

## Ethnobotanical survey of medicinal plants used for treating diabetes in Agadir Ida Outanane region, Southwestern Morocco

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**Abstract:** In Morocco, diabetes affects 6.6% of men and women nation-wide and is higher in urban areas. Medicinal plants are used commonly by local people of Morocco for treating diabetes. The aim of this study was to identify plants species used for curing diabetes in the Agadir Ida Outanane region, Southwest Morocco. Data were collected by semi-structured and structured interviews. 400 interviews were conducted with knowledgeable villagers. The obtained data were analyzed through fidelity level (FL: 0-100%), use value (UV) and relative frequency of citation (RFC: 0-1). This ethnobotanical survey has identified 22 species belonging to 14 families distributed. The most represented families are Lamiaceae and Asteraceae. Three plants species, *Cladanthus mixtus* (L.) Chevall, *Pulicaria mauritanica* Batt., and *Salvia aegyptiaca* L., are mentioned for the first time for traditional treatment of diabetes. The most frequently cited plant species are *Argania spinosa* (L.) Skeels, *Cistus creticus* L., *Globularia alypum* L., *Olea europaea* L. This survey shows that traditional medicine is still used and constituted a very rich heritage in Agadir Ida Outanane region. The collected data may help for archiving and conservation of traditional knowledge on the use of medicinal plants in the study area. In addition, it forms a basis for preliminary information required for future phytochemical investigation on the most used plants.

**Keywords:** Traditional medicine, Ethnobotanic, Medicinal plants, Phytochemical research, Southwest Morocco.

## 1. Introduction

Diabetes has been seen a very fast emergence by the change of the lifestyles and the diets. This pathology seems to be the result of the environmental, food and behavioral factors (excess weight, settled way of life) [1]. Diabetes is a chronic disease that occurs either when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces [2]. Diabetes mellitus is a metabolic disorder of the endocrine system with disturbances in carbohydrate, protein, and lipid metabolism characterized by chronic hyperglycemia [3]. Diabetes was the direct cause of 1.5 million deaths [4]. More than 80% of diabetes deaths occur in low and middle-income countries [5]. Diabetes will be the 7<sup>th</sup> leading cause of death in 2030 [2].

Three types of diabetes have been distinguished [6]: Type 1 diabetes is characterized by deficient insulin production and requires daily administration of insulin, Type 2 diabetes: results from the body's ineffective use of insulin and gestational diabetes: is hyperglycemia with blood glucose values above normal but below those diagnostic of diabetes, occurring during pregnancy.

In Morocco, the shift in diet and the change in lifestyle appear to contribute to what seems to be a rapidly growing nutrition and health problem [7]. Diabetes constitutes a major problem of public health [8], by its important and increasing prevalence on one part, and its socioeconomic impact of other one part [9]. In Morocco, diabetes equally affects 6.6% of men and women nation-wide, but is higher in urban areas [7]. Some studies showed figures being situated around 608 000 persons in 1995 [10]. This figure will achieve 2,5 million the horizon 2030 [11].

Phytotherapy offers a valuable opportunity to discover new natural molecules with beneficial effects on glucose homeostasis [8]. The importance of Phytotherapy is increasing day by day in many rural populations in developing countries due to the harmful side effects of synthetic drugs, the inability of existing modern therapies to control all the pathological aspects of the diabetic disorder, and enormous cost of modern drugs as well as the poor availability of the advanced therapies [12].

From the last years, it has been focused on an intensive pharmacological analysis of Moroccan medicinal plants, especially anti-diabetic plants used in traditional Phytotherapy in order to discover new potential and natural remedies susceptible to enrich the therapeutic arsenal of diabetes mellitus [1, 13, 14, 15]. This work aimed to identify species used as

antidiabetic plants within Agadir Ida Outanane population, in order to contribute to the safeguarding of knowledge and local expertise.

## 2. Materials and methods

### 2.1. Study area

The study area of Agadir Ida Outanane, part of Souss Massa region, extends over a rough surface of 240.000 hectares. This area is also a part of the Arganeary Reserve Biosphere approved by the UNESCO in 1998 [16]. It is limited at the west by the Atlantic Ocean, at the south by Inezgane Ait Melloul's prefecture, at the north by the provinces of Essaouira and Chichaoua and at the east by the province of Taroudant (Figure 1). It includes 13 territorial communes: Agadir, Drarga, Amskroud, Idmine, Tiqui, Imouzzar, Akesri, Aourir, Taghazout, Tamri, Imsouane, Aziar and Tadrart.

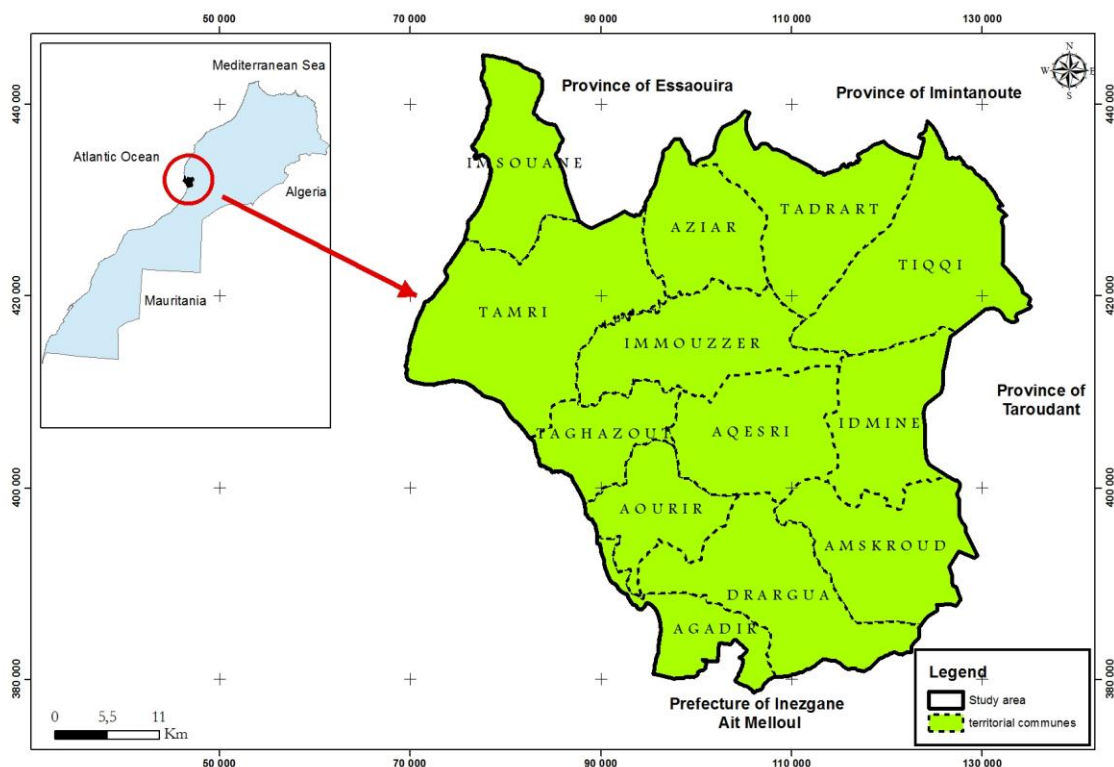


Figure 1. The map representing the study area

The population of Agadir Ida OuTanane is about 486 048 inhabitants. The density average is about 212 inhabitants/km<sup>2</sup>. 21.2 % of the population live in rural areas while 78.8 % in urban zones. The study area can be globally classified in the dry and semi-arid climate floor in freshly hot winter with a seasonal pluviometric regime where more than 51 % of the annual precipitation falls in winter. The precipitation levels vary between 5 and 34 C°. The elevation

*AJMAP V6 N2, 2020.*

ranges from 200 m to approximately 1800 m. The area of Agadir Ida Outanane is characterized by particularly vegetation formed by a mixture of Tropical, Macaronesian, Mediterranean and endemic elements [17].

## 2.2. Data collection

To realize this ethnobotanical study, the data were collected through semi-structured and structured interviews. This ethnobotanical survey was conducted from September 2012 to May 2015. Therefore, 400 interviews were conducted. The information was collected about the plant used to treat diabetes mellitus and their local names (Berber and/or Arabic), its uses, its origin, its used parts, method of preparation and the demographic characteristics of participants in the study.

All the species were mentioned by the respondents by their common label/name. The taxonomic identification of the species was later made by means of the literature: “Moroccan Flora” [18], “Vascular Flora of Morocco, Inventory and Chorology” [19], “The traditional Moroccan pharmacopoeia” [20], “Guide of the healing plants” [21], “The healing plants of Morocco” [22], “Healing plants in the Maghreb and the basic care” [23].

## 2.3. Data analysis

To study the importance of plant species used for curing diabetes, the quantitative indices have been calculated: Fidelity level (FL), Use value (UV) and Relative frequency of citation (RFC).

**Fidelity Level (FL):** The FL is the percentage of informants who suggested the use of a species to treat diabetes. FL level is calculated by the following formula:

$$\% FL = \frac{Np}{N} \times 100$$

where: Np is the number of informants that claimed a use of a plant species to treat diabetes and N is the total number of questioned informants [24].

**Use Value (UV):** UV determines most frequently used plant species. The UV was calculated on the basis of the following formula:

$$UV = \frac{\sum U}{N}$$

Where U is the number of use for a plant species mentioned by each informant and N is the total number of informants cited this species [25].

**Relative Frequency of Citation (RFC):** RFC determined the most popular medicinal plants accepted by the majority of the informants for treating diabetes [26]. The RFC was calculated by using the following formula:

$$RFC = \frac{FC}{N} \quad (0 < RFC < 1).$$

Where FC is the number of informants who mentioned the use of the species and N is the total number of informants [27].

### 3. Results and discussions

#### 3.1. Interviewee's demographic characteristics

A total of 400 informants including traditional healers, 52% are women and 48% are men. The frequency of medicinal plant use increased with age in this study. The age of respondents varies between 20 and 80 years. The people older than 50 years of age have a frequency of use of medicinal plants by 56%, followed by age categories (40 to 50), (30 to 40), (20 to 30) and (< 20 years) with 22%, 13%, 7% and 2%, respectively (Figure 2). These results show that elderly people have more ethno medicinal knowledge than younger people. This indicates that this kind of knowledge is acquired after a long accumulated experience. The experience accumulated with the age constitutes the main information source on a local scale about the use of plants in traditional medicine [28].

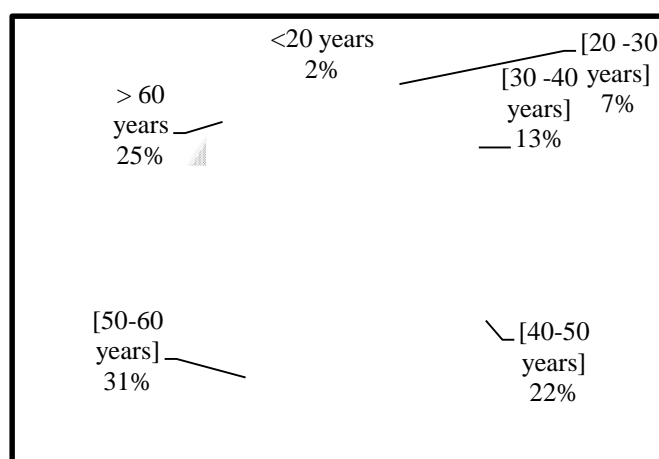


Figure 2. Age categories

#### 3.2. Medicinal plants used by the population

The present ethnobotanical survey recorded information on 22 plant species, belonging to 14 families used to treat diabetes. These 22 plant species were cited by at least

five different informants (Table 1). The most represented families are Lamiaceae with 6 species (27.27%), Asteraceae with four species (18.18%), Asphodelaceae, Cistaceae, Cucurbitaceae, Cupressaceae, Euphorbiaceae, Fabaceae, Myrtaceae, Oleaceae, Plantaginaceae, Ranunculaceae, Rhamnaceae and Sapotaceae had 1 species each (4.55%) (Figure 3).

The first two families, which are well represented in the study area, exist everywhere in Morocco and constitute the major groups of the medicinal flora in most of other Mediterranean countries [29, 30, 31]. Most of the identified families are represented by one or two species, which shows that the used healing plants are not only concentrated in some families and genera. This agrees with other ethnobotanic studies made outside Morocco and in the Mediterranean region [31, 32].

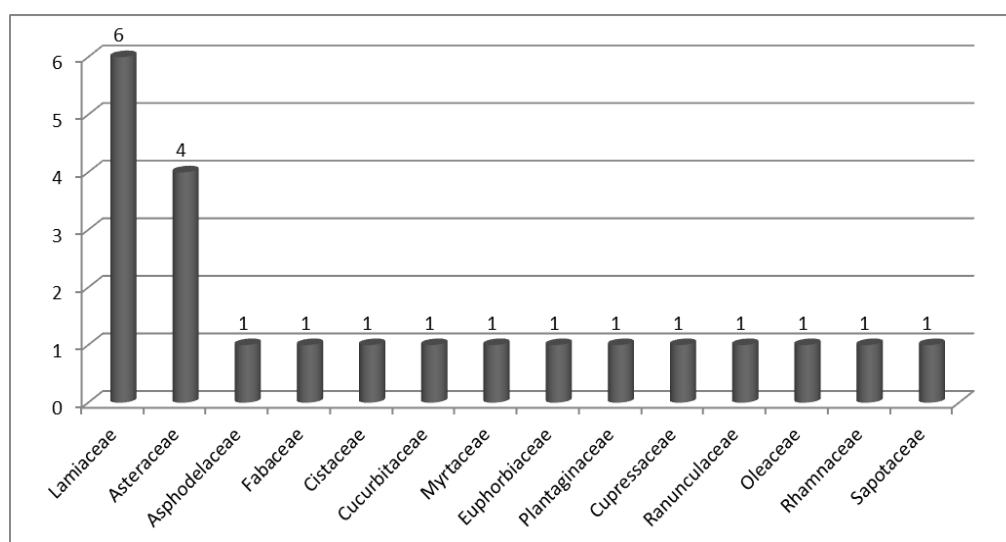


Figure 3. Number of medicinal species per botanical family

The majority of medicinal plants (86.36 %) registered in this survey are spontaneous species and some plants (13.64 %) are cultivated in the study area (Table 1). The large number of plant species used in the study area indicates the dependence of local population on medicinal plants to treat diabetes mellitus and represent a good indicator of the profound knowledge on herbal plants by the local people living in Agadir Ida Outanane region. Plants species most used by the local people to treat diabetes are *Argania spinosa*, *Olea europea*, *Globularia alypum* and *Tetraclinis articulata* (Figure 4).

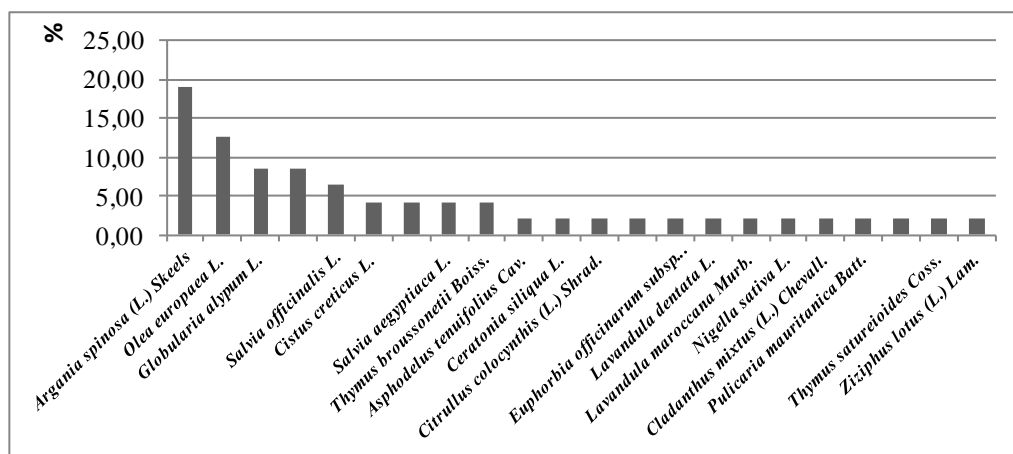


Figure 4. Use frequency of the medicinal plants to treat diabetes

### 3.3. Plant parts used, their preparation and administration

The results obtained at the level of the province of Agadir Ida Outanane show that the most used plant part is the leaf (61 %) followed by seeds (17 %), and fruit, tubers, whole plant, stem and roots (4%) (Figure 5). The results of this study showed that aerial plant parts play an important role in herbal medicine preparation in Agadir Ida Outanane region, agreeing with the results of studies in Morocco [31] and in other countries [34].

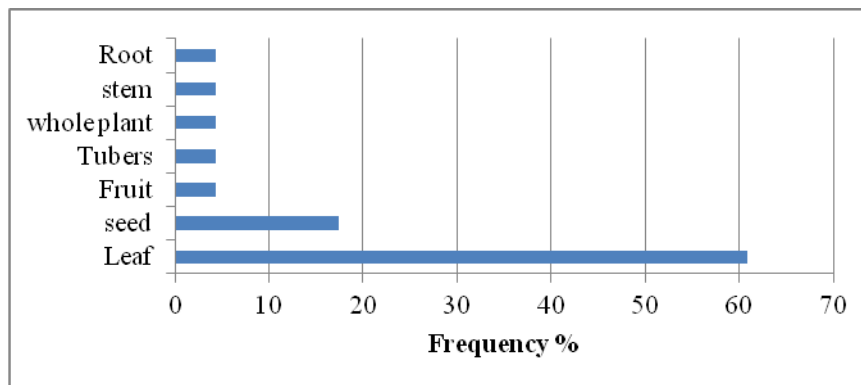


Figure 5. Frequency of plants parts used to treat diabetes

The main preparation of administration of plants is to the decoction and infusion as 41.67 and 33.33% respectively, followed by powder preparation (20.83%) and raw 4.17 % (Figure 6). The water is a solvent used to make most preparations. Diverse plant parts were also mixed with oil, honey, milk or tea for improving their acceptability and their medicinal properties. In other regions of Morocco and worldwide, decoction and infusion were also the most used herbs preparations [29, 35]. The totality of the remedies was taken orally.

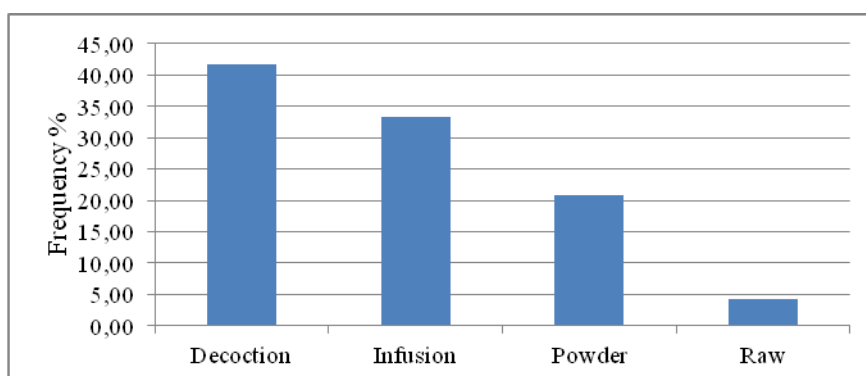


Figure 6. Frequency of methods preparation of plants

### 3.4. Ethnobotanical indices

Fidelity level (FL) and Use value (UV) of each species is calculated from the available information. FL indicates the informants' choice for a potential plant species to treat a given disease; UV determined most frequently used plant species, whereas RFC determined the most popular medicinal plants accepted by the majority of the informants for treating diabetes [26]. FL, UV and RFC values of identified plants species for the study area ranges from 12.77% to 85.11%, 0.71 to 2.22, 0.11 to 0.60 respectively (Table 1).

Of the 22 inventoried species seven plants were identified with FL greater than 50%: *Argania spinosa*, *Globularia alypum*, *Olea europaea*, *Cladanthus mixtus*, *Pulicaria mauritanica*, *Salvia aegyptiaca* and *Tetraclinis articulata*. Five species showed high values (>2) of UV: *A. spinosa*, *G. alypum*, *C. mixtus*, *P. mauritanica* and *S. aegyptiaca* (Table 1).

Of all medicinal plants reported in this study, the most popular medicinal plants used to treat diabetes with high RFC (>0.5) are: *A. spinosa*, *C. creticus*, *G. alypum*, *O. europaea*, *C. mixtus*, *P. mauritanica*, *T. articulata* and *T. satureioides* (Table 1).

In the obtained results in Agadir Ida Outanane region, *A. spinosa*, *G. alypum*, *C. mixtus* and *P. mauritanica* shows high values of UV and also possess high RFC. Our results are similar to those reported in other studies in Morocco where *A. spinosa*, *C. creticus*, *G. alypum*, and *O. europaea* are the plant species most used to treat diabetes [14, 15, 29, 30, 31, 36].

To the best of our knowledge, *Cladanthus mixtus*, *Pulicaria mauritanica* and *Salvia aegyptiaca* are mentioned for the first time for treating diabetes. The antidiabetic activity of these plants (Table 1) must be experimentally approved by in vivo, in vitro and/or clinical studies. Several studies have investigated the antidiabetic effect of these plants species: *Argania spinosa* [37], *Citrullus colocynthis* [38], *Globularia alypum* [39], *Olea europaea* [36], *Salvia officinalis* [40].



Table 1. Plants traditionally use to treat diabetes in Agadir Ida Outanane region

Latin names of species / Family	Local name	Type of plants	Used parts	Preparation	Mode of administration	Number of citation	FL	UV	RFC	Literature references in relationship of medicinal use of plants in diabetes
<i>Argania spinosa</i> (L.) Skeels / Sapotaceae	Argane	Spontaneous	Fruit, Leaf	Infusion, raw	Oral	18	85.11	2.22	0.60	[14, 29, 30]
<i>Asphodelus tenuifolius</i> Cav. / Asphodelaceae	Iguri, L-berwag	Spontaneous	Tubers	Powder	Oral	16	29.79	0.88	0.40	[14]
<i>Ceratonia siliqua</i> L. / Fabaceae	Tikida, Kharroub	Spontaneous	Leaf	Infusion	Oral	10	25.53	1.20	0.33	[14, 41]
<i>Cistus creticus</i> L. / Cistaceae	Irguel	Spontaneous	Leaf	Powder mixed with honey, nigelle and cresson	Oral	17	29.79	0.82	0.53	[30, 31]
<i>Citrullus colocynthis</i> (L.) Shrad / Cucurbitaceae	Aferziz, Hadja	Spontaneous	Seed	Powder	Oral	9	21.28	1.11	0.19	[14, 29, 30, 41]
<i>Cladanthus mixtus</i> (L.) Chevall / Asteraceae	Ijdignbamlal, Babonj	Spontaneous	Whole plant	Infusion, decoction	Oral	6	59.57	2.15	0.54	
<i>Euphorbia officinarum</i> subsp. <i>echinus</i> (Hook.	Tikiout, Zaggoum,	Spontaneous	Stem	Powder	Oral	9	19.15	1.00	0.19	[14, 29]

f. &Coss.) Vindt / Euphorbiaceae	Daghmus									
<i>Globularia alypum</i> L. / Plantaginaceae	Tasselgha, Ainarnab	Spontaneous	Leaf	Decoction	Oral	12	53.19	2.08	0.55	[14, 15, 30]
<i>Kleinia anteuphorbium</i> (L.) Haw. / Asteraceae	Acheberde au	Spontaneous	Leaf	Decoction	Oral	5	38.30	1.00	0.38	
<i>Lavandula dentata</i> L. / Lamiaceae	Igerch, Halhal	Spontaneous	Leaf	Decoction	Oral	6	12.77	1.20	0.11	[13, 15]
<i>Lavandula maroccana</i> Murb. / Lamiaceae	Iguiz, Khzama	Spontaneous	Leaf	Decoction	Oral	16	17.02	1.33	0.13	[29, 30]
<i>Launaea arborescens</i> (Batt.) Murb./ Asteraceae	Ifrskel, Oujan, Mmu- lbeyna	Spontaneous	Root	Decoction	Oral	15	25.53	0.75	0.34	[13, 14, 20, 30]
<i>Nigella sativa</i> L. / Ranunculaceae	Sanouj, Habba saouda	Cultivated	Seed	Powder mixed with honey	Oral	18	27.66	0.87	0.32	[1, 14, 15]
<i>Olea europaea</i> L. / Oleaceae	Zitoun, Zit Zbouj, Azemmour	Spontaneous	Leaf	Infusion	Oral	13	68.09	1.78	0.54	[1, 14, 15, 29, 30, 41]
<i>Pulicaria mauritanica</i> Batt. /	Bamghar	Spontaneous	Leaf	Decoction	Oral	12	53.19	2.08	0.52	

Asteraceae										
<i>Salvia aegyptiaca</i> L. /Lamiaceae	Idarki	Spontaneous	Leaf	Decoction	Oral	13	57.45	2.08	0.28	
<i>Salvia officinalis</i> L. / Lamiaceae	Salmia	Cultivated	Leaf	Decoction	Oral	17	25.53	0.71	0.36	[1, 14, 15, 30, 41]
<i>Syzygium aromaticum</i> (L.) Merr. & L. M. Perry / Myrtaceae	Korenfal	Cultivated	Seed	Infusion	Oral	18	14.89	1.17	0.13	[13]
<i>Tetraclinis articulata</i> (Vahl) Mast. / Cupressaceae	Azouka, Aârar	Spontaneous	Leaf	Infusion	Oral	12	51.06	2.00	0.48	[13, 15]
<i>Thymus broussonetii</i> Boiss. / Lamiaceae	Azoukni, Zaater	Spontaneous	Leaf	Infusion	Oral	12	21.28	0.83	0.26	[14]
<i>Thymus satureio</i> Coss. /Lamiaceae	Tazouknni , Zaitra	Spontaneous	Leaf	Infusion	Oral	12	29.79	1.17	0.52	[13, 14]
<i>Ziziphus lotus</i> (L.) Lam. / Rhamnaceae	Azegar, Sedra, Nbeg	Spontaneous	Seed	Decoction	Oral	6	17.02	1.33	0.13	[13, 14]

## 4. Conclusion

The traditional medicine plays an important role in the local population of the Agadir Ida Outanane region, Southern Morocco, of healthcare system. The people of Agadir Ida Outanane region depend on traditional medicine to treat diabetes because there have the efficacy of herbal medicine and there have little economic means to access western medicine. This study has led to the identification of 22 plants species used for curing diabetes and contribute to preserving knowledge of medicinal plants. Three plants species, *Cladanthus mixtus* (L.) Chevall, *Pulicaria mauritanica* Batt., and *Salvia aegyptiaca* L., are mentioned for the first time for traditional treatment of diabetes.

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**Arabian Journal of Medicinal and Aromatic Plants**

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**ISSN 2458-5920**