Ethnobotanical survey about the management of diabetes with medicinal plants used by diabetic patients in Region of Fez-Meknes, Morocco

Hamza Mechchate, Imane Es-safi, Fatima Zahra Jawhari, Amina Bari, Andriy Grafov, Dalila Bousta

Research

Abstract

Background: Diabetes mellitus is a major public health problem in Morocco with more than 1.6 million cases of diabetes in 2017 with an expectation to rise to over 2.7 million cases in 2045. The aim of this work is to provide ethnobotanical information on some of the medicinal plants used by diabetic patients to treat their illness in the region of Fez-Meknes (Morocco).

Methods: A semi-structured and simple questionnaire was carried out. A total of 422 interviews were conducted with diabetic patients presented to diagnosis in the Hassan II Hospital center in Fez in Morocco. The data were analyzed through use value (UV) and relative frequency of citations (RFC).

Results: In total, 50 plant species belonging to 27 families were reported. Lamiaceae (14%), Apiaceae (12%) and Fabaceae (12%) were reported as the most represented families. Among the collected species, 6 plants were reported for the first time as antidiabetic plants in Morocco. The most frequently cited plant species are Trigonella foenum graecum (8.41%), Olea europaea (7.71%) and Prunus amygdalus var. amara (7.71%). Almost 67% and 33% of diabetic patient use medicinal plants as a complement and alternatives to their medication respectively.

Conclusion: This study showed the importance of medicinal plants in the healthcare system for treating diabetes. Knowledge of the use of medicinal plants that are used to manage diabetes may contribute to their preservation and to undertake further pharmacological studies.

Keywords: Ethnobotanical survey, Diabetes, Management of Diabetes, Medicinal plant, Fez-Meknes, Morocco

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Background

Diabetes is a serious, chronic disease (WHO 1999). Raised blood glucose, a common effect of uncontrolled diabetes, may, over time, lead to serious damage to the heart, blood vessels, eyes, kidneys and nerves. More than 400 million people live with diabetes (WHO 2016). According to the International Diabetes Federation (IDF) there were 425 million people in the world with diabetes and this...
is projected to increase to 629 million by 2045 (IDF 2017). In Morocco, diabetes mellitus is one of the most common metabolic diseases, there were over 1.6 million cases of diabetes in 2017 and it will rise to about 2.7 in 2045 (IDF 2017).

Diabetes occurs in two main forms, type 1 and type 2. Type 1 accounts for about 10% of diabetes cases, usually caused by an autoimmune attack on β-cells pancreatic, inducing a decrease in insulin secretion. Whereas type 2 is mainly due to insulin resistance (Marx 2002) and accounts about 90% of the cases. It is usually associated with obesity or age.

All forms of diabetes are associated with a number of complications such as retinopathy, nephropathy, neuropathy and cardiovascular disease (King et al. 1998). These complications are due in part to a chronic rise in blood sugar, leading to damage to blood vessels. Currently, diabetes treatment relies heavily on diet, sports, oral hypoglycemic and insulin (Mohler et al. 2009)

Morocco is known for its rich vegetation and plant biodiversity with more than 5200 species and subspecies of vascular plants including 900 endemic plants (Fennane and Ibn Tattou 2012) and over 743 taxa belonging to 101 families and 371 genera. Among these taxa, 40 are endemic to Morocco of medicinal plants (Jamaleddine et al. 2017). The use of medicinal plant and folk medicine date since immemorial time local folk medicine takes a huge part in Moroccan culture and it’s by far the most important source of remedies for primary healthcare (Bellakhdar et al. 1991)

Many studies showed how Moroccan deal with this chronic disease by using medicinal plants (Eddouks et al. 2002; El Amrani et al. 2010; Bousta et al. 2014; Skalli et al. 2019). However the use of medicinal plants by diabetic patient for treatment of Diabetes in the region of Fez-Meknes has not been conducted. Therefore, the aim of this study was to explore and identify medicinal plant species used by diabetic patients in Region of Fez-Meknes.

**Materials and methods**

**Study area**

The study was conducted with 422 diabetic patients in the Hassan II Hospital center in Fez, Morocco (Figure 1). The main hospital who receives patients from all the region which cover a wide geographical area to respond to a population of over 4 million population. There by covering the entire new Fez-Meknes region, which covers an area of 40,075 Km² or 5.7% of the national territory. This region is located in the Plain of Saiss, halfway between the north and the south of the Kingdom of Morocco. The maximum average temperature is 37 ° C and the minimum is 6 ° C. The region of Fez-Meknes is administratively two prefectures: the Prefecture of Fez and the Prefecture of Meknes and the seven provinces of Boulemane, El Hajeb, Ifrane, Moulay Yaâcoub, Sefrou, Taounate and Taza (Monographie Generale, 2015)

![Fig. 1. Map of the study area](image)
Data collection
An ethnobotanical survey was conducted from December 2018 to May 2019. The data were collected through a semi-structured and simple questionnaire (Annex A).

Plant identification
Local names, plant ‘props’ (freshly collected plant material or photographs) were used to identify the plants listed by the patients. Voucher specimens of each plant have been collected with the approval of patients and deposited at the herbarium of the Biotechnology laboratory and preservation of natural resources in the Faculty of Sciences, Dhar el Mahraz Fez. Identification of botanical names were undertaken in collaboration with Prof. Amina Bari (Botanist) and following the “Flore Practique du Maroc” (Practical Flora of Morocco) (Fennane et al. 1999).

Data analysis
Fidelity level (FL)
Fidelity level is useful for identifying the key informants’ most preferred species used for treating certain ailments. The medicinal plants that are widely used by the local people have higher FL values than those that are less popular. Fidelity level shows the percentage of informants claiming the use of a certain plant species for the same major purpose. This is designed to quantify the importance of the species for a given purpose.

\[ FL(\%) = \frac{NP}{N} \times 100, \]

where \( NP \) is the number of informants that claimed a use of a plant species to treat a particular disease and \( N \) is the number of informants that used plants as a medicine to treat any given disease (Friedman et al. 1986).

Use value (UV)
The use-value is a quantitative method that demonstrates the relative importance of species known locally, calculated using the following formula (Phillips et al. 1994):

\[ UV = \frac{\sum U}{N} \]

Where, “U” refers to the number of uses mentioned by the informants for a given species and “N” refers to the total number of informants interviewed. If a plant secures a high UV score that indicates there are many use reports for that plant, while a low score indicates fewer use reports cited by the informants.

Relative frequency of citations
The relative frequency of citation shows the local importance of each species and it’s obtained by dividing the number of informants, who mention the use of the species, also known as the Frequency Citation (FC), by the number of informants participating in the survey (N) (Tardio and Pardo-de-Santayana 2008).

\[ RFC = \frac{FC}{N} \left(0 < RFC < 1\right) \]

Statistical analysis
Raw data entries were carried out using Microsoft Excel 2016 for windows, Frequencies were calculated with JASP statistics version 0.9.2.0 for windows and figures were made with GraphPad Prism version 6.01 for windows.

Results and discussion
Socio-demographic profile of the diabetic patients
Our results (Table 1) indicate that women (83.65%) used medicinal plants more frequently than men (16.35%). This was also the result of other surveys conducted in different regions of Morocco (Ziyyat et al. 1997; Jouad et al. 2001; Eddouks et al. 2002; Tahraoui et al. 2007; Benkhnigue et al. 2014; Bousta et al. 2014; Skalli et al. 2019). This is related to the role of the women in the region in housekeeping and management of the house problems, having the knowledge of medicinal plants is by the time transmitted by mother and daughter and also by neighbor’s, family and friend. This knowledge could be sometime helpful with minor and major health problems. Women are more attached than men to everything traditional.

The age reparation of the patient interviewed was: for those between 50-65 (53.1%) followed by those between 35-49 (34.4%) and for the ages between 25-34 and more than 65 it was 5.7% and 6.8% respectively our study matched earlier studies that have shown that the use of medicinal plants was more important in age categories between 30 and 60 years (Ziyyat et al. 1997; Jouad et al. 2001; Barkaoui et al. 2017) this category is represented by mostly married women who unroll their main activities in their house.

Most of our interviewed were illiterate with a frequency of 65.7% and about 25.8% who attended elementary school and 7.6% attended the Middle school and only 0.9 attended the university. Same as many other surveys (Ziyyat et al. 1997; Jouad et al. 2001; Benkhnigue et al. 2014; Barkaoui et al. 2017; Skalli et al. 2019) High frequency of illiteracy because of the participation of the girls in the house.
activity to transmit all their knowledge about housekeeping and also the use of medicinal plants in daily life to be prepared to roll their own house in the future. Of the participants 88.1% were married, 6.2 widower, 3.2% were single and 2.5 % are divorced. In order to reduce their expenses, married people tend to use cheaper and effective alternative to deal with their different illness, medicinal plant appear to be the first and perfect choice to start with.

Table 1. Sociodemographic profile of the diabetic patients

| Variable               | Subgroup     | Number | Percentage (%) |
|------------------------|--------------|--------|---------------|
| Sex                    | Male         | 69     | 16,35         |
|                        | Female       | 353    | 83,65         |
| Age                    | 25 - 34 years| 24     | 5,70          |
|                        | 35 - 49 years| 145    | 34,40         |
|                        | 50 - 65 years| 224    | 53,10         |
|                        | > 65 years   | 29     | 6,80          |
| Educational level      | Illiterate   | 277    | 66,7          |
|                        | Elementary   | 109    | 25,8          |
|                        | Middle school| 32     | 7,6           |
|                        | University   | 4      | 0,9           |
| Familial situation     | Married      | 372    | 88,1          |
|                        | Single       | 13     | 3,2           |
|                        | Divorced     | 11     | 2,5           |
|                        | Widower      | 26     | 6,2           |

Sources of information
Their sources of information varied between Herboriste 6.2%, the internet 5.3%, books 1.7% explored by themselves 2.0% but their most important source was other experiences with 84.8% same as (Benkhnigue et al. 2014). This could be explained by the specialties of our society women tend to talk a with each other about their daily problems and this how many new medicinal plant knowledge is spread.

Reasons to use medicinal plants
Those who preferred the phytotherapical care justifying it by its effectiveness 69.2% and the 30.8% left were more convinced about its availability, low cost, and almost no side effect. In accordance with (Jouad et al. 2001) who find that the reasons for the use of medicinal plants are that these natural remedies are less cheap (53%) and more efficient than modern medicines.

Preference between modern and traditional healthcare
Almost the totality (421 of the 422) has indicated that they will consult medical personnel in case of sickness. This result reflects a good reasoning because the medical personnel is the only one who could provide true diagnosis.

Diversity of medicinal plants
In this ethnobotanical survey we recorded information on a total of 50 medicinal plant species, belonging to 27 families (Table 1). Information such as the local name of plant species, used parts, mode of preparation, ethnobotanical indices are provided for each species. Families with the most reported plant species were Lamiaceae (7 species, 14%), Apiaceae (6 species, 12%) and Fabaceae (6 species, 12%) (Figure 2). This result is in agreement with previous reports where these families were the most represented families in diabetes mellitus treatment in Morocco (Benkhnigue et al. 2014; Barkaoui et al. 2017; Skalli et al. 2019). Dominance of these families could be attributed to their abundance in the Moroccan flora (Fennane and Ibn Tattou, 2012). Among the 50 collected species, 6 plants were reported for the first time as antidiabetic plants in Morocco and 5 were reported elsewhere (Table 2).

Fidelity level, Use value and relative frequency of citation of the medicinal plants
Values of collected plants species ranged from 28.57 to 100% (FL), 1 to 3.50 (UV) and 0.23 to 8.41 (RFC). The UV of Nigella sativa L. and Ficus carica were reported to cure all diseases basing on their religion as a result their UV and FL was not calculated. (Table 3). Of the 50 inventoried species 20 plant species were identified with FL greater than 0.60: Ammi visnaga, Coriandrum sativum, Foeniculum vulgare, Opuntia ficus-indica, Mill. Ceratonia siliqua,
Lupinus albus, Vicia faba, Lavandula stoechas, Marrubium Vulgare, Rosmarinus officinalis, Cinnamomum verum, Salvia officinalis, Linum usitatissimum, Myrtus communis, Olea europaea, Papaver rhoeas, Pinus pinaster ssp. hamiltonii var moghrebiana, Loliurn multiflorum, Prunus amygdalus var. arama, Zygophyllum gaetulum.

The plants that have less UV indicated that the plants are significantly used to treat diabetes in the area. Accordingly, a total of 12 plant species have a UV equal or less than 1.50. These plants were: Ammi visnaga, Coriandrum sativum, Opuntia ficus-indica, Mill. Vicia faba, Lavandula stoechas, Linum usitatissimum, Myrtus communis, Olea europaea, Papaver rhoeas, Loliurn multiflorum, Prunus Amygdalus var. arama, Zygophyllum gaetulum.)

Based on RFC values, the most frequently used plants to treat diabetes. are Trigonella foenum graecum (8.41), Olea europaea (7.71), Prunus amygdalus var. arama (7.71), Caralluma europaea (6.31), Marrubium vulgare (4.44) and Zingiber officinale (3.97). Similar results were reported in other studies conducted in Morocco for Trigonella foenum-graecum (Ziyat et al. 1997; Jouad et al. 2001; Eddouks et al. 2002; Benkhnigue et al. 2014; Bousta et al. 2014; Skalli et al. 2019), Olea europea (Jouad et al. 2001; Tahraoui et al. 2007; Benkhnigue et al. 2014; Bousta et al. 2014; Skalli et al. 2019), Marrubium vulgare (Jouad et al. 2001; Eddouks et al. 2002; Barkaoui et al. 2017) and Caralluma europaea (Benkhnigue et al. 2014).

Previous laboratory analysis of Trigonella foenum-graecum has shown that the plant has a dose-related hypoglycemic effect in normal and diabetic rats (Khosla et al. 1995; Abdel-Barry et al. 1997; Raju et al. 2001; Xue et al. 2007) and in type II diabetic patients (Gupta et al. 1984). It has an effect also on glucose homeostasis (Abdel-Barry et al. 1997; Raju et al. 2001; Xue et al. 2007), insulin resistance (Gupta et al. 1984), insulin mimetic effect (Baquer et al. 2011), antioxidant and protective effect (Tripathi and Chandra 2010; Kumar et al. 2012). Olea europaea has been also reported having a significant antidiabetic effect on diabetic rats (Eidi et al. 2009; Wainstein et al. 2012; El-Amin et al. 2013; Sangi et al. 2015) and on rabbits (Al-Azzawiie and Alhamdani 2006). It attenuates early diabetic neuropathic pain (Kaeidi et al., 2011). It improves insulin sensitivity (de Bock et al. 2013). Therapeutic effect on lipidic and carbohydrate metabolism (Bennani Kabchi et al. 2000).

Plant parts used, mode of preparation and administration
Seeds were the most frequently used plant parts with a percentage of 33% followed by aerial part (31%) (Figure 3). Dried plants were mostly (59%) used to prepare the treatment and 41% used fresh plant parts. Decoction is the major preparation mode with a percentage of (39%), followed by powder (29%), raw (18%), juice (12%) and infusion (2%).

Plants used as complement or alternative medicine to conventional medicine
The use of medicinal plants were reported as complement (67%) and alternative (33%) to modern medicine (Table 3). Morocco is a country where the knowledge of traditional medicines is incorporated into its culture and is by far a very valuable heritage. Aside from sometimes its low efficacy which may explain the choice of conventional medicine by certain people over medicinal plants.

Conclusions
Several medicinal plants were being used in the study area to treat diabetes. Diabetic patients highly use medicinal plants as a complement and also as alternatives. Six plant species were reported for the first time in Morocco and 5 plants from elsewhere. The wide variety of medicinal plants that are used to treat diabetes and the frequency of citation support the important role of plants in the primary healthcare system of Moroccans. The wide variety of medicinal plants that are used to treat diabetes and the frequency of use among diabetic patients support the important role of plants in the primary healthcare system of Moroccans people. Development of the sector of medicinal plants is a major challenge to come for the scientific community from where the obligation to expand the research to validate or denied the use of certain plant against certain disease and aware people about their toxicity. Therefore, this documented information on the medicinal plants used in the region of Fez-Meknes may be used as baseline data for future pharmacological and phytochemical studies.

Declarations
List of Abbreviations: FL: Fidelity level; UV: Use value; RFC: Relative frequency of citations; F: Fresh; D: Dried; AP: Aerial part; S: Seed; R: Roots; Res: Resin; Epi: Epicarp; L: Leaves; Fr: Fruit; C: Complement; AM: Alternative medicine; ND: No data
Ethics approval and consent to participate: Before conducting interviews, prior informed consent was obtained from all participants. No further ethics approval was required.
Consent for publication: Not applicable
Conflict of interest: The authors declare that they have no conflict of interest.
Table 2. Medicinal plants used for the treatment of diabetes in the region of Fez-Meknes Morocco

| Name of plants       | Vernacular name | Citation | RFC | UV  | FL  | Citation in Morocco                                                                 |
|----------------------|-----------------|----------|-----|-----|-----|-------------------------------------------------------------------------------------|
| Apiaceae             |                 |          |     |     |     |                                                                                     |
| Ammi visnaga (L.) Lam. BPRN20 | Bechnikha | 9  | 2.10 | 1.44 | 69.23 | (Bousta et al., 2014; Eddouks et al., 2002; Jouad et al., 2001a, 2002; Tahraoui et al., 2007) |
| Apium graveolens L. BPRN25 | Krafess | 8  | 1.87 | 1.88 | 53.33 | No Data                                                                 (Gutierrez et al., 2014; ROGHANI et al., 2008; Roghani et al., 2007) |
| Carum carvi L. BPRN15 | Karwiya         | 8  | 1.87 | 2.00 | 50.00 | (Amrani et al., 2010; Barkaoui et al., 2017; Benkhnigue et al., 2014; Eddouks et al., 2002; El Jouad et al., 2001; Tahraoui et al., 2007) |
| Coriandrum sativum L. BPRN28 | Kassbour | 12 | 2.80 | 1.41 | 70.58 |                                                                 (M. Eidi et al., 2009; Gray and Flatt, 1999; Naquvi et al., 2004; Sreelatha et al., 2009; Sreelatha and Inbavalli, 2012; Waheed et al., 2006) |
| Foeniculum vulgare Mill. BPRN18 | Hebet hlawa | 8  | 1.87 | 1.62 | 61.15 | (El-Hilaly et al., 2003; Tahraoui et al., 2007)                                                                 (Anitha et al., 2014; El-Soud et al., 2011; Mostafa et al., 2015; Özbek et al., 2003) |
| Petroselinum crispum Mill. BPRN30 | Maadnouss | 5  | 1.17 | 2.80 | 35.70 | (Tahraoui et al., 2007)                                                                 (Bolkent et al., 2004; OzsoySacan et al., 2006; Sener et al., 2003; Soliman et al., 2015; Tunali et al., 1999) |
| Apocynaceae          |                 |          |     |     |     |                                                                                     |
| Caralluma europaea Guss. BPRN64 | Daghmous | 27 | 6.31 | 1.85 | 54.00 | (Benkhnigue et al., 2014)                                                                 (Dra et al., 2018) |
| Asteraceae           |                 |          |     |     |     |                                                                                     |
| Artemisia absinthium L. BPRN46 | Chiba | 3  | 0.70 | 2.00 | 50.00 | (Benkhnigue et al., 2014; Eddouks et al., 2002; El Amrani et al., 2010; Jouad et al., 2001a; Tahraoui et al., 2007) |
| Artemisia herba alba asso L. BPRN16 | Chih | 15 | 3.50 | 2.33 | 42.85 | (Benkhnigue et al., 2014; Eddouks et al., 2002; El Amrani et al., 2010; Jouad et al., 2001a; Tahraoui et al., 2007) |

(Citation elsewhere: (Demoz et al., 2015) (Gutierrrez et al., 2014; ROGHANI et al., 2008; Roghani et al., 2007) (Eidi et al., 2010; Ene et al., 2008; Haidari et al., 2011) (Daradka et al., 2014) (Anitha et al., 2014; El-Soud et al., 2011; Mostafa et al., 2015; Özbek et al., 2003) (Al-Waili, 1986; Awad et al., 2012; Boudjelal et al., 2015; Hamza et al., 2015; Taştekin et al., 2006))
| Family           | Species                          | Location | Radiation | Growth | Yield (%) | References                                                                 |
|------------------|----------------------------------|----------|-----------|--------|-----------|-----------------------------------------------------------------------------|
| **Brassicaceae** | *Chamaemelum nobile* L.         | Babounj  | 8         | 1.87   | 2.50      | 40.00 (Eddouks et al., 2002, 2005a; Lemhadri, 2007)                        |
|                  | *Lepidium sativum* L.           | Heb rchad| 2         | 0.47   | 3.00      | 33.33 (Bnouham et al., 2002; Eddouks et al., 2005b; Eddouks and Maghrani, 2008; Jouad et al., 2001b; Tahraoui et al., 2007) | (Attia et al., 2018; Rachid et al., 2012) |
|                  | *Raphanus sativus* L.           | Fjel     | 3         | 0.70   | 2.00      | 50.00 (Barkaoui et al., 2017; El-Hilaly et al., 2003; Jouad et al., 2001b; Mrabti et al., 2019) |
| **Burseraceae**  | *Commiphora myrrha* (Nees) Engl. | Lmorra   | 1         | 0.23   | 2.00      | 50.00 (Ubillas et al., 1999)                                              |
| **Cactaceae**    | *Opuntia ficus-indica* (L.) Mill.| Hendia   | 7         | 1.63   | 1.00      | 100.00 (Berraouan et al., 2015; Jouad et al., 2001b; Tahraoui et al., 2007) |
| **Chenopodiaceae** | *Chenopodium ambrosioides* L. | M'khinza | 3         | 0.70   | 2.60      | 37.50 (Eddouks et al., 2002; El Amrani et al., 2010; Jouad et al., 2001b; Zyyat et al., 1997) |
| **Convolvulaceae** | *Ipomoea batatas* (L.)         | Batata hlouwa | 3     | 0.70   | 2.00      | 50.00 (Kusano et al., 2001; Kusano and Abe, 2000; Li et al., 2009; Ludvik et al., 2008, 2004, 2003, 2002; Zhao et al., 2007) |
| **Cucurbitaceae** | *Cucumis sativus* var. flexuosus L. | Feqous  | 1         | 0.23   | 2.00      | 50.00 No data                                                              |
|                  | *Cucumis melo* var. flexuosus L. | Feqous   | 1         | 0.23   | 2.00      | 50.00 No data                                                              |
| Fabaceae            |          |          |          |          |                                      |
|---------------------|----------|----------|----------|----------|-------------------------------------|
| **Ceratonia siliqua** | L.       | BPRN61   | Alkaroub | 6        | 1.40 1.66 60.0  (Barkaoui et al., 2017; Skalli et al., 2019) |
| **Cicer arietinum**  | L.       | BPRN21   | Homos    | 2        | 0.47 3.0 33.33 (Kabbaj et al., 2012) |
| **Glycine max**     | (L.) Merr. | BPRN40   | Soja     | 5        | 1.17 1.8 55.55 (Barkaoui et al., 2017; Katiri et al., 2017; Mrabti et al., 2019; Tahraoui et al., 2007) |
| **Lupinus albus**   | L.       | BPRN41   | Foul gnawa | 9        | 2.10 1.00 100.00 (Eddouks et al., 2002; Haddad et al., 2001; Jouad et al., 2001b) |
| **Trigonella foenum-** | *graecum* | L.       | Helba    | 36       | 8.41 2.02 49.31 (Barkaoui et al., 2017; Jouad et al., 2001b; Tahraoui et al., 2007; Ziyyat et al., 1997) |
| **Vicia faba**      | L.       | BPRN51   | Foul     | 3        | 0.70 1.00 100.00 (Barkaoui et al., 2017; Jouad et al., 2001b; Tahraoui et al., 2007; Ziyyat et al., 1997) |
| **Lamiaceae**       |          |          |          |          |                                      |
| **Calamintha officinalis** | Moench. | BPRN14   | Manta    | 3        | 0.70 2.00 50.00 (Eddouks et al., 2017; Jouad et al., 2001b; Lemhadri et al., 2004) |
| **Lavandula stoechas** | L. | BPRN56   | Khzama   | 6        | 1.40 1.50 66.66 (Barkaoui et al., 2017; Benkhnigue et al., 2014; Tahraoui et al., 2007) |
| **Marrubium vulgare** | L.       | BPRN55   | Meriwta  | 19       | 4.44 1.57 63.33 (Barkaoui et al., 2017; Benkhnigue et al., 2014; Eddouks et al., 2002; El Amrani et al., 2010; Jouad et al., 2001a; Tahraoui et al., 2007; Ziyyat et al., 1997) |
| **Mentha pulegium** | L.       | BPRN49   | Fliou    | 14       | 3.27 2.28 43.75 (Eddouks et al., 2002; El Amrani et al., 2010; Jouad et al., 2001a; Ziyyat et al., 1997) |
| **Origanum compactum** | Benth. | BPRN11   | Zaater   | 6        | 1.40 3.50 28.57 (Eddouks et al., 2002; Jouad et al., 2001a; Ziyyat et al., 1997) |

(Badele and Bodhankar, 2009; Benalla et al., 2010; Gina et al., 2016) || (Milek dos Santos et al., 2015; Rtibi et al., 2017b, 2017a; Yaniv et al., 1987) || (Dilawari et al., 1981; Prathapath et al., 2011) || (Badole and Bodhankar, 2009; Benalla et al., 2010; Gina et al., 2016) || (Abdel-Barry et al., 1997; Hannan et al., 2007, 2003; Raju et al., 2001; Vats et al., 2002) || (Singh et al., 2012) || (Sebai et al., 2013) || (Boudjelal et al., 2015; Elberry et al., 2015; Herrera-Arellano et al., 2004; Vergara-Galicia et al., 2012; Yaniv et al., 1987) || (Rachid et al., 2012) ||
| Family          | Species                        | Reference 1                      | Reference 2                      | Reference 3                      | Reference 4                      | Reference 5                      | Reference 6                      | Reference 7                      | Reference 8                      |
|-----------------|--------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|
| Lauraceae       | *Cinnamomum verum* J. Presl    | Karfa                            | 3                                | 0.70                             | 1.66                             | 60.00                            | No data                          | No data                          | No data                          |
|                 |                                |                                  |                                  |                                  |                                  |                                  |                                  |                                  |                                  |
| Liliaceae       | *Allium cepa* L.               | Bassla                           | 4                                | 0.93                             | 2.50                             | 40.00                            | (Campos et al., 2003; Kumari et al., 1995; Mathew and Augusti, 1975; Rachid et al., 2012) |                                  |                                  |
|                 |                                |                                  |                                  |                                  |                                  |                                  |                                  |                                  |                                  |
|                 | *Allium sativum* L.            | Touma                            | 3                                | 0.70                             | 2.66                             | 37.50                            | (Ashraf et al., 2011; Eidi et al., 2006; Islam and Choi, 2008; Mostofa et al., 2007) |                                  |                                  |
|                 |                                |                                  |                                  |                                  |                                  |                                  |                                  |                                  |                                  |
| Lamiaceae       | *Salvia officinalis* L.        | Salmiya                          | 15                               | 3.50                             | 1.53                             | 65.21                            | (Eidi and Eidi, 2009; Eidi et al., 2005; Kianbakht and Dabaghian, 2013; Lima et al., 2006) |                                  |                                  |
|                 |                                |                                  |                                  |                                  |                                  |                                  |                                  |                                  |                                  |
| Linaceae        | *Linum usitatissimum* L.       | Zeriat el Ketan                  | 16                               | 3.74                             | 1.50                             | 66.66                            | (Ghule et al., 2012; Mani et al., 2011) |                                  |                                  |
|                 |                                |                                  |                                  |                                  |                                  |                                  |                                  |                                  |                                  |
| Lythraceae      | *Punica granatum* L.           | Reman                            | 9                                | 2.10                             | 1.88                             | 52.94                            | (Das et al., 2001; Huang et al., 2005; Jafri et al., 2000; Li et al., 2005; Radhika et al., 2011) |                                  |                                  |
|                 |                                |                                  |                                  |                                  |                                  |                                  |                                  |                                  |                                  |
| Moraceae        | *Ficus carica* L.              | Tine                             | 3                                | 0.70                             | ND                               | ND                               | (Abo et al., 2008; Rachid et al., 2012) |                                  |                                  |
### Myrtaceae

*Myrtus communis* L.  
BPRN60

| Variety | Location   | BPRN | R. | C. | VT. |
|---------|------------|------|----|----|-----|
| Rihane  |            | 3    | 0.70 | 1.00 | 100.00 |

(Eddouks et al., 2002; Jouad et al., 2001b; Tahraoui et al., 2007; Ziyyat et al., 1997)  
(Mahmoudzadeh-Sagheb et al., 2010; Rachid et al., 2012; Telli et al., 2016)

*Eucalyptus globulus* Labill.  
BPRN23

| Variety | Location   | BPRN | R. | C. | VT. |
|---------|------------|------|----|----|-----|
| Kaliptus|            | 6    | 1.40 | 2.00 | 50.0 |

(Benkhnigue et al., 2014; Bousta et al., 2014; Eddouks et al., 2002; El Amrani et al., 2010; Jouad et al., 2001b; Orch et al., 2015; Tahraoui et al., 2007; Zayneb et al., 2015; Ziyyat et al., 1997)

### Oleaceae

*Olea europaea* L.  
BPRN12

| Variety | Location   | BPRN | R. | C. | VT. |
|---------|------------|------|----|----|-----|
| Zitoune  |            | 33   | 7.71 | 1.36 | 73.33 |

(Benkhnigue et al., 2014; Bousta et al., 2014; Eddouks et al., 2002; El Amrani et al., 2010; Jouad et al., 2001b; Orch et al., 2015; Tahraoui et al., 2007; Zayneb et al., 2015; Ziyyat et al., 1997)

(Eddouks et al., 2002; Katiri et al., 2017)

### Papaveraceae

*Papaver rhoes L.*  
BPRN54

| Variety | Location   | BPRN | R. | C. | VT. |
|---------|------------|------|----|----|-----|
| Belaaman|            | 1    | 0.23 | 1.00 | 100.00 |

(Eddouks et al., 2002; Katiri et al., 2017)

### Pedaliaceae

*Sesamum indicum* L.  
BPRN66

| Variety | Location   | BPRN | R. | C. | VT. |
|---------|------------|------|----|----|-----|
| Zenjlane |            | 3    | 0.70 | 2.00 | 50.00 |

(Eddouks, 2017; Eddouks et al., 2002; Jouad et al., 2001b; Tahraoui et al., 2007)

(Bhuvaneswari and Krishnakumari, n.d.; TAKEUCHI et al., 2001; Wikul et al., 2012)

### Pinaceae

*Quercus suber* L.  
BPRN13

| Variety | Location   | BPRN | R. | C. | VT. |
|---------|------------|------|----|----|-----|
| Dbagh    |            | 1    | 0.23 | 3.00 | 33.33 |

No data

### Poaceae

*Lolium multiflorum* Lam.  
BPRN48

| Variety | Location   | BPRN | R. | C. | VT. |
|---------|------------|------|----|----|-----|
| Zwane   |            | 2    | 0.46 | 1.00 | 100.00 |

(Katiri et al., 2017)

No data

### Ranunculaceae

*Nigella sativa* L.  
BPRN53

| Variety | Location   | BPRN | R. | C. | VT. |
|---------|------------|------|----|----|-----|
| Sanouj  |            | 9    | 2.10 | ND | ND |

(Eddouks et al., 2002; Jouad et al., 2001b; Tahraoui et al., 2007; Ziyyat et al., 1997)

(Bamosa et al., n.d.; Fararh et al., 2002; Kanter et al., 2003; Meral et al., 2001)

### Rhamnaceae

*Zizyphus lotus* L.  
BPRN09

| Variety | Location   | BPRN | R. | C. | VT. |
|---------|------------|------|----|----|-----|
| Sidra(nbeg) |          | 6    | 1.40 | 2.16 | 46.15 |

(Barkaoui et al., 2017; Jouad et al., 2001b; Katiri et al., 2017; Tahraoui et al., 2007; Ziyyat et al., 1997)

(Benammar and Baghdad, 2014; Glombitza et al., 1994)
| Family          | Genus                          | Species               | State  | Formulation, preparation and dosage                                                                 | Other ethnopharmacological uses                   | Complement or alternative medicine |
|-----------------|--------------------------------|-----------------------|--------|------------------------------------------------------------------------------------------------------|-----------------------------------------------|-----------------------------------|
| Rosaceae        | **Prunus amygdalus** Stokes var. amara L. | BPRN17                |        | Louze Imor 33 7.71 1.24 80.48 (Eddouks, 2017; Jouad et al., 2001b; Merzouki et al., 2003)             | No data                                       |                                   |
| Zingiberaceae   | **Zingiber officinale** Rosc. BPRN62 | Skinjbir              | 17     | 3.97 1.82 54.83 No data (Al-Amin et al., 2006; Islam and Choi, 2008; Mahluji et al., 2013)          | No data                                       |                                   |
| Zygophyllaceae  | **Zygophyllum gaetulum** Emb. & Maire | BPRN15                |        | Aagaya 1 0.23 1.00 100.00 (Eddouks et al., 2002; Jaouhari et al., 2000, 1999; Jouad et al., 2001a; Tahraoui et al., 2007) | No data                                       |                                   |

Table 3. Formulation and information about medicinal plants used for the treatment of diabetes in the region of Fez-Meknes Morocco
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### Cactaceae
- **Opuntia ficus-indica** (L.) Mill.
  - Epi/F or D Juice, variable quantity mix with water, 1-2 C/D
  - No other uses mentioned
  - AM

### Chenopodiaceae
- **Chenopodium ambrosioides** L.
  - AP/F Juice, variable quantity mix with water, lemon juice 1-2 C/D
  - Antipyretic, headache
  - C,AM

### Convolvulaceae
- **Ipomoea batatas** L.
  - R/F Raw, 1-2 pieces/D
  - Cholesterol, anticancer
  - C,AM

### Cucurbitaceae
- **Cucumis sativus** L.
  - Fr/F Raw, 1-2 pieces/D
  - Antipyretic
  - C

- **Cucumis melo var. flexuosus** L.
  - Fr/F Raw, 1-2 pieces/D
  - Antipyretic
  - C

### Fabaceae
- **Ceratonia siliqua** L.
  - Fr/D Decoction, handful quantity in 1 L of water 1-2 C/D
  - No other uses mentioned
  - C,AM

- **Cicer arietinum** L.
  - S/D Raw fraiche seeds 10-20 pieces/D
  - Against Digestion problems and diarrhea
  - C

- **Glycine max** (L.) Merr.
  - S/F Raw dried seeds 10-15 pieces/day; powder 1-3 TS/D
  - Against Digestion problems and diarrhea
  - C

- **Lupinus albus** L.
  - S/D Powder 1-3 TS/D
  - Aesthetic
  - C

- **Trigonella foenum-graecum** L.
  - S/D Infusion, handful quantity in 1 L of water soaked overnight 1-2 C/D; Powder 1-3 TS/D
  - Increase appetite, breast milk production, weight gain, against cholesterol, Detox.
  - AM

- **Vicia faba** L.
  - S/F Raw fraiche seeds 10-20 pieces/D
  - C

### Lamiaceae
- **Calamintha officinalis** auct.
  - AP/F Decoction, handful quantity in 1 L of water, 1-2 C/D
  - Against different aches, Antipyretic
  - C

- **Lavandula dentata** L.
  - AP/D Decoction, handful quantity in 1 L of water, 1-2 C/D; hydrolates 1-2 C/D
  - Cardiovascular problems.
  - C,AM

- **Marrubium Vulgare** L.
  - AP/F or D Decoction, handful quantity in 1 L of water, 1-2 C/D; hydrolates 1-2 C/D
  - Gastrointestinal problems, Antimicrobial, antiseptic and anti-inflammatory proprieties.
  - C

- **Mentha pulegium** L.
  - AP/F or D Decoction, handful quantity in 1 L of water, 1-2 C/D; hydrolates 1-2 C/D; powder, 1-2 TS/D
  - Flu, respiratory problems, Rheumatism
  - C

- **Origanum compactum** Benth.
  - AP/F or D Decoction, handful quantity in 1 L of water, 1-2 C/D; hydrolates 1-2 C/D; powder, 1-2 TS/D
  - Digestion problems, against men erection
  - C

- **Rosmarinus officinalis** L.
  - AP/F or D Decoction, handful quantity in 1 L of water, 1-2 C/D; hydrolates 1-2 C/D; powder, 1-2 TS/D
  - Cholesterol, digestion problems and to have appetite
  - C

- **Thymus vulgaris** L.
  - AP/F or D Decoction, handful quantity in 1 L of water, 1-2 C/D; hydrolates 1-2 C/D; powder, 1-2 TS/D
  - C

### Lauraceae
- **Cinnamomum verum** J. Presl
  - Bark/D decoction of powder, 1-2 in 500 ml of water 1-2 C/D
  - Menstrual pain
  - C

### Liliaceae
- **Allium cepa** L.
  - Bulb/F Raw 1-2 pieces/D
  - Cholesterol, inflammation and edema formation
  - C

- **Allium sativum** L.
  - S/F Raw 3-9 pieces
  - Cardiovascular problems, colon problems
  - C

- **Salvia officinalis** L.
  - L/F or D Decoction, handful quantity in 1 L of water, 1-2 C/D
  - Menstrual pain, Cardiovascular problems
  - C

### Linaceae
- **Linum usitatissimum** L.
  - S/D Powder, 1-4 TS/D
  - Bloating, cholesterol, food transit
  - C,AM
| Family          | Species                        | Form   | Preparation | Ingredient                  | Condition                                      | Code       |
|-----------------|--------------------------------|--------|-------------|------------------------------|------------------------------------------------|-----------|
| **Lythraceae**  | Punica granatum L.             | Epi/D  | Decoction, handful quantity in 1 L of water, 1-2 C/D, include with bread preparation | Kidney problems, Detox                          | C;AM      |
| **Moraceae**    | Ficus carica L.                | L/D    | Decoction, variable quantity in 1 L of water, 1-2 C/D | All diseases                                   | C         |
| **Myrtaceae**   | Myrtus communis L.             | L/F or D | Decoction, handful quantity in 1 L of water, 1-2 C/D | No other uses mentioned                         | C         |
| **Oleaceae**    | Eucalyptus globulus Labill.    | L/F or D | Decoction, handful quantity in 1 L of water, 1-2 C/D | Flu, Respiratory problems                      | C         |
| **Oleasteraceae** | Olea europaea L.               | L/F    | Decoction, handful quantity in 1 L of water, 1-2 C/D | Cholesterol, Cardiovascular problems, dental care | AM        |
| **Papaveraceae**| Papaver rhoeas L.              | S/D    | Powder, 1-2 TS/D | No other uses mentioned            |           |
| **Pedaliaceae** | Sesamum indicum L.             | S/D    | Powder, 1-3 TS/D, include with bread preparation | Bloating, Digestion problems                   | C         |
| **Pinaceae**    | Pinus pinaster ssp. hamiltonii var moghrebiana H. del Villar | Eco/D  | Decoction, 1 TS in 1 L of water, 1-2 C/D | gastric ulcer, hair care                        | AM        |
| **Poaceae**     | Lolium multiflorum Lam.        | S/D    | Powder, 1-2 TS/D | No other uses mentioned          | C;AM      |
| **Ranunculaceae** | Nigella sativa L.              | S/D    | Powder 1-2 TS, include with bread preparation | All disease                                    | C         |
| **Rhamnaceae**  | Zizyphus lotus L.              | S/D    | Decoction, handful quantity in 1 L of water, 1-2 C/D | Kidney problems                               | C         |
| **Rosaceae**    | Prunus amygdalus var. amara L. | S/D    | Raw dried seeds 3-7 pieces/day | Aesthetic, Stomach ache                     | C;AM      |
| **Zingiberaceae** | Zingiber officinale Rosc.   | Rhi/F or D | Juice of fresh rhizome, variable quantity in water, 1-2 C/D, Powder of dried rhizomes 1-3 TS/D | flu, tiredness and anticancer                     | C         |
| **Zygophyllaceae** | Zygophyllum gaetulum Emb. & Maire | AP/D   | Decoction, handful quantity in 1 L of water, 1-2 C/D | No other uses mentioned                         | AM        |

**F**: Fresh; **D**: Dried; **AP**: Aerial part; **S**: Seeds; **R**: Roots; **Res**: Resin; **Epi**: Epicarp; **L**: Leaves; **Fr**: Fruit; **C**: Complement; **AM**: Alternative medicine
Ethnobotany Research and Applications

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References
Abdel-Barry JA, Abdel-Hassan IA, Al-Haiemi MHH. 1997. Hypoglycaemic and antihyperglycaemic effects of Trigonella foenum-graecum leaf in normal and alloxan induced diabetic rats. Journal of Ethnopharmacology. 58(3):149-155. doi:10.1016/S0378-8741(97)00101-3.

Abdel-Barry JA, Abdel-Hassan IA, Al-Haiemi MHH. 1997. Hypoglycaemic and antihyperglycaemic effects of Trigonella foenum-graecum leaf in normal and alloxan induced diabetic rats. Journal of Ethnopharmacology. 58(3):149-155. doi:10.1016/S0378-8741(97)00101-3.

Abo KA, Fred-Jaiyesimi AA, Jaiyesimi AEA. 2008. Ethnobotanical studies of medicinal plants used in the management of diabetes mellitus in South Western Nigeria. Journal of Ethnopharmacology. 115(1):67-71. doi:10.1016/j.jep.2007.09.005.

Ahmad M, Khan MA, Arshad M, Zafar M. 2003. Ethnophytotherapeutical Approaches for The Treatment of Diabetes by The Local Inhabitants of District Attock (Pakistan). Pakistan Journal of Botany 41(6):

Ahmad M, Qureshi R, Arshad M, Khan MA, Zafar M. 2003. Traditional herbal remedies used for the Treament of diabetes from district Attock (Pakistan). Pakistan Journal of Botany 41(6):2777-2782.

Aissaoui A, Zizi S, Israili ZH, Lyoussi B. 2011. Hypoglycemic and hypolipidemic effects of Coriandrum sativum L. in Meriones shawi rats. Journal of ethnopharmacology. 137(1):652-661.

Al-Amin ZM, Thomson M, Al-Qattan KK, Peltonen-Shalaby R, Ali M. 2006. Anti-diabetic and hypolipidaemic properties of ginger (Zingiber officinale) in streptozotocin-induced diabetic rats. British Journal of Nutrition. 96(4):660-666. doi:10.1079/BJN20061849.

Al-Azzawie HF, Alhamdani M-SS. 2006. Hypoglycemic and antioxidant effect of oleuropein in alloxan-diabetic rabbits. Life sciences. 78(12):1371-1377.

Al-Hader AA, Hasan ZA, Aqel MB. 1994. Hypoglycemic and insulin release inhibitory effects of Rosmarinus officinalis. Journal of Ethnopharmacology. 43(3):217-221. doi:10.1016/0378-8741(94)90046-9.

Aljarah AK, Hameed IH. 2018. In Vitro Anti-diabetic Properties of Methanolic Extract of Thymus vulgaris Using α-glucosidase and α-amylase Inhibition Assay and Determination of its Bioactive Chemical Compounds. Indian Journal of Public Health Research & Development. 9(3):388. doi:10.5958/0976-5506.2018.00241.3.

Allali H, Benmehdi H, Dib MA, Tabti B, Ghalem S, Benabadji N. 2008. Phytotherapy of Diabetes in West Algeria. Asian J Chem. 20(4):10.

Alonso-Castro AJ, Maldonado-Miranda JJ, Zarate-Martinez A, del Rosario Jacobo-Salcedo M, Fernández-Galicia C, Figueroa-Zuñiga LA, Rios-Reyes NA, de León-Rubio MA, Medellín-Castillo NA, Reyes-Munguia A. 2012. Medicinal plants used in the Huasteca Potosina, Mexico. Journal of ethnopharmacology. 143(1):292-298.

Al-Waili NS. 1986. Treatment of diabetes mellitus by Artemisia herba-alba extract: preliminary study. Clinical and Experimental Pharmacology & Physiology. 13(7):569-573.

Amin ME, Virk P, Elobeid MAR, Almarhoon ZM, Hassan ZK, Omer SA, Merghani NM, Daghestani MH, Olayan EMA. 2013. Anti-diabetic effect of Murraya koenigii (L) and Olea europaea (L) leaf extracts on streptozotocin induced diabetic rats. Pak J Pharm Sci.:8.

Anitha T, Balakumar C, Ilango KB, Benedict Jose C, Vetivel D. 2014. Antidiabetic activity of the aqueous extracts of Foeniculum vulgare on streptozotocin-induced diabetic rats. International Journal of Advances in Pharmaceutical Biology and Chemistry 3(2):487-494.

Ashraf R, Khan RA, Ashraf I. 2011. Garlic (Allium sativum) supplementation with standard anti-diabetic agent priovides better diabetic control in type 2 diabetis patients. Pakistan Journal of Pharmacological Sciences:7.

Attia ES, Amer AH, Hasanein MA. 2018. The hypoglycemic an antioxidant activities of garden cress (Lepidium sativum L) seed on alloxan-induced diabetic male rats. Natural Product Research.:1-5.
Awad Nagwa E., Seida AA, Shaffie ZE, El-Aziz AMA, Awad N. E. 2012. Hypoglycemic activity of Artemisia herba-alba Asso.,used in Egyptian traditional medicine as hypoglycemic remedy. Journal of Applied Pharmaceutical Science. 2(03):30-39.

Badole SL, Bodhankar SL. 2009. Investigation of antihyperglycemic activity of Glycine max (L.) Merr. on serum glucose level in diabetic mice. Journal of Complementary and Integrative Medicine. 6(1). doi:10.2202/1553-3840.1207. [accessed 2019 May 12]. https://www.degruyter.com/view/j/jcim.2009.6.1/jcim .2009.6.1.1207/jcim.2009.6.1.1207.xml.

Bakirel T, Bakirel U, Keleş ÖÜ, Ülgen SG, Yardibi H. 2008. In vivo assessment of medicinal plants and antioxidant activities of rosemary (Rosmarinus officinalis) in alloxan-diabetic rabbits. Journal of Ethnopharmacology. 116(1):64-73. doi:10.1016/j.jep.2007.10.039.

Bamosa AO, Kaatabi H, Lebda FM. 2010 Effect of Nigella sativa seeds on the glycemic control of patients with type 2 diabetes mellitus. Indian Journal of Physiology and Pharmacology 4(4):344-354.

Baquer NZ, Kumar P, Taha A, Kale R, Cowsik S, McLean P. 2011. Metabolic and molecular action of Trigonella foenum-graecum (fenugreek) and trace metals in experimental diabetic tissues. Journal of Bioscience 36(2):383-396. doi:10.1007/s12038-011-9042-0.

Barkaoui M, Kattiri A, Boubaker H, Msanda F. 2017. Ethnobotanical survey of medicinal plants used in the traditional treatment of diabetes in Chouka Ait Baha and Tiznit (Western Anti-Atlas), Morocco. Journal of Ethnopharmacology. 198:338-350. doi:10.1016/j.jep.2017.01.023.

Barkaoui M, Kattiri A, Boubaker H, Msanda F. 2017. Ethnobotanical survey of medicinal plants used in the traditional treatment of diabetes in Chouka Ait Baha and Tiznit (Western Anti-Atlas), Morocco. Journal of Ethnopharmacology. 198:338-350. doi:10.1016/j.jep.2017.01.023.

Bellakhdar J, Claissre R, Fleurentin J, Younos C. 1991. Repertory of standard herbal drugs in the Moroccan pharmacopoea. Journal of Ethnopharmacology 35(2):123-143.

Benalla W, Bellahcen S, Bnouham M. 2010. Antidiabetic Medicinal Plants as a Source of Alpha Glucosidase Inhibitors. Current Diabetes Reviews 6(4) doi:http://dx.doi.org/10.2174/157339910791698826.

Benammar C, Baghdad C. 2014. Antidiabetic and Antioxidant Activities of Zizyphus lotus L Aqueous Extracts in Wistar Rats. Journal of Nutrition & Food Sciences. s8. doi:10.4172/2155-9600.S8-004.

Benkhnigue O, Ben Akka F, Salhi S, Fadli M, Douira A, Zidane L. 2014. Catalogue des plantes médicinales utilisées dans le traitement du diabète dans la région d’Al Haouz-Rhamna (Maroc). Journal of Animal and Plant Science 23:3539-68.

Bennani Kabchi N, Fdhil H, Cherrah Y, El Bouayadi F, Kehel L, Marquie G. 2000. Therapeutic effect of Olea europea var. oleaster leaves on lipidic and carbohydrate metabolism in obese and prediabetic sand rat (Psamommys obesus). Annales Pharmaceutiques Francaises (France).

Berraouan A, Abderrahim Z, Hassane M, Abdelkhaleq L, Mohammed A, Mohamed B. 2015. Evaluation of protective effect of cactus pear seed oil (Opuntia ficus-indica (L.) Mill) against alloxan-induced diabetes in mice. Asian Pacific journal of tropical medicine. 8(7):532-537.

Bhuvaneswari P, Krishnakumari s. antihyperglycemic potential of Sesamum indicum Linn. seeds in streptozotocin induced diabetic rats. 4:5.

Bnouham M, Legssyer A, Mekht H, Ziyyat A. 2002. Medicinal plants used in the treatment of diabetes in Morocco. International Journal of Diabetes and Metabolism. 10:33-50.

Bolkent S, Yanardag R, Ozsoy-Sacan O, Karabulut-Bulan O. 2004. Effects of parsley (Petroselinum crispum) on the liver of diabetic rats: a morphological and biochemical study. Phytotherapy Research. 18(12):996-999.

Boudjelal A, Siracusa L, Henchiri C, Sarri M, Abderrahim B, Baai F, Roberto G. 2015. Antidiabetic effects of aqueous infusions of Artemisia herba-alba and Ajuga iva in alloxan-induced diabetic rats. Planta medica. 81(09):696-704.

Bousta D, Boukhiria S, Aafii A, Ghanmi M, el L. 2014. Ethnopharmacological Study of anti-diabetic medicinal plants used in the Middle-Atlas region of Morocco (Sefrou region). Pharma Health Sciences 2(5):75-79

Butterweck V, Semlin L, Feistel B, Pischel I, Bauer K, Verspohl EJ. 2011. Comparative evaluation of two different Opuntia ficus-indica extracts for blood sugar lowering effects in rats. Phytotherapy Research. 25(3):370-375.

Campos KE, Diniz YS, Cataneo AC, Faine LA, Alves MJOF, Novelli ELB. 2003. Hypoglycaemic and antioxidant effects of onion, Allium cepa: dietary onion addition, antioxidant activity and hypoglycaemic effects on diabetic rats. International Journal of Food Sciences and Nutrition. 54(3):241-246. doi:10.1080/09637480120092062.
Daradka HM, Abas MM, Mohammad MA, Jaffar MM. 2014. Antidiabetic effect of Artemisia absinthium extracts on alloxan-induced diabetic rats. Comparative Clinical Pathology 23(6):1733-1742.

Das AK, Mandal SC, Banerjee SK, Sinha S, Saha BP, Pal M. 2001. Studies on the hypoglycaemic activity of Punica granatum seed in streptozotocin induced diabetic rats. Phytotherapy Research 15(7):628-629. doi:10.1002/ptr.740.

De Bock M, Derraik JG, Brennan CM, Biggs JB, Morgan PE, Hodgkinson SC, Hofman PL, Cutfield WS. 2013. Olive (Olea europaea L.) leaf polyphenols improve insulin sensitivity in middle-aged overweight men: a randomized, placebo-controlled, crossover trial. PloS one. 8(3):e57622.

Dehghani F, Azizi M, Panjehshahin MR. 2011. The Effects of aqueous extract of Raphanus sativus on blood glucose, triglyceride and cholesterol in diabetic rats. Iranian Journal of Pharmacology and Therapeutics. 10(2):66-0.

Del Carmen Juárez-Vázquez M, Carranza-Álvarez C, Alonso-Castro AJ, González-Alcaraz VF, Bravo-Acevedo E, Chamorro-Tinajero FJ, Solano E. 2013. Ethnobotany of medicinal plants used in Xalpatlahuac, Guerrero, México. Journal of Ethnopharmacology. 148(2):521-527.

Demoz M, Gachoki K, Mungai K, Negusse B. 2015. Ethnobotanical survey and preliminary phytochemical studies of plants traditionally used for diabetes in Eritrea. European Journal of Medicinal Plants. 9(2):1-11.

Dilawari JB, Kamath PS, Batta RP, Mukewar S, Raghavan S. 1981. Reduction of postprandial plasma glucose by Bengal gram dal (Cicer arietinum) and Rajmah (Phaseolus vulgaris). American Journal of Clinical Nutrition 34(11):2450-2453. doi:10.1093/ajcn/34.11.2450.

Dixit Y, Kar A. 2010. Protective role of three vegetable peels in alloxan induced diabetes mellitus in male mice. Plant Foods for Human Nutrition. 65(3):284-289.

Dra LA, Sellami S, Rais H, Aziz F, Aghraz A, Bekkouche K, Markouk M, Larhsini M. 2018. Antidiabetic potential of Caralluma europaea against alloxan-induced diabetes in mice. Saudi Journal of Biological Sciences 26(6):1171-1178.

Eddouks M, Hebi M, Ajebi M, El Hidani A, Sulpice T, Burcelin R. 2017 Feb 20. Étude de l’activité antidiabétique de Capparis spinosa L. et de Calamintha officinalis Moench chez la souris diabétique. Phytothérapie. doi:10.1007/s10298-017-1105-4. [accessed 2019 May 12]. https://doi.org/10.1007/s10298-017-1105-4.

Eddouks M, Lemhadri A, Zeggwag NA, Michel JB. 2005. Potent hypoglycaemic activity of the aqueous extract of Chamaemelum nobile in normal and streptozotocin-induced diabetic rats. Diabetes Research and Clinical Practice. 67(3):189-195.

Eddouks M, Maghrani M, Lemhadri A, Ouahidi M-L, Jouad H. 2002. Ethnopharmacological survey of medicinal plants used for the treatment of diabetes mellitus, hypertension and cardiac diseases in the south-east region of Morocco (Tafilalet). Journal of Ethnopharmacology. 82(2-3):97-103.

Eddouks M, Maghrani M, Zeggwag N-A, Michel JB. 2005. Study of the hypoglycaemic activity of Lepidium sativum L. aqueous extract in normal and diabetic rats. Journal of Ethnopharmacology. 97(2):391-395.

Eddouks M. 2017. Contribution to the study of medicinal plants used in the treatment of diabetes, obesity and hypertension in Tafilalet region (Morocco). Arabian Journal of Medicinal and Aromatic Plants. 3(2):124-161.

Eidi A, Eidi M, Darzi R. 2009. Antidiabetic effect of Olea europaea L. in normal and diabetic rats. Phytotherapy Research. 23(3):347-350. doi:10.1002/ptr.2629.

Eidi A, Eidi M, Esmaeili E. 2006. Antidiabetic effect of garlic (Allium sativum L.) in normal and streptozotocin-induced diabetic rats. Phytomedicine. 13(9):624-629. doi:10.1016/j.phymed.2005.09.010.

Eidi A, Eidi M, Haeri Rohani A, Basati F. 2010. Hypoglycemic effect of ethanolic extract of Carum carvi L. seeds in normal and streptozotocin-induced diabetic rats. 113:106:(35)3.

Eidi A, Eidi M, Oryan SH, Falihyan F, Darzi Darounkala R. 2004. Hypoglycaemic effect of alcoholic extract of olive (Olea europaea L.) leaf in healthy and diabetic rats. Journal of Medicinal Plants. 4(12):36-40.

Eidi A, Eidi M. 2009. Antidiabetic effects of sage (Salvia officinalis L.) leaves in normal and streptozotocin-induced diabetic rats. Diabetes & Metabolic Syndrome: Clinical Research & Reviews 3(1):40-44. doi:10.1016/j.dsx.2008.10.007.
release from pancreatic beta cells in streptozotocin-induced diabetic rats. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives. 23(3):404-406.

Eidi M, Eidi A, Zamanizadeh H. 2005. Effect of Salvia officinalis L. leaves on serum glucose and insulin in healthy and streptozotocin-induced diabetic rats. Journal of Ethnopharmacology. 100(3):310-313. doi:10.1016/j.jep.2005.03.008.

El Amrani F, Rhallab A, Alaoui T, El Badaoui K, Chakir S. 2010. Étude ethnopharmacologique de quelques plantes utilisées dans le traitement du diabète dans la région de Meknès-Tafilalet (Maroc). Phytothérapie. 8(3):161-165.

Elberry AA, Harraz FM, Ghareib SA, Gabr SA, Nagy AA, Abdel-Sattar E. 2015. Methanolic extract of Marrubium vulgare ameliorates hyperglycemia and dyslipidemia in streptozotocin-induced diabetic rats. International journal of diabetes mellitus. 3(1):37-44.

Effeliah MS, Akhter MH, Khan MT. 1984. Anti-hyperglycaemic effect of an extract of Myrtus communis in streptozotocin-induced diabetic mice. Journal of ethnopharmacology. 11(3):275-281.

El-Hilaly J, Hmanmouchi M, Lyoussi B. 2003. Ethnobotanical studies and economic evaluation of medicinal plants in Taounate province (Northern Morocco). Journal of Ethnopharmacology. 86(2-3):149-158.

El-Soud N, El-Laithy N, El-Saied G, Wahby M, Khalil M, Morsy F, Shaffie N. 2011. Antidiabetic activities of Foeniculum vulgare Mill. essential oil in streptozotocin-induced diabetic rats. Macedonian Journal of Medical Sciences. 4(2):139-146.

Emam M. 2012. Comparative evaluation of antidiabetic activity of Rosmarinus officinalis L. and Chamomile recutita in streptozotocin induced diabetic rats. Agriculture and Biology Journal of North America. 3(6):247-252. doi:10.5251/abjna.2012.3.6.247.252.

Ene AC, Nwankwo EA, Samdi LM. 2008. Alloxan-induced diabetes in rats and the effects of Black caraway (Carum carvi (L.) oil on their body weights. Journal of Pharmacology and Toxicology. 3(2):141-146.

Enigbokan MA, Felder TB, Thompson JO, Kuti JO, Ekpenyong KI. 1996. Hypoglycaemic effects of Opuntia ficus-indica Mill., Opuntia lintheimeri Engelm and Opuntia robusta Wendl. in streptozotocin-induced diabetic rats. Phytotherapy Research. 10(5):379-382.

Errajraji A, Ouhdouch F, El-Ansari N. 2010. Usage des plantes médicinales dans le traitement du diabète de type 2 au Maroc: Use of medicinal plants for type 2 diabetes treatment, in Morocco. Médecine des Maladies Métaboliques. 4(3):301-304. doi:10.1016/S1957-2557(10)70064-X.

Fararh KM, Atoji Y, Shimizu Y, Takewaki T. 2002. Isulnulotropic properties of Nigella sativa oil in Streptozotocin plus Nicotinamide diabetic hamster. Research in Veterinary Science. 73(3):279-282. doi:10.1016/S0034-0731(02)0108-X.

Fennane, Ibn Tattou. 2012. Statistiques et commentaires sur l’inventaire actuel de la flore vasculaire du Maroc. Bulletin de l’institut Scientifique Rabat, section Sciences de la Vie 34(1):1-9.

Frati AC, Jiménez E, Ariza CR. 1990. Hypoglycemic effect of Opuntia ficus indica in non insulin-dependent diabetes mellitus patients. Phytotherapy research. 4(5):195-197.

Friedman, J., Yaniv, Z., Dafni, A., Palewitch, D. 1986. A preliminary classification of the healing potential of medicinal plants, based on a rational analysis of an ethnopharmacological field survey among Bedouins in the Negev Desert, Israel. Journal of Ethnopharmacology 16, 275-287. https://doi.org/10.1016/0378-8741(86)90094-2

Ghule AE, Jadhav SS, Bodhankar SL. 2012. Effect of ethanolic extract of seeds of Linum usitatissimum (Linn.) in hyperglycaemia associated ROS production in PBMCs and pancreatic tissue of alloxan induced diabetic rats. Asian Pacific Journal of Tropical Disease. 2(5):405-410. doi:10.1016/S2222-1808(12)60088-7.

Gina LP, Aulanni’am A, Mahdi C. 2016. MDA and Histologic profile of pancreatic diabetic-rats model administered with extract of Glycine max (L.) Merr. The Journal of Pure and Applied Chemistry Research. 5(1):40-47. doi:10.21776/ub.jpacr.2016.005.01.226.

Glombitza K-W, Mahran GH, Mirhom YW, Michel KG, Motawi TK. 1994. Hypoglycemic and Antihyperglycemic Effects of Zizyphus spinosa-christi in Rats. Planta Med. 60(3):244-247. doi:10.1055/s-2006-959488.

Gray AM, Flatt PR. 1999. Insulin-secreting activity of the traditional antidiabetic plant Viscum album
Hypoglycemic activity of *Neurolea lobata* (L.) R. BR. Journal of Ethnopharmacology. 10(3):323-327.

Haddad PS, Dépôt M, Settaf A, Cherrah Y. 2001. Use of antidiabetic plants in Morocco and Québec. Diabetes Care. 24(3):608-609. doi:10.2337/diicare.24.3.608-a.

Haidari F, Seyed-Sadjadi N, Taha-Jalali M, Mohammed-Shahi M. 2011. The effect of oral administration of *Carum carvi* on weight, serum glucose, and lipid profile in streptozotocin-induced diabetic rats. Saudi Medical Journal. 32(7):695-700.

Hamza N, Berke B, Cheze C, Marais S, Lorrain S, Abdouelfath A, Lassalle R, Carles D, Gin H, Moore N. 2015. Effect of *Centaurium erythraeum* Rafn, *Artemisia herba-alba* Asso and *Trigonella foenum-graecum* L. on liver fat accumulation in C57BL/6J mice with high-fat diet-induced type 2 diabetes. Journal of Ethnopharmacology. 171:4-11.

Hannan JMA, Ali L, Rokeya B, Khaque J, Akhter M, Flatt PR, Abdel-Wahab YHA. 2007. Soluble dietary fibre fraction of *Trigonella foenum-graecum* (fenugreek) seed improves glucose homeostasis in animal models of type 1 and type 2 diabetes by delaying carbohydrate digestion and absorption and enhancing insulin action. British Journal of Nutrition. 97(3):514-521. doi:10.1017/S0007114507657869.

Hannan JMA, Rokeya B, Faroque O, Nahar N, Moshuzzaman M, Azad Khan AK, Ali L. 2003. Effect of soluble dietary fibre fraction of *Trigonella foenum graecum* on glycermic, insulinenic, lipidemic and platelet aggregation status of Type 2 diabetic model rats. Journal of Ethnopharmacology. 88(1):73-77. doi:10.1016/S0378-8741(03)00190-9.

Heidari H, Kamalinejad M, Noubarani M, Rahmati M, Jafarian I, Adibian H, Eskandari MR. 2016. Protective mechanisms of *Cucumis sativus* in diabetes-related models of oxidative stress and carbonyl stress. BioImpacts. 6(1):33.

Herrera-Arelliano A, Aguilar-Santamaría L, Garcia-Hernández B, Nicasio-Torres P, Tortoriello J. 2004. Clinical trial of *Cecropia obtusifolia* and *Marrubium vulgare* leaf extracts on blood glucose and serum lipids in type 2 diabetics. Phytomedicine. 11(7-8):561-566.

Huang THW, Peng G, Kota BP, Li GQ, Yamahara J, Roufogalis BD, Li Y. 2005. Anti-diabetic action of *Punica granatum* flower extract: Activation of PPAR-γ and identification of an active component. Toxicology and Applied Pharmacology. 207(2):160-169. doi:10.1016/j.taap.2004.12.009.

IDF. 2017. International Diabetes Federation. IDF Diabetes Atlas, 8th edn. Brussels, Belgium.

Islam MdS, Choi H. 2008. Comparative Effects of Dietary Ginger (Zingiber officinale) and Garlic (Allium sativum) Investigated in a Type 2 Diabetes Model of Rats. Journal of Medicinal Food. 11(1):152-159. doi:10.1089/jmf.2007.634.

Jafri MA, Aslam M, Javed K, Singh S. 2000. Effect of *Punica granatum* Linn. (flowers) on blood glucose level in normal and alloxan-induced diabetic rats. Journal of Ethnopharmacology. 70(3):309-314. doi:10.1016/S0378-8741(99)00170-1.

Jamaleddine M, El Oualidi J, Taleb MS, El Alaoui-Faris FE. 2017. Inventaire et état de conservation des plantes aromatiques et médicinales (PAM) au Maroc. Phytothérapie. 15(3):114-122. doi:10.1007/s10298-017-1131-2.

Jauhari JT, Lazrek HB, Jana M. 2000. The hypoglycemic activity of *Zygophyllum gaetulum* extracts in alloxan-induced hyperglycemic rats. Journal of Ethnopharmacology. 69(1):17-20. doi:10.1016/S0378-8741(99)00084-1.

Jauhari JT, Lazrek HB, Seddik A, Jana M. 1999. Hypoglycaemic response to *Zygophyllum gaetulum* extracts in patients with non-insulin-dependent diabetes mellitus. Journal of Ethnopharmacology. 64(3):211-217. doi:10.1016/S0378-8741(98)00124-X.

Jouad H, Haloui M, Rhiouani H, El Hilaly J, Eddouks M. 2001. Ethnobotanical survey of medicinal plants used for the treatment of diabetes, cardiac and renal diseases in the North centre region of Morocco (Fez-Boulemane). Journal of Ethnopharmacology. 77(2-3):175-182.

Jouad H, Maghrani M, Eddouks M. 2002. Hypoglycemic effect of aqueous extract of *Ammi visnaga* in normal and streptozotocin-induced diabetic rats. Journal of herbal pharmacotherapy. 2(4):19-29.

(mistletoe). Journal of Endocrinology 160(3):409-414.
Jouad H, Maghrani M, Hassani RAE, Eddouks M. 2004. Hypoglycemic activity of aqueous extract of Eucalyptus globulus in normal and Streptozotocin-induced diabetic rats. *Journal of Herbs, Spices & Medicinal Plants*. 10(4):19-28. doi:10.1300/J044v10n04_03.

Kabbaj FZ, Meddah B, Cherrah Y. 2012. Ethnopharmacological profile of traditional plants used in Morocco by cancer patients as herbal therapeutics. *Phytopharmacology* 2(2):243-256.

Kaeidi A, Esmaeili-Mahani S, Sheibani V, Abbasnejad M, Rasoulian B, Hajializadeh Z, Afrazi S. 2011. Olive (*Olea europaea* L.) leaf extract attenuates early diabetic neuropathic pain through prevention of high glucose-induced apoptosis: in vitro and in vivo studies. *Journal of ethnopharmacology*. 136(1):188-196.

Kanter M, Meral I, Yener Z, Ozbek H, Demir H. 2003. Partial Regeneration/Proliferation of the β-Cells in the Islets of Langerhans by *Nigella sativa* L. in Streptozotocin-Induced Diabetic Rats. *Tohoku J Exp Med*. 201(4):213-219. doi:10.1620/tjem.201.213.

Karthiyanin T, Kumar R, Kumar KS, Sahu RK, Roy A. 2015. Evaluation of antidiabetic and hypolipidemic effect of *Cucumis sativus* fruit in streptozotocin-induced-diabetic rats. *Biomedical and Pharmacology Journal*. 2(2):351-355.

Katiri A, Barkaoui M, Msanda F, Boubaker H. 2017. Ethnobotanical survey of medicinal plants used for the treatment of diabetes in the Tizi n’ Test region (Taroudant Province, Morocco). *Journal of Pharmacognosy & Natural Products*. 03(01). doi:10.4172/2472-0992.1000130.

Khosla P, Gupta DD, Nagpal RK. 1995. Effect of *Trigonella foenum graecum* (Fenugreek) on blood glucose in normal and diabetic rats. *Indian Journal of Physiology and Pharmacology*. 39:173-173.

Kianbakht S, Dabaghian FH. 2013. Improved glycemic control and lipid profile in hyperlipidemic type 2 diabetic patients consuming *Allium cepa* leaf extract: A randomized placebo. *Controlled clinical trial. Complementary Therapies in Medicine*. 21(5):441-446. doi:10.1016/j.ctim.2013.07.004.

King H, Aubert RE, Herman WH. 1998. Global burden of diabetes, 1995-2025: prevalence, numerical estimates, and projections. *Diabetes Care*. 21(9):1414-1431.

Knecht KT, Nguyen H, Auker AD, Kinder DH. 2006. Effects of extracts of Lupine seed on blood glucose levels in glucose resistant mice. *Journal of Herbal Pharmacotherapy*. 6(3-4):89-104. doi:10.1080/J157v06n03_04.

Kooei-Hosseinanadadi O, Moini M, Safarpoor A, Derakhshanfar A, Sepehriramesh M. 2015. Effects of dietary *Thymus vulgaris* extract alone or with atorvastatin on the liver, kidney, heart, and brain histopathological features in diabetic and hyperlipidemic male rats. *Complementary Clinical Pathology*. 24(6):1311-1315. doi:10.1007/s00580-015-2070-7.

Kumar P, Kale RK, Baquer NZ. 2012. Antihyperglycemic and protective effects of *Trigonella foenum graecum* seed powder on biochemical alterations in alloxan diabetic rats. *European review for medical and pharmacological sciences*. 16:18-27.

Kumari K, Mathew BC, Augusti KT. 1995. Antidiabetic and hypolipidemic effects of S-methyl cysteine sulfoxide isolated from *Allium cepa* Linn. *Indian Journal of Biochemistry and Biophysics*. 32(1):49-54.

Kusano S, Abe H, Tamura H. 2001. Isolation of antidiabetic components from white-skinned sweet potato (*Ipomoea batatas* L.). *Bioscience, biotechnology, and biochemistry*. 65(1):109-114.

Kusano S, Abe H. 2000. Antidiabetic activity of white skinned sweet potato (*Ipomoea batatas* L.) in obese Zucker fatty rats. *Biological and pharmaceutical bulletin*. 23(1):23-26.

Lemhadri A, Zeggwagh N-A, Maghrani M, Jouad H, Michel JB, Eddouks M. 2004. Hypoglycaemic effect of *Calamintha officinalis* Moench. in normal and streptozotocin-induced diabetic rats. *Journal of Pharmacy and Pharmacology*. 56(6):795-799. doi:10.1211/0022357023510.

Lemhadri A. 2007. Evaluation pharmacologique de l’activité antidiabétique de quelques plantes médicinales de la région de Tafilalet. Doctoral RThesis, Mohammed V University, Rabat.

Li F, Li Q, Gao D, Peng Y. 2009. The optimal extraction parameters and anti-diabetic activity of flavonoids from *Ipomoea batatas* leaf. *African Journal of Traditional, Complementary and Alternative Medicines*. 6(2).

Li Y, Wen S, Kota BP, Peng G, Li QQ, Yamahara J, Roufogalis BD. 2005. *Punica granatum* flower extract, a potent α-glucosidase inhibitor, improves postprandial hyperglycemia in Zucker diabetic fatty rats. *Journal of Ethnopharmacology*. 99(2):239-244. doi:10.1016/j.jep.2005.02.030.

Lima CF, Azevedo MF, Araujo R, Fernandes-Ferreira M, Pereira-Wilson C. 2006. Metformin-like effect of *Salvia officinalis* (common sage): is it useful in diabetes prevention? *British Journal of Nutrition*. 96(2):326-333. doi:10.1079/BJN20061832.
Ludvik B, Hanefeld M, Pacini G. 2008. Improved metabolic control by Ipomoea batatas (Caiapo) is associated with increased adiponectin and decreased fibrinogen levels in type 2 diabetic subjects. Diabetes, Obesity and Metabolism. 10(7):586-592.

Ludvik B, Neuffer B, Pacini G. 2004. Efficacy of Ipomoea batatas (Caiapo) on diabetes control in type 2 diabetic subjects treated with diet. Diabetes care. 27(2):436-440.

Ludvik B, Waldhäusl W, Prager R, Kautzky-Willer A, Pacini G. 2003. Mode of action of Ipomoea batatas (Caiapo) in type 2 diabetic patients. Metabolism. 52(7):875-880.

Ludvik BH, Mahjoobian K, Waldhaeusl W, Hofer A, Prager R, Kautzky-Willer A, Pacini G. 2002. The effect of Ipomoea batatas (Caiapo) on glucose metabolism and serum cholesterol in patients with type 2 diabetes: a randomized study. Diabetes Care. 25(1):239-240.

Maultsi S, Attari VE, Mobasser M, Payahoo L, Ostadrarahimi A, Gotzari SE. 2013. Effects of ginger (Zingiber officinale) on plasma glucose level, HbA1c and insulin sensitivity in type 2 diabetic patients. International Journal of Food Sciences and Nutrition. 64(6):682-686. doi:10.3109/09637468.2013.775223.

Mahmoudzadeh-Sagheb H, Heidari Z, Bokaeian M, Moudi B. 2010. Antidiabetic effects of Eucalyptus globulus on pancreatic islets: a stereological study. Folia Morphologica. 69(2):112-118.

Mani UV, Mani I, Biswas M, Kumar SN. 2011. An open-label study on the effect of flax seed powder (Linum usitatissimum) supplementation in the management of diabetes mellitus. Journal of Dietary Supplements. 8(3):257-265. doi:10.3109/19390211.2011.593615.

Mansour HA, Newairy A-SA, Yousef MI, Sheweita SA. 2002. Biochemical study on the effects of some Egyptian herbs in alloxan-induced diabetic rats. Toxicology. 170(3):221-228. doi:10.1016/S0300-483X(01)00555-8.

Marx J. 2002. Unraveling the Causes of Diabetes. Science. 296(5568):686-689. doi:10.1126/science.296.5568.686.

Mathew PT, Augusti KT. 1975. Hypoglycaemic effects of onion, Allium cepa Linn. on diabetes mellitus - a preliminary report. Indian Journal of Physiogy and Pharmacology 19(4):213-217.

Meral I, Yener Z, Kahraman T, Mert N. 2001. Effect of Nigella sativa on Glucose concentration, Lipid peroxidation, anti-oxidant defence system and liver damage in experimentally-induced diabetic rabbits. Journal of Veterinary Medicine Series A. 48(10):593-599. doi:10.1046/j.1439-0442.2001.00393.x.

Merzouki A, Ed-Derfoufi F, Molero Mesa J. 2003. Contribución al conocimiento de la medicina rifeña tradicional III: fitoterapia de la diabetes en la provincia de Chefchaouen (norte de Marruecos). Contribution to the Knowledge of Riffian traditional medicine III: phytotherapy of diabetes in Chefchaouen province (North of Morocco). [accessed 2019 May 13]. http://digibug.ugr.es/handle/10481/28228.

Milek dos Santos L, Tomzack Tulio L, Fuganti Campos L, Ramos Dorneles M, Carneiro Hecke Krüger C. 2015. Glycemic response to Carob (Ceratonia silqua L) in healthy subjects and with the in vitro hydrolysis index. Nutricion Hospitalaria. 31(1). [accessed 2019 May 12]. http://www.redalyc.org/resumen.oa?id=3092328780.54.

Minaiyan M, Zolfaghari B, Kamal A. 2011. Effect of hydroalcoholic and buthanolic extract of Cucumis sativus seeds on blood glucose level of normal and streptozotocin-induced diabetic rats. Iranian journal of basic medical sciences. Iranian Journal of Basic Science14(5):436.

Mohler ML, He Y, Wu Z, Hwang DJ, Miller DD. 2009. Recent and emerging anti-diabetes targets. Medicinal Research Revue. 29(1):125-195. doi:10.1002/med.20142.

Monographie Generale. 2015. La Région de Fès-Meknès. ROYAUME DU MAROC Ministère de l’Intérieur Direction Générale des Collectivités Locales.

Mostafa DM, El-Alim SHA, Asfour MH, Al-Okbi SY, Mohamed DA, Awad G. 2015. Transdermal nanoemulsions of Foeniculum vulgare Mill. essential oil: Preparation, characterization and evaluation of antidiabetic potential. Journal of Drug Delivery Science and Technology. 29:99-106.

Mostafa M, Choudhury ME, Hossain MA, Islam MZ, Islam MS, Sumon MH. 2007. Antidiabetic effects of Catharanthus roseus, Azadirachta indica, Allium sativum and glimepride in experimentally diabetic induced rats. Bangladesh Journal of Veterinary Medicine. 1:99-102. doi:10.3329/bjvm.v5i1.1324.

Mrabti HN, Jaradat N, Kachmar MR, Ed-Dra A, Ouahbi A, Cherrah Y, Faouzi MEA. 2019. Integrative herbal treatments of diabetes in Beni Mellal region of Morocco. Journal of integrative medicine.

Naquvi KJ, Ali M, Ahmad J. 2004. Antidiabetic activity of aqueous extract of Coriandrum sativum L.
Fruits in streptozotocin induced rats. Indian Journal of Experimental Biology 42(9):909-12.

Orch H, Douira A, Zidane L. 2015. Étude ethnobotanique des plantes médicinales utilisées dans le traitement du diabète, et des maladies cardiaques dans la région d’Izarène (Nord du Maroc). Journal of Applied Biosciences 86(1):7940-7956. doi:10.4314/jab.v86i1.3.

Otoom SA, Al-Safi SA, Kerem ZK, Alkofahi A. 2006. The Use of Medicinal Herbs by Diabetic Jordanian Patients. Journal of Herbal Pharmacotherapy. 6(2):31-41. doi:10.1080/J157v06n02_03.

Özdek H, Öztürk M, Bayram İ, Uğraş S, Çitoğlu GS. 2003. Hypoglycemic and hepatoprotective effects of Foeniculum vulgare miller seed fixed oil extract in mice and rats. Eastern Journal of Medicine. 8(2):35-40.

Ozsoy-Sacan O, Yanardag R, Orak H, Ozgey Y, Yarat A, Tunali T. 2006. Effects of parsley (Petroselinum crispum) extract versus glibornuride on the liver of streptozotocin-induced diabetic rats. Journal of Ethnopharmacology. 104(1-2):175-181.

Phillips O, Gentry A h., Reynel C, Wilkin P, Galvez-Durand B C. 1994. Quantitative Ethnobotany and Amazonian Conservation. Conservation Biology. 8(1):225-248. doi:10.1046/j.1523-1739.1994.08010225.x.

Prathapan A, Fahad K, Thomas BK, Philip RM, Raghu KG. 2011. Effect of sprouting on antioxidant and inhibitory potential of two varieties of Bengal gram (Cicer arietinum L.) against key enzymes linked to type-2 diabetes. International Journal of Food Sciences and Nutrition. 62(3):234-238. doi:10.3109/09637486.2010.529801.

Rachid A, Rabah D, Farid L, Zohra SF, Houcine B, Nacéra B. 2012. Ethnopharmacological survey of medicinal plants used in the traditional treatment of diabetes mellitus in the North Western and South Western Algeria. Journal of Medicinal Plants Research. 6(10):2041-2050.

Rahdika S, Smila KH, Muthezhilan R. 2011. Antidiabetic and Hypolipidemic Activity of Punica granatum Linn on Alloxan Induced Rats. World Journal of Biological Sciences 6(4):178.182.

Raju J, Gupta D, Rao AR, Yadava PK, Baquer NZ. 2001. Trigonella foenum graecum (fenugreek) seed powder improves glucose homeostasis in alloxan diabetic rat tissues by reversing the altered glycolytic, gluconeogenic and lipogenic enzymes. Molecular Cell Biochemistry 224(1):45-51. doi:10.1023/A:1011974630828.

Ramadan KS, Khalil QA, Danial EN, Alnahdi HS, Ayaz NO. 2013. Hypoglycemic and hepatoprotective activity of Rosmarinus officinalis extract in diabetic rats. Journal of Physiology and Biochemistry 69(4):779-783. doi:10.1007/s13105-013-0253-8.

Roghani M, Baluchnejadmogarad T, Amin A, Amirtouri R. 2007. The effect of administration of Apium graveolens aqueous extract on the serum levels of glucose and lipids of diabetic rats. Iranian Journal of Endocrinology and Metabolism. 9(2):177-181.

Roghani M, Baluchnejadmogarad T, Ramezani M. 2008. The effect of chronic oral feeding of aerial part of Apium graveolens L. on blood levels of glucose and lipids of Streptozotocin-diabetic rats. Iranian Journal of Medicinal and Aromatic Plants 23/4(38):458-467.

Rtibi K, Selmi S, Grami D, Amri M, Eto B, El-benna J, Sebai H, Marzouki L. 2017. Chemical constituents and pharmacological actions of carob pods and leaves (Ceratonia siliqua L.) on the gastrointestinal tract: A review. Biomedicine & Pharmacotherapy. 93:522-528. doi:10.1016/j.biopha.2017.06.088.

Rtibi K, Selmi S, Grami D, Saidani K, Sebai H, Amri M, Eto B, Marzouki L. 2017. Ceratonia siliqua L. (immature carob bean) inhibits intestinal glucose absorption, improves glucose tolerance and protects against alloxan-induced diabetes in rat. Journal of the Science of Food and Agriculture. 97(8):2664-2670. doi:10.1002/jsfa.8091.

Sato H, Genet C, Strehle A, Thomas C, Lobstein A, Wagner A, Mioskowski C, Auwerx J, Saladin R. 2007. Anti-hyperglycemic activity of a TGR5 agonist isolated from Olea europaea. Biochemical and Biophysical Research Communications. 362(4):793-798. doi:10.1016/j.bbrc.2007.06.130.

Sebai H, Selmi S, Rtibi K, Souli A, Gharbi N, Sakly M. 2013. Lavandula stoechas L. essential oils attenuate hyperglycemia and protect against oxidative stress in alloxan-induced diabetic rats. Lipids in Health and Disease. 12(1):189. doi:10.1186/1476-511X-12-189.

Sener G, Saçan Ö, Yanardag R, Ayanoglu-Düller G. 2003. Effects of parsley (Petroselinum crispum) on the aorta and heart of STZ induced diabetic rats. Plant Foods for Human Nutrition. 58(3):1-7.

Sepici A, Gürbüz I, Çevik C, Yesilada E. 2004. Hypoglycaemic effects of myrtle oil in normal and alloxan-diabetic rabbits. Journal of Ethnopharmacology. 93(2):311-318. doi:10.1016/j.jep.2004.03.049.

Sharmin R, Khan MRI, Akhtar MA, Alim A, Islam MA, Anisuzzaman ASM, Ahmed M. 2013. Hypoglycemic
and hypolipidemic effects of cucumber, white pumpkin and ridge gourd in alloxan induced diabetic rats. Journal of Scientific Research. 5(1):161-170.

Shukla S, Chatterji S, Mehta S, Rai PK, Singh RK, Yadav DK, Watal G. 2011. Antidiabetic effect of Raphanus sativus root juice. Pharmaceutical biology. 49(1):32-37.

Singh PP, Jha S, Irchhaiya R. 2012. Antidiabetic and antioxidant activity of hydroxycinnamic acids from Calamintha officinalis. Moench. Med Chem Res. 21(8):1717-1721. doi:10.1007/s00044-011-9690-5.

Skalli S, Hassikou R, Arahou M. 2019. An ethnobotanical survey of medicinal plants used for diabetes treatment in Rabat, Morocco. Heliyon. 5(3):e01421. doi:10.1016/j.heliyon.2019.e01421.

Soliman HA, Eltablawy NA, Hamed MS. 2015. The ameliorative effect of Petroselinum crispum (parsley) on some diabetes complications. Journal of Medicinal Plants Studies. 3(4):92-100.

Song M-J, Lee S-M, Kim D-K. 2011. Antidiabetic effect of Chenopodium ambrosioides. Phytopharmacology 1:12-15.

Sreelatha S, Inavalli R. 2012. Antioxidant, antihyperglycemic, and antihyperlipidemic effects of Coriandrum sativum leaf and stem in Alloxan-induced diabetic rats. Journal of Food science. 77(7):T119-T123.

Sreelatha S, Padma PR, Umadevi M. 2009. Protective effects of Coriandrum sativum extracts on carbon tetrachloride-induced hepatotoxicity in rats. Food Chem Toxicol. 47(4):702-708. doi:10.1016/j.fct.2008.12.022.

Tahraoui A, El-Hilaly J, Israili ZH, Lyoussi B. 2007. Ethnopharmacological survey of plants used in the traditional treatment of hypertension and diabetes in south-eastern Morocco (Errachidia province). Journal of ethnopharmacology. 110(1):105-117.

Takeuchi H, Mooi Ly, Inagaki Y, He P. 2001. Hypoglycemic effect of a hot-water extract from defatted Sesame (Sesamum indicum L.) seed on the blood glucose level in genetically diabetic KK-Ay mice. Bioscience, Biotechnology, and Biochemistry. 65(10):2318-2321. doi:10.1271/bbb.65.2318

Taniguchi H, Kobayashi-Hattori K, Tenmyo C, Kamei T, Uda Y, Sugita-Konishi Y, Oishi Y, Takita T. 2006. Effect of Japanese radish (Raphanus sativus) sprout (Kaiware-daikon) on carbohydrate and lipid metabolisms in normal and streptozotocin-induced diabetic rats. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives. 20(4):274-278.

Taniguchi H, Muroi R, Kobayashi-Hattori K, Uda Y, Oishi Y, Takita T. 2007. Differing effects of water-soluble and fat-soluble extracts from Japanese radish (Raphanus sativus) sprouts on carbohydrate and lipid metabolism in normal and streptozotocin-induced diabetic rats. Journal of nutritional science and vitaminology. 53(3):261-266.

Tardio J, Pardo-de-Santayana M. 2008. Cultural Importance Indices: A Comparative analysis based on the useful wild plants of southern Cantabria (Northern Spain). Econ Bot. 62(1):24-39. doi:10.1007/s12231-007-9004-5.

Taştekin D, Atasever M, Aadvüge G, Keles M, Tastekin A. 2006. Hypoglycaemic effect of Artemisia herba-alba in experimental hyperglycaemic rats. Bulletin of the Veterinary Institute Pulawy 50:235-238.

Tellii A, Esnault M-A, Ould El Hadj Khelil A. 2016. An ethnopharmacological survey of plants used in traditional diabetes treatment in south-eastern Algeria (Ouargla province). Journal of Arid Environments 127:82-92. doi:10.1016/j.jaridenv.2015.11.005.

Tripathi UN, Chandra D. 2010. Anti-hyperglycemic and anti-oxidative effect of aqueous extract of Momordica charantia pulp and Trigonella foenum graecum seed in alloxan-induced diabetic rats. Indian Journal of Biochemistry and Biophysics 47(4):227-233.

Tunali T, Yarat A, Yanardag R, Özçelik F, Özsoy Ö, Ergenekon G, Emekli N. 1999. Effect of parsley (Petroselinum crispum) on the skin of STZ induced diabetic rats. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives. 13(2):138-141.

Ubillas RP, Mendez CD, Jolad SD, Luo J, King SR, Carlson TJ, Fort DM. 1999. Antihyperglycemic furanosesquiterpenes from Commiphora myrrha. Planta medica.65(08):778-779.

Vadivelan R, Dhanabal SP, Vadhaswani A, Elango K. 2012. [alpha]-Glucosidase and [alpha]-Amylase INHIBITORY activities of Raphanus stivus L.. International Journal of Pharmaceutical Sciences and Research 3(9):3186.

Vats V, Grover JK, Rathi SS. 2002. 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(1):95-100. doi:10.1016/S0378-8741(01)00374-9.
Vergara-Galicia J, Aguirre-Crespo F, Tun-Suarez A, Aguirre Crespo A, Estrada-Carrillo M, Jaime-Huerta I, Flores-Flores A, Estrada-Soto A, Ortiz-Andrade R. 2012. Acute hypoglycemic effect of ethanolic extracts from Marrubium vulgare. Phytomedicine 3(1):54-60.

Waheed A, Miana GA, Ahmad SI, Khan MA. 2006. Clinical investigation of hypoglycemic effect of Coriandrum sativum in type-2 (NIDDM) diabetic patients. Pakistan Journal of Pharmacology 23(1):7-11.

Wainstein J, Ganz T, Boaz M, Bar Dayan Y, Dolev E, Kerem Z, Madar Z. 2012. Olive leaf extract as a hypoglycemic agent in both human diabetic subjects and in rats. Journal of Medicinal Food 15(7):605-610.

Wazaify M, Affi FU, El-Khateeb M, Ajlouni K. 2011. Complementary and alternative medicine use among Jordanian patients with diabetes. Complementary Therapies in Clinical Practice 17(2):71-75. doi:10.1016/j.ctcp.2011.02.002.

WHO. 1999. World Health Organization, Definition, Diagnosis and Classification of Diabetes Mellitus and its Complications: Report of a WHO Consultation. Part1: Diagnosis and Classification of Diabetes Mellitus. Geneva.

WHO. 2016. World Health Organization, Global report on diabetes. Geneva.

Wikul A, Damsud T, Kataoka K, Phuwapraisirisan P. 2012. (+)-Pinoresinol is a putative hypoglycemic agent in defatted sesame (Sesamum indicum) seeds though inhibiting α-glucosidase. Bioorganic & Medicinal Chemistry Letters. 22(16):5215-5217 doi:10.1016/j.bmcl.2012.06.068.

Xue W-L, Li X-S, Zhang J, Liu Y-H, Wang Z-L, Zhang R-J. 2007. Effect of Trigonella foenum-graecum (Fenugreek) extract on blood glucose, blood lipid and hemorheological properties in streptozotocin-induced diabetic rats. Asia Pacific Journal of Clinical Nutrition 16(S1):422-426.

Yang N, Zhao M, Zhu B, Yang B, Chen C, Cui C, Jiang Y. 2008. Anti-diabetic effects of polysaccharides from Opuntia monacantha cladode in normal and streptozotocin-induced diabetic rats. Innovative Food Science & Emerging Technologies 9(4):570-574.

Yaniv Z, Dafni A, Friedman J, Palevitch D. 1987. Plants used for the treatment of diabetes in Israel. Journal of Ethnopharmacology 19(2):145-151.

Zahmatkesh M, Fallah Huseini H, Hajiaghaee R, Heidari M, Mehrfararin A, Tavakoli-far B. 2012. The Effects of Cinnamomum zeylanicum J. Presl on Blood Glucose Level in Patients with Type 2 Diabetes, a Double-blind Clinical Trial. Journal of Medicinal Plants 1(41):258-263.

Zayeb A, Hayat A, Bouchra A, Youssef H, Hanane L. 2015. Herbal medicines use among diabetic patients in Oriental Morocco. Journal of Pharmacognosy and Phytotherapy 7(2):9. doi:10.5897/JPP2014.0338.

Zhao R, Li Q, Long L, Li J, Yang R, Gao D. 2007. Antidiabetic activity of flavone from Ipomoea batatas leaf in non-insulin dependent diabetic rats. International Journal of Food Science & Technology 42(1):80-85.

Ziyyat A, Legssyer A, Mekhfi H, Dassouli A, Serhrouchni M, Benjelloun W. 1997. Phytotherapy of hypertension and diabetes in oriental Morocco. Journal of Ethnopharmacology, 58(1):45-51.
Annex A : Ethnobotanical questionnaire

Université Sidi Mohamed Ben Abdellah- Fès Institut National des Plantes Médicinales et Aromatiques

Modèle-Questionnaire d’Enquête Ethno-pharmacologique Prof D. BOUSTA

| Fiche n° : |
|-------------------------------------------------------------------------------------------------|
| Classement (par thème, ordre alphabétique, région ou autre) : .................................................. |
| Documents annexées (photos, diapositives, herbiers...) : .............................................................. |

| 1- RENSEIGNEMENT SUR L’INFORMATEUR |
|------------------------------------|
| - Sexe : Femme…………………………Homme ...................................................................................... |
| - Age : 18-24 □ 25-34 □ 35-49 □ 49-65 □ 65≥ □ |
| - Origine ethnique : .................................... .................................... ........................................ |
| - Commune: ................................................................................................................................. |
| - Niveau d'instruction : Néant □ Primaire □ Secondaire □ Universitaire □ |
| - Situation familiale : Célibataire □ Marié □ |
| - Métier : Herboriste .................Guérisseur ........................................................................... |
| ............................................................................................................................... |
| - Comment vous avez eu ces connaissances ? Lui-même □ Expérience des autres □ Herboriste □ |
| Livres □ Occasionnellement □ Autres □ ..................................................................................... |
| - Exerce t-il d'autre pratique médicinale traditionnelle ? Si oui, les quels ? ................................................................. |
| - Que préférez-vous ? les soins médicaux □ Les soins phytothérapeutiques □ |
| -Pourquoi? ................................................................................................................................. |
| -Qui consultez-vous en cas de maladie ? : Personnel médical □ Guérisseur □ |
| -Autres .......................................................................................................................................... |

| 2- RENSEIGNEMENT SUR LE PRATICIEN |
|------------------------------------|
| Nom : ..............................................Prénom : ...........................................Age : ......................... |
| Lieu de Naissance : ...................... Lieu d'établissement : .................................................. |
| Appartenance ethnique ou origine régionale: ................................................................................ |
**Qualification et compétence du praticien :**

Niveau d'instruction :

Depuis quand exerce-t-il le métier de guérisseur ?

Qui l'a formé ?

S'il s'agit d'un praticien lettré, quels livres de médecine arabe possède-t-il ? Est-il polyvalent ou exerce une spécialité ?

Est-il spécialisé dans le traitement d'une maladie ?

A-t-il formé quelqu'un ?

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**2 – RENSEIGNEMENT SUR LE PRODUIT**

2-1 Simple :

2.1.1 - Caractéristiques de l'habitat de la plante

Sol :

Relief :

Climat :

Action anthropique :

Aire de répartition :

2.2 – Systématique

-Famille:

-Genre:

-Espèce:

2.3 Dénominations locales :
| 2-1 Plante : (Seule) |
|----------------------|
| Parties utilisées :  Tige □ Fleurs □ Fruits □ Graine □ Écorce □ Rhizome □ Bulbe □ Latex □  |
| Feuilles □ Plante entière □ Autres combinaisons □ : |
| État de la plante : Fraîche □ Desséché □ |
| Forme d’emploi : Tisane □ Poudre □ Huiles essentielles □ |
| Lieu de récolte : …………………………………. Lieu d’acquisition:………………………… |
| Produit : local □ sauvage □ local □ cultivé □ importé □ |
| Autres : ………………………………………………………………………………………………….. |
| Conditions et modalités de la récolte : (saison, période du jour, etc.) |
| Autres utilisations médicinales : |

| 2-2 Mixte : (recette) |
|----------------------|
| Parties utilisées :  Tige □ Fleurs □ Fruits □ Graine □ Écorce □ Rhizome □ Bulbe □  |
| Feuilles □ Plante entière □ Autres combinaisons □ : |
| État de la plante : Fraîche □ Desséché □ |
| Lieu de récolte des plantes |
| Lieu d’acquisition |
| Produit : local □ sauvage □ local cultivé □ importé □ |
| Autres : ………………………………………………………………………………………………….. |
| Conditions et modalités de la récolte : (saison, période du jour, etc.) |
| Traitement reçu par le produit: (séchage, pulvérisation) |
| Indications (si celles-ci varient en fonction des parties, faire une fiche pour chaque partie) |
## Autres utilisations médicales :

| | |
|---|---|

## Toxicité, effets secondaires : toxicité pour l'homme et/ou le bétail, risque et effets indésirables :

| | |
|---|---|

## Dose :

| | |
|---|---|

## Mode de préparation :

| | |
|---|---|

## Posologie :

**Pour les nourrissons** : 1fois/jour □ 2fois/jour □ 3fois/jour □ Autres □ :

**Pour les enfants** : 1fois/jour □ 2fois/jour □ 3fois/jour □ Autres □ :

**Pour les Adultes** : 1fois/jour □ 2fois/jour □ 3fois/jour □ Autres □ :

**Pour les personnes âgées** : 1fois/jour □ 2fois/jour □ 3fois/jour □ Autres □ :
Durée d’utilisation (durée de traitement) :

Un jour □ Une semaine □ Un mois □ Jusqu’à la guérison □

Mode d’administration :

……………………………………………………………………………………………………………………………
……………………………………………………………………………………………………………………………
……………………………………………………………………………………………………………………………
……………………………………………………………………………………………………………………………

Utilisation Comme :

□ Complément au médicament
□ Alternative

Associations :

……………………………………………………………………………………………………………………………
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Autres informations :

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