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Review Article

Traditional Knowledge of Medicinal Plants Used in the Northeastern Part of Morocco

Mohamed Reda Kachmar,[1] **Hanae Naceiri Mrabti**,[2] **Meryem Bellahmar**,[1] **Abdelilah Ouahbi**,[1] **Zoubida Haloui**,[1] **Khalid El Badaoui**,[1] **Abdelhakim Bouyahya**,[3] **and Said Chakir**[1]

[1]*Team of Medicinal and Aromatic Plants Valorisation and Environment, Environment and Health Laboratory, Faculty of Sciences, Moulay Ismail University, P. O. Box 11201, Zitoune, Meknes, Morocco*
[2]*Laboratory of Pharmacology and Toxicology, Bio Pharmaceutical and Toxicological Analysis Research Team, Faculty of Medicine and Pharmacy, Mohammed V University, BP 6203, Rabat, Morocco*
[3]*Laboratory of Human Pathologies Biology, Department of Biology, Faculty of Sciences, Genomic Center of Human Pathologies, Faculty of Medicine and Pharmacy, Mohammed V University, Rabat, Morocco*

Correspondence should be addressed to Abdelhakim Bouyahya; boyahyaa-90@hotmail.fr

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The knowledge of the plants that are used may provide insight on their properties for further exploration. This study aimed to identify and collect data about medicinal plants used in traditional medicine by the population of the provincial region of Taza, Morocco. An ethnobotanical survey was carried out among 200 informants, competent villagers, herbalists, and traditional healers from the provincial region of Taza city through direct interviews using a structured questionnaire. The survey reported 55 plant species belonging to 28 families used in the folk medicine. Informants' results showed that the most frequently used plants were *Origanum compactum*, *Mentha pulegium*, *Rosmarinus officinalis* L., *Aloysia citrodora*, *Calamintha officinalis* Moench, and *Artemisia herba-alba* Asso., with a relative frequency of citation of 76%, 72%, 60%, 42%, 40%, and 30%, respectively. Moreover, in this study, the Lamiaceae family was the most commonly reported plant family, and the leaves were the most frequently used parts of the plants; otherwise, decoction and infusion were the most used modes in the preparation of remedies from medicinal plants in the traditional medicine. The sociodemographic characteristics showed that women use medicinal plants slightly more than men, the illiterate people use the medicinal plant the most, and old people have more information about the medicinal plants than the new generations. The region of Taza of Morocco has an important floristic biodiversity of medicinal plants which are used in traditional medicine practice. This result provides a good database for pharmacological screening in the search for new plants that can contain new bioactive molecules that can be used as a bioactive ingredient of medicament or as a biological alternative in pharmacology.

1. Introduction

For a long time, plants have played a very important role in the daily lives of human life [1]. Herbal medicines have traditionally been used because of several benefits; they are affordable and easily accessible, and there is no evidence of resistance to whole plant extracts or of effectiveness [2]. This sort of traditional medicinal knowledge has been regularly practiced in homes and is transferred from generation to generation with the passage of time [3]. Nowadays, the use of plants as a way of treatment is still very important for many rural and urban Moroccans [4]. In recent decades, scientific studies have increasingly focused on plants used in traditional medicine to treat various diseases through botanical surveys and laboratory biological tests on animal models to discover certain species with medicinal properties that may

replace certain chemical drugs with side effects [5, 6]. Morocco is a Mediterranean country which is crisscrossed from east to west and from southwest to northeast by four mountain ranges, the Rif, the Middle Atlas, the High Atlas, and the Anti-Atlas; his position between two seas and a vast desert results in a complete range of Mediterranean bioclimates. This varied climate provides habitat for rich and varied flora: more than 4200 spontaneous species and some 1500 introduced species have been catalogued [1, 7, 8]. The region of Taza is located between the mountain ranges of the Rif and the Middle Atlas; its climate is characterized by dry and very hot summer and cold, precipitating, and partly snowy winter. During the year, the temperature generally ranges from 5°C to 36°C and is rarely below 2°C or above 41°C. This climate makes this region very rich in plant biodiversity and in wide varieties of indigenous medicinal plants used by the local population in the folk medicine. To the best of our knowledge, few works in the literature were interested in this region. Thus, the aim of this work was to collect information about plant species used in folk medicine by the traditional healers and local population of this region to treat diseases and human pathologies. For these reasons, the current survey was conducted in the provincial area of Taza of Morocco (northeastern Morocco).

2. Materials and Methods

2.1. Study Area. Taza city is administratively part of the Region of Fez-Meknes, it is located in the northeast of Morocco, and it is located in a mountain pass where the mountain range of the Rif and that of the Middle Atlas meet (Figure 1). Taza province is bordered to the north by the province of Al Hoceima, to the northeast by the province of Nador, to the east by the province of Taourirt, to the south by that of Boulemane, and to the west by the province of Taounate and that of Sefrou (latitude: 34°13′00″N, longitude: 4°01′00″W, and altitude: 550 m). This city covers an area of 37 km^2 with a population of 148,456 inhabitants in 2014.

2.2. Ethnobotanical Survey. The first interview was conducted with the informants, giving them a brief explanation of the objective of the study and the importance of the information they were going to provide in order to sensitize them to participate in this study. In total, 200 people were interviewed directly between May and August 2016 through ethnobotanical surveys in different localities, cities, towns, villages, and douars in the province of Taza.

During the interviews, structured questionnaires were used for data documentation, 20 questionnaires for each zone, and the selected zones were dispersed between the city of Taza, the villages, and the douars of the Rif Mountains and the Middle Atlas belonging administratively to the province of Taza. Each questionnaire consisted of two parts. The first part concerns demographic information such as sex, age, educational level, source of information, and the profession of the participants, while the second part has informative questions on local names of plant species, mode preparation (decoction, maceration, infusion, etc.), the plant part used (stems, roots, leaves, seeds, aerial part, etc.), the method of administration, and the diseases treated by the plants mentioned by the informant. In each interview, the names of the plants were recorded in Moroccan Arabic when they were mentioned.

The botanical materials of 55 plant species were collected from the informants and kept in special glass frames; they were later identified by Pr. Abdelilah Rahou (Faculty of Sciences, Moulay Ismail University, Meknès). The confirmation was carried out by Dr. Mohamed Reda Kachmar using means of the literature.

These samples of plant materials were given herbarium specimen codes, and the voucher plant samples were kept in the Herbarium of the Botany Department of the Scientific Institute of Rabat, Morocco. The complete floristic list was established after the identification and verification of the samples; the identification process was realized using the following references: Moroccan Medicinal and Aromatic Plants [9], Vascular Flora of Morocco [10], Practical Flora of Morocco [10], and Traditional Moroccan Pharmacopoeia [11]. The taxonomy was confirmed on the basis of data available on the International Plant Names Index website: https://www.ipni.org/.

2.3. Ethnopharmacological Parameter Analysis

2.3.1. Relative Frequency of Citation. On the basis of the local therapeutic importance of each plant species, the relative frequency of citation (RFC) was calculated according to the following formula [12]:

$$\mathrm{RFC} = \frac{\mathrm{FC}}{N}, \tag{1}$$

where FC is the number of participants who mentioned the use of a plant species and N is the total number of participants.

2.4. Statistical Analysis. The results obtained were processed and analysed using Excel 2010 software.

3. Results

3.1. Sociodemographic Characteristics. A total of 200 participants comprising herbalists, competent villagers, traditional healers, and normal people from Taza city, including 114 women (57%) and 86 men (43%), were interviewed. Their average age was 52 years with a minimum of 19 years and a maximum of 85 years. The majority of the informants belonged to the rural area (90%), and 61% were illiterate. The majority of participants received their education about herbal medicine from herbalists (54%), while the rest learned from their older family members or from other people (Table 1).

3.2. Medicinal Plants

3.2.1. Medicinal Plants Used by the Informants in the Treatment of Various Diseases. The survey reached 56 plant

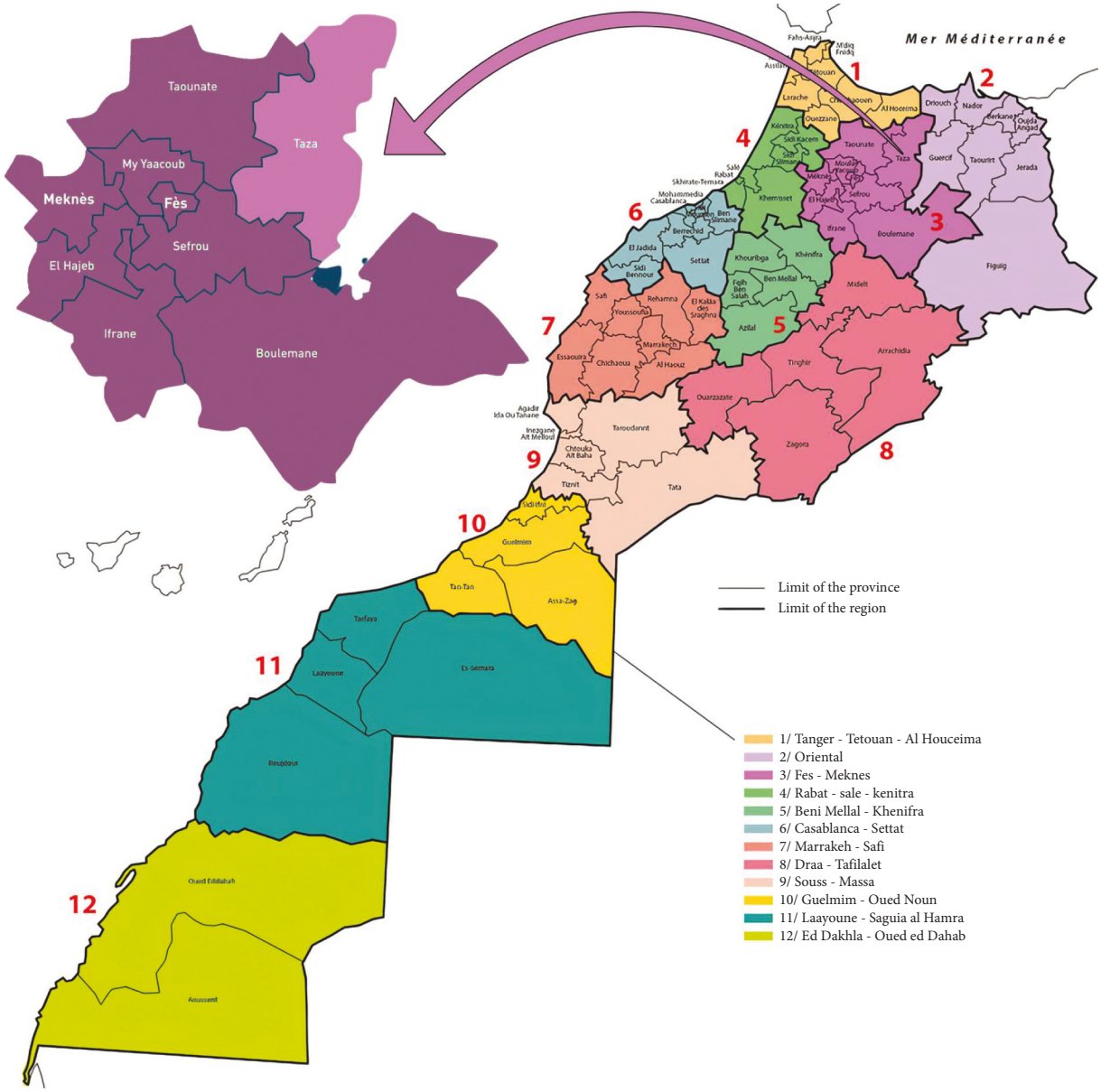

Figure 1: Map of the studied area (northeastern part of Morocco) (source: institutional website of the High Commission for Planning, Kingdom of Morocco, https://www.hcp.ma/region-fes/index.php?start=44).

species used in the treatment of various diseases by the participants in the Taza region. The most used species were *Origanum compactum* with the highest RFC ratio (76%), followed by *Mentha pulegium*, *Rosmarinus officinalis* L., *Aloysia citrodora*, *Calamintha officinalis* Moench, and *Artemisia herba-alba* Asso., with the RFC value of 72%, 60%, 42%, 40%, and 30%, respectively (Table 2). The images of the plants with the highest RFC values are shown in Figure 2.

Plants were grouped into 28 families; this census also shows different routes of administration of the drugs, the preparation methods, and the part of the plants used in the traditional medicine as presented in Table 1. The most presented families were Lamiaceae (14 species), Apiaceae (6 species), Asteraceae (5 species), and Myrtaceae (3 species) followed by Cupressaceae, Lauraceae, and Zingiberaceae (2 species). All other families were presented by one species as shown in Figure 3.

3.3. Used Parts, Methods of Preparation, and Modes of Administration. Results obtained in this study showed that leaves were the most used part of the plants (57.35%) followed by the stems (13.23%), seeds (11.76%), roots (7.35%), flowers (5.88%), fruits (2.94%), and barks (1.47%) (Figure 4). Our survey also showed that decoction and infusion were the most used methods of preparation with frequencies of 29.11% and 27.84%, respectively, followed by the raw form (20.25%), powder form (17.72%), fumigation (3.79%), and vegetable oil (1.26%) (Figure 5). Oral administration of the drugs had the highest frequency (70%), while the other

Table 1: Sociodemographic characteristics of the respondents.

Characteristics	Number of informants (n)	Frequency (%)
Ages (years)		
18–30	64	32
30–50	96	48
>50	40	20
Total	200	100
Gender		
Male	86	43
Female	114	57
Total	200	100
Education		
Illiterate	122	61
Primary school	26	13
Secondary school	18	9
High school	10	5
University	24	12
Total	200	100
Profession		
Sans	38	19
Peasant	40	20
Housewife	74	37
Herbalist	12	6
Official	30	15
Others	6	3
Total	200	100
Origin of knowledge		
Herbalist	108	54
Popular culture	46	23
Family heritage	32	16
Others	14	7
Total	200	100

administration modes (brushing, rinsing, massage, and inhalation) presented the rest 30% (Figure 6).

4. Discussion

The main goal of this study is to identify the medicinal plants used in the province of Taza city. This region has an important and diversified heritage of aromatic and medicinal plants widely used in traditional medicine by the local population. This richness is also reflected by broad culture in phytotherapy and phytopharmacology among the selected informants, particularly herbalists and traditional healers.

Sociodemographic results showed that the age of all participants was between 20 and 86 years, and the most presented group of the informants having the age between 30 and 50 years (48%). The result also showed that females use medicinal plants a little bit more than males. Our results confirm those obtained by other ethnobotanical studies made in other regions in Morocco [7, 128]. This must be due to that women are in charge of drying, stocking of medicinal plants, and preparing recipes for the care of family members.

Interviews showed that older people are particularly competent than the young generation and had a greater knowledge of the uses of medicinal plants for the cure of various diseases; similar results were observed by other studies [30, 129]. However, this finding did not exclude other age groups with valuable knowledge about herbal remedies. In fact, older people are expected to provide more reliable information because they hold more ancestral knowledge transmitted orally. The transmission of this valuable knowledge and medicinal recipes from the old to the new generation is not always assured and is now in decline [129].

In this study, women were the most presented (57%) than men (43%). These results agree with those of a previous ethnobotanical study done in the province of Tata, Souss-Massa region in Morocco [19]. This study was led in the southeast region of Morocco, while our study was conducted in the northeast region of Morocco; these two regions differ by their geographical locations and their climatic zones and consequently a difference in their plant biodiversity, which obviously affects the choice of the plant's species used in traditional medicine. Therefore, our survey showed that the most used plants in the Taza region were *Origanum compactum*, *Mentha pulegium*, *Rosmarinus officinalis*, *Aloysia citrodora*, *Calamintha officinalis* Moench, and *Artemisia herba-alba* Asso., while *Artemisia huguetii*, *Mentha pulegium*, *Trigonella*

Table 2: Medicinal plants used in traditional medicine in Taza city region, Morocco.

Family name	Plant species	Voucher codes	Vernacular name	Parts used	Preparation mode	Administration mode	RFC (%)	Utilisation	Ethnomedicinal uses recorded in the literature inside Morocco	Pharmacological properties verified *in vivo* and/or *in vitro*
Amaranthaceae	*Chenopodium ambrosioides* L.	RAB135-16	Mkhinza	Leaves	Raw with juice, raw	Oral Basting	13	Digestive tract infections Asthma Hepatitis	Headaches, migraine, measles, jaundice, syphilis, fever [4]	Antioxidant and immunostimulant [13] Antioxidant, anti-inflammatory, and improvement of intestinal immune status [14]
Amaryllidaceae	*Allium sativum* L.	RAB15-16	Touma	Leaves	Powder	Oral	3	Diabetes Cold Grippe Hypertension	Scorpion and snake bite, intestinal pain, hypertension [1]	Antioxidative and antigenotoxic effects [15]
Anacardiaceae	*Pistacia lentiscus* L.		Drou	Leaves	Decoction	Oral	5	Digestive system pathologies	Digestive diseases and evil eye [1]	Antibacterial activity [16]
Apiaceae	*Daucus crinitus* Desf.		Bozfor	Leaves	Raw Decoction	Oral Inhalation	2	Digestive system disorders	Digestive system [8]	Antimicrobial [17]
Apiaceae	*Foeniculum vulgare* Mill.	RAB92-16	Lbesbas Nafaa	Roots Leaves Seeds	Decoction Infusion Decoction	Oral Oral	4.5	Gastrointestinal diseases Rheumatism Asthma	Mouthwash [18] Kidney diseases, digestive, pain, diabetes [19]	Anti-inflammatory, analgesic, and antioxidant [20] Antibacterial [21]
Apiaceae	*Pimpinella anisum* L.	RAB231-16	Habbat Hlawa	Seeds	Raw	Oral	3	Diabetes, allergy, asthma, digestive system stimulation, tooth care	Spasmolitic, carminative, stomachic, diuretic, expectorant, stimulant kidney diseases, gastric pain, diabetes, antiemetic, tooth care [19]	Antioxidant and antimicrobial [22] Antimicrobial and cytotoxic [23]
Apiaceae	*Petroselinum sativum*	RAB266-16	Maâdnous	Stems Leaves	Decoction	Oral	3	Gastrointestinal infections, heart disease, hypertension, allergy	Cardiac disease and hypertension [24]	Antioxidant and antibacterial [25] Antihypertensive [26]
Apiaceae	*Cuminum cyminum* L.		Lkamoun	Seeds	Infusion	Oral	6	Gastrointestinal infections, stomach ache	Diabetes, cardiovascular diseases, and pathologies of the digestive system [4]	Antimicrobial and cytotoxic activities [27]
Apiaceae	*Coriandrum sativum* L.		Lkazber	Leaves Stems	Infusion	Oral	5.5	Hypertension	Cardiac disease and hypertension [24]	Antioxidant effect [28] Protection of gastric mucosal damage [29]

Table 2: Continued.

Family name	Plant species	Voucher codes	Vernacular name	Parts used	Preparation mode	Administration mode	RFC (%)	Utilisation	Ethnomedicinal uses recorded in the literature inside Morocco	Pharmacological properties verified *in vivo* and/or *in vitro*
Apocynaceae	*Nerium oleander* L.	RAB188-16	Defla	Leaves	Infusion Raw	Oral Basting	2	Heart disease, hypertension, diabetes, dermatosis, fever, headache, sciatic nerve pain	Hypertension, cardiac disease, and diabetes [24] Rheumatism, osteoporosis, arthrosis [30]	Antioxidant, antimicrobial, and antitumor [31]
Aristolochiaceae	*Aristolochia longa*		Baraztam	Roots	Decoction Powder	Oral Basting Rinsing	17	Cold, tooth pain, osteoarticular pain, inflammation, allergy	Cardiovascular diseases, neurological diseases [32]	Cytotoxic and antimicrobial [33] Antibacterial [34]
Asteraceae	*Dittrichia viscosa*		Bagramane	Leaves	Raw Infusion	Basting Oral Massage	5	Cold, osteoarticular pain Diabetes Wormer	Dental abscesses [35]	Gastroprotection [36] Antibacterial and antifungal [37] Antibacterial and antioxidant [38]
Asteraceae	*Atractylis gummifera* L.		Addade	Roots	Decoction	Oral	3	Cold Rheumatism Abdominal pain	Tooth whitening, toothache, mouth ulcers, gingival bleeding, gingivitis, herpes labialis, bad breath, stomatitis [35]	Antidiabetic [39]
Asteraceae	*Artemisia herba-alba* Asso.	RAB26-16	Chih	Leaves Stems	Decoction	Oral	30	Gastrointestinal infections Abdominal pain Cold Nausea	Wounds, rheumatism, appetite stimulant, indigestion, diarrhea, bad breath, anthelmintic, emmenagogue, nausea, stomach pain [40]	Nephroprotective [41] Antimicrobial and antioxidant [42] Antioxidant, anticancer, and anti-inflammatory [43]
Asteraceae	*Artemisia absinthium* L.	RAB33-16	Chiba	Leaves	Infusion	Oral	4	Intestinal parasites Dyspepsia Renal colic	Cold and flu, cholagogue, diuretic [44]	Antioxidant and antimicrobial activities [45]
Asteraceae	*Matricaria chamomilla*	RAB151-15	Babounj	Flowers	Infusion Powder	Oral Rinsing	16	Eczema Psoriasis Depression Intestinal colic	Colic, Diarrhée, Nervosité, Depression, Angines, Aphtes, Menstruations douloureuses, Fièvre, Abcès, infections [46]	Antibiofilm and anticaries [47], radical scavenging and antioxidant activity [48]

Table 2: Continued.

Family name	Plant species	Voucher codes	Vernacular name	Parts used	Preparation mode	Administration mode	RFC (%)	Utilisation	Ethnomedicinal uses recorded in the literature inside Morocco	Pharmacological properties verified *in vivo* and/or *in vitro*
Capparaceae	*Capparis spinosa* L.		Lkabbar	Fruits	Raw Powder	Oral Basting	6	Digestive tract disorders Dermatological affections Diabetes Helminthiasis Respiratory problems, rheumatic pain, kidney stones	Stomach pain, asthma [40]	Antidiabetic and antihyperlipidemic [49] Antioxidant [50]
Caryophyllaceae	*Herniaria cinerea* DC.		Harast lahjer	Leaves Stems	Decoction	Oral	13	Diabetes Kidney stones	Antiurolithiasis [51] Bladder disorders, kidney stones, diuretic, reduced blood levels of uric acid [52]	Diuretic and decreased renal stone formation [53]
Cistaceae	*Cistus ladanifer* L.	RAB 108848	Touzala lbayda	Leaves	Decoction	Oral	1	Gastric pain	Gastric pain, common cold, and against digestive disorders [54]	Hypoglycemic and hypolipidemic [55] Antibacterial [56]
Cupressaceae	*Juniperus phoenicea*	RAB 108845	Al'Araâr Elbeldi	Leaves	Decoction, raw	Oral	2	Gastrointestinal infections Asthma	Asthma, hepatitis, and rheumatism [57]	Antibacterial activity [58]
Cupressaceae	*Tetraclinis articulata* (Vahl) Mast.	RAB187-16	Al'Araâr	Leaves	Infusion Fumigation	Oral Inhalation	14	Stomach ache Hypotensive Diabetes	Endocrinological, general health, gastrointestinal, otolaryngological, and respiratory [59]	Antioxidant, antimicrobial, anti-inflammatory, and cytotoxic [60] Antibacterial [61]
Euphorbiaceae	*Ricinus communis*		Lkherwaa	Seeds	Oil	Massage Rinsing	8.5	Skin diseases, hair loss	Hair and face care [19]	Antiviral [62]
Fabaceae	*Trigonella foenum-graecum L.*		Lhelba	Seeds	Raw	Oral	4	Stomach ache Diuretic Diabetes	Diabetes, cardiovascular diseases, power problems [4]	Antimicrobial [63] Hypocholesterolemic and anti-inflammatory [64] Antiallergic [65]
Gentianaceae	*Centaurium erythraea* Rafn.	RAB 108847	Gossat lhaya	Leaves Stems	Decoction Powder	Oral Rinsing	9	Diabetes Wound healing Stomach ache Wound inflammation Analgesic	Hepatitis, asthma, and rheumatism [57] Digestive system and kidney diseases [1] Allergy and increasing energy [4]	Antioxidant and anti-inflammatory effects [66] Antihyperglycemic activity [67] Diuretic effects [68]

Table 2: Continued.

Family name	Plant species	Voucher codes	Vernacular name	Parts used	Preparation mode	Administration mode	RFC (%)	Utilisation	Ethnomedicinal uses recorded in the literature inside Morocco	Pharmacological properties verified *in vivo* and/or *in vitro*
Lamiaceae	*Mentha pulegium*		Flio	Leaves	Infusion Decoction	Oral	72	Flu Cold	Cold, respiratory canals [1] Pathologies of the digestive system, cold problems, and pathologies of the respiratory system [4]	Antioxidant and antimutagenic activities [69]
Lamiaceae	*Origanum compactum* Benth.		Zaâtar	Leaves	Decoction Infusion Powder	Oral Rinsing	76	Gastrointestinal infection Stomach ache Fever Cold	Emmenagogue, nausea, food poisoning, asthma [40]	Antioxidant and antibacterial activities [70] Antiproliferative effect [71] Antimutagenic effect [72]
Lamiaceae	*Calamintha officinalis* Moench	RAB69-16	Manta	Leaves	Decoction Infusion	Oral	40	Flu Cold	Against different aches, antipyretic [73]	Antioxidant [74] Antioxidant and antimicrobial [75]
Lamiaceae	*Marrubium vulgare* L.	RAB364-16	Mriwta	Leaves	Decoction Raw	Oral Basting	11	Liver disease, respiratory problems, fever, diabetes	Toothache, gingival bleeding, bad breath, gingivitis [35]	Hepatoprotective [76] Antioxidant and antifungal [77]
Lamiaceae	*Mentha rotundifolia*		Mchichetru	Leaves	Infusion	Oral	16	Cold Grippe	Skin pathologies, respiratory disorders, digestive disorders [78]	Anti-inflammatory, analgesic, and antioxidant [79] Insecticidal and antifungal [80]
Lamiaceae	*Ajuga iva* (L.) Schreb.	RAB23-16	Chendgoura	Leaves Stems	Raw Infusion Powder	Oral	4	Diabetes Rheumatism Allergy Digestive disorders Antidiarrhea	Rheumatism, allergy, cancer [57] Cardiovascular diseases, pathologies of the digestive system, pathologies of the respiratory system [4]	Antibacterial activity [81] Antihyperglycemic activity [82,83]

Table 2: Continued.

Family name	Plant species	Voucher codes	Vernacular name	Parts used	Preparation mode	Administration mode	RFC (%)	Utilisation	Ethnomedicinal uses recorded in the literature inside Morocco	Pharmacological properties verified *in vivo* and/or *in vitro*
Lamiaceae	*Rosmarinus officinalis* L.		Azir	Leaves Flowers	Decoction Infusion	Oral Massage	60	Gastric disorders Digestive system pathologies Heart disease	Cardiac disease, hypertension, and diabetes [24] Allergy, asthma, cancer, infections, and immune system depression [57] Pathologies of the digestive system, allergy, and dermocosmetology [4]	Antibacterial activity [84] Diuretic effects [68]
Lamiaceae	*Salvia officinalis* L.	RAB354-16	Salmia	Leaves	Infusion	Oral	21	Diabetes	Diabetes [6] Respiratory, digestive, circulatory [85] Cold, cough, diabetes, rheumatism, stomachic, carminative, choleretic, tonic, antisudorific, spasmolytic, throat pain, stomach pain, antiseptic, haemostatic [19]	Antioxidant, antibacterial, and antileishmanial activities [86]
Lamiaceae	*Lavandula stoechas* L.		Lhalhal	Leaves	Infusion	Oral	2.5	Gastrointestinal disorders	Rheumatism and asthma [57] Rheumatism and digestive system [1] Pathologies of the digestive system and diabetes [4]	Antibacterial activity [81]
Lamiaceae	*Thymus vulgaris* L.		Zaitra	Stems Leaves	Decoction	Oral	17	Cold Asthma Digestive tract infections	Colic, Diarrhea, Digestive disorders, Flatulence, Cooling, Bronchitis, Flu, Cough, Toothache, Painful menstruation, and Anemia infections [46] Gum disease, halitosis, oral ulcers [18]	Antioxidant and antibacterial [87] Antioxidative [88]
Lamiaceae	*Lavandula*		Lkhzama	Leaves Flowers	Powder	Oral	20	Urinary system disorder	ND	ND
Lamiaceae	*Mentha spicata* L.		Naanaa	Leaves Stems	Infusion	Oral	4	Cold Grippe	Migraine [89] Respiratory, skin [85]	Antibacterial [90] Antioxidant [91]

Table 2: Continued.

Family name	Plant species	Voucher codes	Vernacular name	Parts used	Preparation mode	Administration mode	RFC (%)	Utilisation	Ethnomedicinal uses recorded in the literature inside Morocco	Pharmacological properties verified *in vivo* and/or *in vitro*
Lamiaceae	*Origanum majorana* L.		Mardedoch	Leaves	Infusion Decoction	Oral	7	Gastrointestinal infections Stomach ache Cold	Cephalalgia [40] Gum disease, dental pain [18]	Antidepressant-like effects [92] Antioxidant, antimicrobial, cytotoxicity, and antiacetylcholinesterase [93]
Lamiaceae	*Ocimum basilicum* L.		Hbeq	Leaves	Infusion	Oral	10	Urinary system disorder	Allergy, cardiovascular diseases, and pathologies of the urinary system [4] Against mosquito, sinusitis, and tachycardia [94]	Antibacterial activity of essential oil [84]
Lauraceae	*Laurus nobilis* L.		Warkat sidna mossa	Leaves	Infusion	Oral	7	Respiratory problems Cough Digestive problems	Liver, pancreas, and digestive pain, face care, rheumatism, antiseptic, diuretic, sedative, rheumatism, calefacient [19]	Gastroprotective [95] Antibacterial and antibiofilm [96]
Lauraceae	*Cinnamomum verum* J. Presl		Lkarfa	Bark	Powder	Oral Rinsing	4	Cold Digestive system disorders Diabetes	Emmenagogue, hypercholesterolemia, obesity, painful periods [40]	Antibacterial [97] Antifungal [98]
Lythraceae	*Lawsonia inermis* L.		Lhana	Leaves	Powder	Basting	8	Hair protection Wound healing	Hair care, antifungal, burns, sprains, hypotensive, emetic, stomach pains, digestive disorders [19]	Antibacterial and antifungal [99] Wound healing [100] Antibacterial [101]
Moraceae	*Ficus carica* L.	RAB82-16	Chriha Lkarmous	Fruits	Raw	Oral	1.5	Asthma	Digestive system [1] Pathologies of the digestive system, pathologies of the circulatory system, and cardiovascular diseases [4]	Anticancer [102] Hepatoprotective and nephroprotective [103]
Myrtaceae	*Eucalyptus globulus* Labill (sp)	RAB93-16	Al'Kalitouss	Leaves	Fumigation	Inhalation	11	Flu	Diabetes [6] Asthma [57]	Antibacterial activity [104] Hypoglycemic activity [105]

Table 2: Continued.

Family name	Plant species	Voucher codes	Vernacular name	Parts used	Preparation mode	Administration mode	RFC (%)	Utilisation	Ethnomedicinal uses recorded in the literature inside Morocco	Pharmacological properties verified *in vivo* and/or *in vitro*
Myrtaceae	*Myrtus communis* L.	RAB496-16	Arraihan	Leaves	Raw Decoction	Massage Oral	13	Hair loss Diarrhea	Diabetes [6] Cardiac weakness, digestive system [1]	Antioxidant activity [106] Antigenotoxic effect [107] Hypoglycemic effect [108]
Myrtaceae	*Eugenia caryophyllata*	RAB412-16	Qronfel	Flowers	Decoction Powder	Inhalation Massage Rinsing	3	Grippe Tooth pain	Headaches, migraine, pathologies of the digestive system, dermocosmetology [4]	Antibacterial and antioxidant [109] Antioxidant capacity and cytotoxic activity [110]
Nitrariaceae	*Peganum harmala* L.		Lharmal	Seeds	Fumigation	Inhalation	6.5	Rheumatism, back pain, fever	Gingivitis, toothache, mouth ulcers, herpes labialis, bad breath, stomatitis [35] Spasmolitic, sterility, uterus diseases, vermifuge, abortifacient, ritual, magic practice, and to relieve bad fate, hair care, eczema, neoplasms [19]	Antiviral [111] Antibacterial and antifungal [112]
Pedaliaceae	*Sesamum indicum* L.	RAB528-16	Ajenjlane	Seeds	Raw	Oral	1	Digestive system disorders	Appetite stimulant [40] Bloating, digestion problems [73]	Antiulcer [113] Gastroprotective [114] Antirheumatoid [115]
Ranunculaceae	*Nigella sativa* L.	RAB358-16	Lhaba sawda Sanûj	Seeds	Oil	Massage	2	Eczema Psoriasis	Appetite stimulant, kidney diseases, cough [40]	Nephron-protective [116] Antibacterial [117]
Rhamnaceae	*Ziziphus lotus* (L.) Lam.	RAB622-16	Sedra	Leaves Stems	Infusion	Oral	1.5	Headache Joint pain	Cardiac ailments, pulmonary infection, haemostatic, colic animals, diabetes, stomach pain, diarrhea, kidney stones, throat pain, pectoral and emollient, jaundice [19]	Antiglycaemic, anticholesterolemic, antioxidant, and antimicrobial [118]
Rosaceae	*Alchemilla vulgaris*		Gdam sbaâ	Leaves	Raw Powder	Rinsing	4.5	Wound healing Inflammation of wounds	ND	ND
Thymelaeaceae	*Daphne gnidium* L.		Lzaz	Leaves	Raw	Basting	9	Hair loss	Hair care and hair strengthening [1] Dermocosmetology, fever, and head problems [4]	Anti-inflammatory [119] Antimicrobial [120]
Urticaceae	*Urtica dioica* L.	RAB565-16	Lhriga	Leaves	Decoction	Oral	8	Urinary system problem	Diabetes [6] Osteoporosis [30] Renal weakness, digestive system [1]	Antibacterial [121] Antioxidant, antimicrobial, antiulcer, and analgesic [22]

Table 2: Continued.

Family name	Plant species	Voucher codes	Vernacular name	Parts used	Preparation mode	Administration mode	RFC (%)	Utilisation	Ethnomedicinal uses recorded in the literature inside Morocco	Pharmacological properties verified *in vivo* and/or *in vitro*
Verbenaceae	*Aloysia citrodora* Palau		Lwiza	Leaves	Infusion Decoction	Oral	42	Stomach ache Hypertension Diabetes	Sedative, hypertension, cold [40] Digestive, antiseptic, carminative, sedative, gastric lavage, calming, calefacient [19]	Antioxidant activity and antimicrobial properties [122]
Zingiberaceae	*Curcuma longa* L.		Lkharkoum	Roots	Powder	Basting	1	Pain Skin diseases	Dermatological, genitourinary, hepatic [32] Urinary-genital, mouth, breast, lung, digestive [123]	Antibacterial [124] Cytotoxic, antioxidant, and anti-inflammatory [125]
Zingiberaceae	*Zingiber officinale* Roscoe.		Skine jbir	Roots	Cooked powder	Oral	3	Cough	Aphrodisiac, cold, asthma, bronchitis, calefacient, depurative, analgesic, spice, digestive [19]	Antioxidant activity [126] Antibacterial [127]

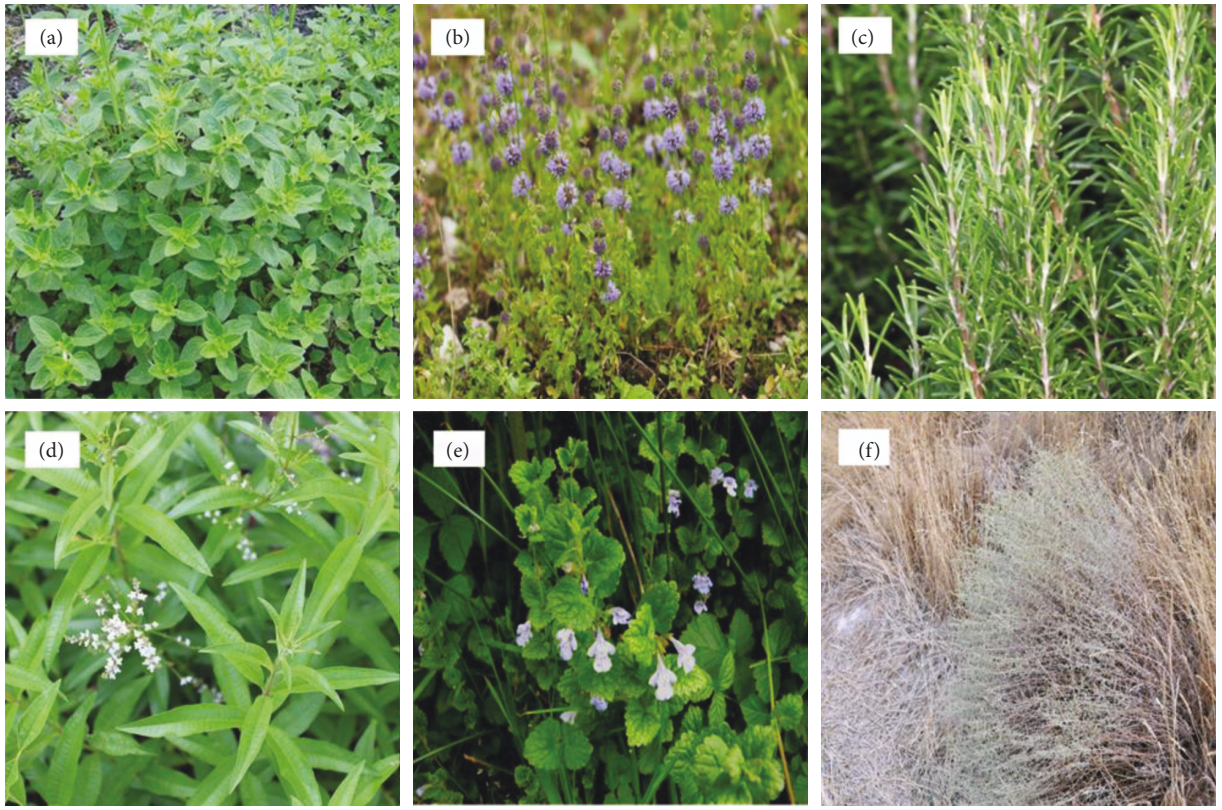

Figure 2: The pictures of (a) *Origanum compactum*, (b) *Mentha pulegium*, (c) *Rosmarinus officinalis L.*, (d) *Aloysia citrodora*, (e) *Calamintha officinalis* Moench, and (f) *Artemisia herba-alba* Asso.

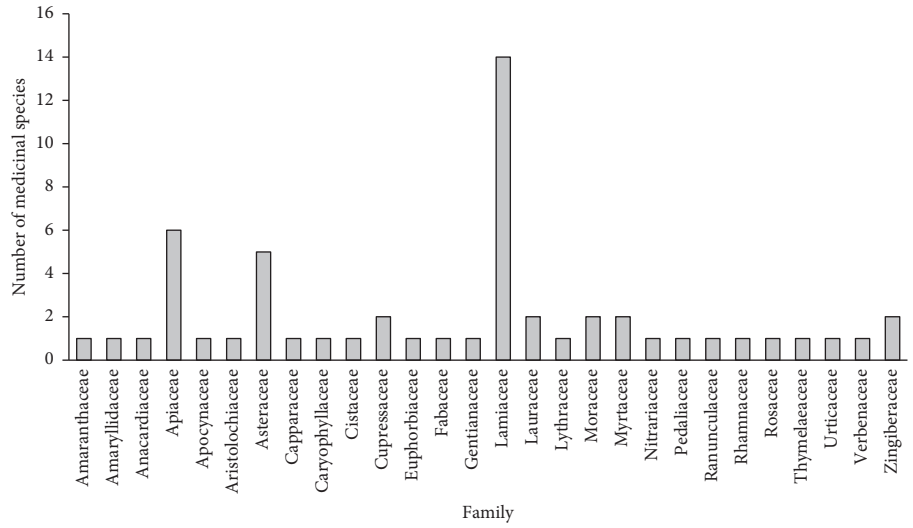

Figure 3: Number of species in each family mentioned by the respondents.

foenum-graecum, *Mentha suaveolens*, *Lavandula mairei*, and *Nigella sativa* were the most cited for their use in the traditional medicine in the study [19].

Results showed that 61% of the informants were illiterate, and their age was older than 40 years. These results are in agreement with other ethnobotanical studies carried out in Morocco [130] and Algeria [131]. The use of medicinal plants in traditional medicine is more widespread among illiterate people. These results are confirmed by other studies, which have shown that people with a lower level of education have more expertise in the uses of plants in traditional medicine [132, 133]. On the contrary, the results of this survey indicate the predominance of some plant families such as the Lamiaceae, the Apiaceae, and the Asteraceae. The

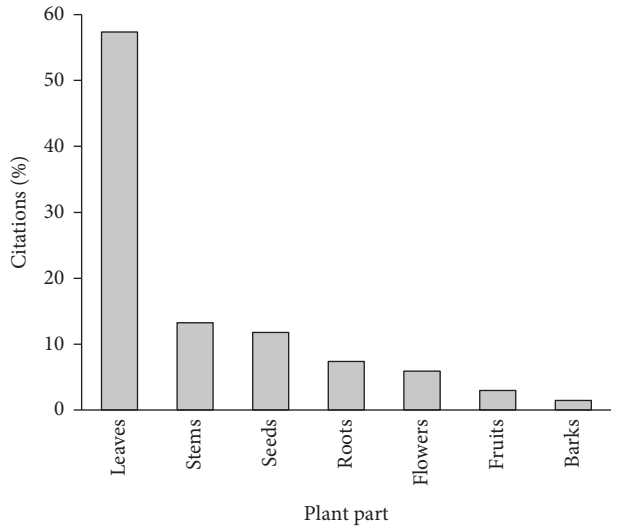

Figure 4: Frequency of different parts used.

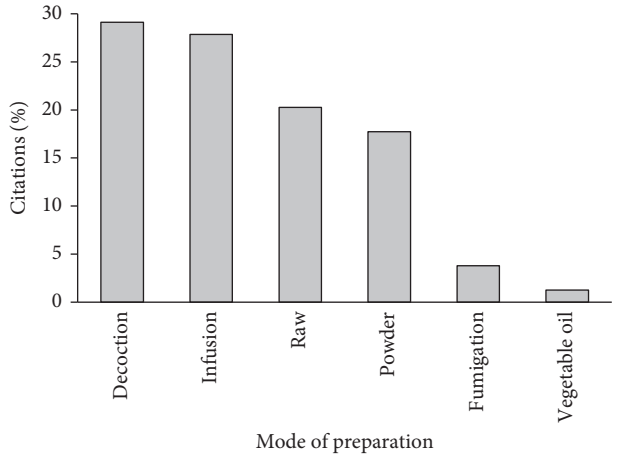

Figure 5: Frequency of different preparation methods.

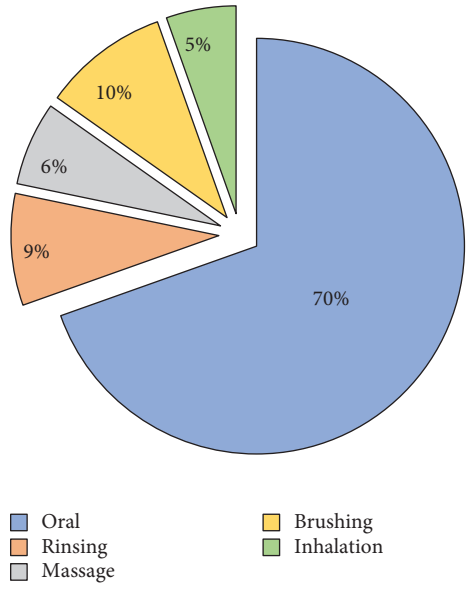

Figure 6: Frequency of the administration mode.

predominance of these families has already been observed in a study carried out in another African country [134] and another study carried out in southeast Morocco [19]. Furthermore, the most used species by the population of Taza province were *Origanum compactum* with the highest RFC (76%), followed by *Mentha pulegium*, *Rosmarinus officinalis*, *Aloysia citrodora Palau*, *Calamintha officinalis* Moench, and *Artemisia herba-alba* Asso., with RFC values of 72%, 60%, 42%, 40%, and 30%, respectively. The medicinal properties that these plants have were experimentally proven by several studies carried out *in vivo* and/or *in vitro* by [135–141]. The plants used mainly by the population of the Taza region are almost the same as those previously mentioned in Morocco [4, 7] and in Algeria [142].

The use of leaves in traditional medicine could be attributed to their availability, the simplicity of their harvest, and their richness in therapeutic substances [143]. On the contrary, decoction was the most used method of preparing medicinal plants (29.11%) followed by infusion (27.84%), the raw form (20.25%), the powder form (17.72%), fumigation (3.79%), and the vegetable oil form (1.26%). This observation is in agreement with other ethnobotanical studies [57], which indicate that the recipes were essentially prepared by decoction, about 67% of herbal preparations were in the liquid form, and water was the solvent of choice in the preparation of herbal recipes because it is abundant and easy to access. The vast majority of remedies were taken orally (70%); similar results have been obtained in other studies [7, 57].

5. Conclusion

This study showed that Taza region has a rich and varied patrimony of medicinal plant species used in the folk medicine to treat different diseases. In fact, the traditional recipes based on those plants must be validated and grouped into databases to become as a source for alternative therapeutic compounds, and their use must be conducted by safety and efficacy data, especially for herbalists and traditional healers. Nonetheless, chemical, pharmacological, and toxicological investigations in the medicinal plant area are required to determine and confirm their chemical composition and clinical uses to standardize their correct therapeutic doses.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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