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The modalities of use of medicinal flora in the province of Taza (Northern Morocco): Via an ethnobotanical and ethnopharmacological survey

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Abstract: An ethnobotanical survey was carried out between April 2019 and April 2020 to verify the modalities of use of medicinal flora in the province of Taza. The main objective of this study is to determine the modalities of the use of medicinal flora using a survey questionnaire and quantitative analysis. An updated catalog of plants used in the Taza region will be produced at the end of the analysis. In the population studied, 59% are women and 52% are illiterate. 75 taxa are identified and grouped into 42 families, of which Lamiaceae (FUV=0.083) and Cupressaceae (FUV=0.068) are the most frequent. Criterion of Preparation (CP), Criterion of Part Used (CPU), and Criterion of Administration (CA) were calculated. Leaves are the most used part (60%), and the preparation of remedies is essentially based on decoctions (49%), and administration is mainly done orally (77%). The highest UV value was obtained for Rosmarinus officinalis L. (0.184), and Origanum compactum Benth. (0.184) and Thymus zygis L. (0.177). These same species also present the highest RFC. The highest FL value was obtained for 64 taxa. The highest ICF value was obtained for urinary/urological disorders (0.839) and metabolic diseases (0.831). Seven categories of diseases are treated and PCA analysis showed that PC1 accounted for 80.92% of the total variation while PC2 presented 13.86%, and PC1 is strongly influenced by FC, RFC, UV, and UR, while FL influences PC2. These results are considered to be a very important source of information for the study area and may help to prevent the loss of traditional knowledge on the use of medicinal plants.

Keywords: *Ethnobotanical indices, Medicinal plants, Morocco, Survey, Taza province.*

1. Introduction

Many users of medicinal plants are generally unaware of the factors that cause the beneficial effects of traditional remedies [1]. Traditional medicinal knowledge is regularly applied by the local population and is transmitted over time, from generation to generation [2]. On the other hand, according to the World Health Organization, 80% of the world's population turns to medicinal plants to meet their primary health needs [3]. The use of medicinal plants in herbal medicine is experiencing remarkable growth and people are looking for "natural" medicines as a therapeutic method [4]. Plants have been used for centuries to treat human, animal, and plant diseases, as they contain valuable components with healing properties, their therapeutic properties come from multiple active substances called secondary metabolites that accumulate in various organs and some cases in specific plant cells [4]. In the case of aromatic and medicinal plants, the extracted secondary metabolites (phenols, polypeptides, triterpenoids, and alkaloids) are an effective defense against pathogenic parasites [5]. In

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this sense, plant resources represent an excellent opportunity to discover new chemical entities with a wide range of activities, such as antioxidants and antimicrobials. [6].

Morocco, with its geographical and climatic contrasts, has great vegetation richness. The flora's diversification and richness offer a fertile ground for practicing herbal medicine [7]. Indeed, based on a recent inventory, its flora includes 155 families, 981 genera, 3913 native species, 426 type subspecies (autonymous), and 872 additional subspecies [8].

For this, Moroccan populations have preserved a precious knowledge of traditional medicine [9]. Thus, the province of Taza which is located between the Rif and Middle Atlas mountain ranges, with a climate characterized by dry, overheated summers and cold winters with occasional precipitation and snowfall [10], presents a commendable wealth of scale of the kingdom [7, 9,11, 12,13,14,15, 16,17,18]. A new work has made it possible to construct a checklist of 202 medicinal plants used in the province of Taza [18] where 91 quantified medicinal species treat 14 groups of diseases [7]. Then, a Valorization and quantification of the qualitative knowledge of the new ethnobotanical knowledge characterizing the medicinal flora of the province of Taza (northern Morocco) was carried out [18]. Based on the indices obtained, provincial quantification studies have shown the importance of certain medicinal plants in the treatment of disease [7, 15, 18]. Criteria such as Criterion of Preparation (CP), Criterion of Part Used (CPU), and Criterion of Administration (CA) were calculated to facilitate the quantitative analysis of these qualitative characteristics [18]. To study the features that characterize the vegetation of the Province of Taza, especially regarding medicinal plants used to treat illnesses [7, 9, 11, 12, 13, 14, 15].

The present study was carried out to update the list of the local medicinal flora and, above all, to elucidate the methods of preparation of these traditional remedies, based either on local plants or on plant material imported into the study area, focusing on 12 different sites and/or localities in the province of Taza, some of which had not been explored before. At the same time, there will be a comparison of the patterns of use that we have identified with those of previous studies [7, 9, 11, 12, 13, 14, 15, 17, 18]. The use of ethnobotanical indices is crucial for the quantification and analysis of knowledge related to plant use, including socio-demographic data, methods of preparation, methods of administration, and diseases treated.

2. Materials and Methods

2.1. Study Area

The province of Taza was officially created as a province on 13 October 1952. Although it is geographically located in the northeast of Morocco, it is also part of the Fez-Meknes region. This province has an area of 7098.50 km2, with 34 rural communes and 04 urban communes [10]. Regarding geomorphology, Taza province is characterized by heterogeneity [19]. The relief is a highly diversified mosaic zone, dominated by mountainous terrain, varying in altitude from 184 to 3010 m (Figure 1). It is characterized by its diversity and richness in terms of the natural environment [20]. Indeed, the region sounds like a great place to visit, especially with its warm and pleasant Mediterranean climate. It's interesting to know that the Tazekka National Park, which is located not too far away from Taza, is home to many medicinal plants. It would be fascinating to explore the park and learn more about these plants. In addition, the region is characterized by its warm, Mediterranean climate, changing from cool winters to hot days in the summer months. Located around 20 km southwest of Taza, we find the Tazekka National Park, covering 580 ha and containing various medicinal plants [12]. According to the population and housing census of September 1994, the legal population of the province of Taza is 708,025 inhabitants [20]. It is divided into 206,181 urban inhabitants and 501,844 rural inhabitants [20]. The present research presents an ethnobotanical study carried out in 12 localities of Taza province (Figure 1), including three urbans: Taza, Tahla, and Oued Amlil, and also 9 rural: bab boudir, Beni ftah, Bab Marzouka, Galdamane, Meknassa charqia, Had Msila, Ras El ma, Had oulad zbayer, and Sabt boukelal, using a face-to-face questionnaire. This survey was carried out in the province of Taza between the period of April 2019 and April 2020, it was carried out among herbalists and the population. The different sites of this survey in the province are distributed in (Figure 1) with the percentage of each area. In the region of Taza, the climate is warm and temperate. The winter is

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characterized by much higher precipitation than the summer. In Taza, the average annual rainfall is 563 mm [21].In addition, it is dominated in summer by a hot wind from the east or southeast, while in winter; the moist westerly wind is responsible for most of the precipitation recorded in the region [22].

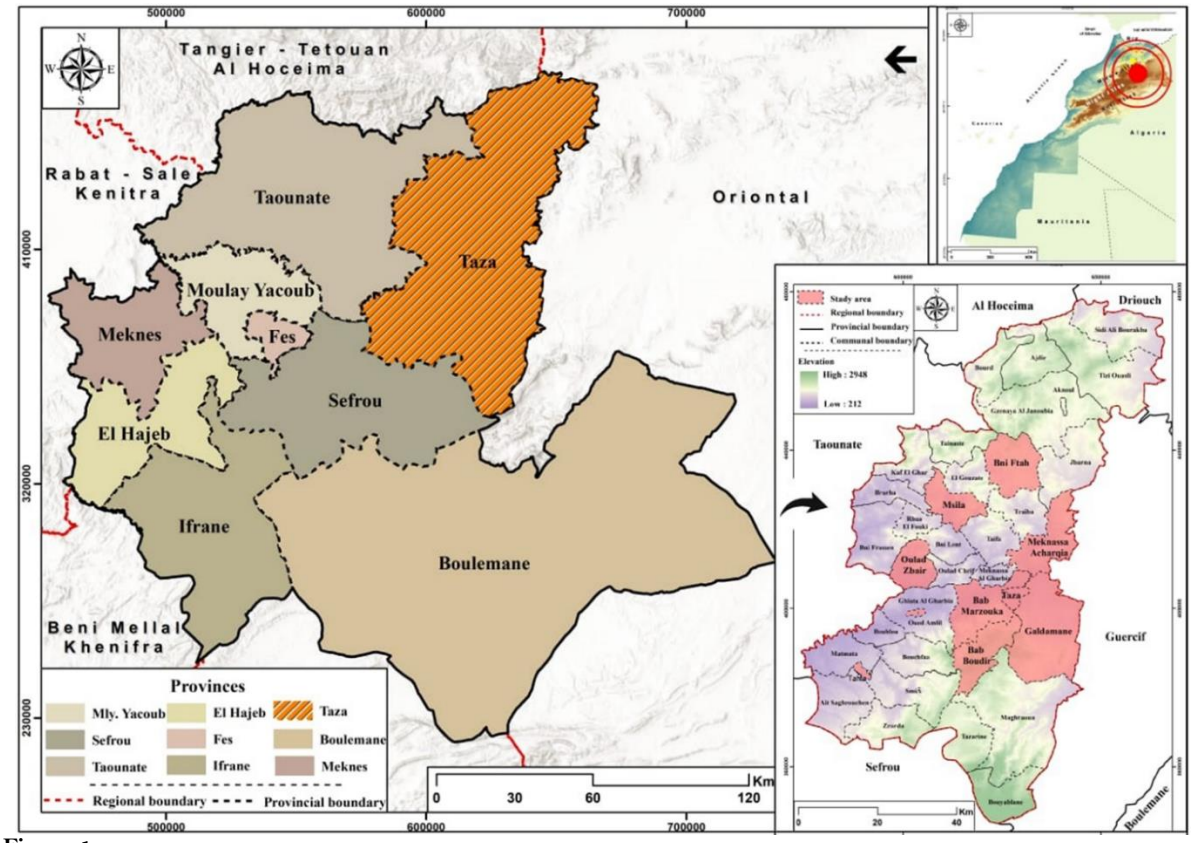

Figure 1.
Located stations in the province of TAZA (prepared using ArcGIS software 10.3.1).

2.2. Ethnobotanical Survey

The local population studied was directly questioned about the different traditional medicinal uses of plants. The survey was carried out using a questionnaire, to obtain a detailed ethnobotanical directory for the 12 sites in the province of Taza. The survey sample was randomly selected to ensure accuracy and objectivity. In the first phase of this study, a preliminary survey was carried out without a questionnaire to become familiar with the field and the local language. In conversations with local people, the aim was to gain fundamental knowledge about the therapeutic uses of medicinal plants and the methods of use of different types of plant material. During the second part of the survey, participants were presented with a comprehensive questionnaire during individual field interviews. This questionnaire was pre-established at the Ecology Unit, Department of Plant Protection and the Environment (Plant unit), National School of Agriculture of Meknes, Morocco, and consisted of three distinct parts. The first section aimed to collect information about the participant's background, including details such as age, gender, education level, and family situation. The second section was designed to collect information about the plant and its local applications, including the local vernacular name, collection period, and parts used. The third section of the survey was structured specifically to collect data on participants' methods of preparation and therapeutic administration, including dosage details. Finally, under the supervision of Professor Ghizlane Echchgadda of the Department of Ecology (plant unit), National School of Agriculture of Meknès, a list of medicinal plants used in the province of Taza has been identified and drawn up.

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2.3. Plant Species Identification and Preservation

At the same time, plant samples were collected. Herbarium plates were also made at the sites where the plants were collected. The taxonomy and identification of plant species were carried out for certain taxa in the field, and others at the Ecology Unit, Department of Plant Protection and the Environment (Plant Unit), National School of Agriculture of Meknes by the Botanist Pr. Ghizlane Echchgadda at the Ecology Unit, Department of Plant Protection and the Environment (Plant Unit), National School of Agriculture of Meknes from using the specialized literature **[23, 24, 25].** The scientific names of the plants were verified according to the "African Plant Database" **[26]**, and "World Flora Online" **[27]**.

Data processing of the present work was first classified in the Microsoft Excel database. Secondly, one-way analysis of variance (ANOVA) was performed to analyze the socio-demographic data of patients and determine whether there were any significant variations between the means (p values ≤0.05 were considered statistically significant). Using IBM SPSS Statistics 25 software, data were entered, processed, and quantitatively analyzed by calculating ethnobotanical indices using simple determination methods. The graphs were created in Excel software version 2013. Finally, based on the ethnobotanical indices, a principal component analysis (PCA) was performed using XLSTAT statistics software version 2016. The map of the study area was produced using ArcGIS software 10.3.1.

2.4. Quantitative Data Analysis

To discuss the results of this study and to indicate their novelty value in other ethnobotanical studies, the Criterion of Preparation (CP), Criterion of Part Used (CPU), and Criterion of Administration (CA) were calculated. Also, several quantitative ethnobotanical indices were used: Use Value (UV), the Relative Frequency of Citation (RFC), the Family importance value (FIV), Family importance value (FIV), the level of fidelity (FL), Plant part value (VPP) and the Informant Consensus Factor (ICF).

2.4.1. The Criterion of Preparation (CP)

The preparation criterion (strictly greater than 1) is the number of preparation methods (infusion, decoction, maceration, etc.) that a specific medicinal plant can present [18]. This criterion indicates the diversity of ways a medicinal plant can be transformed for use [18].

2.4.2. The criterion of Part Used (CPU)

The criterion of parts used (strictly greater than 1) represents the number of parts (leaves, stalks, fruit, etc.) of a specific medicinal plant used [18]. This criterion highlights the diversity of plant parts used for medicinal purposes.

2.4.3. The Criterion of Administration (CA)

The criterion of administration (strictly greater than 1) lists the different ways of administering a medicinal plant and represents the number of modes of administration (oral or other) that a specific herb exhibits during its use [18].

2.4.4. Relative Frequency of Citation (RFC)

Relative Frequency of Citation (RFC), the Local importance of each plant species was calculated based on the following reference **[28]**:

$$RFC = F_C / N \quad (1)$$

Where Fc is the number of informants who mentioned the use of the species, and N is the total number of informants (N).

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2.4.5. Use Value (UV)

The use value of species (UV), a quantitative method that demonstrates the relative importance of species known locally, was calculated according to the following formula used by Vitalini, *et al.* [29]:

$$UV = \frac{\sum U_i}{N} \quad (2)$$

Where U_i is the number of use reports mentioned by each informant i and N is the total number of informants interviewed for a given plant species.

2.4.6. Family Importance Value (FIV)

FIV represents the relative importance of families. This value is used to determine the biological taxonomic value of plants, which is obtained by dividing the number of respondents who declared the family (FC_{family}) by the number of species within each family (N_S), according to Sreekeesoon and Mahomoodally [30]:

$$FIV = FC_{family} / N_S \quad (3)$$

2.4.7. Family Use Value (FUV)

The FUV identifies the significance of plant families. It is an index of cultural importance that can be applied in ethnobotany to calculate the value of biological plant taxons. The FUV was calculated according to the following formula, already used by Friedman, *et al.* [31]:

$$FUV = \frac{UV_s}{N_s} \quad (4)$$

Where UV_s=UV is the number of informants mentioning the family and N_s is the total number of species within each family.

2.4.8. Fidelity Level (FL)

Fidelity level (FL) is the percentage of informants who mentioned the uses of certain plant species to treat a particular ailment in the study area. The FL index is calculated using the formula used by Sreekeesoon and Mahomoodally [30]:

$$FL(\%) = \frac{I_p}{I_u} x100 \quad (5)$$

Where I_p is the number of informants who independently indicated the use of a species for the same major ailment and I_u is the total number of informants who mentioned the plant for any major ailment.

2.4.9. Value of Plant Part Used (VPP)

The value of the plant part used (VPP) was calculated using the following formula, according to Gomez-Beloz [32]:

$$VPP = \frac{RU_{Plant\_part}}{RU} \quad (6)$$

RU is the number of uses reported of all parts of the plant and RU_{Plant_part} is the sum of uses reported per part of the plant, the part with the highest VPP is the most used by the respondents.

Informant Consensus Factor (ICF)

The ICF for each use category was calculated using the following formula by Heinrich, *et al.* [33]:

$$ICF = \frac{N_{ur} - N_t}{N_{ur} - 1} \quad (7)$$

Where ICF is the Informant Consensus Factor, N_{ur} is the number of mentions in each category and N_t is the number of taxa used in each category. The values for the factor range from 0 to 1.

3. Results and Discussion

3.1. Demographic Characteristics of Informants

The results of this study show that women are more likely than men to use medicinal plants for health care, with a frequency of 59% versus 41% (Table 1). This is similar to other studies conducted in the same province [11, 15]. This difference between the two groups can be explained by the fact that

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women are responsible for domestic activities (preparing food and taking care of sick family members). On the other hand, men are more responsible for harvesting or buying plants. These results are in line with other Moroccan ethnobotanical studies **[34, 35, 36].**

Based on the data presented in Table 1 and Figure 2, those aged 40-59 are the most likely to use medicinal plants (55%), followed by those aged 60 and above. The present study also shows that those aged under 25 and 26-39 years represent 29% and 12% respectively for using medicinal plants (P=0.001). These percentages show that the use of medicinal plants for the treatment of diseases requires the use of older people. This is because they have more knowledge about medicinal plants than other age groups. This is an indication that this type of knowledge is acquired after a long accumulation of experience. The main source of local information on the use of plants in traditional medicine is the experience accumulated over time **[37].** There is also a loss of information about medicinal plants. This can be explained by the distrust of certain people, especially young people, who tend to no longer believe in this traditional medicine. These findings confirm those of Benlamdini, *et al.* [38] and El Hafian, *et al.* [39].

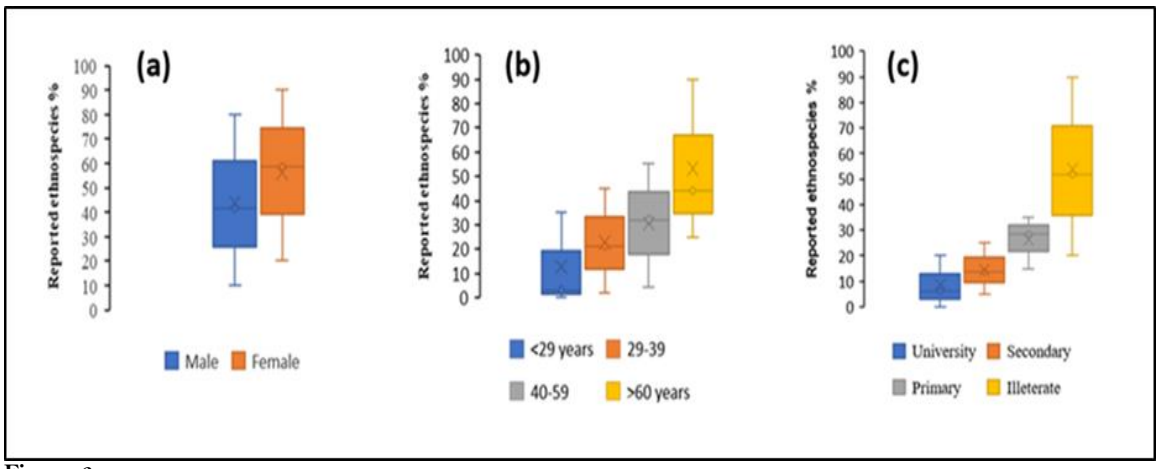

Figure 2.
Number of reported ethnospecies variations according to (a) gender; (b) age; and (c) education level.

In the current study (Table 1), married people had the highest use of medicinal plants, at 90%, while single people had the lowest, at 10% *(*P = 0.001*)*. Compared to other research, the results obtained are similar to those of Boulfia, *et al.* [9]; El Brahmi, *et al.* [15] and Jeddi, *et al.* [40]. This result seems obvious, since for married people, it means they can avoid or reduce the costs of material expenses incurred by the doctor and pharmacist.

The educational levels of the population studied are as follows: 29% at the primary level, 14% at the secondary level, and 6% at the university level, while 52% were illiterate. At the Moroccan scale, these results align with those obtained for Mechraâ Bel Ksiri [41] and are different from those obtained by another study in Taza [9]. The low percentage of use of medicinal plants by people with secondary and/or university education can be explained by the fact that they are aware of the danger of excessive use of plants in terms of dose toxicity. On the other hand, most surveys were carried out in rural areas where populations have a low level of education. The type of medicine practiced is predominantly traditional (79%) (Table 1). This shows that the Tazi population has a strong relationship with traditional remedies based on medicinal plants for healing, as reported in other works [7, 9, 11, 12, 13, 15].

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Table 1.
Sociodemographic profile of the informants in the study area.

Characters	Variables	Number of used ethnospecies (%)	Numbers of informants (%)	*p-value*
Age groups	<29 years	2 (3%)	3(2%)	0.001 ***
	29-39	16 (21%)	19(12%)	
	40-59	24 (32%)	81(55%)	
	>60 years	33 (44%)	44(29%)	
Sex	Female	49(65%)	86(58%)	0.001 ***
	Male	26(35%)	61(41%)	
Family situation	Married	57(76%)	133(90%)	0.001***
	Single	18(24%)	14(10%)	
Educational level	Illiterate	34(45%)	76(51%)	0.01**
	Primary	24(32%)	42(28%)	
	Secondary	12(16%)	20(13%)	
	University	5(5%)	9(9%)	
Type of medicine practiced	Traditional	5(75%)	117(79%)	0.05 *
	Modern medicine	8(11%)	7(5%)	
	Traditional and modern medicine	11(15%)	23(16%)	

Note: Significant at $p < 0.05$ probability level; **Significant at $p < 0.01$ probability level; ***Significant at $p < 0.001$ probability level.

3.2. Medicinal Taxa Used, Botanical Families, and Ethnobotanical Indices

Based on 147 interviews carried out in the study area, an ethnofloristic catalog was developed (Table 4). A total of 75 medicinal taxa grouped into 42 families were identified. The plant material of these taxa is either collected directly by users in nature or purchased from herbalists or traditional healers. Thus, for the treatment of diseases, the local population uses this medicinal flora belonging to 42 families.

The most represented families are Lamiaceae (18 species), Asteraceae (5 species), Fabaceae (5 species), Myrtaceae (3 species), and Cistaceae (3 species). Indeed, several national studies have shown that the flora used for traditional medicine is generally dominated by Lamiaceae, Asteraceae, and Fabaceae, here are some examples: Mehdioui and Kahouadji **[34];** Khabbach, et al. **[11];** Bouharb, et al. **[42]** and Ghabbour, et al. **[18].** The medicinal flora of the province shows that *Thymus zygis* L. (Zaitra), *Rosmarinnus officinalis* L. (Azir), *Origanum compactum* Benth. (Zaâtar), *Calamintha menthifolia* Host L. (Manta), *Salvia officinalis* L. (Salmiya) and *Mentha suaveolens* Ehrh. (Mchichtro) are the medicinal plants most appreciated by users according to the data obtained from UV in Table 4. These results are in agreement with those obtained for the Pre-Rif of Taza **[11]**. Table 4 gives the scientific name of each plant, its family, its local name, the part used, the preparation method adopted by local people, as well as the FUV, UR, UV, and FL data. In addition, of the 75 species listed in Table 4, two plants mentioned by the interviewers were imported from other locations. These were *Aucklandia costus* Falc. imported from the Himalayas **[43]** and *Hyoscyamus muticus* L. imported from Egypt **[44]**.

3.3. The Most Used Families, Their Family Use Value (FUV) And Family Importance Value (FIV)

Based on the number of taxa recorded in each family (Table 4). The botanical families most represented in the study area are Lamiaceae (18 taxa), Asteraceae and Fabaceae (5 taxa for each of them), Myrtaceae (3 taxa), Cistaceae, and Oleaceae (2 taxa for each of them), while the other families were represented by a single species. Thus, the families that present the highest citation frequency are those of Lamiaceae (198 citations) followed by the Asteraceae (64 citations) (Table 4). The Lamiaceae family is also the most frequently cited family in other works carried out in Taza **[15, 18],** which demonstrates the importance of this family in medicinal use. Concerning the FUV index, the FUV values of the 5 most used families, according to Table 4 are the Lamiaceae (0.082), the Cupressaceae

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(0.068), the Asteraceae (0.066), the Verbenaceae (0.054), the Aristolochiaceae (0.048) and Euphorbiaceae (0.04). Regarding the FIV index, the families Aristolochiaceae, Plumbaginaceae, and Lamiaceae are the most represented, with the following values respectively: 22, 20, and 14.14.

In comparison with the study by El Brahimi, *et al.* **[15],** the results of the UV and FIV analyses in this study show a significant difference. The high consumption of medicinal plants in this region (the habits of the population studied) may explain these results. On the other hand, a strong presentation of families in the plant flora studied can be explained by the ecological factors of the study area which favor the development and adaptation of species belonging to these families. These results contribute to the conservation and sustainable management of plant resources. These families show their cultural importance by providing insight into the potential impact of their use on local biodiversity. These results complement recent work in Taza province **[7, 18]** by guiding conservation efforts and supporting the development of sustainable practices for ecological preservation.

3.4. Frequency of Citation (FC) and Relative Frequency of Citation (RFC)

The taxa with the highest citation frequency (Table 4) are *Rosmarinus officinalis* L. (32), *Thymus zygis* L. (32), *Calamintha menthifolia* Host (29), *Origanum compactum* Benth. (28), and *Dittrichia viscosa* (L.) Greuter (25). These species also have the highest relative citation frequency (Table 4) with *Rosmarinus officinalis* L. (0.22), *Thymus zygis* L. (0.22), *Calamintha menthifolia* Host (0.20), *Origanum compactum* Benth. (0.19) and *Dittrichia viscosa* (L.) Greuter (0.19). In the work of Ghabbour, et al. **[7]** the highest RFC was noted for *Olea europaea* L. (RFC=0.294), while *Origanum compactum* Benth and *Rosmarinus officinalis* L. have respectively (RFC=0.132) and (RFC=0.126). While, *Origanum compactum* Benth., and *Thymus zygis* L. were also ranked among the top three in terms of RFC **[15].**

3.5. Diversity Of Medicinal Plants and Their Values UV

The use value is used to assess the relative importance of the reported medicinal plants. The taxa with the highest UV index were reported by a large number of informants. The UV results (Table 4) showed a variation between 0.007 and 0.184. While the use value varied between 0.003 and 0.606 **[7]**. *Rosmarinus officinalis* L. and *Origanum compactum* Benth. had the highest UV (0.184), followed by *Thymus zygis* L. (0.177), *Calamintha menthifolia Host* (0.163), *Dittrichia viscosa* (L.) Greuter (0.130) and *Salvia Officinalis* L. (0.109).These UVs obtained are lower than those noted by Ghabbour, et al. **[7]** where the UVs of *Salvia officinalis* L., *Trigonella foenum-graecum* L., and *Rosmarinus officinalis* L. being the most important, with respectively the following UVs: 0.606, 0.453, and 0.444.

The UVs raised here (Table 4) clearly show the important place of these taxa in popular culture and the heritage knowledge of the local population **[7, 15]**. Medicinal plant taxa with high UV should be further evaluated through phytochemical and pharmaceutical analyses. These taxa should also be prioritized for conservation, as their preferred uses may threaten their populations through over-exploitation.

3.6. Fidelity Level Index (FL)

The FL precision value (Table 4) is an important way of determining which disease a particular species is most effective against. In the present study, the FL of the plant taxa varied between 16 % and 100 %, while they varied between 28.48 % and 100 % **[7]**. The results also showed that 64 medicinal taxa had an FL of 100% for specific medicinal use. These results show the great fidelity of the taxa in their specific medicinal use within the Taza population. Hence, the proposal of a specific "plant-disease" relationship is based on a better healing potential, whose FL evaluates in particular the specific efficacy of a species for the treatment of disease **[7]**.

3.7. Categories of Pathologies and Their Informant Consensus Factor (ICF)

The categories of diseases are treated by several species (Table 2), and the results obtained show that the diseases of the digestive system (36 taxa), respiratory system (19 taxa), skin (18 taxa), and metabolic diseases (16 taxa) are the most represented. These results agree with previous studies **[7, 15],** where digestive diseases are the most represented (19.68% and 23.66%). In addition, the most

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represented categories are diseases of the digestive system (67 taxa - 23.66%), endocrine, nutritional and metabolic diseases (63 taxa - 33.89%), diseases of the circulatory system (39 taxa - 10.14%), and certain infectious and parasitic diseases (37 taxa - 9.57%) [7].

This research on treatment with medicinal taxa suggests the need for ethnopharmacological studies to establish this relationship between diseases and the taxa used in their treatment. The ICF is an index for specific pathologies. It is calculated from medicinal plants specifically used for their treatment. In this study, the ICF values (Table 2) varied from 0.706 to 0.839 depending on the categories of use while they varied from 0 to 0.92 [7]. The category with the highest degree was urinary/urological disorders (ICF = 0.839), followed by metabolic diseases (ICF = 0.831), respiratory diseases (ICF = 0.778), nervous system diseases (ICF = 0.775), and digestive system diseases (ICF = 0.750).

Comparing the results of the present study with those of Ghabbour, *et al.* [7], whose category of endocrine, nutritional and metabolic diseases has the highest ICF (0.92), followed by the category of diseases of the digestive system (0.88), the category of certain infectious diseases and parasitic diseases and the category of diseases of the circulatory system (0.83 each). In addition, this level of ICF indicates the appropriate reliability of the informants about the consumption of the various species of medicinal plants In the area studied and shows that the people of Taza share their knowledge on the principal species of medicinal plants for the treatment of the major illnesses present in the region. The survey conducted in Taza Province further supports the findings of Ghabbour, *et al.* [7] on the correlation between the consumption of medicinal plants with the diseases treated by these species in this region.

Table 2.
Informant Consensus Factor (ICF) values by categories for treating various diseases.

Categories	List of plant species used (we have the number of uses)	Nt	Nur	ICF
Digestive system	*Ajuga iva* (L.) Schreb. (3), *Arbutus unedo* L. (1), *Artemisia herba-alba* Asso (2), *Calamintha menthifolia* Host. (2), *Centaurium erythraea* Rafn (1), *Ceratonia siliqua* L. (1), *Dysphania ambrosioides* (L.) Mosyakin & Clemants (3) *Cistus ladanifer* L. (2), *Cistus salviifolius* L.(2), *Corrigiola telephiifolia* Pourr. (4), *Dittrichia viscosa* (L.) Greuter (17), *Globularia alypum* L. (3), *Juncus acutus* L. (1), *Lepidium sativum* L. (1), *Linum usitatissimum* L. (2), *Marrubium vulgare* L. (6), *Nerium oleander* L. (2), *Thymus zygis* L. (4), *Origanum majorana* L. (1), *Origanum compactum* Benth. (27), *Pelargonium odoratissimum* (L.) L'Hér. (2), *Phillyrea latifolia* L. (1), *Pimpinella anisum* L. (1), *Pinus halepensis* Mill. (1), *Piper cubeba* L. f. (2), *Pistacia lentiscus* L. (4), *Punica granatum* L. (6), *Quercus suber* L. (2), *Rosmarinus officinalis* L. (25), *Salvia officinalis* L. (3), *Silene vulgaris* (Moench) Garcke. (1), *Tetraclinis articulata* (Vahl) Mast. (2), *Thymelaea lanuginosa* (Lam.) Ceballos & C. Vicioso (2), *Fumana scoparia* Pomel (1), *Trigonella foenum-graecum* L. (1), *Ziziphus jujuba* Mill. (3).	36	141	0.750
Respiratory system	*Aloysia citrodora* Palau (1), *Arbutus unedo* L. (1), *Calamintha menthifolia Host.* (24), *Dittrichia viscosa* (L.) Greuter (3), *Eucalyptus globulus* Labill. (5), *Lavandula multifida* L. (1), *Lavandula stoechas* L.(6), *Lepidium sativum* L. (1), *Marrubium vulgare* L. (5), *Mentha pulegium* L. (7), *Mentha suaveolens* Ehrh. (4), *Opuntia ficus-indica* (L.) Mill. (2), *Thymus zygis* L. (1), *Origanum majorana* L. (2), *Pelargonium odoratissimum* (L.) L'Hér. (6), *Phillyrea latifolia* L. (2), *Rosmarinus officinalis* L. (6), *Salvia verbenaca* L. (1). *Fumana scoparia* Pomel (4).	19	82	0.778

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Urinary system	*Chamaemelum fuscatum* (Brot.) Vasc. (9), *Euphorbia resinifera* O.Berg (6), *Herniaria hirsuta* L. (4), *Opuntia ficus-indica* (L.) Mill. (1), *Teucrium polium* L. subsp. polium (3), *Ziziphus lotus* (L.) Lam. (1)	6	32	0.839
Metabolic diseases	*Ajuga iva* (L.) Schreb. (1), *Aristolochia fontanesii* Boiss. & Reut. (7), *Artemisia herba-alba* Asso (2), *Capparis spinosa* L. (4), *Centaurium erythraea* Rafn (3), *Globularia alypum* L. (1), *Marrubium vulgare* L. (7), *Olea europaea* L. *(1)*, *Opuntia ficus-indica* (L.) Mill. (1), *Thymus zygis* L. (23), *Origanum majorana* L. (8), *Peganum harmala* L. (2), *Salvia officinalis* L. (12), *Salvia verbenaca* L. (1), *Aucklandia costus* Falc. (1), *Tamarix africana* Poir. (1).	16	90	0.831
Skin	*Agave americana* L. (2), *Anthyllis cytisoides* L. (1), *Chamaemelum fuscatum* (Brot.) Vasc. (2), *Daphne gnidium* L. (5), *Dittrichia viscosa* (L.) Greuter (5), *Hyoscyamus muticus* L. (4), *Juglans regia* L.(1), *Lavandula multifida* L. (7), *Myrtus communis* L. (2), *Ononis natrix* L. (1), *Pistacia lentiscus* L. (4), *Plantago major* L. (1), *Plumbago europaea* L. (9), *Ruta montana* (L.) L. (4), *Selaginella* P. Beauv. (2), *Syzygium aromaticum* (L.) Merr. & L.M. Perry (1), *Urtica dioica* L. (1), *Ziziphus lotus* (L.) Lam. (1).	18	63	0.726
Nervous system	*Aloysia citrodora* Palau (8), *Ammoides pusilla* (Brot.) Breistr. (2), *Artemisia herba-alba* Asso (12), *Chamaemelum fuscatum* (Brot.) Vasc. (4), *Crataegus monogyna* Jacq. *(1)*, *Glycyrrhiza glabra* L. (2, *Myrtus communis* L. (1), *Piper cubeba* L. f. (1), *Syzygium aromaticum* (L.) Merr. & L.M. Perry (3), *Vogtia annua (L.)* Oberpr. & Sonboli (7).	10	41	0.775
Skeletal and muscular system	*Capparis spinosa* L. (2), *Clematis flammula* L. (1), *Nigella sativa* L. (2), *Thymus zygis* L. (2), *Tetraclinis articulata* (Vahl) Mast. (10).	6	18	0.706

NT is the Number of uses for categories of diseases and Nur is the number of plants used for a specific ailment by all informants.

3.8. The Value of the Plant Part Used (VPP)

The population of Taza province harvests different parts of the plant (seed, root, flower, fruit, leaf, and whole plant) to prepare traditional remedies. The results obtained (Figure 3 and Table 4) showed that the highest criterion of used part (CPU=4) is used for the species *Dittrichia viscosa* (L.) Greuter, and that the leaf was reported as the most used part with a VPP of around 0.601, followed by the aerial part, leaf and stem, root, seed, fruit, bark, flower and lastly stem with VPP values in the following order: 0.169, 0.069, 0.045, 0.052, 0.023, 0.019, 0.008, 0.004.

Similar results indicated that the leaf was the most used plant part in the province of Taza (Morocco) **[9]**, and even outside Morocco **[45, 46]**. The leaves are mainly used for their availability, ease of harvesting, and simplicity in preparing remedies. In addition, the leaves are the site of photosynthesis and sometimes the storage of secondary metabolites responsible for the biological properties of the plant. In another study **[18]**, two plant species, *Anethum foeniculum* L. and *Petroselinum crispum* (Mill.) Fuss. had the highest used part criterion (CPU=4), and this result agrees with the present study.

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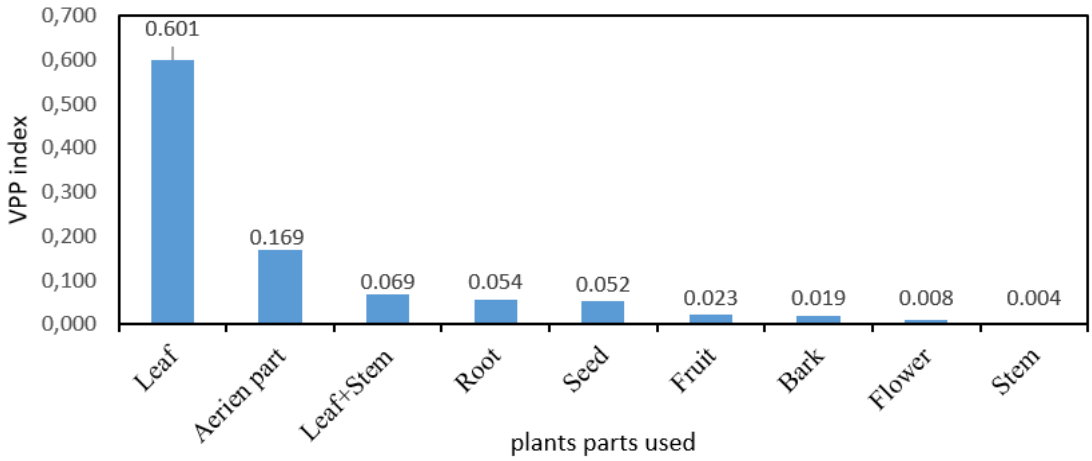

Figure 3.
The value of the plant part used.

3.9. Methods of Remedy Preparations

The results obtained for the method of preparation of the plant part used (Figure 4) showed that decoction is the most frequent method of preparation with a percentage of 49%, followed by preparation in powder form (29%), by infusion (16%), by extraction (5%) and by maceration (1%). In addition, Table 4 shows that the highest criterion of preparation (CP=3) is used for the species *Lavandula multifida* L. On the other hand, Ghabbour, *et al.* [18] show that the highest preparation criterion observed of two plant species of *Euphorbia resinifera* O.Berg and *Trigonella foenum-graecum* L. is CP = 5.

The best use of a plant would be one that guarantees all its properties while allowing the extraction and assimilation of the active ingredients. In addition, medicinal plants have undesirable effects when misused by the population. Furthermore, the results showed that most recipes are prepared either by a single plant with a percentage of 65% or with a collection of plants in combination with other materials at 35%. Indeed, the type of medicinal remedy generally depends on the nature of the pathologies treated by the local population. The results mentioned are similar to those obtained by Kachmar, *et al.* [13] and El Brahmi, *et al.* [15], particularly concerning the most used method of preparation (decoction).

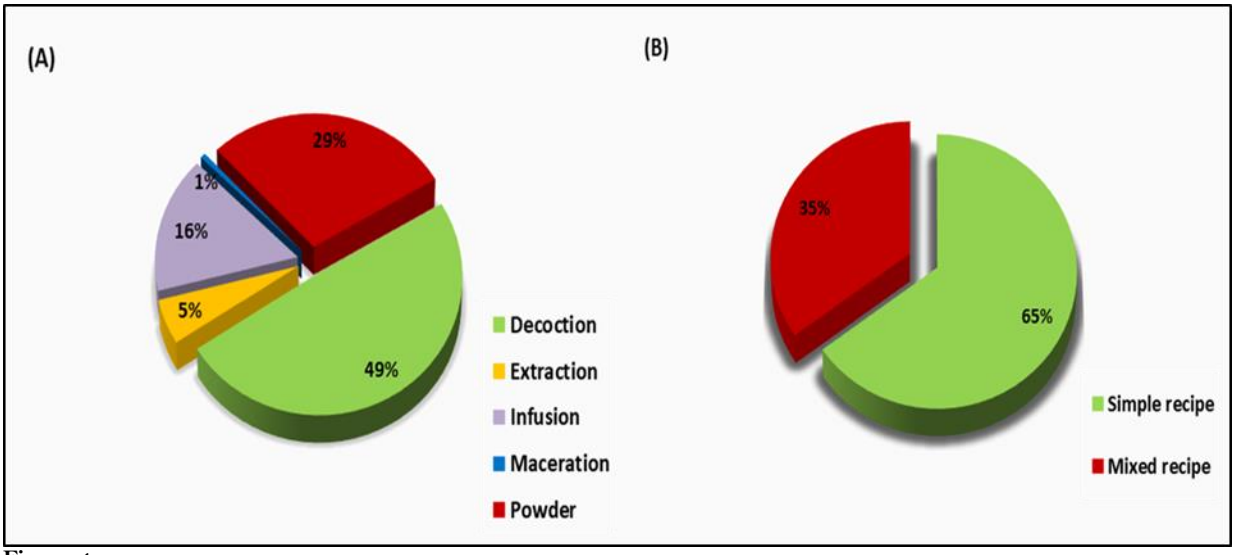

Figure 4.
Distribution of the various preparations of medicinal plants according to the mode of preparation **(A)** and the type of the recipe **(B)**.

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3.10. Administration Mode

Concerning the mode of administration, Table 4 shows that the highest criterion of administration (CA=3) is used for two species *Chamaemelum fuscatum* (Brot.) Vasc. And *Vogtia annua (L.)* Oberpr. & Sonboli. In further analysis, Ghabbour, *et al.* [18] found that 20 plant species had the highest administration criterion (AC=2). In addition, Figure 5 shows that oral ingestion is the most used mode with a percentage of 77%, a result similar to that obtained by El Brahmi, *et al.* [15] carried out in other municipalities in the province of Taza, followed by infusion (16%), local applications (6%), gargling, chewing and other methods with a percentage less than 2%. Also, the majority of interviewers showed that medicinal plants are used in random and indeterminate doses due to a lack of education, which subsequently results in health problems that can lead to toxicity. In addition, some plants are not recommended for pregnant women. Therefore, it is necessary to educate the provincial authorities. Most people don't know the seriousness of the side effects of most medicinal plants.

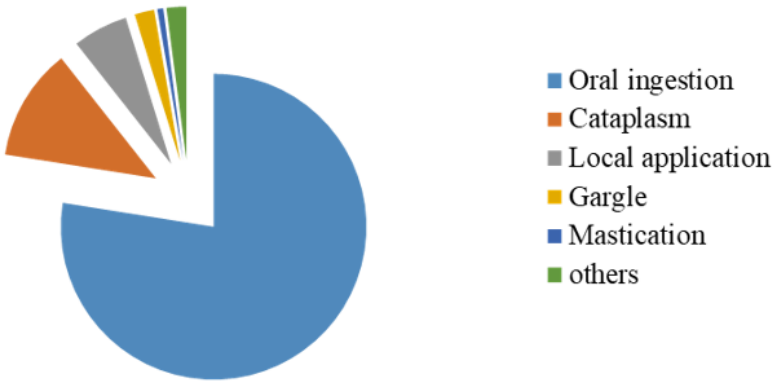

Figure 5.
Distribution of frequency of medicinal plants used by mode of administration.

3.11. The Modalities of Used and Comparative Evaluation of the Medicinal Plants Most Frequently Inventoried in the Province of Taza as Used for Traditional Purposes

Based on the results presented in Table 3, it is evident that the utilization of medicinal plants varies substantially depending on the population being studied and the intended therapeutic use. Among the different methods of use, decoction is most commonly employed, followed by infusion and powder. After conducting an in-depth analysis, we can conclude that this field requires further extensive research to understand all the modalities being used by the population under study, including preparation, administration, and extraction.

According to a comparative study of the modalities of use of medicinal plants in the province of Taza by researchers (Table 3), there is an interesting diversity of modalities (decoction, infusion, cataplasm, or in the form of essential oil). For the *Artemisia herba-alba* Asso plant, the infusion mode was the first to be declared by the researchers in the present study, while other studies found that decoction was the most widely used mode for this plant. Regarding the following plants: *Chamaemelum fuscatum* (Brot.) Vasc, *Herniaria hirsuta* L. *Dittrichia viscosa* (L.) Greuter and *Lavandula multifida* L. can be used either as a decoction or in powder form [11, 13, 15]. In addition, the second difference is in the use of the *Pistacia lentiscus* L. plant. In the present research, this plant can be used in powder form; while Kachmar, *et al.* [13] have found that it can be used as a fumigant. El Brahmi, *et al.* [15] declared for the first time that the following plants: *Origanum compactum* Benth, *Rosmarinus officinalis* L., and *Calamintha menthifolia* Host will be used as essential oils.

A comparative evaluation of local uses of the most used taxons and the vernacular names was developed (Table 3) based on the results of various studies carried out in the province of Taza, namely: Kabbach, *et al.* [11]; Kachmar, *et al.* [13]; El Brahmi, *et al.* [15]; Ghabbour, *et al.* [7], and Ghabbour, *et al.* [18].

The comparative list of some medicinal plants presented in Table 3 and used in the province of Taza

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shows that the vernacular names of most of the selected plants remain the same with some modifications (Magraman, Bayramane/Bagramane) in the work of Kabbach, *et al.* [11] and Kachmar, *et al.* [13].

However, the therapeutic use of plants differs from one research project to another but in the majority of cases, it remains in the same section of the pathologies treated. This variation of the therapeutic use of plants is linked to the community studied and also depends on the needs of the population and its tradition.

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Table 3.
Comparative list of the modalities of use of the medicinal plants most frequently inventoried in the province of Taza as used for traditional purposes.

Taxon	The present study Vernacular name Therapeutic use Modalities of use	Khabbach, *et al.* [11] Vernacular name Therapeutic use Modalities of use	Kachmar, *et al.* [13] Vernacular name Therapeutic use Modalities of use	El Brahmi, *et al.* [15] Vernacular name Therapeutic use Modalities of use	Ghabbour, *et al.* [7,18] Vernacular name Therapeutic use Modalities of use
Artemisia herba-alba Asso	Chih Cold, Stomach ache, chill Decoction/ Infusion	Chih Anti-rheumatic, anti-rheum, stomachic Decoction	Chih Gastrointestinal, infections, Abdominal Decoction	Chih Diabetes, anti-inflammatory, stomach pain Decoction	Diabetes, Digestive system, Intestinal pain, Cold, Cough, Microbial infection, (Covid 19) Fever, Immune deficiency, Depression Stomach pain, Flu, Tiredness, Dizziness, Nervousness Decoction/ Infusion
Chamaemelum fuscatum (Brot.) Vasc.	Babounj Hair and face care, Stomach ache Decoction/ Powder	Babounej Antidepressant, against anemia - against hair loss Decoction/ Cataplasm	Babounj Colic, diarrhea, nervousness, depression, angina, mouth ulcers Infusion/Powder	Babounj romi Digestive problems, sedative, haircare, eye disease, allergy Decoction/ Infusion/Powder	
Dittrichia viscosa (L.) Greuter	Magraman Stomach ache,injuries Decoction	Bayramane Carminative, purgative, vulnerary, stomachic Decoction	Bagramane Cold, osteoarticular pain, Diabetes Wormer Infusion	Magraman Skin disease, cancer, digestive problems Decoction/ Infusion/Powder	Aesthetic, Perfumery, Ornamental Infusion/Powder
Herniaria hirsuta L.	Haras lahjar Renal lithiasis, urinary tract infection Decoction	Herast lahjar Analgesic nephritis, depurative Decoction	Harast lahjer Diabetes Kidney stones Decoction	Harass elhajer Kidney disease Infusion	Hypertension, Digestive system, Osteoporosis, Renal system Decoction/ Infusion
Lavandula multifida L.	Lkhzama Diuretics Decoction /Powder	L'khzama Tonic, stimulant and anti-rheum, hair treatment Decoction /Powder	Lkhzama Urinary system, disorder Powder	Lakhzama Cold problem, burn treatment, digestive disease, kidney disease, rheumatological disease, haircare Decoction/ Infusion	Perfumery, Culinary, Aesthetic, Ornamental Infusion/Decoction/Brute/Essential oils

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Origanum compactum Benth	Zàatar Bad digestion and bloating Infusion	Zàatar, zouy Purgative, stomachic, carminative, analgesic, anti-emetic, anti-rheumatic, anti-diabetic, anti-ulcer, anti-diarrheal, against menstrual pain, anti-intoxication Decoction/Powder	Zàatar Gastro-intestinal, infection, Stomach ache, Fever Cold Decoction/Infusion/Powder	Zaater Cold problems, genito-urinary disease, respiratory disease, digestive problems, appetite stimulation Decoction/Infusion Maceration/Powder/Essential oil	Diabetes, Digestive system, Cold, Cough Microbial, infection (COVID-19), Fever Respiratory system, Cancer, Stomach pain Tiredness, Nervousness Flu, Mouth diseases, Cardiac Infusion/Decoction
Pistacia lentiscus L.	Tro Gastroenteritis Decoction/Powder	Fadis, atro Anti-rheum, carminative, purgative, anti-diarrheal – anti-migraine Decoction/Inhalation	Drou Digestive system, pathologies Decoction	Drou Digestive problems Decoction	Digestive system, Stomach pain, Mouth sores Infusion
Rosmarinus officinalis L.	Azir Stomach ache, cold Decoction	Azir Purgative, sedative (aorta palpitations, called locally "Boumzoui"), anti-rheum, anti-rheumatic, liver protection Decoction/Fumigation	Azir Gastric disorders, Digestive system, pathologies, Heart disease Decoction/Infusion	Azir Digestive problems, burn treatment, sedative, blood circulation stimulation, anti-inflammatory, cold problems, haircare Decoction/Infusion/Essential oil	Diabetes, Headaches, Digestive system, Intestinal pain, Cold, Cough Fever, Respiratory system, Renal system, Dental pain, Stomach pain, Tiredness, Diarrhea Intestin, Dizziness, Sexual Impotence, Nervous system, Nervousness Flu, Sexual diseases, Mouth diseases, Circulatory diseases, Cardiac and stomach ulcers Infusion/Decoction/Powder
Salvia Officinalis L.	Salmiya Diabetes, hypertension, urinary tract infection Decoction/Infusion	Salmiya Anti-diabetes, carminative, purgative Decoction	Samiya Diabetes Infusion	Salmiya Digestive disease, diabetes, face care hypertension Infusion	Diabetes, Hypotension, Digestive system, Cough, Immune deficiency, Respiratory system, Renal system, Stomach pain, Tiredness, Cardiac, Dizziness Sexual impotence, Sexual diseases, Circulatory diseases Infusion/Decoction
-*Tetraclinis articulata* (Vahl) Mast.	Aâraâr Stomach ache Decoction/ Powder	L'âarâar, amr'zi Locally analgesic, stomachic, anti-rheumatic Decoction/Fumigation/ Local application	Al'Araàr Stomach-ache, Hypotensive, Diabetes Infusion/Fumigation	El-aaraa Digestive affection, haircare Decoction/Powder/Fumigation	Diabetes, Digestive system, Intestinal pain, Cold, Respiratory system, Stomach pain, Intoxication

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-*Aristolochia fontanesii* Boiss. & Reut.	Barztem Cancer,Scorpion bites Powder	Bar'ztem Vulnerary, anticancer, anti-ulcer Powder	Baraztam Cold, tooth pain, osteoarticular pain, inflammation, allergy Decoction/Powder	Bereztem Cancer, digestive problems, kidney disease, skin disease Powder/Decoction/Maceration	Saignement, Mouth sores, Infection, Goitre Sores Orally/ External app
-*Eucalyptus globulus* Labill. *Eucalyptus* sp	Kalitous knee pain, cold Decoction	Kalitous Anti-rheum, anti-rheumatic, anti-flu Decoction/Inhalation	Al'Kalitouss Flu Fumigation	Elkalibtouse Respiratory disease, diabetes Decoction/Fumigation	Diabetes, Hypertension, Cardiac, Digestive system, Asthma Fever, Immune deficiency, Lung Flu, inflammation, Respiratory system Yellowing Infusion/Decoction
- *Aloysia citriodora* Palau	Lwiza Stomach aches, purgative decoction	L'wiza Analgesic in pediatric, stomachic, purgative Decoction	Lwiza Stomach-ache, Hypertension, Diabetes Infusion/Decoction	Lwiza Digestive disease, cold problem, sedative, hypertension Infusion	Hypertension, Digestive system, Intestinal pain, Fever, Immune deficiency, Depression, Tachycardia, Nervous system Infusion/Decoction
Calamintha menthifolia Host	Manta Cold problem, fever problems Decoction/ Powder	T'minṭa, manṭa Anti-rheum, antitussive, stomachic Decoction in milk	Manta Flu Cold Decoction/Infusion	Manta Digestive disorder, cold problem, sedative, antiinflammatory, cough, fever, respiratory disease Decoction/Infusion/Powder Essential oil	Diabetes, Digestive system, Cold, Cough, Fever, Respiratory system, Renal system, Stomach pain, Diarrhea, Flu, Sexual diseases, Mouth diseases, Stomach ulcer Infusion/Decoction

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The majority of diseases treated by these plants studied are problems of the digestive system and respiratory systems (19.68% and f 9.93% respectively) **[15].** Thus, new medicinal uses have recently been highlighted by Ghabbour, *et al.* [7], which means constantly updating ethnobotanical research.

The plant diversity of the study environment is the most perceptible manifestation of the natural wealth of medicinal plants [7, 9, 11, 12,13,14,15, 16, 17, 18] which appears in the province of Taza.

3.12. Medicinal Plants and Their Importance in A Variety of Taxa

It is interesting to note that the plant diversity in the study environment is a clear indication of the natural wealth of medicinal plants, as previously highlighted in various studies **[7, 12, 13, 14, 15, 16, 17, 18]**. In addition, this is particularly true for the province of Taza, where a wide range of medicinal plants can be found. The most noticeable manifestation of the natural wealth of medicinal plants in the province of Taza appears in the previous works

According to scientific research conducted in the Taza province from 2012 to 2024 **[7, 11, 17, 18]**, a plant species is considered the primary unit of plant classification. Plants of the same species form a community within the plant world, while related species form a family. The present study contributes to the knowledge of the diversity of various plant species such as Rockrose (*Cistus ladanifer* L. and *Cistus salviifolius* L.), Origanum (*Origanum majorana* L.and *Origanum compactum* Benth.), Lavandula (*Lavandula stoechas* L. and *Lavandula multifida* L.) and Mint (*Mentha suaveolens* Ehrh. and *Mentha pulegium* L.).

Due to the vast diversity of plant species in Morocco, the country has great potential for medicinal plants **[47].** In fact, according to the National Agency for Medicines and Aromatic Plants **[48]**, Morocco ranks second in the world after Turkey in this regard. It is important to preserve this wealth by adopting solutions that promote the development of the sector. One of the key solutions includes enhancing the management of production and marketing to better value Moroccan medicinal plants. Additionally, it is imperative to ensure the availability of expertise, such as analyses and studies, and foster various partnerships through national and international cooperation.

3.13. Principal Component Analysis (PCA)

Results of the principal component analysis (PCA) (Figure 6) showed that the first two components (PC1 & PC2 = 94.78% of the total variation) are sufficient to represent and interpret the results of the ethnobotanical indices studied. PC1 accounted for 80.92% of the total variation while PC2 presented 13.86%. PC1 is strongly influenced by FC, RFC, UV, and UR, while PC2 is influenced by FL. The results obtained confirm those of Ghabbour, *et al.* **[7]** whose PCA results showed that the first two axes represented the majority of the total variation (95.62%) of which PC1 (ROP, RFC, IC, UV, and T) presented 79.48% of the total variance, while PC2 (FL) shows 16.75% of the variation. These results confirm the suggestion of Ghabbour, *et al.* **[7]** named the first component (PC1) "the importance of the uses of medicinal plants" and designated the second component as an indicator of the faithfulness of use in the face of an illness.

From the first two main components (PC1 and PC2), a biplane was created to simplify the diffusion of species according to the ethnobotanical variables studied, and a selection was made to classify three groups of plant species (G1, G2, and G3) for medicinal use. The species distribution is close to that found in Ghabbour, *et al.* **[7].** G1 and G2 are characterized by a significant number of medicinal taxons as is the case in Ghabbour, et al. **[7].**

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Table 4.
Summary list of traditional uses of plant species inventoried in the province of Taza.

Scientific names of families	VC	Scientific names of species	Local name	Parts used	CPU	Preparation	CP	Mode of administration	CA	Medicinal uses	FL (%)	FC	RFC	RU	UV	FUV	FCF	FIV
maranthaceae	1°	*Dysphania ambrosioides* (L.) Mosyakin & Clemants	Mkhinza	Leaf	1	Decoction	1	Orally	1	Fever problems, headaches	100/100	**3**	**0,02**	3	0.02	**0.02**	**3**	**3**
Anacardiaceae	2°	*Pistacia lentiscus* L.	Tro	Leaf	1	Decoction Powder	2	Orally	1	Gastroenteritis	100	8	0,054	4	0.027	**0.027**	**8**	**8**
Apiaceae	3°	*Ammoides pusilla* (Brot.) Breistr.	Nokha	Leaf	1	Decoction	1	Orally	1	Bad digestion, diarrhea,	100/100	2	0.014	2	0.014	**0.01**	**3**	**1.5**
	4°	*Pimpinella anisum* L.	Habat hlawa	Seed	1	Liquid extract	2	Orally	1	Digestive disease, diabetes	100/100	1	0,007	1	0.007			
Apocynaceae	5°	*Nerium oleander* L.	Dafla	Leaf	1	Infusion	1	Externally, orally	2	Abscess, cold problema	100/100	2	0,014	2	0.014	**0.014**	**2**	**2**
Aristolochiaceae	6°	*Aristolochia fontanesii* Boiss. & Reut.	Barztem	Leaf	1	Powder	1	Orally, externally	2	Cancer, scorpion bites	100/100	22	0,15	7	0.046	**0.048**	**22**	**22**
Asparagaceae	7°	*Agave americana* L.	Sabar	Leaf	1	Liquid extract	2	Externally Brushing	2	Hair care	100	2	0.014	2	0.014	**0.014**	**2**	**2**
Asteraceae	8°	*Artemisia herba-alba* Asso	Chih	Leaf+Stem	2	Decoction Infusion	2	Orally	1	Digestive disease, cold problema	100/16/16	16	0,109	12	0.082	**0.066**	**64**	**12.8**
	9	*Aucklandia costus* Falc.	Arghis	Root	1	Powder	1	Orally	1	Diabetes	100	1	0.007	1	0.007			
	10°	*Chamaemelum fuscatum* (Brot.) Vasc.	Babounj	Leaf+Stem	2	Decoction Powder	2	Orally, externally Brushing	3	Digestive disease, hair and face care	100/44/22	15	0,102	9	0.061			
	11°	*Dittrichia viscosa* (L.) Greuter	Magraman	Leaf/ Aerial part /Seed/Root	4	Decoction Powder	2	Orally, massage	2	Digestive disease, Skin disease	89/16/26	25	0,17	19	0.13			
	12°	*Vogtia annua (L.)* Oberpr. & Sonboli	Timarsad	Leaf	1	Powder	1	Orally, gagarism	3	Digestive disease, cold problem, tooth pain	100/100/100	7	0.046	7	0.046			
Brassicaceae	13°	*Lepidium sativum* L.	Hab rchad	Seed	1	Powder	1	Orally	1	Digestive disease	100	2	0,014	1	0.007	**0.007**	**2**	**2**
Cactaceae	14°	*Opuntia ficus-indica* (L.) Mill.	Lhendiya	Leaf/Fruit	2	Liquid extract	2	Inhalation, orally	2	Respiratory allergy, asthma, diabetes	100/50/50	4	0,027	2	0.014	**0.014**	**4**	**4**
Capparaceae	15°	*Capparis spinosa* L.	Lkabar	Fruit	1	Decoction Powder	2	Orally	1	Rheumatism, diabetes	100/66	7	0,046	3	0.02	**0.02**	7	7

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Caryophyllaceae	16°	*Corrigiola telephiifolia* Pourr.	Sarghina	Root	1	Powder	1	Externally	1	Eczema, hemorrhoids	100/100	4	0.027	4	0.027	0.017		
	17°	*Herniaria hirsuta* L.	Haras lahjar	Aerial part	1	Decoction	1	Orally	1	Renal lithiasis, urinary tract infection	100/100/100	4	0,027	4	0.027		9	3
	18°	*Silene vulgaris* (Moench) Garcke	Tighighacht	Leaf	1	Powder	1	Orally	1	Cold problema	100	1	0.007	1	0.007			
Cistaceae	19°	*Cistus ladanifer* L.	Tazoult	Leaf	1	Powder	1	Orally	1	Digestive disease	100	2	0.014	2	0.014	0.018		
	20°	*Cistus salviifolius* L.	Tangroucht	Leaf	1	Infusion	1	Orally	1	Digestive disease	100	2	0.014	2	0.014		9	3
	21°	*Fumana scoparia* Pomel	Touchent	Aerial part	1	Infusion	1	Orally	1	Digestive disease	100	5	0.034	4	0.027			
Cupressaceae	22°	*Tetraclinis articulata* (Vahl) Mast.	Aâraâr	Leaf	1	Decoction Powder	2	Orally	1	Digestive disease	100	13	0,068	10	0.068	0.068	13	13
Ericaceae	23°	*Arbutus unedo* L.	Sasnou	Root	1	Decoction Powder	2	Orally	1	Diabetes	100	2	0.014	1	0.007	0.007	2	2
Euphorbiaceae	24°	*Euphorbia resinifera* O.Berg	Daghmous	Aerial part	1	Liquid extract	2	Orally	1	Renal litiasis	100	14	0,095	6	0.04	0.04	14	14
Fabaceae	25°	*Anthyllis cytisoides* L.	Talghut	Leaf	1	Powder	1	Externally massage	2	Skin disease	100	1	0.007	1	0.007	0.0084		
	26°	*Ceratonia siliqua* L.	Lkharoub	Leaf	1	Powder	1	Orally	1	Diarrhea, digestive disease	100/100	1	0.007	1	0.007			
	27°	*Glycyrrhiza glabra* L.	Aâr'ksous	Stem	1	Powder	1	Gagarism	1	Tooth pain	100	2	0,013	2	0.014		6	1.2
	28°	*Ononis natrix* L.	Aftaz	Aerial part	1	Powder	1	Externally	1	Against hemorrhages	100	1	0,007	1	0.007			
	29°	*Trigonella foenum-graecum* L.	Lhalba	Seed	1	Powder	1	Orally	1	Digestive disease, diabetes	100/100	1	0.007	1	0.007			
Fagaceae	30°	*Quercus suber* L.	Balout	Bark	1	Decoction	1	Orally	1	Digestive disease	100	2	0,014	2	0.014	0.014	2	2
Gentianaceae	31°	*Centaurium erythraea* Rafn	Gassat lhaya	Leaf	1	Decoction	1	Orally, externally	2	Diabetes, digestive disease, fever problema	66/66/33	4	0,027	3	0.02	0.02	4	4
Geraniaceae	32°	*Pelargonium odoratissimum* (L.) L'Hér.	Al aâtrcha	Leaf	1	Infusion	1	Orally	1	Cold problema	100	6	0,041	6	0.04	0.04	6	6
Juglandaceae	33°	*Juglans regia* L.	Gouz	Aerial part	1	Powder	1	Gagarism	1	Tooth care	100	1	0,007	1	0.007	0.007	1	1
Juncaceae	34°	*Juncus acutus* L.	Smar	Flower	1	Decoction	1	Orally	1	Cold problema	100	1	0.007	1	0.007	0.007	1	1
Lamiaceae	35°	*Ajuga iva* (L.) Schreb.	changora	Aerial part	1	Powder	1	Orally	1	Digestive disease	100	4	0,027	3	0.02	0.082		
	36°	*Calamintha menthifolia* Host	Manta	Leaf/Aerial part	2	Decoction Powder	2	Orally	1	Cold problem, fever problems	80/100/40	29	0,197	24	0.163		198	14.14
	37°	*Lavandula multifida* L.	Lkhzama	Leaf	1	Decoction /Powder/ Essential oils	3	Externally	1	Diuretics	100	8	0,054	7	0.048			

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	38°	*Lavandula stoechas* L.	Halhal	Leaf	1	Decoction	1	Orally	1	Anemia, Diabetes	100/100	6	0,041	6	0.041			
	39°	*Marrubium vulgare* L.	Mariwa	Leaf	1	Decoction Powder	2	Orally	1	Large intestine pain, diabetes	55/36/55	16	0,109	11	0.074			
	40°	*Mentha pulegium* L.	Fliyo	Aerial part	1	Decoction	1	Orally	1	Cold problema	100	7	0,046	7	0.046			
	41°	*Mentha suaveolens* Ehrh.	Mchichtro	Leaf	1	Decoction	1	Orally	1	Fever, headaches	100	4	0.027	4	0.027			
	42°	*Origanum compactum* Benth.	Zaâtar	Leaf	1	Infusion	1	Orally	1	Bad digestion and bloating	100	28	0,19	27	0.184			
	43°	*Origanum majorana* L.	Mardadouch	Aerial part	1	Decocton Infusion	2	Orally inhalation	2	Diabetes, respiratory problems	22/88	11	0,075	9	0.061			
	44°	*Rosmarinus officinalis* L.	Azir	Leaf	1	Decoction	1	Orally	1	Digestive disease, cold problema	96/22	32	0,218	27	0.184			
	45°	*Salvia officinalis* L.	Salmiya	Leaf	1	Deoction Infusion	2	Orally	1	Diabetes, hypertension, urinary tract infection	20/80/20	16	0,109	15	0.102			
	46°	*Salvia verbenaca* L.	Khiyata	Leaf	1	Decoction	1	Externally, Orally	2	Skin disease, constipation	50/50	2	0.014	1	0.007			
	47°	*Teucrium polium* L. subsp. polium	Fatat lahjar	Aerial part	1	Decoction	1	Orally	1	Renal litiasis	100	3	0,02	3	0.02			
	48°	*Thymus zygis* L.	Zâitra	Leaf	1	Decoction Infusion	2	Orally	1	Digestive disease,cold problema	20/80	32	0,218	26	0.177			
Linaceae	49°	*Linum usitatissimum* L.	Zriaât lketaan	Seed	1	Powder	1	Orally	1	Intestinal problems	100	2	0.014	2	0.014	0.014	2	2
Myrtaceae	50°	*Eucalyptus globulus* Labill.	Kalitous	Leaf	1	Decoction	1	Orally	1	Rheumatological disease, cold problema	100/100	5	0.034	5	0.034	0.023		
	51°	*Myrtus communis* L.	Rayhan	Flower/Leaf	2	Decoction Powder	2	Orally	1	Headaches and stress	100/50	3	0.02	2	0.014		12	4
	52°	*Syzygium aromaticum* (L.) Merr. & L.M. Perry	Qranfal	Seed	1	Liquid extract	2	Externally Brushing	2	Hair care	100/33	4	0.027	3	0.02			
Oleaceae	53°	*Olea europaea* L.	zaytoun	Leaf	1	Infusion	1	Orally	1	Hypertension, cholesterol, diabetes	100/100/100	1	0.007	1	0.007	0.014		
	54°	*Phillyrea latifolia* L.	Amlilas	Leaf	1	Decoction	1	Orally	1	Anemia problema	33/66	3	0,02	3	0.02		4	2
Pinaceae	55°	*Pinus halepensis* Mill.	Tayda	Bark	1	Decoction	1	Externally	1	Toxicity problema	100	1	0.007	1	0.007	0.007	1	1
Piperaceae	56°	*Piper cubeba* L. f.	Lkebaba	Flower	1	Decoction	1	Gagarism	1	Tooth care	50/50	3	0.02	2	0.014	0.014	1	1
Plantaginaceae	57°	*Globularia alypum* L.	Tassalgha	Leaf	1	Infusion	1	Orally	1	Digestive problems, diabetes	100/33	4	0.027	3	0.02	0.014	5	2.5

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	58°	*Plantago major* L.	Massassa	Leaf	1	Powder	1	Externally	1	Skin disease	100	1	0.007	1	0.007			
Plumbaginaceae	59°	*Plumbago europaea* L.	Swak raâyan	Leaf	1	Powder	1	Externally	1	Alopecia	100	20	0,14	3	0.02	0.02	20	20
Poaceae	60°	*Cenchrus americanus* (L.) Morrone	Ilan	Seed	1	Powder	1	Externally, orally	1	Broken bones disease, digestive problems	100/100	2	0,014	2	0.014	0.014	2	2
Lythraceae	61°	*Punica granatum* L.	Raman	Bark	1	Decoction	1	Orally	1	Digestive problems	100	6	0.04	6	0.04	0.04	6	6
Ranunculaceae	62°	*Nigella sativa* L.	Sanouj	Seed	1	Powder	1	Orally	1	Allergic problems	100	2	0.014	2	0.014	0.011	3	1.5
	63°	*Clematis flammula* L.	Nar barda	Aerial part	1	Powder	1	Externally	1	Rheumatism	100	1	0.007	1	0.007			
Rhamnaceae	64°	*Ziziphus lotus* (L.) Lam.	Sidr	Fruit/Leaf	2	Liquid extract	2	Externally Orally	2	Renal lithiasis, digestive problems	50/50	2	0.014	1	0.007	0.014	5	2.5
	65°	*Ziziphus jujuba* Mill.	Bozofor	Root	1	Maceration	1	Orally	1	Digestive problems, intestinal disease	100/100	3	0,02	3	0.02			
Rosaceae	66°	*Crataegus monogyna* Jacq.	Zaârour	Leaf+Stem	2	Decoction	1	Gagarism	1	Tooth care	100	1	0.007	1	0.007	0.007	1	1
Rutaceae	67°	*Ruta montana* (L.) L.	Wram/Figel	Leaf	1	Decoction	1	Externally	1	Skin disease	100	4	0,027	4	0.027	0.027	4	4
Selaginellaceae	68°	*Selaginella* P. Beauv.	Sanbel	Leaf	1	Powder	1	Externally	1	Alopecia	100	2	0.014	2	0.014	0.014	2	2
Solanaceae	69	*Hyoscyamus muticus* L.	Guinguit	Seed	1	Powder	1	Externally	1	Eczema	100	4	0,027	4	0.027	0.027	4	4
Tamaricaceae	70°	*Tamarix africana* Poir.	Tanmacht	Leaf	1	Decoction	1	Orally	1	Diabetes	100	1	0.007	1	0.007	0.007	1	1
Thymelaeaceae	71°	*Daphne gnidium* L.	Lazaz	Leaf	1	Powder	1	Externally	1	Hair care	100	5	0.034	5	0.034	0.024	9	4.5
	72°	*Thymelaea hirsuta* (L.) Endl.	Lmatnane	Leaf	1	Infusion	1	Orally	1	Diabetes	100	4	0.027	2	0.014			
Urticaceae	73°	*Urtica dioica* L.	Horiga	Leaf	1	Powder	1	Externally	1	Skin disease	100	1	0,007	1	0.007	0.007	1	1
Verbenaceae	74°	*Aloysia citrodora* Palau	Lwiza	Leaf	1	Decoction	1	Orally	1	Digestive disease, hypertension	100/100	9	0,061	8	0.054	0.054	9	9
Nitrariaceae	75°	*Peganum harmala* L.	Harmal	Seed	1	Infusion Powder	2	Orally	1	Digestive problems	100	4	0,027	2	0.014	0.014	4	4
42 families		75 Species																

Note: FC: Frequency of Citation, RFC: Relative Frequency of Citation, RU: Uses Reported, UV: Use Value, FUV: Family use value, FCF: Family Frequence Citation, FIV: Family importance value VC=Voucher codes (°: Identified).

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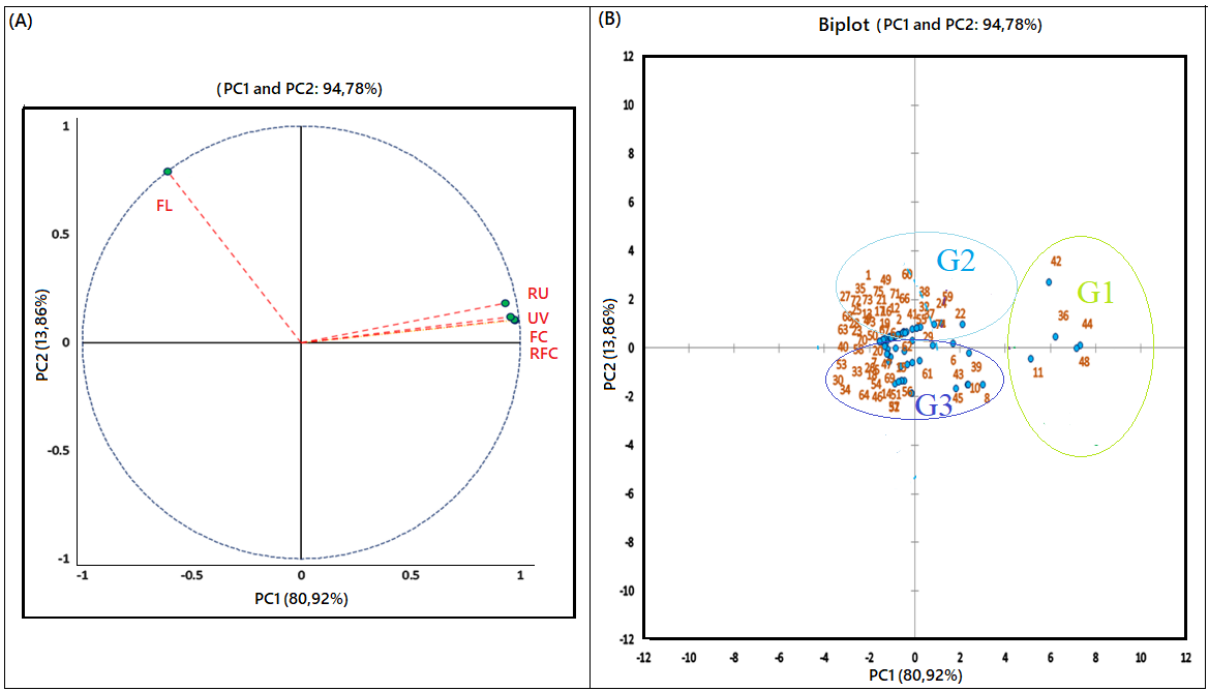

Figure 6.
Principal components analysis of the ethnobotanical indices (A) and Biplot (B) for plant species (according to their number codes in Table 4) according to the two components of (PC1) and of (PC2).

G3 consists of the medicinal taxons of *Rosmarinus officinalis* L., *Origanum compactum* Benth., *Thymus zygis* L., *Calamintha menthifolia* Host, and *Dittrichia viscosa* (L.) Greuter with the highest UV and RFC, strongly correlated with PC1. *Rosmarinus officinalis* L., *Origanum compactum* Benth., *Thymus zygis* L. and *Calamintha menthifolia* Host are positively correlated with RFC, FC, UV, and UR, while *Dittrichia viscosa* (L.) Greuter is negatively correlated (Figure 6). The number of species (5) forming the G3 remains close to the number found (8) in a study by Ghabbour, *et al.* **[7].** The analysis and comparative discussion of these results within the province of Taza, quantitatively show the importance of the use of medicinal plants by the population of Taza. Thus, further work in the same direction is necessary to better understand the specific status of the indices of these medicinal taxons.

4. Conclusion

The province of Taza contains interesting plant biodiversity exploited by the population and is specifically characterized by great botanical diversity in medicinal plants for therapeutic use. Medicinal plants are used more by married people. Most of the medicinal taxons used in our study area are Lamiaceae, Asteraceae, and Fabaceae, and are widely used in the treatment of pathologies of the digestive system (ICF = 0.750), metabolic diseases (ICF = 0.831), respiratory system (ICF = 0.778), and skin diseases (ICF = 0.726). The leaves are the most used part. The preparation method differs depending on the pathologies to be treated, but the decoction remains the most common preparation method. Oral administration is the most used (77%), and various ethnobotanical clues point to these important medicinal uses. The present study is an inventory that constitutes a source of information that contributes to a better knowledge of medicinal plant resources and the preservation of local popular know-how in the Taza province. It can also constitute a database to enable the valorization of this heritage through the discovery of new active ingredients that can be used for various purposes.

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List of Abbreviations:
UV: Use Value, FC: Frequency of Citation, RFC: Relative Frequency of Citation, FUV: Family Use Value, FIV: Family importance value, Ns: Number of species within each family, IAR: Informant Agreement Ratio, FL: Fidelity level, VPP: Value of the plant part used, RU: Number of uses reported of all parts of the plant, ICF: Informant Consensus Factor, Nur: Number of mentions in each category, Nt: Number of taxa used in each category, VC=Voucher codes.

Authors' Contribution:
G. Echchgadda, S. Chakir, and F. El Hajli: Ideas, design, supervision, validation of the study, manuscript preparation, and review. F. El Hajli and I. Ghabbour: Concepts, the definition of intellectual content, literature search, experimental studies, data acquisition and analysis, statistical analysis, manuscript preparation, and review. A. Khabbach: Experimental studies, manuscript preparation, editing, and review. S. Bouhraoua: Data analysis and manuscript review. K. Hammani: Supervised, manuscript preparation and review. M.R. Kachmar: Manuscript review

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