

Ethnobotanical Survey of Medicinal Plants Used for the Treatment of Diabetes in Manisa, Turkey

(Tinjauan Etnobotani bagi Tumbuhan Ubatan yang Digunakan dalam Rawatan Kencing Manis di Manisa, Turki)

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ABSTRACT

In this study, medicinal plants which are traditionally used for treatment of diabetes mellitus in Manisa and its environs have been investigated. A detailed market survey and ethnobotanical enquiry was performed in the region. In all, 121 medicinal herb dealers were interviewed together with the patients suffering from diabetes. After questionnaire studies, plant specimens were collected from medicinal herb markets known locally as 'aktars' or 'baharatchi', a total of 27 plant taxa belonging to 15 families were identified to be used for the treatment of diabetes. These taxa mostly belonged to the families Rosaceae (5 taxa), Lamiaceae (3 taxa), Fabaceae (2 taxa) and Asteraceae (2 taxa). The most important anti-diabetic plants are; Zizyphus jujube Mill. (jujube), Origanum onites L. (oregano), Ceracus mahaleb L. (mahaleb) and Trigonella foenum-graecum L. (fenugreek). Attempts are being made to investigate their active compounds responsible for the hypoglycemic activity.

Keywords: Diabetes; ethnobotany; Manisa; medicinal plants; Turkey

ABSTRAK

Dalam kajian ini tumbuhan ubatan yang digunakan secara tradisi bagi rawatan kencing manis di Manisa dan kawasan sekitarnya telah dikaji. Suatu tinjauan pasaran yang terperinci dan pertanyaan etnobotani telah dijalankan di rantau itu. Sejumlah 121 penjual herba ubatan telah ditemui duga bersama dengan pesakit yang mengidap kencing manis. Selepas kajian soal selidik spesimen tumbuhan diambil dari pasar herba ubatan yang dikenali sebagai 'aktars' atau 'baharatchi', sejumlah 27 takson tumbuhan tergolong kepada 15 famili telah digunakan bagi rawatan kencing manis. Takson ini kebanyakannya tergolong dalam famili Rosaceae (5 takson), Lamiaceae (3 takson), Fabaceae (2 takson) dan Asteraceae (2 takson). Tumbuhan anti-kencing manis yang terpenting ialah; Zizyphus jujube Mill. (jujube), Origanum onites L. (oregano), Ceracus mahaleb L. (mahaleb) dan Trigonella foenum-graecum L. (fenugreek). Percubaan telah diambil untuk meneliti sebatian aktif yang bertanggungjawab bagi kegiatan hipoglisemia.

Kata kunci: Etnobotani; kencing manis; Manisa; tumbuhan ubatan; Turki

INTRODUCTION

Diabetes mellitus is one of the most common non-communicable diseases. It is one of the major killer of mankind and is rapidly becoming a global health crisis. There are nearly 285 million (6.6% of population aged 20-79 years) diabetic patients across the globe. In 2005, nearly 1.1 million people died worldwide due to this disease. It is estimated that the number of diabetes patients will reach 450 million in 2030 with 97% showing type 2 diabetes mellitus (T₂DM; non-insulin dependent diabetes mellitus) (Israili 2010, 2011). A large number of the patients are prediabetic (with impaired glucose intolerance and insulin resistance) (Israili 2010). Latter is a major risk factor for cardiovascular disease, together with other complications (acute metabolic -ketoacidosis and hyperosmolar non-ketotic syndrome), macrovascular (coronary, cerebrovascular and peripheral vascular disease) and microvascular (peripheral neuropathy, retinopathy and

nephropathy) all being a major cause for hospitalization and ever increasing financial burden on the society (Israili 2010).

Many antidiabetic drugs have been developed and are used globally in managing hyperglycemia in T₂DM. (Israili 2011). Therapy with conventional drugs typically becomes less effective over time and more than 50% of patients with diabetes do not achieve current glycemic goals (Israili 2010).

Majority of the patients are not treated well because current treatments have many shortcomings, including safety and tolerability issues and inconvenience of the dose of medicine given. As such, the issue of diabetes is one of the most important in human health that need to be studied. According to a recent report obesity and diabetes rates in Turkey have risen over the last 13 years (Satman et al. 2002). The percentage of diabetics has gone up from 5

to 7.2% in 1998 to 13.7% in 2010 (Öztürk et al. 2000). One of the main reasons for this is an increase in the prevalence of obesity (from 22.3 to 31.2%).

The treatment of this disease using plants is very old (Vats et al. 2001). The traditional plant medicines have proved of great help all through the history. There is a common use of alternative medicines by diabetic patients in Turkey. A recent survey has revealed that 35 to 41% of diabetic patients use complementary and alternative medicines (mostly botanicals) in addition to conventional medicine (Ceylan et al. 2009; Küçükçüçlü et al. 2010). Several botanicals were used in Turkey by diabetic patients (Aslan et al. 2010; Erenmemişoğlu et al. 1995; İnanç et al. 2007; Onal et al. 2005; Özbek et al. 2004). Currently approximately 1500 plants are used globally for the traditional treatment of diabetes. The aim of this study was to present ethnobotanical information concerning the anti-diabetic plants used in the State of Manisa and its environs in Turkey.

STUDY AREA

Manisa is one of the agriculturally well developed States in Turkey, located in West Anatolia, between Spil Mountain and Gediz River (Figure 1), covering an area of 13.810 sq. km, between the 38°36'50"N latitudes and 27°26'03"E longitudes. The State consists of plains and mountainous areas. Manisa, Salihli and Turgutlu plains are most famous and fertile plains and Spil, Yunt, Cal and Bozdağ are the main important mountains. It enjoys typical Mediterranean climate with hot, dry summers lasting longer and short and cool winters (Duman 1985; Durmuskahya 2005). The annual rainfall varies between 700 and 800 mm. The temperature reaches 35°C in summer and drops down to -5°C in winter. The historical foundation of this State goes back to BC 3000. Several civilizations have flourished here namely; Hittites, Phrygians, Lydians, Romans, Byzantines and Ottoman (Durmuskahya 2006). The plant cover is characterized by Mediterranean vegetation and includes phrygana, maquis and forest zones.

MATERIALS & METHODS

An ethnobotanical study was conducted during 2008-2010 to obtain information on the plants used to treat diabetes mellitus. In all, 26 herbal markets ('aktars') in the research area were visited. Out of 26 herb vendors all 26 were males, but out of 95 diabetic patients 69 were women and 26 men. The fresh plants as well as dry samples were purchased from the herbal markets and identified with the help of 'Flora of Turkey and the East Aegean Islands and Flora Europaea' (Davis 1985; Güner et al. 2000). The voucher specimens have been deposited at the Celal Bayar University Botany Department Herbarium. Direct interviews with herb vendors who work in herbal markets and customers were also carried out. A questionnaire prepared before the start of this work was given to the respective candidates and filled out during each interview. A total of 121 informants (69 female and 52 male individuals) were interviewed. Age of the respondents varied between 38 and 71 years. Mostly informants with basic education were interviewed, only a few had undergraduate or graduate level education (89% undergraduates, 11% graduates). The following ethnobotanical data were recorded; locality, socio-demographic data (age, gender and educational background), vernacular plant names, plant parts used, method of preparation, dosage forms and method of administration.

RESULTS AND DISCUSSION

A total of 27 plant species belonging to 15 families were recorded to be used for the treatment of diabetes mellitus by the inhabitants in the study area (Table 1). Out of these 9 are reported for the first time as used to cure diabetes. Eighteen plants have been reported earlier as anti-diabetics in by other studies in Turkey. The ethnobotanical information about the plants, the parts used, method of preparation, dosage prepared and reported anti-diabetic activity are given in Table 1.

In most cases leaves are used for the preparation of drug (Table 2) and the method of preparation is generally



FIGURE 1. Study area (Map of Turkey and Manisa District)

TABLE 1. List of plants used as anti-diabetics in Manisa

Botanical Name	Family	Vernacular name	Part used	Status of domestication	Citation frequency	Antidiabetic recipe	Anti-diabetic activity
<i>Sarcopoterium spinosum</i>	Rosaceae	Abdestbozan	Stem	Wild	3	Decoction prepared from stem. One glass taken orally	Smirin et al. 2010
<i>Amygdalus communis</i> subsp. <i>amara</i>	Rosaceae	Acı badem	Seeds	Cultivated	10	3-4 dried seed eaten in the morning	Li et al. 2004
<i>Rubus sanctus</i>	Rosaceae	Böğürtlen	Dried roots and leaves	Wild	5	Herbal tea prepared from roots and leaves and taken 2-3 times a day	Cakıloğlu & Turkoglu 2011; Cakıloğlu et al. 2011; Khosla et al. 1995; Stark & Madar 1993
<i>Sorbus domestica</i>	Rosaceae	Üvez	Fruits	Wild	4	3-4 dried fruits are eaten	Tuzlaci & Aymaz 2001
<i>Ceracus mahaleb</i>	Rosaceae	Mahlep	Fruits	Wild-cultivated	12	Dried seeds powdered and 1 small spoon is taken orally or infusion made and a cup drunk a day	Çömlekçioğlu & Karaman 2004; Khatir et al. 1999
<i>Teucrium pollium</i>	Labiatae	Kısa Mahmut	Whole plant	Wild	5	Dried herb used as herbal tea, taken orally 1-2 times a day	Çakıloğlu & Turkoglu 2011; Genet et al. 1999; Polat & Satıl 2012
<i>Satureja cuneifolia</i>	Labiatae	Dağ çayı	Stem and leaves	Wild	3	Dried herb used as herbal tea, taken orally 1-2 times a day	Not found
<i>Origanum onites</i>	Labiatae	İzmir kekiği	Stem and leaves	Wild-cultivated	13	Leaves and stem distilled with steam and a small glass drunk orally twice a day	Polat & Satıl 2012; Tuzlaci & Aymaz 2001
<i>Lupinus albus</i>	Leguminosae	Acı bakla	Seeds	Wild	10	5-6 dried seed are eaten	Amin et al. 1988; Çömlekçioğlu & Karaman 2008
<i>Trigonella foeniculum-graecum</i>	Leguminosae	Çemen	Seeds	Cultivated	9	One spoon of dried and powdered seeds eaten twice a day or infusion made with dried seed and one cup taken a day	Abdel-Barry et al. 1997; Kaushik et al. 2010; Leatherdale et al. 1981; Li et al. 2004; Shani et al. 1974; Trojan-Rodriguez et al. 2012; Tuzlaci & Tolon 2000
<i>Juglans regia</i>	Juglandaceae	Ceviz	Leaves and fruit shell	Cultivated	5	Herbal infusion made from leaves or fruit shells	Not found
<i>Vaccinium myrtillus</i>	Ericaceae	Yaban mersini	Dried fruits	Wild	6	8-10 fruits eaten a day	Not found

(continue)

Continued (TABLE 1)

Botanical Name	Family	Vernacular name	Part used	Status of domestication	Citation frequency	Antidiabetic recipe	Anti-diabetic activity
<i>Zizyphus jujuba</i>	Rhamnaceae	Hünnap	Dried fruits	Cultivated	18	5-6 dried fruits eaten in a day	Polat & Satil 2012; Shirdeh et al. 2000
<i>Eucalyptus camaldulensis</i>	Myrtaceae	Ökalyptus	Dried leaves	Wild	1	Herbal infusion made from leaves	Day et al. 1990
<i>Myrtus communis</i>	Myrtaceae	Mersin	Dried leaves	Wild	6	8-10 fruits eaten a day	Not found
<i>Cistus laurifolius</i>	Cistaceae	Defne yapraklı laden	Dried leaves	Wild	11	50 g of leaves boiled in 250 mL water. Decoction used twice a day before meal	Polat & Satil 2012
<i>Polygonatum multiflorum</i>	Polygonaceae	Çobandegneği	Dried leaves	Wild	2	Herbal infusion made from leaves.	Not found
<i>Sexamum indicum</i>	Pedaliaceae	Susam	Seeds	Cultivated	1	25-30 g seeds eaten	Not found
<i>Olea europaea</i>	Oleaceae	Zeytin	Leaves	Cultivated	8	Herbal infusion made from leaves and consumed 2-3 times a day	Cakici et al. 1994; Raman & Lau 1996; Tuzlaci & Aymaz 2001
<i>Geranium robertianum</i>	Geraniaceae	Dönbaba	Dried whole plant	Wild	1	Herbal infusion made from leaves	Not found
<i>Nigella sativa</i>	Ranunculaceae	Çörekotu	Seeds	Cultivated	5	Seeds powdered and one spoon taken orally before meal	Benhaddou-Andalousi et al. 2008
<i>Momordica charantia</i>	Cucurbitaceae	Kudretnarı	Dried fruits	Cultivated	3	Dried and powdered fruits taken orally or fruits macerated with olive oil and one spoon taken orally a day	Abo et al. 2008; Ahmad et al. 2009; Cakici et al. 1994; Chaturveirdi et al. 2004; Day et al. 1990; Israeli 2010; Jasayaira et al. 2000; Latiff et al. 1980; Leatherdale et al. 1981; Miura et al. 2001; Raman & Lau 1996
<i>Ricinus communis</i>	Euphorbiaceae	Hint yağı	Seeds	Wild-ornamental	4	4-5 dried fruits are eaten a day	Not found
<i>Berberis crataegina</i>	Berberidaceae	Karamuk	Dried roots	Wild	9	Decoction or infusion prepared from dried root and taken orally 1-2 times a day	Not found
<i>Cnicus benedictus</i>	Asteraceae	Mübarek diken	Dried stem, leaves	Wild	2	Herbal infusion made from leaves	Cakiloglu et al. 2011
<i>Scorzonera</i> sp.	Asteraceae	Eşek marulu	Dried stem, leaves	Wild	2	Herbal infusion made from leaves	Cakiloglu et al. 2011
<i>Foeniculum vulgare</i>	Apiaceae	Rezene	Seeds	Wild-cultivated	3	Herbal infusion made from seeds and taken orally twice a day	Not found

hot water infusion or oral intake (Table 3). All the species identified here were found to have a bitter taste except jujube, service tree and raspberry. Many people interviewed in the State believe that consumption of bitter products decreases the blood glucose level (Shirdel et al. 2009). Out of these, oregano water extract, bitter almond, white lupin and castor oil plant have very bitter taste and are used extensively.

TABLE 2. Plant parts used as anti-diabetics

Part of plant	Number
Leaves	9
Seeds	7
Fruits	5
Stem	5
Roots	2
Whole plant	2

TABLE 3. Methods of preparation

Method of preparation	Number
Infusion	13
Eaten dried	9
Decoction	4
Eaten fresh	2
Maserated with olive oil	1

Savory (*Satureja cuneifolia*), walnut (*Juglans regia*), bilberry (*Vaccinium myrtillus*), myrtle (*Myrtus communis*), solomon's seal (*Polygonatum multiflorum*), sesame (*Sesamum indicum*), herb Robert (*Geranium robertianum*), castor oil plant (*Ricinus communis*), barberries (*Berberis crateagina*) and fennel (*Foeniculum vulgare*) were recorded to be used as anti-diabetic plants locally in Manisa. These have not been reported as anti-diabetic plant earlier from Turkey. Sesame, fennel and walnut are cultivated as food plants and Castor oil plant is used as an ornamental in parks and gardens. Seventeen plants taxa have been identified with the same usage in former studies (Abo et al. 2008). Many of them are found in Manisa region in wild form and some of them are cultivated for sale in herbal markets (Table 4).

Oregano (*Origanum onites*) is generally consumed as a 'kekik suyu' (distilled water) and is sold as a commercial product in local markets and on herbal shops. Oregano oil is also used traditionally in digestive problems, influenza, cold, rheumatism and abdominal pains. Its use as an anti-diabetic species has also been reported from Gönen and Edremit region (Polat & Satil 2012; Tuzlaci & Aymaz 2001).

Mahaleb (*Cerasus mahaleb*) is generally found in the wild in Manisa. Dried and powdered fruits are used as anti-diabetic as well as a spice in traditional pastry. The plant is

used for the same purpose in Elazığ and Kahramanmaraş (Cakiloglu & Turkoglu 2011; Çömlekçioğlu & Karaman 2008). Laurel leaves (*Laurus nobilis*) are usually collected from the wild and used as a herbal tea for diabetes. The leaves can also be purchased from the herbal markets. Polat and Satil (2012) reported that, this plant is used for the same purpose around Edremit Gulf. The decoction is taken twice a day for one week, but no clinical study has been undertaken as yet.

Bitter almond (*Amygdalus communis* subsp. *amara*) is one of the most frequently mentioned herbal treatment for diabetes in Manisa. Generally it is sold in herbal shops and local markets. Many patients eat 4-5 dried seeds of this species a day. It is used for the same purpose in Kahramanmaraş as well (Çömlekçioğlu & Karaman 2008). White lupin (*Lupinus albus*) is another well mentioned plant for diabetes. This annual herb grows in the west and south parts of Turkey, but is sold only at herbal markets. The seeds are crushed and eaten, similar usage has been reported from Kahramanmaraş (Çömlekçioğlu & Karaman 2008).

Fenugreek (*Trigonella foenum-graecum*) is also used for diabetes in Manisa. It is cultivated as a spice in Turkey and generally used for producing 'pastırma' (pressed meat cured with garlic and other spices). There are many studies regarding antimicrobial and antibacterial effects of fenugreek besides anti-diabetic. In India and China it is used as an anti-diabetic plant (Kausnik et al. 2010; Li et al. 2004). The extracts, powder and gum of fenugreek seeds and leaves are reported to have shown anti-diabetic and hypocholesterolemic properties during the clinical trials within animals as well as humans (Abdel Barry et al. 1997; Al Habori & Raman 1998; Ali et al. 1995; Amin et al. 1988; Genet et al. 1999; Gomez & Bhaskar 1998; Gupta & Lal 2001; Kathir et al. 1999; Khosla et al. 1995; Ribes et al. 1984; Shani et al. 1974; Stark & Madar 1993; Trojan-Rodriguez et al. 2012; Vats et al. 2001).

Bitter melon (*Momordica charantia*) is found as an ornamental plant in Manisa but it is also used as a medicinal plant in case of diabetes and ulcer. Many studies showed that it has anti-diabetic properties during the clinical trials in animals (Abo et al. 2008; Ahmad et al. 2009; Cakici et al. 1994; Chaturverdi et al. 2004; Day et al. 1990; İsraili 2010; Jayasooriya et al. 2000; Latif et al. 1980; Leatherdale et al. 1981; Miura et al. 2001; Raman & Lau 1996).

Other plants used with the same purpose are; olive (*Olea europae*), walnut (*Juglans regia*), fennel (*Foeniculum vulgare*), sesame (*Sesamum indicum*) and black cumin (*Nigella sativa*). Bilberry (*Vaccinium myrtillus*), myrtle (*Myrtus communis*) and raspberry (*Rubus sanctus*) are found in the wild naturally in Manisa. Fresh fruits are consumed frequently and dried leaves and fruits are also used as anti-diabetics (Benhaddou-Andoussi et al. 2008; İsraili 2010). All herb vendors working in the markets are males, but major number of customers are females who come to the herbal market and buy medicinal plants. The use of medicinal plants is more common among women than men.

TABLE 4. Most commonly used anti-diabetic plants in Manisa

Most commonly used anti-diabetic plants in Manisa	Citation frequency
<i>Zizyphus jujuba</i>	18
<i>Origanum onites</i>	13
<i>Ceracus mahaleb</i>	12
<i>Cistus laurifolius</i>	11
<i>Amygdalus communis</i> ssp. <i>amara</i>	10
<i>Lupinus albus</i>	10
<i>Trigonella foenicum-graecum</i>	9
<i>Berberis crategina</i>	9

The education level of herb vendors shows that 5 of them (19%) have graduated from primary school, 10 (39%) have graduated from the secondary school and 11 (42%) from high school. Generally women aged between 39 and 61 years use much more herbal plants than men, aged between 43 and 71. Women said that they obtained information about herbal plants from their mothers and grandmothers, traditional healers, their friends and nowadays from television programmes. Men obtained their medicinal herbal knowledge from their ancestors, friends, traditional healers and some books. These results showed that women have fundamental role in transmission of traditional medicinal herbal knowledge. People believe that traditional herbal medicines is more safe without side effects than synthetic drugs. Moreover herbals are much cheaper than the medicines sold at pharmacy shops. The people in the rural areas have more accessibility to herbal products.

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REFERENCES

- Abdel-Barry, J.A., Abdel-Hassan, I.A. & Al-Hakiem, M.H. 1997. Hypoglycemic and antihyperglycemic effects of *Trigonella foenum-graecum* leaf in normal and alloxan induced diabetic rats. *Journal of Ethnopharmacology* 58: 149-155.
- Abo, K.A., Ferd-Jaiyesimi, A.A. & Jaiyesimi, A.E.A. 2008. Ethnobotanical studies of medicinal plants used in the management of diabetes mellitus in South Western Nigeria. *Journal of Ethnopharmacology* 115: 67-71.
- Ahmad, M., Qureshi, R., Arshad, M., Khan, M.A. & Zafar, M. 2009. Traditional herbal remedies used for the treatment of diabetes from district Attock (Pakistan). *Pakistan Journal of Botany* 41: 2777-2782.
- Ali, L., Kalam, A., Khan, A., Hassan, Z., Mosihuzzaman, M., Nahar, N., Nasreen, T., Nure Alam, M. & Rokeya, B. 1995. Characterization of the hypoglycemic effects of *Trigonella foenum-graecum* seed. *Planta Medica* 55: 358-360.
- Al-Habbori, M. & Raman, A. 1998. Antidiabetic and hypocholesterolemic effects of fenugreek. *Phytotherapy Research* 12: 233-242.
- Amin, R.M., Abdul-Salam, S.A. & Mohammad, S.S. 1988. Effect of Fenugreek and Lupine seeds on the development of experimental diabetes in rats. *Planta Medica* 54: 286-289.
- Aslan, M., Orhan, N., Orhan, D.D. & Ergun, F. 2010. Hypoglycemic activity and antioxidant potential of some medicinal plants traditionally used in Turkey for diabetes. *Journal of Ethnopharmacology* 128: 384-389.
- Benhaddou-Andaloussi, A., Martineau, L.C., Spoor, D., Vuong, T., Leduc, C., Joly, E., Burt, A., Meddah, B., Settaf, A., Arnason, J.T., Prentki, M. & Haddad, P.S. 2008. Antidiabetic activity of *Nigella sativa* seed extract in cultured pancreatic β -cells, skeletal muscle cells, and adipocytes. *Pharmaceutical Biology* 46: 96-104.
- Cakıcı, I., Hurmoglu, C., Tunctan, B., Abacioglu, C., Kanzik, I. & Sener, B. 1994. Hypoglycemic effect of *Momordica charantia* extracts in normoglycemic or cyproheptadine-induced hyperglycemic mice. *Journal of Ethnopharmacology* 44: 117-121.
- Cakiloğlu, U. & Turkoglu, I. 2011. An ethnobotanical survey of medicinal plants in Sivrice (Elazığ-Turkey). *Journal of Ethnopharmacology* 132: 165-175.
- Cakiloglu, U., Khatun, S., Turkoglu, I. & Hayta, S. 2011. Ethnopharmacological survey of medicinal plants in Maden (Elazığ-Turkey). *Journal of Ethnopharmacology* 137: 469-486.
- Ceylan, S., Azal, O. & Taslipinar, A. 2009. Complementary and alternative medicine use among Turkish diabetes patients. *Complementary Therapies in Medicine* 17: 78-83.
- Chaturvedi, P., George, S., Milinganyo, M. & Tripathi, Y.B. 2004. Effect of *Momordica charantia* on lipid profile and oral glucose tolerance in diabetic rats. *Phytotherapy Research* 18: 954-956.
- Çömlekçiöğlü, N. & Karaman, Ş. 2008. The medicinal plants found in the local herbal markets in the city of Kahramanmaraş in Turkey. *KSU Journal of Science and Engineering* 11: 23-32.
- Davis, P.H. 1965-1985. *Flora of Turkey and East Aegean Islands*. Edinburgh: Edinburgh University Press. Vol:1-10.
- Day, C., Cartwright, T., Provost, J. & Bailey, C.J. 1990. Hypoglycemic effects of *Momordica charantia* extracts. *Planta Medica* 56: 426-429.
- Durmuşkahya, C. 2005. Lower Gediz River Vegetation Ecology, (dissertation). Manisa, Celal Bayar University (Unpublished).
- Durmuşkahya, C. 2006. *Most Common Trees and Shrubs of Aegean Region (Turkey)*. Ankara: Forest and Environment Ministry Publishing.
- Duman, H. 1985. Flora and vegetation of Manisa Mountain (Spil), (dissertation). Ankara, Gazi University (Unpublished).

- Erenmemisoglu, A., Kelestimur, F. & Köker, H. 1995. Hypoglycemic effect of *Zizyphus jujuba* leaves. *Journal Pharm Pharmacology* 47: 72-74.
- Genet, S., Kale, R.K. & Baquer, N.Z. 1999. Effects of vanadate, insulin and fenugreek (*Trigonella foenum graecum*) on creatinine kinase levels in tissues of diabetic rat. *Indian Journal of Experimental Biology* 37: 200-202.
- Gomez, M.P.J. & Bhaskar, G. 1998. Antidiabetic effects of fenugreek seed extract (*Trigonella foenum-graecum*) on *Anabas testudineus* with special reference to carbohydrate metabolism. *Journal of Ecotoxicology & Environmental Monitoring* 8: 103-106.
- Gupta, R. & Lal, B. 2001. Effect of *Trigonella foenum-graecum* (fenugreek) seeds on glycemic control and insulin resistance in Type 2 diabetes mellitus: A double blind placebo controlled study. *Journal of Association of Physicians of India* 49: 1057-1061.
- Güner, A., Özhatay, N., Ekim, T. & Başer, K.H.C. 2000. *Flora of Turkey and the East Aegean Islands*. Edinburgh: Edinburgh University Press.
- Israilli, Z.H. 2010. *Diabetes and Its Treatment with Botanicals in Turkey*. Merkez Efendi Symposium Book, Denizli, Turkey.
- Israilli, Z.H. 2011. Advances in the treatment of type 2 diabetes mellitus. *American Journal of Therapeutics* 18: 117-152.
- Inanç, N., Çiçek, B. & Sahin, H. 2007. Use of herbs by the patients with diabetes in Kayseri, Turkey. *Pakistan Journal of Nutrition* 6: 310-312.
- Jayasooriya, A.P., Sakono, M., Yukizaki, C., Kawano, M., Yamamoto, K. & Fukuda N. 2000. Effects of *Momordica charantia* powder on serum glucose levels and various lipid parameters in rats fed with cholesterol-free and cholesterol-enriched diets. *Journal of Ethnopharmacology* 72: 331-336.
- Kaushik, G., Satya, S., Khandewal, K.R. & Naik, S.N. 2010. Commonly consumed Indian plant food materials in the management of diabetes mellitus, diabetes & metabolic syndrome. *Clinical Research & Reviews* 4: 21-40.
- Khatir, A.M.M., Ding, X.L. & Fang, T. 1999. Hypoglycaemic effect of fenugreek gum on normal and alloxan diabetic rats. *Journal of Wuxi University of Light Industry* 18: 16-20.
- Khosla, P., Gupta, D.D. & Nagpal, R.K. 1995. Effect of *Trigonella foenum-graecum* (Fenugreek) on blood glucose in normal and diabetic rats. *Indian Journal of Physiological Pharmacology* 39: 173-174.
- Küçükgülçlü, Ö., Kızılcı, S., Mert, H., Uğur, Ö., Besen, D.B. & Ünsal, E. 2010. Complementary and alternative medicine use among people with diabetes in Turkey. *Western Journal of Nursing Research* 22: 20-26.
- Latiff, A., Ismail, G., Omar, M., Said, M.I. & Kadri, A. 1980. A multivariate approach to the study of medicinal plants in Malaysia. *Journal Singapore National Academy of Science* 13: 101113.
- Leatherdale, B.A., Panesar, R.K., Singh, G., Atkins, T.W., Bailey, C.J. & Bignell, A.H. 1981. Improvement in glucose tolerance due to *Momordica charantia* (karela). *British Medical Journal (Clin. Res. Ed.)* 282: 1823-1824.
- Li, W., Zheng, H.C., Bukuru, J. & De Kimpe, N. 2004. Natural medicines used in the traditional Chinese medical system for therapy of diabetes mellitus. *Journal of Ethnopharmacology* 92: 1-24.
- Miura, T., Itoh, C., Iwamoto, N., Kato, M., Kawai, M., Park, S.R. & Suzuki, I. 2001. Hypoglycemic activity of the fruit of the *Momordica charantia* in type 2 diabetic mice. *Journal of Nutrition, Sciences and Vitaminology* 47: 340-344.
- Onal, S., Timur, S., Okutucu, B. & Zihnioğlu, F. 2005. Inhibition of alpha-glucosidase by aqueous extracts of some potent antidiabetic medicinal herbs. *Preparative Biochemistry and Biotechnology* 35: 29-36.
- Özbek, H., Ceylan, E., Kara, M., Özgökçe, F. & Koyuncu, M. 2004. Hypoglycemic effect of *Rheum ribes* roots in alloxan induced diabetic and normal mice. *Scand. J. Lab. Anim. Sci.* 31(2): 113-115.
- Öztürk, Y., Aykut, M., Kelestimur, F., Günay, O., Çetinkaya, F. & Ceyhan, O. 2000. Prevalance of diabetes mellitus and affected factors in the district of Kayseri. *Turk. J. Med. Sci.* 30: 181-185.
- Polat, R. & Satıl, F. 2012. An ethnobotanical survey of medicinal plants in Edremit Gulf (Balıkesir- Turkey). *Journal of Ethnopharmacology* 139: 626-641.
- Raman, A. & Lau, C. 1996. Anti-diabetic properties and phytochemistry of *Momordica charantia* L. (Cucurbitaceae). *Phytomedicine* 2: 349-362.
- Ribes, G., Savaire, Y., Baccou, J.C., Valette, G., Chenon, D. & Trimble, D.R. 1984. Effects of fenugreek seeds on endocrine pancreatic secretions in dogs. *Annals of Nutrition Metabolism* 28: 37-43.
- Satman, I., Yilmaz, T. & Sengul, A. 2002. Population-based study of diabetes and risk characteristics in Turkey: Results of the Turkish Diabetes Epidemiology Study (TURDEP). *Diabetes Care* 25: 1551-1556.
- Shani, J., Goldschmied, A., Joseph, B., Zhronson, A. & Sulman, F.G. 1974. Hypoglycemic effect of *Trigonella foenum graecum* and *Lupinus termis* seeds and their major alkaloids in alloxan diabetic and normal rats. *Achievements of International Pharmacodynamical Therapy* 214: 27-37.
- Shirdel, Z., Madani, H. & Mirbadalzadeh, R. 2009. Investigation into the hypoglycemic effect of hydroalcoholic extract of *Zizyphus Jujuba* Leaves on blood glucose and lipids in Alloxan-Induced diabetes in rats. *Iranian Journal of Diabetes and Lipid Disorders* 1: 13-19.
- Smirin, P., Taler, D., Abitbol, G., Brutman-Barazani, T., Kerem, Z., Sampson, S.R. & Rosenzweig, T. 2010. *Sarcopoterium spinosum* extract as an antidiabetic agent: *In vitro* and *in vivo* study. *Journal of Ethnopharmacology* 129: 10-17.
- Stark, A. & Madar, Z. 1993. The effect of an ethanol extract derived from fenugreek (*Trigonella foenum-graecum*) on bile acid absorption and cholesterol levels in rats. *British Journal of Nutrition* 69: 277-287.
- Trojan-Rodrigues, M., Alves, T.L.S., Soares, G.L.G. & Ritter, R.M. 2012. Plants used as antidiabetics in popular medicine in Rio Grande do Sul, southern Brazil. *Journal of Ethnopharmacology* 139: 155-163.
- Tuzlacı, E. & Tolon, E. 2000. Turkish folk medicinal plants, Part III: Şile (İstanbul-Turkey). *Fitoterapia* 71: 673-685.
- Tuzlacı, E. & Aymaz, P.E. 2001. Turkish folk medicinal plants. Part IV: Gönen (Balıkesir-Turkey). *Fitoterapia*: 72: 323-343.
- Vats, V., Grover, J.K. & Rathi, S.S. 2001. Evaluation of anti-hyperglycemic and hypoglycemic effect of *Trigonella foenum-graecum* Linn., *Ocimum sanctum* Linn. and *Pterocarpus marsupium* Linn. in normal and alloxanized diabetic rats. *Journal of Ethnopharmacology* 79: 95-100.

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