Ethnobotanical characterization of halophytes with medicinal virtues, 
Case of the Macta wetland flora: North-West Algeria

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Abstract
Here is an ethnobotanical study on halophytic plants with medicinal virtues traditionally used by the populations surrounding the Macta wetland (north-western Algeria). An ethnobotanical survey was carried out and the data collected were statistically analyzed by using the R software and 150 questionnaire sheets. The results obtained allowed the identification of 53 plants including 32 halophytic species with medicinal virtues belonging to 28 genera and 17 botanical families. On the basis of the ethnobotanical survey, we identified 43.75% of the species that are used as anti-inflammatory, 28% to treat diuretic disorders, 21.87% to treat uro-genital disorders, 18.75% for their effects on the digestive system, and 15% of the plants which are used against diabetes. Multifactorial analysis reveals a good correspondence between the ethnobotanical aspect of plant species and their therapeutic uses. The results obtained indicate the appearance of five typical use profiles specific to medicinal virtues.

Keywords: Ethnobotanical surveys, spontaneous medicinal plants, phytotherapy, Macta, North West Algeria.

Introduction
The valorization of natural resources is a concern that has become increasingly important in many countries in recent decades. Thus, since its General Assembly, the WHO has been recommending the evaluation of the safety and efficacy of plant-based medicines with a view to standardize their use and to integrate them into conventional health care systems (O.M.S. 2002).

In Algeria, traditional medicine has long been used thanks to the richness and diversity of its flora, which constitutes a real phylogenetic reservoir, with about 3000 species and subspecies of vascular plants, which enables it to occupy a privileged place among the Mediterranean countries that have a long medical tradition and traditional know-how based on medicinal plants (Bouzid et al., 2017). However, the Algerian medicinal forest remains little-known nowadays because, out of the few thousand plant species, the number of medicinal species does not exceed 600 (Mokkadem, 1999). That’s to say 15% of the total Algerian forest. It certainly constitutes an integral part of the culture of the Algerian population. The halophytes are part of this reservoir thanks to their multiple ecological and agroalimentary interests (Batanouny, 1994). Some of them have been used in traditional medicine for centuries (Batanouny, 1994; Mokkadem, 1999; Paetzold, 1989; Squires, 1994). Currently and thanks to their richness in biologically active molecules, several halophytic species are used as remedies against certain diseases such as cancers, gastrointestinal diseases, urinary tract and liver problems, inflammations, diabetes and dental caries (Ksouri et al., 2008).
On one hand, in Algeria, many researchers have carried out in-depth studies on a large number of medicinal plants (Adjadj, 2009; Aissaoui, 2010; Hamimed, 2009), but on the other hand, no ethnobotanical studies have been carried out on spontaneous medicinal plants in wetlands and in particular the Ramsar site known as the Macta marshes.

The present work proposes to fill, at least in part, this gap in one of the most important Ramsar sites in Algeria. Thanks to its biogeographical position, its plant diversity, as well as the knowledge on the traditional use of certain plants in the treatment of diseases, the Macta wetland in the North-Western of Algeria, provides a very important field of work. In this perspective, the objectives of this work are (i) To list and count the halophytic plants with medicinal virtues in the Macta wetland, (ii) To evaluate the richness and diversity of this medicinal flora in the study area and (iii) To recall the therapeutic properties and traditional use of halophytes with medicinal virtues present in the study area.

**Materials and methods**

This article is part of an approach that aims, through an ethnobotanical survey (Annex) and a bibliographical study of biological activities, at studying the biodiversity of halophytes with medicinal virtues, at highlighting them and to offer researchers a research axis for better exploitation of halophytes.

**Study region**

The Macta wetland is a triangular depression covering an area of 44500 ha. It is located in North Western Algeria [latitude 35.607°N and longitude 0.0489°W] (Fig. 1). It is bounded to the North by the Mediterranean Sea, to the south by the mountains of Beni-Chougrane, to the East by the Mostaganem plateau and to the west by the Sebkha of Oran. The study area is fed by three main rivers: Wadi Sig, Wadi Habra and Wadi Tinn. On the geological level, there are four geological formations: the marine Pliocene, the continental Pliocene, the Calabrien and the continental Quaternary (Gaucher and Simmoneau, 1951).

![Map of Algeria showing the location of the Macta wetland.](image)

**Figure 1.** Location of the Macta wetland.

The bioclimate is semi-arid with a mean annual rainfall ranging from 380 to 450 mm, but rainfall can drop from 250 to 300 mm during deserted periods and a thermal regime ranging from 17 to 19°C (Megharbi, 2017). The soils are related to: (i) dune soils, (ii) alluvial soils where clay...
texture dominates at the level of the plains and (iii) solontchaks and solonetzs for the rest of the wetland (Gaucher and Simmoneau 1951, Sitayeb and Benabdeli 2008). The spontaneous flora of the Macta wetland includes 477 species in 76 families and 282 genera, 45% of which are halophytes (Megharbi, 2009).

Sampling

Our work strategy consisted of the following two axes:

Species collection

We chose subjective sampling in five main habitats (Quezel and Santa, 1962, 1963). 50 floristic surveys were carried out on quadrates with a minimum area of about 100 m² (Le Floch et al., 2010). The taxonomic identification of the species was done with the help of specialists and plant catalogs (Barbault, 1992). The nomenclature adopted is that of the flora of Algeria and the Synonymous Catalogue of the flora of Tunisia (Simmoneau, 1952; Vidal, 1998).

Ethnobotanical data collection

The information was collected through semi structured interviews, questionnaires and personal observations. A questionnaire was administered to the local people, through face to face interviews. The mean age of the 150 respondents (50 men and 100 women) was 54.8 years (ranging from 20 to 90 years). During these interviews, only people who had knowledge regarding medicinal plants were invited to a survey study. The questioning is focused on the following information (age, sex, therapeutic practice).

Biodiversity indices

We have retained the Shannon-Weaver index in the different sites in order to describe the specific diversity of medicinal halophytes. The evaluation of the specific diversity of the different groupings was completed by the equitability index (E). The Shannon-Weaver index varies from 0 to 5 bits, while equitability varies from 0 to 1. It tends towards 0 when almost all the numbers are concentrated on one species. It is 1 when all the species have the same abundance (Deil, 2005).

Statistical approach

Principal component analysis proposes, from a rectangular table of data, the values of quantitative variables (therapeutic properties) for n units (plant species). The factorial axes are interpreted from the contributions of the considered variables (Belouahem-Abed et al., 2009). The hierarchical ascending classification allows these properties to be grouped in the form of steps according to Euclidean distance. The collected data were processed using the R software (version 3.4.1).

Results

The ethnobotanical surveys carried out in the field allowed us to elaborate a catalog of 105 plant species. We present in this article 53 halophyte species among these, 32 of which were identified by the people who underwent our survey as species with medicinal virtues. The monographs of these 32 species are presented in alphabetical order of families, biological types and chorological types (Table 1). For each species, we have specified the local use and therapeutic properties (Table 2).
Table 1. List of species encountered in the field.

| Species                          | Family             | Biological forms | Chorology characteristic               |
|----------------------------------|--------------------|------------------|----------------------------------------|
| Mesembryanthemum nodiflorum      | Aizoaceae          | TH               | Mediterranean                           |
| Aizoon hispanicum               | Aizoaceae          | TH               | Mediterranean and Irano-Touranian       |
| Mesembryanthemum crystallinum    | Aizoaceae          | TH               | Sub-Cosmopolitan                       |
| Arthrocnemum macrostachyum      | Amaranthaceae      | CH               | Mediterranean                           |
| Atriplex halimus                | Amaranthaceae      | CH               | Mediterranean                           |
| Atriplex prostrata              | Amaranthaceae      | TH               | Circumboreal                           |
| Beta macrocarpa                 | Amaranthaceae      | TH               | Mediterranean                           |
| Carex vermiculatum              | Amaranthaceae      | TH               | Mediterranean                           |
| Salsola kali                    | Amaranthaceae      | TH               | Palaeo-Temperate                       |
| Sarcocornia fruticosa           | Amaranthaceae      | CH               | Cosmopolitan                           |
| Suaeda fruticosa                | Amaranthaceae      | CH               | Cosmopolitan                           |
| Suaeda maritima                 | Amaranthaceae      | CH               | Cosmopolitan                           |
| Bupleurum semicompositum        | Apiaceae           | TH               | Mediterranean                           |
| Chamaemelum fuscatum            | Asteraceae         | TH               | Mediterranean                           |
| Lactuca saligna                 | Asteraceae         | TH               | Sub Mediterranean                       |
| Scorzoneroides muelleri         | Asteraceae         | TH               | Mediterranean                           |
| Senecio glaucus                 | Asteraceae         | TH               | Mediterranean and Irano-Touranian-Saharo-Sindian |
| Hymenolobus procumbens          | Brassicaceae       | TH               | Cosmopolitan                           |
| Silene rubella                  | Caryophyllaceae    | TH               | Mediterranean                           |
| Spergularia diandra             | Caryophyllaceae    | TH               | Sub-Iranian-Tour                       |
| Spergularia marina              | Caryophyllaceae    | TH               | Mediterranean-Spepe                    |
| Chenopodium murale              | Chenopodiaceae     | TH               | Cosmopolitan                           |
| Cressa cretica                  | Convolvulaceae     | CH               | Sub-Cosmopolitan                       |
| Carex divisa                    | Cuparaceae         | G                | Mediterranean-Atlantic                  |
| Bolboschoenus glaucus           | Cyperaceae         | Hcri             | Cosmopolitan                           |
| Frankenia laevis                | Frankeniaceae      | Hcri             | Palaeo-Temperate                       |
| Frankenia pulvulenta             | Frankeniaceae      | TH               | Mediterranean                           |
| Schenckia spicata               | Gentianaceae       | Hcri             | Mediterranean                           |
| Juncus acutus                   | Juncaceae          | G                | Sub-Cosmopolitan                       |
| Juncus bufonius                 | Juncaceae          | Hcri             | Cosmopolitan                           |
| Juncus maritimus                | Juncaceae          | Hcri             | Sub-Cosmopolitan                       |
| Juncus subulatus                | Juncaceae          | Hcri             | Circum-Mediterranean                   |
| Teucrium pseudo-chamaepilys     | Lamiaceae          | CH               | Mediterranean                           |
| Plantago coronopus              | Plantaginaceae     | Hcri             | Palaeo-temperate                       |
| Limonium delicatulum            | Plumbaginaceae     | Hcri             | Mediterranean                           |
| Limonium dariaei                | Plumbaginaceae     | Hcri             | Endemic                               |
| Limonium lobatum                | Plumbaginaceae     | TH               | Mediterranean                           |
| Atropis convoluta               | Poaceae            | CH               | Palaeo-temperate                       |
| Festuca arundinacea             | Poaceae            | Hcri             | Circumbor                              |
| Hainardia cylindrica            | Poaceae            | TH               | Mediterranean                           |
| Phragmites australis            | Poaceae            | Hél              | Cosmopolitan                           |
| Rostraria cristata              | Poaceae            | TH               | Sub-Cosmopolitan                       |
| Schismus arabisicus             | Poaceae            | TH               | Macar-Mediterranean                    |
| Aeluropus littoralis            | Poaceae            | Hcri             | Circum-Mediterranean                   |
| Hordeum murinum                 | Poaceae            | TH               | Mediterranean                           |
| Parapholis incurva              | Poaceae            | TH               | Mediterranean                           |
| Sphenopus divericatus           | Poaceae            | TH               | Pale-Subtropical                       |
| Rumex crispus                   | Polygonaceae       | CH               | Cosmopolitan                           |
| Ranunculus aquatilis            | Renunculaceae      | Hél              | Cosmopolitan                           |
| Limbarda crithmoneus            | Synantheraceae     | CH               | Mediterranean-Atlantic                  |
| Tamarix africana                | Tamaricaceae       | PH               | Mediterranean                           |
| Tamarix gallica                 | Tamaricaceae       | PH               | North Tropical                         |

Legend: TH: Therophytes; PH: Phanerophytes; Hél: Helophyte; CH: Chamaephytes; Hcri: Hemicryptophytes; G: Geophyte. Cosm. Cosmopolitan; Atl. Atlantique; Irano-Tour: Iranian-Touranian; Sub-Sind.: Saharo-Sindian; Eur. Europe; End. Endemic; Macar.: Macaronesian.
Table 2. List of halophyte species with medicinal properties in the Macta wetland.

| Species                    | Therapeutic properties                      | Part used          |
|----------------------------|---------------------------------------------|--------------------|
| Aeluropus littoralis        | Fever, Diarrhea                             | Leaf               |
| Arthrocnemum macrostachyum | Anti-inflammatory, Fortifier                 | Leafs, Seed        |
| Atriplex halimus            | Digestive disorders, Dermal Disorders, Antidiabetic, Antiseptic, Anti-rheumatismal | Decoction          |
| Atriplex prostrata          | Anti-inflammatory                           | Whole plant        |
| Bolboschoenus glaucus       | Astringent, Antidiabetic, Diuretic          | Rhizome            |
| Caroxylon vermiculatum      | Digestive disorders                         | Seed               |
| Chamaeleonium fascatum      | Anti-inflammatory                           | Leafs              |
| Chenopodium murale          | Anti-inflammatory, Anti-rheumatismal, Digestive disorders | Decoction, pass    |
| Cressa cretica              | Anti-diabetic, Anti-inflammatory            | Leaves             |
| Festuca arundinacea         | Genito-urinary disease                      | Bousses            |
| Frankenia pulverulenta      | Anti-inflammatory                           | Leafs              |
| Hordeum marinum             | Metabolic disorders, Fortifier              | Whole plant        |
| Juncus acutus               | Diuretic, Anti-inflammatory, Colic, Genito-urinary disease, Sedative | Fruits, Decoction   |
| Juncus maritimus            | Digestive disorders, anti-diabetic          | Fruits, Decoction   |
| Lactuca saligna             | Fever, diarhée, Genito-urinary disease      | Leaves             |
| Limbarda crithmoides        | Diuretic, Anti-inflammatory                 | Leafs              |
| Limonium delicatulum        | Anti-inflammatory, Liver diseases           | Seed               |
| Limonium lobatum            | Astringent                                  | Stem               |
| Mesembryanthemum crystallinum | Antiseptic, Diuretic, Dermatological disorders, Anti-inflammatory, Genito-urinary disease, Respiratory disorders | Leafs |
| Mesembryanthemum nodiflorum | Digestive disorders, Anti-inflammatory      | Leaves             |
| Peganum harmala             | anti-rheumatismal, Anti-inflammatory, Genito-urinary disease, Sedative | Seed |
| Phragmites australis        | Antidiabetic, Diuretic                      | Leafs              |
| Rumex crispus               | Respiratory disorders                       | Seed               |
| Salsola kali                | Diuretic                                    | Leafs              |
| Sarcocornia fruticosa       | Diuretic, Liver diseases, Digestive disorders, Fortifier | Fresh plant       |
| Schenkia spicata            | Dermatological disorders                    | Seed               |
| Schismus arabicus           | Astringent, Diuretic                        | Leafes             |
| Silene rubella              | Anti-inflammatory, Sedative                 | Seed               |
| Spargularia diandra         | Genito-urinary disease                      | Extract            |
| Spargularia marina          | Anti-inflammatory, Genito-urinary disease    | Extract            |
| Suaeda vera                 | Osteoarticular disorders, Antidiabetic, Liver diseases | Whole plant   |
| Suaeda maritima             | anti-rheumatismal, Anti-inflammatory        | Extract            |
| Tamarix africana            | Astringent, Anti-inflammatory               | Leafes             |
| Tamarix gallica             | Astringent, Diuretic, anti-diabetic, Cardio-vasculaire disorders | Leafes, écorce    |
| Teucrium pseudo-chamaepilys | Anti-inflammatory, Antiseptic, Digestive disorders | Leafes |

**Biological types**

With an analyzing of Table 1, we found that Therophytes represent 49.05%, while Chamaephytes and Hemicryptophytes represent at least 20.75% of all species encountered. The percentage of Geophytes and Phanerophytes reaches 3.77% while Heliophytes constitute 1.88%.

**Families with frequent use**

The results obtained show that the medicinal halophytes identified in the study area are divided into 13 families and 20 genera. Among the 13 families identified those mostly represented in this region are: Amaranthaceae (33.33%), Poaceae (11.11%), Juncaceae (7.40%), Tamaricaceae (7.40%), Synantheraceae (7.40%) and Aïzoaceae (7.40%). The other families represent a rate of about 3.7% (Fig. 2).
Biogeographic Elements

While examining, we notice that the species are the Mediterranean species that predominate in this formation with 33.96%. The cosmopolitan species come in the second position with a portion of order 28.30%. In third position are the broadly distributed species with a portion of order 18.86%, followed by Nordic species 15.09%. Finally, two endemic halophytic species with medicinal virtues present a rate of 3.77%.

Biodiversity analysis

There are five main habitats in the Macta marshes: coastal sands, wet meadows, lawns, swamps, and succulent salt steppes (Quezel and Santa, 1962, 1963). The wet meadows contain a very important number of medicinal halophytes. This is the *Sarcocornia fruticosa* grouping (Table 3). Wet depressions occupy second place with ten medicinal halophytic species, dominated mainly by *Cressa cretica*. Coastal sands and marshes contain the same number of medicinal halophytic species. These two environments are dominated respectively by: *Mesembryanthemum crystallinum* and *Phragmites australis*. Finally, the salt steppes, an environment dominated by *Suaeda vera* contains three medicinal halophytes.

**Figure 2.** Comparative of botanical families with medicinal properties of Macta wetland halophyte.

**Table 3.** Biodiversity indices of medicinal halophytes

| Medicinal Halophytes | Coastal sand | Wet meadows | Wet depressions | Marshes | Salty steppes |
|----------------------|--------------|-------------|----------------|---------|---------------|
|                      | 12.5%        | 43.75%      | 21.87%         | 12.5%   | 9.37%         |
| Average richness     | 11.2         | 5.3         | 7.5            | 12.8    | 14            |
| Shannon Index        | 1.272        | 1.331       | 1.620          | 1.613   | 1.902         |
| Piérou Index         | 0.526        | 0.798       | 0.804          | 0.632   | 0.720         |

Biodiversity indices

Diversity index values are lower in near shore sands and wet grasslands than in the other three habitats (Table 3). The equitability of Piérou leads to the conclusion that wet depressions present a homogeneous and specialized environment.
**Therapeutic properties**

The hierarchical ascending classification reveals five classes of traditional therapy, which are the anti-inflammatory, astringent and diuretic properties, genitourinary affections, digestive affections and finally metabolic affections (Fig. 3).

The analysis of the main components of the therapeutic effects gave the results that we present in the two figures 4 and 5:

On the hand, on the positive side, at the end of axis 1, a group of species with strong contributions namely *Mesembryanthemum crystallinum, Juncus acutus, Tamarix africana* and *Peganum harmala* well correlated with anti-inflammatory properties (3.087) and those related to genitourinary disorders (1.043). On the other hand, on the negative side, we note the presence of *Bolboschoenus glaucus, Tamarix gallica* and *Schismus arabicus*, which are related to astringent activities (-0.849). The axis 2 remains explained in its positive side the species used as diuretic (+2.27) namely *Mesembryanthemum crystallinum* and *Lactuca saligna*. This axis opposes on its negative side the species effective against the digestive affections (-1.34) and which possess antirheumatic activities (-0.790) namely respectively *Atriplex halimus, Sarcocornia fruticosa* and *Teucrium pseudo-chamaepilys* (Figure 4).

![Dendrogram of the therapeutic properties of Macta halophytes.](image)

**Figure 3.** Dendrogram of the therapeutic properties of Macta halophytes.

![PCA factor A1-A2 design.](image)

**Figure 4.** PCA factor A1-A2 design.
Axis 3 shows on its positive side the use of halophytes for endocrine disorders (diabetes) (+1.205) of which three species are included Atriplex halimus, Teucrium pseudo-chamaepilys and Chenopodium murale. The negative side of this axis explains the traditional application against genito-urinary affections (-1.374) and dermal affections (-0.730) and respiratory affections (-0.591). The species correlated by these uses are Silene rubella, Spergularia marina, Atriplex halimus and Rumex crispus (Fig. 5). It is distinguished that these halophytes play an important role in the regulation of the metabolism and can be used as vitamins.

![Figure 5. PCA factor A1-A3 design](image)

**Discussion**

Therophytes mainly make up the biological spectrum. The dominance of annual species reflects the adaptation of communities to unpredictable environmental conditions (Tomaselli et al., 2011). Hemicryptophytes are also fairly well represented. Wetlands are generally favorable to their proliferation (Dargie and El Demerdash, 1991). The richest families are Amanranthaceae, Poaceae, Juncaceae, Tamaricaceae, Synantheraceae and Aizoaceae, with respectively 33.33%, 11.11%, 7.4%, and 7.4% of taxa. This order is different from that recorded for the whole flora of salt marshes in Italy (Adi et al., 2016) and that of the Mediterranean coast of Sinai (Megharbi, 2017). Chorologically, the Mediterranean element dominates the other elements (Benwahhoud et al., 2001). The meadows and wet depressions shelter an important diversity of medicinal halophytes, which gives a strong chance for the multiplication of these species (Saidana et al., 2008, 2012).

**Conclusion**

The flora of halophytes with medicinal virtues in the wetland of the Macta is rich with 27 species among which we count 47% of Therophytes and 37% of Chamaephytes. The distribution of these species in the major taxonomic groups indicates that the dominant families are Amaranthaceae and Poaceae. These species are diversely distributed according to continent and more than 44% are Mediterranean. The Ethnobotanical investigations carried out in the Macta wetland show that the thirty-two medicinal halophytes species identified are used, in different forms of medicinal preparations, in the fight against various pathologies (diabetes, digestive problems, inflammation…etc.). The therapeutic effects of these halophytes are multiple and constitute a basis for the pharmaceutical industry.

Many halophyte species with medicinal virtues in the wetland of Macta, have become threatened
due to habitat loss caused by several factors (draining of marshes, rapid urbanization and pollution). Thus, the current result can be integrated into future management plans for the conservation of threatened medicinal plants, while local populations should be involved in the formulation of problems and in the decision-making process.

Despite the importance of these medicinal plants reported, much of this potential remains poorly and undervalued for a variety of reasons ranging from lack of knowledge to lack of efforts to conserve this heritage. This article constitutes a source of information which contributes to knowledge of halophytes with medicinal virtues and to a safeguarding of the local popular know-how. It can also constitute a database for the valorization of medicinal halophytes of wetlands in Algeria with a view to the active principles that can be used in pharmacology.

Author’s Contributions

Dr Megharbi Ahmed contribution: field trips, carrying out statistical processing.

Dr Kechairi Réda contribution: drafting and correspondence of the manuscript.

Ethics

No conflicts to report.

References

Adam M. Dobiáš P. Eisner A. Ventura K. 2009. Extraction of antioxidants from plants using ultrasonic methods and their antioxidant capacity. Journal of separation science, 32: 288-294.

ADI N. Amrani S. Hirche A. Boughani A. Nedjraoui D. 2016. Diversité biologique et phytogéographique pour des niveaux différents de salinité dans la région du Chott-Ech-Chergui (sud-ouest de l’Algérie). Revue d'écologie, 71(4), 342-355.

Adjadj M. 2009. Propriétés Antioxydantes et Activité Inhibitrice de la Xanthine Oxydase des Extraits de la Plante Médicinale Ajuga iva, Mémoire de Magister en Toxicologie cellulaire et moléculaire, Université Med. Mentouri de Constantine, Algérie.

Aissaoui H. 2010. Recherche et détermination structurale des métabolites secondaires de type flavonique d’une espèce de la famille des Verbenacées Mémoire de Magister en chimie, Université Mentouri Constantine, Algérie.

Aniya Y. Miyagi C. Nakandakari A. Kamiya S. Imaizumi N. Ichiba T. 2002. Free radical scavenging action of the medicinal herb Limonium wrightii from the Okinawa islands. Phytochemistry, 9: 239-244.

Barbault R. 1992. Écologie des peuplements: Structure, dynamique et évolution. Paris: Masson. 273p.

Batanouny KH. 1994. Halophytes and halophytic plant communities in the Arab Region, pp : 139-163. Halophytes as a resource for livestock and for rehabilitation of degraded lands, Springer.

Belouahem-Abed D, Belouahem F, De Bélair G. 2009. Biodiversité floristique et vulnérabilité des aulnaies glutineuses de la Numidie algérienne (NE Algérien). European journal of scientific research, 32: 329-361.

Benguerba A. 2008. Étude phytochimique et de la phase butanolique de l'espèce Inula crithmoides L., Thèse de Magister. Univ. Med. Mentouri de Constantine, Algérie.

Benwahhoud M. Jouad H. Eddouks M. Lyoussi B. 2001. Hypoglycemic effect of Suaeda fruticosa in streptozotocin-induced diabetic rats. Journal of ethnopharmacology, 76: 35-38.

Bose J. Rodrigo-Moreno A. Shabala S. 2014. ROS homeostasis in halophytes in the context of salinity stress tolerance. Journal of experimental botany, 65: 1241-1257.

Bouftira I. Chedly A. Sfar S. 2009. Antioxidant and antibacterial properties of Mesembryanthemum crystallinum and Carpobrotus edulis extracts. Asian Journal of Chemistry, 21: 549-559.

Bouzid A. Chadli R. Bouzid K. 2017. Étude ethnomédicinale de la plante médicinale Arbutus unedo L. dans la région de Sidi Bel Abbés en Algérie occidentale. Phytothérapie, 15: 373-378.

Brink M. Achigan-Dako EG. 2012. Plantes à fibres, Ressources végétales de l’Afrique Tropicale.
Fondation PROTA/CTA.

Cavaleiro C. Salgueiro I.R. Miguel MG. Da Cunha AP. 2004. Analysis by gas chromatography–mass spectrometry of the volatile components of Teucrium lusitanicum and Teucrium algarbiensis. Journal of Chromatography A, 1033: 187-190.

Chekroun-Bechlaghem N. Belyagoubi-Benhammou N. Belyagoubi L. Gismondi A. Nanni V. Di Marco G. Canuti L. Canini A. El Haci I.A. Atik Bekkara F. 2019a. Phytochemical analysis and antioxidant activity of Tamarix africana, Arthrocnemum macrostachyum and Suaeda fruticosa, three halophyte species from Algeria. Plant Biosystems-An International Journal Dealing with all Aspects of Plant Biology, 153(6), 843-852.

Chekroun-Bechlaghem N. Belyagoubi-Benhammou N. Belyagoubi L. Mansour S. Djebli N. Bouakline H. Gismondi A. Nanni V. Di Marco G. Canuti L. Canini A. Atik Bekkara F. 2019b. Antimicrobial and anti-inflammatory activities of three halophyte plants from Algeria and detection of some biomolecules by HPLC-DAD. Natural product research, 1-5. DOI: 10.1080/14786419.2019.1655413

Dargie T. El Demerdash M. 1991. A quantitative study of vegetation–environme relationships in two Egyptian deserts. Journal of Vegetation Science, 2: 3-10.

Day C. 1990. Hypoglycaemic compounds from plants. New anti diabetic drugs, Smith-Gordon, London, pp: 267-278.

Deil U. 2005. A review on habitats, plant traits and vegetation of ephemeral wetlands–a global perspective. Phytocoenologia, 35: 533-706.

Gaucher G. Simmoneau P. 1951. Monographie agricole de la plaine de Saint-Denis-du-Sig Terres & Eaux, 7: 14-15.

Hamimed S. 2009. Caractérisation chimique des principes à effet antidermatophyte des racines d’Anacyclus pyrethrum L., Mémoire de Magister en chimie organique, Université Med. Mentouri de Constantine, Algérie.

Kim HS. Kim J-A. Karadeniz F. Ahn B-N. Kong C-S. 2014. Radical scavenging and anti-inflammatory effects of the halophyte Spergularia marina Griseb. Zeitschrift für Naturforschung C, 69: 425-433.

Ksouri R. Megdiche W. Falleh H. Trabelsi N. Boulaba M. Smaoui A. Abdelly C. 2008. Influence of biological, environmental and technical factors on phenolic content and antioxidant activities of Tunisian halophytes. Comptes Rendus Biologies, 331: 865-873.

Ksouri R. Ksouri WM. Jallali I. Debez A. Magné C. Hiroko I. Abdelly C. 2012. Medicinal halophytes: potent source of health promoting biomolecules with medical, nutraceutical and food applications. Critical reviews in biotechnology, 32: 289-326.

Le Floch É. Boulos L. Vela E. 2010. Catalogue synonymique commenté de la flore de Tunisie: Simpact Ed. : Tunisie.

Medini F. Fellah H. Ksouri R. Abdelly C. 2014. Total phenolic, flavonoid and tannin contents and antioxidant and antimicrobial activities of organic extracts of shoots of the plant Limonium delictatum. Journal of Taibah University for science 8: 216-224.

Megharbi A. 2009. Diagnostic phytoécologique de quelques zones humides de l’ouest Algérien. Mémoire de Magister, FSB/USTHB Alger, Algérie.

Megharbi A. 2017. Approche synécologique et dynamiques des groupements des halophytes des marais de la Macta, Thèse de Doctorat. USTHB Alger, Algérie.

Mokkadem A. 1999. Cause de dégradation des plantes médicinales et aromatiques d'Algérie. Revue Vie et Nature, 7: 24-26.

O.M.S. 2002. Stratégie de l’OMS pour la médecine traditionnelle pour 2002-2005 : Besoins croissants et potentiels. Report OMS.

Paetzold H. 1989. Shrublands of the USSR in Asia. The biology and utilization of shrubs: 199-223.

Quezel P, Santa S. 1962, 1963. Nouvelle flore de l’Algérie et des régions désertiques méridionales. V. 1-2 (CNRS, Paris : France).

Qureshi R. Bhatti GR. 2008. Ethnobotany of plants used by the Thari people of Nara Desert,
Pakistan. Fitoterapia, 79: 468-473.

**Ricci D. Fraternale D. Giamperi L. Bucchini A. Epifano F. Burini G. Curini M. 2005.** Chemical composition, antimicrobial and antioxidant activity of the essential oil of Teucrium marum (Lamiaceae). Journal of ethnopharmacology, 98: 195-200.

**Sahli R. 2017.** Étude phytochimique de quelques plantes extrêmphiles Tunisiennes et exploration de leurs activités biologiques Thèse de Doctorat, Univ. Lille, France.

**Saidana D. Mahjoub M. Boussaada O. Chriaa J. Chéraif I. Daami M. Mighri Z. Helal A. 2008.** Chemical composition and antimicrobial activity of volatile compounds of Tamarix boveana (Tamaricaceae). Microbiological research, 163: 445-455.

**Shanna S. Parmar V. 1998.** Novel constituents of Tamarix species. Journal of scientific & industrial research, 57: 873-890.

**Simmoneau P. 1952.** La végétation halophile de la plaine de Perrégaux, Thèse de Doctorat, Faculté des Sciences, Alger, Algérie.

**Sitayeb T. Benabdell J. 2008.** Contribution à l'étude de la dynamique de l'occupation des sols de la plaine de la Macta (Algérie) à l'aide de la télédétection et des systèmes d'information géographique. Comptes Rendus Biologies, 331: 466-474.

**Squires VR. 1994.** Overview of problems and prospects for utilizing halophytes as a resource for livestock and for rehabilitation of degraded lands. Halophytes as a resource for livestock and for rehabilitation of degraded lands. Springer, pp: 1-6.

**Sunita P. Jha S. Pattanayak SP. 2011.** Anti-inflammatory and in-vivo Antioxidant activities of *Cressa cretica* Linn., a halophytic plant. Middle-East Journal of Scientific Research, 8: 129-140.

**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: 105-117.

**Tomaselli V, Di Pietro R, Sciandrello S. 2011.** Plant communities structure and composition in three coastal wetlands in southern Apulia (Italy). Biologia, 66: 1027-1043.

**Vidal É. 1998.** Organisation des phytocénoses en milieu insulaire méditerranéen perturbé: analyse des inter-relations entre les colonies de Goélands leucophées et la végétation des îles de Marseille. Thèse. Doctorat. Univ. Aix-Marseille III, France, pp: 42-43.