

Full Length Research Paper

Ethnobotanical study and phytochemical screening of six medicinal plants used in traditional medicine in the Northeastern Sahara of Algeria (area of Ouargla)

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Received 21 August, 2015; Accepted 12 October, 2015

An ethnobotanical survey was undertaken to collect information from traditional healers on the use of plants (*Atriplex halimus* L., *Searsia tripartita* (Ucria) Moffett, *Limoniastrum guyonianum* Durieu ex Boiss., *Haplophyllum tuberculatum* Juss., *Tamarix gallica* L. and *Nitraria retusa* (Forssk.) Asch.) in folkloric medicine of Ouargla (Algeria), using a predesigned questionnaire. The studied plants were screened for the presence of secondary metabolites. The traditional healers in the study area used the investigated species for the treatment of various diseases. The average of the informant consensus factor (F_{IC}) value for all ailment categories was 0.93, with the highest number of species being used for digestive problems (449) followed by dermatological symptoms (154) and nervous disorders (144). These pathologies were mainly treated by leaves in the form of decoction, representing the dominant formulation. The oral administration which regrouped the major form of usage, which was in form of drink, was most exercised. The phytochemical analysis showed the presence of polyphenolic compounds and saponins in almost all tested plants. For the other metabolites classes, results varied between plants. The multi-uses of species demonstrated the importance of these plants and the diversity of the ancestral knowledge.

Key words: Ethnobotanical study, spontaneous plants, traditional pharmacopeia, phytochemical analysis, Ouargla.

INTRODUCTION

Plants have occupied a prominent place and have been for man, a privileged point of contact with nature and

health. Herbal remedies are increasingly popular and used based on sound values. They have been tested by

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our ancestors, of whose virtues confer a significant place in traditional therapy (Tabuti et al., 2003). The World Health Organization (WHO, 2000) defines the traditional medicine as the sum total of the knowledge, skills and practices based on the theories, beliefs, and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness. Medicinal plants have provided modern medicine with numerous plant derived therapeutic agents. Most of these plant derived drugs were originally discovered through the study of traditional cures and folk knowledge of native population (Hudaib et al., 2008). A survey was done by USA in the University of the Illinois (Chicago), in 2001 and it was discovered that among medicinal substances found in the market, 122 came from plants (of 94 different species). Among these natural molecules, 80% have been used in combination with the same ones or similar to those for which plants of same origin were used in traditional medicine (Fabricant and Farnsworth, 2000). It shows very well that the uses of plants fact integral part of traditions of all cultures and that the medicinal valorization of these practices is therefore very interesting.

Algeria, with its large area and diversified climate has a varied flora, which is a source of rich and abundant medical matter. On the other hand, Algeria with its history and its strategic location, has benefited from different cultures: Berber, Greco-Roman and Islamic. Important knowledge of plant medicine, currently used in traditional Algerian medicine, originated in the medical heritage of Muslim civilization, transmitted from generation to generation (Chériti et al., 1995; Bellakhdar, 1997). In this light, an ethnobotanical investigation on traditherapeuteses, herbalists and individuals living in contacts with some medicinal plants was done in the goal to exploit the ancestral knowledge of the traditional pharmacopeia, that is transmitted by oral tradition. Indeed, it is very important to translate traditional knowledge to scientific knowledge, in order to help in preserving the knowledge of medicinal plants and should direct biologist and phytochemist in their search to promising species and bioactive constituents.

MATERIALS AND METHODS

Study area

The study was conducted in South-eastern Algeria, in the province of Ouargla, which is located 790 km away from Algiers, and a surface area of 163.230 km². It is limited to North by the Wilayas of Djelfa and El-Oued, to East by Tunisia, to South by the Wilayas of Tamanrasset and Illizi and to West by Ghardaïa (Figure 1). The region of Ouargla is located at the bottom of a very large pan of the low valley of the Oued M'ya, to an altitude of 157 m. The geographical coordinates are: latitude 32° 45' North and 31° 45' South, longitude 5° 20 ' East and 5° 45' West (Rouvillois-Brigol, 1975). The area is characterized by the predominance of dunes all along the valley, Sebkhass and massive dune alterative with funds

on which agriculture irrigation was installed. The hydrographic network of Ouargla region mainly consists of three major hydrological elements, Oued M'Ya, Oued N'Sa and Oued M'Zab. These last two Oued participate to some extent, in the water supply of water tables despite low precipitation and their stormy character (Rouvillois-Brigol, 1975).

It has a climate particularly contrasted in spite of the relatively Northern latitude. The average annual temperature, according to the Office National de la Météorologie (ONM) for years (2003 to 2013) range from about 36.74°C in July for the hottest month and 11.50°C in January for the coldest month. Precipitations are very reduced and irregular to crossbar seasons and years. Their distribution is nearly marked by a drought absolute in month of May until the month of August. The yearly middle precipitations are in the order of 3.03 mm, with a maximum of 7 mm for the month of January. The total population residing in the region are estimated at 558 563 inhabitants, with a density of 3.4 inhabitants/km².

The inhabitants are ethnic-multiple, with Berber, Arab, African and Mestizo which come from mixed marriages. The main feature of the region is the youth of the population, as the majority of the population is under 25 years old, with a natural growth rate of around 2.15%. Working in the land has always been for the people of the region, who use it as their main source of activity and economy. It has space in agro-pastoral activity, strongly dominated by date palm and cereal in pivot, because of its climate and mobilization of water resources. The total agricultural area amounts to 4877393 ha, about 29.9% of the total area of the province.

Interviews and plant material collection

In order to determine the possible usage of the plant species (*Atriplex halimus* L., *Searsia tripartita* (Ucria) Moffett, *Limoniastrum guyonianum* Durieu ex Boiss., *Haplophyllum tuberculatum* Juss., *Tamarix gallica* L. and *Nitraria retusa* (Forssk.) Asch.) in traditional pharmacopeia of Ouargla region, an ethnobotanical survey was launched since 2011 to 2013, which targeted population groups including; herbalists, traditional healers, herbal practitioners, nomads and physicians. Most of the people interviewed were traditional healers. These plants have attracted serious attention because of their chemo taxonomic criteria. They belong to a botanical family known to frequently contain some secondary metabolites and possess pharmacological potentials. A total of 200 informants (45% of them were female and 55% were male), whose ages ranged from 20 to 80 years participated in this study. The investigation was performed using a predesigned questionnaire which included their age, sex, their job, with questions relating to the plants, the scientific and common names, plant parts in use, methods and forms of preparations and therapeutic indications. All interviews were carried out in the native language (Arabic) of the study area.

Plant samples were collected from the field and were dried and compressed in papers. Papers were changed daily until they remained dry after compression. The voucher specimens of medicinal plants collected was identified based on the "Flora and vegetation of Sahara" (Ozenda, 1983), with the help of the Herbarium specimens available at the Herbarium of the Faculty of Sciences of Nature and Life of the University Kasdi Merbah, Ouargla (Algeria). It should be noted that the new phylogenetic classification APG II (Angiosperm Phylogeny Group, 2003) was adopted in order to update the families cited in Table 1.

Data analysis

Informant consensus factor (F_{IC})

Informant consensus factor (F_{IC}) was employed to deduce the



Figure 1. Geographical location of the study area.

homogeneity of the information about a specific plant use to treat a particular category of ailments. All citations were placed into ailment categories for which the plant was claimed to be used. These were either denominated after the affected organ including, skin, auditory, skeletal, visual, poisonous, endocrine, respiratory, nervous system, genital, metabolic, circulatory, digestive, urinary tract, cancerous or parasitic diseases. The F_{IC} results could be useful in prioritizing medicinal plants for further scientific validation of plants and plant products (Moshi et al., 2009; Giday et al., 2009), as pharmacologically effective remedies are expected from plants with higher F_{IC} values (Trotter and Logan, 1986). The informant consensus factor (F_{IC}) was calculated to estimate user variability of medicinal plants (Heinrich et al., 1998; Canales et al., 2005). F_{IC} values ranged from 0.00 to 1.00. High F_{IC} values were obtained when only one or a few plant species was reported to be used by a high proportion of informants to treat a particular ailment, whereas low F_{IC} values indicated that informants disagreed over which plant to use (Heinrich et al., 1998). High F_{IC} values can thus be used to pinpoint particularly interesting species for the search of bioactive compounds (Canales et al., 2005). F_{IC} is calculated using the following formula:

$$F_{IC} = N_{ur} - \frac{N_t}{(N_{ur} - 1)}$$

Where N_{ur} is the number of individual plant use reports for a particular illness category and N_t is the total number of species used by all informants for this illness category.

Frequency of use (F_c)

The frequency of use (F_c), the percentage of informants claiming the use of specie in the treatment of diseases, was calculated according to the formula:

$$F_c (\%) = n/N \times 100$$

Where n is the number of informants that claim the use of a plant species to treat a particular disease, and N is the number of informants that use the plants as a medicine to treat any given disease.

Phytochemical analysis

These are tests performed to collect data on the composition of the studied plants (in powder form). Most are based on colorimetric assays and also precipitation, using various reagents. The methods used for the characterization of the chemical groups present in each plant follow the protocols described by Ronchetti et al.

Table 1. Traditional uses of studied species in folkloric medicine of Ouargla (Algeria).

Family	Scientific name	Vernacular name	Area of collection	Additives	Traditional uses
Amaranthaceae	<i>Atriplex halimus</i> L.	G'ttaf	Biskra (34° 45' 14.3" N, 005° 24' 43.5" E) Altitude 2 m	Honey, salt with honey, oil, milk, local butter (Dhan), <i>Citrus sinensis</i> (L.) Osbeck (laymoune)	Catarrh stomacal, constipation, diarrhea, gas, bloating, cyst hydatique, fibrome, hypertension, antiseptic, burns, diabetes, fever, jaunasse, anemia, cardiac disease, otitis, rheumatism, cough, obesity, tumor, tiredness, diuretic, vermifuge, involuntary urine, vomiting, wounds and ulcers, tonsillitis, goiters, gallbladder disease, calming, fortify the gums, infertility, prostate, fall of placenta, nephrolithiasis, hypercholesterolemia
Anacardiaceae	<i>Searsia tripartita</i> (Ucria) Moffett	Djedari	Ghardaïa (32° 13' 09.1" N, 003° 30' 00.1" E) Altitude 519 m	Honey, oil, milk, <i>Origanum vulgare</i> L. (Zâatar)	Diabetes, bloating, fever, kidney disease, cutaneous lesions, migraines, diarrhea, anemia, menstrual disorders, cardiac disease, otitis, inflammation of the mouth, jaunasse, gas, leprosy, catarrh stomacal, cephalalgia, hypertension, loss of appetite, flu, prostate, hemorrhoids, rheumatism, weakness of vision
Plumbaginaceae	<i>Limoniastrum guyonianum</i> Durieu ex Boiss.	Zeta	Ouargla (33° 12' 30.9" N, 006° 07' 59.6" E) Altitude 299 m	<i>Punica granatum</i> L. (reman)	Antiseptic, burn, leprosy, wounds and ulcers, strengthening, diabetes, jaunasse, anemia, cough, constipation, gas, kidney disease, pains of the head, hypertension, obesity, scorpion stings, tonsillitis and flu, fortify the gum, liver disease
Rutaceae	<i>Haplophyllum tuberculatum</i> Juss.	Fidjel	Ghardaïa (32° 13' 19.3" N, 003° 29' 59.9" E) Altitude 314 m	oil, salt with honey, local butter (Dhan), <i>Punica granatum</i> L. (reman), <i>Artemisia campestris</i> L. (dgouft), <i>Allium cepa</i> L. (el-besla), <i>Carum carvi</i> L. (karwya)	Antiseptic, injuries and ulcers, calming, hypnotic neurological, infertility, diabetes, bloating, fever, liver disease, otitis, rheumatism, vermifuge, obesity, constipation, colon, diarrhea, gas, hypertension, menstrual pain, cardiac disease, scorpion stings, flu, vomiting, throat inflammation, sweat, tonsillitis, cough, loss of appetite
Tamaricaceae	<i>Tamarix gallica</i> L.	Tarfa	Ouargla (33° 17' 12.5" N, 006° 01' 55.5" E) Altitude 1 m	Salt with honey, vinegar	Antiseptic, burn, leprosy, injuries and ulcers, pikes of scorpions and bugs, illnesses of the kidney, diarrhea, anemia, jaunasse, inflammation the gum and of the mouth, gastric ulcer, cephalalgia, hypertension, diabetes, illness of joints, hemorrhage, diuretic, inflammation of the pancreas
Zygophyllaceae	<i>Nitraria retusa</i> (Forssk.) Asch.)	Ghardaq	Ouargla (33° 13' 02.9" N, 006° 02' 39" E) Altitude 1 m	Honey, milk, egg white, oil, <i>Lawsonia inermis</i> L. (el-hana), <i>Allium cepa</i> L. (el-besla)	Antiseptic, cutaneous wound, burn, diabetes, fever, constipation, laxative, diarrhea, cardiac disease, scorpion stings, cough, gastric ulcer, cephalalgia, hypertension, loss of appetite, colon, prostate, articular pains, conjunctivitis, diseases of eyes and eyelids, weakness of vision, fortify the gum.

(1971), Hegnauer (1973), Wagner (1983) and Bekro et al. (2007).

RESULTS

During the ethnobotanical investigation, a total of 200 answers were obtained concerning the use of

researched species (Table 1). For each species, scientific and vernacular name, family, therapeutic properties and eventual supplenemts were provided. Plant resources are often used multi-contextually. All species in this study were used in more than one disease category, and about 15 disease categories were identified from the investigated region.

These are more or less involved in the cure of illnesses recorded in the different apparatuses, skin, auditory, skeletal, visual, poisonous, endocrine, respiratory, nervous system, genital, metabolic, circulatory, digestive, urinary tract, cancerous or parasitic diseases. These categories could be considered as a reflection of the cure concept of the local people of Ouargla. The level

Table 2. Informant consensus factor (F_{IC}) for different ailment categories.

Ailment	Skin disease	Auditory disease	Respiratory disease	Nervous disease	Genital disease	Metabolic disease	Circulatory disease	Digestive disease	Urinary disease	Skeletal disease	Visual disease	Endocrine disease	Poisonous disease	Cancerous disease	Parasitic disease
Number of taxa (N_t)	6	4	6	6	4	6	6	6	6	6	3	4	4	1	1
Number of use reports (N_{ur})	154	35	48	144	83	129	79	449	42	33	17	21	30	10	23
F_{IC}	0.97	0.91	0.89	0.97	0.96	0.96	0.94	0.99	0.88	0.84	0.88	0.85	0.90	1.00	1.00

Table 3. Frequency of use (F_C) (%) values of medicinal plants cited by informants for being used against a given ailment.

Species	Skin disease	Auditory disease	Respiratory disease	Nervous disease	Genital disease	Metabolic disease	Circulatory disease	Digestive disease	Urinary disease	Skeletal disease	Visual disease	Endocrine disease	Poisonous disease	Cancerous disease	Parasitic disease
<i>A. halimus</i>	2.78	0.35	2.43	1.04	15.97	7.99	3.13	38.54	7.29	2.43	1.04	5.56	/	3.47	7.99
<i>S. tripartita</i>	11.27	1.41	2.11	1.41	0.70	2.11	10.56	66.90	0.70	0.70	0.70	1.41	/	/	/
<i>Li. guyonianum</i>	36.91	4.03	18.12	4.70	0.67	20.81	2.68	6.04	0.67	1.34	/	/	4.03	/	/
<i>H. tuberculatum</i>	2.69	7.76	1.49	38.81	10.45	1.79	5.07	26.27	1.49	2.99	/	/	1.19	/	/
<i>T. gallica</i>	5.04	/	1.26	0.42	/	23.95	10.50	47.48	3.78	1.26	/	0.84	5.46	/	/
<i>N. retusa</i>	37.24	/	2.07	0.69	/	6.21	6.21	22.76	3.45	6.90	8.97	0.69	4.83	/	/

of informants agreement was high for most ailment categories (mean F_{IC} = 0.93) and total consensus (F_{IC} = 1.00) was even obtained for cancerous and parasitic diseases, followed by digestive disease (F_{IC} = 0.99), dermatological symptoms and nervous disorders (F_{IC} = 0.97) in the second and third categories, respectively (Table 2). Endocrine (F_{IC} = 0.85) and skeletal category (F_{IC} = 0.84) showed relatively low levels of consensus.

The highest plant use citation (449) was cited for digestive problems, followed by dermatological symptoms (154) and nervous disorders (144). For digestive problems we reported *S. tripartita* (F_C = 66.90%), *T. gallica* (F_C = 47.48%) and *A. halimus* (F_C = 38.54%) as the plants with most the

frequent use. While for dermatological diseases, *N. retusa* (F_C = 37.24%) and *L. guyonianum* (F_C = 36.91%) were preferred (Table 3). Finally, for nervous disorders, *H. tuberculatum* was the one with the biggest record (F_C = 38.81%) (Table 3). Various plant parts (leaves, stem, bark, fruits, seeds, root, flowers etc) were used for different therapeutic preparations, with the leaves predominating for all species, beginning with 44.26% for *S. tripartita* and arriving at 53.33% for *L. guyonianum* (Figure 2). The studied plants were formulated by the local population using six methods of preparation (decoction, infusion, steeping, powder, excerpt and torrefaction) (Figure 3).

The decoction was the most frequent method of

preparation followed by the use of powder and infusion in second place for (*T. gallica*, *S. tripartita*, *N. retusa* and *L. guyonianum*) and (*H. tuberculatum* and *A. halimus*) in this order. For the application of different aforementioned symptom treatments, different methods of administration in the form of drinks followed by auditory instillation for *H. tuberculatum* plant, the ingestion concerning *A. halimus* specie, the local application for *N. retusa*, *S. tripartita* and *L. guyonianum* species, these last two fashions nearly occupied second rank, with a percentage similar to *T. gallica* (13 and 12%), successively (Figure 4).

The use of species for different treatments is not always singular, but one often runs to a natural

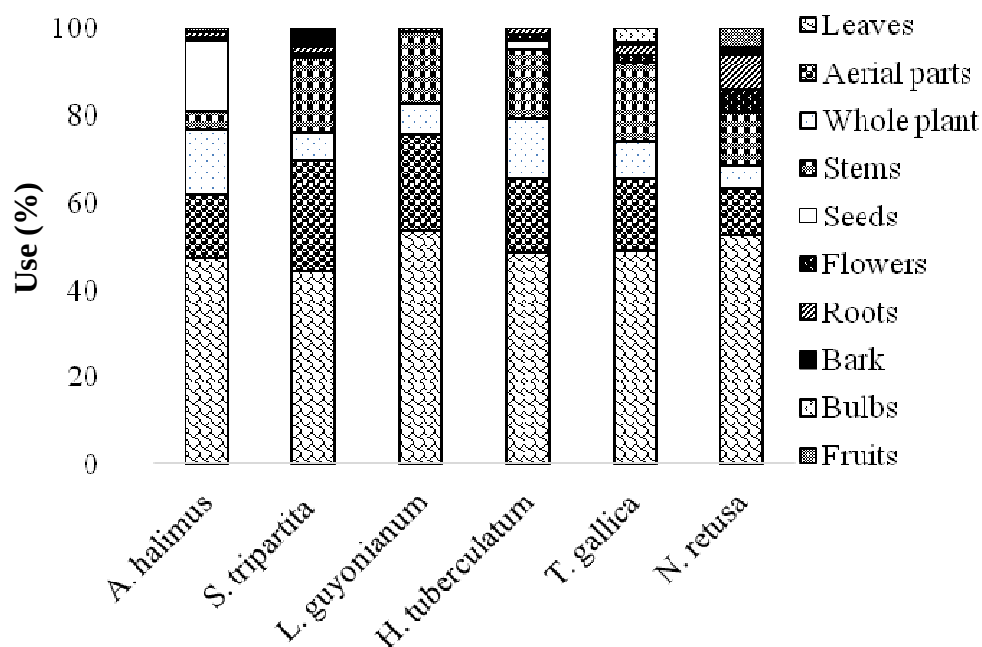


Figure 2. Percentage of plants uses according to the used part.

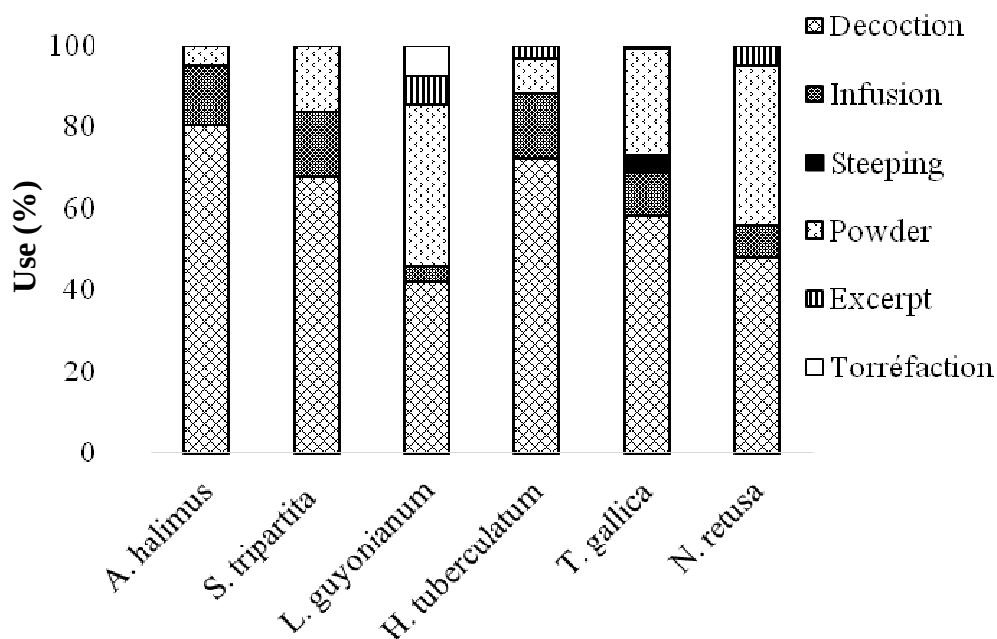


Figure 3. Percentage of plants' uses according to forms of preparation.

supplement addition for a given treatment. To this effect *H. tuberculatum* was usually mixed with 07 supplements, *A. halimus* with 06, *N. retusa* with 05, *S. tripartita* with 04, *T. gallica* with 02 and *L. guyonianum* with 01 (Table 1). Phytochemical analysis of composition aimed to determine the chemical groups responsible for the

claimed therapeutic effects. Results are summarized in Table 4. Obtained results indicated the presence of polyphenols and saponins, with an absence of alkaloids, anthocyanins and anthracenosides (free and O-combined) in all tested plants. For the other metabolites groups, the results varied. Furthermore, sterols, triterpenes

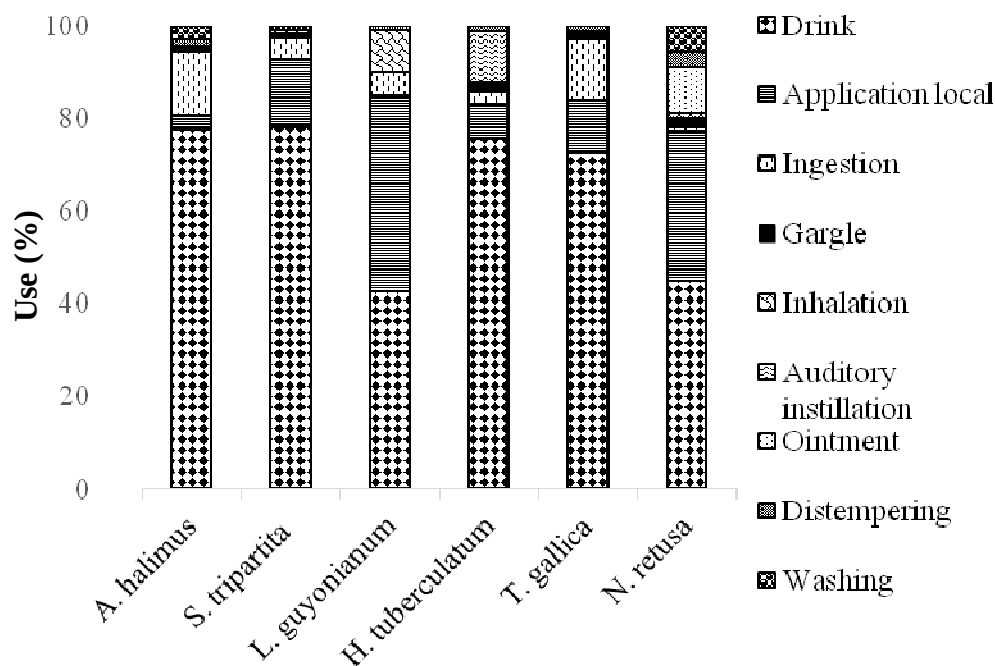


Figure 4. Percentage of plants' uses according to methods of administration.

and free flavonoids were detected in all species except *A. halimus*. The test of tannin gallic was positive only in *T. gallica* plant.

DISCUSSION

The local residents provided information on the researched species and the traditional therapeutic practices of the local population of the region of Ouargla. These medicinal applications spanned a total of 15 disease categories. Each plant might be used to treat various diseases. This can be interpreted as an optimization of natural resources due to tight connection of the people with their local environment (Pieroni et al., 2002). Digestive disease was the most important ailment treated on the basis of number of citations for medicinal uses followed by dermatological symptoms and nervous disorders. For digestive problems we reported *S. tripartita*, *T. gallica* and *A. halimus* as the plants with most frequent use, while for dermatological diseases, *N. retusa* and *L. guyonianum* were preferred (Table 3). The elevated usage of the studied plants for digestive diseases was understandable as this was considered by various authors, local and from other region, as the symptoms with the highest use of medicinal plants for its treatment. Results of the inventory of Ould El-Hadj et al. (2003) led in the region of Ouargla, indicated that digestive problems dominated with a rate of 26.4%. The relative importance assigned to them was similar to that registered by Scarpa (2004) in other geographical areas

(Northwestern Argentine Chaco) which indicated that 90 species (26.5% of the total uses) and 58 species (14.6%) were used mainly for diseases of the digestive tract and skin infections, respectively.

Concerning nervous disorders, *H. tuberculatum* had the biggest record. Some traditional uses reported for *Haplophyllum* species suggested that this plant may have activity on central nervous system. For instance, the leaves of this plant infused with vinegar was given to children for the treatment of convulsion and other nervous disorders (Al-Said et al., 1990). Different parts of documented plants were used as medicine by the local traditional healers. Among these, the leaves were most commonly used for the treatment of diseases. The predominance usage of an organ in relation to another in the therapeutic domain can be due to the concentration in active components in this organ. Leaves are the center of most photochemical reactions and are reservoirs of certain metabolites (Chamouleau, 1979). Collection of leaves and then using them as medicine is very easy as compared to roots, flowers and fruits (Giday et al., 2009). Another reason of using leaves could be concerning conservation of the plants, as digging out roots might result in the death of the plant and consequently putting the species in a vulnerable condition (Rehecho et al., 2011).

Preparation of medicinal plants varied, such as decoction, infusion, steeping, powder, excerpt and torrefaction. However aqueous decoction was the most frequent form of preparation which was followed by powder and infusion. These results agreed with the

Table 4. Phytochemical screening of studied plants.

Chemical groups		<i>A. halimus</i>	<i>S. tripartita</i>	<i>L. guyonianum</i>	<i>H.tubercula tum</i>	<i>T. gallica</i>	<i>N. retusa</i>
Polyphenols		+	+++	+++	++	+++	++
Tannins	Catechic	++	+++	+++	-	+++	+++
	Gallic	-	-	-	-	+++	-
Flavonoids	Free	-	++	++	++	+++	+
	Leucoanthocyanes	-	+++	-	-	+++	++
	Catechols	-	-	++	-	-	-
Anthocyanins		-	-	-	-	-	-
Anthracenosides	Free	-	-	-	-	-	-
	O- heterosides	-	-	-	-	-	-
	C- heterosides	-	+	+++	-	+++	-
	G- heterosides	-	++	++	-	++	-
Alkaloids		-	-	-	-	-	-
Sterols		-	++	+++	++	++	+++
Polyterpens		-	++	+++	++	++	+++
Saponins (foaming index)		142.85	500	111.11	250	166.66	500

- (Absent), + (Low in abundance), ++ (Moderate in abundance), +++ (High in abundance).

literature of Kola et al. (2008) and Pascal et al. (2011), where preparations were made with water as a solvent. Infusion was used for delicate plant organs (leaves, bloom heads and flowers) to preserve active principles. For Lori and Devan (2005), infusion was appropriate for delicate and light organs, whereas for hard and compact organs (woods, barks, stems, branches and roots), extraction of active principles required prolonged treatment under heat. The decoction was the beneficial preparation method in order to extract a maximal quantity of the active principles and attenuate or cancel the toxic effect of certain revenues.

Medicinal plants are usually used internally or externally which depends on the illness. The oral consumption of the medicinal plants consisted mainly of remedies used against digestive diseases. Almost all the internal remedies prepared from medicinal plants were prepared in oil, honey, salt with honey, milk, local butter (Dhan), vinegar and egg white. On one hand, the additives like oil, honey, salt with honey, milk, local butter (Dhan), vinegar and egg white are commonly believed to serve as a vehicle to transport the remedies. On the other hand, the combination of studied species with other plants was probably justified by their common therapeutic action and their mixture was perhaps aimed at reinforcing such action. Advices of associations are dictated by a search to increase the efficiency of treatment; it means that taken all together, these constituent will be more efficient than if they were taken separately. Synergy that exists inside a same plant can be improved again and reinforced by the action devised by several natural substances.

The phytochemical investigations revealed the presence of polyphenolic compounds and saponins in almost all tested plants (Table 4). For the other

phytocompounds, results varied between plants. Some of the more commonly known phytochemicals, including flavonoids, tannins and saponins were observed in the present study and have all been reported to aid man by creating a preventive barrier against diseases and sicknesses. These metabolites classes have been associated with different pharmacological activities including antibacterial, antioxydant and analgesic properties, which could justify and confirm the therapeutic traditional preparation indications on the basis of plants (Ajibola and Motoyoshi, 1992).

A. halimus (Amaranthaceae) known under the name of "G'ttaf" in Ouargla, was mentioned for the treatment of digestive ($F_C = 38.54\%$) and genital ($F_C = 15.97\%$) diseases. Studies on the chemical constituents of *A. halimus* have been carried out by many investigators and have shown the presence of various compounds. For example, tannins, flavonoids, saponins, alkaloids and resins (Bayoumi and El-Shaer, 1992). In the Arab world, *A. halimus* was used to treat chest ailments, as a laxative, to cure stomach pains, for intestinal worms and to regulate gall bladder excretions (Day, 1990; Le Houérou, 1992). According to those surveyed for example *S. tripartita* (Anacardiaceae) known locally as "Djedari", aqueous decoction (67.96%), powder (16.50%) or infusion (15.53%) was considered as the most popular methods of preparation that can address several diseases such as digestive ($F_C = 66.90\%$), skin ($F_C = 11.27\%$) and circulatory ($F_C = 10.56\%$). Concerning the chemical studies of this plant, several compounds such as flavonoids, biflavonoids, isobiflavonoids, catechin, epicatechin-3-O-gallate, proanthocyanidin oligomers and polymers, polysaccharides, condensed tannins have been isolated from different parts of the plant (Tebourbi et al., 2006; Alimi et al., 2013). This plant has been used in

Tunisian traditional medicine to treat diarrhoea and dysentery. The root bark extract of this specie has been reported to be beneficial in curing gastric ulcers (Abbassi and Hani, 2012).

In traditional medicine of Ouargla, *L. guyonianum* (Plumbaginaceae) known locally as “Zeta” was used as decoction (42.34%) or powder (39, 64%) preparation by the local residents to cure skin ($F_C = 36.91\%$), metabolic ($F_C = 20.81\%$) and respiratory ($F_C = 18.12\%$) diseases. The essential oil of *L. guyonianum* from Monastir region (Tunisia) consisted these main constituents: (3Z) hex-3-enylmethanoate (9.18%) in roots, furfural (14.63%) in seeds, methyl-2,4-dimethylbenzoate (14.70%) in leaves and 3-phenylprop-2-enylpentanoate (15.05%) in flowers. Furthermore, evaluation of antibacterial effects against five bacterias: *Escherichia coli* ATCC 35218, *Pseudomonas aeruginosa* ATCC 27853, *Staphylococcus epidermidis* NCIMB 8853, *Staphylococcus aureus* ATCC 29213 and *Micrococcus luteus* NCIMB 8166 showed that the indicated oils prevented visible growth of all tested bacteria at a lower concentration (MIC = 0.02 mg/ ml) (Hammami et al., 2011). Recently, it was mentioned that ethyl acetate extract of the aerial parts of *L. guyonianum* from Gabes in Tunisia contained gallo catechin, epigallocatechin and epigallocatechin-3- O-gallate which showed anti-oxidant activities (Trabelsi et al., 2012). This endemic species has been used in Algerian folk medicine to treat gastric infections. It has also been employed as an anti-bacterial drug in the treatment of bronchitis (Le Floch, 1983).

H. tuberculatum (Rutaceae) known under the name of “Fidjel” in Ouargla was widely used in decoction (72.43%) or infusion (16.22%) forms for nervous ($F_C = 38.81$), digestive ($F_C = 26.27\%$) and genital ($F_C = 10.45$) diseases by indigenous groups. Literature survey relayed that a number of phytochemical investigation studies have been reported indicating that *H. tuberculatum* is rich in alkaloids and volatile constituents (Al-Burtamani et al., 2005). The essential oil of the aerial parts of *H. tuberculatum* from Beni Abbes in Algeria is characterized by the major components: α -phellandrene (2.1%), β -phellandrene (3.0%), terpinene-4-ol (3.2%), p-cymene-8-ol (2.9%), piperitone (17.8), 2,4-bis(1,1-dimethylethyl)-phenol (28.3%), (1E,4E)-germacrene B (2.1%), hexadec-1-ene (3.2%) and octadec-1-ene (2.1%) (Mechehoud et al., 2014). This specie is used in traditional medicine as a remedy for headaches and arthritis, the juice is applied as a wart removal, skin discoloration, infections and parasitic diseases (Al-Burtamani et al., 2005). It is also used to treat nervous system, infertility and fever (Said et al., 2002).

T. gallica (Tamaricaceae) known under the name of “Tarfa” in Ouargla, was mainly used in the form of decoction (58.18 %) or powder (26, 06 %) for the treatment of digestive ($F_C = 47.48\%$), metabolic ($F_C = 23.95\%$) and circulatory ($F_C = 10.50\%$) diseases. Studies on the chemical constituents of *T. gallica* have been

carried out by many investigators and have shown the presence of polyphenolic compounds, such as flavonoids, phenolic acids, tannins and coumarins (Mahmoud et al., 1994, Djurdjević et al., 2006). The *n*-butanol extract of the aerial parts of *T. gallica* from Tebessa in Algeria is characterized by the presence of two flavonoids: 5-Hydroxy-3,7, 4'-trimethoxyflavone and 3,5,7-Trihydroxy-4'-methoxyflavone (Lefahal et al., 2010). In Algeria and surrounding areas, the plant has been used medicinally for rheumatism, diarrhoea and other maladies (Kalpna et al., 2011). The branchlets and the leaves are astringent and diuretic. An external compress of the leaves helps to stop bleeding in wounds. The plants have been reported to be useful in leucoderma, spleen trouble and eye diseases (Sharma and Parmar, 1998).

N. retusa (Zygophyllaceae) known locally as “Ghardaq” in folkloric medicine of Ouargla was used by the traditional healers as decoction (48.04 %) or powder (39, 22 %) preparation to treat skin ($F_C = 37.24\%$) and digestive ($F_C = 22.76\%$) diseases. Chemical study on *N. retusa* have shown the presence of O- glycosides of flavones and flavonols compounds in addition to flavones c- glycosides which exhibits a notable activity in protecting against oxidative stress (Hussein et al., 2009). Belkadar (1997) indicated that a decoction of fresh leaves of *N. retusa* was used in Morocco in case of poisoning, stomach upset, ulcers, gastritis, enteritis, heartburn, colitis, and colonic abdominal pain. In Tunisia and Egypt, the dry leaves of this plant are used in decoction as a substitute to tea and to make cataplasms. Ashes of this plant have the property to withdraw liquids (blood, lymph) from infected wounds (Shaltout et al., 2003).

Conclusions

The population of the survey used the inventoried plants to treat different diseases whose dominants illnesses are digestive diseases, followed by dermatological symptoms and nervous system disorders. The multi-uses of species demonstrated the importance of these plants and the diversity of the ancestral knowledge due to tight connection of the people with their local environment. The traditional medicines constitute in fact a very rich heritage, which should be transmitted to the younger generations. This plant heritage constitute an inestimable treasure that will be able to be valorizes and used subsequently as the therapeutic products of basis to produce medicines improved with the contribution of analyses of the chemical composition and the active principles of these medicinal plants.

Conflict of Interests

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

The authors would like to thank the different medicinal plants users (traditional healers, herbalists, herbal practitioners, nomads and physicians) interviewed in this study and the enumerators for making it possible for them to speak to them and learn more from their experience.

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