

PROTEIN CONTENT IN BEE-COLLECTED POLLEN OF SOME PLANTS IN FORESTRY REGION

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Abstract

Proteins are one of the main components of honey bee-collected pollen. In present days pollen is of great interest as food supplement. The objective of this research was to determine the protein content of pollen in some floral species in semi-mountain area and to analyse the length of life of bees fed on different protein content in the pollen. The analysis of 30 samples showed that bee pollen was described by a content of protein, which depends on the botanical origin of bee-collected pollen. The percentage of the total protein content in the bee pollen grains ranged from 14.83 % for *Helianthus annuus* L. to 26.14 % for that of *Prunus cerasifera* Ehrh., and the average value was 20.90 %. In this research Rosaceae floral species had the highest levels of protein content of all studied representatives. The impact of the protein food on the length of life of worker bees was found. The average lifespan of worker bees fed on pollen from *P. cerasifera* was 24.74 days, whereas it was 16.92 days for the worker bees fed on pollen from *H. annuus*. Lifespan of honey bees consumed pollen with higher protein content is prolonged compared to those that consumed pollen with lower protein content.

Key words: honey bee, monoflora pollen, protein.

Introduction

Pollen plays a key role in the development, reproduction and productivity of honey bees (*Apis mellifera* L.) (Radev et al. 2014), as it is rich in nutritional components (Dietz 1975, Brodschneider and Crailsheim 2010). Pollen also plays a major role in the development of honey bee larvae and vitality of colony (Schmidt et al. 1987, Roulston and Cane 2000). In present time the researches in bee pollen are under deep studies, because it is a rich source of proteins and amino acids. Bee pollen is also used by humans (Ianuzzi 1993, Campos et al. 1997).

According to previous studies protein content in pollen depends on the plant species (Roulston and Cane 2000). Protein content in pollen grains collected by honey bees from different plant species in USA ranges from 7 % to 30 % (Todd and Bretherick 1942), from 8 % to 40 % (Herbert 1992), and from 9.5 % for *Pinus radiata* D. Don to 36.9 % for *Banksia ornata* F. Muell ex. Meisn. in Australia (Rayner and Langridge 1985). In another study in the USA, Roulston et al. (2000) found protein content ranging from 2.5 % for *Cupressus arizonica* Greene to 61.7 % for *Primula clevelandii* (Greene) A. R. Mast et Reveal. Research conducted by Liolios

et al. (2016) in the region of Thessaloniki, Greece showed that it ranged from 12.8 % of *Smilax* sp. L. to 30.1 % for *Fallopia* sp. Adans., with an average of 20.8 %. Radev (2018) determined protein content in pollen in fifty plants in Central Thracian lowland. He discovered a range from 11.5 % for *Chondrilla juncea* L. to 27.4 % for *Cucumis melo* L., and the average value was 19.9 %. Maurizio (1960) classified pollen in four groups upon the influence on honey bee physiology. The first group with high quality pollen includes willow, fruit trees, white clover, and corn. The second group includes less contained nutritious pollen from elm, dandelion and cottonwood. The third group includes pollen with a fair nutritional value from hazelnut and alder. The fourth group includes plants with the poorest nutritive value in pollen – species of pine trees. The protein content in pollen of *Acacia* on the Australian coast is 16 %, whereas the protein content in pollen of *Acacia* inside the continent is 26 % – 29 % (Kleinschmidt and Kondos 1977). According to a study by Taranov (1986) pollen from anemophilous plants is poorer in protein than the entomophilous.

The objective of this research was to determine the protein content of pollen in some floral species in semi-mountain area. Also, it is analysed the length of life of bees fed on pollen from a taxa with different protein content in it, to give a light on the impact of the protein on the vitality of honey bees.

Materials and Methods

Bottom pollen traps were used at five beehives and the pollen grains were collected every second day during the apicultural season in region of Saedinenie (42°36'96" E and 25°30'95" N), Bulgaria.

The area is located at the end of the central part of the mountain of Sredna gora, part of the administrative district of Stara Zagora, 308 m a.s.l.

Four hundred and twenty samples of mixed pollen were collected. The pollen loads of each hive were carefully mixed and a sample of 10 % was taken (Dimou and Thrasyvoulou 2007). Pollen pellets were separated over white sheets according to the physical characteristics – colour, shape and structure. Palynological analysis was carried out using a similar methodology as described by Louveaux et al. (1978). To identify the pollen database of plants from the area was created.

For nitrogen content determination, pollen was analysed using Kjeldahl method. The crude protein content was estimated using factor 5.60 (Rabie et al. 1983), applying formula (1).

$$P = 0.791 \frac{V}{m}, \quad (1)$$

where: P is crude protein content, %; V is the volume, mL of HCl used for titration; and m is the amount of pollen, g.

Three replicates from each sample were analyzed, and the results were averaged.

They were made into two groups with five cages 10×10×10 cm each. One hundred newly emerged worker bees were placed in each cage and fed on 50 % sugar syrup. In the quantity of 20 mL sugar syrup for the first group, two grams of pollen from *P. cerasifera* and for the second group, two grams of pollen from *H. annuus* were added. The syrup was changed daily with new one. The experimental cages were covered for darkness in a room at a temperature of 28 °C. Worker bees were viewed every day and the last dead was taken out.

The results were statistically processed by using Excel and Anova to compare the

protein content between identified pollen grains and the lent of life of worker bees.

Results and Discussion

The protein contents of bee-collected pollen grains from 10 identified floral species in the studied area are represented in Fig. 1. The percentage ranged from 14.83 % for *H. annuus* to 26.14 % for that of *P. cerasifera* and the average value was 20.90 %. Other protein contents of pollen are reported in Fig. 1 as well.

The results confirmed other studies – the fact that pollen grains from different plants have different protein con-

tents. In this study results of some honey bee plants belonging to the families: Asteraceae, Rosaceae, Chenopodiaceae, Juglandaceae, Fabaceae, Salicaceae, Papaveraceae and Brassicaceae are presented.

No significant difference in the protein content between anemophilous compared to entomophilous floral species ($F \leq F_{crit}$, Anova: Single factor) was found in this study. *Salix* sp. was called as wind-pollinated floral species in the present study. It is noted that anemophilous plants especially *Juglans regia* L. provided very high protein content – 18.24 %, and *Salix* sp. – 19.94 %.

In this study significant difference was

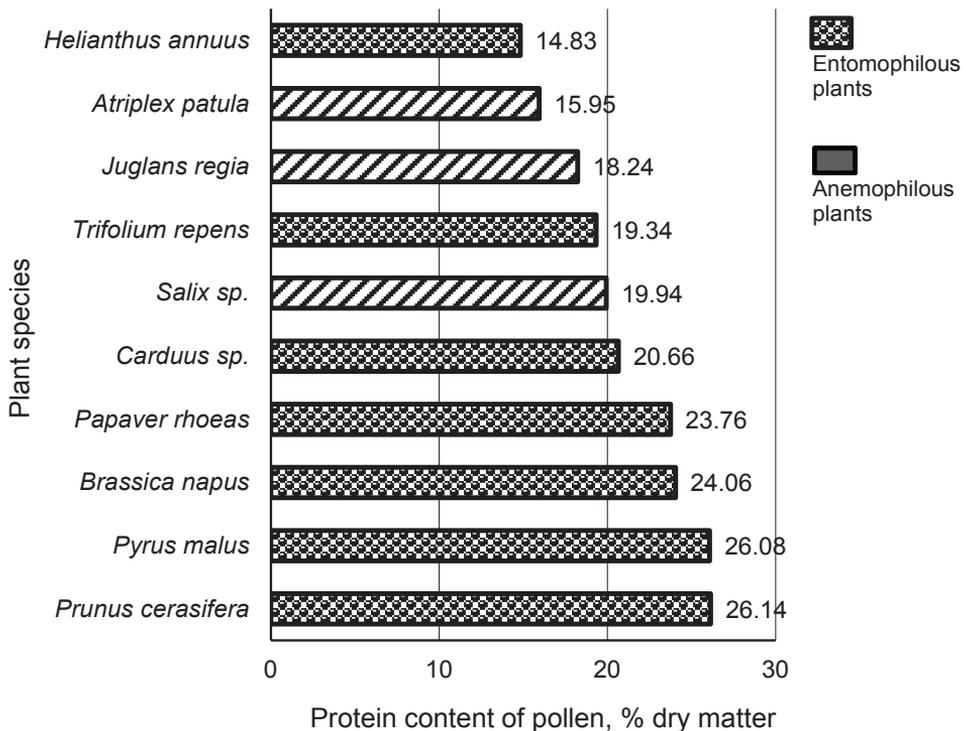


Fig. 1. Protein content of 10 pollen species.

found between the lifespan of worker bees fed on pollen from *H. annuus* (14.83 % protein content) compared to the lifespan of worker bees fed on pollen from *P. cerasifera* (26.14 %) (Table 1). For worker bees fed on pollen from *P. cerasifera* it was 24.74 days, whereas it was 16.92 days for those fed on pollen from *H. annuus* ($F > F_{crit}$, Anova: Single factor). The lifespan of honey bees that consumed pollen with higher protein content is prolonged compared to those that consumed pollen with lower protein content. There has been a highly significant positive correlation ($r = 1, p \leq 0.05$).

Table 1. Average length of life of worker bees.

Fed worker bees	Average length of life in days	Means \pm std
Worker bees fed on sugar syrup and pollen from <i>Prunus cerasifera</i>	24.74	24.74 \pm 1.06
Worker bees fed on sugar syrup and pollen from <i>Helianthus annuus</i>	16.92	16.92 \pm 0.87

In this research Rosaceae plant species showed the highest levels of protein content of all studied representatives. The one frequently cultivated crop *H. annuus* produces pollen with the lowest protein content. The other frequently cultivated crop *Brassica napus* L. produces pollen with the third highest protein content. The protein content levels of the cultivated plants may be due to hybrid influences and further researches are recommended.

In the present study protein content value is much higher for: *Carduus* sp. with 2.86 %; *Pyrus malus* with 2.88 %; *P. cerasifera* with 3.74 %; especially *J. regia* with 4.84 %, and much lower for *Trifolium repens* with 4.76 % compared to Radev (2018) previous results for Central Thracian lowland.

The protein content results are compared for the species given in Table 2.

The varied results among the studies may be due to many reasons – different methods of analysis, climate, geographical region, soil composition and for the cultivated plants the hybrid variety. Further researches could give more light for the protein supply available to honey

Table 2. Comparing pollen protein contents results in %.

Species	Our present results	Our previous results (Radev 2018)	Results of other authors
<i>Prunus cerasifera</i>	26.14	22.4 ↓	
<i>Pyrus malus</i>	26.08	23.2 ↓	
<i>Brassica napus</i>	24.06	25.1 ≈	31.9 ² ↑
<i>Papaver rhoeas</i>	23.76	24.3 ≈	24.51 ⁵ ≈
<i>Carduus</i> sp.	20.66	19.9 ≈	
<i>Salix</i> sp.	19.94	17.8 ↓	22.2 ⁵ ≈
<i>Trifolium repens</i>	19.34	24.1 ↑	35.4 ¹ ↑
<i>Juglans regia</i>	18.24	13.4 ↓	25.1 ⁴ ↑
<i>Atriplex patula</i>	15.95	13.1 ↓	17.1 ³ ≈
<i>Helianthus annuus</i>	14.83	14.5 ≈	29.8 ⁴ ↑

The sources of other authors: Robertson (1929)¹, Rayner and Langridge (1985)², Proctor et al. (1996)³, Roulston et al. (2000)⁴, and Liolios et al. (2016)⁵. Comparison with our present results: ≈ – similar result, ↑ – higher result, ↓ – lower result.

bees. This information about nutritional value of pollen could be used by specialists for further research studies.

Conclusions

The percentage of the total protein content in the bee-collected pollen grains ranged from 14.83 % for *H. annuus* to 26.14 % for that of *P. cerasifera* and the average value was 20.90 %. In this research Rosaceae floral species had the highest levels of protein content of all studied representatives. It is noted that anemophilous plants especially *J. regia* provide very high protein content. The average length of life of worker bees fed on pollen from *P. cerasifera* was 24.74 days, whereas it was 16.92 days for the worker bees fed on pollen from *H. annuus*. Lifespan of honey bees that consumed pollen with higher protein content is prolonged compared to those that consumed pollen with lower protein content.

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