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Characterization of Different Floral Origins Honey Samples from Santa Fe (Argentine) by Palynological, Physicochemical and Sensory data

Ciappini [1*], María C; Gatti[1], María B.; Di Vito[1], María V.; Gattuso[2], Susana; Gattuso[2], Martha

[1] Universidad del Centro Educativo Latinoamericano - Avenida Pellegrini 1332, S 2000 BUN Rosario, Santa Fe, Argentina – TE 54 341 4499292 – e-mail: laboratorio@ucel.edu.ar

[2] Facultad de Ciencias Bioquímicas y Farmacéuticas, Universidad Nacional de Rosario
Suipacha 531, S2002LRK Rosario, Santa Fe Argentina – TE 54 341 4804592

* Correspondent author: laboratorio@ucel.edu.ar or mcciappini@hotmail.com
TE/Fax 54 341 4499292 int. 138

ABSTRACT

The aim of the present work was to describe honey from Argentina, in order to contribute to their characterization for commercial purposes. Samples were physicochemical and sensory examined using a quantitative descriptive analysis method. Fifty samples analyzed with 54.8% characterized as monofloral, mostly clover (60.9%) and eucalyptus (26.1%) honey. Clover honey had a weak and non-persistent fruity and floral odour. Eucalyptus samples had a vegetable odour and intense sweetness; the ones from the islands had a ripe fruit and transformed sugar flavor. The moisture content varied from 16.5 to 20.5% and acidity from 8.6 to 45.9%. Island samples showed darker Pfund's colour values than those coming from other regions. Principal component analysis was performed on sensory and physicochemical variables for grouping the samples in the multidimensional space. Honeys were correctly classified according to its floral origin. Further studies are needed in order to investigate other floral origins to provide a robust model to classify honey samples from this region.

Key words: *honey, sensory- palynologic analysis*

INTRODUCTION

Physicochemical and melissopalynological characteristics from honey of different origins were fully examined in the past and in the last ten years [1, 2, 3, 4]. Honey contains about 181 substances including sugars, proteins, moisture, vitamins, minerals, hydroxymethyfurfural, enzymes, flavonoids, phenolic acids, volatile compounds, and so on [5]. Aroma composition and new chemical markers like volatile compounds appeared to be characteristics of this floral origin [6]. There are some others profiles of components that could probably be used for the detection of geographical origin: oligosaccharides [7], amino acids [8], trace elements [9]. Multivariate chemometrics techniques such as principal components analysis, cluster analysis, linear discriminant analysis were used to classify honeys on the basis of the chemical data [10, 11]. Rheological and thermal properties have been reported [12, 13], and there are several studies about sensory characteristics [14, 15, 16].

Honey samples that are available commercially differ in quality on account of various factors like seasons, packaging and processing conditions, floral source, geographical origin, and storage period. The currently international market demands the set up of honey quality control protocols according to the botanical origin based on pollen content and sensory characteristics. The European Standard Directive 110/01, defines honey as unifloral when it is from a completely or partially botanical origin including its pollen, physicochemical and sensory characteristics corresponding to their origin. Consequently, the three analytical systems are complementary assays to characterize those [17]. However little information is available about botanically typified, sensory and physicochemical examined honey [18, 19, 20].

The variety of botanical species in the province of Santa Fe (Argentina; 28º - 35º SL; 58º- 62º WL) makes possible to obtain honey with different sensory and physicochemical characteristics. This attributes conferring the product with different commercial values. There are very few studies from Argentineans honeys [21], although this country is the second world exporter. The pollen content of Santa Fe honey was poorly studied while the sensory characteristics are almost unknown up to now since there are no complete characterizing studies in this province.

The objective of the present study was to determine the physicochemical characteristics, botanical origin, and a sensory description of honeys in the province of Santa Fe (Argentine). These aspects are essential for honey commercialization have not been evaluated systematically. The aim of this research was to provide a reference for commercial strategies for sellers and buyers.

MATERIALS AND METHODS

Honey sampling

Honey samples (about 1 kg each) of the 2005/06 harvest, were collected and packaged in hermetically sealed glass flasks. Sampling was carried out in honey production and bee-hive product areas of Santa Fe Province, Argentina (28º - 35º SL; 58º- 62º WL).

Qualitative melissopalynological analysis

The qualitative melissopalynological analysis was carried preparing each sample mounted in glycerol – gelatine [22]. At least 300 pollen grains were counted for an estimation of the relative frequencies of pollen types. Morphological types of pollen grains were determined using a photographic atlas [23, 24] and a collection of

reference pollen slides provided by “Cátedra de Botánica Morfológica y Sistemática” from the Faculty of Biochemical and Pharmaceutical Sciences, National University of Rosario. Unifloral honeys were considered those with a dominant pollen type (D) over 45%; except for *Eucalyptus* sp. (D 70%), *Citrus* sp. (D 45 %), *Melilotus* sp. and *Medicago sativa*, (D 20%), according to international values admitted [25].

Physicochemical determinations

a- Refractometric moisture, according to 969.38 AOAC Method [26], with a handheld refractometer at 20ºC (Atago, Japan Model REF 106c).
b- Free acidity, according to 962.19 AOAC Method [26].
c- Sugars: glucose, fructose, sucrose and maltose were assessed by liquid chromatography, according to 977.20 AOAC Method [26], using a Shimadzu LC 10-AS chromatograph, equipped with a refractive index IR-10A detector and 300 x 4 (id) mm Aminax HPX 87 C (Ca^{++}) (Biorad) 5μm column, and precolumn (4mm) of the same material. It was operated at oven and detector temperature of 23ºC. Mobile phase was acetonitrile: water (83:17), degassed by magnetic stirring 15 min under vacuum, at a flow rate of 0.6 ml/min. Standard solutions were prepared diluting 3.804 g fructose (SIGMA), 3.010 g glucose (SIGMA), 0.602 g sucrose (SIGMA) and 0.301 g maltose (SIGMA) in 100 ml water. A solution of 5.000 g of honey sample diluted to volume (50 mL) with water and filter through 0.45 μm filter, was injected into the chromatograph (loop volume 20 μL). Sugars were automatically integrated according to standard solution concentrations.
d- Pfund color, according to [27].

Sensory analysis

a) Descriptors and panel

The panel consisted of 8 people in the age group of 23-56 years, comprising both male and female, who had been selected and training according [28]. They were selected from a recruited group of thirty six people using eight screening test: a basic taste test, an odour recognition test, the Ishihara Test for colour, two intensity ranking test (acid taste and bitter taste), a description test of texture and sequential test for difference. The standard were prepared as described in [29] for the initiation and training of assessors in the detection and recognition of odours, and as described in [30] for the investigation of sensitive of taste. Assessors were training in odour and flavour lexicon with references and natural products [31]. The training involved ten sessions during which they were trained in performing a descriptive test.

b) Sensory analysis

Testing was performed in a sensory laboratory with individual booth under daylight. Thirty grams of honey sample was served at room temperature (23 $\pm$ 2 ºC) in a wineglass labelled with three digit codes. Three successive phases were considered: visual, olfactory and gustatory. Honey was observed to evaluate its aspect, consistence, cleanness and eventual defects of crystallization, spreading on the glass surface of the container with swirling movement and taking short sniffs. A honey aliquot was taken to observe crystallization and fluidity. A small portion was placed on the tongue, allowing it to dissolve with saliva and projecting it to the back of the oral cavity to appreciate flavour and aroma. Evaluation of crystalline structure was performed on the same sample or on a successive one, pressing it between the tongue and the palate to perceive crystals cohesion, dimension and form. Finally, taste and persistence were evaluated after swallowing the sample. Five samples

were done in a session; water and unsalted bread were used as palate cleansing material in between the samples. A duplicate was given at each session to check the panel performance. Perceived sensations were register on individual sheet. Each term was evaluated using a scale ranging from one (very slight perception) to ten (very intense). The panellists were asked to mark the perceived intensity of the attribute by drawing a vertical line. The mean scores for intensity were calculated and tabulated.

Statistical analysis

Results represent the average of at least three replications for moisture content, free acidity, sugars and colour. Principal Component Analysis (PCA) was employed for determining the relationship among group of variables in the data set. PCA and correlation Pearson's coefficient was carried out using statistical software BioEstat [32].

RESULTS

Geographical and botanical origin

The province was divided in three phytogeographic areas, namely Northern Chaco (north), Center Espinal (Center) and Southern Pampa (South), adding the Island zone that has important weather characteristics and its mellifera flora are different from the others that are worth to taking into account. Table 1 shows the botanical and geographical origin of the analyzed honeys. It can be seen there are multifloral and monofloral (54.8%) honeys, mainly clover (*Trifolium* sp.) (60.9%) and eucalyptus (*Eucalyptus* sp.) honeys (26.1%); there were also found from chañar (*Geoffroea decorticans*), carob (*Prosopis* sp.) and willow (*Salix* sp.) species. Clover honey was found especially in Center and Southern zones, while eucalyptus was harvested in the Southern and Island zones. Botanical characteristics of honeys from the Southern Pampa zone are in agreement with [33].

***Table 1**: Geographical, botanical and physical characteristics of samples honeys*

Sample number	Geographical origin	*Floral source*	Physical state[a]
1	Vera Dept.	Monofloral (*Geoffroea decorticans*)	C
2	Las Colonias Dept.	Monofloral (*Trifolium* sp.)	C
3	La Capital Dept.(island)	Multifloral (1)	C/L
4	La invernada Island, Rosario Dept.	Multifloral (2)	C/L
5	Sunchales, Castellanos Dept.	Monofloral (*Trifolium* sp.)	C/L
6	Sunchales Tacural, Castellanos Dept.	Monofloral (*Trifolium* sp.)	C/L
7	Humberto Primo, Castellanos Dept.	Multifloral (3)	C/L
8	Humberto Primo, Castellanos Dept.	Multifloral (3)	C/L
9	Humberto Primo, Castellanos Dept.	Multifloral (3)	C/L
10	Humberto Primo, Castellanos Dept.	Monofloral (*Trifolium* sp.)	C
11	Humberto Primo, Castellanos Dept.	Monofloral (*Trifolium* sp.)	C/L
12	Las Colonias Dept.	Monofloral (*Trifolium* sp.)	C/L
13	Granadero Baigorria (island), Rosario Dept.	Multifloral (4)	C/L
14	San Genaro, San Jerónimo Dept.	Monofloral (*Eucalyptus* sp.)	C
15	Rosario Dept. (island)	Multifloral (5)	C/L
16	Humberto Primo, Castellanos Dept.	Monofloral (*Trifolium* sp.)	C

17	El Banco Island, San Lorenzo Dept.	Monofloral (*Salix* sp.)	C
18	Encanto Island, province of Santa Fe	Monofloral (*Eucalyptus* sp.)	C
19	Aldao, San Lorenzo Dept.	Monofloral (*Trifolium* sp.)	C/L
20	Province of Santa Fe	Multifloral (6)	C
21	Campo Grande, San Jerónimo Dept.	ND[b]	C
22	Campo Grande, San Jerónimo Dept.	ND[b]	C/L
23	Campo Grande, San Jerónimo Dept.	ND[b]	L
24	Villa Cañas, Gral. López Dept.	Monofloral (*Eucalyptus* sp.)	C
25	Villa Cañas, Gral. López Dept.	Multifloral (7)	C
26	Venado Tuerto, Gral. López Dept.	Multifloral (8)	C
27	Villa Cañas, Gral. López Dept.	Multifloral (9)	C/L
28	Villa Cañas, Gral. López Dept.	Multifloral (10)	C/L
29	San Jorge, San Martín Dept.	Multifloral (11)	C/L
30	San Jorge, San Martín Dept.	Monofloral (*Trifolium* sp.)	C/L
31	Cañada de Gómez, Iriondo Dept.	Monofloral (*Trifolium* sp.)	C
32	San Francisco, Gral. López Dept.	Multifloral (12)	C
33	Tostado, 9 de Julio Dept.	Monofloral (*Trifolium* sp.)	C/L
34	Chañar Ladeado, Caseros Dept.	Monofloral (*Eucalyptus* sp.)	C/L
35	Tostado, 9 de Julio Dept.	Multifloral (13)	C/L
36	Province of Santa Fe	Multifloral (14)	C
37	Rufino, Gral. López Dept.	Multifloral (15)	C/L
38	Province of Santa Fe (island)	Multifloral (16)	L
39	Province of Entre Ríos	Multifloral (17)	C
40	Province of Santa Fe	Monofloral (*Eucalyptus* sp.)	C
41	Province of Santa Fe	Multifloral (18)	C
42	Province of Entre Ríos	Multifloral (19)	C/L
43	San Guillermo, San Cristóbal Dept.	Multifloral (20)	C
44	Rufino, Gral. López Dept.	Monofloral (*Trifolium* sp.)	C/L
45	Rufino, Gral. López Dept.	Monofloral (*Eucalyptus* sp.)	C
46	Alcorta, Constitución Dept.	Multifloral (21)	C
47	Province of Santa Fe (north)	Monofloral (*Prosopis* sp.)	L
48	Monigotes, San Cristóbal Dept.	Monofloral (*Trifolium* sp.)	C
49	Province of Santa Fe	ND[b]	C/L
50	Ceres, San Cristóbal Dept.	Monofloral (*Trifolium* sp.)	C/L

[a] C: crystallized; L: liquid; C/L: crystallized / liquid mixture

[b] ND: Not determined

(1) *Polygonum* sp.*, Eryithrina crista-galli,* Brassicaceae*, Salix* sp.

(2) *Carduus* sp.*, Polygonum* sp.*,* Asteraceae*, Sagittaria montevidensis.*

(3) *Trifolium* sp.*, Helianthus annuus, Cichorium intybus, Carduus* sp.*,* Chenopodiaceae, Brassicaceae.

(4) *Trifolium* sp., *Polygonum* sp., Brassicaceae, *Carduus* sp.*, Salix* sp.*, Portulacca oleracea.*

(5) *Verbesina encelioides, Trifolium* sp.*, Helianthus annuus, Eucalyptus* sp., *Carduus* sp., Brassicaceae.

(6) *Carduus* sp.*,* Brassicaceae*, Verbesina encelioides, Bidens* sp.*,* Cynarea, Poaceae, Laminaceae*.*

(7) *Eucalyptus* sp.*, Trifolium* sp.*, Medicago* sp., *Carduus* sp.*, Apium* sp.

(8) *Trifolium* sp.*, Lotus* sp.*, Eucalyptus* sp.*, Echium plantagineum, Helianthus annuus,* Poaceae

(9) *Eucalyptus* sp.*, Mendicago* sp.*, Trifolium* sp., Brassicaceae, *Echium plantagineum.*

(10) *Trifolium* sp., *Trifolium pratensis,* Mirtaceae*, Eucalyptus* sp., Brassicaceae.

(11) *Trifolium* sp., *Apium* sp., Brassicaceae, *Helianthus annuus, Eucalyptus* sp.*, Echium plantagineum.*

(12) *Trifolium* sp.*, Trifolium pratensis, Carduus* sp., *Helianthus annuus, Eucalyptus* sp. *Verbecina encelioides,* Poaceae, *Portulacca oleracea, Cichorium intybus.*

(13) Verbenaceae*, Trifolium* sp.*, Apium* sp., Brassicaceae*, Lactuta sativa, Taraxacum officinale, Carduus* sp.

(14) *Eucalyptus* sp.*, Trifolium* sp.*, Trifolium pratensis, Helianthus annuus, Carduus* sp.*,* Brassicaceae.

(15) *Eucalyptus* sp.*, Trifolium* sp., *Trifolium pratensis, Melilotus* sp.*, Helianthus annuus, Carduus* sp., Brassicaceae*, Passiflora* sp.*, Ammi viznaga,* Chenopodiaceae.

(16) *Parkinsonia aculeata, Tessaria intergrifolia*, *Eucalyptus* sp.*, Polygonum* sp.*, Trifolium* sp., *Bidens* sp.*, Eichhornia crassipes, Carduus* sp.*,* Brassicaceae*, Passiflora* sp.*, Ammi visnaga.*

(17) *Eucalyptus* sp.*, Trifolium* sp., *Prosopis* sp.*, Portulaca oleracea, Apium, Mirtaceae.*

(18) *Trifolium* sp., *Eucalyptus* sp., *Echium plantagineum, Melilotus* sp., Chenopodiaceae, Mirtaceae.

(19) *Trifolium* sp.*, Eucalyptus* sp., *Echium plantagineum, Baccharis salicifolia, Helianthus annuus,* Brassicaceae*, Apium* sp., *Cichorium intybus, Carduus* sp.*,* Mirtaceae.

(20) *Trifolium* sp., *Eucalyptus* sp.*, Helianthus annuus,* Brassicaceae, *Apium* sp.*, Cichorium intybus, Bidens* sp..

(21) *Eucalyptus* sp., Mirtaceae, *Polygonum* sp.*, Trifolium* sp.*,* Heliantheae, *Helianthus annuus, Carduus* sp., Poaceae.

Sensory analysis

The multifloral honeys showed a variety of colours and floral, fruit, spicy and vegetable odour and flavour notes. However, the islands' multifloral honeys were characterized by their ripen fruit and transformed sugar. All of them were dark amber and liquid.

Eucalyptus honey is characterized by the presence of small crystals, easily dissolved in the mouth but perceptible. It is of moderate persistent odour with vegetable aroma; slightly persistent milky, malted notes, as dry pasture herb. It is also characterized by its moderate sweetness without salted or bitter notes. Samples from Southern zones were dark with green colour notes. The presence of willows and *mirtaceae* in one sample of eucalyptus honey from the Island, modify the sensory characteristics of this type. Difference with the aspect is the presence of reddish shade and moderate brightness. It is characterized by woody notes, a caramel and weak phenol aroma. It has an intense and persistent sweetness in the mouth and also produces slight astringency and metallic notes. Modification of sensory attributes yielded presumably by nectars of other floral origin in eucalyptus honeys, according to pollen analysis, might emphasize the European regulations regarding the necessity of fulfilling pollen, physicochemical and sensory characteristics according to their origin to be considered as unifloral (EU 110/01).

Clover honey crystallizes naturally yielding small and middle crystals; easily dissolve in mouth, with creamy and weakly sand texture. It is characterized by its slight fruit, floral and non persistent odour with citric notes. It is of moderate, slightly persistent sweetness. Astringent and pungent trigeminal sensations appear after swallowing. Unlike the other ones, medicinal note and a very light metallic taste were present in one sample, indicating a possible chemical contamination.

Willow honey is described as an aromatic honey with dried fruit, warm ripens and anethole notes, a moderate sweetness and low but persistent odour intensity. It is crystalline with scanty small crystals of creamy texture, with reddish bright colour.

Carob honey is characterized by the absence of crystals yields a smooth oral texture. It is of dark amber in colour with reddish/orange notes and very bright; intense aroma, chemical, spicy liquorice-like odour and slightly perceptible bitterness with candy notes.

Chañar honey crystallizes forming scanty small crystals, easily dissolved in the mouth with a creamy and smooth texture. It is of floral but low and slight persistent aroma with vanilla flavor and residual astringency.

Typifying of unifloral honeys require at least 15 samples for each species [34]. The number of samples of chañar, willow and carob honey hereby presented is lower; consequently, the characterization of unifloral honeys found is incomplete.

Physicochemical analysis

Moisture content varied from 16.5 to 20.5%. This parameter is associated with fermentation phenomena and is important in honey preservation. Three samples (6%) were above 20% limit established. Tosi *et a*l [35] reported 29% of honey assayed with moisture content above this limit from 2000/2003 harvest.

The percent acidity of samples harvested in the Northern, Center and Southern zones varied from 8.6 to 33.5 meq/Kg, Islands' samples acidity varied from 16.6 to 45.9%; 28% of them had percentage acidity above 40 meq/Kg, limit established for commercialization. Free acidity has positive correlation with moisture

content (r = 0.69); it is related with geographic origin: Island's samples have the highest moisture content and highest percent acidity.

Islands honeys were darker than those of other zones. Most of the samples are white, extra light amber and light amber (Table 2).

Sugar content of honey samples

Sugar content (fructose, glucose, maltose and sucrose) of honey samples is observed in Table 2; as expected, fructose and glucose are the dominant species; the sum (fructose + glucose) ranged between about 68 – 82%. Maltose and sucrose were much less abundant; maltose was generally below 1%, while sucrose amounted as high as 0.5-3%. The eucalyptus honey fructose/glucose (F/G) ratio: 1.31 is almost the same for clover, 1.40, and multifloral honeys, 1.37.

Table 2: Colour and Sugar content (g/100 g) of honey samples

Sample number	Fructose	Glucose	Maltose	Sucrose	Fructose plus Glucose	Colour mm Pfund[a]
1	42.82	38.02	0.02	0.10	80.84	43.3 - ELA
2	45.39	34.89	0.16	1.06	80.82	42.3 - ELA
3	45.91	34.42	0.14	0.99	80.83	104.1 - A
4	43.95	35.88	0.39	1.50	79.83	35.5 - ELA
5	44.97	36.73	0.32	0.48	81.70	29.5 - W
6	45.17	35.71	0.28	1.28	80.88	16.7 - W
7	45.21	36.19	0.29	1.29	81.40	20.7 - W
8	43.76	36.70	0.17	1.20	80.46	28.5 - W
9	44.61	34.36	0.16	0.97	78.97	30.5 - W
10	41.74	32.78	0.33	1.22	74.52	20.7 – W
11	42.00	35.40	0.24	1.43	77.40	56 - LA
12	42.16	37.00	0.07	1.66	79.16	52.0 - LA
13	44.26	38.00	0.07	0.14	82.26	118.7 - D
14	43.49	39.04	0.58	0.33	82.53	10.0 - WW
15	41.02	38.23	0.48	1.58	79.25	140.0 - D
16	43.94	33.96	0.23	1.09	77.90	38.0 - W
17	44.87	30.39	0.48	1.66	75.26	140.0 - D
18	45.69	31.40	0.41	1.69	77.09	96.1 - A
19	47.74	27.88	0.65	0.60	75.62	64.8 - LA
20	44.23	33.53	0.29	1.34	77.76	113.7 – A
21	44.22	33.19	0.95	2.23	77.41	57 – LA
22	47.35	32.73	0.59	0.49	80.08	63.8 – LA
23	46.22	33.54	0.47	0.77	79.76	24.7 - W
24	45.45	34.94	0.16	1.07	80.39	40.3 – ELA
25	44.59	32.64	0.48	1.68	77.23	57 – LA
26	45.32	34.63	0.06	1.46	79.95	41.3 – ELA
27	44.85	23.65	2.47	2.93	68.50	102.1 – A
28	44.97	37.06	0.12	0.89	82.03	50.1 – LA
29	45.05	33.30	0.33	1.23	78.35	29.5 – W
30	45.27	35.07	0.45	1.25	80.34	62.8 – LA
31	42.59	32.15	0.83	1.67	74.74	28.6 - W
32	44.54	34.30	0.34	1.36	78.84	37.3 – ELA
33	47.11	26.50	0.49	1.41	73.61	39.3 – ELA
34	44.38	32.93	0.62	1.54	77.31	45.1 – ELA
35	44.39	35.05	0.31	0.37	79.44	46.1 – ELA
36	44.88	32.64	0.61	1.54	77.52	36.3 ELA
37	45.52	30.36	0.79	1.74	75.88	63.8 – LA
38	51.75	24.41	0.51	1.52	76.16	116 – D
39	46.47	31.93	0.70	2.01	78.40	74.6 – LA

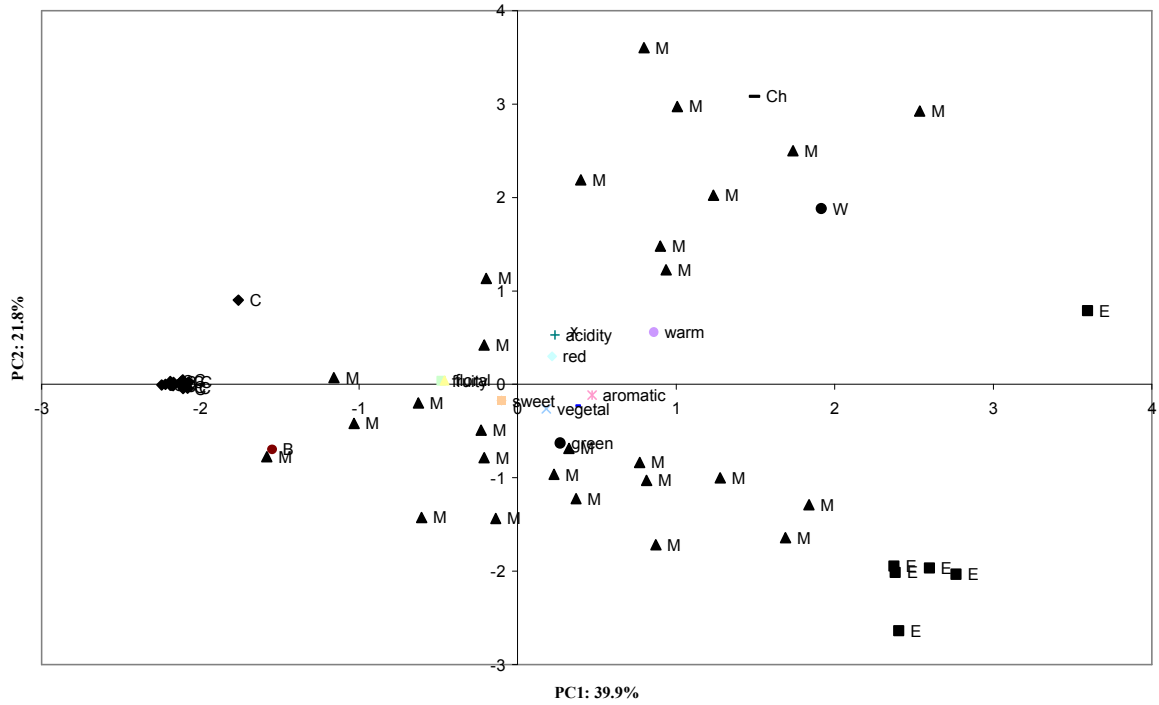
40	41.09	29.74	1.42	0.71	70.83	76.6 – LA
41	44.17	33.47	0.54	0.56	77.64	43.3 – ELA
42	39.81	28.25	0.37	0.38	68.06	47.1 – ELA
43	46.33	31.00	0.27	1.27	77.33	29.5 – W
44	43.91	33.22	0.23	1.02	77.13	23.7 – W
47	42.06	27.95	0.72	0.75	70.01	118.4 – D
48	49.77	27.32	0.40	0.55	77.09	19.7 – W
49	42.76	28.54	0.33	0.40	71.30	18.7 - W
50	48.93	23.06	0.24	0.47	71.99	61.8 - W

[a]: WW: water white; W: white; ELA: extra light amber; A: amber; D: dark amber

PCA

Physicochemical and selected sensory parameters were subjected to PCA. Figure 1 represents the plot of the attributes in the plane defined by the first two components. A two factor model selected that explain 61.7% of total variance. This percentage of variance explained is within the range usually obtained in the sensory analysis of food [36]. The first dimension separates odour/aroma attributes: floral/fruity from vegetal, warm and aromatic. Floral and fruity attributes were cluster together. The second dimension separates colours: green from red and sweet from acidity. From the results obtained it was observed that honey from different botanical origin appear to be well separated. One sample from eucalyptus honey is located away from the other samples of this botanical origin, agreed with sensory description. Attributes namely floral, fruity, aromatic, warm and vegetable, red and green were the major sensory variables, while acidity was the major physico-chemical attributes contributing to the grouping of honey samples.

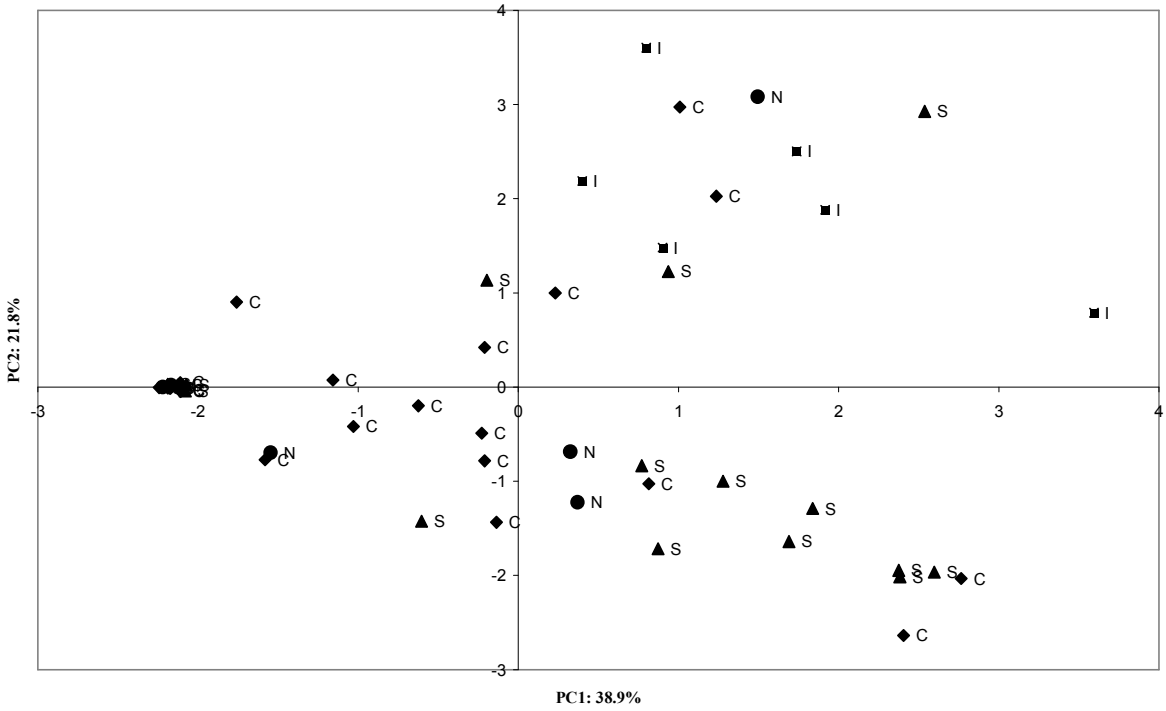
Figure 1 - Principal Components Analysis of honey samples considering its botanical origin: **C** clover; **E** eucalyptus; **M** multifloral; **B** Carob; **W** willow; **Ch** Chañar



Samples from Island were grouped together in the multidimensional space (Figure 2). PCA was found to be an effective tool in grouping the honey samples

based in sensory data, agree with [37]. A standardization of honey may further improve its quality.

Figure 2- Principal Components Analysis of honey samples considering its geographic origin: **N** Northern Chaco; **C** Center Espinal; **S** Southern Pampa; **I** Island



DISCUSSIONS

From the study of 50 honey samples from Santa Fe province (Argentine), it is possible to verify their compliance with international standards; only 6% of the total samples show one defect (moisture or acidity). The pollen analysis showed the main botanical species for honey production are clover and eucalyptus. Principal component analysis is a useful tool to discriminate honey by floral origin.

ACKNWOLEDGEMENTS

The authors are grateful to Ricardo Biani, General Director of Ecology and Protection of the Fauna, Ministry of Production of the Province of Santa Fe, who provided honeys samples and production data.

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