Central European Journal of Botany

Has been issued since 2015.
E-ISSN 2413-757X
2021. 7(1). Issued once a year

Journal is indexed by: OAJI, MIAR

All manuscripts are peer reviewed by experts in the respective field. Authors of the manuscripts bear responsibility for their content, credibility and reliability.

Editorial board doesn't expect the manuscripts' authors to always agree with its opinion.

Postal Address: 1367/4, Stara Vajnorska str., Bratislava – Nove Mesto, Slovak Republic, 831 04

Website: http://ejournal34.com/
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Founder and Editor: Academic Publishing House Researcher s.r.o.

Release date 01.06.21.
Format 21 × 29,7/4.

Headset Georgia.

Order № CEJB-7.

Central European Journal of Botany

2021

Is. 1

C O N T E N T S

Articles

Published in the Slovak Republic
Central European Journal of Botany
Has been issued since 2015.
E-ISSN 2413-757X
2021. 7(1): 3-8

DOI: 10.13187/cejb.2021.1.3
www.ejournal34.com

Articles

Effect of Black Seeds (Nigella Sativa) on Some Parasitic Diseases: A Review

Huda Dhaher Al-Marsomy [a, *], Qudus Wamidh Jamal [a], Zainab Abed Muhsin AL-Haboobi [b]

[a] Al-Nahtrain University, Iraq
[b] AL-Furat AL-Awsat Technical University, Karbala Technical Institute, Iraq

Abstract

Parasitology is a branch of biology that studies the interaction of two microorganisms, one of whom benefits and the other threatens. Previously include Bacteria, Fungi and viruses, now are limited to parasitic protozoa, helminthis, arthropods and species of arthropods serve as a vector for parasite. Six important human tropical illnesses are known and five are parasitic diseases. Parasitic diseases are high prevalence in developing countries where poverty and poor hygiene are predominant. As a result, using chemical drugs is costlier.

For thousands of years humans used herbal plants for treatment as a science named herbal medicine (botanical medicines or phytomedicine). Because of their efficacy, safety, low cost, and lesser side effects, traditional herbal medicine is often used as the first line of protection in disease treatment by 80 percent of the world's population.

Nigella sativa has been used for medicinal purposes and food from ancients , both as a herb and oil. *N. sativa* belong to the genus Nigella.

This review aims to investigate the possibility of using black seeds as a therapeutic agent in protozoal and helminthic disease based on published data.

Keywords: *Nigella sativa*, Protozoa, Helminth.

1. Introduction

Phytomedicine, also known as herbal medicine, refers to the use of plant parts for medical purposes (Bhardwaj et al., 2018). Numerous modern medications are obtained mainly from plants, such as aspirin (willow bark), digitoxin (foxglove), morphine (opium poppy), quinine (cinchona bark), and pilocarpine (jaborandi) (Bulter, 2004).

Nigella sativa is a comments herbal plant that really has stimulated the interest of researchers. It is often known as black seed (capsulated plant seed), black cumins, Love-in-a-mist, Habatut, Barakah, Sonez, Habatut, Sauda, Kalonji, Krishana, Jiraka, and Sidadanah (Ijaz et al., 2017).

Classification of the plant (Ijaz et al., 2017)

Kingdom: Plantae.

Subkingdom: Tracheobionata that is, vascular plant.

Supervision: Spermatophyte.

* Corresponding author
E-mail addresses: Hudaalmarsome@yahoo.com (H. Dhaher Al-Marsomy)

Order: Ranunculales.
Family: Ranunculaceae Butter cup family.
Genera: *Nigella*.
Species: *sativa*.

Plant Morphology

Nigella is a genus of about 14 species of annual plants in the family Ranunculaceae, native to southern Europe, North Africa and Southwest Asia.

Nigella sativa Linn grows to 20-30 cm tall with finely divided, linear leaves. Flow *Nigella sativa ers* are pale blue and white in colour with 5-10 petals with a variable number of sepals and are characterized by the presence of nectaries. The gynoecium is composed of a variable number of multiovule carpels, developing into a follicle after pollination. Terminal fruit is a capsule having many rectories, pocket like epicalyx present. Seeds are small, dicotyledonous, trigonous black, rugulose-tubercular (Jabbar et al., 2006).

Chemical Composition (Ali, Blunden, 2003; Boskabady, Shirmohammadi, 2002):

Seeds of the herbal is the common part used in cooking and for medical purpose. It is contain total ash (4.8 %), carbohydrates (24.9 %), crude fiber (8.4 %) fat (28.5 %), protein (26.7 %). and a good amount of various vitamins and minerals like Cu, P, Zn, and Fe.

Also contain fatty oil rich in unsaturated fatty acids, constituting dihomolinoleic acid (10 %), eicosadienoic acid (3 %), linoleic acid (50-60 %) and oleic acid (20 %), and saturated fatty acids (palmitic and stearic acids) constitute up to 30 %. α-Sitosterol is the major sterol, accounting for 44-54 % of the total sterols in *N. sativa* oils, followed by stigmasterol (6.57-20.9 %).

The most important active compounds of *N. sativa* are thymoquinonem (TQ) (30-48 %), *t*-anethole (1-4 %), carvacrol (6-12 %), *p*-cymene (7-15 %) thymohydroquinone, dithymoquinone (nigellone), 4-terpineol (2-7 %), sesquiterpene longifolene (1-8 %), α-pinene, and thymol.

Nigella sativa also contains other compounds such as carvone, citronellol, limonene, in trace amounts, and two varieties of alkaloids, i.e. isoquinoline alkaloids (e.g. nigellicimine and nigellicimine-*N*-oxide) and pyrazole alkaloids (e.g. nigellidine and nigellicine).

Medical Important of *Nigella stevia*:

Nigella sativa has both historical and religious roots. The healing power of black seed was mentioned by Prophet Mohammad (PBUH). Black cumin is also referred to as "Curative black cumin" in the Holy Bible (Al-Ghamdi, 2001). Black seeds are used to treat a variety of ailments such as airway disorders, chronic headaches, back pain, diabetes, paralysis, infection, inflammation, hypertension, and digestive tract problems. It is also applied topically to blisters, nasal abscesses, orchitis, eczema, and swollen joints (Yimer et al., 2019).

2. Methods

Searching on “PubMed” database for the Keyword *Nigella sativa* gives 1,524 results, and searching with the keyword *Nigella sativa*, Parasitic disease results in 30 results and most of these searches are cited in this review.

3. Discussion and results

Parasitic disease

The cause of the parasitic disease is the infection by parasites (a eukaryotic microorganism) living in or on the host (another organism). Parasites of humans are divided into two groups: Endoparasite (inside the host) and Ectoparasite (on the skin). Endoparasites include protozoa usually single cell and Helminths they are multicellular (Paniker, 2013).

Humans become infected either directly through ingestion of contaminated food or water, or passively through vector bites. Parasitic diseases are ubiquitous throughout the world, especially in developing nations, causing around 3 billion human infections. The infection's major risk factors include parasite pathogenicity, host immunity, the environment, and social settings (Paniker, 2013).

Chemotherapy is necessary for clinical management and disease control; however, drug resistance has emerged in some parasites; in addition, high costs, poor compliance, and side effects encourage researchers to develop drugs that are safer and less toxic; thus, more interest has been placed on herbal remedies such as black seeds.

All information regarding the parasite and sickness is based on this references (Paniker, 2013).

Effect of *N. satvia* on Protozoa parasite

Protozoal parasite divided in Four groups depending on the locomotion organs, this include: amoeba, Flagellates, Sporozoa and Ciliates.

***Acanthamoeba* Species**

This type of *Entamoeba* is Opportunistic free-living, Parasite exists in active trophozoite and resistant cyst, humans get infection by inhalation of cyst or trophozoite, ingestion of cysts, or through traumatized skin or eyes. The parasite can produce granulomatous amoebic encephalitis (GAE) or Acanthamoeba keratitis (AK), an infection of the eye that typically occurs in healthy persons and develops from the entry of the amoebic cyst through abrasions on the cornea. The development of resistance and failure of the currently used drugs represent a therapeutic predicament. Using the aqueous extract of the black seed and chitosan nanoparticles against experimentally induced AK, on the 5th day post infection the medications were applied, on 10th day clinical examination of the cornea and cultivation of the corneal scraps indicate a 100 % cure, followed in the 15th and 20th day the result of these agents (singly or combined) show potential for the development of new, effective, and safe therapeutic alternatives (Elkadery et al., 2019).

Another search, study the *in vitro* effect of Thymoquinone of *Nigella sativa* on two important parasitic diseases that transmitted through the oral-faecal route to humans. The parasites are *Entamoeba histolytica* and *Giardia lamblia*, these diseases causing diarrhoea leading to anaemia and malabsorption. The result indicates that Thymoquinone is more potent *against E. histolytica* than *G. lamblia* (Sheikh et al., 2016).

Flagellates are a group of parasite moving by Flagellate, they includes *Leishmainaspp*., *Trypanosomaspp., Trichomonas spp. and Giardia lamblia.*

All members of the genus *Leishmania* are obligate intracellular parasites that pass their life cycle in 2 hosts – the mammalian host and the insect vector (female sandfly). Parasite inside the macrophage of the human appears as Amastigote and inside the vector as promastigote. The disease common in tropic and subtropic area, and occur in three forms: Cutaneous form (usually self-healing disease), Visceral form and mucocutaneous (usually danger and need treatment). Mahmoudvand et al. (2015), mentioned that the Antileishmanial effects of essential oil and methanolic extract of *Nigella sativa* (0-200 µg/mL) and thymoquinone (0-25 µg/mL) on promastigotes of *Leishmania tropica* and *L. infantum* and their cytotoxicity activities against murine macrophages using the MTT assay at 24, 48, and 72 h. and leishmanicidal effects against amastigotes were investigated in a macrophage model, for 48 and 72 h., the result showed a potent leishmanicidal activity of thymoquinone, against both species with an *in vitro* model (Mahmoudvand et al., 2015). Abamor and Allahverdiyev (2016) investigate the antileishmanial activities of *Nigella sativa* oil (NSO) entrapped poly-ε-caprolactone (PCL) nanoparticles on *Leishmania infantum* promastigotes and amastigotes *in vitro*. This process was characterized by scanning electron microscope, dynamic light scattering, Fourier transform infrared, encapsulation efficiency measurements, and release profile evaluations. The PCL nanoparticles released approximately 85 % of entrapped oil molecules after incubation for 288 h. All investigated formulations demonstrated strong antileishmanial effects on *L. infantum* promastigotes. The tested formulations decreased infection indexes of macrophages in a range between 2.4 – and 4.1-fold, in contrast, to control, thus indicating the strong anti-amastigote activities of NSO encapsulated PCL nanoparticles. immunomodulatory effects of NSO-loaded PCL nanoparticles showed an increase in nitric oxide produced amounts within macrophages by 2-3.5-fold in contrast to use of free oil.

Trichomoniasis is the most common sexually transmitted disease caused by the trophozoite of *Trichomonas vaginalis*. The Metronidazole is the best drug for treatment, recently there are reports about drug – resistant so medicinal plants could be a source of new antiprotozoal drugs such as *Nigella sativa* alcoholic extract and oil, as well as *Phaseolus vulgaris*. Aminou et al. (2016) study the *in vitro* activity on the ultrastructure of the parasite in comparison to metronidazole. Both *Nigella sativa* oil and *P. vulgaris* lectin showed ahigh toxic effect on parasite structure, while the effect of *Nigella sativa* alcoholic extract was moderate. This agreement with another result the inhibitory effect of aqueous extract of *N sativa* is dose depended and had a low effect on the parasite growth (Tonkal, 2009).

The fourth group of protozoa is Sporozoa, this group include Malaria, *Toxoplasma gondii*, *Cryptosporidium spp*. and others. All causes serious diseases in human.

Using albino mice infected with *Plasmodium voelli*, and Chloroquine (CQ) as drug in the control group. The antimalarial and antioxidant activities of methanolic extract of *N. sativa* seeds (MENS) were investigated (Okeola et al., 2011). The extract significantly ($p < 0.05$) suppressed the infection in the mice by 94 %, while CQ, the reference drug, produced 86 % suppression when compared to the untreated group after the fifth day of treatment. These results suggest that *N. sativa* seeds have a strong antioxidant property and, maybe a good Phyto therapeutic agent against malaria infection.

Two different isolates of Blastocystis hominis were treated with the aqueous extract of *Nigella sativa* then evaluated and compared with metronidazole as active standard drug. *Nigella sativa* at 500 µg/ml concentration has a significant inhibitory effect on both isolates. So, it is considered as the most active concentration of Nigella aqueous extract (El Wakil, 2007). The same result of the concentration of 500 mg/of *N. sativa* aqueous extract was improved in another study (Eida et al., 2016).

Toxoplasmosis is an asymptomatic disease in an immunocompetent person, while in immunocompromised causes dangerous complications and in the fetus if it transmitted vertically. The disease is treated by Pyrimethamine which is intolerable by many patients. Mady et al. (2016) assess the therapeutic effects of *Nigella sativa* oil (NSO) alone and combined with pyrimethamine (PYR) compared to a combination of clindamycin (CLN) and (PYR) on one hundred albino mice. Impression smears from the liver and spleen, and histopathological and ultrastructural studies were done. Liver malondialdehyde (MDA) level and total antioxidant capacity (TAC) were determined. Interferon-γ and specific IgM were also measured in sera by ELISA. The result showed the combination of NSO with PYR had a potent effect (Synergistic), whereas NSO alone has no direct anti-Toxoplasma effect.

Effect of *N. sativia* on Helminth parasite.

The helminthic parasites are multicellular organisms. Helminths, which occur as parasites in humans belong to 2 phyla (Paniker, 2013):

- Phylum Platyhelminthes. It includes 2 classes: Cestoda (tapeworms) and Trematoda (Flukes or digeneans);
- Phylum Nemathelminthes (Nematoda). It includes class Nematoda and 2 subclasses: Adenophoraea (Aphasmidia) and Secernentea (Phasmidia).

Helminth parasites causing important and serious diseases like Schistosomiasis, Hydatid diseas, Filariasis and so on.

Dog tapeworm or hydatid cysts caused by a cestode worm *Echinococcus granulosis* and *E. multigularus*, The disease is prevalent in most parts of the world, though it is most extensive in the sheep and cattle raising areas of Australia, Africa, and South America. It is also common in Europe, China, and the Middle. The adult worm lives in the digestive system of dogs and other canine carnivora (wolf and fox).While the larval stage (hydatid cyst) is found in humans and herbivores animals (sheep, goat, cattle and horse). Traditionally surgical removal was considered as the best mode of treatment of cysts or giving drugs in conjunction before surgery to kill protoscolices, to avoid anaphylactic shock from leakage of hydatid fluid into the peritoneum and to decrease opportunities for recurrences.

El-Baby et al. (2019) studied the scolicidal efficacy of hydroalcoholic extract of *Punica granatum* peel and *Nigella sativa* on the protoscolices of CE that collected from infected camels. *N. sativa* showed the highest scolicidal efficacy at 100 mg/mL and 10 mg/mL concentrations after 30 and 60 min, they concluded that *N. sativa* extract is more potent than *P. granatum* peel extract regarding scolicidal effect.

Another study, evaluate the in vitro scolicidal effect of *Ni. sativa* essential oil and also its active principle, thymoquinone, against protoscolices of hydatid cysts (aseptically) aspirated from livers of infected sheep . The results also indicated the potential of *N. sativa* as a natural source for production of a new scolicidal agent for use in hydatid cyst surgery (Mahmoudvand et al., 2014).

Schistosomiasis is a water-borne disease constituting an important public health problem. It is estimated that over 100 million people are infected with *Schistosoma. haematobium, S. mansoni*, and *S. japonicum*. Praziquantel is the drug of choice but the evolving of drug-resistant

by the parasite reduces the effectiveness of this traditional drug. Medhat et al. (2016) studied the effect of two natural products, *Nigella sativa* oil and *Chroococcus turgidus* (separately or in a combination) to explore their effect on *S. mansoni* in infected mice. They concluded that both extract are promising natural compounds that can be used in fighting schistosomiasis. Similar resuts obtained by Ali et al. (2016).

The antiparasitic effect of *Nigella sativa* on different Helminth infections (Alone or with another plant extract) was studied like *Hymenolepis nana* in mice (Ayaz et al., 2007). *Fasciola giganticaan* is economically important global disease of ruminants in the temperate and tropical (Uiiah et al., 2017), *Trichinella spiralis* in the experimentally infected rat (EL Ezz, 2005), *Toxocara canis* (Mussa et al., 2011). All results confirmed the powerful of *N. sativa* on both protozoa and helminths, and that the effect is dose and time dependent. Other possible explanations are that plant extracts have an effect on Bactria or fungi, which have a symbiotic relationship with the parasite, and that several studies have also shown that *N. sativa* has an anti-bacterial and anti-fungal effect (Salem et al., 2010; Azeiz et al., 2013).

3. Conclusion

Finally, we can conclude that the black seed is achieving positive results in the treatment and control of parasitic diseases, but still more research is required at the cellular and molecular level to assess the specific mechanisms or effects of the plant. There is indeed a need for further research with large samples, across a longer period of time, and to study the potential side effects for a long time. Investigate several factors that may affect plant quality, such as soil, environmental conditions (temperature, humidity), and extraction technique.

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Published in the Slovak Republic
Central European Journal of Botany
Has been issued since 2015.
E-ISSN 2413-757X
2021. 7(1): 9-12

DOI: 10.13187/cejb.2021.1.9
www.ejournal34.com

Study of Tomato Leaf Miner (*Tuta absoluta M.)* in Georgia at Different Temperatures

Tatia Khositashvili [a, *], Tea Khositashvili [b]

[a] LEPL Technical University of Georgia, Tbilisi, Georgia
[b] Iakob Gogebashvili Telavi State University, Telavi, Georgia

Abstract

South American tomato leaf miner Tuta absoluta is a micro lepidoptera insect, which mainly damages tomatoes. Nowadays, it is spread almost worldwide.In Georgia it was discovered in March 2011 and now it is met in all greenhouse farms. In the article are considered the previously unknown details about the South American tomato leaf miner in the conditions of Georgia, as this pest has not been studied for years. The level of pest spread was determined – intense, medium and weak location. In Georgia, for the first time, was studied the duration of phases of the development of the South American tomato leaf miner (Tuta absoluta) under different temperature conditions and the number of females and males at different temperatures was established. In the conditions of Georgia, for the first time, studies were carried out on the peculiarities of ontogenesis, the spread of female pests on plant organs in percent. The experiments were carried out at constant temperatures of 10°C, 15°C, 20°C, 25°C and 300C Tutaabsoluta completed its development at all these temperatures, humidity 70 ± 10%. Tuta absoluta completed its development at all these temperatures. According to the European and Mediterranean Plant Protection Organization (EPPO) and the North American Plant Protection Organization (NAPPO), Tuta absoluta is spread with the seeds, tomato fruits and plastic containers used during harvesting. In the imago and worm phase, it is characterized by the very fast migration ability.

Keywords: biological control, life cycle, lepidoptera, tomato leaf miner.

1. Introduction

Throughout the world, the provision of vegetables to the population is of utmost importance, and a large part of it are the products, which are produced in closed ground. Considerable experience acquired by farmers engaged in agriculture confirms, that growing vegetables in closed ground provides protection of plants from severe climatic conditions, greenhouse farming makes it possible to produce vegetables in the zone where farming is rather hazardous throughout the year, at different temperature conditions. Over the past years, the importance of vegetable crops has increased, as a large part of the population in our country is often fasting and also some are willing simply to eat dietary products. Given all this, it is important to provide the population with vegetable crops not only in summer, but also in winter, when vegetables are in short supply and they are mainly grown in closed ground.

The purpose of our research was in the newly emerged populations was studied the number of males and females and the fertility of females. The development of the larvae pest was studied in

* Corresponding author
E-mail addresses: teee87@gail.com (T. Khositashvili)

all four larvae ages (the first, second, third and fourth) as well as the period of pupating. The studies were conducted at five levels of temperature 10°C, 15°C, 20°C, 25°C and 30°C. The Effective of temperature was determined by the Warner formula: $1 / D = a + bT$, where $1/D$ is the development rate (1/development time). T is the temperature (°C) and a and b are the angular and linear coefficients of the line (Krechemer, Foerster, 2015).

2. Materials and methods

The research objects. Areas of intense, medium, and weak distribution of pest were identified. Intensive distribution zone – Kvemo Kartli, Shida Kartli, Kakheti, Imereti. Medium distribution zone: Mtskheta-Mtianeti, Samegrelo-Zemo Svaneti, Ajara and weak distribution zone: Racha-Lechhumi, Guria, Samtskhe-Javakheti.

By official method used Bremer method. For the feeding, the larvae were given the healthy leaves of tomato treated in sodium solution and covered with cotton wetted in water with honey, to avoid premature wilting of the leaves. At the end of feeding, the larvae entered the pupae phase, after which it became possible to establish the number of female and male individuals using the Bremer method: $L = \frac{f}{m+f}$ where, f is the number of female individuals in the population, m – the number of male individuals as a result of which was established the sex ratio.

3. Results

Even under the natural temperature fluctuations, the pest can damage the tomatoes. As a result of studies carried out in greenhouse farms of the regions Mtskheta-Mtianeti and Kvemo Kartli (Eastern Georgia), it was found that eggs are small, cylindrical, length 0.35 mm, intensity-0.22 mm. Yellowish-white (at the beginning) and yellowish-orange (before hatching). Eggs are laid on the underside of the leaf individually or in soapy groups, less frequently on the stem and very rarely on the fruit (see Table 1).

Table 1. Distribution of sex products according to the plant organs 2018

Plant parts	Percentage Distribution, %
Leaves	73
Stems	21
Flowers	5
Green fruits	1

The ontogenesis phases of *Tuta absoluta* M.-egg, larvae, pups and imago, i.e. are characterized by complete metamorphosis (Figure 1). The laying of eggs by female individuals on the different organs of the plant is recorded as follows: 73 % on the leaves, 21 % – on the stems, 5 % – on the calux leaves and 1 % on green fruits (see Figure 1) (Khositashvili, Lobzhanidze, 2019).

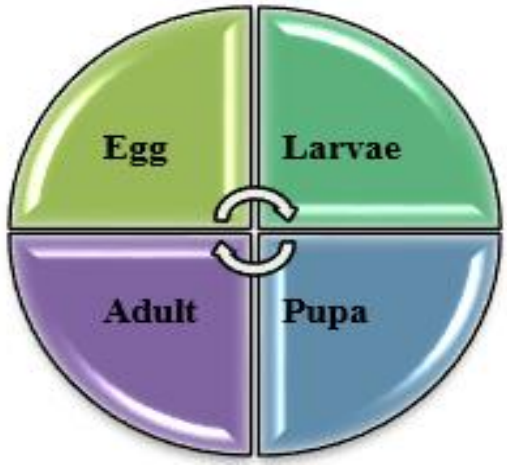

Fig. 1. Development time (days) of the different life stages of *Tuta absoluta* recorded at five constant temperatures 2019

The experiments were carried out at temperatures of 10°C, 15°C, 20°C, 25°C and 30°C. As the study shows, the South American tomato moth develop in a wide range of temperatures. *Tutaabsoluta* completed its development at all these temperatures In the conditions of the natural temperature fluctuations, the pest still can damage the tomatoes and develop (see Figure 2) (Khositashvili, Lobzhanidze, 2016).

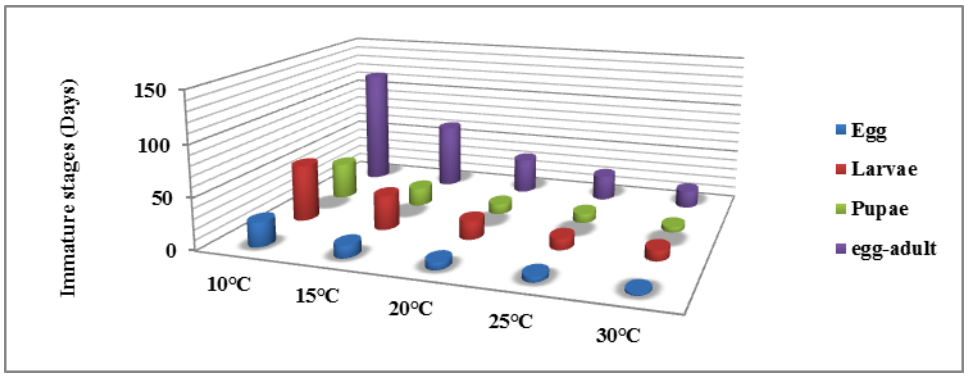

Fig. 2. Estimated parameters of the models used to describe the relationship between the adult life history traits of *Tuta absoluta* and temperature

The *Tuta absoluta M* is more intensively multiplied at 20°C and 25°C. For the feeding, the larvae were given the healthy leaves of tomato treated in sodium solution and covered with cotton wetted in water with honey, to avoid premature wilting of the leaves. At the end of feeding, the larvae entered the pupae phase, after which it became possible to establish the number of female and male individuals using the Bremer method. There were no significant differences in the lifespan of males and females.

Tuta absoluta M refers to polyvoltine insect species in which the phases of development of different generations are mixed with each other, so it is almost impossible to make an exact phenogram (see Figure 3).

Mean longevity of females and males of *Tuta absoluta* recorded at five constant temperatures 2019 (Figure 3).

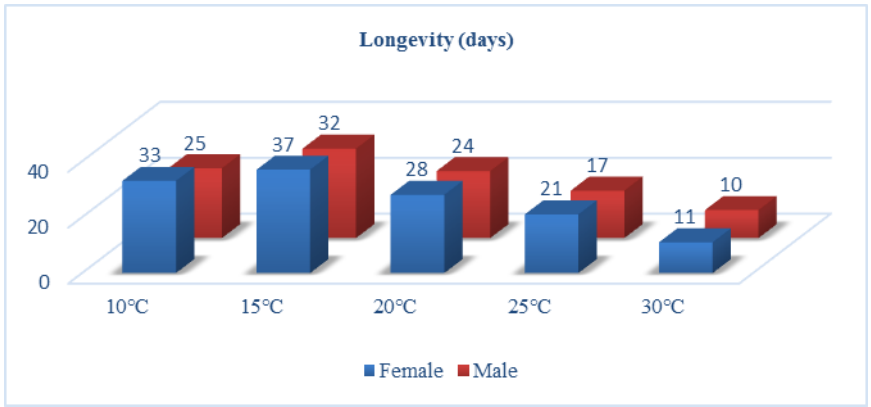

Fig. 3. The longevity of females kept at 30°C was significantly less than that of those kept at 10, 15 and 20°C. There were no significant differences in the lifespan of males and females

Tuta absoluta M. is a micro Lepidoptera leaf miner with a high reproductive potential, capable of up to 10-12 generation per year under optimal conditions. Its life cycle is completed within 29-38 days. In the conditions of Georgia the optimal temperature of pest development was determined 20°C and 25°C. The lower developmental threshold (the lower temperature threshold) was estimated 10.0 °C. (Khositashvili, Lobzhanidze, 2016; Krechemer, Foerster, 2015).

3. Conclusion

The most important aim of our study is the new invasion species of the South American tomato mining moth (*Tuta absoluta* M.), harming cultural and wild plant species of the Solanum family.

The relevance of the issue is largely determined by the fact that the South American tomato mining moth (*Tuta absoluta* M.) is also ranked twelfth in the list of restrictedly widespread pests by the Resolution No. 429 of the Government of Georgia (document dated 31 December 2010, on conducting veterinary border-quarantine control and phyto sanitary border-quarantine control).

It was very important to study in detail the reproduction features of the noted pest, as this species has recently been advented in our country and it is natural that in the conditions of Georgia the pest revealed completely different biological features. Basing the above mentioned, it's impossible to outline rational measures and implement them timely and effectively. At the same time, it is important to take into account that the pest has high reproductive potential (can produce 9.0-12.0 generations, sexual production 160-260 eggs). The biological cycle is completed in 31.0-39.0 days. The optimum temperature was set to 20-25.0°C and the upper and lower limits of temperature – 8.0 ° C and 35 ° C.

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Published in the Slovak Republic
Central European Journal of Botany
Has been issued since 2015.
E-ISSN 2413-757X
2021. 7(1): 13-25

DOI: 10.13187/cejb.2021.1.13
www.ejournal34.com

Some Plants used as Diabetic in Turkey Traditional Medicine

Ömer Kiliç [a, *], Meryem Kök [a], Şinasi Yildirimli [b]

[a] Adıyaman University, Adıyaman, Turkey
[b] Hacettepe University, Ankara, Turkey

Abstract

Diabetes is one of the most common diseases globally, it leads to hyperglycemia and prolonged hyperglycemia can cause severe immortalities every system of the human body; change in the metabolism of lipids, carbohydrates, proteins, and in the long term, with eye, kidney, cardiovascular, and neurological complications. In spite of the developments in medicinal chemistry, traditional medicine is still a common practice for the treatment of diabetes. The number of studies on plants used by the public in diabetes is few. Conventionally there are some medicines to treat diabetes mellitus but desired effective treatment is still not to be achieved. Thus, it is essential to look for more effective antidiabetic agents with fewer side effects like natural medicinal and aromatic plants. However some medicinal and aromatic plant derived products have proven to be effective and safe in the treatment of various types of diabetes mellitus. So researches are going on for the development of alternative effective therapy against this common disease. In Turkey ethnobotany, some medicinal and aromatic plants have been used as blood sugar lowering agents. Turkish flora with more than 13.000 plant taxa and medicinal plants are widely used traditionally for the prevention and cure of diabetes and many of them are used for different purposes.

This article consists of 147 plant taxa which are reported to have good antidiabetic property and 39 plant taxa from Çelikhan (Adıyaman-Turkey) provinces which have potential antidiabetic property. In addition this study focuses on diabetes mellitus and the role of plants in the treatment of diabetes mellitus in Turkey, in order to provide additional information for healthcare professionals.

Keywords: antidiabetic plants, traditional medicine, diabetes mellitus, medicinal plants.

1. Introduction

Diabetes mellitus is a common illness affecting most of the people; it is estimated that 25 % of the world population is affected by this disease (WHO, 2016). Diabetes mellitus is a metabolic irregulity characterized by a loss of glucose homeostasis, due to disturbances of carbohydrate, protein and fat metabolism, resulting from defects in insulin production and secretion (Barcelo, Rajpathak, 2001). This disease can result in long-term damage to the kidneys, eyes, liver, nerves, heart and blood vessels of humans and can lead to death (Pari, Saravanan, 2004). Diabetes mellitus is associated with reduced quality of life and increased risk factors for mortality and morbidity (Upendra et al., 2020). Medicinal and aromatic plants, have been used in virtually all cultures and in ethnobotany as a source of drug. It has been estimated that more than 80 % of population, rely on traditional medicine for their primary health care needs and it is assumed that

* Corresponding author
E-mail addresses: omerkilic77@gmail.com (Ö. Kiliç)

a major part of traditional therapy involves the use of medicinal plant extracts or their active substances (Ignacimuthu et al., 2006).

Medicinal and aromatic plants today as in the past extensively used for various diseases and these economically important plants are considered as a therapeutic aid for reducing illness of human being. Natural compounds, natural drugs and natural medicinal plants may be good and feasible alternatives for the treatment of diabetes and these substances may even reduce the risk of the disease. There are a large planty of plants and natural pruducts that have been discussed in literature for their antidiabetic effects (Soumyanath, 2006). The search for natural products to cure illness has received considerable attentions in which medicinal and aromatic plants have been the most important source (Okwu, 2001). They are believed to be an important source of new chemical substances with potential therapeutic effects, and due to the crucial role that plant-derived compounds have played in drug discovery, and development for the treatment of several illness (Rang, Dale, 1991). Medicinal and aromatic plant taxa have become targets in searching for drugs and in the management and treatment of chronic diseases. Traditional therapies are available for diabetes mellitus; but in developing countries the anti-diabetic medicines are not affordable by many people as they are expensive, so alternatively traditional medicinal plants by several research groups to overcome the diabetes. Although, oral hypoglycemic agents are the mainstay of cure of diabetes, they have prominent side effects and fail to significantly alter the course of diabetic complications and there is need to look for more efficacious agents with lesser side effects (Rang, Dale, 1991). Traditional medicine products are playing significant roles in the lives of the people across the world in the face of the global upsurge of drug resistance, toxicity, adverse effects and increasing costs of synthetic products (Mbi, Bilikha, 1998). Herbal medicine is used for remedy of diabetes in developing countries where the cost of conventional medicines is a burden to the population (Saravanan, Pari, 2008). Some medicinal and aromatic plants of Turkey and Çelikhan (Adıyaman-Turkey) provinces have been found to be useful to successfully manage diabetes. In Turkey more than 2500 plant taxa are estimated to have potential for phytotherapeutic use and approximately half of them to be used as folk remedies in ethnobotany (Yeşilada, 2009). In Turkey, some plants have been claimed to possess medicinal properties, employed in the treatment of many diseases is quite common. One of the big advantages of these plants is that these are readily available and have low side effects. The ethnobotanical information and traditional medicine reports more than 800 plant taxa may possess antidiabetic potential in the world (Alarcon-Aguilara et al., 1998). Presently, medicinal plants continue to play an important role in the management of diabetes mellitus, especially in developing countries where many people do not have access to modern antidiabetic drugs (Acharya, Shrivastava, 2008). However, the some knowledge of medicinal uses of plants and ethnobotanical properties are lost or to be forgotten. Therefore, there is need to collect and document this knowledge before such rich heritages are lost.

Our main purpose in this study is to prevent the disappearance of the information about the plants used in the treatment of diabetes or to transfer this information to the future generations, to present it to the interest and knowledge of the people living in different regions and the local people, then to serve as a source for those who want to work on the subject or those who work on this subject to direct the pharmacological studies to be carried out on the plants we have collected and reported. In addition, the present review work was aimed to collect and document medicinal plants used for the treatment diabetes mellitus in traditional medicine of Turkey, by thorough literature survey and field study from Çelikhan (Adıyaman-Turkey) provinces. This research also may be useful for scholars who are doing research in phyto-pharmacology and helping to build up their knowledge on developing alternative medicine for various kind of diabetes melilitus and associated ailments and to present a scientifically relevant review for both researchers and readers, who are interested in the biologically active plants traditionally used in the treatment of diabetes.

2. Materials and methods

This research was carried out by thorough searching of different ethnobotany research articles of Turkey. As a result of this study, 147 taxa were determined from the literature survey and showed in Table 1. Table 1 was arranged by specifying the family of the plant, the local name, the part of the plant used and the way of use, based on the region where the plants are used. As a result of field studies from Çelikhan (Adıyaman-Turkey) provinces in the 2019–2020 years 39 plant taxa were collected from their habitat have potential to be used in the treatment of diabetes.

Table 1. Medicinal plants having antidiabetic activity

Family	Botanical name	Local name	Used part	Usage
Rosaceae	Rubus hirtus	Yaban üzümü	Roots	Decoction (Sezik et al., 1997)
Caprifoliaceae	Sambucus nigra	Mürver	Flowers	Infusion (Sezik et al., 1997)
Rosaceae	Sorbus domestica	Üvez	Leaves	Decoction (Sezik et al., 1997)
Cupressaceae	Juniperus foetidissima	Kara ardıç	Cones	Decoction (Tuzlacı, Erol, 1999)
Cupressaceae	Juniperus oxycedrus	Diken ardıçı	Leaves and cones	Decoction (Tuzlacı, Erol, 1999)
Moraceae	Morus rubra	Kara dut	Fruiıt juice	Drink before meals (Tuzlacı, Erol, 1999)
Fagaceae	Quercus coccifera	Pırnal çalısı	Roots and brackets	Decoction (Tuzlacı, Erol, 1999)
Lamiaceae	Teucrium polium	Oğlan otu	Leaves	Decoction (Tuzlacı, Erol, 1999)
Rosaceae	Rosa canina	Kuşburnu	Fruits	Decoction (Yeşilada et al., 1999)
Liliaceae	Allium sativum	Sarımsak	Onions	It is eaten raw (Tuzlacı, Tolon, 2000)
Oleaeceae	Olea europea var. europea	Zeytin	Leaves	Decoction (Tuzlacı, Tolon, 2000)
Rosaceae	Prunus spinosa subsp. dasyphylla	Göğem eriği	Fruits	Decoction (Tuzlacı, Tolon, 2000)
Urticaceae	Urtica dioica	Isırgan otu	Above ground part	Decoction (Tuzlacı, Tolon, 2000)
Rosaceae	Cydonia oblonga	Ayva	Leaves	Decoction (Tuzlacı, Tolon, 2000)
Pinaceae	Pinus brutia	Kızılçam	Cone, pine leaf	Pine leaf boiled and drinking 1 glass on an empty stomach in the morning (Mıiyaru, 2001)
Rosaceae	Pyrus amygdaliform var. amygdaliform	Çöğür/Ahlat /Aklat	Fruit, twig	Fruit of sugar disease is good, boiled and drunk (Ertuğ, 2000)
Rubiaceae	Galium aparine	Sarı Yoğurt Otu /Yapışkan otu	Leaves and twig	The stems of the sticky herb are beaten when they are wet, and the okra seeds are pounded, mixed, boiled, and are good for diabetes when placed in a bottle (Ertuğ, 2000)
Malvaceae	Malva neglecta	Ebegümeci,	Leaves	It is boiled and eaten (Avcı, Ezer, 2000)
Moraceae	Morus nigra	Kara dut	Leaves	Infusion (Avcı, Ezer, 2000)
Areceae	Arum dentrucatum	Karibel	Leaves	Decoction (Özgökçe, Özçelik, 2004)
Polygonaceae	Rheum ribes	İşkin	Roots	Decoction (Özgökçe, Özçelik, 2004)
Ranunculaceae	Nigella segetalis	Çörek otu	Seeds	Decoction (Özgökçe, Özçelik, 2004)
Lamiaceae	Origanum majorana	Kekik otu	Leaves and flowers	Infusion (Uzun, 2005)
Rosaceae	Rubus sanctus	Böğürtlen	Fruits and leaves	Decoction (Köse et al., 2005)
Cornaceae	Cornus mas	Kızılcık	Berries or fruit juices	Syrup is made from the fruit against diabetes (Özçelik, Balabanlı, 2005)

Fagaceae	Quercus ithaburensis subsp. macrolepis	Palamut	Seeds	Against diabetes, fruit and leaves tea are used (Özçelik, Balabanlı, 2005)
Lamiaceae	Thymbra spicata	Zahter, Kirkekiği, Taş kekigi, Dağ kekigi	Leaves, flowers and fresh shoots	Tea obtained from the leaves is used for diabetes (Özçelik, Balabanlı, 2005)
Lamiaceae	Thymus cilicicus	Kekik	Leaves, flowers and fresh shoots	Tea obtained from the leaves is used for diabetes (Özçelik, Balabanlı, 2005)
Myrtaceae	Myrtus communis	Mersin	Leaves, fruits and fresh branches	Infusion (Özçelik, Balabanlı, 2005)
Polygonacea	Polygonum cognatum	Madımak, Kuş ekmeği	Fresh leaf	It is consumed in the form of a salad or by cooking (Özçelik, Balabanlı, 2005)
Zygophyllaceae	Tribulus terrestris	Demir Pıtırak	Above ground parts	Water obtained from boiling used (Özçelik, Balabanlı, 2005)
Liliace	Allium porrum	Pırasa	Fresh leaves	It is cooked and cooked (Pieronia et al., 2005)
Rutaceae	Citrus paradisi	Greyfrut	Mesocarpal part of the fruits is used	Decoction is prepared from mesocarps (Pieronia et al., 2005)
Anacardiaceae	Pistacia terebinthus	Çitlembik/Menengiç	Dried fruits	It is eaten by drying (Pieronia et al., 2005)
Rosaceae	Prunus spinosa	Erik ekşisi	Dried fruits	Decoction (Pieronia et al., 2005)
Punicaceae	Punica granatum	Nar	Fruits	It is consumed fresh (Pieronia et al., 2005)
Polygonaceae	Rumex acetosella	Kuzu kulagi	Fresh leaves	Packed (Pieronia et al., 2005)
Asteraceae	Taraxacum officinale	Karahindiba	Fresh leaves	Packed (Pieronia et al., 2005)
Urticaceae	Urtica dioica	Isırgan otu	Dried leaves	Decoction (Pieronia et al., 2005)
Zingiberaceae	Zingiber officinalis	Zencefil	Rhizoms	Decoction (Pieronia et al., 2005)
Gramineae	Avena barbata	Yabani yulaf, yabani burçak	Leaves, shoots and flowers	Decoction (Doğanoğlu et al., 2009)
Asteraceae	Artemisia absinthium	Pelin otu	Above ground parts	Boiled and drunk on an empty stomach, it is good for diabetes (Bağcı et al., 2006)
Anacardiaceae	Cotinus coggyria	Tetra	Leaves	Decoction (Ecevit, Özhatay, 2006)
Juglandaceae	Juglans regia	Ceviz	Fruit pericarps	Decoction (Ecevit, Özhatay, 2006)
Lauraceae	Laurus nobilis	Defne	Leaves	Decoction (Ecevit, Özhatay, 2006)
Platanaceae	Platanus orientalis	Çınar	Leaves	Decoction (Ecevit, Özhatay, 2006)
Salicaceae	Populus tremula	Kavak	Leaf and peeled shells	Leaves infusion, shells decoction (Ecevit, Özhatay, 2006)
Rosaceae	Pyrus bulgarica	Ahlat	Fruits	It is pickled (Ecevit, Özhatay, 2006)
Rosaceae	Prunus spinosa subsp. dasyphylla	Güvem	Fruits	It is eaten raw (Ecevit, Özhatay, 2006)

Rosaceae	Rubus discolor	Çoban kösteği, böğürtlen	Roots	Decoction (Ecevit, Özhatay, 2006)
Lamiaceae	Thymus zygioides var. zygioides	Kekik	Fresh shoots	Infusion (Ecevit, Özhatay, 2006)
Lamiaceae	Thymus praecox subsp scorpii	Kekik, Kekik otu, Keküк	Flowers, leaves, fresh shoots	Decoction (Ezer, Arısan, 2006)
Loranthaceae	Viscum album subsp. album	Kökçe, Gökçe, Ökse otu	Leaves and branches	Decoction (Ezer, Arısan, 2006)
Asteraceae	Cnicus benedictus var. benedictus	Mübarek dikeni	Above ground parts	Decoction (Kilic, 2012)
Asteraceae	Scorzonera semicana	Yemlik, gılekoçik	Leaves and roots	Decoction (Kilic, 2012)
Lamiaceae	Teucrium chamaedrys subsp. sinuatum	Kısamahmut, Dalak otu	Leaves and seeds	Infusion (Kilic, 2012)
Araliaceae	Hedera helix	Sarmaşık	Leaves and branches	Decoction (Çakılcıoğlu et al., 2007)
Compositae	Carduus nutans subsp. leiophyllus	Deve dikeni, eşek dikeni, çakır dikeni, eşek gengeri	Air particles	Decoction (Çakılcıoğlu et al., 2007)
Guttiferae	Hypericum perforatum	Kantaron, kantaron cayı, sarı kantaron, kantaryon, sarıcayuz, kantul, kesik otu	Flowers and leaves	Olive oil is used by waiting in olive oil (Çakılcıoğlu et al., 2007)
Geraniaceae	Geranium pratense subsp. finitimum	Turna gagası	Leaves	Decoction (Yeşilada, 2008)
Fabaceae	Vicia ervilia	Burçak, Birçak	Seeds	It is used in powder form (Uğurlu, Seçmen, 2008)
Rhamnaceae	Zizyphus jujuba	Günnap, Hünnap	Fruits	a decoction (Uğurlu, Seçmen, 2008)
Berberidaceae	Berberis crataegina	Karamuk	Fruits	Fruits are consumed raw (Savran et al., 2008)
Asteraceae	Helianthus tuberosus	Yer elması	Under ground part	It is consumed as a vegetable (Savran et al., 2008)
Asteraceae	Carduus pycnocephalus	Su dikeni, Soymaç	Body	The body part is peeled and eaten (Sarper et al., 2009)
Asteraceae	Onopordum acanthium	Kangal	Body	Its body is eaten raw (Sarper et al., 2009)
Brassicaceae	Nasturtium officinale	Su teresi	The whole plant is used.	Consumed fresh (Sarper et al., 2009)
Lamiaceae	Mentha aquatica	Su nanesi	Above ground parts	Consumed fresh (Sarper et al., 2009)
Fabaceae	Lupinus angistifolius	Yahudi baklası	Fruits	Decoction (Ugulu et al., 2009)
Linaceae	Linum usitatissimum	Keten	Seeds	Infusion (Ugulu et al., 2009)
Rosaceae	Crataegus meyeri	Roğık, Rığok	Roots	Decoction (Yeşil, Akalın, 2017)
Lamiaceae	Thymus fallax	Catır, Catri	Flowers and fresh shoots	Infusion, decoction (Yeşil, Akalın, 2017)
Lamiaceae	Thymus kotschyanus	Catır, Catri	Flowers and fresh shoots	Infusion, decoction (Yeşil, Akalın., 2017)

Lamiaceae	Thymus sipyleus subsp. rosulans	Catır, Catri	Flowers and fresh shoots	Infusion (Yeşil, Akalın, 2017)
Rosaceae	Amygdalus communis	Badem	Seeds	Consumed as raw and dried nuts (Yapıcı et al., 2009)
Aristolochiaceae	Aristolochia bottae	loğusa otu, goye deve	Above ground parts	Used in the form of mash in foot wounds due to diabetes (Yapıcı et al., 2009)
Orchidaceae	Orchis simia	Salep	Tubers are used.	Decoction (Yapıcı et al., 2009)
Anarcardiaceae	Rhus coriaria	Sumak	Seeds	The seeds are squeezed and drunk. (Yaldız et al., 2010)
Ericaceae	Vaccinium myrtillus	Mavi Meyveli Ayı Üzümü	Fruits and leaves	Infusion (Yaldız et al., 2010)
Asteraceae	Matricaria chamomilla var. recutita	Papatya	Flowers	Infusion (Tuzlaç et al., 2010)
Zygophyllaceae	Paliurus spina-christi	Kara çalı	Fruits	Decoction (Tuzlaç et al., 2010)
Plantaginaceae	Plantago major subsp. major	Sinirli ot, Sinirli yaprak	Leaves	Decoction (Tuzlaç et al., 2010)
Asteraceae	Anthemis tinctoria var. tinctoria	Sarıpapatya	Flowers	Decoction (Çakılcıoğlu, Türkoğlu., 2010)
Asteraceae	Helichrysum plicatum subsp. plicatum	Solmaz çiçek	Flowers	Decoction (Çakılcıoğlu, Türkoğlu, 2010)
Lamiaceae	Salvia multicaulis	Adaçayı	Flowers and leaves	Decoction (Çakılcıoğlu, Türkoğlu, 2010)
Papaveraceae	Papaver rhoeas	Gelincik	Flowers	Decoction (Çakılcıoğlu, Türkoğlu, 2010)
Poaceae	Agropyron repens	Ayrık	Rhizoms	Decoction (Çakılcıoğlu, Türkoğlu, 2010)
Portulacaceae	Portulaca oleracea	Semizotu	Leaves	Decoction (Çakılcıoğlu, Türkoğlu, 2010)
Fabaceae	Astragalus gummifer	Geven	Roots	Decoction (Çakılcıoğlu, Türkoğlu, 2010)
Liliaceae	Smilax excelsa	Dikenucu, Melülcan	Shoots are used	Decoction (Koca and Yıldırımlı, 2010)
Cistaceae	Cistus laurifolius	Tavşanak,	Leaves	Infusion (Kargıoğlu et al., 2010)
Cistaceae	Cistus parviflorus	Tavşanak, tavşancık	Leaves	Infusion (Kargıoğlu et al., 2010)
Euphorbiaceae	Euphorbia anacampseros Boiss. var. anacampseros	Sütleğen	Above ground parts	Decoction (Kargıoğlu et al., 2010)
Lamiaceae	Stachys annua subsp. annua	Hacıosman otu	Above ground parts	Infusion (Tuzlaç, 2011)
Asteraceae	Achillea tenuifolia	Çoban kirpiği	Leaves	Infusion (Altundağ, Öztürk, 2011)
Rosaceae	Crataegus aronia var. aronia	Gurmut	Fruits	Decoction (Altundağ, Öztürk, 2011)
Dipsacaceae	Dipsacus laciniatus	Pukiç	Roots	Decoction (Altundağ, Öztürk, 2011)
Apiaceae	Ferula caspica	Gırmızı bolu	Above ground parts	Decoction (Altundağ, Öztürk, 2011)
Apiaceae	Ferula rigidula subsp. rigidula	Çaşır	Above ground parts	It is used as porridge (Altundağ, Öztürk, 2011)

Asteraceae	Gundelia tournefortii var. tournefortii	Kenger	Body	Peels are peeled and eaten directly (Altundağ, Öztürk, 2011)
Asteraceae	Jurinella moschus subsp. pinnatisecta	Gazangulpu	Above ground parts	Decoction (Altundağ, Öztürk, 2011)
Rosaceae	Malus sylvestris subsp. orientalis var. orientalis	Alma	Fruits	Decoction (Altundağ, Öztürk, 2011)
Apiaceae	Peucedanum longifolium	Çaşır	Above ground parts	Pickled (Altundağ, Öztürk, 2011)
Caprifoliaceae	Viburnum lantana	Germeşo	Fruits	Decoction (Altundağ, Öztürk, 2011)
Apiaceae	Zosima absinthifolia	Bolu	Leaves	Decoction (Altundağ, Öztürk, 2011)
Asteraceae	Artemisia vulgaris	Pelinotu	Above ground parts	Decoction (Altundağ, Öztürk, 2011)
Rosaceae	Cerasus mahaleb var. mahaleb	Mahlep	Fruits	Decoction (Çakılcıoğlu et al., 2011)
Rosaceae	Cotonoaster nummularia	Karagöz	Fruits	Decoction (Yeşilada, Sezik., 2011)
Asteraceae	Cichorium intybus	Hindiba, Mavihindiba, Radika, Sakizotu	Flowers and leaves	Decoction (Kızılarslan, Özhatay, 2006)
Rosaceae	Laurocerasus officinalis	Karamiş, Karayemis.	Fruits	It is consumed fresh (Kızılarslan, Özhatay, 2006).
Asteraceae	Achillea schischkinii	Civan perçemi	Flowers	Decoction (Tetik et al., 2013)
Fabaceae	Astragalus cephalotes var. brevicalyx	Geven	Roots	Decoction (Tetik et al., 2013)
Rosaceae	Armeniaca vulgaris	Kayısı, mis mis	Fruits and seeds	It is eaten raw (Tetik et al., 2013)
Brassicaceae	Eruca sativa	Roka	Leaves	Salad is made (Akaydın et al., 2013)
Araceae	Arum elongatum subsp. detruncatum	Kardun, Kardu, Kardı	Leaves	Infusion (Polat et al., 2013)
Asteraceae	Anthemis wiedemanniana	Elık Fatık, Papatya	Bracts	Infusion (Polat et al., 2013)
Asteraceae	Chaerophyllum bulbosum	Pueşma, Şomek, Şomyek	Rhizomes	It is cooked and cooked (Polat et al., 2013)
Asteraceae	Scorzonera cinerea	Şing, Vıl	Tubers	Decoction (Polat et al., 2013)
Boraginaceae	Anchusa azurea	Gelazun, Gelezun	Above ground parts and roots	Decoction (Polat et al., 2013)
Liliaceae	Eremurus spectabilis	Helug, Heluk, Gullık	Above ground parts	Cooked (Polat et al., 2013)
Fumariaceae	Fumaria asepala	Şahtere	Above ground parts	Cooked (Kiliç, Bağci, 2013)
Cistaceae	Cistus creticus	Pamukotu	Leaves	Decoction (Akyol, 2013)
Asteraceae	Cirsium arvence subsp. vestitum	At dikeni	Flowers	Infusion (Saraç et al., 2013)
Rosaceae	Fragaria vesca	Kandu	Fruits	It is consumed fresh (Saraç et al., 2013)
Solanaceae	Physalis alkekengi	Altın çilek, Gelinfeneri	Fruits	Decoction (Saraç et al., 2013)

Apiaceae	Eryngium campestre var. virens	Kaplumbağa otu	Body	Consumed fresh (Sarper et al., 2009)
Asteraceae	Carduus pycnocephalus	Su dikeni, Soymaç	Body	Consumed fresh (Sarper et al., 2009)
Adoxaceae	Viburnum opulus	Gilaburu, girebolu	Fruits	Juice is removed (Korkmazet al., 2014)
Fabaceae	Trigonella foenum-graecum	Çemen	Seeds	Butter tea is brewed (Korkmaz et al., 2014)
Apiaceae	Diplotaenia cachrydifolia	Siyabo	Above ground parts	It joins the cheese. Boiled and stored in salt water for a long time and that shape is used (Uceand Tunçtürk, 2020)
Apiaceae	Petroselinum crispum	Maydonoz	Leaves	Decoction (Bulut et al., 2014)
Apiaceae	Peucedanum longifolium	Domuz rezenesi	Above ground parts	It is pickled (Bulut et al., 2014)
Fagaceae	Quercus ithaburensis subsp. macrolepis	Meşe palamutu, Berri	Fruits	Decoction (Akan, Sade Bakır, 2015)
Lamiaceae	Salvia aramiensis	Adaçayı	Leaves	Infusion (Altay et al., 2015)
Cactaceae	Opuntia ficus-indica	Frenk Yemişi	Fruits	Eaten raw (Altay et al., 2015)
Lamiaceae	Origanum syriacum	At kekiği	Leaves	Infusion (Altay et al., 2015)
Apiaceae	Daucus carota	Arnamus otu, Kokar ot, Mayasıl otu	Above ground parts	Infusion (Bulut, 2015)
Apocynaceae	Gymnema sylvestre	Gimneya	Leaves	A decoction (Esen et al., 2015)
Fabaceae	Galega officinalis	Keçisedef otu	Above ground parts	Infusion (Özdemir, Alpınar, 2015)
Dennstaedtiaceae	Pteridium aquilinum	Eğrelti, eğrelti otu	Above ground partsand leaf	Infusion (Sargin, 2015)
Rhamnaceae	Rhamnus rhodopeus subsp. anatolicus	Yağlıcan çehri, Karaköken	Fruits	It is consumed fresh (Arı et al., 2015)
Apiaceae	Apium graveolens	Kereviz	Leaves and seeds	Infusion (Güler et al., 2015)
Solanaceae	Solanum tuberosum	Patates	Tubers are used	It is packed (Han, Bulut., 2015)
Asteraceae	Tripleurospermum parviflorum	Koyungözü, Papatya	Flowers	Decoction (Akgül et al., 2016)
Lamiaceae	Melissa officinalis	Melisa, oğul otu	Leaves	Infusion (Durmuş et al., 2016)
Rosaceae	Rubus caesius	Büküzümü	Leaves	Infusion (Bulut et al., 2017)
Aspleniaceae	Ceterach officinarum	Hüdaverdi otu	Above ground parts	Infusion (Yeşilyurt et al., 2016)

3. Results and discussion

Plants especially medicinal and aromatics are used by the mankind since its origin on the earth for different ailments and for the maintenance of general health; since ancient times, plants remained major natural resource in the World. Diabetes is a condition that is characterized by high blood sugar levels. Most of people worldwide are affected by this common disease. Research on diabetes is ongoing. When a person develops diabetes, insulin deficiency or the body's inability to consume it causes the sugar to remain in the blood instead of reaching the cells and producing

energy. This excess amount of sugar in the blood causes the blood sugar level to exceed normal level. Before the discovery of insulin and hypoglycemic drugs, diabetic patients were treated with medicinal plants and traditional treatments. So far, the positive effects of over 1200 herbal drugs in reducing blood glucose levels or the complications due to hyperglycemia have been established. Each plant may have its own effective component to reduce hyperglycemia. However, these plants have been shown to possess biological activities.

In this study, 147 plant taxa were determined for use in the treatment of diabetes in Turkey ethnobotany. In addition, as a result of field studies from Çelikhan (Adıyaman-Turkey) provinces in the 2019–2020 years 39 plant taxa (*Juniperus oxycedrus* subsp. *oxycedrus*, *Quercus coccifera, Teucrium polium, Rosa canina, Urtica dioica, Malva neglecta, Morus nigra, Rheum ribes, Rubus sanctus, Tribulus terrestris, Thymbra spicata, Rumex acetosella, Artemisia absinthium, Thymus praecox* subsp. *scorpii, Cnicus benedictus* var. *benedictus, Scorzonera semiciana, Teucrium chamaedrys* subsp. *sinuatum, Hypericum perforatum, Vicia ervilia, Carduus pynocephalus* subsp. *pynocephalus, Nasturtium officinale, Crateagus meyeri, Thymus kotschyanus* var. *kotschyanus, Amygdalus communis, Paliurus spina-christi, Plantago major* subsp. *major, Anthemis tinctoria* var. *tinctoria, Helichrysum plicatum* subsp. *plicatum, Salvia multicaulis, Agropyron repens, Papaver rhoaes, Portulaca oleracea, Astragalus gummifer, Gundelia tournefortii* var. *tournefortii, Cichorium intybus, Anchusa azurea* var. *azurea, Eryngium campestre* var. *virens, Trigonella foenum-graecum, Tripleurospermum parviflorum*) were collected from their habitat have potential to be used in the treatment of diabetes. Hence, these important medicinal plants may also have anti-diabetic activities and/or can reduce diabetes complications.

We hope that this study will serve as a guide for the diabetes remedy. When bioactivity studies on these plants are examined, it has shown that they have hypoglycemic effects and can be used to treat various types of the disease with different mechanisms. From the ancient times medicinal and aromatic plants are used for the treatment of many diseases like diabetes. By utilizing the ethno botanical and ethno pharmacological knowledge we know about the medicinal plants which have potent antidiabetic activity. It is necessary to use these herbs consciously in the treatment of diabetes. The more significant reason is that medicinal plants provide rational means for the treatment of many illnesses that are obstinate and incurable in other systems of medicine. These aromatic and medicinal plants often exert a distinctive effect for some diseases including diabetes mellitus. So, it would be interesting to discover new lead constituents for future drug development from the traditional Turkish medicines. Antidiabetic plant taxa can be used as alternatives to synthetic oral hypoglycemic drugs with less or even no prominent side effects. Folklore medicinal plants are mostly used for rural areas; because the availability of lavish amount of medicinal plants those areas. Therefore, treating diabetes mellitus with plant derived compounds which are accessible and do not require laborious pharmaceutical synthesis seems highly attractive. Current research of the antidiabetic activity of the herbs helps to develop effective herbal therapies for such purpose. For the discovery of new potential antidiabetic compounds suitable information about medicinal plants are needed. This article is prepared for providing proper information regarding the medicinal plants having antidiabetic property. The informations which are discussed here regarding the medicinal plants might be helpful for further research on diabetes. Further studies should be carried out to investigate the antidiabetic activity of other plant species that have not yet been studied, and also the bioactive compounds responsible for the antidiabetic activity need to be evaluated.

4. Conclusion

In Turkey, ethnobotanical studies and studies similar to this study are extremely needed in terms of human health and other purposes. Our country is rich in natural plant species. Recognizing and owning this richness is a sensitive issue that needs to be emphasized in order to protect our plant diversity, nature, nutrients and health. Negative effects on plants should be minimized by raising awareness of the local people about the issues that cause negative effects on plants.

5. Acknowledgments

The authors thanks the financial support from the Adıyaman University Scientific Research Project Unit, Adıyaman/Turkey, Project no. ECZFMAP/2019-0004.

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Published in the Slovak Republic
Central European Journal of Botany
Has been issued since 2015.
E-ISSN 2413-757X
2021. 7(1): 26-30

DOI: 10.13187/cejb.2021.1.26
www.ejournal34.com

Some Plants Which Most Visited by Honey Bees from Çelikhan (Adıyaman) and Surroundings

Ömer Kiliç [a, *], Şinasi Yildirimli [b], Zeynep Şahan [a]

[a] Adıyaman University, Adıyaman, Turkey
[b] Hacettepe University, Beytepe-Ankara-Türkiye, Turkey

Abstract

Knowing the characteristics of the beekeeping flora is very important for the productivity of beekeeping activities. Especially it is important that which plants are prefered by honey bees. In this study; important plants for beekeeping activities have been identified in Çelikhan (Adıyaman) and its surroundings. For this purpose, periodic field studies and observations were carried out. In addition, meetings were conducted with beekeepers in Çelikhan (Adıyaman) and its surroundings. As a result of this study, 112 plant taxa which were most visited by honey bees have been determined. The major families include these plant taxa: Lamiaceae (29), Fabaceae (21), Asteraceae (16), Rosaceae (11), Apiaceae (9), and other families (26).

The most visited plants of bees may vary according to ecological conditions, vegetation of the area and many factors like the appearance of flower including colour, shape, morphology, display area and odour In the research area, the most visited plants by bees are more frequent, were detected populated in the field, pollen and nectar sources are more and the flowering period is long and more spreading ones.

Keywords: flora, beekeeping, Çelikhan, Adıyaman.

1. Introduction

Bee's foraging activities initiated by the scout bees that go to the field, return and display a dance communication and odour plume to alert the other bees in hive about the food source, location and distance. The foragers select their foraging plants for pollen, nectar and resin. While bees collect pollen and nectar from plants, they make a significant contribution to crop growth, ecosystem, ecology, agriculture and economy by pollinating plants. In addition, bees are one of the important insect species that have many benefits such as increasing the generation of plants, protecting the ecological balance, and causing high quality and excess fruit formation (Çankaya. Korkmaz, 2008). Some scientific studies have been carried out to reveal the floristic richness of and the originality of the vegetation of Adıyaman (Turkey) (Avcı, 2009; Yıldırımlı, Kılıç, 2018; Yıldırımlı, Kılıç, 2019; Tel, 2009; Tel, Tak, 2012; Tel, Şahin, 2016; Tel, Tak, 2015; Tel, Şimşek, 2017).

We chose this region within the scope of our project work since Çelikhan district of Adıyaman and its surroundings are original in terms of plant species and number due to different ecological factors. According to Davis's Grid system the research area is in C7 square. Our study area is in the Anatolian-Turanian phytogeographic region. The research area and its surroundings have different

* Corresponding author
E-mail addresses: omerkilic77@gmail.com (Ö. Kiliç)

habitats such as steppe, wetland, rocky, forest areas and different ecological characteristics. Bees and plants are highly interconnected, and bees are as important for pollination of plants as plants are important for feeding bees and producing honey.

The plant diversity of area that beehives are located, especially the excess of plants preferred by the bees, the length and the difference of the vegetation period and the length of the flowering periods affect both bee nutrition and the yield and quality of bee products. The determination of the location of hives is very important for successful beekeeping. The vegetation cover, plants that bees mostly visit to get nectar and pollen, and the starting time of flowering and nectar flow time should be well known.

With this study, certain plants most visited by bees in Çelikhan district (Adıyaman) and its surroundings were determined through periodic field studies, interviews with the people of the region engaged in beekeeping in the area and its immediate vicinity. In addition, data have been obtained to contribute the more efficient continuity of beekeeping activities in the region and to contribute relevant literature.

2. Materials and methods

112 plant taxa that spread in natural areas in Çelikhan (Adıyaman) district and its surroundings and visited the most by bees constitute the materials of this study. These bee plants were collected during the vegetation period of 2019–2020 dried in accordance with the herbarium technique, and their diagnosis was made using the works of plant systematists Ö. Kılıç and Ş. Yıldırımlı with Flora of Turkey (Davis, 1965–1985). Plant materials are preserved in Adıyaman University Pharmacy Faculty Herbarium and Yıldırımlı Herbarium from Ankara. Location of research area is seen in Figure 1.

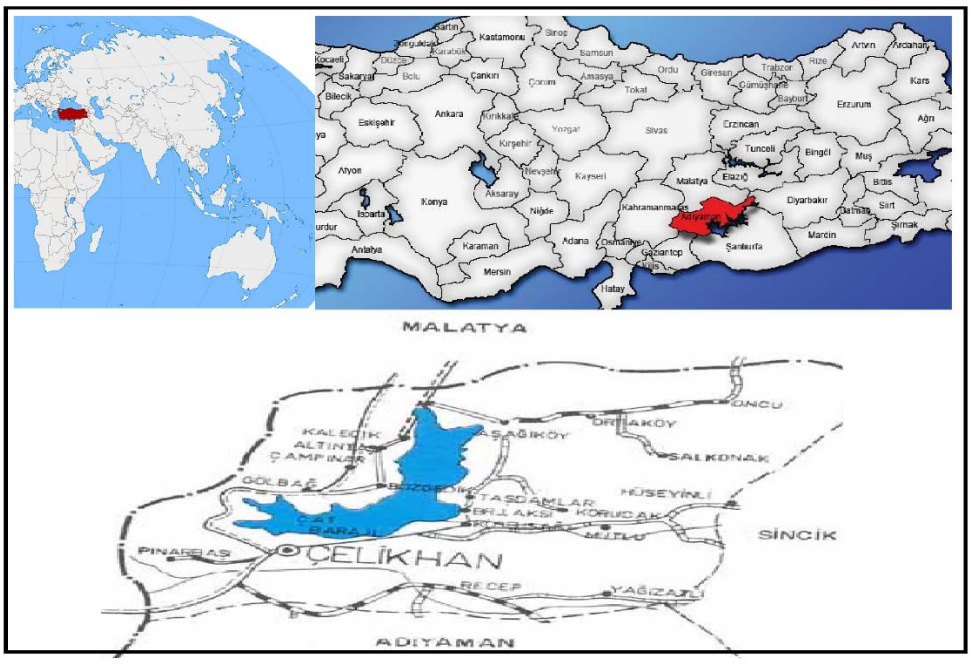

Fig. 1. Location of study area

3. Results and discussion

In the vegetation period of 2019–2020, the 112 plant taxa that spread in the natural areas in Çelikhan (Adıyaman) district and its surroundings and visited the most by bees (*Salvia multicaulis* L., *Mentha longifolia* (L.) Hudson subsp. *longifolia, Phlomis rigida* Labill., *Thymus haussknechtii* Velen, *Teucrium parviflorum* Schreber, *Scutellaria orientalis* L. subsp. *orientalis*, *Salvia verticillata* L. subsp. *verticillata, Teucrium polium* L., *Lamium macrodon* Boiss. et Huet, *Marrubium astracanicum* Jacq. subsp. *astracanicum, Stachys lavandulifolia* Vahl var. *brachydon, Nepeta nuda* L. subsp. *nuda, Lallemantia iberica* (Bieb.) Fisch et Mey., *Satureja boissieri* Hausskn et Boiss., *Thymus kotschyanus*

Boiss. et Hohen var. *kotschyanus, Salvia trichoclada* Benth., *Origanum vulgare* subsp. *gracile* (K.Koch) Ietsw., *Phlomis kurdica* Rech. Fil., *Sideritis vulcacina* Hub. Mor., *Salvia frigida* Boiss, *Thymbra spicata* L., *Marrubium globosum* subsp. *globosum, Origanum acutidens* (Hand.-Mazz.) Ietsw, *Ziziphora taurica* M.Bieb. subsp. *taurica*, *Teucrium polium* L., *Salvia viridis* L., *Phlomis armeniaca* Willd, *Clinopodium graveolens* Kuntze. subsp. *rotundifolium* (Pers.) Govaerts, *Lamium garganicum* L. subsp. *reniforme, Inula helenium* L. subsp. *pseudohelenium* Grierson, *Helichrysum graveolens* (Bieb.) Sweet, *Achillea millefolium* L. subsp. *millefolium, Tripleurospermum parviflorum* (Willd.) Pobed, *Centaurea spectabilis* (Fisch. & C.A.Mey.) Sch.Bip. subsp. *microlapha* (Boiss.) Wagenit, *Achillea vermicularis* Trin., *Helichrysum plicatum* DC. subsp. *plicatum, Cirsium macrobotrys* (K.Koch) Boiss, *Achillea biebersteinii* Afan., *Anthemis armeniaca, Carduus nutans* L. subsp. *leiophyllus, Arctium minus* (Hill.) Berhn subsp. *minus, Anthemis coelopoda* Boiss. var. *coelopoda, Scorzonera latifolia* (Fisch. & C.A.Mey.) DC., *Tanacetum parthenium* (L.) Sch.Bip, *Echinops orientalis* Trautv., *Robinia pseudocacia* L., *Astragalus aduncus* Willd., *Trifolium pratense* L. var. *americanum* Harz, *Astragalus densifolius* Lam. subsp. *densifolius, Astragalus gummifer* Lab., *Vicia cracca* L. subsp. *stenophylla* Vel., *Medicago sativa* L. subsp. *sativa, Colutea cilicica* Boiss. & Balansa, *Lotus gebelia* Vent. var. *gebelia, Astragalus compactus* Lam., *Melilotus officinalis* (L.) Desr., *Trifolium pratense* L. var. *pratense* Boiss. et Bal., *Astragalus kurdicus* Boiss. var. *kurdicus*, *Trifolium arvense* L. var. *arvense, Astragalus bicolor* Lam., *Vicia sativa* L. subsp. *nigra* var. *nigra, Coronilla varia* L. subsp. *varia, Ebenus haussknechtii, Hedysarum syriacum* Boiss., *Vicia canescens* Lab. subsp. *canescens Hedysarum varium* Willd. subsp. *nitidum* Willd., *Pimpinella tragium* Vill. subsp. *pseudotragium* Matthews, *Prangos pabularia* Lindl, *Heracleum persicum* Desf., *Anthriscus nemorosa* (M.Bieb.) Spreng, *Prangos pabularia* Lindl., *Zosima absinthifolia* (Vent.) Link, *Bunium paucifolium* DC. var. *brevipens, Stenotaenia macrocarpa* Freyn et Sint., *Pimpinella adiyamanensis* Yıld & Kılıç, *Celtis tournefortii* Lam., *Pyrus syriaca* Boiss. var. *syriaca, Prunus divaricata* Ledeb. subsp. *divaricata, Malus sylvestris* (L.) Mill. subsp. *orientalis* var. *orientalis*, *Crateagus monogyna* subsp. *monogyna, Crateagus orientalis* subsp. *orientalis, Rubus sanctus* L., *Crateagus meyeri*, *Rosa canina* L., *Potentilla reptans* L., *Cerasus mahaleb* (L.) Mill. var. *mahaleb*, *Aethionema adiyamanense* Kılıç & Yıld, *Aethionema armenum* Boiss., *Galium verum* L. subsp. *verum*, *Cruciata taurica* (Pall. ex Willd.) Ehrend, *Allium scorodoprasum* L. subsp. *rotundum* (L.) Stearn, *Hypericum scabrum* L., *Silene compacta* Fisch., *Hypericum perforatum* L., *Aethionema grandiflorum* var. *sintenisii*, *Acantholimon acerosum* (Willd.) Boiss. var. *acerosum*, *Acanthus dioscoridis* L. var. *dioscoridis, Morus alba* L., *Rhus coriaria* L., *Ficus carica* L. subsp. *carica*, *Phacelia tanacetifolia* Benth, *Ranunculus arvensis* L, *Campanula involucrata* Aucher ex A.DC, *Alcea calvertii* (Boiss.) Boiss., *Cephalaria procera* Fisch. & Avé-Lall., *Silene spergulifolia* (Willd.) M.Bieb, *Pistacia eurycarpa* Yalt, *Verbascum lasianthum* Boiss. ex Benth, *Echium italicum* L., *Anchusa azurea* Mill. var. *azurea*, *Onosma sericeum* Willd., *Alkanna tinctoria* (L.) Tuasch subsp. *tinctoria*) were detected.

In research area, forests consisting of deciduous trees and bushes, steppes in treeless areas, rocky area, creek, aquatic and meadow formations are the main vegetation types. The vegetation characteristics that dominate most of the area have been effective on the soil properties in the study area and as a result, different soil types have emerged. Determination of conservation methods (on-site management, in-situ conservation, ex-situ conservation complementary conservation methods) to ensure the sustainable continuity of natural plant species, which are economically valuable and especially the most visited by bees in this study, and these methods complement each other. Implementation is one of the most important factors in making beekeeping activities in and around the area more profitable. In order to evaluate the existing potentials of Adıyaman in terms of beekeeping in the best way, the importance of nectar honey herbal resources in the field, preserving them with apiary, their conscious use in their natural habitats and supporting studies within this scope are of great importance. For this purpose, the current profile of the province, especially in terms of plant resources preferred by bees, is planned with the continuation of beekeeping accordingly, new investments for the future, determination of project goals and strategies are among the issues that should be seriously dwelled on.

In a study, 65 Lamiaceae taxa that are important, valuable and most visitedby bees in Bingöl province-Sancak district (Turkey) were collected, identified and photographed through regular field studies and interviews with local people doing apiculture during the 2018–2019 vegetation period (Kılıç et al., 2019). In another study, 78 bee plant taxa were identified and the big families of the taxa as follows families: Lamiaceae (20), Fabaceae (16), Asteraceae (14), Rosaceae (7),

Boraginaceae (6) (Demirpolat, Kılıç, 2019). In this study, from Çelikhan (Adıyaman) and surroundings 112 plant taxa which were most visited by honey bees have been determined; the major families were: Lamiaceae (29), Fabaceae (21), Asteraceae (16), Rosaceae (11), Apiaceae (9), and other families (26). In this study, some detected species have economic and ethnobotanic importance (Kilic, Bagci, 2013; Kilic, 2016a) and some researches were carried out with these species (Kilic, Bagci, 2012; Kilic, 2016b; Kilic et al., 2011; Özdemir, Kilic, 2017; Kilic, 2014).

Plants that secrete nectar in nature are examined in three groups as cultivated plants, naturally growing plants and trees and shrubs, and the rich plant flora of Adıyaman and especially the richness of nectar plants have made Adıyaman and Çelikhan an ideal production area for beekeeping. In order to obtain different bee products with the desired characteristics in terms of quality and quantity, it is one of the most important issues to ensure that the plants most preferred by bees are known and protected and to become widespread, and to know the starting and continuing period of flowering and nectar flow.

4. Conclusion

Since the material studied in beekeeping is especially bees and plants, the way to be successful in this field is to know the materials well, to have knowledge about the plants where bees get the most nectar, to use the knowledge in the field and activities, and to know the necessary maintenance, method and management well. In this study, members of Lamiaceae, Asteraceae, Fabaceae were determined as the most visited families by bees. With this study obtained basic data that will contribute to beekeeping activities in Adıyaman and its surrounding. In addition this kind of studies are expected to contribute to the literature, Adıyaman and Çelikhan beekeeping activities and the specialization of Adıyaman University in this field.

5. Acknowledgments

The authors thanks the financial support from the Adıyaman University Scientific Research Project Unit, Adıyaman/Turkey, Project no. ECZFMAP/2019-0004.

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