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HONEY AND THE IMPORTANCE OF HONEY SUPPLY IN SIBIEL VILLAGE, SIBIU COUNTY, ROMANIA

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Abstract

For beekeepers, understanding the honey base in their area is crucial to producing quality honey. Placing hives in locations with adequate nectar and pollen sources can lead to honey production with area-specific properties. In addition, knowledge of the honey flora in a certain region can help identifying optimal times for nectar collection. It is also important to monitor and manage the honey flora in order to maintain bee health and ensure the availability of food sources. This research has two objectives: identification of the honey flora in Sibiel village, Sibiu county, Romania and the quality analysis of honey collected from the area. The honey bee flora was analysed according to several classification criteria: botanical, by the type of food provided to the bees, by biological and economic criteria. In the laboratory, the following quality analyses of honey samples from the four hives studied were carried out: acidity index, electrical conductivity, pH and water content determination. The results obtained show that Sibiel has a honey production base that ensures maintenance, development and even production for upcoming years, and that the honey is a natural, high quality product with high chances of certification.

Key words**:** *honey base, honey quality, Sibiel village, Romania*

INTRODUCTION

Bees fed the gods as well as mortals. They have been admired by everyone, especially scientists, for whom the organisation of the bee family was a model for the organisation of human society. The Greek Herodotus said from the darkness of the Hyperborean lands: "The lands beyond Istru are difficult to penetrate because of the multitude of bees". The "king of kings", Darius, entered in his desire to expand his kingdom. Alexander Macedon also entered in order to impose peace on the rebellious tribes, and then left for his campaign in Asia, from where he returned ten years later in a coffin of honey. Historical accounts state that the diet of the Geto-Dacians consisted mainly of milk, vegetables, fruit and honey [11]. The metopes on the Rome column also confirm these claims.
The honeybee - honey flower relationship is a truly indestructible relationship, essential for natural ecosystems and agricultural production. This binomial, which has a major impact on pollination and plant reproduction, adds, in our era, a third factor: the beekeeper who completes the relationship and enhances the finished product, thus adding the economic and social aspect of beekeeping [1, 2, 3, 4, 5]. In this symbiotic honeybee-flower relationship, the honey plants produce nectar and pollen, essential resources for the bees, and the bees in turn collect the nectar to turn it into honey. The honey base is the primary source of honey and plays a crucial role in determining the quality, taste and nutritional attributes of this important hive product.
The diversity of plants in the hive environment has a major impact on the characteristics of the honey produced.
According to information in the literature, at present, more than 1,000 plant species are identified that provide nectar for bees [7], of which 398 species have been identified in our country, with relevant significance in the field of beekeeping, representing pollen, nectar and

manna resources, essential for bee welfare [17]. From a practical point of view, honey plants are distributed in the following categories: plants cultivated for agricultural purposes, fruit trees and shrubs, forest species, as well as plants that provide nectar in meadow and pasture ecosystems [12]. These categories are considered either reliable, accessible sources of nectar and pollen that provide high honey yields, or sources with a role in early harvest or maintenance, all of which result in a wide range of honey assortments. In this context, the purpose of this research is identification of the honey flora in Sibiel village, Sibiu county, Romania and the quality analysis of honey collected from the area. The flora is studied from a botanical, biological and economic point of view. Honey quality was analyzed in the laboratory, assessing acidity index, electrical conductivity, pH and water content.

MATERIALS AND METHODS

Sibiel is a picturesque "touristic village" located in Sibiu county, in the centre of Romania, in the Cindrel Mountains. Known for its traditional charm, rich diversity of flora, including traditional orchards with local varieties of fruit trees, deciduous and coniferous forests and a variety of wild plants, it presents itself as a favourable environment for the development and expansion of beekeeping activity and higher honey production.

Fig. 1. Location of the apiaries in Sibiel village
Source: Google Maps.

The study was carried out in four stationary apiaries (study areas) in the area of Sibiel. The apiaries belong to the families: Săroiu Daniel (Apiary 1), Someșan Maria (Apiary 2) Ciorgodă Sorin (Apiary 3), Moga Ilie (Apiary 4) (Fig. 1). The apiaries are located at an altitude of 575 m.

The investigation period was the entire growing season of 2022. The sample areas in the four apiaries were 10 m x 10 m. The floristic species in each sample were observed, photographed in order to identify and inventory them. Direct, qualitative collections of botanical material were made. It was prepared for transport to the laboratory where it was identified using various bibliographic resources [6, 8, 10, 13, 14, 15, 16, 18]. Honey samples were also taken from the four apiaries in the study. Sampling was carried out with sterilised instruments in clean glass containers that provided adequate protection against contamination, damage and leakage. The containers were labelled and transported to the laboratory of the Faculty of Agricultural Sciences, Food Industry and Environmental Protection, "Lucian Blaga" University of Sibiu for qualitative analyses such as: determination of honey acidity index; determination of honey electrical conductivity; determination of honey pH; determination of water content. The standard norms STAS SR 784-3: 2009 in Romania and 1151/2012 in Europe were respected.

RESULTS AND DISCUSSIONS

Honey is considered the most valuable food available to man. The product, extracted from honeycombs, is made from nectar, which is not only a source of sugar for bees, but also the main factor contributing to the variety and quality of honey. The origin and quality of nectar is essential for the production of high quality honey, and the diversity of nectar sources plays a significant role in the rich and complex range of honey available. Thus, knowledge of the honey resource by beekeepers is important and is considered the key to success in achieving high quality and high production.

Objective 1. In order to support the beekeepers in the area of Sibiel in the efficient management of honey resources, we present a list of the most common species of honey

plants in the study area. The identified honeybee species have been organized in alphabetical order, grouped by families and species**:**

Apiaceae: *Daucus carota* L. ssp. sativum (Hoffm.) Arc;
Asteraceae: *Taraxacum officinale* Weber s.l;
Betulaceae: *Corylus avellana* Al.;
Boraginaceae: *Myosotis scorpioides* L.;
Brassicaceae: *Barbarea vulgaris* W.T.Aiton, *Brassica nigra* (L.) Koch;
Convolvulaceae: *Convolvulus arvensis* L.;
Cucurbitaceae: *Bryonia alba* L.;
Fagaceae: *Castanea sativa* Mill.;
Juglandaceae: *Juglans regia* L.;
Lamiaceae: *Clinopodium vulgare* Bentham, *Glechoma hederacea* L., *Lamium album* L., *L. maculatum* L., *Melissa officinalis* L., *Salvia glutinosa* L., *Stachys sylvatica* L.;
Leguminosae: *Lotus corniculatus* L., *L. Pedunculatus* Cav., *Medicago lupulina* L., *M. sativa* L., *Robinia pseudoacacia* L., *Trifolium repens* L., *T. pratense* L., *T. rubens* L., *Vicia hirsute* (L.) Gray, *V. sativa* L., *V. sepium* L., *V. villosa* Roth.;
Malvaceae: *Malva neglecta* Wallr.;
Oleaceae: *Syringa vulgaris* L.;
Papaveraceae: *Chelidonium majus* L.;
Rosaceae: *Cerasus vulgaris* Mill., *Cydonia oblonga* Mill., *Filipendula ulmaria* (L.) Maxim., *Fragaria vesca* L., *F. viridis* Duch., *Malus domestica* Borkh., *Prunus cerasifera* Ehrh., *P. domestica* L., *Pyrus communis* L., *Rosa canina* L., *Rubus caesius* L., *R. idaeus* L.;
Rubiaceae: *Galium verum* L.;
Violaceae: *Viola canina* L.;
Vitaceae: *Vitis vinifera* L.

In order to improve the organization and understanding of honey plants in the area, various classification criteria have been adopted including: botanical, by type of food provided to bees, by biological and economic criteria [8].

1. *Botanical classification*. In the analysed apiaries, located in uncultivated or semi-cultivated gardens in Sibiel, 109 plant species were identified [19], of which 47 species have honeybee potential. Botanically, these plants belong to 18 plant families (Table 1).

Table 1. Numerical and relative abundance of honey species in the 4 apiaries surveyed in Sibiel village in 2022

Nr. crt	Plant family	Numerical size	Relative size (%)
1.	Leguminosae	12	25.59
2.	Rosaceae	12	25.59
3.	Lamiaceae	7	14.89
4.	Brassicaceae	2	4.25
5.	Cucurbitaceae	1	2.12
6.	Fagaceae	1	2.12
7.	Papaveraceae	1	2.12
8.	Convolvulaceae	1	2.12
9.	Betulaceae	1	2.12
10.	Rubiaceae	1	2.12
11.	Juglandaceae	1	2.12
12.	Apiaceae	1	2.12
13.	Malvaceae	1	2.12
14.	Boraginaceae	1	2.12
15.	Oleaceae	1	2.12
16.	Asteraceae	1	2.12
17.	Violaceae	1	2.12
18.	Vitaceae	1	2.12
	Total	47	100

Source: Own calculation.

Based on the information in Table 1, the families Leguminosae and Rosaceae have the largest number of honey species, 12 each, representing 51.18% of the total honey species in the area surveyed. The second place is occupied by the family Lamiaceae, with 7 species (14.89%). The third place belongs to the family Brassicaceae, with 2 species (4.25%). The rest of the families Cucurbitaceae, Fagaceae, Papaveraceae, Convolvulaceae, Betulaceae, Rubiaceae, Juglandaceae, Apiaceae, Malvaceae, Boraginaceae, Oleaceae, Asteraceae, Violaceae, Vitaceae are represented by 1 species each (2.12%).

2. *According to the nature of the food* they provide to bees, several beekeeping groups have been identified:

- nectar-pollinating plants that provide bees with both nectar and pollen. The products are offered to bees from March to the end of October, ensuring the maintenance and development of bee families. Of the 47 honey species identified, the majority, 45 species, fall into this group. The flowers of this category are intensively explored by bees at different hours: *Pyrus communis* L., *Mellissa officinalis* L. are visited at midday, *Taraxacum officinale* Weber s.l. is visited in the hours

before midday, and *Trifolium repens* L. provides collections throughout the day. *Trifolium pratense* L., on the other hand, provides abundant secretion to bees only after the second brood, when the flowers are less developed and the bee's proboscis is at that time about the same length as the corolla tube.

- Less common nectar plants provide bees exclusively with nectar. Our research has identified only one taxon in the surveyed area: *Salvia glutinosa* L. Local children are accustomed to plucking the flowers and sucking nectar from the base of the corolla.
- Pollen plants only provide bees with pollen. From this category we cite the representative of the Betulaceae family: *Corylus avellana* Al. The abundance of pollen in spring is an important food resource for bees in the area.

3. In terms of biological and economic classification, the Sibiel honey base comprises the following groups:

Trees and shrubs, also known as forest species, constitute an essential and diversified source of honey resources. The species flower gradually from the beginning of March, when the snow melts, until late autumn. In this category we find specie: Castanea *sativa* Mill., *Corylus avellana* Al., *Juglans regia* L., *Robinia pseudoacacia* L., *Rosa canina* L., *Rubus caesius* L., *R. idaeus* L., *Syringa* vulgaris L. In addition to their economic and forestry relevance and their contribution to the beekeeping industry (by providing nectar and pollen to bees), deciduous species such as *Castanea sativa* Mill., *Corylus avellana* Al. and *Robinia pseudoacacia* L. serve as hosts for some manna-producing insects of the Aphydidae and Lecaniidae families. We note that manna-producing insects on leafy tree species are of limited honey production importance [12], which is reflected in variable manna honey production in the locality.

Wild herbaceous honey plants, including woodland, meadow, roadside and garden plants, which in turn provide significant amounts of nectar and pollen. Of the 32 species identified, the most important are listed below: *Lamium album* L., *Lotus corniculatus* L., *Salvia glutinosa* L., *Taraxacum officinale* Weber s.l, *Trifolium repens* L.

Mellissa officinalis L. has a dual role: it provides nectar collection and is used by beekeepers at the time of flowering to catch the swarm of bees.

Cultivated plants, this category includes fruit trees and shrubs. Tree species, due to their biodiversity and gradual flowering, provide important honey resources for bees in spring when the honey base is poorly represented. Maximum nectar secretion is reached between 7-11 am [12]. We list the fruit species of interest for beekeeping in Sibiel: Cerasus vulgaris Mill., Cydonia oblonga Mill., Malus domestica Borkh., Prunus cerasifera Ehrh., *P. domestica* L., *Pyrus communis* L. They are joined by the shrub *Vitis vinifera* L. whose flowers are searched by bees during the mornings.

According to the economic weight (EAP), the Sibiel honey resources fall into 4 of the 5 categories identified for our country [9].

Table 2. Economic weight of honey plants in the Sibiel area

Crt. No.	EAP	Species
1	M4	*Robinia pseudoacacia* L., *Rubus idaeus* L.
2	M3	*Brassica nigra* (L.) Koch, *Castanea sativa* Mill., *Trifolium repens* L.
3	M2	*Barbarea* vulgaris W.T.Aiton, *Bryonia alba* L., *Clinopodium vulgare* Bentham, *Convolvulus a*rvensis L., *Corylus avellana* Al., *Cydonia oblonga* Mill., *Daucus carota* L. ssp. sativum (Hoffm.) Arc, *Filipendula ulmaria* (L.) Maxim., *Fragaria viridis* Duch., *Glechoma hederacea* L., *Lamium album* L., *L. maculatum* L., *Lotus corniculatus* L., Malus domestica Borkh., *Medicago lupulina* L., *M. sativa* L., *Melissa officinalis* L., *Myosotis scorpioides* L., *Prunus cerasifera* Ehrh., *Cerasus vulgaris* Mill., *Prunus domestica* L., *Pyrus communis* L., *Rosa canina* L., *Rubus caesius* L., *Salvia glutinosa* L., *Stachys sylvatica* L., *Taraxacum officinale* Weber s.l, *Trifolium pratense* L., *T. rubens* L., *Vicia villosa* Roth., *V. vativa* L., *V. sepium* L., *Viola canina* L., *Vitis vinifera* L.
4	M1	*Chelidonium majus* L., *Fragaria vesca* L., *Galium verum* L., *Juglans regia* L., *Lotus pedunculatus* Cav., *Malva neglecta* Wallr., *Syringa vulgaris* L., *Vicia hirsute* (L.) Gray,

Surce: [17].

Analysis of the data in Table 2 shows that in the ecosites surveyed, the honeybee species fall into the following groups:

1. Species with a very high apiculture weight (M4) represent 4.26% of the total honey plants identified. They provide important annual production crops.

2. Species with a high beekeeping weight (M3) representing 6.38% of the honey resource and providing regular or annual production harvest.

3. Species with medium beekeeping weight (M2) with the highest representation, 72.34%. The species provide maintenance, development and sometimes production crops.

4. The low beekeeping species (M1), at 17.02%, provide bees with nectar and pollen, but no production crops.

Of economic importance for beekeepers in the area are nectar-pollinated plants in the first three categories, which account for 82.98%, and support significant honey production.

The symbiotic relationship between bees and the plant world is carried out through entomophilous flowers in the hive environment. The amount of honey obtained from flower nectar is directly related to the total amount of nectar produced and the concentration of sugar in the nectar. These complex interactions between bees and plants are essential to obtain quality honey production and underline, once again, the close dependence between bees and the plant world.

Objective 2. Qualitatively speaking, honey is a complex mixture, the components of which vary primarily according to floral origin, weather conditions, storage and extraction methods. Its composition includes sugars, enzymes, organic acids, vitamins, minerals, antioxidant compounds, antibacterial substances, aromatic substances, water [12].

The following data on the quality of Sibiel honey were obtained from analyses carried out in the faculty laboratory:

a. Acidity index of honey. It is influenced by the honey flora of the studied area and provides information about the quality, freshness and preservation of the honey. Determining the honey acidity index involves measuring the amount of 0.1 N sodium hydroxide (NaOH) needed to neutralise the acids present in a given quantity of honey. This process was carried out by titration and using the formula:

$$\text{Acidity index} = v_{NaOH} * c_{NaOH} * 10 \quad .....(1)$$

where:

v_{NaOH} – volume of NaOH solution used for titration

c_{NaOH} – concentration of NaOH solution

Table 3. Acidity index values for acacia and polyfloral honey from Sibiel

Apiary	Honey type	Acidity Index (mEq)	Maximum value, Standard SR 784:3/ 2009
A1	Acacia	2.78	4
A1	Polyflora	2.82	4
A2	Polyflora	2.93	4
A2	Acacia	2.31	4
A3	Polyflora	2.41	4
A4	Polyflora	1.93	4

Source: Own calculation.

The results obtained are given in Table 3 and show that in Sibiel area, acacia or polyfloral honey has a low acidity index, below the maximum permitted value of 4, which indicates a fresh and good quality honey.**b. The electrical conductivity of honey** refers to its ability to allow electric current to pass through it and is an indirect indicator of honey quality. This is influenced by the content of mineral salts, organic acids and other ionic compounds dissolved in honey.

Table 4. Electrical conductivity values for Sibiel honey

Apiary	Honey type	Electrical conductivity $\mu S \cdot cm^{-1}$
A1	Acacia	1.430
A1	Polyflora	1.150
A2	Polyflora	1.410
A2	Acacia	1.430
A3	Polyflora	1.160
A4	Polyflora	1.120

Source: Own calculation.

As a rule, honey with a higher content of dissolved substances has a higher electrical conductivity. In our research, a conductivity sensor attached to the SPARK LXi2

Datalogger with wireless sensor PS-3210A was used to evaluate the electrical conductivity of honey. The results obtained are shown in Table 4.According to SR 784/3-2009, the electrical conductivity of quality honey ranges from 0.970- 1.430 μS· cm-1. The values obtained from laboratory determinations are within the values of the standard. It results that Sibiel honey is genuine and of high quality, influenced by the type of flowers, the environment and other factors.c.

c. Honey pH refers to the measure of the level of acidity or alkalinity present in honey. pH ranges from 0 to 14, where 7 is considered neutral pH. Values below 7 indicate acidity, while values above 7 indicate alkalinity. Honey pH can fluctuate depending on the type of flowers from which the honey was collected and other variables such as processing and storage.

Honey is slightly acidic, with a pH around 3.9 to 4.5 according to PSR 784-3:2009. Acidity plays an important role in preserving honey and preventing the growth of micro-organisms that could deteriorate its qualities.

In general, honey with a lower pH has better stability over time and attests to its authenticity.

For pH determination in the laboratory, a 5:1 dilution (50 ml distilled water with 10 g honey) was prepared and the pH sensor attached to the SPARK LXi2 Datalogger with wireless sensor PS-3204 was inserted. The values are given in Table 5.

Table 5. pH values of Sibiel honey

Apiary	Honey type	The pH level
A1	Acacia	4,8
A1	Polyflora	4,7
A2	Polyflora	4,8
A2	Acacia	4,7
A3	Polyflora	4,8
A4	Polyflora	4,8

Source: Own calculation

It is found that the pH values of the honey samples from Sibiel are between 4.7- 4.8, which indicates that the honey from the analysed hives is natural.

d. Determination of water content. Honey must have a low water content in order to be considered of good quality and to keep for a long time without problems.

The Abbe-Zeiss refractometer was used to determine the water content of honey. It measures the refractive index which is influenced by the concentration of sugars in honey (Table 6).

Table 6. Water content values of Sibiel honey

Apiary	Honey type	Refractive Index (°Brix)	Water (%)	Dry substance (%)	Density (g/cm^3)
A1	Acacia	1.4896	19.1	80.9	1.4885
A1	Polyflora	1.4910	17.6	82.4	1.4296
A2	Polyflora	1.4785	20.4	76.6	1.3946
A2	Acacia	1.4873	20.1	74.6	1.4580
A3	Polyflora	1.4915	16.8	83.2	1.4310
A4	Polyflora	1.4920	18.9	81.1	1.4930

Source: Own calculation.

According to the standard (STAS SR 784-3: 2009 in Romania and 1151/2012 in Europe), the maximum water content of a quality honey is 20%.

According to Table 6, all honey varieties tested fall within this limit, but honey from hive 2 has a slight risk of fermentation and the taste may be slightly attenuated.

CONCLUSIONS

In the four stationary apiaries in the area of Sibiel, 47 honey species belonging to 18 plant families, both herbaceous and woody, have been identified, constituting an important reservoir of nectar and pollen for bee families, providing important production crops.

The Leguminosae and Rosaceae plant families are the richest in the number of taxa, each with 12, representing half of the identified honeybee base (51.18%).

Of the 47 honeybee species, 45 of them (95.74%) are classified in the nectar-pollinating plant group, which provides the necessary food for the development of bees at different stages, increasing the number of bee families, thus contributing to the expansion of beekeeping activities in the region.

The floristic potential of the area is 82.98% in the first three economically important categories: species with a very high beekeeping weight (4.26%), species with a high beekeeping weight (6.38%) and species

with a medium beekeeping weight (72.34%). Following qualitative laboratory analyses, all the honey varieties taken from the hives of Sibiel are natural.

None of the varieties are interfered with by additives or other stimulants, their value being determined by the nectar collected by the bees from the honey plants in the hives.

The results of the analyses carried out compared with the standard quality norms for honey in Romania and Europe confirm that Sibiel honey is a superior quality product.

The preliminary analyses conducted are intended to pave the way for the future certification of Sibiel honey.

In pursuit of this objective, we suggest conducting more comprehensive examinations encompassing pollen, micro and macro elements, heavy metals, as well as pesticides.

Understanding the honey potential of Sibiel beekeepers results in protecting the biodiversity of honey species, encouraging the development of bee farms and producing more varieties of honey.

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