Journal homepage: www.fia.usv.ro/fiajournal
Journal of Faculty of Food Engineering,
Ştefan cel Mare University of Suceava, Romania
Volume XV, Issue 3 – 2016, pag. 234 - 239

PHYSICO-CHEMICAL AND TEXTURAL PROPERTIES OF HONEYS FROM NORTH EAST PART OF ROMANIA

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Received July 22nd, accepted September 23rd

Abstract:*The aim of this study is to evaluate the physico-chemical (pH, a_w, free acidity, Brix concentration, moisture content, ash content, colour parameters (L*, a*, b*, chroma, hue angle and yellow index, glucose, fructose and sucrose content) and textural (hardness, viscosity, adhesion, cohesiveness, springiness, gumminess and chewiness)) properties of 5 samples of honey of different floral origins (acacia, tilia, sunflower, honeydew and polyfloral). The physico-chemical parameters of honey were in agreement with those reported by other scientists. The moisture content of all the five samples do not exceeded the maximum allowable level of 20% established by the European Commission. The acacia and tilia honeys presented green components, while all the honey presented yellow components. The highest yellow index has observed in the case of tilia honey. The data were submitted to principal component analysis (PCA) and it was found that the two principal components (PCs) explained 100% of the variations in the data set. The PC1 explains 99% of the variability and the PC2 explains 1%. The PC1 separates the honey into two groups: one group below the PC1 represented by acacia, sunflower and polyfloral honeys and the second group below the PC1 represented by tilia and honeydew honeys.*

Keywords: *honey, physico-chemical parameters, texture parameters*

1. Introduction

According to the European Council Directive 2001/110 EC [1], honey is "the natural sweet substances produced by *Apismellifera* bees from the nectar of plants or from secretions of living parts of plants, which the bees collect, transform by combining with specific substances of their own, deposit, dehydrate, store and leave in honeycombs to ripen and mature".
One of the parameter used by the specialist in the food industry for the assessment of food quality and acceptability is food texture. From all the food texture parameters, hardness or firmness is the most used and important one for fruit and vegetables [2]. Texture profile analysis (TPA) sets up a 'bridge' from objective measurement to subjective sensation and makes food texture characteristics more predictable [3].
Honey contains approximately 80% carbohydrates (35% glucose, 40% fructose, and 5% sucrose) and 20% water, serving as an excellent source of energy [4]. In addition, it contains more than 200 components, including amino acids, vitamins, minerals, enzymes, organic acids and phenolic compounds [4, 5].
The characterization of honey from the physico-chemical point of view has been

conducted on honey from Algeria [6], India [7], Slovenia [8], Malaysia [9] and Bangladesh [10].
The aim of this study is to investigate the physico-chemical and textural properties of some honeys from the North East Part of Romania.

2. Materials and methods

Materials
5 honey samples of five different botanical origins (acacia, tilia, sunflower, polyfloral and honeydew) were purchased from local beekeepers from the Suceava county.

Physico-chemical properties
The physico-chemical properties (pH, a_w, free acidity, refraction index, moisture content, ash content, colour parameters (L*, a*, b*, chroma, hue angle and yellow index, glucose, fructose and sucrose content) were determined accordingly to the Harmonised methods of the International Honey Commission [11].

Texture profile analysis (TPA)
The TPA was carried out at 20 °C with Mark 10 Texture Analyzer (Mark 10 Corporation, USA) equipped with a 50 mm disc probe, the flask diameter was of 70 mm. The TPA was operated at a constant speed of 150 mm/min, until a depth of 12.5 mm (the honey column had 25 mm). The TPA can offer a great number of texture parameters, such as: hardness (H), viscosity (V), adhesion (A), cohesiveness (Co), springiness (S), gumminess (G) and chewiness (Ch) [12].

3. Results and discussion
Physico-chemical properties
Physico-chemical properties (pH, a_w, free acidity, refraction index, moisture content, ash content, colour parameters (L*, a*, b*, chroma, hue angle and yellow index, glucose, fructose and sucrose content) of the honey analysed are presented in table 1.

Table 1.

Physico-chemical properties of honey

Parameter	Acacia	Tilia	Polyfloral	Honeydew	Sunflower
pH	4.81	5.36	4.00	5.16	4.17
Aw	0.50	0.52	0.54	0.54	0.51
FreeAcidity (meq acid/k)	4.10	3.40	32.00	17.00	14.40
°Brix	81.30	79.80	81.90	81.90	82.40
Moisture content, %	17.28	18.84	16.83	16.60	16.16
Electrical conductivityµS/cm	136.10	219.60	504.20	937.80	353.20
Ash content, %	0.07	0.11	0.25	0.46	0.17
L*	45.10	32.37	38.89	21.52	36.75
a*	-0.67	-0.17	4.96	5.65	2.78
b*	15.11	14.57	13.72	6.90	12.03
Chroma	15.12	14.57	14.59	8.92	12.35
Hue angle	3.74	3.96	-2.54	0.36	0.41
Yellow index	47.87	64.32	50.40	45.82	46.78
Fructose (g/100g)	48.31	43.14	35.14	40.21	39.40
Glucose (g/100g)	22.06	30.67	34.12	36.40	36.15
Sucrose (g/100g)	1.90	1.09	1.97	0.00	0.80

The pH values of honeys ranged between 4.00 – 5.36, all the honey are acidic as the literature present [13]. The acidic nature of honey is the result of the acids present naturally in it.

The water activity ranged between 0.50 – 0.54; a low water activity product (a_w< 0.70) means that the product is microbiologically safe [14] because this product does not support the growth of foodborne pathogens [15]. The honey free acidity indicates if the honey started to ferment. The maximum allowable level for the free acidity is established to 40 meq acid/kg honey in the case of mono and polyfloral honeys and 50 meq acid/kg in the case of honeydew honeys. All the samples respect this limit.

The moisture content ranged between 16.60 – 18.84 %; all the samples respect the maximum allowable level of 20% established by the European Commission [1] .A moisture content higher than 20% will accelerate the fermentation processes and decrease the stability of honey.

The electrical conductivity ranged between 136.10 – 937.80 µS/cm, as it was normal, the honeydew honeys have the highest electrical conductivity and it was in agreement with the literature (honeydew honeys must have electrical conductivity higher than 800 µS/cm) [16].

Ash content represents the mineral content presented into honeys. The values of the mineral content ranged between 0.07 – 0.46%, in agreement with the literature [17].

An important parameter for the food is the colour. The colour of honey represents the first attribute and for this reason is an important parameter for its commercialization and authentication. Table 1 present the values of honey colour in CIEL*a*b* coordinates: L* (luminosity), a* (negative values indicate green while positive values indicate magenta), b* (negative values indicate blue and positive values indicate yellow), hue angle, chroma and yellow index. The highest luminosity had the acacia honey, followed by polyfloral, while honeydew honey had the lowest luminosity level, being the darkest one. The acacia and tilia honeys presented green components, while all the honey presented yellow components. The highest yellow index has observed in the case of tilia honey.

The major contributors of the honey sugars are fructose and glucose (inverted sugar). The sum of the fructose and glucose content into the honey should not be less than 60 g/100 g honey (European Commission). All five honeys s have inverted sugar content higher than 60 g/100g honey so they comply with the UE regulation. Of all the three sugars determined in honey, fructose was in a higher concentration than glucose, followed by sucrose, which was in lower concentrations. In all the cases the ratio fructose/glucose was higher than 1. The honeydew honey does not contain sucrose.

Texture profile analysis

In figure 1 the texture parameters magnitude are presented for each honey. It can be observed that honeydew honey has the highest chewiness, springiness, adhesion and viscosity. The polyfloral honey had the highest gumminess and hardness. Accordingly to the Pearson correlation, the texture parameters are influenced positively as: hardness with gumminess (r = 0,991**), hardness with chewiness (r = 0.932**), viscosity with adhesion (r = 0.949*), viscosity with springiness (r = 0.817*), adhesion with refraction index (r = 0.996**), gumminess with chewiness (r = 0.969*), and negatively: hardness with fructose content (r = -0.741*), viscosity with sucrose (r = -

0.854*), springiness with water activity (r = -0.782*).

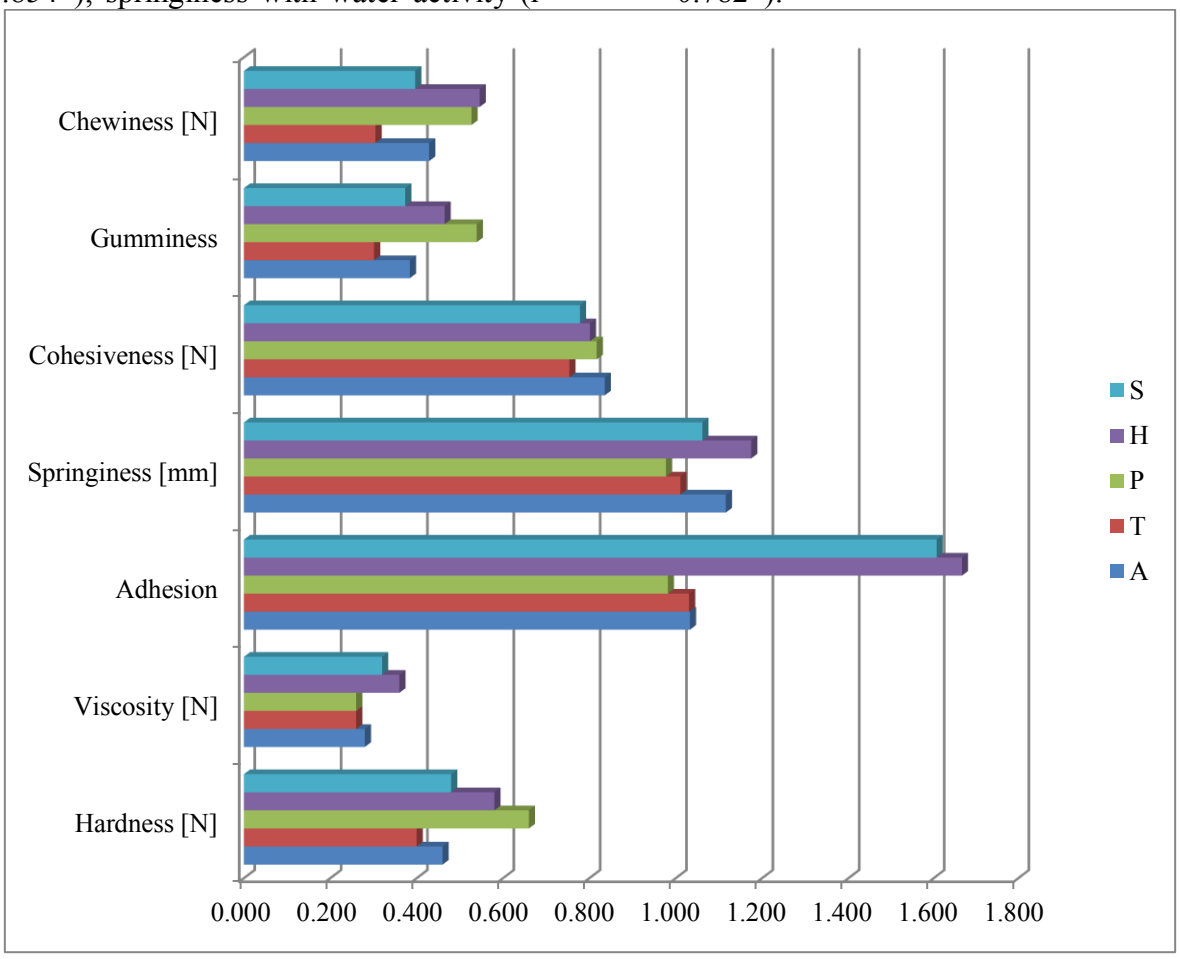

Figure 1.Texture parameters of honey: S- sunflower, H – honeydew, P – polyfloral, T – tilia, A- acacia

The principal component analysis was conducted to evaluate the global effect of the textural and physico-chemical parameters, from a descriptive point of view. Figures 1 and 2 present the scores and compound loadings of PCA analysis performed. It was found that the two principal components (PCs) explained 100% of the variations in the data set. The PC1 explains 99% of the variability and the PC2 explains 1%. It can be observed in the figure 2 that the samples are grouped into two groups separated by the principal component 1: one group below the PC1 represented by the acacia, sunflower and polyfloral honeys and the second group below the PC1 represented by the tilia and honeydew honeys. The two groups can be separated by the electrical conductivity parameter, which is an important parameter for the classification of honeys; the value of this parameter are greater in the case of honeydew and tilia honeys. PCA scores are presented in the figure 3. The refraction index and adhesion have the lowest influence on the projection.

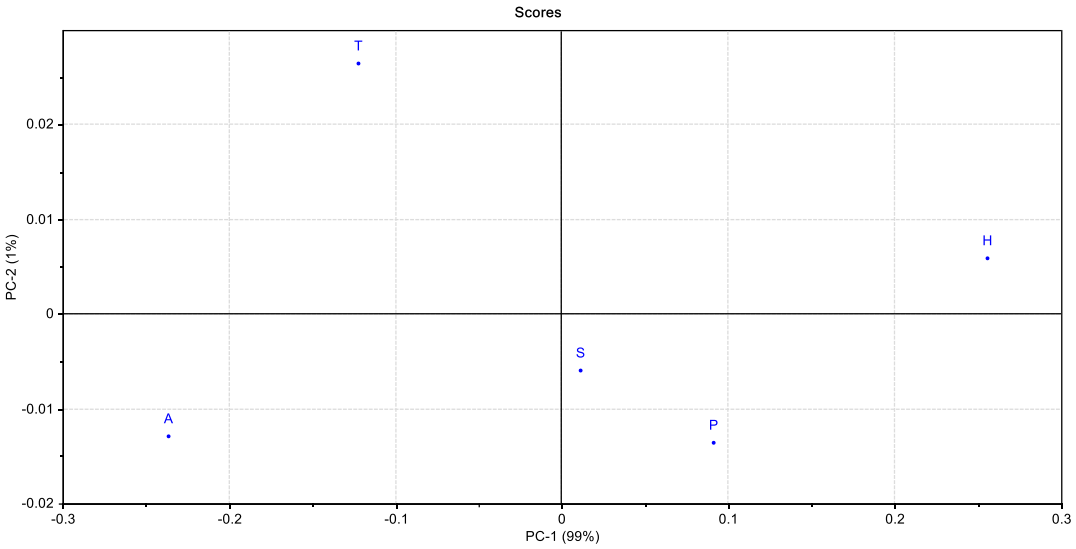

Fig. 2.Principal component analysis – loadings

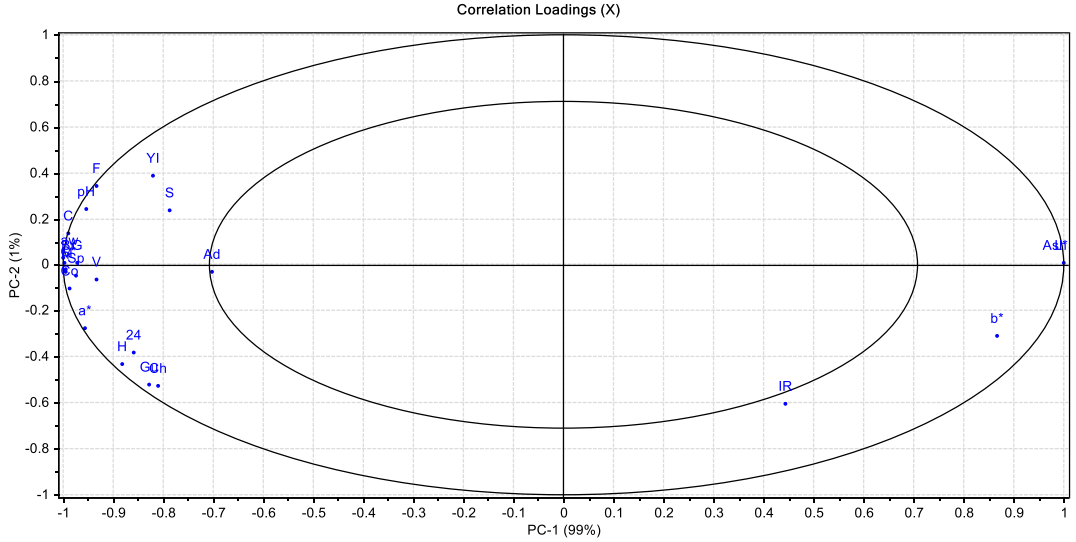

Fig. 3. Principal component analysis - scores

4. Conclusions

The honey analysed were of five different botanical origins (acacia, tilia, sunflower, polyfloral and honeydew). The honey samples complied with the regulations established by the Council Directive 2001/110/EC. The Principal Component Analysis (PCA) permitted the separation of honey samples into two different groups based on conductivity level (one group represented by acacia, sunflower and polyfloral honeys, and the other one represented by tilia and honeydew honeys).

Acknowledgement

This work was supported by a grant of the Romanian National Authority for Scientific Research and Innovation, CNCS

– UEFISCDI, project number PN-II-RU-TE-2014-4-0110.

5. References

[1].Council Directive 2001/110/EC - Council Directive of 20 Decemberrelatingtohoney 2001/110/EC. Official Journal of the European Communities.

[2].KONOPACKA, D., PLOCHARSKI, W.J., Effect of storage conditions on the relationship between apple firmness and texture acceptability. *Postharvest Biology and Technology* 32 (2), 205–211, (2004).

[3].CHEN, L., OPARA, U. L., Approaches to analysis and modelling texture in fresh and processed foods – A review, *Journal of Food Engineering*, 119, 497-507, (2013).

[4].ROSHAN, A. R. A., GAD, H. A., EL-AHMADY, S. H., ABOU-SHOER, M. I., KHANBASH, M. S., & AL-AZIZI, M. M., CharacterizationandDiscrimination of the Floral Origin of SidrHoneybyPhysicochemical Data CombinedwithMultivariateAnalysis. *FoodAnalyticalMethods*, 1-10, (2016)

[5].DE RODRÍGUEZ, G. O., DE FERRER, B. S., FERRER, A., &RODRÍGUEZ, B., Characterization of honeyproduced in Venezuela. *FoodChemistry*, *84*(4), 499-502, (2004).

[6].OUCHEMOUKH, S., LOUAILECHE, H., & SCHWEITZER, P., Physicochemical characteristics and pollen spectrum of some Algerian honeys. *Food Control*, *18*(1), 52-58, (2007).

[7].SAXENA, S., GAUTAM, S., & SHARMA, A., Physical, biochemical and antioxidant properties of some Indian honeys. *Food Chemistry*, *118*(2), 391-397, (2010).

[8].BERTONCELJ, J., DOBERŠEK, U., JAMNIK, M., & GOLOB, T.,Evaluation of the phenolic content, antioxidant activity and colour of Slovenian honey. *Food Chemistry*, *105*(2), 822-828, (2007).

[9].ALJADI, A. M., & KAMARUDDIN, M. Y.,Evaluation of the phenolic contents and antioxidant capacities of two Malaysian floral honeys. *Food Chemistry*, *85*(4), 513-518, (2004).

[10]. ISLAM, A., KHALIL, I., ISLAM, N., MONIRUZZAMAN, M., MOTTALIB, A., SULAIMAN, S. A., & GAN, S. H., Physicochemical and antioxidant properties of Bangladeshi honeys stored for more than one year. *BMC complementary and alternative medicine*, *12*(1), 1, (2012).

[11]. BOGDANOV, S., Harmonised methods of the international honey commission (Swiss Bee Research Centre, FAM, Liebefeld, CH-3003 Bern, Switzerland), (2002).

[12]. CHEN, L., OPARA, U. L., Approaches to analysis and modelling texture in fresh and processed foods – A review, *Journal of Food Engineering*, 119, 497-507, (2013).

[13]. OROIAN, M., Physicochemical and rheological properties of Romanian honeys. *Food Biophysics*, *7*(4), 296-307, (2012).

[14]. GURTLER, J. B., DOYLE, M. P., & KORNACKI, J. L.,The Microbiological Safety of Spices and Low-Water Activity Foods: Correcting Historic Misassumptions. In *The Microbiological Safety of Low Water Activity Foods and Spices* (pp. 3-13). Springer New York, (2014).

[15]. CORDIER, J. L.,Methodological and Sampling Challenges to Testing Spices and Low-Water Activity Food for the Presence of Foodborne Pathogens. In *The Microbiological Safety of Low Water Activity Foods and Spices* (pp. 367-386). Springer New York., (2014).

[16]. BOGDANOV, S., RUOFF, K., & PERSANO ODDO, L., Physico-chemicalmethods for thecharacterisation of unifloralhoneys: a review. *Apidologie*, *35*(Suppl 1), 4-17, (2004).

[17]. CHAKIR, A., ROMANE, A., MARCAZZAN, G. L., & FERRAZZI, P., Physicochemicalproperties of somehoneysproducedfromdifferentplants in Morocco. *Arabian Journal of Chemistry*., (2011).