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ORIGINAL SCIENTIFIC PAPER

Fabaceae family in the pollen spectrum of honey samples from Bosnia and Herzegovina

Porodica Fabaceae u polenskom spektru uzoraka meda iz Bosne i Hercegovine

Velida Bakić[1,*], Sabina Trakić [1], Edina Muratović [1]

1 Department of Biology, Faculty of Science, University of Sarajevo, Zmaja od Bosne 33–35, Sarajevo, Bosnia and Herzegovina

ABSTRACT

As a part of the research, 100 samples of different types of honey from Bosnia and Herzegovina were collected and analyzed. Melisopalynological preparations were prepared in accordance with the Rulebook on methods for the control of honey and other bee products of Bosnia and Herzegovina and in accordance with ICBB propositions. Plant species identification was performed based on micromorphological elements of pollen grains, and qualitative-quantitative analysis of honey samples was conducted. Melisopalynological analysis identified 47 distinct pollen types among a total of 30,000 pollen grains counted. In botanical terms, pollen from 24 plant families was recognized, among which the Fabaceae family had the greatest melisso-palynological significance, and its pollen grains were found in as many as 86% of the analyzed profiles. Pollen grains of the Fabaceae family were identified as dominant in 22%, as accessory in 40%, as important in 21% and as minor in 3% of the palynological profiles. Based on micromorphological characters in melissopalynological spectra, species/genera from the Fabaceae family were identified: *Robinia pseudoacacia* L., *Lotus corniculatus* L., *Trifolium pratense* L., *Trifolium repens* L., *Amorpha fruticosa* L., *Lathyrus* sp., *Medicago sativa* L., and *Onobrychis* sp.

Key words: *Apiflora, Fabaceae, melissopalynology, pollen, honey*

INTRODUCTION – *Uvod*

Honey plants include all plant species whose natural products (pollen, nectar, and honeydew) are the primary food source for honey bees (*Apis mellifera* L.) (Ljevnaić-Mašić et al., 2019; Khan et al., 2024). Honey plants are characterized by a specific combination of physical and chemical properties of pollen grains and nectar, which are the result of a complex interaction of the systematic affiliation of the species, physiological characteristics, and ecological parameters in which the species exists (Chiș & Purcarea, 2011; Tomczyk et al., 2019; Ivanović et al., 2021). The floristic composition of the honey pasture, determined by the specific combination of honey plants at the site, is a key factor that defines the physical, chemical, and biological properties of honey (Evelin et al., 2011; Đogo Mračević et al., 2020; Kolayli et al., 2020; Homrani et al., 2020; Pătruică et al., 2022; Tulu et al., 2023).

In the flora of Bosnia and Herzegovina (B&H), 4498 Spermatophyta have been described, of which 260 spe-

* Corresponding author: Velida Bakić, velida.durmic@yahoo.com, Department of Biology, Faculty of Science, University of Sarajevo, Zmaja od Bosne 33-35, Sarajevo, Bosnia and Herzegovina

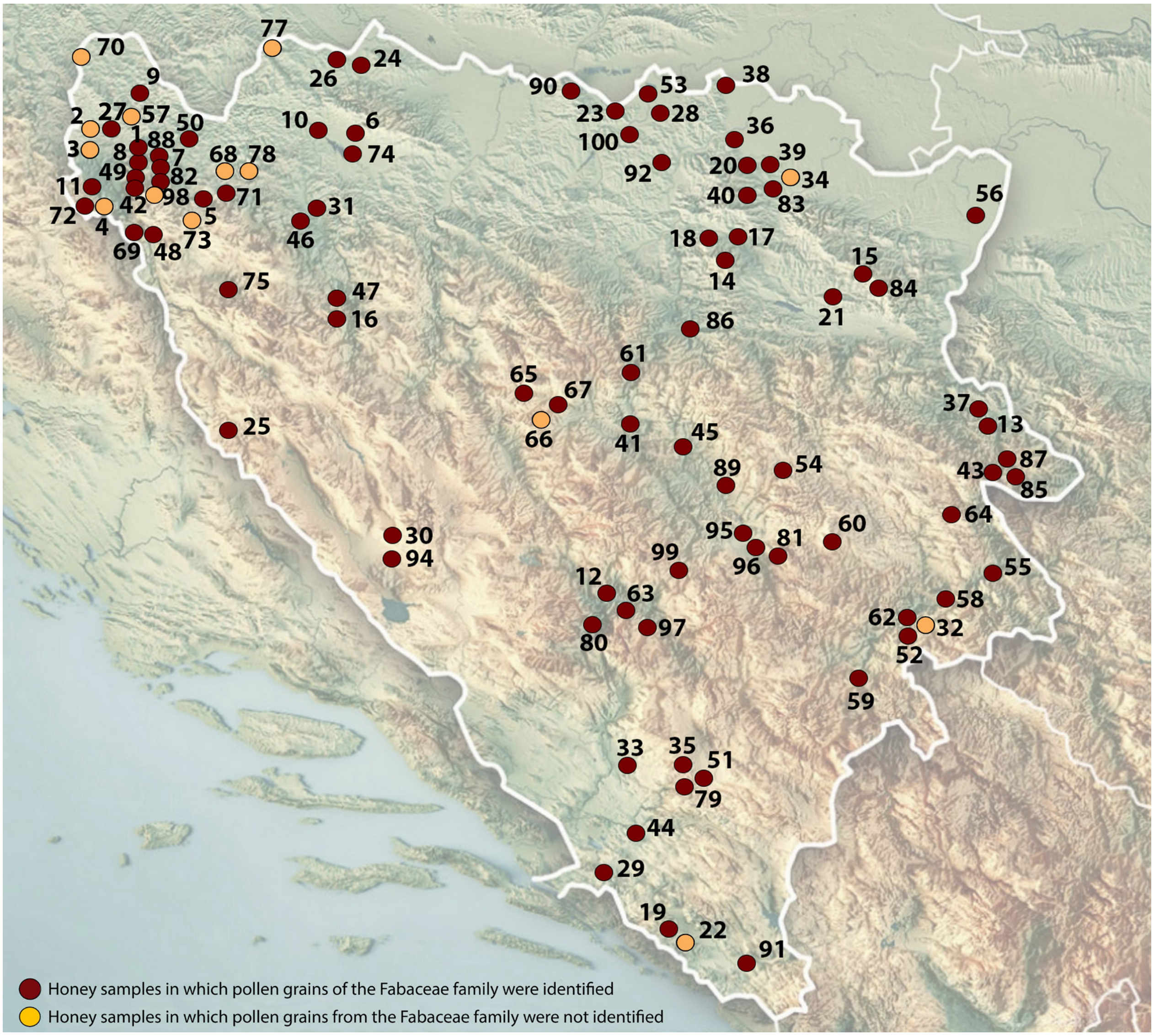


Figure 1. Geographical distribution of the analyzed honey samples

Slika 1. Geografska distribucija analiziranih uzoraka meda

1-Drenova Glavica, 2-Cazin, Koprivna, 3-Cazin, Koprivna, 4-Bihać, 5-Zalin, 6-Kozarac, 7-Bosanska Krupa, 8-Crno jezero, 9-Bužim, Radoč, 10-Prijedor, 11-Bihać, 12-Buturović Polje, 13-Bratunac, 14-Gračanica, 15-Majevica, 16-Ključ, 17-Gračanica, 18-Gračanica, 19-Trebinje, Bobani, 20-Gradačac, 21-Tuzla, 22-Trebinje, Bobani, 23-Bosanski Dubačac, 24-Bosanska Dubica, Babinac, 25-Bosansko Grahovo, 26-Bosanska Dubica, Međeda, 27-Cazin, 28-Bosanski Brod i Derventa, 29-Popovo polje, Ravno, 30-Livno, 31-Prijedor i Sanski Most, 32-Ustikolina, 33-Blagaj, Kamena, 34-Gradačac, 35-Nevesinje, 36-Modriča, 37-Bratunac, 38-Bosanski Brod, Svilaj, 39-Gradačac, 40-Gradačac, Novalići, 41-Zenica, 42-Bosanska Krupa, 43-Srebrenica, 44-Stolac, 45-Kakanj, 46-Sanski Most, 47-Ključ, Sanica, 48-Bosanska Krupa, Suvaja, 49-Bosanska Krupa, Vranjska, 50-Bosanska Krupa, Benkovac, 51-Nevesinje, 52-Goražde, Milanovići, 53-Derventa, Zborišta i Bosanski Brod, 54-Olovo, Nišići, 55-Višegrad, 56-Bijeljina, 57-Cazin, 58- Ustiprača, Radič, 59-Foča, 60-Romanija, 61-Zenica, Nemila, 62-Goražde, 63-Čelebići, 64-Žepa, Begići, 65-Travnik, Karaula, 66-Travnik, Bijelo Buče, 67-Travnik, Karaula, Krčevine, 68-Bosanska Krupa, Jasenica, 69-Bosanska Krupa, Suvaja, 70-Velika Kladuša, 71-Bosanska Krupa, Veliki Dubovik, 72-Bihać, 73-Bosanska Krupa, Zalin, 74-Prijedor, Petrov Gaj, 75-Bosanski Petrovac, 76-Bosanska Krupa, Halkići, 77-Kostajnica, 78-Bosanska krupa, Velika Jasenica, 79-Nevesinje, 80-Jablanica, 81-Pofalići, 82-Bosanska Krupa, 83-Gradačac, 84-Majevica, 85-Srebrenica, Brežani, 86-Zavidovići, 87-Srebrenica, Osmanovići, 88-Bosanska Krupa, 89-Breza, Bukovik, 90-Bosanski Kobaš, 91-Trebinje, 92-Brezići, Bosanski Brod, 94-Livno, 95-Sarajevo, 96-Pofalići, 97-Konjic, 98-Bosanska Krupa, 99-Tarčin, 100-Derventa i Bosanski Brod, Zborišta cies and 68 subspecies belong to the Fabaceae family (Redžić et al., 2008). Plant species of this family possess specific phytochemical compounds such as flavonoids, alkaloids, lectins, and phenolic acids that have antioxidant, anti-inflammatory, antiulcer, antirheumatic, and anticancer properties and activities (Shakoori et al., 2024). The amount of antioxidant substances in species from the Fabaceae family is so high that some studies have recommended using such honey samples for the prevention and treatment of various types of cancer (Myrtsi et al., 2023; Youssef et al., 2023). Given their phytochemical and botanical specificities, representatives of the Fabaceae family are desirable honey-bearing pastures, but there is no literature data on their presence in honey samples originating from B&H. This research aims to determine, based on melissopalynological analysis of honey samples: a) the number of species, b) the percentage share, and c) the frequency of occurrence of species of the Fabaceae family in honey samples from B&H.

MATERIALS AND METHODS – *Materijal i metode*

As part of the research, 100 samples of different types of honey from Bosnia and Herzegovina were collected and analyzed (Figure 1).

Melisopalynological preparations were made in accordance with the Rulebook on methods for the control of honey and other bee products of Bosnia and Herzegovina (2009). The method of analysis of melissopalynological preparations was applied according to the Rulebook as well as the methods proposed by the ICBB (International Commission for Bee Botany) (Von Der Ohe et al., 2004; Rulebook on methods for the control of honey and other bee products of Bosnia and Herzegovina, 2009). All melissopalynological preparations were analyzed using a Wild M20 phase-contrast microscope. Plant species identification was performed based on the micromorphological elements of pollen grains (Erdtman, 1943, 1952; Hesse et al., 2009), and then a qualitative-quantitative analysis of each sample was performed. Qualitative analysis included a list of determined melliferous plants, while quantitative analysis involved recording the exact number of pollen grains in the sample. Based on the results of qualitative-quantitative analysis of the preparations, melissopalynological profiles were created for each sample.

RESULTS AND DISCUSSION – *Rezultati i diskusija*

Melisopalynological analysis of honey samples identified 47 different pollen types and a total of 30,000 pollen grains.

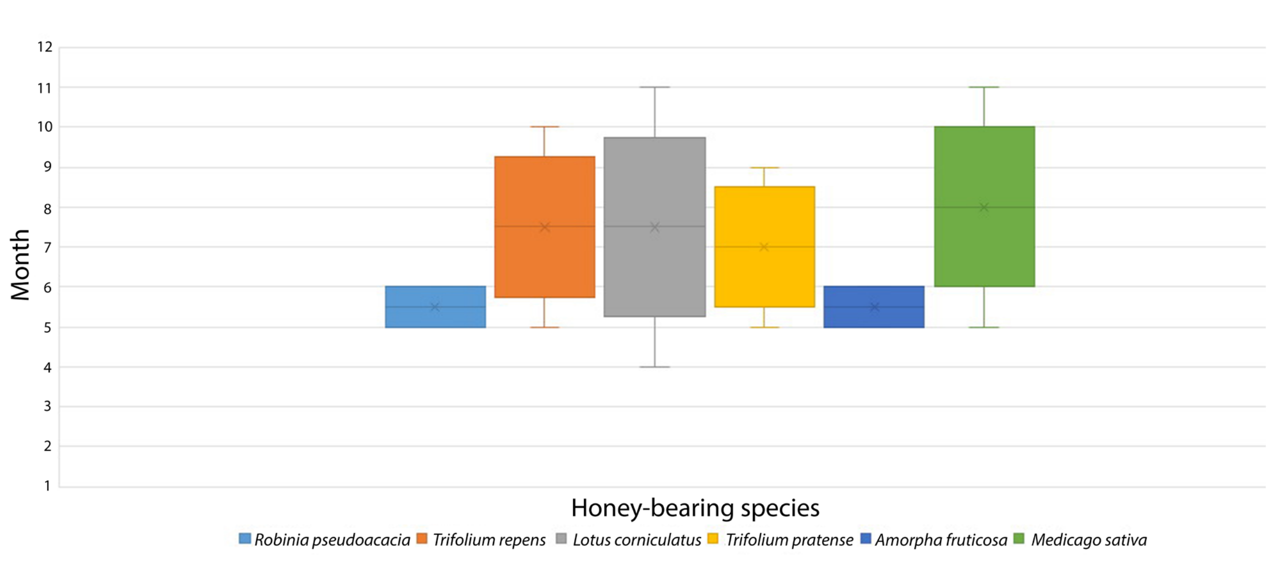
In botanical terms, pollen from 24 plant families was identified, among which the families Fabaceae (26.55%), Compositae (12.77%), and Fagaceae (12.47%) had the greatest melissopalynological significance. In the research, the family Fabaceae had the highest number of honey-bearing species and genera, totaling eight, while Compositae has six, and both Lamiaceae and Rosaceae each have four honey-bearing species.

Table 1. Species/genera of the Fabaceae family identified in the analyzed samples

Tabela 1. Vrste/rodovi porodice Fabaceae identifikovane u analiziranim uzorcima

Species Latin name	Number of pollen grains	The number of samples in which they were detected	F*	N*	P*	L*
Robinia pseudoacacia	6,150	67	5-6	excellent	weak	P
Trifolium repens	367	10	5-10	very good	weak	H (Ch)
Lotus corniculatus	364	9	4-11	very good	very good	H
Trifolium pratense	355	10	5-9	very good	very good	H
Lathyrus sp.	276	13				
Amorpha fruticosa	252	2	5-6	very good	very good	P
Onobrychis sp.	106	6				
Medicago sativa	97	5	5-11	good	weak	H

F* - flowering period, N* - nectar production, P* - pollen production, L* - life form
(P-phanerophyte, H-hemicryptophyte, Ch-chamaephyte) (Oberdörfer, 1957; Mišić & Lakušić, 1990; Umeljić, 2013, 2015)



Graph 1. Flowering period of identified species of the Fabaceae family

Grafikon 1. Period cvjetanja identifikovanih vrsta porodice Fabaceae

Based on the micromorphological characters of pollen grains, the following species/genera from the Fabaceae family were identified: *Robinia pseudoacacia* L., *Lotus corniculatus* L., *Trifolium pratense* L., *Trifolium repens* L., *Amorpha fruticosa* L., *Lathyrus* sp., *Medicago sativa* L., and *Onobrychis* sp. (Table 1).

Of the Fabaceae family's identified pollen grains (7,967), black locust (*Robinia pseudoacacia*) had the greatest honey-producing importance with 6,150 pollen grains. Alfalfa (*Medicago sativa*) had the lowest pollen grain count, with 97 grains in this study (Table 1).

In 67% of palynological profiles, black locust pollen grains were identified as dominant or accessory (Table 1). The honey-bearing plant black locust is characterized by high nectar production, the daily intake of which can be up to 15 kg (Umeljić, 2015), and is one of the most desirable plant species in apiflora (Stanimirović et al., 2000; Umeljić, 2015). Black locust honey is one of the most significant monofloral honeys in Europe (Persano Oddo et al., 2004). In Serbia (Lazarević et al., 2012; Milojković Opsenica et al., 2015) and Croatia (Šarić et al., 2008; Uršulin-Trstenjak et al., 2014, 2015, 2017), it has significant agroeconomic importance within the framework of monofloral honey types. However, black locust is listed among the 40 most invasive woody cryptic species in the world (Richardson & Rejmánek, 2011), and in European databases it is classified as a highly invasive species (EPPO, 2023; DAISIE, 2024) and is included in national lists and watchlists of alien species across Europe (Vítková et al., 2017). In Europe, the presence of black locust has been confirmed in 42 countries, covering a total area of about 2,306,000 ha (Nicolescu et al., 2020). Black locust causes irreversible changes in the physicochemical and biological properties of the soil, but also secretes various allelopathic compounds (e.g., robinetin, myricetin, and quercetin) that can inhibit the growth of other species (Nasir et al., 2005; Boer, 2013; Nicolescu et al., 2020). That is why black locust, although an important honey-bearing species, is also characterized as invasive, and its distribution is strictly controlled on the Asian and European continents (Lazzaro et al., 2018; Lazzaro et al., 2020; Luigi et al., 2023; De Marco et al., 2023).

In addition to black locust, seven species/genera of the Fabaceae family with significant melissopalynological potential were identified in this research (Table 1). Numerous studies confirm that the identified melliferous plant species/genera such as *Lathyrus* sp. (Laxmikant et al., 2014), *Medicago sativa* (Al-Kahtani et al., 2017; Haedo et al., 2022), *Lotus corniculatus* (Murrellt et al., 1982; Pellissier et al., 2012), *Trifolium repens* and *T. pratense* (Shuxuan et al., 2021; Hederström et al., 2024; Harris & Ratnieks, 2024) *Onobrychis* sp. (Kozuharova & Benbassat, 2019; Ozenirler et al., 2019), *Amorpha fruticosa* (Zhu et al., 2020) on a global level have great agro-economic, botanical and melissopalynological significance in the creation of honey pasture.

Understanding of the phenophases of flowering and honeydew of plants is crucial for the optimal use of the melissopalynological potential of honeydew species

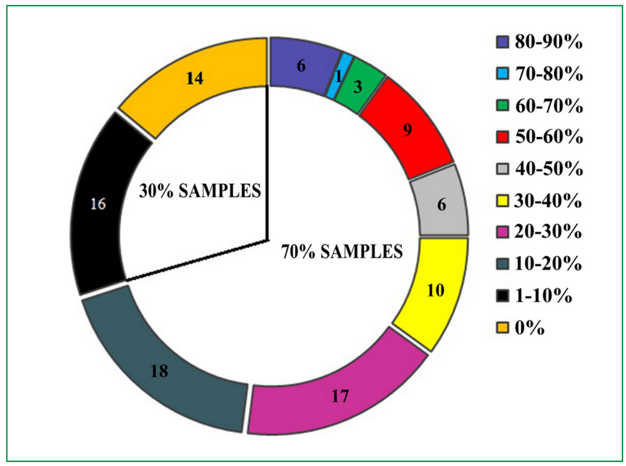
(Topal et al., 2023). The flowering period of the identified plant species/genera of Fabaceae family lasts eight months (from April to November) (Mišić & Lakušić, 1990; Umeljić, 2013, 2015). *Lotus corniculatus* and *Medicago sativa* have the longest flowering phase (from April/May to November), while *Robinia pseudoacacia* and *Amorpha fruticosa* have the shortest (May-June) (Table 1, Graph 1) (Umeljić, 2013; 2015).

The Fabaceae family is characterized by ecological divergence, meaning different species within this family can develop various life forms as a result of adapting to various environmental conditions (Stevanović & Janković, 2001). In this study, the identified honey-bearing species of the Fabaceae family most often appear in two life forms, as hemicryptophytes (H) (four species) and phanerophytes (P) (two species) (Table 1).

Appendix 1 presents the frequency of the melliferous plants in the analyzed pollen spectra of the investigated honey samples at the family level, following Louveaux et al. (1978) and Villalpando-Aguilar et al. (2022). The classifications are: dominant pollen grains (≥45%), accessory (from ≥15% to <45%), important (from ≥3% to <15%), and minor (less than <3%). Pollen grains of the Fabaceae family were identified in 86% of palynological profiles with different frequency categories. Analysis of palynological profiles shows that this family is most often present as accessory (in 40% of palynological profiles) and dominant (in 22%), while it is least represented in the minor category (in 3% of palynological profiles). In the total sample, the percentage of pollen grains of the Fabaceae family varied from 86.33% at the locations Bosanski Brod (sample number 28) and Gračanica (sample number 18) to 1% at the locations Bosanska Dubica (sample number 24) and Olovo (sample number 54) (Appendix 1). The proportion of pollen grains of the Fabaceae family in melissopalynological profiles is of exceptional importance for assessing the antioxidant capacity of honey samples (Majid et al., 2020). Molecular analyses have demonstrated the exceptional antioxidant capacity of this family (Doan et al., 2019; Tungmunnithum et al., 2021; Janarny et al., 2022), so that an increase in the proportion of the Fabaceae family by 1% increases the antioxidant activity of the honey sample by about 1.3% (Shakoori et al., 2024).

Graph 2 presents ten categories differentiated based on the percentage of Fabaceae pollen grains in individual samples, while each of the ten categories includes a different percentage of samples.

Comparison of melissopalynological analyses indicates that plant species from the Fabaceae family are the most abundant honey plants in honey samples from Croatia (Rašić et al., 2018), different regions of Turkey (Gençay et al., 2018; Altay et al., 2018; Topal et al., 2023), and Bulgaria (Balkanska et al., 2023). However, in addition to countries in Europe, the importance of honeydew species from the Fabaceae family has been confirmed at the global level in numerous melissopalynological studies from China (Song et al., 2012), Pakistan (Khan et al., 2024), Ethiopia (Hussein & Seid, 2024), Brazil (Sodré et al., 2007; Haidamus et al., 2019; Barbosaa et al., 2024), Algeria (Bahloul et al., 2022), USA (Hoag Lieux, 1972; Simanonok et al., 2021), Malaysia (Majid et al., 2020), and Saudi Arabia (Raweh et al., 2023). Therefore, we can conclude that B&H Fabaceae species also possess significant honey-bearing potential, making them an important part of the apiflora.



Graph 2. Frequency of categories in the total honey sample of the Fabaceae family. *Categories are given as a percentage share of Fabaceae pollen grains in individual samples, and presented in corresponding colors of the legend

*Grafikon 2. Učestalost kategorija u ukupnom uzorku meda. *Kategorije su definisane prema procentualnom udjelu polenovih zrna porodice Fabaceae u pojedinačnom uzorku, a prikazane su odgovarajućim bojama u legendi*

CONCLUSIONS – *Zaključak*

As part of the research, 100 honey samples from Bosnia and Herzegovina were analyzed. A total of 30,000 pollen grains originating from 24 different plant families were determined. The Fabaceae family had the highest percentage share (26.55%) in the total research, with 7,967 pollen grains. In total, pollen grains of eight species/genera from the Fabaceae family were identified. The percentage share of identified pollen grains in the samples varied from 86% to 1%, and they were detected in as many as 86% of the analyzed melissopalynological profiles. Based on the research results, we can conclude that the Fabaceae family has a great honey-bearing potential and represents an important component of the apiflora of our country. The research results represent a scientific basis for improving the strategy of sustainable beekeeping and preserving the biodiversity of the indigenous apiflora of B&H.

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SAŽETAK

Floristički sastav medonosne paše koji je određen specifičnom kombinacijom medonosnih biljaka na lokalitetu čini ključni faktor koji definiše fizičke, hemijske i biološke osobine meda. Melisopalinološki spektri predstavljaju vjeran odraz florističkog sastava medonosne paše, te je njihova analiza ključna u razumijevanju medonosnog potencijala medonosnog bilja. Cilj ovog istraživanja je, na osnovu melisopalinološke analize uzoraka meda, utvrditi: a) broj vrsta, b) procentualni udio i c) frekvencu pojavljivanja vrsta porodice Fabaceae u uzorcima meda iz Bosne i Hercegovine (BiH). U okviru istraživanja prikupljeno je i analizirano 100 uzoraka različitih tipova meda s prostora Bosne i Hercegovine. Melisopalinološkom analizom je identifikovano 47 različitih tipova polena u ukupno 30.000 izbrojanih polenovih zrna. U botaničkom smislu, identifikovan je polen 24 porodica među kojima je najveći melisopalinološki značaj imala porodica Fabaceae, čija su polenova zrna konstatovana u čak 86% analiziranih profila. Na osnovu mikromorfoloških karaktera polenovih zrna identifikovane su sljedeće vrste/rodovi iz porodice Fabaceae: *Robinia pseudoacacia* L., *Lotus corniculatus* L., *Trifolium pratense* L., *Trifolium repens* L., *Amorpha fruticosa* L., *Lathyrus* sp., *Medicago sativa* L. i *Onobrychis* sp. Polenova zrna porodice Fabaceae kao dominantna identifikovana su u 22%, kao akcesorna, u 40%, kao važna u 21% i kao minorna u 3% palinoloških profila. U okviru rada je prezentirano deset kategorija palinoloških profila koje su diferencirane na osnovu procentualnog udjela polenovih zrna porodice Fabaceae u pojedinačnim uzorcima. Specifično je da je od ukupnog broja uzoraka čak 70% imalo udio polenovih zrna ove porodice više od 10%. Na osnovu rezultata ovog istraživanja može se zaključiti da vrste iz porodice Fabaceae imaju veliki medonosni potencijal i predstavljaju važnu komponentu apiflore BiH. Rezultati istraživanja predstavljaju naučnu osnovu za unapređenje strategije održivog pčelarenja i očuvanje biodiverziteta autohtone apiflore BiH.

Appendix 1. Melisopalynological characterization of the investigated honey samples at the family level (geographical distribution of localities is marked in Figure 1)

Prilog 1. Melisopalinološka karakterizacija istraživanih uzoraka meda na nivou porodice (geografska distribucija lokaliteta je označen na Slici 1)

Location number	dominant (≥45%)	accessory (from ≥15% to <45%)	important (from ≥3% to <15%)	minor (less than <3%)
1	Fagaceae (73.33)	Malvaceae (17.33)	Compositae (5.67), Fabaceae (3.67)	
2	Fagaceae (93.33)		Poaceae (4.33)	Malvaceae (1.33), Rosaceae (1)
3	Fagaceae (97.67)			Rosaceae (1.33), Malvaceae (1)
4	Fagaceae (98.33)			Malvaceae (1), Poaceae (0.67)
5	Malvaceae (50)	Fabaceae (41.33)	Rosaceae (6.33)	Compositae (1.67), Apiaceae (0.67)
6	Fabaceae (57.67)	Oleaceae (30.67)	Compositae (8)	Poaceae (2.33), Cupressaceae (1.33)
7	Malvaceae (62.67)	Fagaceae (24.67)	Fabaceae (4.33), Poaceae (3.67), Plantaginaceae (3)	Compositae (1.67)
8	Malvaceae (62.33)	Fagaceae (24.67)	Fabaceae (7.67), Compositae (5.33)	
9	Fagaceae (89)		Compositae (4.33), Fabaceae (3.33)	Poaceae (2.33), Malvaceae (1)
10	Fabaceae (81.67)		Rosaceae (10), Oleaceae (5.67)	Fagaceae (2.67)
11		Oleaceae (29.67), Fagaceae (25), Fabaceae (21.33)	Pinaceae (10), Viburnaceae (7.33), Compositae (6.67)	
12	Fagaceae (75.67)	Fabaceae (23)		Poaceae (1.33)
13		Poaceae (34.67), Plantaginaceae (34.33), Fabaceae (29)		Compositae (2)
14		Compositae (31.67), Malvaceae (23.33), Fabaceae (18.33)	Poaceae (11), Plantaginaceae (5.33), Apiaceae (4.33), Cornaceae (3), Fagaceae (3)	
15	Fabaceae (48.33)	Malvaceae (23)	Poaceae (9.67), Compositae (7.67), Oleaceae (7.67), Plantaginaceae (3.67)	
16		Compositae (41.33), Fabaceae (27)	Plantaginaceae (12.67), Poaceae (10.33), Juglandaceae (8.67)	
17		Malvaceae (40.67), Fabaceae (21.67), Compositae (15)	Oleaceae (8), Rosaceae (7.67), Poaceae (7)	
18	Fabaceae (85.67)		Oleaceae (6.33), Poaceae(5.67)	Cupressaceae (2.33)
19	Cornaceae (54.67)		Malvaceae (14.67), Fabaceae (13.33), Lamiaceae (9), Poaceae (6.33)	Compositae (2)

Location number	dominant (≥45%)	accessory (from ≥15% to <45%)	important (from ≥3% to <15%)	minor (less than <3%)
20	Fabaceae (55)	Compositae (15.67)	Rosaceae (12.33), Fagaceae (9.33), Poaceae (7.67)	
21		Fabaceae (33.33), Oleaceae (23.67), Poaceae (19)	Malvaceae (11.33), Compositae (8), Plantaginaceae (4.67)	
22	Ericaceae (73.33)		Compositae (9.33), Rosaceae (8.33), Lamiaceae (6), Apiaceae (3)	
23	Fabaceae (57.33)	Compositae (26)	Cornaceae (7.67), Malvaceae (7)	Apiaceae (2)
24	Fagaceae (95)		Compositae (4)	Fabaceae (1)
25		Lamiaceae (43.33), Cornaceae (24.33), Fabaceae (22.67)	Compositae (6), Oleaceae (3.67)	
26		Fabaceae (37.67), Malvaceae (26), Compositae (15.33)	Cornaceae (13), Pinaceae (4.67), Fagaceae (3.33)	
27	Fagaceae (86)		Malvaceae (8.67)	Fabaceae (2.33)
28	Fabaceae (86.33)		Oleaeceae (8.67), Fagaceae (4)	Compositae (1)
29		Cornaceae (23.67), Lamiaceae (23.33), Compositae (23.33)	Fabaceae (11), Rosaceae (9.33), Fagaceae(4.33), Plantaginaceae (3.67)	Apiaceae (1.33)
30	Fabaceae (52.33)	Compositae (17.33)	Cornaceae (5), Poaceae (4.33), Ranunculaceae (4.33), Viburnaceae (4), Ericaceae (4), Malvaceae (3.67), Boraginaceae (3.33)	Pinaceae (1.67)
31	Fabaceae (56)	Oleaceae (26)	Cornaceae (6.33), Poaceae (5.33), Rosaceae (3.67)	Fagaceae (2.67)
32	Rosaceae (47)		Oleaceae (11.33), Poaceae (9.67), Juglandaceae (7.67), Compositae (6.33), Viburnaceae (6.33), Plantaginaceae (6), Cornaceae (5.67)	
33	Rosaceae (42.67)	Lamiaceae (30), Fabaceae (17.67)	Cornaceae (9.33)	Poaceae (0.33)
34	Malvaceae (54.67)	Fagaceae (20.33)	Compositae (11.33), Rosaceae (4.67), Poaceae (4.33)	Caryophyllaceae (2.67), Plantaginaceae (2)
35	Fabaceae (49.67)	Lamiaceae (22.67), Rosaceae (17)	Fagaceae (6.67), Poaceae (4)	
36	Fabaceae (56)	Oleaceae (30.67)	Ericaceae (9.33)	Poaceae (2.67), Compositae (1.33)
37	Fabaceae (56.67)	Oleaceae (30)	Poaceae (7.67), Caryophyllaceae (5.67)	
38	Fabaceae (71.33)	Oleaceae (26.33)		Poaceae (2.33)
39	Fabaceae (82.33)		Rosaceae (6.33), Poaceae (6), Compositae (3)	Caryophyllaceae (2.33)

Location number	dominant (≥45%)	accessory (from ≥15% to <45%)	important (from ≥3% to <15%)	minor (less than <3%)
40	Fabaceae (64.33)	Oleaceae (31)		Fagaceae (2), Cupressaceae (1.33), Poaceae (1.33)
41	Fabaceae (63)	Fagaceae (22)	Compositae (14)	Oleaceae (1)
42		Fabaceae (25), Oleaceae (17.67)	Poaceae (12.33), Malvaceae (11.33), Fagaceae (9.67), Rosaceae (8.67), Compositae (7.67), Caryophyllaceae (7.67)	
43	Fabaceae (61.33)		Oleaceae (9.33), Rosaceae (9), Poaceae (8), Compositae (7.33), Fagaceae (5)	
44		Rosaceae (24), Lamiaceae (22), Fabaceae (19.33)	Simaroubaceae (10), Compositae (9), Poaceae (8.33), Pinaceae (4), Apiaceae (3.33)	
45	Fabaceae (82.33)		Fagaceae (5.33), Compositae (4.67), Poaceae (4.33), Cornaceae (3.33)	
46		Malvaceae (43.67), Fabaceae (23.33), Compositae (20.33)	Plantaginaceae (9), Lamiaceae (3.67)	
47	Malvaceae (50.33)	Fabaceae (26.67)	Compositae (11), Rosaceae (7.67), Poaceae (4.33)	
48		Fabaceae (41.33), Malvaceae (18.67),Fagaceae (16.33), Rosaceae (16.33)	Compositae (7.33)	
49	Malvaceae (40.67)	Fagaceae (16), Compositae (15)	Rosaceae (10.67), Fabaceae (8.67), Poaceae (6)	Apiaceae (1.67), Lamiaceae (1.33)
50	Malvaceae (63)		Fabaceae (14.33), Lamiaceae (7), Apiaceae (6), Compositae (5), Plantaginaceae (4.67)	
51		Fabaceae (30.33), Poaceae (24.33)	Lamiaceae (14), Compositae (11), Plantaginaceae (6.33), Malvaceae (5.33), Polygonaceae (4.33), Apiaceae (4.33)	
52		Malvaceae (33.33), Fagaceae (21.67), Polygonaceae (21.33)	Poaceae (9.67), Compositae (5.67), Plantaginaceae (5.33), Fabaceae (3)	
53	Compositae (73.33)		Fabaceae (8), Malvaceae (6.67), Poaceae (5.67), Chenopodiaceae (3.33), Plantaginaceae (3)	
54		Ericaceae (27.33), Poaceae (24.67)	Plantaginaceae (14.33), Rosaceae (8), Polygonaceae (8), Compositae (6.33), Apiaceae (5.67), Malvaceae (4.67)	Fabaceae (1)

Location number	dominant (≥45%)	accessory (from ≥15% to <45%)	important (from ≥3% to <15%)	minor (less than <3%)
55	Oleaceae (54.33)	Fabaceae (18.33)	Compositae (6.67), Rosaceae (5.67), Poaceae (5.33), Apiaceae (5.33), Lamiaceae (4.33)	
56		Compositae (39.67), Rosaceae (26.67), Fabaceae (18.00)	Poaceae (9.33), Oleaceae (6)	Ericaceae (1.33)
57	Rosaceae (47)	Fagaceae (39.33)	Compositae (7.67), Poaceae (6)	
58		Fabaceae (36.67), Rosaceae (25.33), Fagaceae (14)	Poaceae (11), Compositae (7.33), Malvaceae (5.67)	
59	Fabaceae (82.33)		Plantaginaceae (5.67), Oleaceae (4.33), Poaceae (3)	Compositae (2.67), Apiaceae (2)
60		Rosaceae (26), Fabaceae (25), Compositae (18)	Ericaceae (14), Plantaginaceae (10.67), Poaceae (4)	Apiaceae (2.33)
61	Fabaceae (58.33)		Poaceae (11.67), Oleaceae (11.67), Polygonaceae (7), Rosaceae (4.67), Compositae (4.33)	Cupressaceae (2.33)
62	Fabaceae (45)	Rosaceae (34.67), Oleaceae (16.33)	Compositae (4)	
63	Fagaceae (73.33)	Fabaceae (20)		Rosaceae (2.67), Pinaceae (2), Malvaceae (1.33), Plantaginaceae (0.67)
64		Rosaceae (26.67), Fabaceae (21), Compositae (16.33), Oleaceae (15.33)	Poaceae (10), Fagaceae (8.33)	Malvaceae (2.33)
65		Rosaceae (36), Fabaceae (33.67)	Compositae (11.67), Poaceae (10.33), Fagaceae (8.33)	
66	Oleaceae (91)		Rosaceae (5.33)	Poaceae (2), Polygonaceae (1.67)
67		Rosaceae (39.67), Fabaceae (26.67), Oleaceae (16.33)	Compositae (8.33), Poaceae (7.67)	Plantaginaceae (1.33)
68	Fagaceae (61)	Malvaceae (17.33), Rosaceae (17.33)	Apiaceae (4.33)	
69	Malvaceae (57.67)	Rosaceae (20.67)	Compositae (8), Fabaceae (6.67), Lamiaceae (5.33)	Poaceae (1.67)
70	Fagaceae (71.33)		Compositae (7.67), Poaceae (5.33)	Malvaceae (2)
71		Compositae (38.67), Malvaceae (30.33)	Fabaceae (10.67), Plantaginaceae (7.33), Apiaceae (6.67), Rosaceae (4.33)	Poaceae (2)
72	Compositae (69.67)		Fabaceae (7.33), Plantaginaceae (5.67), Poaceae (6.33), Rosaceae (6), Malvaceae (5)	

Location number	dominant (≥45%)	accessory (from ≥15% to <45%)	important (from ≥3% to <15%)	minor (less than <3%)
73	Malvaceae (84)		Rosaceae (8), Poaceae (5.33)	Compositae (2.67)
74		Compositae (31.67), Fabaceae (15.67), Rosaceae (15.33)	Poaceae (11), Plantaginaceae (7.33), Malvaceae (6.33), Oleaceae (6.33), Polygonaceae (5.67), Apiaceae (4), Fagaceae (3)	
75		Rosaceae (37.33), Compositae (24.33), Fabaceae (24)	Apiaceae (5.67), Plantaginaceae (3), Poaceae (3)	Lamiaceae (2.67)
76	Compositae (52.33)	Fabaceae (32.33)	Plantaginaceae (7.67), Malvaceae (6.33)	Poaceae (1.3)
77	Compositae (70.67)	Malvaceae (29.33)		
78		Malvaceae (34.67), Compositae (34)	Rosaceae (11.33), Lamiaceae (9), Plantaginaceae (5.67), Poaceae (5.33)	
79		Fabaceae (27.33), Compositae (15)	Rosaceae (12.67), Poaceae (10.67), Lamiaceae (8.67), Brassicaceae (8), Polygonaceae (5), Boraginaceae (4.33), Malvaceae (3.33)	Plantaginaceae (2.67), Pinaceae (2.33)
80	Rosaceae (56.67)	Oleaceae (19)	Fabaceae (10.67), Polygonaceae (8.67), Compositae (5)	
81		Fabaceae (38), Compositae (17.33)	Rosaceae (12.33), Plantaginaceae (8.67), Brassicaceae (8.33), Lamiaceae (8), Poaceae (7.33)	
82		Poaceae (31.33), Malvaceae (20)	Compositae (14.67), Rosaceae (10), Lamiaceae (9.67), Fabaceae (5.67), Brassicaceae (4.33), Plantaginaceae (4.33)	
83		Poaceae (15), Rosaceae (15)	Malvaceae (14), Fabaceae (13.33), Plantaginaceae (10.33), Compositae (9.67), Brassicaceae (6.33), Polygonaceae (6), Oleaceae (5.33), Apiaceae (5)	
84		Fabaceae (32), Compositae (22.33)	Malvaceae (13.33), Rosaceae (7), Brassicaceae (6.33), Plantaginaceae (6.33), Boraginaceae (5), Chenopodiaceae (4), Lamiaceae (3.67)	
85		Compositae (25.67), Brassicaceae (22.33)	Fagaceae (12.33), Fabaceae (10.33), Rosaceae (9.33), Malvaceae (9), Poaceae (7.67)	Pinaceae (2), Plantaginaceae (1.33)
86		Fabaceae (23.67), Rosaceae (17.33), Compositae (16)	Plantaginaceae (12), Malvaceae (11.67), Poaceae (11), Polygonaceae (6.33)	Pinaceae (2)
87		Brassicaceae (27.33), Compositae (17), Malvaceae (15)	Poaceae (11), Plantaginaceae (10.67), Fabaceae (8.33), Chenopodiaceae (4.33), Oleaceae (4)	Lamiaceae (2.33)

Location number	dominant (≥45%)	accessory (from ≥15% to <45%)	important (from ≥3% to <15%)	minor (less than <3%)
88	Compositae (54.33)	Malvaceae (18.33), Fabaceae (15.67)	Poaceae (6.33), Plantaginaceae (5.33)	
89	Rosaceae (53.33)	Fabaceae (15.67)	Compositae (10.67), Plantaginaceae (7.67), Poaceae (5)	Pinaceae (2.33), Apiaceae (2), Cornaceae (1.67), Polygonaceae (1.67)
90	Rosaceae (49.33)		Malvaceae (14.33), Compositae (14), Fabaceae (9.33), Poaceae (6), Pinaceae (5.33)	Lamiaceae (1.67)
91		Fabaceae (36.33), Ericaceae (19.33)	Lamiaceae (13.67), Compositae (12.67), Apiaceae (9), Plantaginaceae (8.33)	Rubiaceae (0.67)
92		Ericaceae (31.67), Rosaceae (15.33), Brassicaceae (15)	Fabaceae (11.67), Poaceae (7.33), Cornaceae (5.67), Oleaceae (5.67)	Pinaceae (2)
93		Polygonaceae (18.67), Compositae (17.33), Fabaceae (16.67)	Rosaceae (10.33), Poaceae (10), Lamiaceae (9), Brassicaceae (8.67), Plantaginaceae (7)	Apiaceae (2.33)
94		Fabaceae (27.33), Rubiaceae (22.67), Poaceae (20)	Compositae (11.67), Polygonaceae (8.33), Apiaceae (6.67), Brassicaceae (3.33)	
95		Rosaceae (29.67), Brassicaceae (21.67), Fabaceae (19.67)	Plantaginaceae (9), Oleaceae (8.33), Juglandaceae (4.33), Malvaceae (4), Poaceae (3.33)	
96		Fabaceae (36), Compositae (34), Malvaceae (17.33)	Polygonaceae (12.67)	
97		Fabaceae (42.67), Boraginaceae (26.33)	Poaceae (9.67), Compositae (6.67), Polygonaceae (6.33), Simaroubaceae (5), Cornaceae (3.33)	
98		Rosaceae (28.33), Malvaceae (23.33), Fagaceae (16), Poaceae (15)	Compositae (10.67), Plantaginaceae (6.67)	
99	Fabaceae (59)	Rosaceae (16)	Poaceae (8), Polygonaceae (7.67), Compositae (5.33), Ericaceae (4)	
100	Rosaceae (52.33)		Compositae (12), Poaceae (11.33), Malvaceae (8.33), Fabaceae (6.67), Plantaginaceae (5), Apiaceae (4)	

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