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An ethnobotanical survey of medicinal plants used in the Boujdour Province, Morocco

[Encuesta etnobotánica de plantas medicinales utilizadas en la provincia de Boujdour, Marruecos]

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Abstract: An ethnobotanical survey was carried out across the province of Boujdour in southern Morocco, with the aim of collecting detailed information about the use of medicinal and aromatic plants and evaluating the region's potential in contributing to traditional medicine. The 630 questionnaires used in the ethnobotanical survey show that of the 64 species of plants used which belong to 26 families, the Fabaceae family top the list as the primary contributor (10 species at a rate of 15,62 %). The leaves are the most used parts with a rate of 51.61%). The most widely used pharmaceutical form is the decoction with a rate of 42,58%. The oral route is the most used mode of administration with 69,32%. Of all the disorders and infections treated, the medicinal and aromatic plants identified were used in the treatment of 54 digestive diseases, with correspond to 31,58% of the diseases treated. The results obtained are a very valuable source of information for the region studied and for the national medicinal flora. They can be considered as a source of information for scientific research in the field of phytochemistry and pharmacology and for the purpose of searching for new natural substances.

Keywords: Morocco; Medicinal plants; Ethnobotanical survey; Biodiversity; Boujdour

Resumen: Se realizó una encuesta etnobotánica a lo largo de la provincia de Boujdour, en el sur de Marruecos, con el objetivo de recopilar información detallada sobre el uso de plantas medicinales y aromáticas y evaluar el potencial de la región para contribuir a la medicina tradicional. Los 630 cuestionarios utilizados en la encuesta etnobotánica muestran que de las 64 especies de plantas utilizadas, que pertenecen a 26 familias, la familia Fabaceae lidera la lista como principal contribuyente (10 especies con un porcentaje del 15,62%). Las hojas son las partes más utilizadas con un porcentaje del 51,61%. La forma farmacéutica más utilizada es la decocción, con un porcentaje del 42,58%. La vía oral es el modo de administración más utilizado con un porcentaje del 69,32%. De todos los trastornos y infecciones tratados, las plantas medicinales y aromáticas identificadas se utilizaron para tratar 54 enfermedades digestivas, que corresponden al 31,58% de las enfermedades tratadas. Los resultados obtenidos son una fuente valiosa de información para la región estudiada y para la flora medicinal nacional. Pueden considerarse como una fuente de información para investigaciones científicas en el campo de la fitoquímica y farmacología y para la búsqueda de nuevos sustancias naturales.

Palabras clave: Marruecos; Plantas medicinales; Encuesta etnobotánica; Biodiversidad; Boujdour

INTRODUCTION

Since ancient times, man has been aware of the curative aspects of plants and has taken advantage of them. There is a strong link between plants, which have a source of life, and humans. Plants are the bedrock of our well-being as essential components of our cultures, religions and medicines (Schaal, 2019).

Thanks to its biogeographical position, Morocco features a floristic diversity reaching around 4200 species belonging to 130 families of the total medicinal plant's native to Morocco. The country is home to medicinal plants that have for generations been the main source of medical care (Tabuti *et al*., 2003). The Moroccan population has accumulated a long medical tradition and traditional know-how in phytotherapy, transmitted from one generation to the next, but with the development of the pharmaceutical industry, this precious knowledge needs to be supported and preserved, hence the need to develop the fields of ethnobotany and ethnopharmacology. Aware of this need, various ethnobotanical studies in relation to traditional medicine have been carried out in the Mediterranean basin (Bellakhdar *et al*., 1987; Matuhe, 2001; Scherrer *et al*., 2005; Fougrach *et al*., 2007; Fakchich & Elachouri, 2014; Hafsé *et al*., 2015; El Hilah *et al*., 2016; Jdaidi & Hasnaoui, 2016; Zahir *et al*., 2020).

Moroccans have for long recognized the value of traditional medical practices and have acquired know-how in this field by trying to cure certain illnesses with medicinal plants (Hmamouchi & Agoumi, 1993; Scherrer, 2005). Indeed, the Moroccan pharmacopoeia has been developed and enriched by the knowledge contributed by the various ethnic groups who migrated to Morocco from different regions (Bellakhdar, 1997). In this way, medicinal plants constitute a treasure trove of information for those who have decided to approach their daily ailments differently, turning their backs on the chemical arsenal of modern medicine (Hseini & Kahovadji, 2007).

Indeed, the use of plants in phytotherapy is very old and is currently experiencing a revival of interest among the public, as is the case in the province of Boujdour (Boutabia *et al*., 2011; Lazli *et al*., 2019), the region targeted by this study, thanks to its position as a crossroads of Arab, Berber and southern African Saharan societies; the population of Boujdour accumulated knowledge of medicinal plants that will be an alternative means of improving the standard of living for the local population.

The aim of the present study is to cast light on the variety of purposes for which medicinal and aromatic plants are used in the Boujdour area. The study, conducted by means of questionnaires and interviews with the local population of the Boujdour region, will shed light on this ancestral knowledge for which there are no written sources. Indeed, data on regional medicinal plants is very fragmented and scattered, as is this know-how is currently held by only a few people, hence the interest of this study.

The ethnobotanical approach is of great importance in this field. It makes it possible to list remedies for many diseases and to build up a database of medicinal plants to preserve the moral capital or ancestral knowledge that is based essentially on an oral tradition in the face of the scarcity and inadequacy of ethnobotanical data on the region's medicinal plants in the literature. Recently, a great deal of ethnopharmacological and ethnobotanical research has been carried out in different regions of Morocco (Bammi & Douira, 2002; Ghourri *et al*., 2012; Benlamdini *et al*., 2014; El Hafian *et al*., 2014; El Hilah *et al*., 2015; Daoudi *et al*., 2016; El Alami *et al*., 2016), with the aim of preserving indigenous knowledge and developing a strategy to protect floral biodiversity.

MATERIAL AND METHODS

Description of the scope of the study

The province of Boujdour occupies the central part of Morocco's southern Sahara, it is bordered to the north by the province of Laayoune, to the south by the region of Dakhla-Awsarde, to the east by the Islamic Republic of Mauritania and to the west by the Atlantic Ocean. It spans across an area of 3734 km^2.

It is formed by a large desert zone, characterized by the presence of the vast plateau of the Hammada, presenting no great accidents of relief, except the beds dug by the wadis, the depressions of the Sebkhats and some dune cords, this zone is subdivided colloquially into four parties: Assarfa, Aftoute, Imricli Hmar and Imrikli Byade.

The climate of the province is a Saharan climate, cold in winter, dry and very hot in summer, marked by the scarcity of rainfall. On the coastal strip, temperatures are moderate and influenced by the proximity of the Atlantic Ocean.

Rainfall is particularly sparse. The average observed for the past decade is around 60 mm.

Precipitation is sporadic, brief, violent and stormy.

According to the results of the General Census of Population and Housing 2004, the population of Boujdour is made up of 35% of young people under 15 and 61,5% in the bracket of [15 years, 59 years] and 3,5% over 60 years old.

Plant material

It consists of all the medicinal and aromatic plant species listed and harvested in three parts of the province of Boujdour which are: Assarfa, Aftoute and Imricli Hmar.

Technical equipment for ethnobotanical study

For this study, conventional equipment was used to collect the various information and to collect the plant samples. These include, among other things, survey sheets, pruning shears, plastic bag labels, newspapers, cardboard folders, glue, presses, plastic bags, digital camera.

Ethnobotanical survey

To carry out this work, we were able to meet people from the region, who were born there and have lived in the region for a long time; their mastery of the traditional pharmacopoeia vis-à-vis the medicinal and aromatic plants of the area studied was a prerequisite for their being part of the survey.

During the ethnobotanical survey, the interviews were carried out according to a plan adopted for the situations of this population and according to their availability; We have for some, made several visits, the objective of the first visit was to acclimatize and familiarize ourselves with the terrain and local vocabulary as well as to collect information on the habitat in order to obtain general information on the existing medicinal and aromatic plants in Boujdour. No questionnaires were used at this stage. On the other visits, we interviewed 630 people to carry out ethnobotanical surveys in the region using questionnaires that included questions on the local names of the species, the organs or parts of the plant used, their methods of preparation and administration of the recipes, the mode of administration, the diseases treated as well as personal information on the interviewees, such as their age, level of education, family situation and sex. The questions were asked in the local language: Hassani.

Indeed, we used a method and a sampling plan adaptable to the objectives and context of our study. These include the random sampling stratified sampling technique (Laaribya *et al*., 2010).

The accumulation of target information was carried out in two ways:

- Either directly during a field trip after harvesting the plant as suggested by Cunningham in 2002 (Cunningham *et al*., 2002)
- Or; if the interviewee is too old or busy, we gather and collect the plant samples and then we inquire about the information in the questionnaire (Diatta *et al*., 2013).

While gathering information, we collect several samples of the same plant, medicinal and aromatic species to validate the maximum of the target information of our questionnaire, and to conduct individual interviews with several interviewees.

The taxonomic identification of plant species collected in the field was made at the biology department of the science faculty - Kenitra, using available herbaria and using the literature and the catalog of Moroccan plants (Emberger & Maire, 1941; Bellakhdar, 1997).

Finally, the data is recorded on raw data sheets and then transferred to a database then processed by statistical processing software.

RESULTS

Different categories of users of medicinal and aromatic plants

The 630 people adults of Saharan origin interviewed targeted in this study all use traditional medicine.

Gender approach

The results show that women use medicinal and aromatic plants in the region more than men. Women come first with 76,19% then men with 23,81% (Figure No. 2).

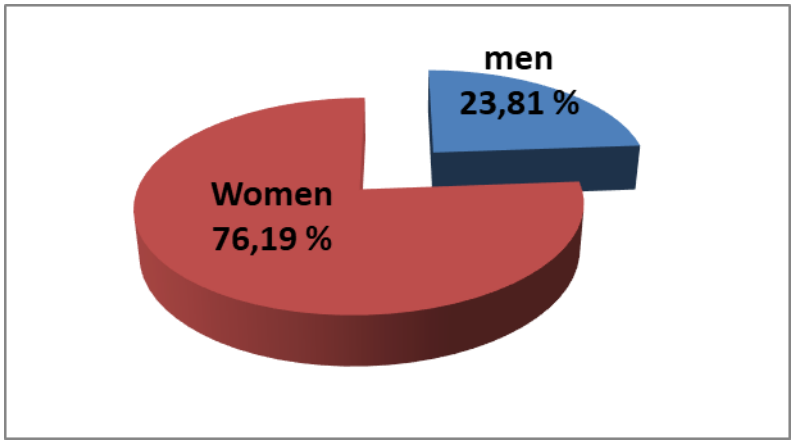

Figure No. 2
Distribution of the frequency of use of medicinal plants by sex in Boujdour

Age approach

Data processing enabled us to obtain the graph in Figure No. 3, which shows that across the Province of Boujdour, people over the age of 70 have a frequency of use of medicinal plants by 30,77%. The age brackets]20-35],]35-50] and]50-70] come next with percentages of 14,80%, 22.70% and 24,70% respectively. of the age group]15-20], the percentage is very low (7,03%)

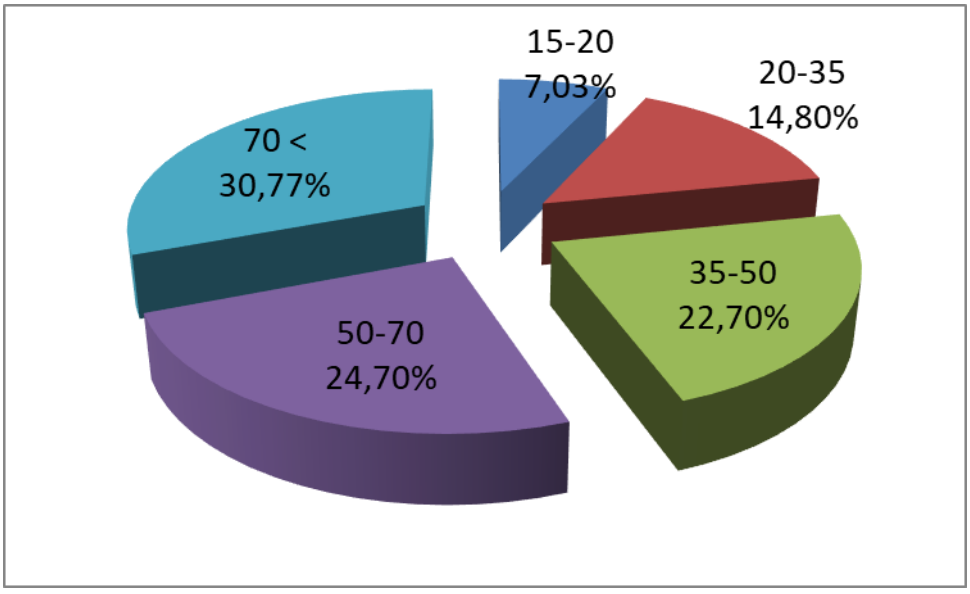

Figure No. 3
Distribution of the frequency of use of medicinal plants by age groups in Boujdour

Marital status approach

Married people are more interested in this art than single people. The results show that (94,73%) of married people are interested in medicinal and aromatic plants compared to only (5,27%) of single people (Figure No. 4).

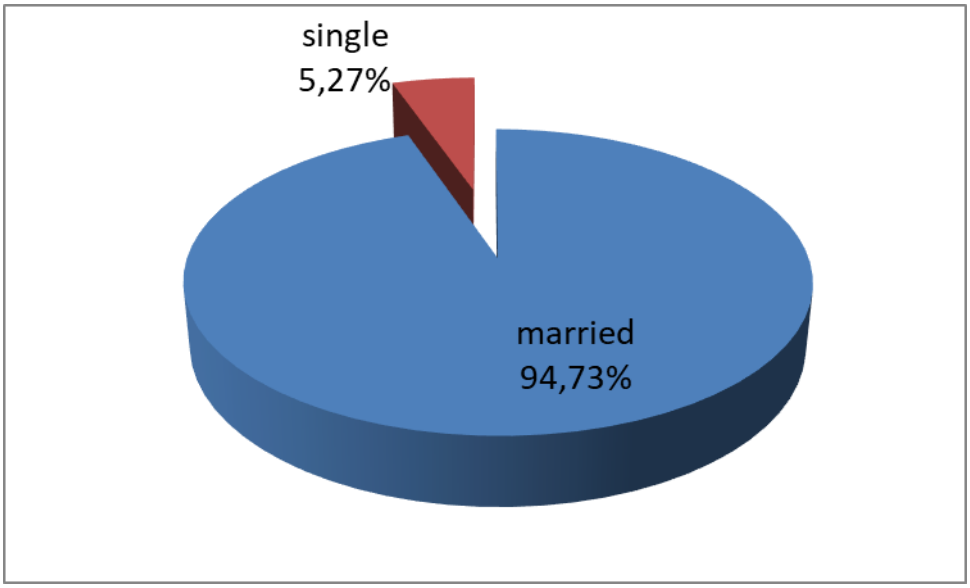

Figure No. 4
Distribution of the frequency of use of medicinal plants by marital status in Boujdour

Habitat approach

The results shows that 100% of the population studied often spend most of their time outside the city (Elbadiya).

Profile of traditional use of medicinal and aromatic plants in Boujdour

The accumulation of information collected during the questioning of the 630 people of Saharan origins targeted is summarized in Table No. 1.

The ethnobotanical survey shows that the medicinal and aromatic plants used in the province of Boujdour are very diversified.

The listed plants and their therapeutic indications are grouped in Table No. 1; the plants are presented by the frequency of each family. For each listed plant, we give the family name, the scientific name, the vernacular name, the part used, the mode of preparation applied by the local population, as well as its pharmacological action.

Botanical investigations

The investigations carried out in the Department of Biology enabled us to inventory sixty-four (64) species divided into twenty-seven (26) botanical families.

Analysis of the results of this study (Figure No. 5) shows that the Fabaceae family predominates with 10 species used (15,62%), followed by the Asteraceae family with 9 species (14,06%), the Amarantaceae family with 8 species (12,50%), and (4,76%) for the two families: Euphorbiaceae, Lamiaceae and Asparagaceae with 3 species, as well as (3,17%) for the families: Aizoaceae, Anacardiaceae, Apiaceae, Brassicaceae, Capparaceae, Cistaceae , Poaceae, Solanaceae, with 2 species. And finally (1,5%) with 1 species for the following families: Apocynaceae, Boraginaceae, Convolvulaceae, Cucurbitaceae, Cynomoriaceae, Frankeniaceae, Tamaricaceae, Malvaceae Pezizaceae, Plumbaginaceae, Polygonaceae, and Zygophyllaceae.

Parts of the plants used

Each part of the plant has therapeutic properties; in our study area, medicinal plants can be used (Figure No. 6) entirely (5,38%), or in parts (leaves, stem, root, latex, fruits and seed). In our study area, the use of the leaves is predominant with a percentage of (51,61%), then the stems with a percentage of (17,20%) and the flowers (10,75%), then the roots and the fruits with a percentage of (5,38%) and finally seeds and latex with a percentage of (2,15%). Although the use of the leaves is represented by a large percentage, it was noticed during the survey that in the field users tend to uproot the whole plant instead of focusing only on the desired part (mainly the leaves).

Routes of drug administration

The results of the survey showed that among the 176 routes of administration recorded, the oral route is the route most administered at 122 times with a rate of 69,32%, then at 50 times the cataplasm route with a rate of 28,42% and finally the rectal route at 4 times with at a rate of 2,27% (Figure No. 7).

Table No. 1
Medicinal plants used in traditional medicine in the province of Boujdour

Family	Botanical name	Local name	Plant part used	Preparation modes	Route of administration	Traditional uses
Fabaceae	*Acacia tortilis*	Ettalh	Leaves, seeds	Decoction powder	Oral Oral Oral Cataplasm Oral	Antidiuretic. Stomach diseases. Headaches. Gingivitis. Sore throats.
Fabaceae	*Acacia ehrenbergiana*	Ettamate	Leaves, flowers	Decoction & infusion	Cataplasm Oral	Anti inflammatory Stomach aches.
Fabaceae	*Lotus chazaliei*	Tamekchichete	Leaves, stems & flowers	Infusion	Oral	Fever.
Fabaceae	*Lotus ossakensis*	attike	Whole plant	Powder	Oral	Gastric pain.
Fabaceae	*Lotus glinoides*	Umm halous	Leaves	Powder	Oral	Gastric pain.
Fabaceae	*Hippocrepis multisiliquosa*	Elmkharssa	Stems & leaves	Powdre	Oral	Gastric pain.
Fabaceae	*Medicago laciniata*	Ntale	Stems & Leaves	Decoction, powder	Oral	Gastric pain.
Fabaceae	*Crotalaria saharae*	Alfoula	Leaves	Powder.	Oral	Gastric pain.
Fabaceae	*Psoralea plicata Del*	Tatraret	Leaves	Powder	Oral	Gastric pain.
Fabaceae	*Retama raetam*	Errtam	Leaves	Powder and decoction.	Oral Cataplasm	Gastric pain. Brushing teeth (meswak).
Asteraceae	*Launaea arborescens*	Omm lbina	Stems & latex	Powder and decoction.	Oral Oral Oral Cataplasm Reclal Cataplasm Oral Oral Cataplasm Oral	Antibacterial. Antidiabetic. Kidney disease. Dermatological disease. Hemorrhoids. Corn pain in the foot. Fever in children. Gastric pain. Skin injury.

						Negative effect on the liver.
Asteraceae	*Matricacia pubescens*	Lerabyan	Stems & Leaves	Infusion, decoction & Powder.	Oral Cataplasm Oral	Influenza. Rheumatism. Bronchitis
Asteraceae	*Centaurea pungens*	Bounghire	flowers & Leaves	Decoction	Oral	Mouth cleanser: Mouthwash.
Asteraceae	*Anvillea garcinii*	Ennakde	Leaves	Powder & decoction	Cataplasm Oral	The cold of the back. Gastric pain.
Asteraceae	*Bubonium graveoleus*	Ettafssa	Leaves, Stems & Roots.	Powder	Cataplasm Cataplasm Cataplasm Cataplasm Oral Cataplasm	Against muscle tearing. Tooth pain. Gingivitis. Oral diseases. Gum inflammation Brushing teeth (meswak).
Asteraceae	*Artemisia reptans*	Chihiyya	Leaves & Stems	Decoction, powder & infusion	Oral	Gastric pain.
Asteraceae	*Chrysanthemum coronarium*	Elghahwane	Whole plant	Powder & decoction.	Oral	Gastric pain.
Asteraceae	*Brocchia cinerea*	Algartofa or rebruba	Leaves	Decoction	Oral	Gastric pain.
Asteraceae	*Kelinia anteuphorbium*	Chebaatou	Whole plant	Powder	Oral or Cataplasm	Rheumatism.
Amaranthaceae	*Bassia tomentosa*	Elghbira	Stems & Leaves	Decoction, infusion & powder	Rectal Oral Oral Oral	Constipation. Digestive diseases. Food poisoning. Gastric pain.
Amaranthaceae	*Salsola tertagona*	Laarade	Leaves & flowers	Decoction, infusion & powder.	Oral Oral Oral Oral	Gastric ache. Gastric pain. Gastrointestinal pain. Antidiabetic.
Amaranthaceae	*Salsola vermiculata*	Ejjalle	Leaves	Powder & decoction.	Oral Oral	Gastric pain. Gastrointestinal pain.
Amaranthaceae	*Hammada scoparia*	Ramte	Leaves	Powder, infusion & decoction.	Cataplasm Cataplasm Cataplasm Cataplasm Cataplasm Oral	Skin injury. Joint displacemen. Mouth cleanser: mouthwash. Treatment of oral diseases. Toothache. Gastric pain.
Amaranthaceae	*Suaeda monodiana*	Essawide	Leaves	powder	Cataplasm Cataplasm	Head skin treatment. Against hair loss.
Amaranthaceae	*Atriplex halimus*	Lgtafe	Leaves	Powder, Decoction & infusion.	Oral Oral Oral Oral	Antidiabetic. Bowel pain. Kidney pain. Against (food)

					Oral Oral Rectal	poisoning. Anti-diarrheal. Against rheumatism. Vagina cyst treatment.
Amaranthaceae	*Nucularia perrinii*	Asskaf	Leaves	Decoction & powder.	Oral Cataplasm	Gastric pain. Anti-inflammatory.
Amaranthaceae	*Anabasis aphylla.* L ssp. *africana (murb) Maire*	El-ajrum	Leaves	Infusion	Oral Oral Oral	Gastric pain. Against coughing. Lung diseases.
Euphorbiaceae	*Euphobia echinus*	Daghmouss	Aerial part	Decoction & powder.	Cataplasm Oral Cataplasm Oral	Horn at the foot. Antidiabetic. Dermatological pain. Fever.
Euphorbiaceae	*Euphobia obtusifolia*	Farnan- afdir	Stems	Fresh stem	Cataplasm	Tooth pain.
Euphorbiaceae	*Euphobia catyptrata*	Rammada	Stems	Decoction	Oral Oral	Antimicrobial. Gastric pain.
lamiaceae	*Salvia aegyptiaca*	Tazoukanite	Leaves	Decoction	Oral Oral	Fever. Gastric pain.
lamiaceae	*Teucrium polium*	Chandgoura	Leaves	Decoction, infusion	Oral Oral	Headache. Chest disease.
lamiaceae	*Lavandula coronopifolia*	Kahelet elkhayel	Stems, leaves & flowers	Decoction	Cataplasm Oral Oral Oral	Mouth cleaner: Shower bath. Anti-bacterial. Filtration of the kidney Gallbladder
Asparagaceae	*Asparagus pastoriancic*	Essakoum	Fruits	Poudre	Oral Oral	Anti-bacterial. Anti-microbial
Asparagaceae	*Urginea ollivieri*	Farnane	Roots	Powder	Oral	Gastric pain.
Asparagaceae	*Asparagus altissimus* (Murb)	Essaghiaa	Whole plant	Powder	Cataplasm	Against dermal fungi.
Aizoaceae	*Opophytum theurkanfii*	Afzou	Leaves	Decoction	Cataplasm Oral Cataplasm Oral	Anti-microbial. Antibacterial. Anti-inflammatory. Bowel cleanser.
Aizoacées	*Mesembryanthemum nodiflorum*	Agbarou	Leaves	Decoction	Cataplasm Oral Cataplasm Oral	Antimicrobial. Antibacterial. Anti inflammatory. Bowel cleanser.
Anacardiaceae	*Rhus tripartita*	Ajdarri	Leaves & Barks	Decoction, infusion & powder	Oral Cataplasm Cataplasm Cataplasm	Gastric ulcer. Antitoxic (arthropod). Antimicrobial. Toothbrush (meswak).
Anacardiaceae	*Rhus albida*	El-Zouwaya	Leaves	Decoction, infusion &	Oral Oral	Hypertension. Gastric pain.

				Powder	Rectal	Stimulates digestion.
Apiaceae	*Levisticum latifolium*	Adkane	Leaves	Powder	Cataplasm Oral Cataplasm Oral	Antimicrobial. Antibacterial. Anti-inflammatoire. Bowel cleanser.
Apiaceae	*Ammodaucus leucotrichus*	Kamoun errag	Seeds	Decoction	Oral Oral Cataplasm Cataplasm Cataplasm	Fever. Influenza. Against the Poison Serpents. Against poison scorpions. Against insect bites (can be mixed With acacia.).
Brassicaceae	*Anastatica hierochuntica*	Elkamcha	Leaves	Decoction, infusion	Oral Oral Oral Oral Oral	Anti-diabetic. Kidney filtration. Sexual disease. Prohibited for pregnant women until the moment of delivery. Influenza.
Brassicaceae	*Diplotaxis pitardiana*	Elkarkaze	Leaves	Décoction & infusion	Cataplasm Oral Oral Oral	Fever. Gastric pain. Stimulates the appetite. Anti-diabetic.
Capparaceae	*Maerua crassifolia*	Attil-sadrakhadra	Stems, Leaves	Decoction & Powder	Oral Oral Oral Cataplasm Oral Oral Cataplasm Cataplasm Oral	Gastric pain. Stomach disease. Aids digestion. Brushing teeth (meswak). Headache. Stomach pain. Soothing cleanser. Wound pains. Anti-bacterial.
Capparaceae	*Capparis decidua*	Aknin	fruits	Powder	Oral	Gastric pain.
Cistaceae	*Hilianthemum multisiliquosa*	Elyarguigue	Leaves, Stems & flowers	Decoction, infusion	Cataplasm	Soften head skin.
Cistaceae	*Hilianthemum lippii*	Elyarguigue	Leaves, Stems & flowers	Decoction, infusion	Cataplasm	Soften head skin.
Poaceae	*Lygeum spartum*	Elhalfa	Stems	Decoction	Oral	Gonorrhea (sexual disease).
Poaceae	*Stipagrostis pungens*	E-ssbat	Leaves & Roots	Powder & decoction	Oral Oral	Kidney treatment. Gastric pain.
Solanaceae	*Lycium intricatum*	Elghardeg	Leaves	Décoction, Fresh	Oral Cataplasm	Clean the intestine. Against tumors.

				Leaves	Cataplasm Oral	Against skin infections. Antidiabetic.
Solanaceae	*Datura stramonium*	Chedeg el-jmal	flowers	Decoction Powder	Oral Oral Oral	Fever. Pain from throat diseases. Against inflammation of the tonsils.
Apocynaceae	*Periploca angustifolia*	Elhallabe	Leaves & flowers	Décoction & infusion	Oral Oral	Stomach ache. Intestinal pain.
Boraginaceae	*Heliotropium erosum*	Lhabaliya	Flowers & Leaves	Decoction & infusion	Cataplasm Oral Oral	Burn treatment. Chronic constipation. The filtration of the intestines.
Convolvulaceae	*Cressa cretica*	Hannateerrag	Stems & Leaves	Decoction	Oral oral	Anti-diabetic. Against hepatitis.
Cucurbitaceae	*Citrullus colocynthis*	Hdaj elhmar	fruits	Fresh Fruits	Oral Oral Oral	Anti-bacterial. Rheumatism. Stomach ache.
Cynomoriaceae	*Cynomorium coccineum*	E-ttartout	Leaves	Powder	Oral	Anti diabetic.
Frankeniaceae	*Frankenia corymbosa desf*	Lamlaffa	Leaves	Decoction	Oral	Anti-bacterial.
Tamaricaceae	*Tamarix aphylla*	Ettarfa	Leaves	Decoction	Oral Oral Oral	Anti-microbial. Vitiligo disease. Gastric ulcer.
Malvaceae	*Malva parviflora*	Elkhabiza _ Elbakoula	Leaves	Infusion	Oral	Influenza.
Pezizaceae	*Terfezia terfezioides*	Ettarfasse	Roots	Decoction, fresh roots	Oral Oral	Fever. Rheumatism.
Plumbaginaceae	*Limonium sinatum ssp beaumierianum*	Elgharssa	Leaves	Powder	Oral Oral	Gastric pain, Anti diabetic.
Polygonaceae	*Emex spinosa*	Elhanzabe	Roots	Powder	Oral	Stomach ache.
Zygophyllaceae	*Zygophyllum gaetulum*	Elaagaya-Elbaraya	Fruits, leaves	Decoction	Oral Oral Oral Oral Cataplasm Cataplasm Oral	Anti-microbial. Gastric ulcer. Anti-diarrheal. Headache. Inflammation of the skin. Burnt skin. Anti-diabetic.

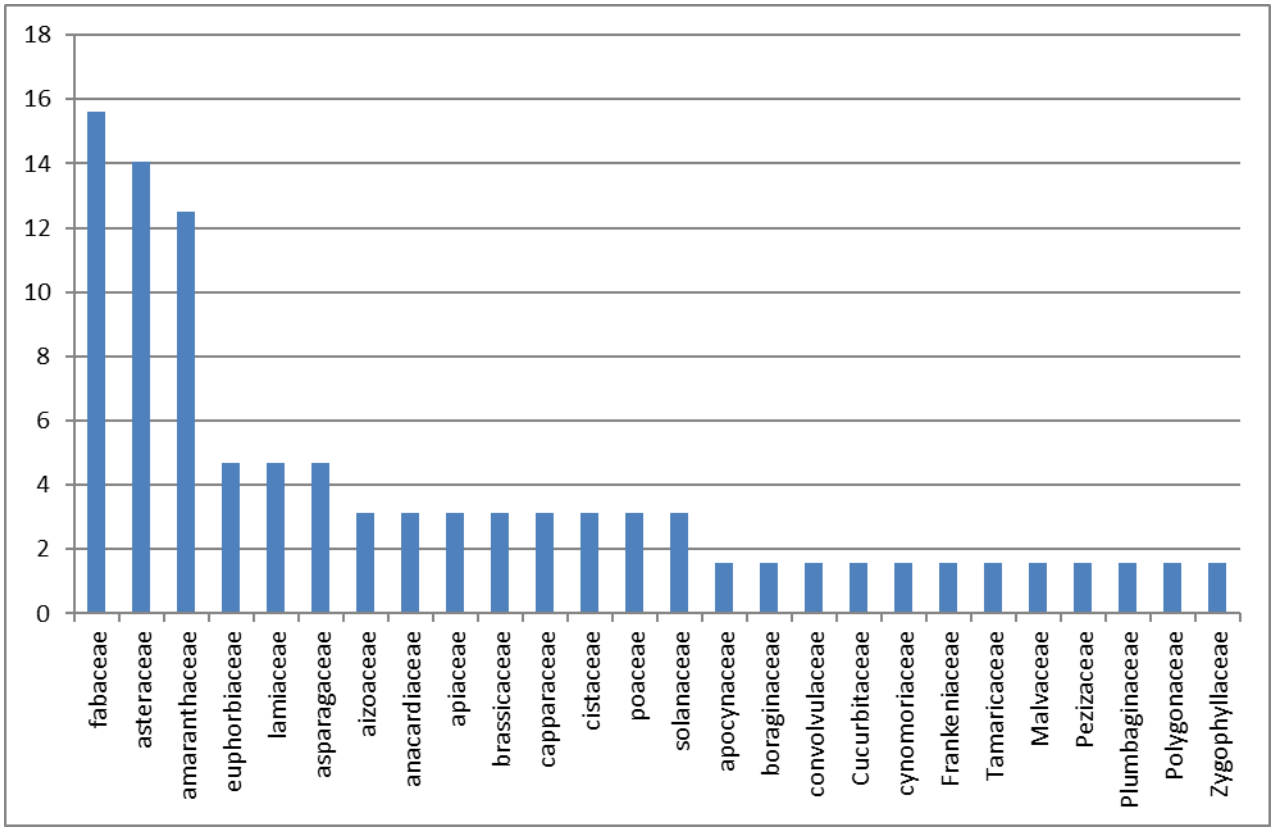

Figure No. 5
Representation of botanical family frequencies parts of the plants used

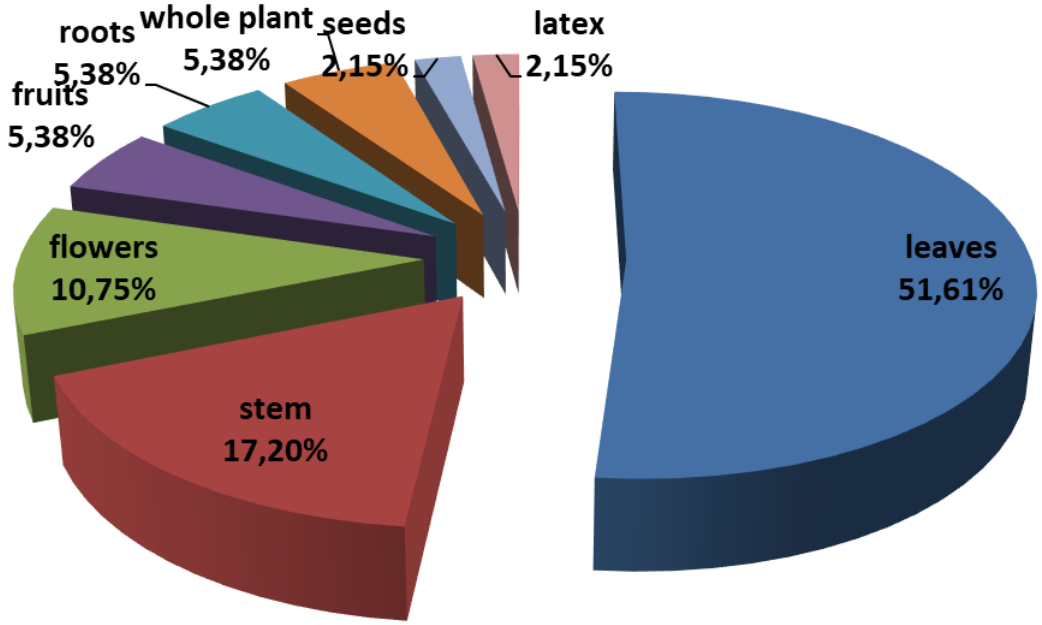

Figure No. 6
Representation of the distribution of the percentages of the different parts used of the medicinal plants used in Boujdour

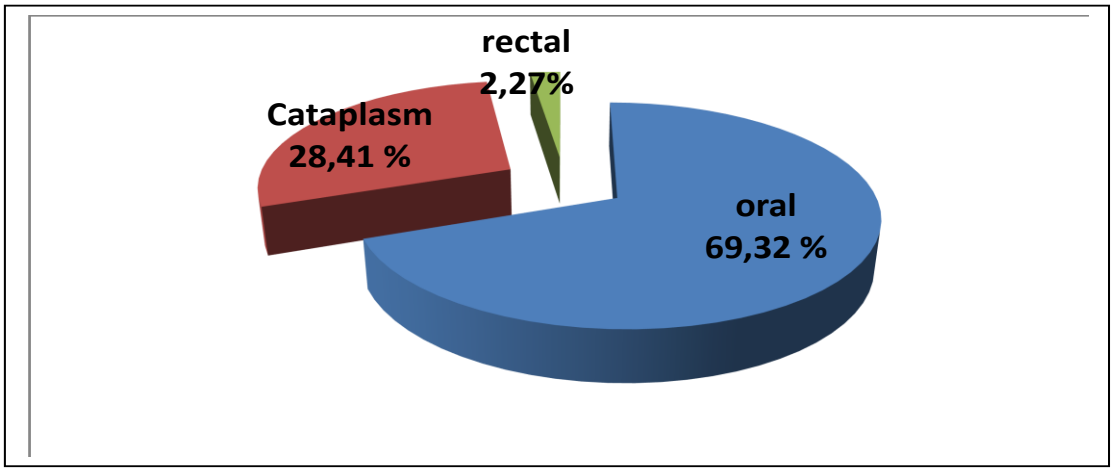

Figure No. 7
Representation of the different routes of administration of the preparations

Recipe preparation techniques
The ethnobotanical study of these medicinal and aromatic plants shows that the decoction constitutes the predominant preparation technique (42,58%), then the use in powder form (35,64%), infusion (17,82%) and other modes with 3,96% (Figure No. 8).

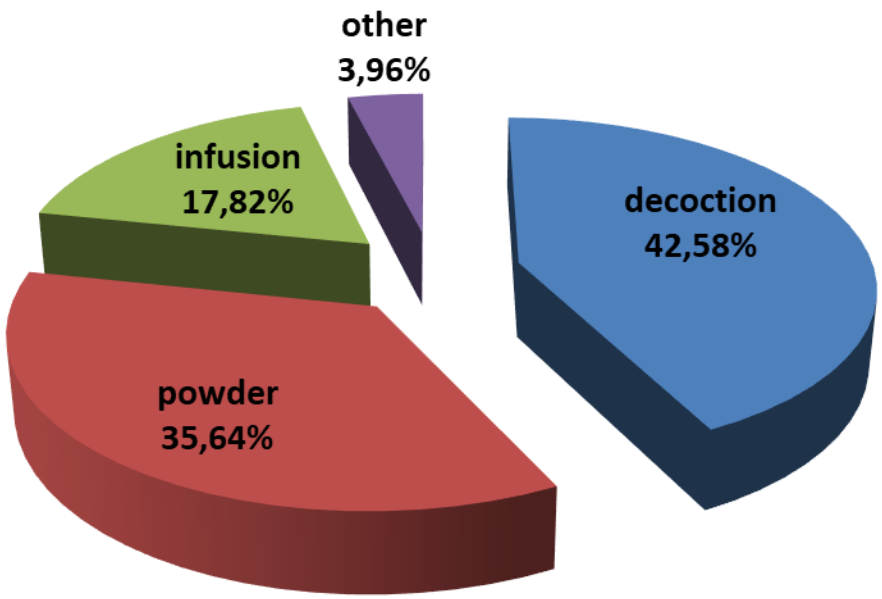

Figure No. 8
Representation of the distrubition of the modes of preparation of the medicinal plants used in Boujdour

The different types and categories of diseases treated by these medicinal plants used

The results of this ethnobotanical study of medicinal and aromatic plants show that these plants are used in the treatment of disorders such (Figure No. 9).as digestive disorders (31,58%), bacterial diseases (10,53%), oral diseases (9,94%), metabolic disorders (8.77%), uro-genital disorders (7,02%), skin disorders (6,43%), osteoarticular disorders (5,85%), fever (5,85%), respiratory disorders (4,09%), headaches (4,09%), as anti-inflammatory agents(3,51%), and as anti-toxication agents (2,34%).

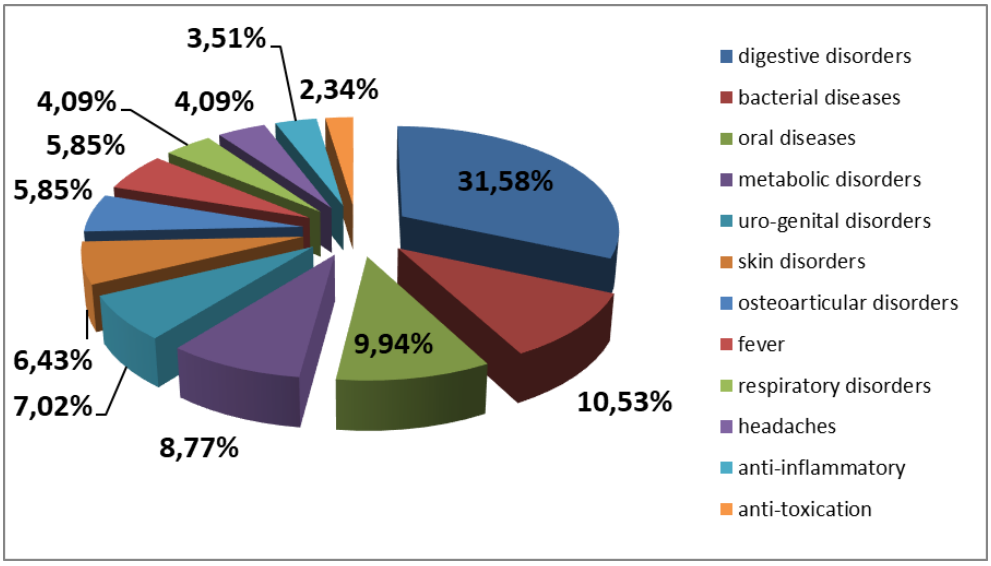

Figure No. 9

Distribution of the different uses of medicinal plants in the province of Boujdour

DISCUSSION

This study shows that the province of Boujdour is very rich in medicinal and aromatic plants and that herbal medicine is widely used there. However, the knowledge of the uses of medicinal and aromatic plants and their properties is unevenly distributed either according to sex and age, or according to the marital status.

The results of this study confirm other ethnobotanical works carried out previously at the national level, which showed that women hold more traditional phytotherapeutic knowledge compared to men (Figure No. 1) (Diatta *et al*., 2013).

These results also confirm that the oldest people possess the greatest knowledge about medicinal and aromatic plants compared to other age groups, and that this knowledge is transmitted through the generations, which means the experience accumulated with age is the main source of information at the local level (Mehdioui & Kahouadji, 2007; Ouhaddou *et al*., 2014).

The results also demonstrate that married people represent the principal segment of society with the greatest knowledge about the uses of medicinal and aromatic plants in the region, which indicates that this knowledge is preserved through families (Ouhaddou *et al*., 2014).

In fact, the transmission of knowledge of the uses of medicinal and aromatic plants and their properties is in major regression because it is not always ensured (Bellakhdar, 1997). Whatever experience individuals have is transmitted only orally through generations, which makes it susceptible to regression and eventually, total loss. Furthermore, certain knowledge remains confined within the same family given that it is only passed from mothers to their married daughters. This goes to show that the age factor represents a main and determinative variable in the transmission as well as the loss of information about the use of plants in traditional medicine.at the local level.

Subsequently, the results obtained show the presence of certain factors that significantly undermine the use of the phytotherapeutic resources

of the region. One such factor is the mistrust of young people which can in part be ascribed to their movement to and from urban areas. This growing mistrust further contributes to the regression of this knowledge as fewer people now believe in its value as a potentially effective weapon against ailments compared to the modern medicine. This situation creates an urgent need for intervention to preserve this precious knowledge (Anyinam *et al*., 1995).

In the present study, we recorded 64 medicinal plants belonging to 27 plant families which are used in the management of 176 different diseases. ethnobotanical studies have been reported in previous literature from other areas of Morocco, Khabbach *et al*. (2012), reported a total of 73 medicinal plants belonging to 39 families to treat 44 diseases in Taza province in northern Morocco. El-Hilaly *et al*. (2003), reported 102 medicinal plants belonging to 48 families, used in folk herbal medicine of Taounate province in the treatment of 174 diseases, the largest number of plant species related to the Fabaceae family. Similar results were reported by (Abouri *et al*., 2012; Ajjoun *et al*., 2021). Native healers used all parts of plants in the preparations of herbal remedies, of which the leaves were most often used. Similar results have been reported in previous literature (Bouayyadi *et al*., 2015; Benali *et al*., 2017). The use of the leaves in remedy preparations can be explained by the ease of harvesting and storing the plants (Skalli *et al*., 2019; Yebouk *et al*., 2020), the tendency of the locals to rely on these plants can be attributed to the fact that they are rich in the medically active ingredients accumulated during photosynthesis (Simbo, 2010).

Traditional healers used various methods of preparation including decoction, powder and infusion, but the dominant mode of preparing remedies was decoction. Similar results were reported by (Fadili *et al*., 2017; El Boullani *et al*., 2022; Bencheikh *et al*., 2021). We also found that the oral route of administration was the most frequently used method in traditional medicine. The results which were reported (Miara *et al*., 2018; Mrabti *et al*., 2019); show that digestive disorders are the disorders most treated by folk herbal medicine in the Boujdour region, similar results have been reported (Zahir *et al*., 2020; Jeddi *et al*., 2021).

These results can be ascribed largely to factors related either to a traditional system of water conservation, or to factors related to the remoteness of health centers.

CONCLUSION AND RECOMMENDATIONS

Our study draws its importance from the absence and scarcity of studies on the traditional use of medicinal and aromatic plants in the province of Boujdour.

In this context, we carried out a more in-depth ethnobotanical survey in this province, to enrich the ethnobotanical data of this region.

The inventory of plants shows the presence of 64 species divided into 27 botanical families involved in the treatment of 176 diseases, of which 54 diseases classify as digestive disorders at a rate of 31,58%. Our survey records that the leaves are the parts the most used with a rate of 51,61%), the decoction is the most used pharmaceutical form at a rate of 42,58% and the oral route is the most used mode of administration at 73,68%.

All the results recorded through the ethnobotanical survey carried out in the province of Boujdour undoubtedly show that the local population widely used traditional herbal medicine. However, the same results show a regression or a loss of traditional knowledge negatively affects young people. This regression may be due to the way in which knowledge is transmitted across generations.

To preserve this natural and cultural heritage and promote its use by future generations, we recommend and call on researchers in phytotherapy, microbiology and pharmacology to engage with the findings of this study to either confirm or refute the therapeutic practices of the community. Such an engagement will serve to consolidate the valuable cultural heritage of the local population. A documentation of this heritage will also prove decisive in its preservation.

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