



## Plant Origins of Propolis from Hakkari, Turkey

Nesrin ECEM BAYRAM<sup>1,2</sup>, Kadriye SORKUN<sup>3,\*</sup>, Gul CEVAHIR OZ<sup>4</sup>

<sup>1</sup>Bayburt University, Aydıntepe Vocational College, Department of Food Processing, 69000 Bayburt, Turkey

<sup>2</sup>Bayburt University Beekeeping Research, Development and Application Center, 69000 Bayburt, Turkey

<sup>3,\*</sup>Hacettepe University, Faculty of Science, Department of Biology, 06800 Ankara, Turkey

<sup>4</sup>Istanbul University, Faculty of Science, Department of Biology, 34134 Istanbul, Turkey

### Article Info

Received: 14/05/2017

Accepted: 24/04/2018

### Keywords

Propolis  
Palynological  
Plant origin  
Hakkari

### Abstract

In this study, palynological analysis of 64 propolis samples from Hakkari province in Eastern Anatolia Region of Turkey was carried out. By microscopic analysis method, pollen diagnosis was made in propolis samples, and plants which may be propolis sources, were estimated. As a result, 71 plant taxa belonging to 34 families were identified at different rates in propolis samples. The pollens of the plants belonging to the family Apiaceae (2.7%-35%), Asteraceae (3.4%-35.4%) and, Fabaceae (12%-66%) were considerably found in the propolis of the Hakkari province. This study is the first report introducing the plant profile of Hakkari propolis in detail.

## 1. INTRODUCTION

Propolis is a natural product that honey bees collect from different parts of plants for strengthening and providing hygiene in hives [1]. The bee enriches this substance by mixing it with active enzymes excreted from glands between the head and the thorax, and plant pollen [2]. In general, the propolis contains, beeswax, plant wax, essential oils, pollen, tannins, mechanical alien substances, lipoprotein substances, calcium, mangan, magnesium, zinc, tin, copper, iron, aluminum, silver, sodium, resin, potassium, chromium, strontium elements, and A, B, B1, B2, B5, B6, C, D, E vitamins [3-5].

Pollen may be transferred to propolis from the plants where nectar is harvested by the bees or from atmospheric pollen [6]. Plant secretions in different ecosystems can be a source of propolis [7]. The variety of plant species in which propolis is concentrated differs according to the region and season. For honey bees, plants such as *Pinus* spp., *Betula* spp., *Populus* spp., *Aesculus hippocastanum*, *Salix* spp., *Alnus* spp., *Prunus* spp., *Ulmus* spp., *Quercus* spp., *Fraxinus excelsior* are among the important species that constitute the herbal source of propolis [8]. In the researches carried out; *Populus nigra*, *P. alba*, *P. tremuloides*, *P. euphratica*, *Salix* spp., *Eucalyptus* spp. and *Castanea sativa* were determined as plants that are the sources of propolis in Turkey [9].

Important plant resources in apiculture (beekeeping) can be determined by carrying out the pollen analysis of bee products. Determination of the botanical origin of propolis, which is used as a therapeutic agent, is important for propolis quality control and standardization [10]. In recent years, many studies have been carried out on the chemical properties and therapeutic effects of propolis, however, no standardization has been achieved. In order to provide the full standardization of propolis, plant sources

\*Corresponding author, e-mail: kadriye@hacettepe.edu.tr

need to be known clearly. In this study, it was aimed to present a detailed report on plant sources of propolis, which is used for many purposes by people since centuries.

## **2. MATERIALS AND METHODS**

### **2.1. Propolis Samples**

Raw propolis samples were supplied from apiaries at 64 different locations from four districts (Merkez, Yüksekova, Şemdinli, Çukurca) of Hakkari in 2011-2012. 13 of the samples were collected from Merkez, 19 from Yüksekova, 30 from Şemdinli and 2 from Çukurca. Raw propolis samples were collected with traps placed on the top of beehives.

### **2.2. Collection of Plants for Making Reference Pollen Preparations**

Samples of flowering plants around the apiaries, from which propolis was collected, were collected in order to prepare reference preparations. The plants were brought to the laboratory in pressed holders for diagnosis, then reference pollen preparations were prepared according to Wodehouse (1935) [11]. The pollen in the anther of the flower was allowed to fall on the slide. 2-3 drops of 96% ethyl alcohol was dropped on the pollens on the slide. The preparation was allowed to stand on the heater until the alcohol evaporated. A portion of basic fuchsine added glycerin-gelatin was taken and placed on the pollens, and it was covered with coverslip after it was melted. The slides were turned down for drying. These preparations were used as references in the identification of pollens in propolis.

### **2.3. Microscopic Analyses of Propolis Samples**

The pollen spectra of propolis samples were determined according to the methodology described by Warakomska and Maciejewicz (1992) [12]. Briefly, 1 g of propolis sample was extracted with ethanol-ether-acetone (1:1:1) and vortexed. After extraction, this mixture was filtered through a strainer with 0.250 mm holes. The suspension was centrifuged for 20 minutes at 3500-4000 rpm. The supernatant liquid was then poured off; and the basic fuchsine added glycerin gelatin of about 1-2 mm<sup>3</sup> width was taken with the help of a sterile needle; by being transferred onto a slide by imbruing it in the pellet remaining in the bottom of the centrifuge tube. The slide in this form was heated at 30-40 °C to allow the dissolution of basic fuchsine added glycerin gelatin; and then the 18x18 lamella was covered on top of it. Preparation was kept thus for nearly 12 hours, and then it became suitable for examination.

The pollen preparations that are prepared to determine the botanical origins of propolis were examined with a Leica DM500 light microscope. The X100 lens was used; because the X10 and X40 lenses were insufficient to identify the pollens during the diagnosis. Pollen counts were made on X10 and X40 lenses starting from the upper left corner, for easier use. In the diagnosis of pollen grains, the microphotographs of pollens in the literature and the reference preparations were utilized [13-18].

The amount of pollen ranging: between 0 % and 5 % was considered as the rare group, between 6 % and 20 % was considered as the minor group, between 21 % and 50 % was considered as the secondary group and pollen exceeding 50 % was called as the dominant group [19].

## **3. RESULTS AND DISCUSSION**

Pollen of the Fabaceae (12-66%), Asteraceae (3.4-35.4%) and Apiaceae (2.7-35%) families was detected at varying percentages in each of 64 propolis samples. Also; other families in various rational percentages were determined such that Boraginaceae (1.9-18.1%), Brassicaceae (0.4-16%), Caryophyllaceae (0.2-15%), Lamiaceae (2-14.5%) and Salicaceae (0.8-12.4%). It is mentioned in literature that families Fabaceae, Asteraceae, Boraginaceae, Brassicaceae and Salicaceae are the main families of nectar sources [20]. The results of this study show that there is a parallelism between the families for nectar and propolis sources.

Identified pollens belonging to different families in 64 samples were identified classified as rare, minor, secondary and dominant in the samples of propolis obtained from Hakkari province. Frequency of pollen types in propolis samples are listed in Table 1. Pollens of 34 families were identified namely; Acanthaceae, Aceraceae, Apiaceae, Asteraceae, Boraginaceae, Brassicaceae, Campanulaceae, Caprifoliaceae, Caryophyllaceae, Chenopodiaceae, Cucurbitaceae, Dipsacaceae, Fabaceae, Fagaceae, Geraniaceae, Guttiferae, Iridiaceae, Juglandaceae, Lamiaceae, Liliaceae, Lythraceae, Malvaceae, Onagraceae, Papaveraceae, Plantaginaceae, Poaceae, Polygonaceae, Ranunculaceae, Rhamnaceae, Rosaceae, Rubiaceae, Salicaceae, Scrophulariaceae, and Solanaceae.

On the other hand, the pollens from *Pimpinella* spp., *Eryngium* spp., *Seseli* spp., *Bupleurum* spp., *Chaerophyllum* spp. taxa of family Apiaceae; from *Crepis* spp., *Achillea* spp., *Helichrysum* spp., *Centaurea* spp., *Tanacetum* spp., *Taraxacum* spp., *Anthemis* spp., *Xeranthemum* spp., *Cirsium* spp., *Echinops* spp., *Senecio* spp., *Picris* spp. taxa of family Asteraceae; from *Echium* spp., *Anchusa* spp., *Onosma* spp., *Symptum* spp., *Alkanna* spp., *Cerinth* spp. taxa of family Boraginaceae; *Isatis* spp., *Brassica* spp., *Aethionema* spp., *Erysimum* spp. taxa of family Brassicaceae; from *Gypsophila* spp., *Silene* spp., *Dianthus* spp., *Minuartia* spp. taxa of family Caryophyllaceae; from *Lathyrus* spp., *Lotus* spp., *Onobrychis* spp., *Melilotus* spp., *Trifolium* spp., *Astragalus* spp., *Medicago* spp., *Glycyrrhiza* spp. taxa of family Fabaceae; from *Salvia* spp., *Teucrium* spp., *Lallemantia* spp., *Stachys* spp., *Prunella* spp., *Nepeta* spp., *Mentha* spp. taxa of family Lamiaceae; from *Salix* spp., and *Populus* spp. taxa of family Salicaceae were found. Therefore, it can be stated that these plants, whose pollen were diagnosed, form the origins for the plant source of Hakkari propolis.

Pollens of 28 families and 47 taxa were identified in 13 propolis samples obtained from the Merkez district of Hakkari province. Pollen of family Salicaceae and Lamiaceae, which is known to be an important propolis source was found to be at the highest level in propolis samples obtained from the Merkez district.

Among the 19 propolis samples collected from the Yüksekova district, pollens belonging to 29 families were found at different ratios. Pollens belonging to family Fabaceae (15-66%) were found most frequently; while pollens belonging to family Apiaceae were at the ratio of 2.7-34%, and those of family Asteraceae with the ratio of 3.4-32% were found. In addition, these families were followed by pollens belonging to families Brassicaceae (3.4-18.1%), Caryophyllaceae (0.2-15%), Lamiaceae (2-12%), Boraginaceae (0.4-8.2%) and Salicaceae (0.8-12%) in rare and minor ratios.

Similar to the findings in the Yüksekova propolis samples, within the 30 propolis samples collected from Şemdinli district, pollens belonging to family Fabaceae were found most frequently. Pollens belonging to the families Apiaceae and Asteraceae were also found in minor and secondary ratios in the samples of other provinces. In the two samples of the Çukurca district the pollens of family Fabaceae (36.7-38.6%) are found as secondary; and the pollens belonging to family Asteraceae and Lamiaceae were found as minor proportions. In addition, the pollens from families Apiaceae, Boraginaceae, Brassicaceae, Campanulaceae, Poaceae, Rosaceae and Salicaceae, were identified in both samples.

Warakomska and Maciejewicz (1992) [12] identified pollens of Asteraceae (*Achillea*, *Taraxacum*), Fabaceae (*Lotus*, *Melilotus*, *Trifolium*), Ranunculaceae, Rosaceae (*Rubus*) and Salicaceae (*Salix*) as a result of microscopic analysis in Polish propolis.

Santos et al. (2003) [21] have conducted microscopic analyzes of the propolis samples they collected from Brazil in different seasons and have identified 31 different pollen types. It has also been reported that pollens belonging to the *Schinus*, *Vernonia*, *Dicleni*, *Hyptis*, *Myrcia*, *Weinmania* and *Baccharis* taxa are found in different proportions in all the studied propolis samples. In our study which is similar to this study, pollens belonging to families Acanthaceae, Asteraceae, Lamiaceae, Malvaceae, Onagraceae, Rubiaceae and Solanaceae were found at different rates. Barth (1998) [22] has found pollens of *Eupatorium*, *Cecropia* and *Eucalyptus* types frequently, as the result of pollen analysis of 11 propolis samples.

**Table 1.** Frequency of pollen types in propolis samples (M: Merkez, Y: Yüksekova, S: Şemdinli, C: Çukurca)

Sample Code	Rare Pollen	Minor pollen	Secondary Pollen	Dominant Pollen
M1	<i>Achillea</i> spp., Campanulaceae, Caryophyllaceae, <i>Centaurea</i> spp., <i>Crepis</i> spp., <i>Dianthus</i> spp., Dipsacaceae, <i>Echium</i> spp., <i>Eryngium</i> spp., Fabaceae, <i>Gypsophila</i> spp., <i>Helichrysum</i> spp., <i>Isatis</i> spp., Lamiaceae, <i>Lathyrus</i> spp., Liliaceae, <i>Lotus</i> spp., <i>Melilotus</i> spp., <i>Mentha</i> spp., <i>Onobrychis</i> spp., <i>Pimpinella</i> spp., Poaceae, <i>Potentilla</i> spp., Ranunculaceae, Rosaceae, <i>Salvia</i> spp., <i>Silene</i> spp., Unidentified, <i>Teucrium</i> spp., <i>Trifolium</i> spp.	Apiaceae, Asteraceae, <i>Astragalus</i> spp., Brassicaceae, Boraginaceae, Fabaceae, Salicaceae	-	-
M2	<i>Achillea</i> spp., <i>Astragalus</i> spp., <i>Bupleurum</i> spp., Campanulaceae, <i>Centaurea</i> spp., <i>Erysimum</i> spp., <i>Gypsophila</i> spp., <i>Isatis</i> spp., <i>Lotus</i> spp., <i>Melilotus</i> spp., <i>Minuartia</i> spp., <i>Onobrychis</i> spp., <i>Pimpinella</i> spp., Poaceae, <i>Potentilla</i> spp., Ranunculaceae, <i>Rosa</i> spp., Salicaceae, <i>Salvia</i> spp., <i>Seseli</i> spp., <i>Silene</i> spp., <i>Tanacetum</i> spp., Unidentified, <i>Taraxacum</i> spp., <i>Trifolium</i> spp.	Apiaceae, Brassicaceae, Caryophyllaceae, Fabaceae, Lamiaceae	Asteraceae	-
M3	<i>Achillea</i> spp., <i>Anchusa</i> spp., Boraginaceae, <i>Bupleurum</i> spp., <i>Campanula</i> spp., Caryophyllaceae, Dipsacaceae, <i>Epilobium</i> spp., <i>Eryngium</i> spp., <i>Lallemantia</i> spp., <i>Lotus</i> spp., Malvaceae, <i>Mentha</i> spp., <i>Onobrychis</i> spp., Poaceae, <i>Rumex</i> spp., <i>Salix</i> spp., <i>Salvia</i> spp., Solanaceae, <i>Tanacetum</i> spp., <i>Taraxacum</i> spp., <i>Trifolium</i> spp.	Apiaceae, Asteraceae, <i>Astragalus</i> spp., Brassicaceae, Fabaceae, Lamiaceae, Rosaceae	-	-
M4	<i>Achillea</i> spp., <i>Astragalus</i> spp., Campanulaceae, Caprifoliaceae, Caryophyllaceae, <i>Centaurea</i> spp., Dipsacaceae, <i>Echium</i> spp., <i>Eryngium</i> spp., <i>Lallemantia</i> spp., Lamiaceae, <i>Lotus</i> spp., <i>Mentha</i> spp., <i>Onobrychis</i> spp., <i>Pimpinella</i> spp., Poaceae, <i>Rosa</i> spp., <i>Salvia</i> spp., Unidentified, <i>Taraxacum</i> spp., <i>Teucrium</i> spp.	Apiaceae, Asteraceae, Boraginaceae, Brassicaceae, Fabaceae, Rosaceae, <i>Salix</i> spp.	-	-
M5	<i>Anchusa</i> spp., <i>Anthemis</i> spp., <i>Astragalus</i> spp., Boraginaceae, <i>Campanula</i> spp., Campanulaceae, Caryophyllaceae, <i>Centaurea</i> spp., <i>Crepis</i> spp., Dipsacaceae, <i>Echium</i> spp., Fabaceae, Fagaceae, Geraniaceae, <i>Mentha</i> spp., <i>Onobrychis</i> spp., <i>Onosma</i> spp., Poaceae, Ranunculaceae, Rosaceae, <i>Salix</i> spp., <i>Salvia</i> spp., <i>Scrophularia</i> spp., <i>Stachys</i> spp., <i>Tanacetum</i> spp., Unidentified, <i>Taraxacum</i> spp., <i>Trifolium</i> spp.	Apiaceae, Brassicaceae, Lamiaceae	Asteraceae	-
M6	<i>Anchusa</i> spp., <i>Anthemis</i> spp., <i>Astragalus</i> spp., <i>Echium</i> spp., Fagaceae, Geraniaceae, Poaceae, Rosaceae, <i>Salix</i> spp., <i>Tanacetum</i> spp.	Apiaceae, Asteraceae, Boraginaceae, Brassicaceae, Campanulaceae, Fabaceae, Lamiaceae, <i>Onobrychis</i> spp., <i>Trifolium</i> spp.	-	-

**Table 1.** (Continued) Frequency of pollen types in propolis samples (M: Merkez, Y: Yüksekova, S: Şemdinli, C: Çukurca)

Sample Code	Rare Pollen	Minor pollen	Secondary Pollen	Dominant Pollen
M7	<i>Achillea</i> spp., Boraginaceae, Brassicaceae, <i>Bupleurum</i> spp., <i>Campanula</i> spp., Campanulaceae, <i>Centaurea</i> spp., <i>Crepis</i> spp., <i>Eryngium</i> spp., Fagaceae, <i>Helichrysum</i> spp., <i>Onobrychis</i> spp., Poaceae, Rosaceae, <i>Salvia</i> spp., Solanaceae, <i>Stachys</i> spp., <i>Tanacetum</i> spp., Unidentified, <i>Taraxacum</i> spp., <i>Teucrium</i> spp., <i>Trifolium</i> spp.	Apiaceae, Asteraceae, Fabaceae, Lamiaceae, <i>Salix</i> spp.	-	-
M8	<i>Achillea</i> spp., Brassicaceae, <i>Campanula</i> spp., Campanulaceae, Caryophyllaceae, Cucurbitaceae, <i>Eryngium</i> spp., Geraniaceae, <i>Helichrysum</i> spp., <i>Lathyrus</i> spp., <i>Lotus</i> spp., Malvaceae, <i>Onobrychis</i> spp., <i>Pimpinella</i> spp., Poaceae, <i>Tanacetum</i> spp., <i>Taraxacum</i> spp.	Apiaceae, Asteraceae, Boraginaceae, Fabaceae, Lamiaceae, Rosaceae, <i>Salix</i> spp.	-	-
M9	Brassicaceae, <i>Campanula</i> spp., Campanulaceae, Caryophyllaceae, Lamiaceae, <i>Onobrychis</i> spp., Ranunculaceae, <i>Salix</i> spp., <i>Salvia</i> spp.	Apiaceae, Asteraceae, Boraginaceae, Rosaceae	Fabaceae	-
M10	<i>Acanthus</i> spp., <i>Anchusa</i> spp., <i>Anthemis</i> spp., <i>Astragalus</i> spp., Boraginaceae, Campanulaceae, <i>Centaurea</i> spp., Dipsacaceae, <i>Hypericum</i> spp., <i>Lotus</i> spp., <i>Onosma</i> spp., <i>Ornithogalum</i> spp., Plantaginaceae, Poaceae, Ranunculaceae, Rosaceae, <i>Salix</i> spp., <i>Silene</i> spp.	Apiaceae, Asteraceae, Brassicaceae, Caryophyllaceae, Fabaceae, Lamiaceae	-	-
M11	<i>Anchusa</i> spp., Boraginaceae, <i>Campanula</i> spp., Caryophyllaceae, <i>Crepis</i> spp., Cucurbitaceae, <i>Echium</i> spp., Geraniaceae, <i>Isatis</i> spp., Liliaceae, <i>Lotus</i> spp., <i>Onobrychis</i> spp., <i>Papaver</i> spp., Poaceae, <i>Salix</i> spp., <i>Trifolium</i> spp.	Apiaceae, Asteraceae, Brassicaceae, Fabaceae, Lamiaceae, Rosaceae	-	-
M12	<i>Acanthus</i> spp., <i>Achillea</i> spp., <i>Anthemis</i> spp., <i>Asperula</i> spp., <i>Bupleurum</i> spp., <i>Campanula</i> spp., Campanulaceae, <i>Chaerophyllum</i> spp., <i>Crepis</i> spp., <i>Hypericum</i> spp., Lamiaceae, <i>Lotus</i> spp., Malvaceae, <i>Mentha</i> spp., <i>Onobrychis</i> spp., <i>Onosma</i> spp., <i>Ornithogalum</i> spp., <i>Plantago</i> spp., Poaceae, <i>Salix</i> spp., <i>Tanacetum</i> spp., Unidentified, <i>Trifolium</i> spp., <i>Xeranthemum</i> spp.	Apiaceae, Boraginaceae, Brassicaceae, Caryophyllaceae, Fabaceae, Rosaceae	Asteraceae	-
M13	<i>Acanthus</i> spp., <i>Anthemis</i> spp., Boraginaceae, Campanulaceae, <i>Centaurea</i> spp., <i>Galium</i> spp., <i>Lotus</i> spp., <i>Onobrychis</i> spp., <i>Onosma</i> spp., Plantaginaceae, Poaceae, Rosaceae, <i>Salix</i> spp., <i>Xeranthemum</i> spp.	Apiaceae, Asteraceae, <i>Astragalus</i> spp., Brassicaceae, Caryophyllaceae, Lamiaceae	Fabaceae	-
Y1	<i>Acanthus</i> spp., Boraginaceae, Caryophyllaceae, <i>Centaurea</i> spp., <i>Onobrychis</i> spp., <i>Onosma</i> spp., Poaceae, <i>Silene</i> spp., <i>Trifolium</i> spp.	Asteraceae, <i>Astragalus</i> spp., Brassicaceae, Fabaceae, Rosaceae	Apiaceae, Lamiaceae	-
Y2	<i>Acanthus</i> spp., <i>Astragalus</i> spp., Boraginaceae, Brassicaceae, <i>Bupleurum</i> spp., Caryophyllaceae, <i>Centaurea</i> spp., <i>Cirsium</i> spp., <i>Echinops</i> spp., <i>Eryngium</i> spp., <i>Hypericum</i> spp., <i>Juglans</i> spp., Lamiaceae, <i>Lathyrus</i> spp., <i>Lotus</i> spp., <i>Medicago</i> spp., <i>Ornithogalum</i> spp., <i>Pimpinella</i> spp., Poaceae, <i>Populus</i> spp., Rosaceae, <i>Salix</i> spp., <i>Seseli</i> spp., Unidentified, <i>Trifolium</i> spp.	Apiaceae, <i>Chaerophyllum</i> spp., Fabaceae	Asteraceae	-

**Table 1.** (Continued) Frequency of pollen types in propolis samples (M: Merkez, Y: Yüksekova, S: Şemdinli, C: Çukurca)

Sample Code	Rare Pollen	Minor pollen	Secondary Pollen	Dominant Pollen
Y3	Boraginaceae, Campanulaceae, <i>Centaurea</i> spp., <i>Hypericum</i> spp., Juglandaceae, Lamiaceae, <i>Medicago</i> spp., <i>Onobrychis</i> spp., Poaceae, <i>Potentilla</i> spp., Rosaceae	Apiaceae, Asteraceae, <i>Astragalus</i> spp., Brassicaceae, Caryophyllaceae, Fabaceae	-	-
Y4	<i>Acanthus</i> spp., <i>Alkanna</i> spp., Boraginaceae, <i>Campanula</i> spp., Campanulaceae, Caryophyllaceae, Dipsacaceae, <i>Echinops</i> spp. <i>Hypericum</i> spp., Iridiaceae, <i>Juglans</i> spp., Lamiaceae, <i>Lotus</i> spp., <i>Medicago</i> spp., <i>Onosma</i> spp., Poaceae, Rosaceae, <i>Salix</i> spp., <i>Scabiosa</i> spp., Unidentified	Apiaceae, Asteraceae, <i>Astragalus</i> spp., Brassicaceae, Fabaceae	-	-
Y5	Asteraceae, <i>Astragalus</i> spp., Brassicaceae, Caryophyllaceae, Cucurbitaceae, <i>Ornithogalum</i> spp., Poaceae, Rosaceae	Apiaceae, Boraginaceae, <i>Lotus</i> spp.	-	Fabaceae
Y6	<i>Anthemis</i> spp., Apiaceae, Boraginaceae, Brassicaceae, Campanulaceae, <i>Centaurea</i> spp., <i>Cirsium</i> spp., <i>Echium</i> spp., Geraniaceae, <i>Gypsophila</i> spp., <i>Hypericum</i> spp., <i>Isatis</i> spp., <i>Lallemantia</i> spp., Lamiaceae, <i>Melilotus</i> spp., <i>Onobrychis</i> spp., <i>Picris</i> spp., Poaceae, <i>Quercus</i> spp., <i>Ranunculus</i> spp., Rosaceae, <i>Salix</i> spp., <i>Salvia</i> spp., <i>Silene</i> spp., <i>Symptum</i> spp., Unidentified, <i>Teucrium</i> spp., <i>Trifolium</i> spp., <i>Xeranthemum</i> spp.	Asteraceae, Caryophyllaceae, Fabaceae	-	-
Y7	<i>Potentilla</i> spp.	Apiaceae, Boraginaceae, Brassicaceae, <i>Centaurea</i> spp., <i>Silene</i> spp., Lamiaceae, <i>Melilotus</i> spp., Rosaceae, <i>Trifolium</i> spp.	Fabaceae	-
Y8	Boraginaceae, <i>Erysimum</i> spp., Campanulaceae, <i>Centaurea</i> spp., Dipsacaceae, <i>Hypericum</i> spp., Lamiaceae, <i>Medicago</i> spp., Poaceae, <i>Potentilla</i> spp., Rosaceae, <i>Salix</i> spp.	Apiaceae, Asteraceae, <i>Astragalus</i> spp., Brassicaceae, Caryophyllaceae, Fabaceae	-	-
Y9	<i>Astragalus</i> spp., Boraginaceae, Campanulaceae, <i>Centaurea</i> spp., <i>Crepis</i> spp., Dipsacaceae, Iridiaceae, Lamiaceae, Malvaceae, Poaceae, <i>Potentilla</i> spp., Rosaceae, <i>Salvia</i> spp., <i>Silene</i> spp., Unidentified, <i>Xeranthemum</i> spp.	Apiaceae, Asteraceae, Brassicaceae, Caryophyllaceae, Fabaceae, <i>Onobrychis</i> spp.	-	-
Y10	<i>Acanthus</i> spp., <i>Acer</i> spp., <i>Alkanna</i> spp., <i>Anchusa</i> spp., <i>Astragalus</i> spp., Boraginaceae, Campanulaceae, <i>Centaurea</i> spp., Chenopodiaceae, <i>Crepis</i> spp., Dipsacaceae, <i>Eryngium</i> spp., Fabaceae, Geraniaceae, <i>Hypericum</i> spp., Lamiaceae, Malvaceae, <i>Medicago</i> spp., <i>Onobrychis</i> spp., Papaveraceae, <i>Picris</i> spp., Poaceae, <i>Ranunculus</i> spp., Rhamnaceae, Rosaceae, Unidentified, <i>Xeranthemum</i> spp.	Apiaceae, Brassicaceae, Caryophyllaceae, <i>Lotus</i> spp.	Asteraceae	-

**Table 1.** (Continued) Frequency of pollen types in propolis samples (M: Merkez, Y: Yüksekova, S: Şemdinli, C: Çukurca)

Sample Code	Rare Pollen	Minor pollen	Secondary Pollen	Dominant Pollen
Y11	<i>Acanthus</i> spp., Boraginaceae, Brassicaceae, Caryophyllaceae, Dipsacaceae, <i>Gypsophila</i> spp., <i>Isatis</i> spp., <i>Onobrychis</i> spp., <i>Onosma</i> spp., Poaceae, <i>Populus</i> spp., Rosaceae, <i>Salvia</i> spp., Unidentified, <i>Taraxacum</i> spp.	Apiaceae, <i>Cirsium</i> spp. Asteraceae, <i>Astragalus</i> spp., Fabaceae, Lamiaceae, <i>Xeranthemum</i> spp.	-	-
Y12	Boraginaceae, Campanulaceae, <i>Centaurea</i> spp., Chenopodiaceae, Dipsacaceae, Fabaceae, Lamiaceae, Liliaceae, <i>Lotus</i> spp., <i>Onobrychis</i> spp., <i>Quercus</i> spp.	<i>Alkanna</i> spp., Apiaceae, Asteraceae, <i>Astragalus</i> spp., Brassicaceae, Caryophyllaceae, <i>Hypericum</i> spp., Poaceae	-	-
Y13	<i>Asperula</i> spp., <i>Astragalus</i> spp., Boraginaceae, Brassicaceae, Campanulaceae, Caryophyllaceae, <i>Centaurea</i> spp., Dipsacaceae, <i>Echium</i> spp., <i>Hypericum</i> spp., Lamiaceae, <i>Lathyrus</i> spp., <i>Medicago</i> spp., <i>Ornithogalum</i> spp., <i>Plantago</i> spp., Poaceae, <i>Populus</i> spp., Rosaceae, <i>Salix</i> spp., <i>Salvia</i> spp., <i>Symptum</i> spp., Unidentified, <i>Taraxacum</i> spp., <i>Trifolium</i> spp.	Apiaceae, <i>Onobrychis</i> spp., Fabaceae	Asteraceae	-
Y14	<i>Achillea</i> spp., <i>Astragalus</i> spp., Boraginaceae, Campanulaceae, <i>Cerinth</i> spp., <i>Chaerophyllum</i> spp., Dipsacaceae, Lamiaceae, <i>Lotus</i> spp., <i>Lythrum</i> spp., Malvaceae, <i>Onobrychis</i> spp., <i>Papaver</i> spp., <i>Plantago</i> spp., Poaceae, <i>Ranunculus</i> spp., <i>Salvia</i> spp., Unidentified, <i>Taraxacum</i> spp., <i>Teucrium</i> spp., <i>Trifolium</i> spp., <i>Xeranthemum</i> spp.	Apiaceae, Asteraceae	Fabaceae	-
Y15	<i>Astragalus</i> spp., Boraginaceae, Campanulaceae, Caryophyllaceae, <i>Chaerophyllum</i> spp., Dipsacaceae, <i>Echinops</i> spp., <i>Eryngium</i> spp., <i>Glycyrrhiza</i> spp., <i>Hypericum</i> spp., Lamiaceae, <i>Lotus</i> spp., Malvaceae, <i>Onobrychis</i> spp., <i>Plantago</i> spp., Poaceae, <i>Ranunculus</i> spp., Rosaceae, <i>Salix</i> spp., <i>Salvia</i> spp., <i>Taraxacum</i> spp.	Asteraceae, Brassicaceae, <i>Centaurea</i> spp., Fabaceae, <i>Trifolium</i> spp.	Apiaceae	-
Y16	Boraginaceae, Brassicaceae, Campanulaceae, Caryophyllaceae, <i>Centaurea</i> spp., <i>Chaerophyllum</i> spp., <i>Echium</i> spp., <i>Eryngium</i> spp., Lamiaceae, <i>Lotus</i> spp., <i>Medicago</i> spp., <i>Onobrychis</i> spp., <i>Plantago</i> spp., Poaceae, Rosaceae, <i>Salix</i> spp., <i>Taraxacum</i> spp., <i>Trifolium</i> spp.	Apiaceae, Asteraceae, <i>Astragalus</i> spp., Fabaceae	-	-
Y17	<i>Asperula</i> spp., <i>Astragalus</i> spp., <i>Brassica</i> spp., Campanulaceae, Caryophyllaceae, <i>Centaurea</i> spp., <i>Crepis</i> spp., <i>Glycyrrhiza</i> spp., Lamiaceae, <i>Lotus</i> spp., <i>Melilotus</i> spp., <i>Onobrychis</i> spp., <i>Plantago</i> spp., <i>Potentilla</i> spp., <i>Ranunculus</i> spp., Rosaceae, <i>Rubus</i> spp., <i>Salix</i> spp., <i>Scabiosa</i> spp., <i>Tanacetum</i> spp., <i>Taraxacum</i> spp.	Apiaceae, Brassicaceae, Fabaceae, <i>Trifolium</i> spp.	Asteraceae	-

**Table 1.** (Continued) Frequency of pollen types in propolis samples (M: Merkez, Y: Yüksekova, S: Şemdinli, C: Çukurca)

Sample Code	Rare Pollen	Minor pollen	Secondary Pollen	Dominant Pollen
Y18	<i>Asperula</i> spp., <i>Astragalus</i> spp., Boraginaceae, <i>Campanula</i> spp., Campanulaceae, Caryophyllaceae, <i>Centaurea</i> spp., <i>Chaerophyllum</i> spp., Dipsacaceae, <i>Echinops</i> spp., <i>Eryngium</i> spp., Geraniaceae, <i>Glycyrrhiza</i> spp., <i>Gypsophila</i> spp., <i>Lotus</i> spp., Malvaceae, <i>Onobrychis</i> spp., <i>Plantago</i> spp., Poaceae, <i>Potentilla</i> spp., <i>Quercus</i> spp., Ranunculaceae, <i>Rosa</i> spp., Rosaceae, <i>Rubus</i> spp., <i>Salix</i> spp., <i>Salvia</i> spp., <i>Scabiosa</i> spp., Unidentified	Apiaceae, Asteraceae, Brassicaceae, Fabaceae, Lamiaceae, <i>Taraxacum</i> spp.	-	-
Y19	<i>Astragalus</i> spp., Boraginaceae, Campanulaceae, Caryophyllaceae, <i>Centaurea</i> spp., <i>Echium</i> spp., <i>Glycyrrhiza</i> spp., Malvaceae, <i>Ornithogalum</i> spp., <i>Plantago</i> spp., Poaceae, <i>Populus</i> spp., <i>Quercus</i> spp., <i>Rosa</i> spp., Rosaceae, <i>Salvia</i> spp., Unidentified, <i>Taraxacum</i> spp.	Apiaceae, Asteraceae, Brassicaceae, Fabaceae, Lamiaceae, <i>Onobrychis</i> spp., <i>Salix</i> spp., <i>Trifolium</i> spp.	-	-
S1	<i>Astragalus</i> spp., Boraginaceae, Brassicaceae, Caryophyllaceae, Dipsacaceae, <i>Hypericum</i> spp., <i>Onobrychis</i> spp., <i>Taraxacum</i> spp.	Apiaceae, Asteraceae, Fabaceae, <i>Gypsophila</i> spp., Lamiaceae, <i>Lotus</i> spp., <i>Xeranthemum</i> spp.	-	-
S2	Brassicaceae, Campanulaceae, Caryophyllaceae, Dipsacaceae, <i>Gypsophila</i> spp., Liliaceae, <i>Lotus</i> spp., <i>Pimpinella</i> spp., Rosaceae, <i>Silene</i> spp.	Apiaceae, Asteraceae, <i>Astragalus</i> spp., Fabaceae, Lamiaceae, Poaceae	-	-
S3	<i>Anthemis</i> spp., Asteraceae, Boraginaceae, Campanulaceae, Caryophyllaceae, <i>Chaerophyllum</i> spp., <i>Hypericum</i> spp., <i>Isatis</i> spp., <i>Plantago</i> spp., Rosaceae, Scrophulariaceae, <i>Silene</i> spp., <i>Teucrium</i> spp.	Apiaceae, <i>Astragalus</i> spp., Brassicaceae, Fabaceae, Lamiaceae, <i>Lotus</i> spp., Poaceae	-	-
S4	<i>Astragalus</i> spp., Boraginaceae, Brassicaceae, Campanulaceae, Caryophyllaceae, <i>Centaurea</i> spp., Dipsacaceae, <i>Echinops</i> spp., <i>Echium</i> spp., <i>Galium</i> spp., <i>Gypsophila</i> spp., <i>Helichrysum</i> spp., Lamiaceae, <i>Lotus</i> spp., <i>Medicago</i> spp., <i>Onobrychis</i> spp., Poaceae, Ranunculaceae, Rosaceae, <i>Salix</i> spp., <i>Symptum</i> spp., Unidentified, <i>Trifolium</i> spp.	Apiaceae, Asteraceae	Fabaceae	-
S5	Boraginaceae, Brassicaceae, <i>Campanula</i> spp., Campanulaceae, Caryophyllaceae, <i>Gypsophila</i> spp., Lamiaceae, <i>Lotus</i> spp., Poaceae, Ranunculaceae, Rosaceae, <i>Salix</i> spp., <i>Tanacetum</i> spp., <i>Trifolium</i> spp.	Apiaceae, Asteraceae, <i>Astragalus</i> spp., Unidentified	Fabaceae	-
S6	Boraginaceae, Brassicaceae, Dipsacaceae, Geraniaceae, <i>Hypericum</i> spp., <i>Lallemantia</i> spp., Lamiaceae, Poaceae, Rosaceae, <i>Veronica</i> spp.	Apiaceae, Asteraceae, <i>Astragalus</i> spp., <i>Trifolium</i> spp.	Fabaceae	-
S7	Brassicaceae, <i>Campanula</i> spp., Dipsacaceae, <i>Hypericum</i> spp., Poaceae	Asteraceae, Boraginaceae, Lamiaceae, Rosaceae	Apiaceae, Fabaceae	-



**Table 1.** (Continued) Frequency of pollen types in propolis samples (M: Merkez, Y: Yüksekova, S: Şemdinli, C: Çukurca)

Sample Code	Rare Pollen	Minor pollen	Secondary Pollen	Dominant Pollen
S8	<i>Astragalus</i> spp., Boraginaceae, Brassicaceae, Campanulaceae, Caryophyllaceae, Dipsacaceae, <i>Gypsophila</i> spp., Liliaceae, <i>Lotus</i> spp., <i>Medicago</i> spp., <i>Onobrychis</i> spp., Poaceae, <i>Quercus</i> spp., Rosaceae	Apiaceae, Asteraceae, Lamiaceae, <i>Salix</i> spp., <i>Silene</i> spp.	Fabaceae	-
S9	Boraginaceae, Brassica spp., <i>Campanula</i> spp., Campanulaceae, Caryophyllaceae, <i>Centaurea</i> spp., Dipsacaceae, <i>Echinops</i> spp., <i>Glycyrrhiza</i> spp., <i>Gypsophila</i> spp., <i>Hypericum</i> spp., Lamiaceae, Liliaceae, <i>Lotus</i> spp., Malvaceae, <i>Medicago</i> spp., <i>Onobrychis</i> spp., Poaceae, <i>Prunella</i> spp., Ranunculaceae, Rosaceae, <i>Salix</i> spp., <i>Stachys</i> spp., <i>Symptum</i> spp., Unidentified, <i>Trifolium</i> spp.	Apiaceae, Asteraceae, <i>Astragalus</i> spp., Brassicaceae, Fabaceae	-	-
S10	<i>Astragalus</i> spp., Boraginaceae, <i>Bupleurum</i> spp., <i>Campanula</i> spp., Campanulaceae, Caryophyllaceae, <i>Centaurea</i> spp., Dipsacaceae, Geraniaceae, <i>Hypericum</i> spp., Lamiaceae, <i>Lotus</i> spp., <i>Medicago</i> spp., <i>Onobrychis</i> spp., <i>Ornithogalum</i> spp., Poaceae, Rosaceae, <i>Salvia</i> spp., <i>Silene</i> spp., <i>Symptum</i> spp., Unidentified, <i>Trifolium</i> spp., <i>Xeranthemum</i> spp.	Apiaceae, Asteraceae, Brassicaceae	Fabaceae	-
S11	<i>Acanthus</i> spp., Boraginaceae, Brassicaceae, Campanulaceae, <i>Silene</i> spp., <i>Astragalus</i> spp., Geraniaceae, <i>Hypericum</i> spp., Lamiaceae, Poaceae, Rosaceae	Asteraceae, Unidentified	Apiaceae, Fabaceae	-
S12	<i>Acanthus</i> spp., Brassicaceae, <i>Campanula</i> spp., Campanulaceae, Dipsacaceae, Geraniaceae, <i>Hypericum</i> spp., <i>Onobrychis</i> spp., <i>Plantago</i> spp., Poaceae, Ranunculaceae, Rosaceae, <i>Salvia</i> spp., <i>Silene</i> spp., Unidentified, <i>Teucrium</i> spp., <i>Veronica</i> spp.	Apiaceae, Asteraceae, <i>Astragalus</i> spp., Fabaceae, Lamiaceae, <i>Salix</i> spp.		-
S13	Boraginaceae, Brassicaceae, <i>Campanula</i> spp., Campanulaceae, Caryophyllaceae, <i>Centaurea</i> spp., Dipsacaceae, <i>Echinops</i> spp., <i>Juglans</i> spp, Liliaceae, <i>Onobrychis</i> spp., <i>Plantago</i> spp., Rosaceae, <i>Salix</i> spp., Unidentified, <i>Trifolium</i> spp., <i>Veronica</i> spp.	Asteraceae, <i>Astragalus</i> spp., Lamiaceae	Apiaceae, Fabaceae	-
S14	<i>Astragalus</i> spp., Boraginaceae, Brassicaceae, <i>Campanula</i> spp., Campanulaceae, Caryophyllaceae, <i>Centaurea</i> spp., Dipsacaceae, <i>Echinops</i> spp., <i>Eryngium</i> spp., <i>Onobrychis</i> spp., Poaceae, Ranunculaceae, Rhamnaceae, Rosaceae, <i>Salix</i> spp., <i>Silene</i> spp., <i>Symptum</i> spp., Unidentified, <i>Teucrium</i> spp.	Apiaceae, Asteraceae, Fabaceae, Lamiaceae	-	-
S15	<i>Achillea</i> spp., Boraginaceae, Campanulaceae, Caryophyllaceae, Dipsacaceae, <i>Echinops</i> spp., <i>Echium</i> spp., Malvaceae, <i>Melilotus</i> spp., <i>Onobrychis</i> spp., Poaceae, <i>Ranunculus</i> spp., Rosaceae, <i>Salix</i> spp., Unidentified	Apiaceae, Asteraceae, <i>Astragalus</i> spp., Fabaceae, Lamiaceae, <i>Trifolium</i> spp.	-	-
S16	<i>Acanthus</i> spp., <i>Aethionema</i> spp., Asteraceae, Brassicaceae, <i>Campanula</i> spp., Campanulaceae, Caryophyllaceae, Dipsacaceae, <i>Echinops</i> spp., <i>Eryngium</i> spp., Lamiaceae, <i>Medicago</i> spp., <i>Onobrychis</i> spp., <i>Ornithogalum</i> spp., <i>Plantago</i> spp., Poaceae, <i>Ranunculus</i> spp., Rosaceae, <i>Rumex</i> spp., <i>Salix</i> spp., Unidentified, <i>Taraxacum</i> spp., <i>Teucrium</i> spp.	Apiaceae, <i>Astragalus</i> spp., Boraginaceae, Fabaceae, Geraniaceae, <i>Juglans</i> spp., <i>Lotus</i> spp., <i>Trifolium</i> spp.	-	-

**Table 1.** (Continued) Frequency of pollen types in propolis samples (M: Merkez, Y: Yüksekova, S: Şemdinli, C: Çukurca)

Sample Code	Rare Pollen	Minor pollen	Secondary Pollen	Dominant Pollen
S17	<i>Acanthus</i> spp., <i>Anchusa</i> spp., <i>Astragalus</i> spp., Boraginaceae, Brassicaceae, <i>Campanula</i> spp., Caryophyllaceae, Dipsacaceae, <i>Eryngium</i> spp., <i>Gypsophila</i> spp., <i>Isatis</i> spp., <i>Medicago</i> spp., <i>Onobrychis</i> spp., <i>Onosma</i> spp., Poaceae, <i>Potentilla</i> spp., Ranunculaceae, <i>Rosa</i> spp., Rosaceae, <i>Salix</i> spp., <i>Salvia</i> spp., <i>Scabiosa</i> spp., <i>Silene</i> spp., Unidentified, <i>Taraxacum</i> spp., <i>Teucrium</i> spp., <i>Trifolium</i> spp.	Apiaceae, Asteraceae, <i>Hypericum</i> spp., Lamiaceae	Fabaceae	-
S18	<i>Astragalus</i> spp., Brassicaceae, <i>Brassicasp.</i> , Campanulaceae, Caryophyllaceae, <i>Centaurea</i> spp., Dipsacaceae, <i>Echinops</i> spp., <i>Isatis</i> spp., Liliaceae, <i>Lotus</i> spp., <i>Onobrychis</i> spp., Poaceae, Ranunculaceae, Rosaceae, <i>Silene</i> spp., <i>Stachys</i> spp., Unidentified, <i>Taraxacum</i> spp., <i>Trifolium</i> spp.	Apiaceae, Asteraceae, Geraniaceae, Lamiaceae	Fabaceae	-
S19	Boraginaceae, Brassica spp., Campanulaceae, Caryophyllaceae, Dipsacaceae, <i>Echinops</i> spp., <i>Eryngium</i> spp., <i>Onobrychis</i> spp., Poaceae, <i>Potentilla</i> spp., <i>Pyrus</i> spp., Ranunculaceae, Rosaceae, <i>Rubus</i> spp., <i>Scabiosa</i> spp., <i>Silene</i> spp., <i>Taraxacum</i> spp.	Apiaceae, Asteraceae, <i>Astragalus</i> spp., Fabaceae, Lamiaceae, Unidentified		-
S20	<i>Anthemis</i> spp., Boraginaceae, <i>Brassica</i> spp., Brassicaceae, <i>Campanula</i> spp., Caryophyllaceae, <i>Centaurea</i> spp., <i>Crepis</i> spp., <i>Echinops</i> spp., <i>Eryngium</i> spp., <i>Gypsophila</i> spp., <i>Isatis</i> spp., Lamiaceae, <i>Lathyrus</i> spp., <i>Medicago</i> spp., <i>Onobrychis</i> spp., Poaceae, <i>Potentilla</i> spp., Rosaceae, Rubiaceae, <i>Scabiosa</i> spp., <i>Silene</i> spp., Unidentified, <i>Trifolium</i> spp., <i>Xeranthemum</i> spp.	Asteraceae, <i>Astragalus</i> spp.	Apiaceae, Fabaceae	-
S21	<i>Achillea</i> spp., <i>Anthemis</i> spp., Asteraceae, Boraginaceae, <i>Brassica</i> spp., Brassicaceae, <i>Bupleurum</i> spp., <i>Campanula</i> spp., <i>Centaurea</i> spp., <i>Chaerophyllum</i> spp., <i>Crepis</i> spp., Dipsacaceae, <i>Echinops</i> spp., <i>Eryngium</i> spp., <i>Gypsophila</i> spp., <i>Isatis</i> spp., Lamiaceae, <i>Medicago</i> spp., <i>Onobrychis</i> spp., <i>Pimpinella</i> spp., Poaceae, Ranunculaceae, Rosaceae, Rubiaceae, <i>Salix</i> spp., <i>Silene</i> spp., <i>Symptum</i> spp., Unidentified, <i>Trifolium</i> spp.	<i>Astragalus</i> spp., Fabaceae	Apiaceae	-
S22	<i>Achillea</i> spp., Asteraceae, <i>Astragalus</i> spp., Boraginaceae, Brassicaceae, <i>Campanula</i> spp., Campanulaceae, <i>Centaurea</i> spp., <i>Chaerophyllum</i> spp., <i>Crepis</i> spp., Dipsacaceae, <i>Echinops</i> spp., Lamiaceae, <i>Nepeta</i> spp., <i>Onobrychis</i> spp., Poaceae, <i>Potentilla</i> spp., Rosaceae, <i>Scabiosa</i> spp., Unidentified, <i>Trifolium</i> spp.	Fabaceae	Apiaceae	-
S23	<i>Anthemis</i> spp., <i>Campanula</i> spp., Campanulaceae, <i>Chaerophyllum</i> spp., <i>Cirsium</i> spp., <i>Crepis</i> spp., <i>Echinops</i> spp., <i>Eryngium</i> spp., <i>Gypsophila</i> spp., Lamiaceae, <i>Onobrychis</i> spp., Poaceae, <i>Rosa</i> spp., Rosaceae, <i>Scabiosa</i> spp., <i>Silene</i> spp., <i>Tanacetum</i> spp., Unidentified, <i>Taraxacum</i> spp.	Asteraceae, <i>Astragalus</i> spp., Brassicaceae, <i>Centaurea</i> spp., Fabaceae	Apiaceae	-

**Table 1.** (Continued) Frequency of pollen types in propolis samples (M: Merkez, Y: Yüksekova, S: Şemdinli, C: Çukurca)

Sample Code	Rare Pollen	Minor pollen	Secondary Pollen	Dominant Pollen
S24	<i>Astragalus</i> spp., Boraginaceae, Brassicaceae, Campanulaceae, <i>Centaurea</i> spp., <i>Echinops</i> spp., <i>Gypsophila</i> spp., <i>Helichrysum</i> spp., Lamiaceae, Malvaceae, <i>Medicago</i> spp., <i>Minuartia</i> spp., <i>Onobrychis</i> spp., <i>Plantago</i> spp., Poaceae, Rosaceae, <i>Salvia</i> spp., <i>Senecio</i> spp., <i>Tanacetum</i> spp., Unidentified, <i>Taraxacum</i> spp., <i>Teucrium</i> spp.	Apiaceae, Asteraceae, Fabaceae, Geraniaceae	-	-
S25	<i>Acanthus</i> spp., <i>Achillea</i> spp., Boraginaceae, Campanulaceae, Caryophyllaceae, <i>Centaurea</i> spp., <i>Chaerophyllum</i> spp., Dipsacaceae, <i>Echinops</i> spp., <i>Galium</i> spp., <i>Isatis</i> spp., <i>Lotus</i> spp., <i>Medicago</i> spp., <i>Minuartia</i> spp., <i>Nepeta</i> spp., <i>Onobrychis</i> spp., <i>Ornithogalum</i> spp., <i>Papaver</i> spp., Poaceae, Ranunculaceae, Rosaceae, <i>Salvia</i> spp., <i>Seseli</i> spp., <i>Silene</i> spp., Unidentified, <i>Taraxacum</i> spp., <i>Trifolium</i> spp., <i>Xeranthemum</i> spp.	Apiaceae, Asteraceae, <i>Astragalus</i> spp., Brassicaceae, Fabaceae, Lamiaceae	-	-
S26	<i>Acanthus</i> spp., <i>Asperula</i> spp., Boraginaceae, Brassicaceae, <i>Brassica</i> spp., Campanulaceae, Caryophyllaceae, <i>Centaurea</i> spp., <i>Chaerophyllum</i> spp., <i>Gypsophila</i> spp., Lamiaceae, <i>Onobrychis</i> spp., <i>Plantago</i> spp., Poaceae, Ranunculaceae, Rosaceae, Rubiaceae, Unidentified, <i>Taraxacum</i> spp., <i>Trifolium</i> spp.	Apiaceae, Asteraceae, <i>Astragalus</i> spp., Fabaceae, <i>Salix</i> spp.	-	-
S27	<i>Achillea</i> spp., <i>Anthemis</i> spp., <i>Astragalus</i> spp., Boraginaceae, Brassicaceae, <i>Bupleurum</i> spp., Campanulaceae, Caryophyllaceae, <i>Centaurea</i> spp., <i>Chaerophyllum</i> spp., <i>Cirsium</i> spp., <i>Echinops</i> spp., <i>Eryngium</i> spp., <i>Geranium</i> spp., <i>Gypsophila</i> spp., Lamiaceae, <i>Lathyrus</i> spp., <i>Lotus</i> spp., <i>Medicago</i> spp., <i>Minuartia</i> spp., <i>Onobrychis</i> spp., <i>Pimpinella</i> spp., <i>Plantago</i> spp., Poaceae, Ranunculaceae, <i>Rosa</i> spp., Rosaceae, <i>Salix</i> spp., <i>Salvia</i> spp., <i>Scabiosa</i> spp., <i>Stachys</i> spp., Unidentified, <i>Taraxacum</i> spp., <i>Teucrium</i> spp., <i>Trifolium</i> spp., <i>Xeranthemum</i> spp.	Apiaceae, Asteraceae, Fabaceae	-	-
S28	<i>Anthemis</i> spp., Apiaceae, Brassicaceae, Campanulaceae, Caryophyllaceae, <i>Centaurea</i> spp., <i>Echinops</i> spp., <i>Eryngium</i> spp., <i>Galium</i> spp., Lamiaceae, <i>Lotus</i> spp., <i>Medicago</i> spp., <i>Pimpinella</i> spp., Poaceae, Rosaceae, <i>Salix</i> spp., <i>Tanacetum</i> spp., Unidentified, <i>Taraxacum</i> spp.	Asteraceae, <i>Astragalus</i> spp., Fabaceae, <i>Onobrychis</i> spp., <i>Trifolium</i> spp.	-	-
S29	Boraginaceae, Campanulaceae, <i>Centaurea</i> spp., <i>Dianthus</i> spp., <i>Gypsophila</i> spp., Lamiaceae, <i>Onobrychis</i> spp., Poaceae, <i>Ranunculus</i> spp., <i>Rosa</i> spp., <i>Salix</i> spp., <i>Silene</i> spp.	Apiaceae, Asteraceae, <i>Astragalus</i> spp., Brassicaceae, Fabaceae, Rosaceae, <i>Trifolium</i> spp.	-	-
S30	Boraginaceae, Campanulaceae, Caryophyllaceae, <i>Centaurea</i> spp., <i>Chaerophyllum</i> spp., <i>Eryngium</i> spp., Lamiaceae, <i>Medicago</i> spp., <i>Onobrychis</i> spp., Poaceae, Rosaceae, Rubiaceae, <i>Salix</i> spp., <i>Salvia</i> spp., <i>Silene</i> spp., Unidentified, <i>Trifolium</i> spp.	Asteraceae, Brassicaceae, Fabaceae, <i>Hypericum</i> spp.	Apiaceae	-

**Table 1.** (Continued): Frequency of pollen types in propolis samples (M: Merkez, Y: Yüksekova, S: Şemdinli, C: Çukurca)

Sample Code	Rare Pollen	Minor pollen	Secondary Pollen	Dominant Pollen
C1	Boraginaceae, Brassicaceae, Campanulaceae, Dipsacaceae, Plantaginaceae, Ranunculaceae, Rosaceae, Salicaceae	Apiaceae, Asteraceae, Lamiaceae, Poaceae	Fabaceae	-
C2	Boraginaceae, Brassicaceae, Campanulaceae, Caryophyllaceae, Guttiferae, Poaceae, Rosaceae, Salicaceae	Apiaceae, Lamiaceae	Asteraceae, Fabaceae	-

The first detailed study on the microscopic analysis of propolis in Turkey was carried out by Gencay and Sorkun (2006) [23]. In this study, it was determined that pollens found in 30 propolis samples collected from Kemaliye-Erzincan region belong to 32 families. Researchers have reported that some species belonging to family Apiaceae, Asteraceae, Campanulaceae, Fabaceae, Fagaceae, Lamiaceae, Liliaceae, Pinaceae, Rosaceae, Salicaceae, Rhamnaceae and Scrophulariaceae are found as the herbal source of propolis samples. Gencay and Sorkun (2012) [24] identified 51 taxa belonging to 38 different families, as a result of microscopic analysis of 92 propolis samples collected from eight districts of Tekirdag province.

Matos et al. (2014) [25] identified 56 pollen types belonging to 19 families and 36 types, as the result of the palynological analysis of 22 propolis samples collected from Brazil. They observed that the densest family were Fabaceae with 9 pollen types, followed by the Asteraceae family with 7 pollen types.

The differences in the results of the studies on the microscopic analysis of propolis may be due to the geographical location of the sample sources, the climate characteristics, and according to these, the variation in plant diversity and density. Such situations may cause to change of pollen content of propolis, which is a plant-derived bee product to be different. In addition, the way of collecting propolis from the hives and the difference in bee races that collect propolis may also affect the pollen content.

#### **ACKNOWLEDGEMENTS**

This study was supported by Scientific Research Projects Unit (Project code: 40525) from Istanbul University.

#### **CONFLICT OF INTEREST**

No conflict of interest was declared by the authors.

#### **REFERENCES**

- [1] Mărghitaş, L.A., Dezmirean, D.S., Bobiş, O., “Important developments in Romanian propolis research”, *Evidence-Based Complementary and Alternative Medicine*, 1(1):1-9, (2013).
- [2] Gençay, Ö., Sorkun, K., “What do know about propolis?”, *Technical apiculture*,1(1): 17-21, (2002).
- [3] Hepşen, İ.F., Tilgen, F., Er, H., “Propolis: medical properties and ophthalmologic use”, *Journal of Turgut Özal Medical Center*, 3(4): 386-91, (1996).
- [4] Parolia, A., Kundabala, M., Rao, N. N., Acharya, S. R., Agrawal, P., Mohan, M., Thomas, M, “A comparative histological analysis of human pulp following direct pulp capping with propolis, mineral trioxide aggregate and dycal”, *Australian Dental Journal*, 55(1): 59-64, (2010).
- [5] Ecem Bayram, N., Karadayı, M., Güllüce, M., Bayram, S., Sorkun, K., Cevahir, Ö., Aydoğan, M., Koç, T. Y., Alaylar, B., Salih, B., “Genotoxic and antigenotoxic evaluation of propolis by using in vitro bacterial assay systems”, *Mellifera*, 15(1): 29-36, (2015).
- [6] D’albore, G.R., “L’ origine géographique de la propolis”, *Apidologie*, 10 (3): 241-267, (1979).
- [7] Silici, S., “Investigation of biologically active components in propolis samples from different botanical origin, Erciyes University Journal of Institute of Science and Technology”, 24 (1-2):120-128, (2008).
- [8] Kumova, U., Korkmaz, A., Avcı, B.C., Ceyran, G., “An important bee product: propolis”, *Uludağ Bee Journal.*, 2: 10-24, (2002).

- [9] Silici, S., "Turkish propolis: chemical constituents", *Mellifera*, 10(19): 24-33, (2010).
- [10] Silva, C.R.B., Putarov, T., Orsi, R.O., "Pollen spectrum of propolis samples from São Paulo State, Brazil", *Acta Scientiarum*, 35 (3): 297-300, (2013).
- [11] Wodehouse, R. P., "Pollen Grains: Their Structure", McGraw-Hill, New York, (1935).
- [12] Warakomska, Z., Maciejewicz, W., "Microscopic analysis of propolis from Polish regions", *Apidologie*, 23 (4): 277-289, (1992).
- [13] Kapp, R.O. "Pollen and spores", W. M. C. Brown, Dubuque, Iowa, 249 pp., (1969).
- [14] Sawyer, R., "Pollen Identification for Beekeepers", Uni. Coll. Cardiff Press, 11-13, (1981).
- [15] Faegri, K., Iversen, J., "Textbook of pollen analysis. Textbook of pollen analysis (No. Ed. 4)". John Wiley & Sons Ltd., 328 pp., (1989).
- [16] Moore, P.D., Webb J.A., Collinson, M.E. "Pollen Analysis", Blackwell Scientific Publications, London, U.K, (1991).
- [17] Pehlivan, S., "Türkiye'nin Alerjen Polenleri Atlası", 187 pp., (1995).
- [18] Sorkun, K., "Türkiye'nin Nektarlı Bitkileri, Polenleri ve Balları", Palme Yayıncılık, Ankara, 341 pp., (2008).
- [19] Doğan, C., Sorkun K., "Pollen analyses of honeys from Aegean, Marmara, Mediterranean and Black Sea Regions in Turkey", *Mellifera*, 1(1): 2-12, (2001).
- [20] Sorkun, K., İnceoğlu, Ö., "İç Anadolu Bölgesi ballarında polen analizi", *Doğa bilim dergisi*", 8 (1): 222-228, (1984).
- [21] Santos, F.A., Bastos, E.M.A.F., Maia, A.B.R.A., Uzeda, M., Carvalho, M.A.R., Farias, L.M., Moreira, E.S.A., "Brazilian propolis: physicochemical properties, plant origin and antibacterial activity on periodontopathogens", *Phytotherapy Research*, 17(3): 285-289, (2003).
- [22] Barth, O.M., "Pollen analysis of Brazilian propolis", *Grana*, 37(2): 97-101, (1998).
- [23] Gençay, Ö., Sorkun, K., "Microscopic analysis of propolis samples collected from east Anatolia (Kemaliye-Erzincan)", *FABAD Journal of Pharmaceutical Sciences*, 31(1): 192-197, (2006).
- [24] Gençay Çelemlı, Ö., Sorkun, K., "The plant choices of honey bees to collect propolis in Tekirdag Turkey", *Hacettepe Journal of Biology and Chemistry*, 40 (1): 45-51, (2012).
- [25] Matos, V., Alencar, S.M., Santos, F.A.R., "Pollen types and levels of total phenolic compounds in propolis produced by *Apis mellifera* L. (Apidae) in an area of the Semiarid Region of Bahia, Brazil", *Anais da Academia Brasileira de Ciências*, 86(1): 407-418, (2014).