

SUGAR CONTENT OF HONEY BEE-POLLEN FROM ASTERACEAE SPECIES COLLECTED FROM FORESTRY AREA

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Abstract

In the research, HPLC method was used to determine the composition of sugar profile of identified honey bee-pollen from Asteraceae species spread in a forestry area. The analysis showed that bee-pollen is described by a high content of glucose and fructose, which depends on the origin of bee-collected pollen. They constitute from 60.0 % of the total sugar content for *Centaurea cyanus* L. to 100 % for *Carduus* sp., *Centaurea* sp., *Centaurea calcitrapa* L., *Centaurea solstitialis* L. and *Chondrilla juncea* L. bee-pollen. The content of fructose ranged from 13.3 % for *C. juncea* to 20.3 % for *C. calcitrapa*, average 16.8 %. Glucose was the second highest content from 10.2 % for *Echinops ritro* L. to 21.4 % for *C. cyanus*, average 15.5 %. Of all analyzed samples the presence of trisaccharide melezitose was not detected.

Key words: *Apis mellifera*, carbohydrates, monofloral pollen.

Introduction

Till nowadays no scientific evidence has been cited to disprove the claimed properties of bee-pollen (Campos et al. 1997). Sugars constitute the main component of bee-collected pollen grains, and they vary among different pollen taxa according to their origin and the surrounding vegetation (Dimou et al. 2020). Pollen contains a wide variety of sugars (Stanley and Linskens 1974). Several authors (Cirnu et al. 1969, Rosenthal et al. 1969, Herbert and Shimanuki 1978) made first studies on reducing and non-reducing sugars. Studies between hand-collected and bee-collected pollen have shown the importance of the added nectar during pollen load formation to sugar content (Dimou et al. 2020).

Sugar composition of pollen are nectar carbohydrates, mostly fructose and glucose, arabinose, xylose, sucrose, dextrans, starch and cellulose – from 15 % to 60 % (Mladenov 1989). Cellulose is contained in large quantities in exine of pollen grains, but in total amount of all components it is small – from 1 % to 3 %. The starch content reaches up to 7 %. The pollen from *Zea mays* contains up to 22 % starch (Shkenderov and Ivanov 1983). According to other researches sugar content of pollen is about 27 % (Todd and Bretherick 1942, Weygand and Hofmann 1950, McLellan 1977).

The present research aimed to determine the sugar profile of identified honey bee-collected pollen grains from Asteraceae species spread in a forestry area.

These plants provide pollen in autumn, used in early spring next year by honey bees (*Apis mellifera* L.) and is important for honey bee's nutrition diet.

Material and Methods

Pollen traps were used in 5 bee hives and pollen pellets were harvested every 1–2 days from April till September in forestry area of Bratya Daskalovi Municipality (Bulgaria) (42°30'08" E and 25°21'03" N). The area is located at the end in the central part of the mountain Sredna gora, 671 m a.s.l.

Over four hundred samples of bee-pollen pellets are separated over white sheet, according to colour, shape and structure. Distinguishment of morphology of pollen grains and colour of pellets during their collection by bees was made, which helped to separate and identify them. The plant species of each pollen pellet was identified through microscopic examination of grains. Melissopalynological analysis was carried out using methodology of Louveaux et al. (1970). To identify the pollen database of plants from the area was created.

Sugar analysis of bee-pollen was performed by HPLC method (Liolios et al. 2018) in laboratory of Apiculture-Sericulture of Aristotle University, Thessaloniki. All the results were expressed as percentage.

The results were statistically processed by using Anova.

Results and Discussion

Eleven pollen types belonging to Asteraceae were analysed for sugars. Analysis

of monosaccharides was made – fructose and glucose (reducing sugars); disaccharides – saccharose and trehalose (non-reducing sugars), maltose, turanose and melibiose (reducing sugars); and trisaccharide – melezitose (non-reducing sugar). Of all analysed samples the presence of melezitose was not detected (Table 1).

The results of sugars' analysis showed that their percentage varied among the plant species (Table 1). The average percentage content of total sugars was 35.69 % and ranged from 25.1 % for *C. juncea* to 59.7 % for *C. cyanus*. Most quantity of sugars in all identified bee-pollen pellets were the monosaccharides fructose and glucose. They constituting from 60.0 % of the total sugars content for *C. cyanus* to 100 % for *Carduus* sp., *Centaurea* sp., *C. calcitrapa*, *C. solstitialis* and *C. juncea* bee-pollen. Fructose was present in highest concentration of all the analysed sugars, only pollen from *C. cyanus* and *Helianthus annuus* L. contain more glucose. Fructose content ranged from 13.3 % for *C. juncea* to 20.3 % for *C. calcitrapa*, average 16.8 %, and glucose ranged from 10.2 % for *E. ritro* to 21.4 % for *C. cyanus*, average 15.5 %.

Saccharose was found in 2 out of 11 taxa and its highest content 2.1 % was recorded for *H. annuus*. Turanose was detected only in 1 sample, with content 4.8 % for *C. cyanus*. Maltose was found in 3 out of 11 taxa with content ranged from 1.6 % for *Cichorium intybus* L. to 4.3 % for *Taraxacum officinale* (L.) Weber ex F. H. Wigg. Trehalose was detected in two species. The average highest content of it was found in bee-pollen of *E. ritro* – 3.5 %. In the rest of the samples melibiose was only detected in *C. cyanus* with content 12.1 %. Trisaccharide melezitose was not found at any sample (Table 1).

Table 1. Sugar composition of 11 identified bee-collected pollen species in %.

Taxa	Fructose	Glucose	Saccharose	Turanose	Maltose	Trehalose	Melibiose	Melezitose	Total
<i>Carduus</i> sp.	16.7	14.2	NF	NF	NF	NF	NF	NF	30.9
<i>Centaurea</i> sp.	18.9	15.6	NF	NF	NF	NF	NF	NF	34.5
<i>Centaurea calcitrapa</i>	20.3	19.6	NF	NF	NF	NF	NF	NF	39.9
<i>Centaurea cyanus</i>	15.4	21.4	1.8	4.8	4.2	NF	12.1	NF	59.7
<i>Centaurea solstitialis</i>	15.7	15.1	NF	NF	NF	NF	NF	NF	30.8
<i>Chondrilla juncea</i>	13.3	11.8	NF	NF	NF	NF	NF	NF	25.1
<i>Cichorium intybus</i>	17.3	15.7	NF	NF	1.6	NF	NF	NF	34.6
<i>Cirsium</i> sp.	15.8	14.4	NF	NF	NF	2.6	NF	NF	32.8
<i>Echinops ritro</i>	18.9	10.2	NF	NF	NF	3.5	NF	NF	32.6
<i>Helianthus annuus</i>	18.7	20.6	2.1	NF	NF	NF	NF	NF	41.4
<i>Taraxacum officinale</i>	13.9	12.1	NF	NF	4.3	NF	NF	NF	30.3
Maximal value	20.3	21.4	2.1	-	4.3	3.5	-	-	59.7
Minimal value	13.3	10.2	1.8	-	1.6	2.6	-	-	25.1

Note: NF – not found.

According to Szczesna (2007) fructose ranged from: 15.51 % to 19.22 % in samples from Poland; 12.09 % to 22.06 % for Korean samples; 9.74 % to 17.90 % for samples from China. Fructose content of present study was similar. In sugar profile of bee-pollen species from Asteraceae was found that *C. calcitrapa* and *H. annuus* pollen had much higher monosaccharide content, while *C. juncea* and *T. officinale* bee-pollen had fructose and glucose content lower than the rest. *C. cyanus* contains the most variety of sugars. *C. intybus*, *Cirsium* sp., *E. ritro*, *H. annuus*, *T. officinale* contain three types of sugars, and *Carduus* sp., *Centaurea* sp., *C. calcitrapa*, *C. solstitialis*, *C. juncea* contain only monosaccharides. Disaccharides were not always detected (Table 1). Asteraceae plants provide pollen to bees

from early spring till late autumn. In this study it is confirmed that sugars' profile of bee-pollen is characterised mainly by monosaccharides, found by Todd and Bretherick (1942), Stanley and Linskens (1974) and Nicolson (2011).

The average content of fructose is 16.80 % and glucose – 15.51 %. Other sugar contents of pollen are reported in Table 2 as well.

The statistical analysis according to sugar content showed that the monosaccharides are the main sugar ingredients in pollen $y=2.0358x+4.0991$ and $R^2=0.6652$ (Fig. 1).

Author's results for sugars in *C. intybus* are similar to Liolios et al. (2018), while fructose and glucose are much lower for *T. officinale* but maltose is double higher (Table 3).

Table 2. Average sugar content.

Indicator	Fructose	Glucose	Saccharose	Maltose	Trehalose	Total sugars
Average value, %	16.80	15.51	1.95	3.36	3.05	35.69
Means±std	16.8±2.23	15.51±3.66	1.95±0.21	3.36±1.53	3.05±0.64	35.69±9.14

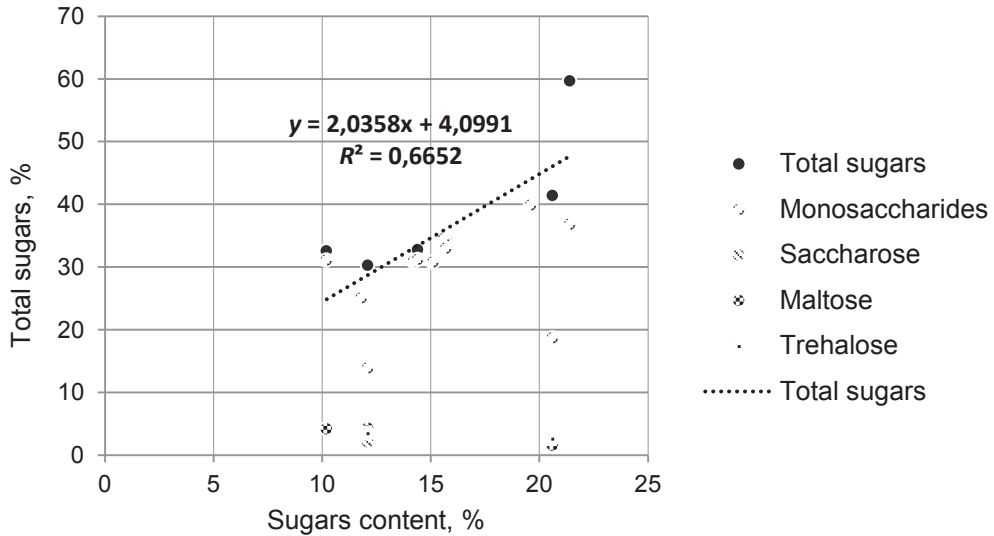


Fig. 1. Sugar content to total sugars.

Table 3. Comparing pollen sugar contents results in %.

Species	Source	Fructose	Glucose	Saccharose	Maltose	Melezitose	Total sugars
<i>Cichorium intybus</i>	1	17.3	15.7	0	1.6	0	34.6
	2	18.5	15.39	0.19	0.86	0.09	35.03
<i>Taraxacum officinale</i>	1	13.9	12.1	0	4.3	0	30.3
	2	20.89	18.68	0	2.05	0	41.62

Note: 1 – author's results; 2 – Liolios et al. (2018) results.

Conclusions

The studies for sugars content of identified bee-pollen are very limited. Obtained results give information and knowledge on sugar content in identified bee-pollen samples from the most popular and important plant family Asteraceae for honey bees. Bee-collected pollen is characterised by a

high content of monosaccharides glucose and fructose.

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