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An ethnopharmacological survey of plants used in traditional diabetes treatment in south-eastern Algeria (Ouargla province)

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ABSTRACT

An ethnopharmacological survey was performed in the Ouargla region (northeast of Algerian Sahara) to document ethnomedicinal knowledge and to catalogue the medicinal plants used to treat diabetes mellitus. We conducted in-person interviews of 289 diabetic patients, 25 herbalists and 10 healers in eight different areas of the Ouargla region. The results indicate that phytotherapy was always practiced to treat disease (60.90%), especially diabetes. Among the type 2 diabetes interviewees, 58 patients (44.27%) used only medicinal plants. Seventy-nine percent of plant users (176) were satisfied with herbal medicine i.e. 74% of the men and only 45.90% of the women. This could be explained by a high education level for the women. A total of 67 plant species that belong to 32 families were mentioned and were used to prepare 130 different formulations for treating diabetes and foot ulcers. Among the 13 most frequently cited species, only 3 were cultivated. More than 34 of the species are wild septentrional Sahara species. Thirteen species (19.40%) are endemic; three of them are reported for the first time as hypoglycaemic plants: *Matricaria pubescens*, *Oudneya africana* and *Rhanterium adpressum*. For nine species, we could not locate experimental data on anti-diabetic activity. Sixty six species are used to treat diabetes, while fifty one are used to treat symptoms that might be related to diabetes (especially foot ulcers). *Anvillea radiata*, *Ammodaucus leucotrichus*, *Artemisia herba-alba* and *Citrullus colocynthis* have the highest values of relative frequency citation (RFC), informant consensus factor (Fic) and use value (UV). They are the most used plant to decrease level of blood glucose and to treat foot ulcer. The new endemic plant species highlighted in the study could reveal an interest for further phytochemical and pharmacological studies.

1. Introduction

Diabetes mellitus (DM) is a global public health problem and is currently emerging as a global epidemic. International Diabetes Federation (IDF)'s most recent estimates indicate that 8.3% of adults (382 million people) suffer from diabetes, and the number of people with the disease is predicted to rise beyond 592 million in less than 25 years (IDF, 2013). However, with 175 million cases currently undiagnosed, many people with diabetes are unknowingly progressing towards complications (IDF, 2013). Moreover, 80% of the affected population lives in low- and middle-income countries, such as Algeria, due to an increase in the sedentary lifestyle, consumption of an energy-rich diet and obesity (IDF, 2013; Abo et al., 2008; Steyn et al., 2004). The diabetes incidence in the Maghrebin population is approximately 12%. In Algeria, more than 4 million people have diabetes. The central region of the country includes the most diabetics with 2.3% followed by the western region with 2.1% (Chakib, 2011). Currently, statistics on the southern region of Algeria are unavailable, but the data show an increase in the number of type 2 diabetes patients (Diabetes House data in Ouargla). Twenty three patients were registered in 2004 (13 women and 10 men) and 889 (444 women and 445 men) in 2014. Furthermore, the number of diabetic patient who lost one or both feet through amputation increased from 11 in 2004 to 46 in 2014 (Mohammed Boudiaf Hospital data in Ouargla).

Diabetes mellitus is characterized by chronically high glucose levels in the blood due to irregularities in insulin levels; further, patients have an altered cellular homeostasis that produces diffuse vascular damage and multi-organ dysfunction. Glycaemia and

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insulinemia levels must be controlled to avoid all the complications induce by diabetes. Many hypoglycaemiant agents, such as biguanides and sulfonylureas, are used separately or with insulin to treat this disease. However, these medications can cause serious side effects. These challenges have motivated researchers to find new efficacious molecules to control diabetes that cause fewer side effects in old and new sources of natural drugs (plants) (Alarcon-Aguilar et al., 2002). Recently, several ethnobotanical studies performed in different parts of world showed that more than 1200 plants are used worldwide for empirical diabetes treatment (Alarcon-Aguilar et al., 2002; Trojan-Rodrigues et al., 2012). However, only approximately 350 have been demonstrated to present hypoglycaemiant activity.

Despite its large surface, diverse climate leading to biodiversity and the presence of different ethnic groups with diverse medicinal plant traditions, the number of ethnopharmacological surveys that have been conducted in Algeria is low (Benderradji et al., 2014; Benhamou and Fazouane, 2013; Boudjelal et al., 2013; Hammiche and Maiza, 2006; Sari et al., 2012). Only three surveys focused on traditional treatments for diabetes. Bouzabata (2013) identified 59 species of plants traditionally used to treat diabetes in the north east of Algeria (Souk Ahras district); Azzi et al. (2012) identified 60 species in the south west and Allali et al. (2008) 58 species in the region of Tlemcen (north western region). In neighbouring Morocco, many ethnobotanical surveys have been performed in different areas in order to describe local pharmacopoeia (for example Abouri et al., 2012; Azaizeh et al., 2003; Bellakhdar et al., 1991; Benkhnigue et al., 2011; El-Hilaly et al., 2003; Jamila and Mostafa, 2014; Merzouki et al., 2000; Sijelmassi, 1993) and to determine traditional phytotherapy of diabetes (Ziyyat et al., 1997; Jouad et al., 2001; Bnouham et al., 2012; Eddouks et al., 2002).

The oasis of Ouargla is located in the northern Algerian Sahara where the use of plant for treating diseases is not documented and more especially for treating diabetes. The region has experienced important urban mutations and socio-economic radical changes with the discovery of oil and gas. The oasis is nearby two big oil fields. In 1900, Blanchet reported that there were three kinds of people in the Ouargla region, the sedentary inhabitant producing dates also known as *Madaniya* “people of the city”; the nomads carrying dates of Ouargla to the local markets and bringing back grain; the parasites that lend to each other. Since the energy revolution connected to the oil exploitation, the technological and economic evolution led to the nomad settlement. Currently, there is no nomad anymore in this region and new health problems appear such as the increase of the diabetes. So, social, cultural and economic changes, the aging of traditional healers and herbalists and the scarcity of some Saharan species due either to weather conditions either to human action, has led to the loss of local knowledge and skills.

Extensive comprehensive studies have not been performed on the use of local plants based on oral tradition in the southern Algerian Sahara. Ould el Hadj et al. (2003) and Maiza et al. (1993) investigated medicinal plants used to treat different ailments and presented only preliminary reports. Hence, our aim was to document the traditional use of plants for treating diabetes mellitus by traditional healers and the local population. The Ouargla region includes the most populated oasis in the Algerian Sahara and was the basis for this study.

2. Material and methods

2.1. Study area: condition, climate and population

The Ouargla region (wilaya of Ouargla) is located in north-east Algerian Sahara, which is one of the largest and most arid deserts in the world (Fig. 1). It is located in the great Oriental Erg, and its administrative centre, Ouargla, is 850 km from the capital, Algiers. The wilaya is bordered by 5 other wilayas on the north by Djelfa and El Oued; on the south by Illizi and Tamanrasset; on the west by Ghardaia; and on the east by Tunisia. Currently, this province has 21 municipalities grouped into 10 Daïras.

The climate is desert and is hyper-arid with very light and irregular rainfall, which varies between 0.01 mm and 17.2 mm each year and which reached 33.52 mm in 2013. The temperatures vary greatly daily (day and night) and annually (summer and winter). The average temperatures are 9.7 °C in January and 50 °C in July (ANDI, 2013). Evapotranspiration also varies with an average of 112 mm in January and 380 mm in July (ONM, 2011). The main geographical components of the Ouargla province are the great sand sea called Oriental Erg, the Hamada (rocky plateaus), the Regs (gravel area), depressions (Daya, Wadi beds, Sebkha and Chott) and valleys (the fossil valley of Oued Mya and the valley of Oued Righ), (Lethielleux, 1984; ANDI, 2013). The plant biodiversity is more important in Regs and Wadi beds (Baameur et al., 2015). The province is mainly inhabited by three ethnic groups, M'zabit (Ibadites), Ouarglis and Arabs (Lethielleux, 1984). In addition to the local population, other ethnic groups have recently populated the wilaya; the population migrations are due to the attractive, booming industrial area and associated jobs. The population of the province was estimated to be 558 563 inhabitants with a density of 3.4 inhabitants per square kilometre (ONS, 2007). Thirty five percent of the population is aged under 15 years. The workforce represents more than 21% of which the administrative and service sectors lead with 53.36% of the workforce, followed by the agricultural sector with 16.5% (ANDI, 2013). The human economy was traditionally based on the cultivation of the date palm.

2.2. Ethnobotanical survey

Ethnobotanical data were obtained from 25 local herbalists, 10 healers and 289 patients suffering from diabetes in eight areas of the region: Ouargla city centre, Sidi Khouiled, Hassi Ben Abdellah, Frane, N'Goussa, El Hadjeira, Alalia and Touggourt (city). These areas are located approximately between (30°–33° N 4°–6° E). The health authorities in the region were contacted for permission and to collaborate with the medical teams authorized to identify and include diabetes patients in this study. The patients were interviewed consistent with ethical rules, and they received information on the study objectives. The survey was performed in the province from January 2010 to December 2012.

A questionnaire was administered to patients through face-to-face interviews (supplementary date). The language used was the local Arabic dialect, spoken by the interviewer. The questionnaire was designed to obtain the following information: (a) general data on the informant (name, sex, age, educational level); (b) plants used (i.e., vernacular names and the part of the plant or organ used); (c) method of medicinal preparation, such as maceration or decoction; and (d) route of administration as well as treatment duration. We interviewed 10 healers and 25 herbalists to verify the patient claims regarding plant use and for plant identification.

We collected wild plants used by the local populations for treating diabetes in five areas of the septentrional Sahara: Oued N'sa (in the portion near Ouargla and Ghardaïa), Hassi El Khefif, Alalia and Guerrara. For each species, specimens were collected, numbered and stored at the Laboratory of Preservation of Ecosystems in arid and semi-arid areas (Faculty of Nature and Life Sciences, University of Ouargla). These species were collected with two herbalists and one healer to confirm that the collected species were the species that are traditionally used and sold. Only 71 patients (289 people surveyed) were familiar with the Sahara plants;