RESEARCH ARTICLE

Ethnobotanical survey of medicinal plants claimed by traditional herbal practitioners to manage digestive disorders in Tafilalet oasis- Morocco

Mohamed Bammou[1*], Hamza Elbouny[2], Hamza El Finou[3], Brahim Ouahzizi[2], Khalid Sellam[1], Laila Nassiri[4], Chakib Alem[2], Lhoussaine El Rhaffari[3] & Eimad Dine Tariq Bouhlali[5]

[1] Environment and Health Team, Moulay Ismail University of Meknes, Faculty of Sciences and Technology Errachidia, 509 Boutalamine, Morocco
[2] Laboratory of Biochemistry, Moulay Ismail University of Meknes, Faculty of Sciences and Technology Errachidia, 509 Boutalamine, Morocco
[3] Laboratory of Bioactives, Health and Environment, Moulay Ismail University of Meknes, Faculty of Sciences, 11201 Zitoune, Morocco
[4] The Environment and Soil Microbiology Unit, Moulay Ismail University of Meknes, Faculty of Sciences, 11201 Zitoune, Morocco
[5] Oasis Systems Research Unit, Regional Centre of Agricultural Research, 2 Errachidia principale, Morocco

OPEN ACCESS

Additional information

Peer review: Publisher thanks Sectional Editor and the other anonymous reviewers for their contribution to the peer review of this work.

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Indexing: Plant Science Today, published by Horizon e-Publishing Group, is covered by Scopus, Web of Science, BIOSIS Previews, Clarivate Analytics, NAAS, UGC Care, etc See https://horizonepublishing.com/journals/index.php/PST/indexing_abstracting

Abstract

To highlight the different medicinal plants traditionally used by the local citizens of the Tafilalet region to treat digestive disorders, floristic and ethnobotanical research was conducted in that region from April 2021 to July 2021.

The ethnobotanical surveys were carried out using questionnaire sheets with 30 herbalists in different areas in Tafilalet (Errachidia, Rissani, and Erfoud). This study enabled us to gather extensive information about local traditions of therapeutic practices using medicinal plants on one hand and to make a floristic catalog of the same plants on the other hand. Thus, this work ended up by identifying 48 species belonging to 28 floristic families in which Apiaceae and Lamiaceae are the most dominant, and the Ranunculaceae exhibited the highest family use value (FUV=0.667). Of the species listed, *Nigella sativa* L. has the highest use value (UVs=0.677). The highest relative citation frequency is noted for *Rosmarinus officinalis* L. and *Nigella sativa* (RFC=0.233). The leaves (29.82%) are the most used part of plants, and a large part of the remedies are used in powder form (35%) and infusion (28%). The most treated digestive disorders are gastritis (26%) and abdominal pain (24%).

Keywords

Digestive disorders; Medicinal plant; Morocco; Oasis of Tafilalet; Traditional medicine

Introduction

The ethnobotany approach is a contraction of ethnology and botany, which is interested in the study of the relationships between man and plants (1). It makes it possible to identify remedies and to build up a database of medicinal plants to protect ancestral knowledge handed down through generations.

Through the ages, man has been interested in the plants he had at his disposal for food and especially for healing (2, 3). According to the estimates of the World Health Organization (WHO), medicinal plants cover 80% of the primary medicinal needs of the world population (4).

Morocco is distinguished by its richness and biodiversity of aromatic and medicinal plants and by its traditional know-how in the exploitation of plants for cosmetic and medicinal applications (5-7). Aromatic and

medicinal plants are among the important natural resources in mountainous areas, from which the population takes directly to improve their income and continue to constitute the main part of the therapeutic arsenal used by the practitioners of traditional medicine to treat people (8). However, in the absence of detailed inventories and ethnobotanical studies, research and projects to develop aromatic and medicinal plants are generally limited (9).

The oasis of Tafilalet is well characterized by a significant diversity of cultures, folklore, and history, this region has always played a significant role as a crossroads for desert caravans between the south and North Africa. This facilitated the enrichment of knowledge in phytotherapy, which was already quite developed in the region due to its floristic potential, especially concerning plants of medicinal and aromatic interest (10). In addition, medicinal plants have an interesting place in health among Tafilalet populations (11). This largely justifies the choice of this region to conduct the ethnobotanical survey.

Throughout history, digestive disorders are maladies that have produced numerous symptoms of Dysphagia, nausea, diarrhea, abdominal pain, vomiting, bloating, constipation, and finally the difficult passage of food or feces (12). Thus, digestive disorders are common symptoms that represent one of the main reasons for consultation for a digestive symptom. The prevalence of digestive disease in the world population is estimated to be 15–20% (12). Considering the interrelated nature of digestive system disorders, the medicinal plants applied for treatment often possess multiple functions and can address various digestive symptoms and disorders (13).

Numerous research focused on exploring the therapeutic potential of medicinal plants in the treatment of chronic diseases like hypertension, diabetes, cardiovascular diseases, asthma and respiratory system, and kidney diseases, is part of the traditional Moroccan phytotherapy across diverse regions. Interestingly, there's a noticeable lack in the literature regarding studies on the treatment of digestive diseases in various Moroccan regions.

The objective of this present work is to carry out a floristic inventory of the medicinal plants used in the treatment of digestive disorders in the oasis of Tafilalet, to show the richness and the diversity of medicinal plants used to treat the digestive disorders, and to recall the therapeutic properties and the traditional use of these medicinal plants to treat digestive disorders in this region.

Materials and Methods

Study zone

Tafilalet (Errachidia province) is a historic region located geographically in the southeast of Morocco (Fig. 1) between latitudes 29° 30'and 32° 30' in the Draa-Tafilalet region. Tafilalet brings together the Ziz and Gheriss valleys. It covers an area of 60,000 km^2 (14). This region is bounded to the northeast by Figuig province, to the west by the two provinces Zagora and Tinghir, to the north by Midelt province, and finally to the south and southeast by Algeria. The region's climate is arid, its precipitations rarely exceed 120 mm per year (14).
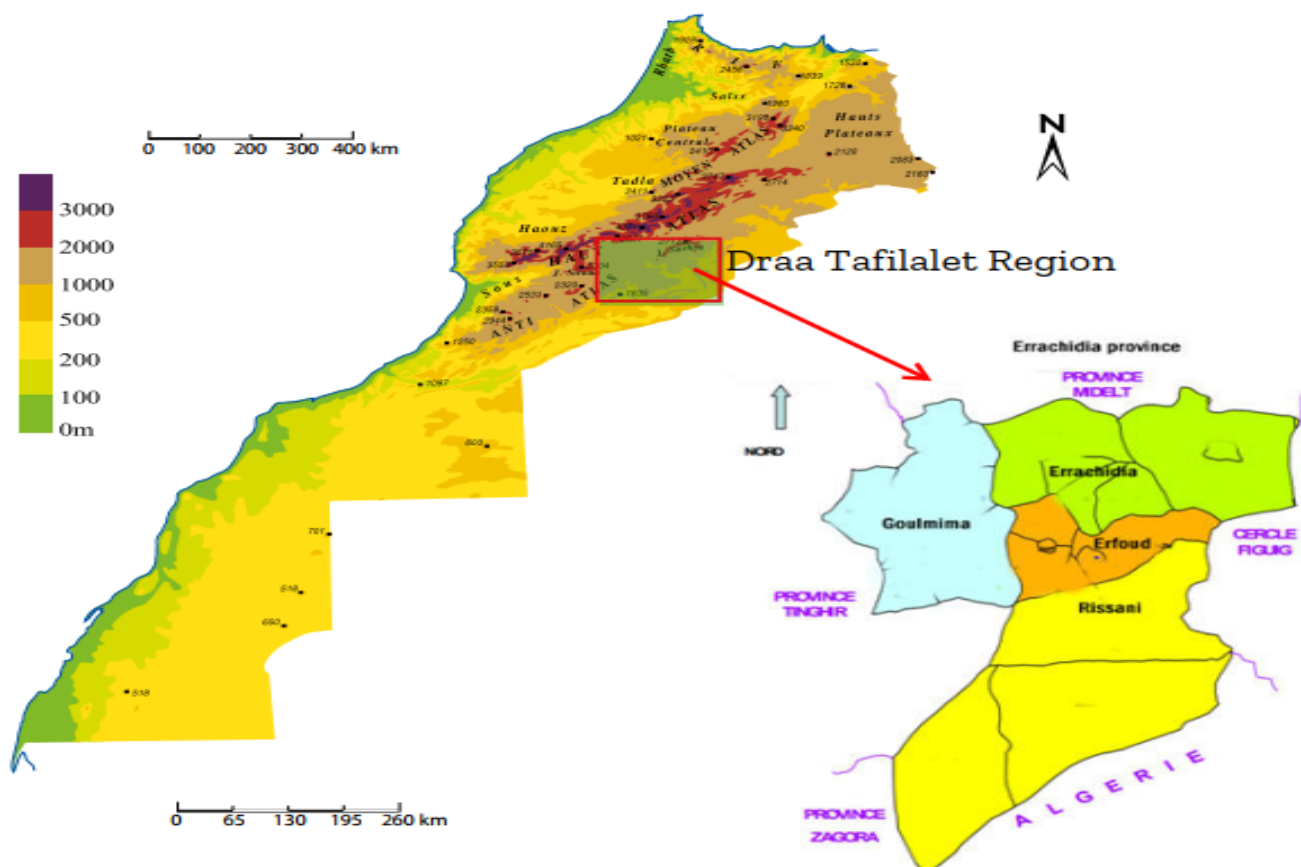

Fig. 1. Geographic location of the Tafilalet region

Methodology

Fig. 2 represents the followed methodology of our study.

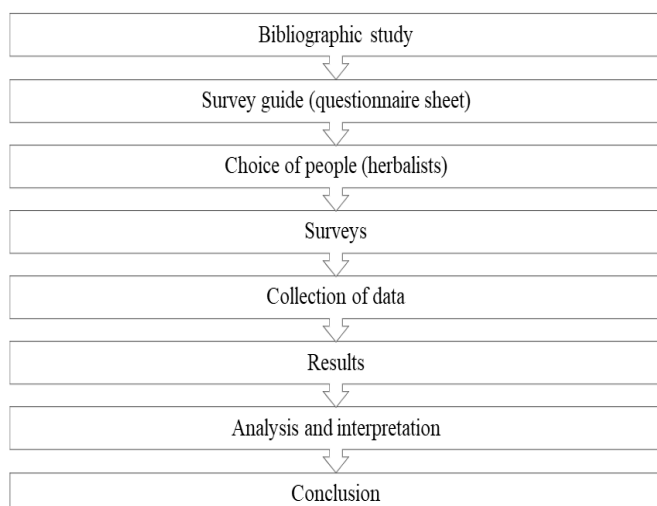| Bibliographic study |
| --- |
| Survey guide (questionnaire sheet) |
| Choice of people (herbalists) |
| Surveys |
| Collection of data |
| Results |
| Analysis and interpretation |
| Conclusion |

Fig. 2. Followed methodology

Data collection and interview methods

From April 1st, 2021 to July 30th, 2021, an ethnobotanical survey was conducted using questionnaire sheets. This survey targeted individuals in the study region (Errachidia, Rissani, and Erfoud) who have experience with medicinal plants, specifically focusing on herbalists.

A list of 150 traditional medicine practitioners in the Tafilalet oasis corresponding to the parent population (P) was established. To obtain a representative sample (N), the ratio (N/P) must be between 15 and 20 (23). Thus, in our case, we retained a ratio equal to 20%, so the sample (N) was 30 local practitioners of traditional medicine.

For data collection, we used the interview technique (questionnaire), the interviews were conducted through a dialogue in both Arabic and Tamazight dialect as needed and explained in simple terms and available to all, especially illiterate respondents. For each person, the interview lasted about 20 minutes. The questionnaire sheet concerns the profile of each respondent and the usage data for each plant used against digestive disorders.

The questionnaire includes detailed questions about the person providing information (sex, age, habitat, level of education, seniority of practice, and source of information), and other information related to medicinal plants such as the local vernacular name of the species, the used parts, and their methods of preparation and administration… etc.

Collection and identification of plant species

Field trips were carried out to observe, examine, and collect species based on the vernacular names of plants used in the Tafilalet region. All species have been identified and voucher specimens have been deposited in the herbarium of the Environment and Health Laboratory of the Faculty of Science and Technology (FST-Errachidia) attached to the Moulay Ismail University of Meknes (UMI) for preservation.

Taxonomical identification of the species was conducted by the FSTE botany team and also concerning the following documents (7, 10, 15-21).

Ethics and consent statement

The Ethical Research Committee of the Medicinal and Aromatic Plants Center (ERCMAPC) under the UMI of Meknes as well as the Regional Directorate of the National Water and Forests Agency granted ethical approval for our study (EA254/19).

Then, before the start of each interview, we obtained the agreement and verbal consent from each interviewee to contribute to this study. All participants were informed that the objective of the research is not commercial but is purely academic. They were also informed that their responses would be published without revealing their identity and that they retained the right to withdraw their information at any time during the interview.

Statistical analysis

For the interpretation of the results, we used Microsoft Excel ® (Microsoft 365; Version 2311 Build 16. 0. 17029. 20068) software with simple analysis methods of descriptive statistics. Using the mean for the quantitative variables and using the headcount and percentages for the qualitative variables.

Quantitative analysis of ethnobotanical data

The collected data were utilized to calculate numerous quantitative indices including relative frequency of citation (RFC), the use value (UV), and finally the family use values (FUV).

Relative frequency of citation (RFC): The RFC makes it possible to determine the species best known and most used to treat digestive disorders. This index shows the local importance of each species, and it is given by the following formula (22):

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

Where: FC = the number of informants using a given species and N = the total number of informants interviewed.

Use value (UVs): The UVs are used to estimate the relative importance of locally known plants. This parameter is calculated for each species using the following formula (22):

$$UVs = \frac{\sum_{I=1}^{I=N} Ui}{N}$$

Where: Ui = the number of use reports mentioned by each informant i for a given species and The total number of informants interviewed.

Family use values (FUV): The FUV serves to determine the importance of plant families and is calculated using the following formula (22).

$$FUV = \frac{\sum UVs}{Ns}$$

Where: UVs = the use value of species belonging to the same family and Ns = the total number of species present in each family.

Results

Socio-demographic data of interviewees

The socio-demographics of the participants are summarized in Table 1, The results showed that the surveyed herbalists are predominantly men. In which 73% of men are against only 27% of women. The herbalists in the Tafilalet region are widespread in all age groups, with a predominance of 40 to 60-year-old people with a percentage of 46%. However, we recorded a rate of around 30% in the age group 20 to 40 years old, while the group aged> 60 years old noted a rate of 24%.

Table 1. Sociodemographic data of herbalists

Variables		Percentage %
Gender	•Male	73%
	•Female	37%
Age	•[20 – 40[Years	30%
	•[40 – 60[Years	46%
	•Over 60 Years	24%
Level of education	•Illiterate	60%
	•Primary school	16%
	•High school	14%
	•University	10%
Age of the practice	•Under 10 years	07%
	•[10 – 20[Years	20%
	•[20 – 30[Years	33%
	•Over 30 Years	40%
Habitat of the respondents	•Urban	67%
	•Rural	33%

Regarding the level of education, 60% of the respondents were not educated (Illiterate), which is relatively high, and it is in direct relationship with the level of education of the oasis population. The 30% of the respondents were split between people who had primary and secondary education, and only 10% of respondents had superior education.

The obtained results show that most of the respondents have a duration of more than 30 years of phytotherapy practice with a percentage of 40%, followed respectively by people who have durations of practice of 20-30 years (33%), 10-20 years (20%), and less than 10 years (7%).

In terms of respondents' habitat, the results obtained show that the respondents are distributed throughout the region studied, whether urban or rural areas, regardless of urban or rural, the majority of the respondents (67%) belong to urban areas whereas 33% of them belong to rural areas. Regarding the sources of knowledge, according to the respondents, most of them (57%) acquire the information from ancestors, followed by the respondents who acquire the information through the experiences of others (27%), and then by the people who have training on phytotherapy 16%.

Botanical families of the species used

The floristic analysis of the inventory carried out enables the differentiation of 48 species across 28 botanical families. Besides that, botanical identification has shown that among the 28 identified families, the most represented botanical families are the Apiaceae and the Lamiaceae, each accounting for 14.58%, followed by the Asteraceae with a percentage of 8.33% (Fig. 3).

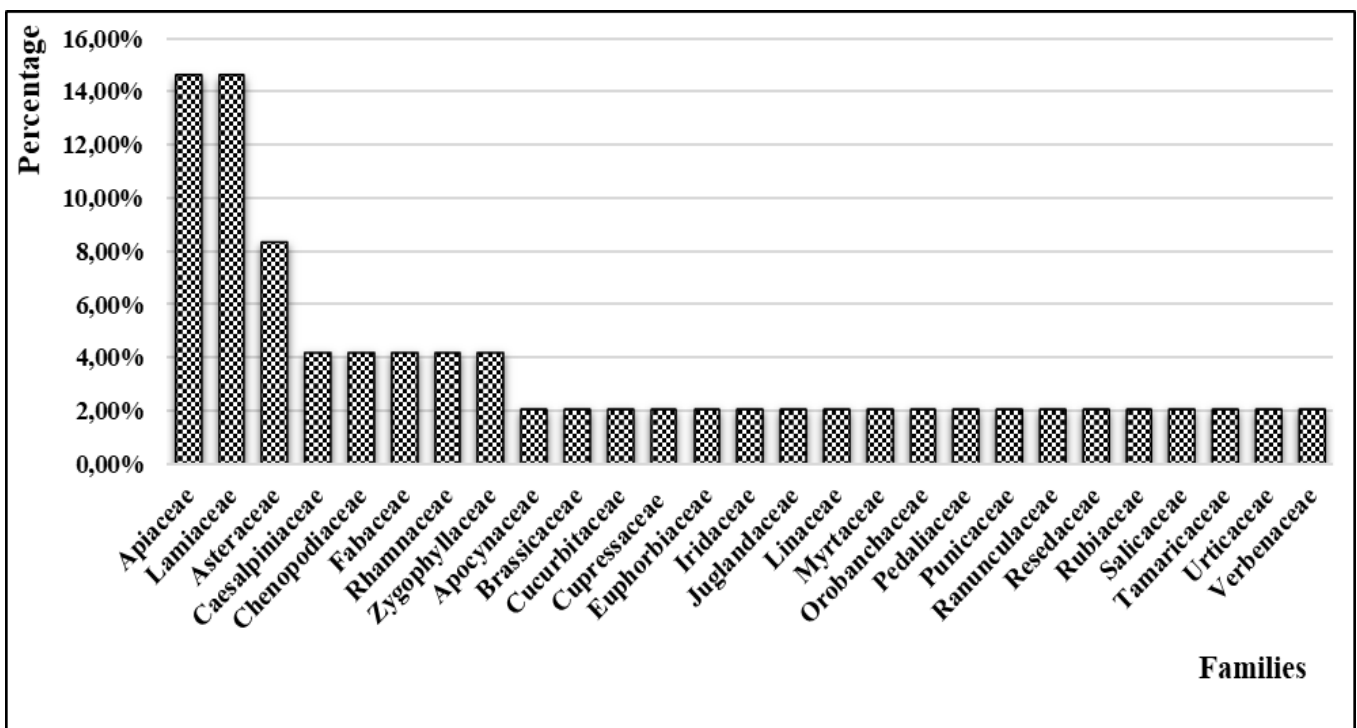The other remaining families have only two or one species (4.16% or 2.08%).

Fig. 3. Distribution of botanical families

Collection area, State, and Parts of plants used

In the Tafilalet region, the study showed that there is a diversity of geographic locations for harvesting the plants, 62% of the plants are harvested in the fields, followed by the valleys (18%), mountains (9%), desert (4%), and other locations (7%) (Fig. 4).
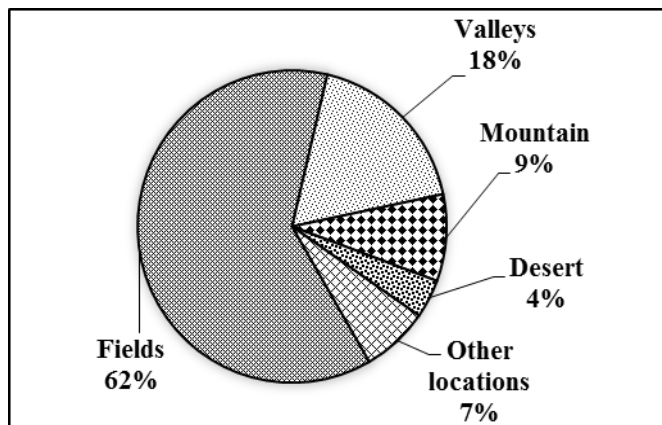

Fig. 4. Medicinal plants distribution according to the location of the collections

The results reveal that the majority of medicinal plants are utilized in their dried state 67% whereas 15% of the cases for the fresh state. The state of use for the rest (18%) is indifferent (Fig.5).
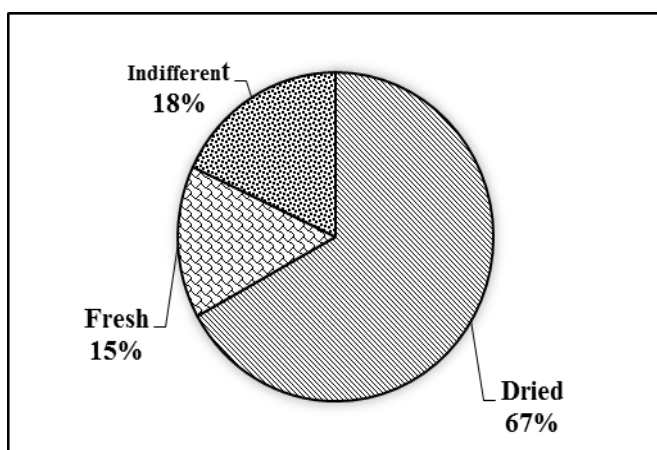

Fig. 5. Proportion of usage states

As it is presented in Fig. 6, the most used parts of the plant are the leaves (29.82%), the seed (22.81%), and the use of the whole plant (19.30%). The flowers and the stems are used at the same rate (10.53%), and the stems are used at a low rate (7.02%). The root is not mentioned in the surveys of our study.

Mode of preparation and administration

Optimal use of a plant requires the choice of an extraction method that preserves all the properties of its active components; certain preparation methods make it possible to extract more significant concentrations of active principles compared to others. Thus, in the study area, several methods of preparation are used, which are decoction, infusion, powder, and raw state. Users are always looking for the simplest method to prepare herbal medicines. Powdered preparation is the most practical mode with a percentage of (35%), followed by infusion (28%), decoction (25%), raw state (11%), and other modes (1%) (Fig. 7).
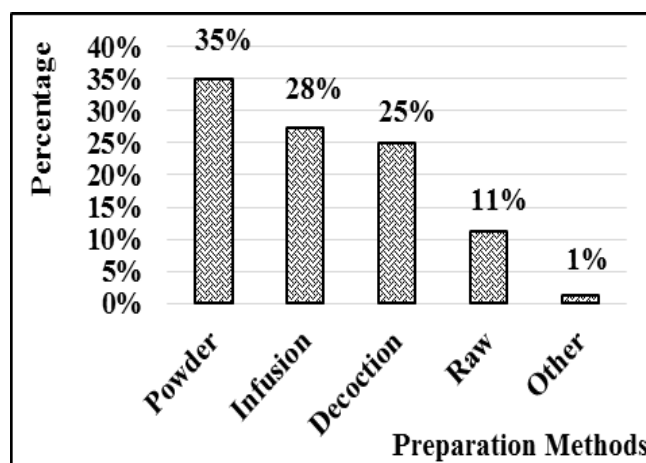

Fig. 7. The proportions of the preparation methods used

The results show that the majority of herbal remedies are used orally with a large percentage (86.95%) and only some plants are used rarely as a massage with a percentage of 8.69% (Fig. 8).
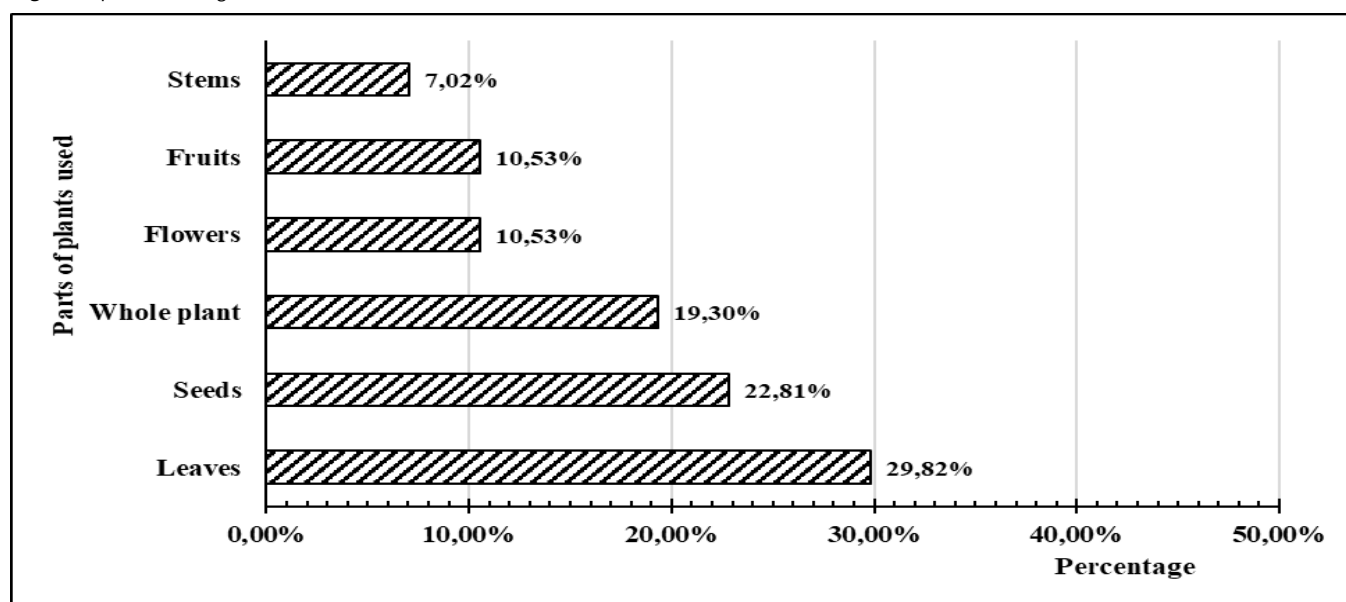

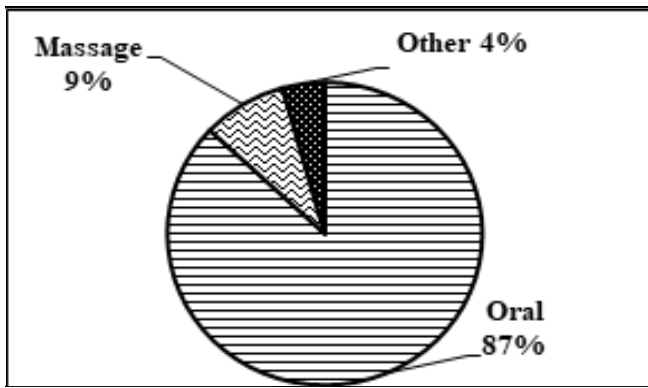**Fig. 6.** Proportion of parts of plants used in the traditional pharmacopeia

Fig. 8. Representation of the percentages of the mode of administration

Treated digestive disorders

Concerning the most treated digestive disorders using plants, the results showed that the majority of respondents use plants to treat gastritis (26%) and abdominal pain (24%), followed by the treatment of constipation and bloating, each with 13%. In the third category, treatment for yellowing (6%), hemorrhoids, diarrhea, and vomiting accounted for 4% each. Other disorders were mentioned with percentages below 2% (Fig. 9).

Dose used and duration of the treatment

The success and efficiency of a remedy are highly dependent on the dosage employed, Therefore, it is fundamental to determine the correct dosage that achieves the desired effects without causing any metabolic disorders (23).

According to the results of our survey (Fig. 10), 13.04% of the population uses medicinal plants in a non-precise and random manner, but the majority use medicinal plants by a spoonful (41.30%), and a cup (32.61%), thus the handful and the pinched rarely used with the following percentages 8.70% and 4.35% respectively. This use of plants without the precision of dose can generate cases of intoxication related to the accumulation of toxic principles.
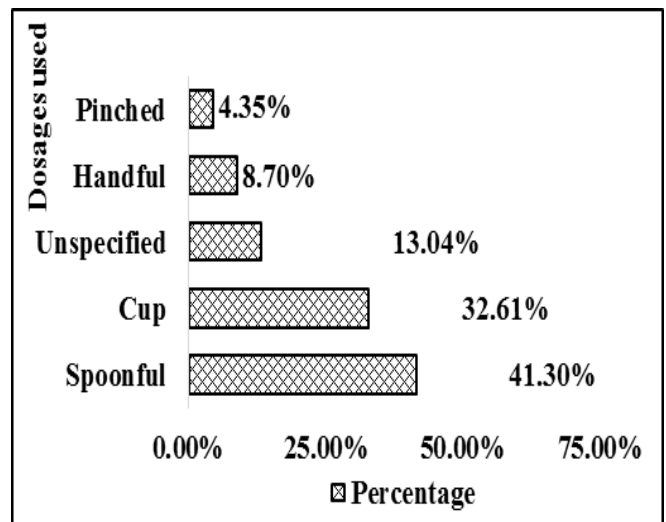

Fig. 10. Representation of the different dosages used

The result Fig. 11 shows the most used duration of treatment which says: until healing (45%), then the use for less than a week (32%), (17%) for a duration of more than a week, and the remaining treatment durations are almost rarely used.
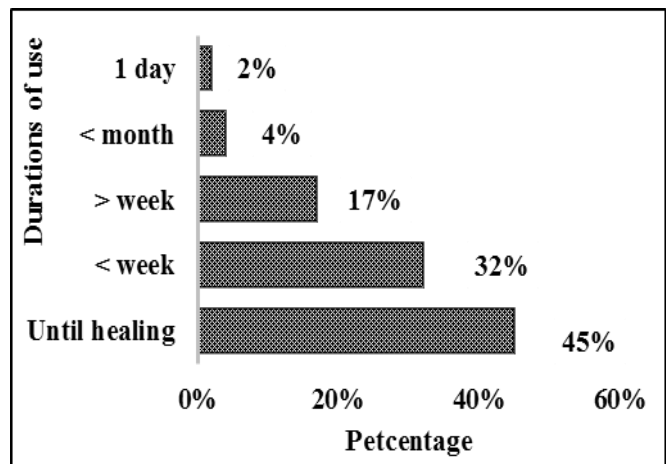

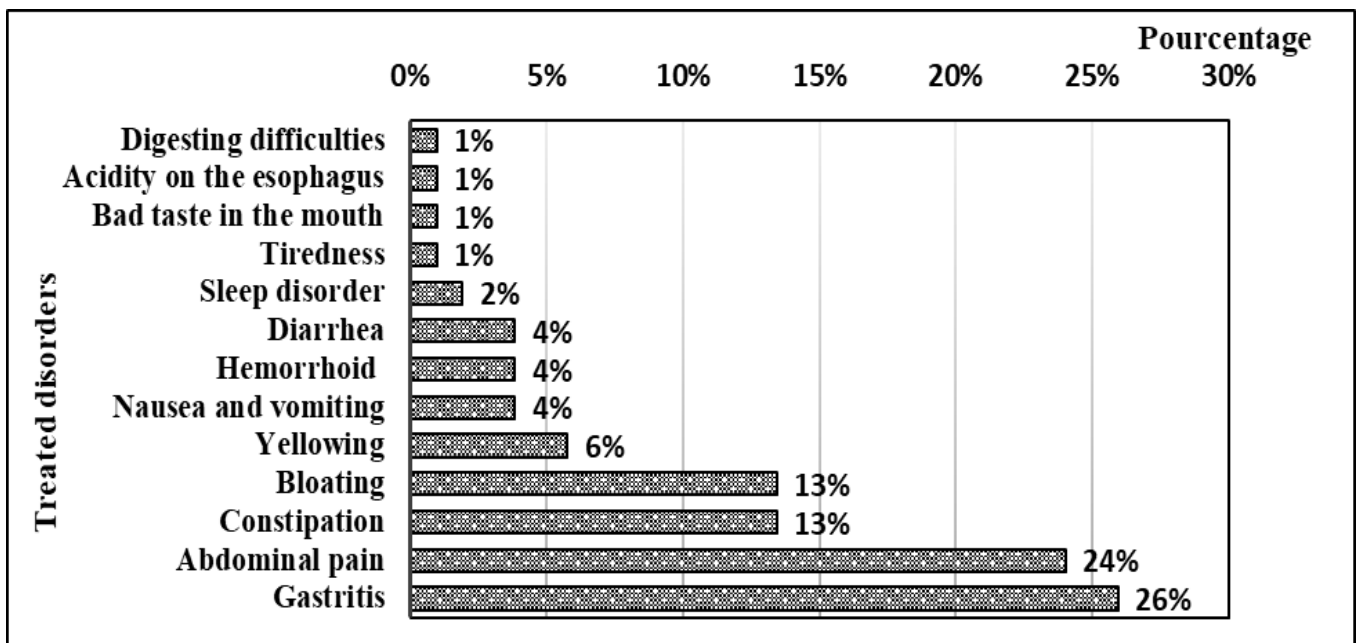**Fig. 11.** Representation of the percentages of durations of use

Fig. 9. Representations of the percentages of the most treated disorders among informants

User satisfaction rate and reason for using plants

According to the survey, most of the users of medicinal plants as a treatment for digestive disorders are very satisfied (48%), and satisfied (43%), and only a few users are not satisfied (9%) (Fig.12).
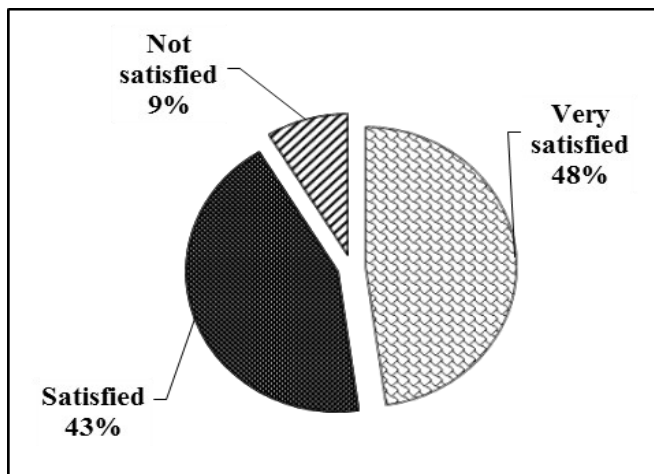

Fig. 12. Representation of user satisfaction rates

As reported in Fig. 13, the obtained results indicate that the majority of medicinal plants utilized in the treatment of digestive disorders are more effective than modern medicine with a percentage of 65%, because they are better than modern medicine (22%), and because of their low cost (13%).
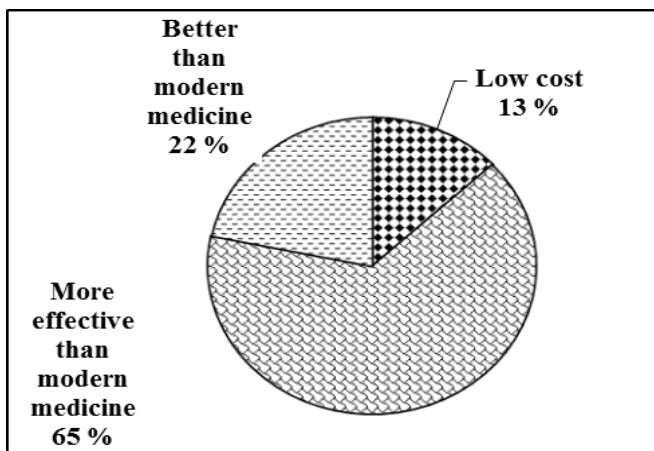

Fig. 13. Distribution of the different reasons for using herbal medicine

Use value of species and families

To assess the relative importance of medicinal plants suggested by traditional medicine practitioners in the Tafilalet region for treating digestive disorders, the use value (UVs) was computed, and it varied between 0.067 to 0.677. The species with the highest use value are *Nigella sativa* L. (UVs=0.677), *Satureja vulgaris* L. (UV=0.6), and *Rosmarinus officinalis* L. (UV=0.533). The lowest value was observed in *Parietaria mauritanica* Durieu, *Populus euphratica* Oliv., *Rubia tinctorum* L., *Nerium oleander* L., *Ammi visnaga* L. (UV=0.067) (Supplementary Table 1). Concerning the use value attributed to plant families, the top three families with the highest UVF are Ranunculaceae (UVF= 0.667), Brassicaceae (UVF=0.433), and Lauraceae (UVF=0.367). The lowest use value is shared between 3 families, and its score is equal to 0.067.

The relative citation frequency (RFC) of species ranged from 0.233 to 0.066. The most cited species by informants are *Rosmarinus officinalis* L. and *Nigella sativa* L. (RFC=0.233). The weakly cited species are *Nerium oleander* L., *Ammi visnaga* L., *Rubia tinctorum* L., *Parietaria mauritanica* Durieu, *Populus euphratica* Oliv., *Reseda alba* L., *Ceratonia siliqua* L., *Salsola longifolia* Forssk., and *Salvadora persica* L. with RFC=0.066 (**Supplementary Table 1**).

Discussion

Nature is the place for a variety of plants, each given distinct medicinal properties. These plants serve as an alternative source for healing, using different parts of the plant to derive therapeutic benefits (24) to address difficulties in accessing conventional health care due to socioeconomic and geographic limitations and insufficient health infrastructure, particularly in rural communities (23).

During this study, the people selected have significant expertise in the practice of phytotherapy or the trade of aromatic and medicinal plants; Thus, they are appropriate to provide correct, credible, and original information on the use of medicinal plants in the oasis ecosystem. the dominance of men in this investigation can be explained by the use of medicinal plants by men in trading, herbal medicine remains mainly a field of men in oasis regions. These findings corroborate the results of other ethnobotanical surveys managed in different areas (25, 26); however, over the past few years, we have noticed the involvement of women in sales, with the creation of associations, cooperatives, economic interest groups (EIG) and specialized pharmacies focusing on medicinal plants, this participation of women is demonstrated in the results of recent ethnobotanical surveys (27).

The dominance of older people over 40% reveals that the knowledge of medicinal plants and the exercise of traditional medicine as well as their properties underscores the necessity for accumulated experience over the years in this field. Nevertheless, it's crucial not to disregard the rejuvenation of this field, which underscores the continuity and durability of knowledge transmission from one generation to the next and the enduring relevance of natural and traditional remedies. Indeed, knowledge of the properties of medicinal plants and their applications in health care are usually acquired after a long practice, accumulated, and transferred from one generation to another (28). However, this transmission of practical knowledge and ability is based on orality representing a real risk of confusion between species leading to serious poisoning problems (11).

The important rate of literacy can constitute a real difficulty to the development of the practice of herbal medicine, following the difficulties encountered by these people to understand precisely the instructions transmitted and to develop on the evolution of this sector, which can lead to anarchic and uncontrolled use of medicinal plants, thus generating risks of intoxication and

serious health problems. Then, efforts must be made to guarantee continuous training for the actors in this sector (29). we can also deduce that not only the population living in rural areas uses traditional medicine to treat digestive diseases since they are in direct contact with plants, but also the population living in urban areas, reflecting the persistence of herbal medicine and attachment to natural plants. care despite urbanization.

In terms of botanical diversity, our results align with those published by Idm'hamd et al. 2023, in a review article exclusively dedicated to the ethnobotanical survey and pharmacological knowledge of plants used to treat digestive illnesses in Morocco, which reported that Apiaceae, Lamiaceae, and Asteraceae are the most responded to families (30). Thus, Apiaceae, Lamiaceae, and Asteraceae in addition to being the most used families in phytotherapy to treat digestive diseases in the study area, are also the richest in spontaneous plants and the most represented in Mediterranean countries (31, 32). In most cases, the plants are used dried because they are not available all year round. The drying, and then the conservation is made in the shelter of the light for this allows the preservation of the majority of the active principles of the plants (33).

The leaves represent the most used part to cure digestive diseases. This first choice is due to the richness of the leaves in beneficial active metabolites as they are the primary site for photosynthesis (34). Furthermore, they are simple to collect, and their harvesting does not influence the plant's life cycle (35).

The choice of the administration mode of treatments used against digestive diseases depends on the chemical nature of the active ingredients and their level of toxicity (36). The prevalence of oral administration can be attributed to its acceptance by patients as this method allows immediate contact of the curative active ingredients with the digestive tract. The frequency of use is also a key parameter for the success of traditional herbal remedies. Overdosing poses risks, even for synthetic medicines and non-toxic medicinal plants (23). However, according to the survey conducted, the respondents tend to administer doses that can be used for varying lengths of time, thus presenting a major risk of intoxication.

According to our results, *Rosmarinus officinalis* L. and *Nigella sativa* L. are well-known plants in the treatment of digestive disorders and would rank among the most effective, they have appreciable local importance. these two species should be taken subsequently for phytochemical analysis, toxicological assessments, and pharmacological studies.

Depending on (37), the high values of ICF (Informant Consensus Factor) assigned to gastrointestinal disorders may be explained by the fact that relative clinical signs are common and are more easily identified by traditional healers.

Nigella sativa L. Often known as black seed; it is classified as an annual flowering plant within the Ranunculaceae family. This plant showed healing potential in gastrointestinal troubles (38). Shahid et al. (2018) explored the efficacy of *Nigella sativa* oil and its main bioactive component on the intestinal tract using animal models, Following the administration of *Nigella sativa* extract, the researchers observed a decline in brush-border membrane enzymatic activity in isolated vesicles Moreover, there was an enhancement observed in both enzymatic and non-enzymatic parameters of the antioxidant defense of the intestinal (39).

Rosmarinus officinalis species which belongs to the Lamiaceae family, is popularly known as rosemary, and native to the temperate regions of the Mediterranean. the same plant was revealed to be used for gastrointestinal system diseases with high Fidelity level values of 71.43% (40).

Conclusion

Herbal medicines are still considered a vital source of healthcare in developing nations, in the deficiency of a modern medical system. Traditional medicine is very widespread in Moroccan society, informants use many plants and their extracts in traditional therapy to treat digestive disorders.

The ethnobotanical studies concerning the use of plants in traditional medicine by the local population of the Tafilalet region made it possible to gather a set of results on the use of medicinal plants in the region concerned and to know the richness and the diversity of plants and medicinal products used digestive disorders treatments. Women and men have shared medicinal knowledge, with an advantage over men in this field. Illiterate people know much more about the therapeutic uses of herbal medicines than other informed people.

This study allowed us to identify 47 medicinal plants belonging to 28 botanical families, the most important of them belongs to Lamiaceae and Apieceae, the leaves are the most used part, and the powder and infusion are the most applied preparation methods. The treated digestive ailments in the area are gastritis, constipation, and diarrhea.

The use of medicinal plants like all medicines must comply with safety rules such as respecting the doses, the duration of treatment, and avoiding the use of medicinal plants and medicines simultaneously. The ethnobotanical knowledge initiated can lead to a development in the field of health, especially in the treatment of digestive diseases. Some of this information will probably have disappeared with industrialization and the loss of ethnic cultures. Thus, a biochemical, pharmacological, and toxicological valorization of plants recommended in traditional medicine is necessary.

Acknowledgements

Authors' contributions

MB and KS: Methodology, investigation, writing; HE, BO, and HE: Participate in surveys and development of the questionnaire and acquired the data; LE, LN, EDTB, and CA: Conceptualization, species identification, critical review, and editing and approved the final version for submission.

Compliance with ethical standards

Declaration The authors do not have any conflict of interest to declare.

Ethical issues: The Ethical Research Committee of the Medicinal and Aromatic Plants Center (ERCMAPC) under the UMI of Meknes as well as the Regional Directorate of the National Water and Forests Agency granted ethical approval for our study (EA254/19).

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Questionnaire sheet

CODE	

DATE: …….. /…………. / 2021

Municipality: ☐ 1. Errachidia   ☐ 2. Rissani   ☐ 3. Erfoud

Age:

Gender: ☐ 1.Female   ☐ 2. male

Habitat: ☐ 1. Urban   ☐ 2. Rural

Level of education: ☐ 1. Illiterate   ☐ 2. Primary   ☐ 3. Secondary   ☐ 4. University

Age of the practice:

Reason for using traditional medicine:

Satisfaction:

Family:

Genus:

Species:

Arabic vernacular name:

Tamazight vernacular name:

Location of the collection: ☐ 1. Valley   ☐ 2. Mountain   ☐ 3. Desert   ☐ 4. Other

State of the plant: ☐ 1. Fresh   ☐ 2. Dried   ☐ 3. Indifferent
☐ You can check multiple boxes

Used part: ☐ 1. Leaves   ☐ 2. Fruits   ☐ 3. Root   ☐ 4. Stems   ☐ 5. Seeds   ☐ 6. Flowers
☐ 7.Whole plant   ☐ 8. Others ☐ You can check multiple boxes

Method of preparation: ☐ 1. Decoction   ☐ 2. Infusion   ☐ 3. Maceration   ☐ 4. Powder   ☐ 5. Raw   ☐ 6. Extract   ☐ 7. Others   ☐ You can check multiple boxes

Used dose: ☐ 1. Spoonful   ☐ 2. Pinch   ☐ 3. Handle   ☐ 4. Cup   ☐ 5. Unspecified
☐ You can check multiple boxes

Administration mode: ☐ 1. Oral   ☐ 2. Massage   ☐ 3. Rinsing   ☐ 4. Bandaging   ☐ 5. Others
☐ You can check multiple boxes

Duration of use: ☐ 1. One day   ☐ 2. < week   ☐ 3. > week   ☐ 4. < month   ☐ 5. Until healing
☐ You can check multiple boxes

Treated digestive disorders:

○	○	○
○	○	○
○	○	○
○	○	○

☐ **You can check multiple boxes**