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Research Article

Characteristic Features of Kolludere Valley (Bitlis-Hizan) Honey

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Abstract: This study was carried out to reveal the characteristic features of honey produced in the Kolludere Valley, which is located within the borders of the Hizan district of Bitlis province. This area is isolated as there are no seasonal migratory beekeepers. In 2022, a flora study was carried out in the area and 133 plant taxa belonging to 19 families from which bees receive nectar or pollen were identified. 23 of these taxa are endemic. Content analysis of honey samples taken from the study area was carried out. Proline value, which is an important parameter of honey quality, was determined as 809.41 mg kg^{-1}, diastase number 28.9, HMF 2.9 mg kg^{-1}, and sucrose 0.2 g/100g. All other parameters (humidity, acidity, pH, fructose+glucose, fructose/glucose, saccharose, maltose, electrical conductivity) were also met standart according to the values of the Food Codex Honey Communiqué and European Union Standards. In addition, pollen analysis of honey samples was made and the data were compared with the flora. In honey samples, pollen is generally minor or rare, and pollen of a dominant taxon was found in only one sample. For this reason, most of the honey produced in the Kolludere Valley was evaluated as flower honey.

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1. Introduction

With the rapidly increasing world population, it is getting harder to reach clean and safe food. Basic foods contaminated with toxic compounds (pesticides, artificial fertilizers, food additives, etc.) are among the most important factors threatening human health (Demir and Ayaz, 2022). One of the foods that has an important place in human nutrition is honey. Honey, with its vitamins, minerals, organic acids, amino acids, enzymes, and compounds such as flavonoids, is an important food that is nutritious, easily digestible, and has protective properties against various diseases (Ozmen and Akalın, 2006; Mutlu et al., 2017). Sugar, moisture, elements, HMF, enzyme, organic acids, vitamins, etc. content, glucose and fructose ratios, pH, acidity, electrical conductivity, etc. parameters determine the value of honey (Acquarone et al., 2007). One of the factors affecting honey quality is plant diversity.

The producers of natural products are decreasing day by day. Therefore, the sustainability of these products is important. Hizan district of Bitlis is one of the best examples of traditional crop cultivation. Honey is an important product for the province of Bitlis. In terms of its geographical structure and vegetation, Hizan is a district that has an advantageous position in terms of beekeeping activities (Ozdemir et al., 2016). Hizan's geographical location and rich plant diversity provide advantages for honey production.

The aim of this study is to reveal the quality of the Kolludere Valley (Hizan) honey with a scientific approach so that it can get the value it deserves. For this purpose, honey flora of the region, pollen analysis, and honey content analysis were revealed.

2. Material and Methods

2.1. Research Area

Kolludere Valley is located in the northeast of Hizan and the west of Gevaş district (Figure 1).

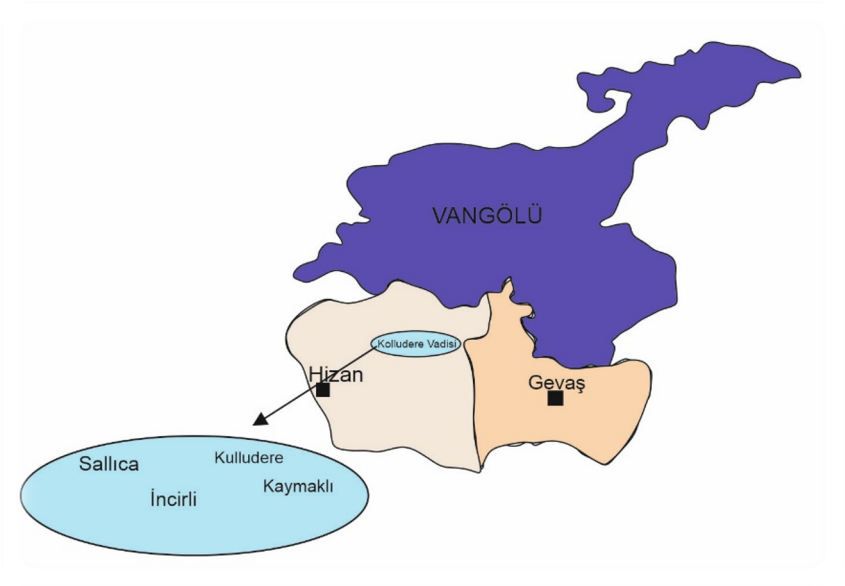

Figure 1. Map of Research area.

2.2. Distinctive Features of Kolludere Valley Honey

Kolludere Valley is a geographically isolated place surrounded by high mountains. In addition, it has a rich plant diversity as it has different habitats such as deep valleys, streams, forest areas, and steppe areas. Because of these properties, it is very suitable for honey production (Behçet, 1994). Beekeeping activity starts in April in the spring and continues until the end of August. Beekeeping starts in June, as the flowering period is a little late in high places. However, the natural comb honey harvest is expected until October.

Beekeepers carry out all their beekeeping activities in Hizan. It is not possible to move it to another place depending on the season. It is also an isolated area as there is no entrance for itinerant beekeepers. Traditional honeycomb is mostly preferred for honey production. (Figure 2). Caucasian honey bees are preferred in Hizan.

Figure 2. An image from the research area.

2.3. Flora study

Between May and August of 2022, a total of 12 field studies were carried out and plant samples visited by bees were collected. The collected samples were identified and preserved in the Herbarium of the Biology Department of the Faculty of Arts and Sciences at Bitlis Eren University. Flora of Türkiye (Davis, 1965 and 1985; Davis et al., 1988) was used to define plant taxa. Families are listed alphabetically, and species according to their importance. The phrase "**END**" has been added to the end of the endemic taxa.

2.4. Honey analysis

Ten honey samples were taken from different locations in the research area. Honey analyses were carried out at Ordu Province Apiculture Research Institute, Food Technology Department Laboratory. The following parameters were determined for each sample.

- Proline (mg kg^{-1})
- Fructose+Glucose (g $100g^{-1}$)
- Fructose/Glucose
- Saccharose (g $100g^{-1}$)
- Maltose (g $100g^{-1}$)
- Humidity %
- pH
- Acidity (meq kg^{-1})
- Electrical conductivity (mS cm^{-1})
- Diastase
- HMF (mg kg^{-1})

Biochemical analyses of honey samples (Proline, electrical conductivity, pH, moisture, acidity, HMF, diastase, fructose, glucose, and maltose) were performed according to the methods specified by Bogdanov et al. (2002).

2.5. Pollen analysis

Pollen analysis is generally used to determine the botanical source of honey (Almeida-Muradian et al., 2005; Bastos et al., 2004). The following method was used for pollen analysis in honey (Sorkun 2008). 10 g of honey is poured into a test tube and diluted with 20 ml of pure water. For this process, a water bath with a temperature of 45 °C is used for 10-15 m. After the mixture is homogenized, the test tube is centrifuged at 3500 rpm for 45 m. After this stage, the particle at the bottom of the tube is transferred to a slide with the help of a needle.

The prepared slides were examined with an Olympus CX21 light microscope. In the diagnosis of pollen, reference pollen microphotographs from various sources (Sawyer, 1981; Pehlivan, 1995;

Sorkun 2008), the pollen slides of the plants collection of Kafkas University Biology Department, and plants collected from the research area were used.

The results obtained from the examinations of the preparations were evaluated according to the criteria used by Louveaux et al. (1978). According to these criteria; 45% or more pollen are dominant, 16-44% secondary, 3-15% minor, and 3% or less trace pollen were accepted. Pollen analyses were carried out by pollen experts from the Department of Biology of Kafkas University.

3. Results and Discussion

3.1. Bee flora of the research area

In the plant samples collected from the research area, 133 taxa belonging to 19 families were determined. 23 of these taxa were endemic (Table 1).

Table 1. Bee plants determined in the research area

Family	Taxon	
Apiaceae	*Eryngium billardieri* F.Delaroche	*Eryngium giganteum* M.Bieb.
	Prangos pabularia Lindl	*Heptaptera anatolica* (Boiss.) Tutin
	E. campestre L.	*Eryngium thyrsoideum* Boiss.
	Ferula orientalis L.	*Heracleum crenatifolium* Boiss. (END)
	Eryngium falcatum F.Delaroche	*Heracleum persicum* Desf
	Ferulago setifolia K.Koch	
Apocynaceae	*Vincetoxicum tmoleum* Boiss	*Vincetoxicum canescens* (Willd.) Decne.
	Vincetoxicum fuscatum subsp. *boissieri* (Kusn.) Browicz	
Asparagaceae	*Muscari comosum* (L.) Mill.	*Ornithogalum narbonense* L.
	M. caucasicum (Griseb.) Baker	*Ornithogalum persicum* Hausskn. ex Bornm
Asteraceae	*Cota wiedemanniana* (Fisch. & C.A.Mey.) Holub	*Cota tinctoria* (L.) J.Gay
	Senecio vernalis Waldst. & Kit	*Gundelia colemerikensis* Fırat (END)
	Echinops orientalis Trautv	*Gundelia tournefortii* var. *armata* Freyn & Sint. (END)
	Echinops ritro L.	*Scorzonera semicana* DC. ((END)
	Onopordum carduchorum Bornm. & Beauverd	*Tanacetum zahlbruckneri* (Náb.) Grierson (END)
	Arctium tomentosum Mill	*Taraxacum kurdiciforme* G.E.Haglund.
	Carlina oligocephala Boiss. & Kotschy	
Boraginaceae	*Anchusa azurea* Mill.	*Onosma armena* DC. (END)
	A. leptophylla subsp. *incana* (Ledeb.) D.F.Chamb. (END)	*Onosma alborosea* subsp. *sanguinolenta* (Vatke) Bornm
	Anchusa leptophylla subsp. *tomentosa* (Boiss.) D.F.Chamb. (END)	*Onosma affinis* Hausskn. ex Riedl (END)
	Alkanna froedinii Rech.f. (END)	*Onosma isaurica* Boiss. & Heldr. (END)
		Onosma rechingeri Riedl (END)
Brassicaceae	*Lepidium latifolium* L.	*Aethionema grandiflorum* Boiss. & Hohen.
	Lepidium draba L.	
Caryophyllaceae	*Gypsophila pallida* Stapf	
Euphorbiaceae	*Euphorbia macroclada* Boiss	*Euphorbia esula* subsp. *tommasiniana* (Bertol.) Kuzmanov
	Euphorbia denticulata Lam	
Fabaceae	*Trifolium badium* subsp. *rytidosemium* var. *rivulare* (Boiss. & Balansa) Hossain	*Astragalus robustus* Bunge
		Astragalus onobrychioides M.Bieb.
	Trifolium hybridum L	*Astragalus amblolepis* Fisch.
	Trifolium nigrescens Viv.	*Astragalus gummifer* Labill
	Trifolium alpestre L	*Astragalus aureus* Willd.
	Trifolium ambiguum M.Bieb.	*Astragalus caspicus* M.Bieb
	Trifolium argutum Sol.	*Astragalus pycnocephalus* Fisch.
	Trifolium arvense L	*Astragalus eriocephalus* Willd
	Trifolium ochroleucum Huds	*Astragalus zahlbruckneri* Hand.-Mazz. (END)
	Trifolium pratense L.	*Astragalus brachycalyx* Fisch. ex Boiss
	Vicia alpestris subsp. *hypoleuca* (Boiss.) P.H.Davis (END)	*Medicago sativa* L.
		Lotus gebelia Vent
	Vicia alpestris Steven	*Onobrychis hajastana* Grossh.
	Ononis spinosa L.	*Onobrychis fallax* Freyn & Sint. ex Freyn

Table 1. Bee plants determined in the research area (contunied)

Family	Taxon	
Fabaceae	*Vicia noeana* Boiss.& Reut. ex Boiss *Vicia sepium* L. *Vicia canescens* Labill. *Vicia cracca* L. *Vicia sativa* L.	*Onobrychis sulphurea* Boiss. & Balansa (END) *Onobrychis montana* DC *Pisum sativum* L
Fagaceae	*Quercus brantii* Lindl *Quercus infectoria* Oliv	*Quercus petraea* subsp. *pinnatiloba* (K.Koch) Menitsky (END)
Hypericaceae	*Hypericum triquetrifolium* Turra *Hypericum lysimachioides* Boiss.& Noë	*Hypericum scabrum* L.
Lamiaceae	*Thymus fedtschenkoi* Ronniger *Thymus kotschyanus* Boiss. & Hohen. *Thymus praecox* Opiz *Thymus haussknechtii* Velen. (END) *Salvia nemorosa* L. *Salvia verticillata* L. *Salvia macrochlamys* Bois	*Stachys annua* (L.) L. *Stachys cretica* L. *Ziziphora capitata* L. *Nepeta italica* L. *Nepeta nuda* L. Lallemantia iberica (M.Bieb.) Fisch. & C.A.Mey *Origanum vulgare* L.
Malvaceae	*Alcea apterocarpa* (Fenzl) Boiss *Alcea kurdica* (Schltdl.) Alef	*Alcea remotiflora* (Boiss. & Heldr.) Alef
Papaveraceae	*Fumaria asepala* Boiss	*Fumaria officinalis* subsp. *cilicica* (Hausskn.) Lidén
Plantaginaceae	*Plantago lanceolata* L.	
Resedaceae	*Reseda lutea* L.	
Rosaceae	*Crataegus pseudoheterophylla* Pojark *Crataegus azarolus* L. *Crataegus orientalis* Pall. ex M.Bieb *Crataegus heterophylloides* Pojark. ex K.I.Chr. (END) *Crataegus meyeri* Pojark. *Crataegus* x *sinaica* Boiss *Crataegus monogyna* Jacq *Rosa hemisphaerica* J. Herrm *Rosa foetida* J.Herrm	*Prunus divaricata* Ledeb. *Rosa canina* L. *Rubus caesius* L. *Cotoneaster nummularius* Fisch. & C.A.Mey *Potentilla anatolica* Peşmen (END) *Potentilla anserina* L. *Potentilla armeniaca* Siegfr. ex Th.Wolf (END) *Potentilla meyeri* Boiss *Potentilla recta* L.
Rubiaceae	*Asperula glomerata* (M.Bieb.) Griseb.	
Scrophulariaceae	*Verbascum orientale* (L.) All *Verbascum oreophilum* K.Koch *Verbascum murbeckianum* Hub.-Mor. (END) *Verbascum kurdicum* Hub.-Mor	*Verbascum agrimoniifolium* (K.Koch) Hub.-Mor *Verbascum songaricum* subsp. *subdecurrens* Hub.-Mor. (END) *Verbascum orientale* (L.) All *Verbascum oreophilum* K.Koch

3.2. Honey Analysis

The amino acid profile can give an idea about the botanical origin of honey samples (Anklam, 1998). Besides proline, honey contains 26 amino acids and their amount depends on the source of the honey (nectar or honey extract). The proline content of honey constantly decreases during storage, so proline is an indicator of honey maturity (Von der Ohe et al., 1991). A minimum value of 180 mg kg^{-1} for proline is internationally accepted (Hermosín et al., 2003).

Many parameters such as proline and HMF content, electrical conductivity, and enzyme activities are important in sugar-added honey. Proline has been proposed as a quality criterion for honey in terms of sugar adulteration (Bogdanov and Martin, 2002). The proline results of the samples taken from different locations were well above the standards. Proline values were in the range of 366-1286, with an average proline value of 809 mg kg^{-1}.

Table 2. Turkish Food Codex Honey Communiqué (Official newspaper; Communiquity No: 2020/7) and European Union standards (Codex Alimentarius, 2001)

Analysis	Limit
Proline (mg kg^{-1})	Minimum 300
Fructose+Glucose (g $100g^{-1}$)	Minimum 60
Fructose/Glucose	0,9-1,4
Saccharose (g $100g^{-1}$)	Maximum 5
Maltose (g $100g^{-1}$)	Maximum 4
Humidity %	Maximum 20
pH	-
Acidity (meq kg^{-1})	Maximum 50
Electrical conductivity (mS/cm)	Maximum 0,8
Diastase	Minimum 8
HMF (mg kg^{-1})	Maximum 40

Table 3. Analysis results of honey samples taken from the research area

Locations	Proline	Fruktoz+Glukoz	Fruktoz/Glukoz	Saccharose	Maltose	Humidity	PH	Acidity	Electrical conductivity	Diastase	HMF
1.Kolludere	640.8	66.6	1.3	N.D*	1.6	15.1	3.8	17.0	0.25	18.5	3.5
2.Sallıca	1048.0	65.7	1.3	N.D*	1.2	17.9	4.2	28.0	0.61	35.0	1.0
3.Kaymaklı	638.5	70.3	1.3	N.D*	1.9	14.4	3.8	18.0	0.24	25.9	2.9
4.İncirli	876.3	70.3	1.3	N.D*	2.0	14.4	3.8	24.0	0.33	36.0	4.5
5.İncirli 2nd station	1286.2	72.8	1.3	N.D*	2.0	13.5	3.8	28.0	0.41	44.1	2.4
6.Kolludere 2nd station	366.7	66.6	1.2	0.9	2.0	16.9	3.8	14.0	0.18	14.3	3.1
Overall Average	809.41	68.7	1.3	0.2	1.8	15.3	3.8	21.5	0.33	28.9	2.9

N.D*: not detected.

In the study, fructose + glucose values of flower honey ranged between 65.7 and 72.8 and it was determined that it was 68.7% on average. Fructose+glucose values were expected to be at least 60 (g $100g^{-1}$). The fructose/glucose ratio was determined as 1.3 on average. The expected value in this parameter should be between 0.9 and 1.4. As the fructose/glucose ratio increases, the tendency to crystallize in honey decreases. Another sugar component value examined was sucrose. Very low sucrose was detected in only two of the samples. The average sucrose was 0.2. This value was found below 5%, which is the highest value determined by the Turkish Food Codex Honey (Official newspaper; Communiquity No: 2020/7) Communique and European Union Standards (Bogdanov et al., 2002). Maltose average was 1.8. The moisture content of honey is the most important criterion in evaluating the maturity and shelf life of honey. The moisture average detected in the samples was 15.3. The standard water ratio should be less than 20%.

The sum of free acids, lactones, and esters determines the total acidity in honey (Kahraman et al., 2010). Free acidity contributes to flavor, provides resistance to microorganisms, increases chemical reactions, antibacterial and antioxidant properties, and also gives some information about the source of honey. The amount of free acid should not be more than 50 meq in 1000 g honey according to the standards. In this study, the average free acid value was 21.5 meq.

Enzyme content is one of the quality criteria of honey. The enzyme invertase, which converts nectar into honey, converts sucrose into glucose and fructose. Diastase enzyme converts starch into small sugars. Although there are different levels in honey depending on the plant source and flora, the diastase rate being more or less than the expected level can give clues during the quality determination in honey. However, the diastase activity may differ depending on the protein amount of the pollen in honey and other substances (Artık, 2004). According to the analysis results, the average diastase number of honey samples was 29. This rate is far above the standards.

The average value of hydroxymethylfurfural (HMF) was 2.9 mg kg^{-1}. HMF is a substance that is formed as a result of heating carbohydrates in honey or storing them in unsuitable environments in terms of heat and is unsuitable for human health. HMF ratio in honey is a maximum 40 mg kg^{-1}. The fact that the HMF value is above this value indicates that the honey may have been stored in a hot environment or subjected to heat treatment and that honey with this feature cannot be sold legally. 5-HMF may be formed by dehydration of sugar at low temperatures under acidic circumstances (Lee and Nagy, 1990). Its concentration rises dramatically as the temperature of the thermal treatment and storage rises (Capuano and Fogliano, 2011). According to Turhan et al. (2008), there is no direct association between the 5-HMF level of honey and its composition.

3.3. Pollen Analysis

As a result, pollens of 43 genera belonging to 20 families were determined. One out of six honey samples were defined as unifloral and five honey samples were defined as polyfloral honey. In a previous study on Bitlis honey, five honey samples were investigated and all of them were found to be multifloral (Kızılpınar Temizer et al., 2020). As a result of pollen analysis of 24 honey samples collected from Siirt province, it was determined that eight of them were unifloral (Gürbüz et al., 2019b). According to honey pollen analysis conducted in Şırnak province, which is one of the regions close to Bitlis province, two of 23 honey samples were determined to be unifloral (Gürbüz et al., 2019a). Unifloral honey was determined at the fifth station. The dominant pollen taxa of fifth station honey is *Taraxacum. Taraxacum* was the most densely pollinated genus. It was present in all samples. It was secondary in the first, second, fourth locations, minor in the sixth location, and a trace in the second location. Especially *Taraxacum kurdiciforme* was the most common species in the region. Pollen analysis was carried out on 67 different honey samples in Hakkari province, and it was determined that *Taraxacum* pollen was dominant in one sample and mostly in minor and trace amounts in the other samples (Sarısu, 2011). According to melissopalynological examinations made on 100 honey samples of Kars province and its district, *Taraxacum* pollen was detected as minor and trace in eight honey samples (Gençay Çelemli et al., 2018). *Taraxacum* (dandelion) honey is a honey produced and characterized in Europe (Oddo and Piro, 2004). Rapid complete granulation with finely ordered crystals, cream to yellow color sometimes with a grayish tint, and an intense pungent ammonia persistent odor and taste are other typical characteristics of Italian dandelion honey (Oddo et al., 1995). Dandelion honey, which is a new record in terms of Turkish monofloral honey, was obtained from Bingöl province, and melissopalynological and chemical content analyses of the honey were performed (Ozenirler et al., 2018). In Bingöl province, one of the eight honey samples was determined to be unifloral and this honey was determined to be *Quercus* honey (Soyer, 2018). The pollens in polyfloral honey were rarely secondary (*Astragalus, Hypericum, Plantago,* and *Taraxacum*), mostly in minor or trace amounts. *Eryngium*, *Taraxacum*, *Astragalus*, *Rosa*, and *Verbascum* were observed in all samples, *Prangos, Arctium, Tragopogon, Vicia, Mentha, Salvia, and Rumex* were observed in five samples, varying in dominant, secondary, minor or trace rates. These results were compatible with the results obtained in the flora determination. According to another study conducted on Bitlis Hizan honey, Rosaceae, Fabaceae, Boraginaceae, and Brassicaceae taxa were observed in all honey samples (Kılıç et al., 2016).

Hypericum was the group that was intensely detected in the research area and preferred by bees. Especially *Hypericum triquetrifolium* was concentrated in the research area. *Hypericum* pollens were detected as secondary in third and sixth locations, and as minor or trace pollen in other locations. In honey research conducted in Hakkari province, *Hypericum* pollen was determined to be dominant in one honey sample (Sarısu, 2011). According to the research conducted by Tosunoğlu et al. (2023) on 44 different honey samples in Gümüşhane province, *Hypericum* pollen was determined as an indicator for altitudes above 1500 m and was also detected as trace, minor, and secondary pollen taxon in 24 pollen samples.

Arctium tomentosum was among the plants that bees showed great interest in the research area. The pollen of this plant was detected in five of the six locations sampled. It was mostly in the minor or trace pollen group. Asteraceae pollen is one of the most abundant pollen taxa in honey samples (Sarısu, 2011; Bakoğlu et al., 2014; Gençay Çelemli et al., 2018; Gürbüz et al., 2019b). Asteraceae pollen also was determined as an indicator for altitudes above 1500 m (Tosunoglu et al., 2023). *Astragalus* (geven) was one of the leading plants in beekeeping. In fact, the name of the honey found in most of Anatolia is

associated with this plant. It was one of the dominant plants of the steppe areas in the search area. *Astragalus* pollen was found in all honey samples. Secondary pollen was detected in two samples (first and third), minor in two of the other locations, and trace pollen in two of them. This means that Kolludere Valley honey was not "geven" honey. It was determined dominantly in honey samples from most places in the Eastern Anatolia region. In the research conducted on five honey samples in Bingöl province, it was determined that two honey samples contained *Astragalus* honey. The taxon whose pollen is most frequently found in Hakkari honey is *Astragalus*, one of the natural plants of the region, and was determined to be the main nectar and pollen source for the local honey (Sarısu, 2011). *Astragalus* honey has antioxidant and antimicrobial properties. The *Astragalus* honey sample from Erzurum has the best antioxidant activity (Küçükaydın et al., 2023).

Verbascum is one of the genus with the most species in the Flora of Türkiye. There are more than 340 species, most of which are endemic in our country, with approximately 360 species worldwide. Endemic species are mostly found in Eastern, Southern, and Central Anatolian regions. Pollen of *Verbascum* was detected in all honey samples taken in the search area. *Verbascum murbeckianum* Hub.-Mor, and *Verbascum songaricum subsp. subdecurrens* Hub.-Purple. are endemic taxa, and also, the type specimen was collected from Bitlis. Therefore, this group has an important place in search area honey. Among the honey samples obtained from Diyarbakır and Bingöl regions which are close to the study area, it was determined that *Verbascum* pollen was dominant at a rate of 97% in mullein honey, while other pollen types (Asteraceae and *Campanula*) were found in trace amounts below 3% (Ozkök, 2019).

Prangos pabularia is one of the plant groups that are found in wide areas in Hizan. According to the statement of beekeepers, it is one of the plants most preferred by bees. Pollens of this plant were detected in five of six samples of Hizan honey. It is generally in the minor or trace pollen group.
Brassicaceae pollen was found in all locations except the fifth location. Most members of this family bloom in early spring and bees do not benefit much in short-term flowering. However, especially the *Lepidium latifolium* is very dense and remains flowering for a long time.

Lamiaceae is one of the most important plant families in terms of beekeeping. However, the pollen of the members of this family was not found in Hizan honey. *Salvia* and *Mentha* pollen were detected in trace or minor amounts in five locations. Ozler (2018) claimed that Fabaceae, Rosaceae, *Eucalyptus*, and *Centaurea* were determined melliferous plants (Ozler, 2018). Sorkun et al. (1989) determined that pollen grains belonging to the families of Asteraceae, Fabaceae, Fagaceae, Myrtaceae, Malvaceae, Brassicaceae, Scrophulariaceae, Lamiaceae, and Oleaceae are the important source of Turkish flower honey (Sorkun et al., 1989).

In the samples from all locations, it was defined as *Taraxacum* honey, because *Taraxacum* was dominant in the fifth sample, and because there was no dominant pollen in the other samples (generally below 45%), the honeys were determined as polyfloral honey (multifloral origin) (Table 4). This shows that the plant biodiversity is high in Hizan, so bees collect pollen from a large number of plants. Since single dominant pollen cannot be determined in polyfloral honey, these honeys are generally named according to the geographical region where they are obtained and offered for sale in this way. Especially in our country, this practice is one of the most important criteria in determining the price of honey.

Honey pollen analysis can be used to determine the botanical origin of honey. This study, which was carried out in Hizan, was also carried out for this purpose. Pollen analysis is also an important parameter in determining the quality of honey. Evaluation of pollen together with other parameters (Flora, proline, HMF, etc.) reveals the characteristic features of Hizan honey.

Honey is classified by pollen analysis. Which plant has the most pollen in honey, is called by the name of that plant (Sorkun, 1985). According to the results of the pollen analysis performed on honey samples from the Kemaliye-Erzincan region, only one of 29 samples was identified as unifloral (Yurtsever, 2004). As a result of the pollen analysis study conducted in the Antalya region, Apiaceae, *Raphanus raphanistrum*, *Cirsium*, *Eucalyptus*, *Plantago,* and *Ulmus* pollens were determined as dominant (Silici, 1995). In their pollen analysis in the Rize region, they found *Castanea sativa* pollen to be dominant (Sorkun et. al., 1989). In the study conducted in Bingöl province, 46.14% of the pollen was composed of *Astragalus,* and the others were composed of *Thymus*, *Tribulus*, and *Lamium* (Bakoğlu et al., 2004).

Table 4. Pollen analysis results of honey samples

		Stations					
		1	2	3	4	5	6
Family	Genus	200	200	200	200	200	200
Amaryllidaceae	*Colchicum*				1		
Apiaceae	*Daucus*	1		2	1		
	Eryngium	9	3	10	5	1	3
	Peucedanum			1	1		
	Prangos	3	20	10		9	12
Asparagaceae	*Muscari*			1			
Asteraceae	*Anthemis*				2		
	Artemisia				1		
	Arctium		15	3	23	8	19
	Bellis		1	1	7		4
	Carduus				6	2	7
	Cichorium	2			1	1	
	Echinops		5	1			
	Scorzonera		9		14		
	Taraxacum	40	36	3	44	120	14
	Tragopogon	8	15		11	8	1
Betulaceae	*Corylus*				5		
Boraginaceae	*Echium*			1		1	
	Onosma	2		1			
Brassicaceae	*Brassica*	4	3	15	3		14
Campanulaceae	*Campanula*		4		2	1	
Euphorbiaceae	*Euphorbia*						1
Fabaceae	*Astragalus*	57	1	40	16	3	13
	Melilotus	5		9	10	1	
	Medicago		16			2	22
	Onobrychis		3	9			
	Vicia	10	1	2	2		1
	Trifolium	1	7		4		1
Hypericaceae	*Hypericum*		13	42	6		45
Lamiaceae	*Mentha*		3	2	1	2	3
	Lamium	1				1	4
	Thymus			6			
	Salvia		4	6	10	3	7
Papaveraceae	*Papaver*				3		
Plantaginaceae	*Plantago*	4	24			32	7
Poaceae	*Poa*	1		1	1		
Poligonaceae	*Rumex*	1	5	8	2		1
Ranunculaceae	*Thalictrum*		4				
Rosaceae	*Rosa*	5	3	13	3	1	2
	Malus		3			1	12
	Potentilla	20			1		2
Scrophulariaceae	*Verbascum*	25	2	12	10	3	5
Urticaceae	*Urtica*	1		1	4		

Conclusion

Field studies and honey analyses (chemical, pollen) conducted in the Kolludere Valley, where intensive beekeeping activities are carried out, show that this place has suitable conditions in terms of beekeeping. The rich flora affects the quality of honey in a very important way (Karakaya et al., 2023). The suitability of values such as proline, diastase, and HMF, which determine the quality of honey, reveals the honey quality of the region. When the results obtained are compared with the results of the provinces that obtained geographical indication certificates in the Eastern Anatolia Region, it was determined that better results were obtained. Thus, the results obtained in this scientific study support the necessity of applying for geographical indication of Hizan Honey and its usability for situations such as the promotion and marketing of honey.

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