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Electrical conductivity and ash content of selected honey types

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Summary

Mineral content of honey can be evaluated through ash content and/or electrical conductivity measurement. It primarily depends on botanical origin but also on soil type where nectar-bearing plant was located. Electrical conductivity, ash content and free acidity of 6 selected honey types, black locust (*Robinia pseudoacacia* L.), chestnut (*Castanea sativa* Mill.), sage (*Salvia officinalis* L.), Christ´s thorn (*Paliurus spina Christi* Mill.), bastard indigo (*Amorpha fruticosa* L.) and honeydew honey were determined, as well as the relationship between those physicochemical parameters. Black locust and bastard indigo honeys, lightest among determined honey types, had lowest ash content and electrical conductivity, while darker chestnut and honeydew honeys had highest values for ash content and electrical conductivity. Good relationship between electrical conductivity and free acidity was obtained (r=0.504), while relationship between electrical conductivity and ash content was very high (r=0.980).

Keywords: honey, electrical conductivity, ash content

Introduction

Honey consist mostly of carbohydrates, but minor constituents, like acids, minerals, flavonoids and enzymes are largely responsible for the differences among individual honey types. Some physicochemical parameters (electrical conductivity, carbohydrate content, enzymes, pH and acidity) in combination with pollen analysis are suggested for unifloral honey characterisation (Anklam, 1998; Persano Oddo et al., 1995).

Mineral content (ash) and composition primarily depends on botanical origin, but also on soil type where nectar-bearing plant was located. Nectar honey generally has lower ash content than honeydew honey. At present, time consuming and difficult measurement of ash content has been replaced by fast and simple electrical conductivity measurement. Electrical conductivity depends on mineral and acid content in honey, the higher their content, the higher the resulting conductivity (Bogdanov et al., 2000). Linear relationship between ash content and electrical conductivity is well documented (Silva et al., 2009; Kropf

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et al., 2008; Bogdanov et al., 2000; Sanz et al., 1994; Sancho et al., 1991) but the resulting linear regression models reported by some authors differ considerably.
The aim of this work was to determine electrical conductivity, ash content and free acidity of 6 honey types, black locust (*Robinia pseudoacacia* L.), chestnut (*Castanea sativa* Mill.), sage (*Salvia officinalis* L.), Christ´s thorn (*Paliurus spina Christi* Mill.), bastard indigo (*Amorpha fruticosa* L.) and honeydew honey, as well as to evaluate relationship between those quality parameters.

Materials and Methods

Honey samples

Honey samples were collected during several production seasons directly from the beekeepers from different regions of Croatia. Samples were subjected to pollen analysis with the aim of confirming honey type (Louveaux et al., 1978; Ministry of Agriculture and Forestry, 2000). Identification of present pollen grains was made by reference to the literature data (Von der Ohe and Von der Ohe, 2003) and/or personal comparative preparation.
From 108 analysed samples, 41 were black locust (*R. pseudoacacia* L.), 25 chestnut (*C. sativa* Mill.), 12 sage (*S. officinalis* L.), 10 Christ´s thorn (*P. spina Christi* Mill.), 6 bastard indigo (*A. fruticosa* L.) and 14 honeydew honey.

Physicochemical parameters

Determined physicochemical parameters were analysed by the officially prescribed methods (Bogdanov et al., 2009; AOAC Official Methods, 2002).
Electrical conductivity was determined in 20 % (w/v) water solution of honey (dry matter basis) at 20 °C. The measurements were performed by means of the conductometer and the results were expressed in mS/cm.
Ash content of honey was determined by burning in electric furnace at 600 °C until constant mass was attained and the results were expressed as percentage by weight.
Free acidity was determined by titrimetric method and the results were expressed in mmol/kg honey.

Data analysis

For each determined physicochemical parameter ranges were given and average values and standard deviation calculated. Relationship between parameters was evaluated using the Pearson correlation coefficient. Data analysis was performed using Microsoft Excel 2003 (*Microsoft Corp.*).

Results and Discussion

Mineral content of honey can be evaluated through ash content and/or electrical conductivity measurement. Average values, standard deviations and ranges of

electrical conductivity, ash content and free acidity of 6 selected honey types are presented in Table 1.

Table 1. Electrical conductivity, ash content and free acidity of analysed honey types

Honey type	Electrical conductivity [mS/cm]			Ash content [%]			Free acidity [mmol/kg]		
	average	SD	min-max	average	SD	min-max	average	SD	min-max
Black locust (n=41)	0.11	0.02	0.09-0.17	0.04	0.01	0.02-0.06	7.5	0.9	5.7 9.7
Chestnut (n=25)	1.27	0.23	0.95-1.66	0.52	0.12	0.34-0.83	14.8	4.9	8.0-25.4
Sage (n=12)	0.24	0.05	0.19-0.33	0.08	0.03	0.06-0.13	17.1	3.4	11.6-25.9
Christ's thorn (n=10)	0.67	0.11	0.56-0.85	0.22	0.04	0.15-0.27	19.6	4.4	13.5-27.7
Bastard indigo (n=6)	0.16	0.03	0.12-0.21	0.02	0.02	0.01-0.05	14.4	1.7	11.9-16.0
Honeydew (n=14)	1.21	0.25	0.93-1.75	0.55	0.15	0.34-0.85	35	13.1	18.2-60.0

Regarding electrical conductivity all 108 samples were in compliance with national (Ministry of Agriculture, Fisheries and Rural Development, 2009) and international (Council of the European Union, 2002) demands, while 3 honeydew honey samples had free acidity above prescribed 50 mmol/kg.

Bastard indigo and black locust honeys had lowest ash content, 0.02 % and 0.04 % respectively, while chestnut (0.52 %) and honeydew honey (0.55 %) had highest ash content. In accordance with results for ash content, same honey types had lowest and highest values of electrical conductivity. Although chestnut honey is nectar honey, it is characterised by very high ash content and electrical conductivity which can be used as differentiation parameter between chestnut and other nectar honeys. Generally, darker honeys have higher ash content and electrical conductivity than lighter honeys.

Ash content and electrical conductivity of black locust and chestnut honey obtained in this work are lower than reported Kropf et al. (2008) for Slovenian and Persano Oddo et al. (1995) for Italian black locust and chestnut honey. Honeydew honey is characterised with high electrical conductivity and ash content, and the results obtained in this work are similar to the results for Czech (Čelechovska and Vorlova, 2001) and Slovenian honeydew honeys (Kropf et al., 2008), while Persano Oddo et al. (1995) reported higher electrical conductivity of honeydew honey. Christ's thorn honey, characteristic for Mediterranean part of Croatia, had higher ash content and electrical conductivity than other Mediterranean honeys like sage, rosemary and lavender. The results for electrical conductivity of Christ's

thorn and sage honey are similar to the results reported in our previous papers (Kenjerić et al., 2006; Kenjerić et al., 2008). Although bastard indigo honey can be compared to black locust regarding electrical conductivity, it has slightly lower ash content and much higher free acidity than black locust honey. Honey acidity depends largely on type of honey but also can give information on fermentation process, storage conditions and processing of honey. Some types of honey have naturally higher acidity without signs of fermentation (Sanz et al, 1994). Usually spring honeys have lower acidity than summer honeys.
Electrical conductivity is ability of sample to conduct electricity. In honey it depends on minerals/ash and acids present. Good relationship between electrical conductivity and free acidity was obtained (r=0.504), while relationship between electrical conductivity and ash content was very high (r=0.980) (Fig. 1 and 2).

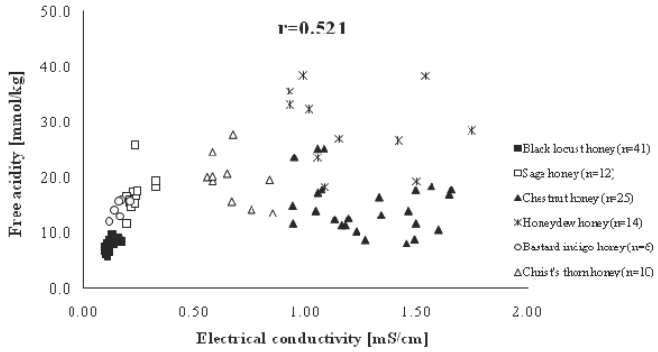

Fig. 1. Relationship between electrical conductivity [mS/cm] and free acidity [mmol/kg] of analysed honey types

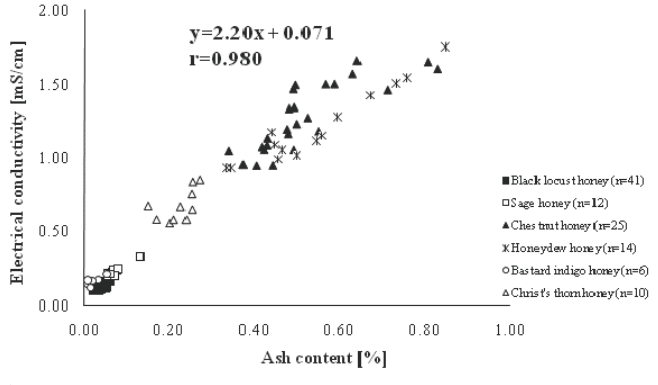

Fig. 2. Relationship between electrical conductivity [mS/cm] and ash content [%] of analysed honey types

Chestnut honey, naturally has very high electrical conductivity and low free acidity, contributes to weaker relationship between electrical conductivity and free acidity. When excluded all chestnut honey samples, the relationship between electrical conductivity and free acidity becomes more significant (r=0.808).
Linear regression model (y=2.20x+0.071, where y is electrical conductivity [mS/cm] and x is ash content [%]) for relationship between electrical conductivity and ash content obtained in this work differs from one proposed by International Honey Commission (IHC) (Bogdanov et al., 2000). The difference also exists between our linear regression model and one reported by Kropf et al. (2008) for Slovenian honeys. Possible explanation of difference could be in different honey types selected and their geographical origin, which results in different electrical conductivity values, as well as different number of samples used for calculation of linear regression model. Due to the difficulties that arise when comparing results calculated with different models, a model prescribed by IHC should be used as often as possible.

Conclusions

In six unifloral Croatian honey types electrical conductivity, ash content, and free acidity were evaluated and ranges for each parameter were given. The lowest ash content and electrical conductivity had lighter honeys, black locust and bastard indigo, while dark chestnut and honeydew honeys had highest values of determined physicochemical parameters. Although bastard indigo and black locust honey are comparable regarding electrical conductivity, the difference between those honey types was noticed in free acidity, which is almost two times higher for bastard indigo than black locust honey. Very high relationship was obtained between electrical conductivity and ash content, while relationship between electrical conductivity and free acidity was weaker, due to low free acidity of chestnut honey.

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