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PHYSICOCHEMICAL PARAMETERS OF WINTER SAVORY (*Satureja montana* L.) HONEY

FIZIKALNO-KEMIJSKI PARAMETRI MEDA OD VRISKA
(*Satureja montana* L.)

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ABSTRACT

The aim of this work was to determine physicochemical parameters of winter savory (*Satureja montana* L.) honey produced in the Adriatic part of Croatia. Honey samples were collected from several production seasons and following physicochemical parameters were determined: water content, electrical conductivity, pH value, free acidity, sugar content, diastase activity and HMF content. The results of electrical conductivity (0.155 - 0.456 mS/cm), free acidity (16.1 - 35.8 mEq/kg) and diastase activity (16.3 - 45.8) varied in a wide range. Fructose/glucose and glucose/water ratios indicate moderate crystallisation rate of the honey.

Key words: winter savory honey, Adriatic Croatia, physicochemical parameters

SAŽETAK

Zadatak rada bio je odrediti fizikalno-kemijske parametre meda od vriska (*Satureja montana* L.) proizvedenog u jadranskom dijelu Republike Hrvatske. Uzorci meda prikupljeni su kroz nekoliko proizvodnih sezona, a uzorcima su određeni sljedeći fizikalno-kemijski parametri: udio vode, električna provodnost, pH vrijednost, slobodna kiselost, udio ugljikohidrata, aktivnost dijastaze i udio HMF-a. Rezultati električne provodnosti (0.155 - 0.456 mS/cm), slobodne kiselosti (16.1 - 35.8 mEq/kg) i aktivnosti dijastaze (16.3 - 45.8) kretali su se u velikom rasponu. Fruktaza/glukoza i glukoza/voda odnosi upućuju na umjerenu brzinu kristalizacije meda od vriska.

Ključne riječi: med od vriska, Jadranska Hrvatska, fizikalno-kemijski parametri

INTRODUCTION

Honey is a substance which honeybees produce from nectar and/or honeydew and the differences in physicochemical characteristics mainly depend on the plant from which it is produced. Geographical position of Croatia enables production of broad spectrum of honey types. Some of them, like black locust (*Robinia pseudoaccacia* L.), lime (*Tillia* sp.), and chestnut (*Castanea sativa* Mill.) honey, are also produced elsewhere in the world, but some honey types e.g. sage (*Salvia officinalis* L.) honey and oak (*Quercus frainetto* Ten.) honeydew honey are characteristic of Croatia. Recently, few papers presenting physicochemical characteristics of honey types produced in Croatia have been published (Mandić *et al.*, 2006; Kenjerić *et al.*, 2006; Kenjerić *et al.*, 2008; Lušić *et al.*, 2009).

Winter savory (*Satureja montana* L.) is a deciduous perennial shrub spread in the Mediterranean Europe (Spain, Italy, France) (Persano Oddo *et al.*, 2004) while in Croatia it inhabits arid, sunny and rocky habitats along the Adriatic coast and the submediterranean part of the country. The flowering season begins at the end of the summer (August) and lasts till late autumn (October). Winter savory is quite unreliable for honey due to the frequent droughts and strong winds during the flowering season. Abundant rain and changeable weather have also significant impact on honey flow. During the flowering season, the winter savory areas are not under the same amount of precipitation, which implies that nectar production is not equal among them. Accordingly, the winter savory produces nectar by areas. These areas could change through the years. It is possible that the locations where winter savory produced nectar well, next year will produce poorly or not at all (Šimić, 1980). Headspace volatile profile of winter savory honey has been recently published (Jerković *et al.*, 2007) but the reports on physicochemical parameters of Croatian winter savory honey, to the best authors knowledge, are not available.

Therefore, the aim of this work was to characterise winter savory honey produced in Croatia.

MATERIALS AND METHODS

Altogether 22 honey samples, declared by the beekeepers as winter savory honey, were selected among samples gathered for the annual Croatian Honey Competition from production seasons 2003, 2004, 2006, 2007 and 2011.

Samples were subjected to qualitative orienting melissopalynological analysis with the aim of confirming honey type. Analysis was performed by counting 300 pollen grains, according to the method of Louveaux *et al.* (1978) and Croatian legislation (Ministry of Agriculture and Forestry, 2000). Identification of present pollen grains was performed by reference to the literature data (Ricciardelli D'Albore, 1997) and personal comparative preparations (Fig. 1). According to the national regulation (Ministry of Agriculture, Fisheries and Rural Development, 2009a) minimum of 20% winter savory pollen in insoluble sediment is necessary for honey declaration as winter savory honey. After performed pollen analysis, the final honey type confirmation was achieved by sensory evaluation of aroma, taste and colour of each honey sample (International Organization for Standardization, 1987).



Figure 1. Microscopic image of winter savory (*Satureja montana* L.) pollen grain (polar view, magnification 400x)

Slika 1. Mikroskopski prikaz peludnog zrnca vriska (*Satureja montana* L.) (polarni položaj, povećanje 400x)

All determined physicochemical characteristics were analysed according to the International Honey Commission methods (Bogdanov, 2009). Moisture was determined by refractometric method at 20°C. Electrical conductivity was measured in 20% (w/v) water solution of honey (dry matter basis) at 20°C. pH value of honey solution (10 g of honey in 75 mL of distilled water) was measured and afterwards, free acidity was determined by titration with 0.1 M NaOH to pH 8.3. Hydroxymethylfurfural (HMF) content was determined according to the spectrophotometric method after White and diastase activity according to the method after Shade. Sugar content was determined by titrimetric (samples from 2003 and 2004 production seasons) and chromatographic (HPLC) method (samples from 2006, 2007 and 2011 seasons).

Average values, range and standard deviation for physicochemical parameters were calculated using Microsoft Excel 2003 software (*Microsoft Corp.*).

RESULTS AND DISCUSSION

With the aim of confirming botanical origin of collected honey samples, pollen analysis was performed. *S. montana* L. pollen is considered under represented and according to the national regulation, the prescribed limit of specific pollen content in insoluble honey sediment required for winter savory unifloral honey is 20% (Ministry of Agriculture, Fisheries and Rural Development, 2009a). The specific *S. montana* L. pollen grain content in analysed samples varied from 22% to 83% (Table 1), which is in compliance with legal requirements for winter savory unifloral honey. Although the prescribed limit of specific pollen grain content for winter savory honey is 20%, 12 analysed samples had more than 45% of *S. montana* L. pollen grain content in insoluble honey sediment. Pollen grain of *S. montana* is polar oblate 6-colpate, oval or hexagonal in polar view and oval depressed (elliptic) in equatorial view. Colpus is 21x4 µm with sharp edges, pointed end and with exina remnants. Exina is semitectate-fine reticulate-heterobrochate 1.5 µm. Dimension in polar axis is 30 µm (29-36 µm) and equatorial diameter is 34 µm (33-40 µm) (Figure 1).

Table 1. Physicochemical parameters of winter savory honey

Tablica 1. Fizikalno-kemijski parametri meda od vriska

Parameter	Average	SD	Minimum	Maximum	Number of samples analysed
<i>S. montana</i> pollen content (%)	51	17	22	83	22
Water content (%)	17.1	1.2	15.0	19.9	22
Electrical conductivity (mS/cm)	0.252	0.086	0.155	0.456	22
pH	3.77	0.16	3.45	4.21	22
Free acidity (mEq/kg)	22.0	4.9	16.1	35.8	22
HMF content (mg/kg)	7.7	5.9	1.2	22.8	22
Diastase activity	28.5	8.3	16.3	45.8	22
Reducing sugars (%)*	76.9	1.3	74.3	78.7	15
Apparent sucrose (%)*	2.9	1.2	1.6	5.5	15
Reducing sugars (%)	79.4	4.6	70.4	85.6	7
Fructose+Glucose (%)	78.0	4.0	69.8	83.1	7
Fructose/Glucose	1.26	0.10	1.05	1.37	7
Glucose/Water	1.98	0.24	1.67	2.30	7
Sucrose (%)	1.0	0.6	0	1.6	7

* determined by titrimetric method

The results of determined physicochemical parameters of 22 winter savory honey samples are summarised in Table 1.

Water content of analysed samples varied from 15.0 to 19.9% confirming compliance with legislation (Ministry of Agriculture, Fisheries and Rural Development, 2009b; Council of the European Union, 2002). In the Republic of Croatia an additional requirements for high quality honeys are not prescribed, like in some EU countries, but according to the Regulation on the evaluation of honey quality at Honey Competitions in the Republic of Croatia (Croatian Beekeepers' Association, 2010), the results of water content as well as HMF content are considered for the final honey rating.

Electrical conductivity is a valuable parameter for honey botanical origin determination. It is mostly used for differentiation between nectar and honeydew honeys, but together with other physicochemical parameters can be used for unifloral honey characterisation. Electrical conductivity of winter

savory honey varied from 0.155 to 0.456 mS/cm. Most of the samples (18 out of 22 analysed samples) had electrical conductivity ranging from 0.155 to 0.287 mS/cm, while 3 samples had electrical conductivity higher than 0.400 mS/cm. Since no honeydew elements were not found in insoluble honey sediments, higher values of electrical conductivity could be due to the presence of nectar from other plant species in honey, as a result of climatic and environmental conditions. Average value of electrical conductivity (0.252 mS/cm) obtained in this work is similar to the values reported by Sanz *et al.* (1994) for Spanish savory honey (0.269 mS/cm). Compared to the other Mediterranean honey types, the results for electrical conductivity are similar to sage (Kenjeric *et al.*, 2006) and lavender honey (Persano Oddo and Piro, 2004) but considerably lower than Christ's thorn (Kenjeric *et al.*, 2008) or eucalyptus honey (Persano Oddo *et al.*, 1995).

Regarding the free acidity, winter savory honey is characterised as of medium free acidity (16.1 - 35.8 mEq/kg, average value 22.0 mEq/kg), and all samples had free acidity below prescribed limit of 50 mEq/kg (Ministry of Agriculture, Fisheries and Rural Development, 2009b; Council of the European Union, 2002).

Sugar profile of winter savory honey is similar to other reported Mediterranean honey types (Persano Oddo and Piro, 2004; Kenjeric *et al.*, 2006; Kenjeric *et al.*, 2008). The sum of fructose and glucose (result from 7 samples) was between 69.8 and 83.1% (average 78.0%) while fructose/glucose ratio was between 1.05 and 1.37 (average 1.26). Glucose/water ratio was relatively high (average value 1.98) and together with relatively low fructose/glucose ratio, resulted in moderate crystallisation rate of winter savory honey. Sucrose content was between 0 and 1.6%, with average value 1.0%.

Hydroxymethylfurfural (HMF) content is an indicator of honey freshness, overheating and storage conditions. Prescribed limit for HMF content is up to 40 mg/kg (Ministry of Agriculture, Fisheries and Rural Development, 2009b; Council of the European Union, 2002). HMF content of winter savory honey samples varied between 1.2 and 22.8 mg/kg and only 5 out of 22 samples had values higher than 10 mg/kg that is set as limit for high quality honey.

Winter savory honey is characterised as of high diastase activity (16.3 - 45.8, average 28.5). Diastase activity mostly depends on botanical origin and

together with other parameters, contributes to characterisation of honey while it is fresh. However, diastase activity decreases during storage and heating and therefore is usually used, together with HMF content, as freshness and overheating indicator.

CONCLUSIONS

Winter savory honey is characterised as of wide range of electrical conductivity (0.155 - 0.456 mS/cm), free acidity (16.1 - 35.8 mEq/kg) and diastase activity (16.3 - 45.8). Fructose/glucose and glucose/water ratios (average 1.26 and 1.98 respectively) correspond to the moderate crystallisation rate of winter savory honey. Further research should include more samples as well as determination of other physicochemical parameters for more complete profile of this specific honey type.

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