (SAS, 1990).

4. Results and discussion

Tables 1 and 2 show the mean (±S.D.) results obtained from the chemical and carbohydrate composition analyses of honey samples, respectively. All parameters were

Table 1
Chemical parameters in samples of Venezuelan multifloral honeys in dry and rainy seasons

Sample	Moisture (%)	Ash (%)	Total acidity (meq/kg)	pH	Nitrogen (mg/100 g)	HMF	Diastase
N1D	19.64±9.11def	0.2190±0.0083a	53.3±2.66h	4.3±0.4e	57.5±0.66a	–	+
N2D	19.28±0.22de	0.2272±0.0093a	39.9±1.09f	3.7±0.5bc	58.8±0.62b	–	+
NWD	20.28±0.11ef	0.1894±0.0062a	24.4±3.29a	3.3±0.4a	71.9±0.14c	–	+
SD	19.39±0.21cd	0.3515±0.0010bc	25.7±0.92b	3.8±0.4c	86.1±1.91e	–	+
N1R	18.76±0.21bc	0.2505±0.0032a	39.6±0.59e	3.3±0.4a	57.5±0.70ab	–	+
N2R	17.80±0.24a	0.3202±0.0011ab	38.7±0.40d	3.3±1.1a	59.0±0.06b	–	+
NWR	20.40±0.06f	0.4498±0.0048b	42.8±2.61g	3.6±0.9b	72.0±0.22c	–	+
SR	18.56±0.22ab	0.6437±0.0300c	34.1±1.09c	3.9±0.8d	83.7±0.71d	–	+
COVENIN	Max. 20	Max. 0.5	Max. 40			–	+
Vit (987)					>30		

Results are expressed as mean values + standard deviations. Means in a column with different coefficients (a–h) are significantly different ($P<0.05$)

Table 2
Sugar mean[1] composition in samples of Venezuelan multifloral honeys in dry and rainy seasons

Sample	Fructose (%)	Glucose (%)	Sucrose (%)	Arabinose (%)	Fructose/Glucose
N1D	40.6	33.1	5.52	0.45	1.22
N2D	39.3	35.4	4.25	nd	1.39
NWD	39.1	29.2	3.03	0.03	1.34
SD	42.6	34.6	2.21	0.35	1.25
N1R	38.5	38.7	3.31	0.34	1.19
N2R	39.2	38.7	3.56	0.44	1.27
NWR	40.1	32.2	2.81	0.50	1.25
SR	44.5	35.7	2.58	0.90	1.25
[1]S.D.	0.26	0.20	0.07	0.03	

nd, not detected

significantly different among regions ($P < 0.05$). Duncan test results are also indicated in Table 1.

Moisture content of honey depends on harvest season, along with the degree of maturity reached in the hive. This parameter is highly important for the shelflife of the honey during storage (Pérez- Arquillué, Conchello, Ariño, Juan, & Herrera, 1994). Six, out of eight samples, yielded moistures between 17.80 and 19.64%, indicating a proper degree of maturity, and that the beekeepers had found the proper time of extraction. Values are in agreement with Venezuelan requirements, $\leqslant 20\%$, (COVENIN 2191-84). Nevertheless, two samples, NWD and NWR, had moisture contents of 20.28 and 20.40%, respectively, slightly above 20% and likely due to earlier extraction of honey from hives. In general, a high moisture content causes the honey to ferment, spoil and lose flavour, causing honey-quality loss (Costa et al., 1999).

The mean value for total acidity found in different Zulian regions lay in the range of 24.4–53.3 meq/kg which agreed with those from other geographical origins (Costa et al., 1999; Kaushi, Joshi, & Gupta, 1993; Pérez-Arquillué et al., 1994). The variation in acidity among different honey types may be attributed to variation due to harvest season (Pérez-Arquillué et al., 1994). El-sherbiny and Rizh (1979) reported that total acidity was higher in cotton honey than in clover honey which indicates the influence of floral types in total acidity. Costa et al. (1999) suggested that xerotolerant yeasts were responsible for raising the average total acidity found in the Brazilian northeast and midwest regions. Venezuelan and International regulations established an acidity content not higher than 40 meq/kg. Six out of eight samples were within this level, indicating absence of undesirable fermentation.

Differences in pH values were significantly different ($P < 0.05$) (Table 1). N1D and SR had significantly higher pH values (4.3 and 3.9, respectively) than the other samples. The pH of a honey is not directly related to the free acidity because of the buffering action of the various acids and minerals present (Abu-Tarboush et al., 1993). The mean values for pH found in different Zulian regions (N2D, SD, NWR, SR) are within the range of Spanish rosemary honey (Pérez-Arquillué et al., 1994). There is not a Venezuelan standard for this parameter, but all values (except for NID) were within the range reported by Pourtallier and Talercio (1970) who established pH $\leqslant 4$ as a normal value.

Honey normally has a low ash content and it depends on the material collected by the bees during foraging on the flora (Abu-Tarboush et al., 1993). The ash content (0.1894–0.4937%) was within the limit allowed by Venezuelan requirements ($\leqslant 0.5\%$).

The diastase activity and the hydromethyl furfural (HMF) content are widely recognized as parameters indicating the freshness of honey (Sancho, Muniategui, Huidoboro, & Simal, 1992). From the results, it can be seen that all samples are fresh and met Venezuelan requirements (COVENIN 2191-84).

In Venezuela, the content of nitrogen has been used to detect honey frauds due to the addition of carbohydrates. Samples containing more than 30 mg nitrogen per 100 g honey have been considered to be genuine (Vit, 1987). The mean values found in the Zulian honeys were in the range 57.5–72.0 mg/100g, which means that all the samples are genuine.

Samples displayed a wide range of sucrose content (2.21–5.52%), but only one sample was above the Venezuelan maximum legal limit of 5% sucrose for multifloral honeys (Table 2). These results are similar (0.07–5.85%) to that found by Pérez-Arquillué et al. (1994). The samples, except one, showed a very small arabinose content (from 0.03 to 0.90%)

Honey consists mostly of the monosaccarides glucose and fructose. The actual proportion of fructose to glucose, in any particular honey, depends largely on the source of the nectar (Anklam, 1998). The average ratio of fructose/glucose is 1.2/1 (White, 1978). All the samples contained more fructose than glucose (Table 2). This indicates that Zulian honeys would be less prone to granulation. Honeys with high fructose/glucose ratios would remain liquid for longer periods (White et al., 1962). The fructose/glucose ratio may have an impact on honey flavour, since fructose is much sweeter than glucose (Mead-Chen, 1977). In relation to fructose, glucose mean values and fructose/glucose ratios, there were no significant differences ($P > 0.05$) among Zulian regions. All honey samples easily met the requirement (65%) of reducing sugar (Codex Honey Standard, 1986; COVENIN 2191-84).

In general, the chemical characteristics of the Venezuelan honey studied met national and international standards.

Acknowledgements

The authors wish to thank the Consejo de Desarrollo Científico y Humanístico (CONDES) for its financial support.

References

Abu-Tarboush, H., Al-Kahtani, H., & El-Sarrage, M. (1993). Floral-type identification and quality evaluation of some honey types. *Food Chemistry*, *46*, 13–17.

Andrade, P., Amaral, M., Isabel, P., Carvalho, J., Seabra, R., & Cunha, A. (1999). Physicochemical attributes and pollen spectrum of Portuguese heather honeys. *Food Chemistry*, *66*, 503–510.

Anklam, E. (1998). A review of the analytical methods to determine the geographical and botanical origin of honey. *Food Chemistry*, *63*, 549–562.

AOAC. (1990). In: K. Helrich (Ed.), *Official methods of analysis* (15th ed). Arlington, VA. USA: Association of Official Analytical Chemists

Bogdanov, S., Vit, P., & Kilchenmann, V. (1996). Sugar profiles and conductivity of stingless bee honeys from Venezuela. *Apidologie*, *27*, 445–450.

Codex Honey Standards. (1986). *Proposed draft codex standard for honey*. *A comprehensive survey*. C. P. Erridge (Ed.). Ottowa, Ontario, Canada.

Costa, L., Albuquerque, M., Trugo, L., Quinteiro, L., Barth, O., Ribeiro, M., & De Maria, C. (1999). Determination of non-volatile compounds of different botanical origin Brazilian honeys. *Food Chemistry*, *65*, 347–352.

Covenin. Comisión Venezolana de Normas Industriales. (1984). Miel de Abeja. Métodos de Ensayo 2136-84. Ministerio de Fomento. Venezuela.

Covenin. Comisión Venezolana de Normas Industriales. (1984). Miel de Abeja. Requisitos 2191-84. Ministerio de Fomento. Venezuela.

El-Sherbiny, G., & Rizk, S. (1979). Chemical composition of both clover and cotton honey produced in A.R.E. Egypt. *J. Food Sci.*, *7*, 69–75.

Esti, M., Panfili, G., Marconi, E., & Trivisomo, M. (1997). Valorization of the honeys from the Molise region through physico-chemical, organoleptic and nutritional assessment. *Food Chemistry*, *58*, 125–128.

Kaushik, R., Joshi, V., & Gupta, J. (1993). Total soluble solids, acidity, pH and standard plate counts in the Indian honey as affected by different treatments and storage condition. *J. Food Sc. Technol.*, *30*, 442–443.

La Grange, V., & Sanders, S. (1988). Honey in cereal-based new food product. *Cereal Foods World.*, *33*, 833–838.

Mead-Chen. (1977). *Cane sugar handbook* (10th ed.). John Wiley and Sons.

Pérez- Arquillué, C., Conchello, P., Ariño, A., Juan, T., & Herrera, A. (1994). Quality evaluation of Spanish rosemary (*Rosmarinus officinalis*) honey. *Food Chemistry*, *51*, 207–210.

Pérez-Arquillué, C., Conchello, P., Ariño, A., Juan, T., & Herrera, A. (1995). Physicochemical attributes and pollen spectrum of some unifloral Spanish honeys. *Food Chemistry*, *54*, 167–172.

Pourtallier, J., & Taliercio, Y. (1970). Les caracteristiques physicochemiques des miels en fonction de leur origine florale.1. Application a un projet de normes pour les grandes varietés de miels. *Bull Apic. Doc. Sci. Technol.*, *13*, 58–67.

Sancho, M., Muniatequi, S., Huidoboro, J., & Simal, J. (1992). Evaluating soluble and insoluble ash, alkalinity of soluble and insoluble ash and total alkalinity of ash in honey using electrical conductivity measurements at 20 °C. *Apidologie*, *23*, 291–297.

SAS. (1990). *SAS user's guide: statistics*. Carry. NC: SAS Institute.

Singh, N., & Kaur, P. (1997). Quality evaluation of different types of Indian honey. *Food Chemistry*, *58*, 129–133.

Sporns, P., Plhak, L., & Friedrich, J. (1992). Alberta honey composition. *Food Research International*, *25*, 93–100.

Steel, R., & Torrie, J. (1980). *Principles and procedures of statistics*. New York: McGraw-Hill.

Swallow, K., & Low, N. (1990). Analysis & quantitation of the carbohydrates in honey using high-performance liquid chromatography. *Journal of Agricultural Food Chemistry*, *38*, 1828–1832.

Vit, P. (1987). Utilidad de la determinación del contenido de nitrógeno en el control de calidad de mieles venezolanas. *Acta Cient. Ven.*, *38*, 511–512.

Vit, P., & Tomas, F. (1998). Flavonoids in Meliponinae honeys from Venezuela related to their botanical, geographical and entomological origin to assess their putative anticataract activity. *Z Lebensm. Unters Torsch A.*, *206*, 288–293.

Vit, P., Rios de Salgrado, A., Novoa, M., Reinosa, J., & Camargo, J. (1994). Antibacterial activity and mineral content of Venezuelan stingless bee honeys. *Proceedings of the Fifth International Conference on Apiculture in Tropical Climates. Brazil*, 254–256.

White, J. W. Jr (1978). Honey. *Adv. Food Res.*, *24*, 287–374.

White, J. W. Jr, Riethof, M., Subers, M., & Kushmir, I. (1962). Composition of American honey. USDA. *Tech. Bull.*, *1261*, 1–124.