

CHECKLIST OF THE MEDICINAL FLORA USED BY THE LOCAL POPULATION IN THE PROVINCE OF TAZA (NORTH-EASTERN MOROCCO) THROUGH AN ETHNOBOTANICAL STUDY

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Abstract

Background: Taza province presents enormous richness and biodiversity. Updating their medicinal plant inventories is crucial for conserving traditional knowledge, sustainable use, health and well-being, economic opportunities and collaborative research.

Question: What new species and families of medicinal plants can we report by widening the ethnobotanical study area in Taza province compared to previous work?

Studied species: 202 medicinal plant species.

Study site and dates: 28 communities in the province of Taza (Morocco), between March and October 2021.

Methods: An ethnobotanical survey including 340 interviewees using a semi-structured questionnaire.

Results: 91 medicinal taxa belonging to 48 families were inventoried. 12 species including three spontaneous: *Atriplex halimus* L., *Citrullus colocynthis* L. Sch and *Micromeria graeca* (L.) Benth. ex Rchb. were reported for the first time. The most frequent species are respectively *Salvia officinalis* L., *Trigonella foenum-graecum* L. and *Rosmarinus officinalis* L. The most frequent families are respectively Lamiaceae, Asteraceae and Fabaceae. Seven new vernacular names have been listed. Most of the plants were spontaneous (55.9 %). The comparative analysis with previous work led to obtaining a checklist of 202 taxa (75 families) of which 65 have specific endemism and 77 (48 spontaneous) are on the red list. The scientific names of 28 species and nine families have been updated.

Conclusions: This checklist (202 taxa) traduces the plant heritage richness of Taza province and constitutes a great database for future scientific research. The 12 newly listed species constitute an added value that deserves to be valued through ethnopharmacological studies.

Keywords: Actualize, ethnobotany, herbal medicines, systematic reference, Tazi communities.

Resumen:

Antecedentes: La provincia de Taza presenta una enorme riqueza y biodiversidad. Actualizar sus inventarios de plantas medicinales es crucial para preservar el conocimiento tradicional.

Preguntas y / o Hipótesis: ¿Qué nuevas especies y familias de plantas medicinales se pueden reportar al ampliar el área de estudio de la provincia de Taza respecto a trabajos anteriores?

Especies de estudio: 202 especies medicinales.

Sitio y años de estudio: 28 comunidades de Taza (Marruecos), entre marzo y octubre (2021).

Métodos: Una encuesta etnobotánica que incluyó a 340 entrevistados mediante un cuestionario semiestructurado.

Resultados: Se inventariaron 91 taxones medicinales pertenecientes a 48 familias. 12 especies, incluidas tres espontáneas: *Atriplex halimus* L., *Citrullus colocynthis* (L.) Sch and *Micromeria graeca* (L.) Benth. ex Rchb. fueron reportados por primera vez. Las especies más frecuentes son respectivamente *Salvia officinalis* L., *Trigonella foenum-graecum* L. y *Rosmarinus officinalis* L.. Las familias más frecuentes son respectivamente Lamiaceae, Asteraceae y Fabaceae. Se han enumerado siete nuevos nombres vernáculos. La mayoría de las plantas fueron espontáneas (55.9 %). El análisis comparativo con trabajos anteriores permitió obtener una lista de verificación de 202 taxones (75 familias) de los cuales 65 tienen endemismo específico y 77 (48 espontáneos) están en la lista roja. Se han actualizado los nombres científicos de 28 especies y nueve familias.

Conclusiones: Esta lista (202 taxones) que refleja la riqueza del patrimonio vegetal de la provincia de Taza, constituye una gran base de datos para futuras investigaciones científicas. Las 12 especies merecen ser evaluadas mediante estudios etnofarmacológicos.

Palabras clave: Actualización, comunidades tazi, etnobotánica, medicinas herbarias, referencia sistemática.

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Considering the development and the merits of modern medicine, the therapeutic virtues due to the various bioactive molecules of plants remain uncontroversial. However, to overcome the harmful effects of toxic plants, a good knowledge of this field is essential.

Phytotherapy is the treatment and prevention of diseases through the use of plants or products containing them (Létard *et al.* 2015). Historically, many infectious diseases have been treated with medicinal plants which have become the source of most medicines (Verma & Singh 2008). Nowadays, less expensive traditional therapeutic systems are spreading in all regions of the world (Létard *et al.* 2015). The therapeutic activity requires an ethnopharmacological validation, showing an interdisciplinary field of biologically active agents that are traditionally used (Süntar 2019).

Ethnobotany is a science that studies the direct interaction of the relationship of humans with the plants of the space where they live (Bennett 2002, Rahman *et al.* 2019). It also has an interest in protection, food and shelter as well as providing remedies against diseases and injuries (Rahman *et al.* 2019). To develop reliable and meaningful semi-structured questions, researchers must have a deep understanding of the topic of interest, and for this reason, semi-structured interviews are often preceded by observations, informal and unstructured interviews (Ashebo 2019).

The history of ethnobotanical surveys in Morocco shows clearly the importance of using medicinal plants. Many ethnobotanical surveys carried out consist of developing questionnaires (often semi-structured) intended for the people questioned. Some surveys have covered the entire kingdom (Bellakhdar 1997a, Bnouham *et al.* 2002, Ismaili *et al.* 2021), while others have been conducted in different regions over the past 25 years (Ziyyat *et al.* 1997, Ennabili *et al.* 2000, Jouad *et al.* 2001, Eddouks *et al.* 2002, 2017, El Hilaly *et al.* 2003, Hseini & Kahouadji 2007, Tahraoui *et al.* 2007, Benkhniqne *et al.* 2010, 2014, El Amrani *et al.* 2010, Hanae 2012, Khabbach *et al.* 2012, Ghourri *et al.* 2013, Hassani *et al.* 2013, Bousta *et al.* 2014, El Yahyaoui *et al.* 2015, Daoudi *et al.* 2016, Mikou *et al.* 2016, Barkaoui *et al.* 2017, Benali *et al.* 2017, Bouyahya *et al.* 2017, Laadim *et al.* 2017, Boulfia *et al.* 2018, El Haouari *et al.* 2018, Chaachouay *et al.* 2019, 2022 Fatiha *et al.* 2019, Mrabti *et al.* 2019, Zougagh *et al.* 2019, Hayat *et al.* 2020, Idm'hand *et al.* 2020, Mechchate *et al.* 2020, Merrouni *et al.* 2021, Kachmar *et al.* 2021, Beniaich *et al.* 2022, El Khomsi *et al.* 2022, Ghanimi *et al.* 2022).

Morocco is a North African country characterized by mountainous and desert areas with great ecological and floristic wealth. The vascular flora of Morocco based on a recent inventory reported 155 families, 981 genera, 3,913 spontaneous species, 426 typical subspecies (autonyms) and 872 additional subspecies (Fennane & Ibn Tattou 2012). The number of strictly endemic is equal to 640 species, representing 16.3 % of the national inventory (Fennane & Ibn Tattou 2012). Of more than 4,000 identified Moroccan species, 800 are endemic and 600 are classified as aromatic or medicinal (Ismaili *et al.* 2021). 500 medicinal plants are economically important (Ennabili *et al.* 2000).

The classification system based on the International Code of Nomenclature of Algae, Fungi, and Plants (Shenzhen Code) (Turland *et al.* 2018) has become very popular. It constitutes a simple systematic reference to unify research on medicinal plants. Compared to all previous works carried out in this province (Khabbach *et al.* 2012, Boulfia *et al.* 2018, El Haouari *et al.* 2018, El Brahimi *et al.* 2022). Our present study was conducted in response to the need for a checklist of medicinal plants from the province of Taza (Morocco). This article aims to provide a comprehensive and up-to-date checklist of taxa and families from 28 communities in Taza province, through an ethnobotanical survey including 340 interviews. In addition, endemism and red list were verified and presented for all taxa constituting the checklist.

Materials and methods

Study area. The Province of Taza located in the North-East of Morocco is a part of the Fez Meknes Region. Its legal population according to data from the general census of population and housing of September 2014 reached 528,419 inhabitants, including 259,260 Masculine, extending over an area of 7,098 Km² (CDS-T 2014). The administrative organization of the province after the last administrative division presents 4 urban communities and 34 rural communities (DRF-M 2016).

The Province of Taza has a strategic geographical position (Figure 1), which has a Mediterranean climate, with a cold and wet winter and a semi-arid summer (Hakkour *et al.* 2016). The temperature and rainfall vary respectively between 1.4 and 45.2 °C and between 100 and 200 mm (Hakkour *et al.* 2016). The Province of Taza includes Tazeka National Park. The latter, created in 1950, is one of the oldest national parks in the Kingdom (Fougrach *et al.* 2007). It has a richness and botanical diversity resulting from its geographical position, orography, edaphic structure, geological history and past and present climatic conditions (Fougrach *et al.* 2007).

Our study area (Figure 1) is divided into 28 communities in the province of Taza, including four urban and 24 rural, which represents a total of 28 communities out of a total set of 38 communities constituting this province.

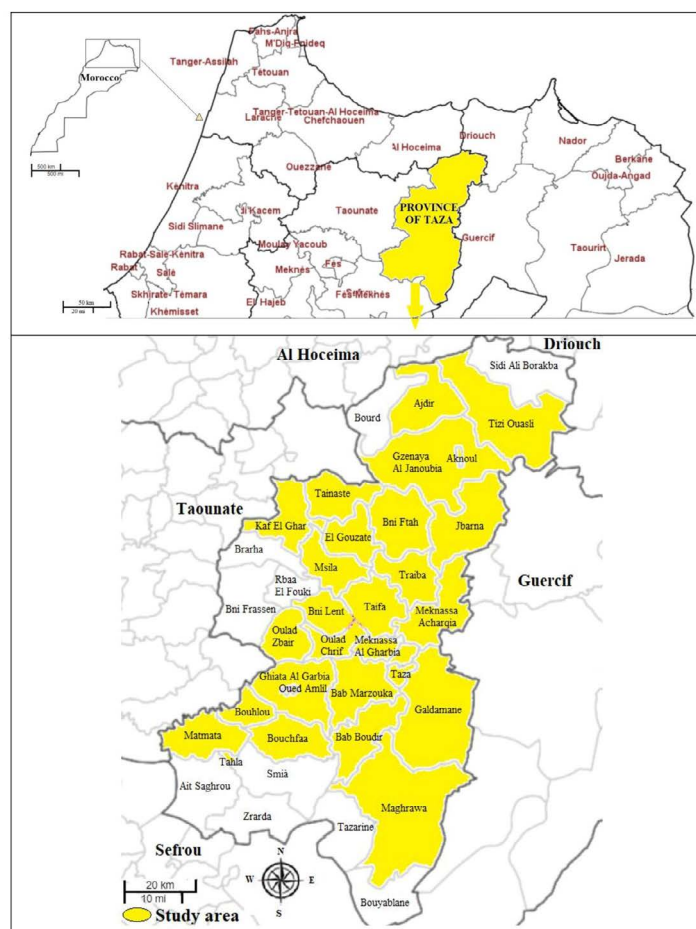


Figure 1. Map showing the study area in the Province of Taza. [created based on (DRF-M2016)].

Methodology followed for an update of the medicinal flora traditionally used in the Province of Taza. To update the medicinal flora used by the local population in the Province of Taza compared to other previous works (Khabbach *et al.* 2012, Boulfia *et al.* 2018, El Haouari *et al.* 2018, El Brahimi *et al.* 2022), the methodology followed in this study aimed to expand the study area in the province of Taza. The present survey is carried out in 28 communities from a total of 38 communities in the province of Taza. However, compared to all previous works carried out in the same province, the ethnobotanical survey reported by Khabbach *et al.* (2012) was limited to 11 communities: Aknoul, Ajdir, Oued Amlil, Taza city and Had Msila (Msila), Jbarna, Merzouka and Malal (Gzenaya Al Janoubia), Bouhdoud (Bni Ftah), Sebt Boukalal (Meknassa Charkia) and Tizi Ousli. Indeed, Boulfia *et al.* (2018) have worked in four communities: Taza City, Aknoul, Gueldamane and Bab Boudir, while El Haouari *et al.* (2018) have surveyed one community of Taza City and El Brahimi *et al.* (2022) have surveyed one community of Bouchfaa.

In addition to the 14 communities previously mentioned (Khabbach *et al.* 2012, Boulfia *et al.* 2018, El Haouari *et al.* 2018, El Brahimi *et al.* 2022), another 14 communities were included for the first time in an ethnobotanical survey (Traiba, Bni Lent, El Gouzate, Tahla, Bouhlou, Taifa, Matmata, Ghiata Al Garbia, Oulad Chrif, Maghrawa, Kaf El Ghar, Tainaste, Meknassa Al Gharbia and Oulad Zbair), which may allow listing new medicinal plants (especially spontaneous taxa) and/or new vernacular names. Especially since the study area presents a very significant natural richness and biodiversity (Figure 2).

Finally, compared to previous local works cited above, our methodology aimed to update all scientific names listed, referring to the International Code of Nomenclature for Algae, Fungi and Plants (Shenzhen Code) (Turland *et al.* 2018), not only to avoid confusion with an old scientific name, but also to maintain their accuracy and stability in the identification and classification, with a view to such possible use.

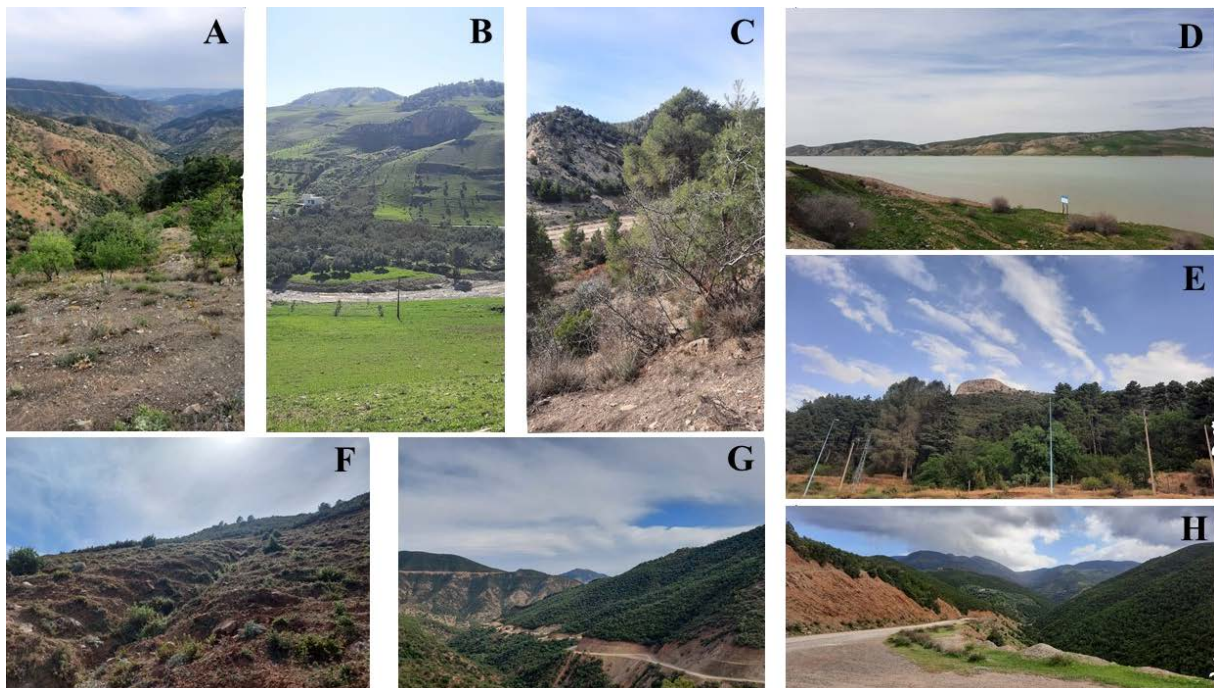


Figure 2: Some photos that illustrate the richness and biodiversity in the province of Taza. [A: Tainaste: Longitude (4° 7' 20" W) - 4.1223 Latitude (34° 33' 39" N) 34.561. B: Taifa: Longitude (4° 0' 58" W) - 4.0161 Latitude (34° 21' 4" N) 34.3511. C: Jbarna: Longitude (3° 51' 41" W) - 3.8616 Latitude (34° 30' 18" N) 34.5051. D: Matmata: Longitude (4° 32' 51" W) - 4.5477 Latitude (34° 6' 31" N) 34.1086. E: Bab Boudir: Longitude (4° 7' 18" W) - 4.1218 Latitude (34° 4' 6" N) 34.0685. F: Bni Ftah: Longitude (4° 3' 15" W) - 4.0544 Latitude (34° 29' 11" N) 34.4865. G: Oulad Chrif: Longitude (4° 6' 5" W) - 4.1015 Latitude (34° 18' 11" N) 34.3031. H: Bab Marzouka: Longitude (4° 8' 44" W) - 4.1457 Latitude (34° 11' 34" N) 34.193.

Methods. This survey is a descriptive and transversal exploratory ethnobotanical study that was carried out among herbalists and ordinary citizens using questionnaire sheets of paper (face-to-face) and note-taking, between March and October 2021.

Questionnaire.- Based on previous works (Ziyyat *et al.* 1997, Ennabili *et al.* 2000, Jouad *et al.* 2001, Eddouks *et al.* 2002, 2017, El Hilaly *et al.* 2003, Hseini & Kahouadji 2007, Tahraoui *et al.* 2007, Benkhniqie *et al.* 2010, 2014, El Amrani *et al.* 2010, Hanae 2012, Khabbach *et al.* 2012, Ghourri *et al.* 2013, Hassani *et al.* 2013, Bousta *et al.* 2014, El Yahyaoui *et al.* 2015, Daoudi *et al.* 2016, Mikou *et al.* 2016, Barkaoui *et al.* 2017, Benali *et al.* 2017, Bouyahya *et al.* 2017, Laadim *et al.* 2017, Boulfia *et al.* 2018, El Haouari *et al.* 2018, Chaachouay *et al.* 2019, Fatiha *et al.* 2019, Mrabti *et al.* 2019, Zougagh *et al.* 2019, Hayat *et al.* 2020, Idm'hand *et al.* 2020, Mechchate *et al.* 2020), a semi-structured questionnaire (Supplementary material) used face to face has been formulated, includes the registration of the vernacular names of medicinal plants and their status, and 340 people (299 ordinary citizens and 41 herbalists) were interviewed.

Determination of scientific names.- A list of vernacular names of medicinal plants used by the surveyed population was compiled. The phonetic transcription of vernacular names is given by the correspondence between the Arabic letters and the French letters as follows: ا=a, ب=b, ت=t, ث=θ, ج=dʒ, 3, g, ح=h, خ=x, د=d, ر=r, ز=z, س=s, ش=ʃ, ص=sʕ, ض=dʕ, ظ=ʔ, ع=ʕ, غ=ɣ, ف=f, ق=q, ك=k, ل=l, م=m, ن=n, ه=h, و=w, ي=y, j, i:.

Almost all of the reported plants used in local traditional medicine have been collected and herbed, and a copy of the herbarium was deposited at the Laboratory of Natural Resources and Environment, Polydisciplinary Faculty of Taza, Sidi Mohamed Ben Abdellah University of Fes. The botanical identification of the scientific names was done by the botanist Pr. KHABBACH Abdelmajid (Laboratory of Biotechnology, Conservation and Valorization of Natural Resources, Faculty of Sciences Dhar El Mahraz, University Sidi Mohamed Ben Abdellah, Fez, Morocco), based on use of specialized literature (Nègre 1962, Quezel & Santa 1962-1963, Fennane *et al.* 1999, Valdés *et al.* 2002, Fennane *et al.* 2007, Fennane *et al.* 2014).

The presentation of the botanical family names of the plants was done in alphabetical order according to the APG III (Angiosperm Phylogeny Group) system (Haston *et al.* 2009). Scientific names of species and families have been updated. The updating and the checking of spelling and author extensions were done using (Bellakhdar 1997b, Fennane *et al.* 1999, Valdés 2002, Fennane *et al.* 2007, Fennane *et al.* 2014, Africain Plant Database 2021-2022 (APD 2022), BDPFA 2022, Tela Botanica 2022, The World Flora Online (WFO 2021-2023). Checklist endemism verification was performed based on the Africain (APD 2022) and Euro Med Plantbase (2023). Also, the research plant list of the present work has been examined in the Red List (IUCN 2023).

Data treatments. The entry and the treatment of the data recorded on the survey sheets were carried out by the IBM SPSS Statistics 25 software. Data analysis was carried out within the framework of descriptive statistics by simple methods of determining percentages and frequency. Graphs and tables obtained using IBM SPSS Statistics 25 software are represented by Microsoft Office Excel software. The map of the study area was created using ArcGIS software. The photos were taken using the Samsung Galaxy A51 smartphone.

Results

Interviews distribution. The results of the distribution of the surveyed population (amounts to 340 persons) among the studied communities (28 communities) are presented in [Table 1](#) as percentages and frequency.

Species of medicinal plants used in the Province of Taza. The results of the medicinal plant species used in traditional medicine by the population of the province of Taza and their characteristics are presented in [Appendix 1](#). Ninety-one species of medicinal plants were identified, whose scientific, vernacular names and herbarium codes are given in [Appendix 1](#). Seven new vernacular names have been listed: δ'ra: (*Pistacia lentiscus*), Zʕit'ra: (*Origanum compactum* Benth. and *Origanum vulgare*), Ta:u:t (*Globularia alypum*), i:zi:r (*Rosmarinus officinalis*), Mrmi:a: (*Salvia officinalis*) and Lba:kor/fri:ha : (*Ficus carica*). Scientific names of 28 species and nine families have been updated based on further works from Taza Province ([Table 2](#)).

The results obtained showed that the most frequent species ([Figure 3](#)) are respectively: *Salvia officinalis* (206), *Trigonella foenum-graecum* (154) and *Rosmarinus officinalis* (151) ([Appendix 1](#)). The results showed that 12 species (three spontaneous, four imported and five cultivated) were reported for the first time in a survey from Taza province, including *Atriplex halimus*, *Citrullus colocynthis* and *Micromeria graeca* that are spontaneous; *Aloe vera*, *Croton tiglium*, *Moringa oleifera* and *Coffea arabica* that are imported, and *Brassica oleracea* subsp. *Capitate*, *Sesamum indicum*, *Cenchrus americanus* Morrone / *Cenchrus spicatus* Cav., *Triticum turgidum* and *Capsicum annuum* that are cultivated ([Appendix 1](#)). Moreover, among these three new spontaneous species, *Micromeria graeca* was the only species mentioned in a single community (the community of Bab Marzouka).

The most used spontaneous taxa are respectively *Rosmarinus officinalis*, *Olea europaea* subsp. *europaea*, *Artemisia herba-alba*, *Mentha pulegium*, *Origanum compactum* and *Calamintha nepeta* subsp. *spruneri* (*Clinopodium nepeta* subsp. *glandulosum*) with (6.6, 5.3, 4.6, 4.0, 3.6 and 2.3 %, respectively) ([Figure 3](#)).

Table 1. Percentage and frequency refer to the total number of interviews applied

Community	Percentage (%)	Frequency
Taza	15.29	52
Aknoul	6.76	23
Oued Amlil	5.58	19
Tahla	4.41	15
Taifa	4.41	15
Bab Boudir	4.12	14
Galdamane	4.12	14
Bab Marzouka	3.53	12
Ghiata Al Garbia	3.24	11
Maghrawa	3.24	11
Msila	3.24	11
Bni Ftah	2.94	10
Meknassa Al Gharbia	2.94	10
Oulad Zbair	2.94	10
Traiba	2.94	10
Bni Lent	2.65	9
El Gouzate	2.65	9
Bouhlou	2.65	9
Meknassa Acharqia	2.65	9
Gzenaya Al Janoubia	2.35	8
Matmata	2.35	8
Jbarna	2.35	8
Oulad Chrif	2.35	8
Ajdir	2.06	7
Kaf El Ghar	2.06	7
Tainaste	2.06	7
Tizi Oualsi	2.06	7
Bouchfaa	2.06	7
Total	100	340

Systematic analysis of local medicinal flora. Botanical family.- Forty-eight families were identified for 91 species ([Appendix 1](#)). The seven most frequent families ([Figure 4](#)) are Lamiaceae (33.5 %) with 16 species, followed by Asteraceae (8.9 %), Fabaceae (8.2 %), Apiaceae (7 %), Oleaceae (5.3 %) and Myrtaceae (4.1 %).

Genus.- 84 genus of medicinal plants have been identified ([Appendix 1](#)). The genus *Salvia* (9 %), *Trigonella* (6.8 %) and *Rosmarinus* (6.6 %) are the most represented.

Plant statue.- The results obtained ([Table 3](#)) showed that the statue of the plant used is dominated by spontaneous plants constituting 55.9 % of the total plants. While the introduced naturalized plants constitute 20.3 %, the cultivated plants occupy 18.0 % and the rest (5.8 %) are imported ([Table 3](#)).

Checklist of medicinal plants of the province of Taza. In addition to 91 species of medicinal plants and 48 botanical families revealed in our survey ([Appendix 1](#)), the sorting of the results of this comparison made it possible to gather 111 species and 27 families. In total, our checklist includes 202 species (91 + 111) and 75 families (48 + 27) ([Appendix 1](#) and [2](#)).

Updating taxa and families in Taza (Morocco) via survey

Table 2. Updated scientific names of species and families based on further work from Taza Province. [Ref: References. (1): Khabbach *et al.* 2012. (2): Boulfia *et al.* 2018. (3): El Haouari *et al.* 2018. (4): El Brahimi *et al.* 2022.].

Family	Family updated	Scientific name	Scientific names updated	Ref
Liliaceae	Alliaceae	<i>Allium cepa</i> , <i>Allium sativum</i>	-	4
Liliaceae	Linaceae	<i>Linum usitatissimum</i>	-	4
Asparagaceae	Euphorbiaceae	<i>Caralluma europeae</i>	<i>Euphorbia resinifera</i> O. Berg	4
Molluginaceae	Caryophyllaceae	<i>Corrigiola telephiifolia</i>	<i>Corrigiola telephiifolia</i> Pour.	4
-	-	<i>Petroselinum sativum</i>	<i>Petroselinum crispum</i>	3
-	-	<i>Lippia citriodora</i>	<i>Aloysia citriodora</i>	3
-	-	<i>Chamaemelum fuscatum</i>	<i>Matricaria chamomilla</i>	1,2
-	-	<i>Opuntia maxima</i>	<i>Opuntia ficus-indica</i>	1
-	-	<i>Ammi visnaga</i>	<i>Visnaga daucoides</i>	1,3
-	-	<i>Foeniculum vulgare</i>	<i>Anethum foeniculum</i>	1,3,4
-	-	<i>Aristolochia longa</i>	<i>Aristolochia fontanesii</i>	4
-	-	<i>Inula viscosa</i> , <i>Inula viscosa</i>	<i>Dittrichia viscosa</i> Greuter	1,3
Caryophyllaceae	Illecebraceae	<i>Herniaria hirusta</i>	-	1,3,4
Chenopodiaceae	Amaranthaceae	<i>Chenopodium ambrosioides</i>	<i>Dysphania ambrosioides</i>	1,2,3,4
		<i>Tetralinis articulata</i> Benth	<i>Tetralinis articulata</i> (Vahl)	3
Leguminosae, Fabaceae	Caesalpiniaceae	<i>Ceratonia siliqua</i>	-	1,3,4
-	-	<i>Trigonella foenum graecum</i>	<i>Trigonella foenum-graecum</i>	4
-	-	<i>Ajuga iva</i>	<i>Ajuga iva</i> Schreb.	3
-	-	<i>Calamintha sylvatica</i> Bromf, <i>Calamintha officinalis</i> Moench and <i>Satureja calamintha nepeta</i>	<i>Calamintha nepeta</i> subsp. <i>spruneri</i> (Boiss.) Nyman	1,3,4
-	-	<i>Mentha viridis</i>	<i>Mentha spicata</i>	4
-	-	<i>Cinnamomum cassia</i> , <i>Cinnamomum zeylanicum</i> and <i>Cinnamomum verum</i>	<i>Cinnamomum cassia</i>	1,3,4
-	-	<i>Malva sylvestris</i> L.	<i>Malva pusilla</i> Sm.	4
-	-	<i>Olea europea</i> Var. <i>Oleaster</i> , <i>Olea europea</i> var. <i>sativa</i>	<i>Olea europaea</i> subsp. <i>europaea</i>	4
-	-	<i>Pennisetum glaucum</i> and <i>Panicum miliaceum</i>	<i>Cenchrus americanus</i> Morrone / <i>Cenchrus spicatus</i> Cav.	1,3
-	-	<i>Prunus amygdalus stokes</i> var. <i>amara</i>	<i>Prunus dulcis</i> Webb	4
Plantaginaceae	Globulariaceae	<i>Globularia alypum</i>	-	2

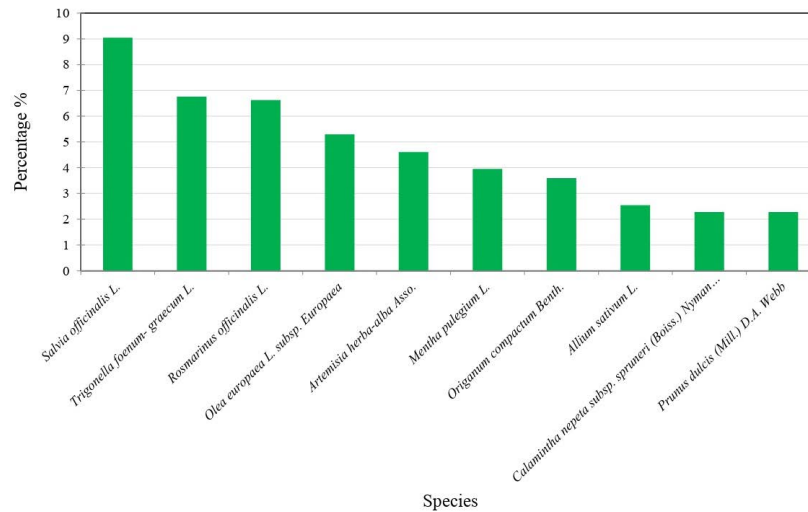


Figure 3. The most used medicinal species in the province of Taza.

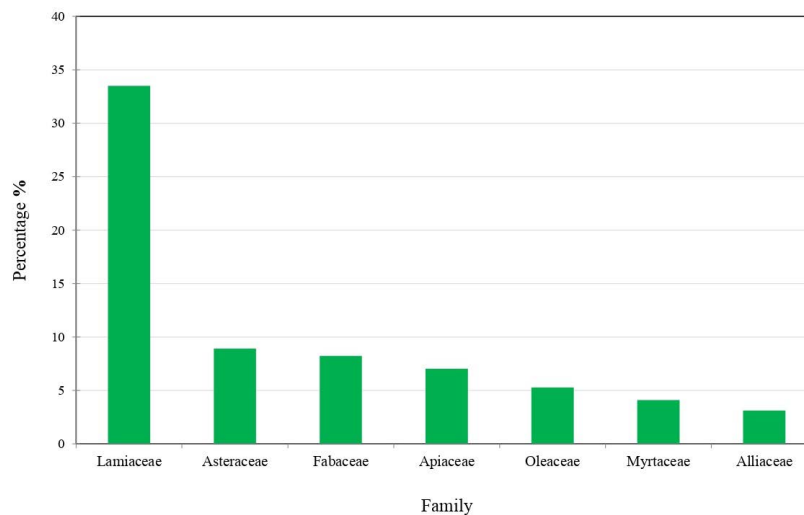


Figure 4. The most used families in the province of Taza.

Endemism and Red List. Among the medicinal species (202 species) constituting the checklist of the province of Taza, 65 species ([Appendices 1](#) and [2](#)) present a specific endemism of which 70.77 % (46 species) are endemic to North Africa, 16.92 % are endemic to Morocco-Algeria, 10.77 % are endemic to Morocco and 1.54 % are endemic to Morocco-Iberia-Algeria ([Figure 5](#)).

Among the medicinal species (202 species) constituting the checklist of the province of Taza, 77 species (including 48 spontaneous) ([Appendices 1](#) and [2](#)) are on the red list, of which 84.41 % (65 species) are of least concern, 7.79 % are vulnerable, 3.90 % are data deficient, 1.30 % are respectively endangered, critically endangered and near threatened ([Figure 6](#)).

Discussion

Interviews distribution. The results obtained from the distribution of the population interviewed among the studied communities showed that the number of Interviews increases proportionately with the increase of the population density of the communities. This is why the number of interviews in the Taza community (52 interviews) remains higher than those in other communities ([Table 1](#)). Indeed, this can be explained by the ease of traveling and finding interviewees in certain communities compared to others characterized by difficult roads and terrain ([Figure 2](#)).

Table 3. Statue of medicinal plants used by the population of Taza.

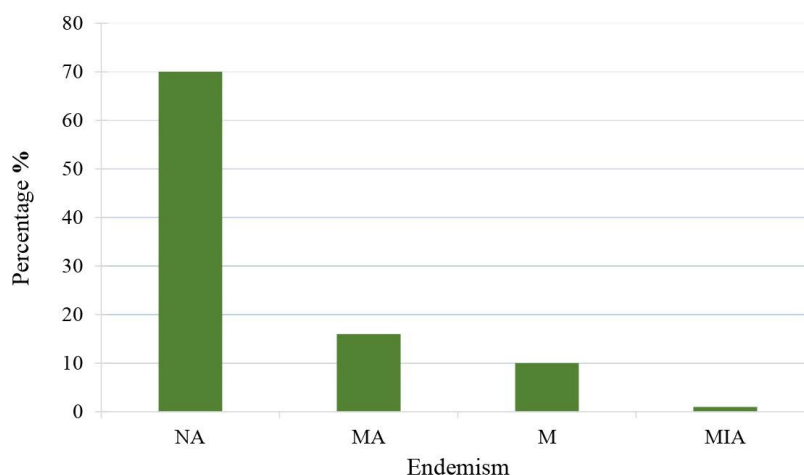
Plant statue	Frequency		Percentage (%)	
Plant statue	Spontaneous	1,274	55.9	
	Introduced naturalized	462	20.3	
	Cultivated	410	18.0	
	Imported	132	5.8	

Medicinal plants used in the Province of Taza. The expansion of the study area (28 municipalities) allowed us to list seven new vernacular names: *ḍra*: (*Pistacia lentiscus*), *Zḡitʿra*: (*Origanum compactum* and *Origanum vulgare*), *Ta:u:t* (*Globularia alypum*), *i:zi:r* (*Rosmarinus officinalis*), *Mmi:a*: (*Salvia officinalis*) and *Lba:kor/ʃri:ha* (*Ficus carica*) compared to other previous works (Khabbach *et al.* 2012, Boulfia *et al.* 2018, El Haouari *et al.* 2018, El Brahimi *et al.* 2022). Whereas here we found confusion (between *Zḡitʿra*: and *Zḡtʿa:r*), because, in the communities of Jbarna and Gzenaya Al Janoubia, the vernacular name of *Zḡitʿra*: is also used for *Origanum compactum* and *Origanum vulgare* than to *Thymus* sp. However, *Zḡitʿra*: is used as the vernacular name of *Thymus* sp. in the surveys carried out in the municipalities of the province of Taza (Khabbach *et al.* 2012, Boulfia *et al.* 2018, El Haouari *et al.* 2018, El Brahimi *et al.* 2022).

A scientific name of the species can have several vernacular names and the opposite. Based on our survey associated with we found several species that share the same vernacular name such as *Phillyrea angustifolia*, *Phillyrea latifolia* and *Rhamnus alaternus* (*Mli:ls*), *Pinus halepensis* and *Pinus pinaster* (*ta:uda:*), *Syzygium aromaticum* and *Eugenia caryophyllata* (*Lqru:nfl*), *Hispida maxim* and *Glycine max* (*So3 a:*), *Origanum compactum*, *Origanum vulgare* and *Origanum elongatum* (*Zḡtʿa:r/ zu:i:/Zḡtʿa:r/*) and *Thymus zygis*, *Thymus manbyanus* subsp. *ciliatus* (*Zḡitʿra:/ zdu:ʃn*) as have been mentione in other studies (Khabbach *et al.* 2012, Boulfia *et al.* 2018, El Haouari *et al.* 2018, El Brahimi *et al.* 2022).

Updating of scientific names of species and families in Taza province was made to maintain their stability and accuracy in identification and classification, which will facilitate future work on these plants.

Comparing the number of plant species (91) obtained in this ethnobotanical survey to that found in some international surveys realized in 2021-2022, we found that our result is higher than that of Singh *et al.* (2022) in the Dindori District of Madhya Pradesh, India (41 species), Megersa & Woldetsadik (2022) in Damot Woyde District, Wolaita Zone, Southern Ethiopia (57 species), Dutta *et al.* (2022) in Urban of Kolkata, India (53 species), Srinivasan *et al.* (2022) in the Delta Regions of Tamil Nadu, India (77 species), Souilah *et al.* (2022) in Central Russikada, northeastern Algeria (73 species) and Ammar *et al.* (2021) in the karst area of Pacitan District, East Java, Indonesia (51 species). However, the number of species found remains lower than those reported by Johnny *et al.* (2022) in southern Sierra Leone (128 species).

**Figure 5.** Endemism of spontaneous medicinal plant of our checklist [M: Morocco, MA: Morocco-Algeria, MIA: Morocco-Iberia-Algeria, NA: North Africa].

In the province of Taza, the number of species identified as medicinal plants is higher than those reported respectively by Khabbach *et al.* (2012) and Boulfia *et al.* (2018). This may be due to the method followed during the survey, the size and diversity of the study area which is larger and more representative (14 communities are studied for the first time) of various ecological niches, and the presence of diverse habitats such as mountains and forests, while El Haouari *et al.* (2018) and El Brahimi *et al.* (2022) which were specific in terms of number and type of population studied have reported respectively 104 and 105 species.

Compared respectively to the other Moroccan Provinces of Errachidia, Chtouka Ait Baha and Tiznit, Sidi Slimane, Casablanca, Nador, Fez and Al Haouz (Tahraoui *et al.* 2007, Barkaoui *et al.* 2017, Laadim *et al.* 2017, Zougagh *et al.* 2019, Hayat *et al.* 2020, Mechchate *et al.* 2020, Ghanimi *et al.* 2022), we noted that the number of species found are respectively (45, 48, 59, 46, 44, 50 and 64 species). This result explains the ecological and ethnobotanical richness that characterizes the population of the province of Taza at the Moroccan level.

Some of those 91 species have been mentioned by other Moroccan ethnobotanical surveys. Thus, the most used species *Salvia officinalis* (Figure 3) is also among the most used according to surveys conducted in different regions of Morocco (Hanae 2012, Khabbach *et al.* 2012, Benkhnigue *et al.* 2014, Bousta *et al.* 2014, Barkaoui *et al.* 2017, Laadim *et al.* 2017, Boulfia *et al.* 2018, El Haouari *et al.* 2018, Chaachouay *et al.* 2022). Moreover, this species has also been reported in other Moroccan surveys (Jouad *et al.* 2001, Tahraoui *et al.* 2007, El Amrani *et al.* 2010, Ghourri *et al.* 2013, Chaachouay *et al.* 2019).

The second most used species, *Trigonella foenum-graecum*, is reported among the most used in terms of frequency, which is also found among the most frequently used in Moroccan surveys by (Ziyyat *et al.* 1997, Jouad *et al.* 2001, Hanae 2012, Laadim *et al.* 2017, Fatiha *et al.* 2019, Mechchate *et al.* 2020) and it is mentioned in other works (El Hilaly *et al.* 2003, Tahraoui *et al.* 2007, El Amrani *et al.* 2010, Ghourri *et al.* 2013, Benkhnigue *et al.* 2014, Bousta *et al.* 2014). This species has been reported in other countries as in Algeria (Telli *et al.* 2016), India (Chacko 2003, Daimari *et al.* 2019) and Bangladesh (Rahmatullah *et al.* 2010).

The third species, *Rosmarinus officinalis*, has been reported as a frequently used species in other Moroccan provinces (Jouad *et al.* 2001, Tahraoui *et al.* 2007, El Amrani *et al.* 2010, Ghourri *et al.* 2013, Chaachouay *et al.* 2019, 2022, Beniaich *et al.* 2022) and in Algeria (Telli *et al.* 2016).

The three spontaneous medicinal plants mentioned for the first time in the province of Taza are already mentioned in other provinces of Morocco: *Atriplex halimus* (Idm'hand *et al.* 2020), *Citrullus colocynthis* (Barkaoui *et al.* 2017) and *Micromeria graeca*. (Teixidor-Toneu *et al.* 2016).

Based on previous studies carried out in the province of Taza, it is noted that species have already been identified: five species (Khabbach *et al.* 2012), five species (Boulfia *et al.* 2018), 13 species (El Haouari *et al.* 2018), seven species (Khabbach *et al.* 2012, Boulfia *et al.* 2018), nine species (Khabbach *et al.* 2012, El Haouari *et al.* 2018), three species (Boulfia *et al.* 2018, El Haouari *et al.* 2018) and 13 species (Khabbach *et al.* 2012, Boulfia *et al.* 2018, El Haouari *et al.* 2018). Recently, an ethnobotanical study carried out in a community of Bouchfaa in the province of Taza (El Brahimi *et al.* 2022), which is one of the 28th communities of our survey, have reported 105 plant species belonging to 52 botanical families. The inclusion of these studies over time allows for a cumulative understanding of the diversity of medicinal plants in Taza province. The studies have contributed to the knowledge base, and the present study has expanded the species list. Combining studies provides a more complete and diverse data set.

Systematic analysis of local medicinal flora. The 91 species recorded belong to 48 botanical families. Our results show that the seven most frequent families (Figure 4) are the Lamiaceae (33.5 %) with 16 species, followed by the Asteraceae (8.9 %), Fabaceae (8.2 %), Apiaceae (7 %), Oleaceae (5.3 %) and Myrtaceae (4.1 %). In Morocco, the families Lamiaceae and Asteraceae are the most represented (Khabbach *et al.* 2012, Boulfia *et al.* 2018, Fatiha *et al.* 2019, Idm'hand *et al.* 2020, El Khomsi *et al.* 2022). Indeed, Lamiaceae has been reported as the most represented by other works (Barkaoui *et al.* 2017, Bouyahya *et al.* 2017, El Haouari *et al.* 2018, Hayat *et al.* 2020, Beniaich *et al.* 2022, El Brahimi *et al.* 2022, Ghanimi *et al.* 2022). Abroad, the family Lamiaceae was reported as the most com-

Updating taxa and families in Taza (Morocco) via survey

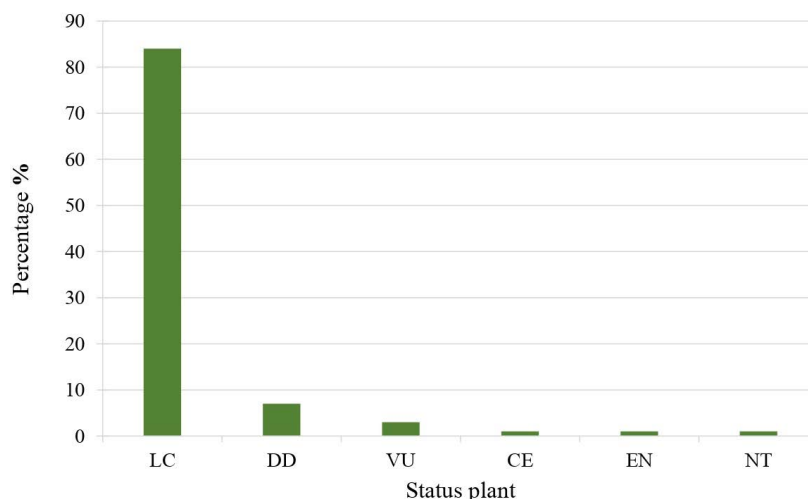


Figure 6. Status of plants in the red list [LC: Least Concern, DD: Data Deficient, VU: Vulnerable, CE: Critically Endangered, EN: Endangered, NT: Near Threatened].

mon by Souilah *et al.* (2022), and the family Asteraceae was the most represented (Megersa & Woldetsadik 2022). Indeed, the number of botanical families of the medicinal flora reported by other authors, on a national scale, is in the order of 28 families (Laadim *et al.* 2017), 34 families (Ghanimi *et al.* 2022), 46 families (El Khomsi *et al.* 2022), 70 families (Chaachouay *et al.* 2022) and 74 families (Fatiha *et al.* 2019).

The genus of *Salvia* (9 %), *Trigonella* (6.8 %) and *Rosmarinus* (6.6 %) are the most represented ([Appendix 1](#)). The 84 genera of medicinal plants identified in this study remain higher than that found in some surveys conducted in other Provinces of Morocco (Tahraoui *et al.* 2007, Barkaoui *et al.* 2017, Laadim *et al.* 2017, Zougagh *et al.* 2019, Hayat *et al.* 2020, Mechchate *et al.* 2020, Ghanimi *et al.* 2022). In addition, the three genera are among the most used according to surveys conducted in different regions of Morocco (Barkaoui *et al.* 2017, Laadim *et al.* 2017, Boulfia *et al.* 2018, El Haouari *et al.* 2018, Fatiha *et al.* 2019, Mechchate *et al.* 2020, Beniaich *et al.* 2022, Chaachouay *et al.* 2022 and in Algeria (Telli *et al.* 2016).

The medicinal plant's statue. The medicinal plants statue is dominated by spontaneous plants constituting 55.9 % of the total species. The results obtained for the status of the plants are not far from those of Mikou *et al.* (2016). The high percentage of indigenous plants suggests a rich diversity of indigenous flora in the province. The diverse composition of spontaneous, introduced, naturalized, cultivated and imported plants highlights the dynamic nature of the province's medicinal plant landscape. This diversity can provide a wide range of therapeutic options while reflecting the interaction between local ecological factors and human agricultural practices.

Checklist of medicinal plants of the province of Taza. The comparison with the four works previously carried out in certain communities of the province of Taza made it possible to enrich our list with other species and families: 30 species and 10 families (Khabbach *et al.* 2012), 28 species and seven families (Boulfia *et al.* 2018), 47 species and 12 families (El Haouari *et al.* 2018) and 39 species and 13 families (El Brahimi *et al.* 2022). Our checklist includes 202 species and 75 families ([Appendices 1](#) and [2](#)). Compiling this checklist of medicinal plant species in Taza province can help in conservation efforts (protection of rare or endangered species), preserve traditional knowledge, ensure their availability to future generations, guide research efforts, ensure the sustainability of important species, and the economic development of the province (source of income for the communities). Contextualizing the checklist (202 medicinal species) at the country level (Morocco), we find that it constitutes 23.41 % of the Moroccan medicinal flora found in Ennabili *et al.* (2023), 33.67 % of the Moroccan species classified as aromatic or medicinal (600 species)

according to Ismaili *et al.* (2021) and 40.40 % of Moroccan medicinal species (500 species) economically important according to Ennabili *et al.* (2000). The number of families found constitutes 72.11 % of the 104 botanical families found recently in Ennabili *et al.* (2023). Spontaneous species constitute 10.80 % of the 602 Moroccan spontaneous taxa found in Ennabili *et al.* (2023).

Endemism and Red List. The statue of the plant used is dominated by spontaneous plants constituting 55.9 % of the total plants (Table 3). This high percentage directed us toward the study of the endemism of the spontaneous plants of our checklist. 65 species (Appendices 1 and 2) present a specific endemism of which 70.77 % (46 species) are endemic to North Africa, 16.92 % are endemic to Morocco-Algeria, 10.77 % are endemic to Morocco and 1.54 % are endemic to Morocco-Iberia-Algeria (Figure 5). The limited geographic range of these endemic species often makes them more vulnerable to extinction. These identified species require specific protection against the threats of habitat loss, invasive species and climate change. Thus, these plants present the biogeographic evolutionary face of the province of Taza and Morocco and contribute to their overall biodiversity. Finally, as these endemic plants with medicinal properties are increasingly used in traditional medicine, understanding their particular endemism can help us identify new sources of medicines and develop new sustainable harvesting practices to protect them.

The IUCN red list has allowed us a comprehensive assessment of the conservation status of the species that make up our Taza province checklist. Identifying the 77 threatened species can help conservation organizations and other parties raise awareness of the need for urgent action to protect them. Thus, our red list is a scientific basis for the development of conservation and protection strategies and policies at the level of the province of Taza and even at the Moroccan level. Conservationists and policymakers can target their efforts more effectively on these plants and develop more effective conservation plans. In the future, this list should be updated regularly, to track changes in species populations and conservation status over time. Thus, this part shows a valuable tool to support international agreements and conventions.

The present study updates the local medicinal flora used in almost all the communities of the province of Taza. The expansion of the study area (14 municipalities out of 28 are surveyed for the first time), and the comparison with previous work within the province gives for the first time a global update of the medicinal flora. A checklist (202 taxa) of which 12 species have been newly listed in this studied province can constitute an excellent database to develop new scientific research based on ethnopharmacological studies to reveal biologically active molecules in the treatment of diseases. Also, the updating of vernacular names and scientific names will facilitate the scientific research of ecologists in this province through the stability and accuracy of identification.

Supplementary material

Supplemental data for this article can be accessed here: <https://doi.org/10.17129/botsci.3420>

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Appendix 1. Medicinal plants used in traditional medicine by the population of the province of Taza [VC: Voucher codes, VN: Vernacular name, SUF: Species use frequency, FUF: frequency of use of families, En: Endimism (M: Morocco, MA: Morocco-Algeria, MIA: Morocco-Iberia-Algeria, NA: North Africa), RL: Red list (LC: Least Concern, VU: Vulnerable, DD: Data Deficient, EN: Endangered).]

Family	Scientific name	VC NV	Plant statue	SUF	FUF	En RL
Agavaceae	<i>Agave sisalana</i> Perrine	<u>1</u> S'a:bra	Naturalized Introduced	1	1	
Alliaceae	<i>Allium cepa</i> L.	<u>2</u> Bs'la	Cultivated	12	70	
	<i>Allium sativum</i> L.	<u>3</u> Ou:ma:/ Ti'fa:rt	Cultivated	58		
Aloaceae	<i>Aloe vera</i> (L.) Burm. f.	<u>4</u> Oli:ra	Imported	3	3	
Amaranthaceae	<i>Atriplex halimus</i> L.	<u>5</u> Lkt'a:f	Spontaneous	5	42	
	<i>Dysphania ambrosioides</i> (L.) Mosyakin & Clemants	<u>6</u> Mxinja:	Introduced Natu- ralized Cultivated	37		
Anacardiaceae	<i>Pistacia lentiscus</i> L.	<u>7</u> ð'sra:/Atru:/ Fa:dis	Spontaneous	4	4	LC
Apiaceae	<i>Ammodaucus leucotrichus</i> Coss. & Durieu	<u>8</u> Lka:mu:n s'u:fi:	Spontaneous	9	160	NA
	<i>Visnaga daucooides</i> Gaertn.	<u>9</u> Bj'nixa:/ Tabj'nixt	Spontaneous	32		
	<i>Apium graveolens</i> L.	<u>10</u> Lkra:fs ^s	Spontaneous	14		LC
	<i>Carum carvi</i> L.	<u>11</u> Krwija:	Cultivated	2		
	<i>Coriandrum sativum</i> L.	<u>12</u> Qu:zbr	Naturalized Introduced	21		
	<i>Cuminum cyminum</i> L.	<u>13</u> Kamu:n	Introduced Natu- ralized Cultivated	9		
	<i>Anethum foeniculum</i> L.	<u>14</u> Lbsba:s/ Na:fʔ ^s	Spontaneous	33		
	<i>Pimpinella anisum</i> L.	<u>15</u> Hbt hla:wa:	Imported	5		
	<i>Petroselinum crispum</i> (Mill.) Fuss	<u>16</u> Mʔ ^s d ^s nu:s	Naturalized Introduced	35		
Apocynaceae	<i>Nerium oleander</i> L.	<u>17</u> ð'a:fla:/ A:i:riri:	Spontaneous	18	18	LC
Arecaceae	<i>Chamaerops humilis</i> L.	<u>18</u> ð ^s oum	Spontaneous	4	4	NA LC
Aristolochiaceae	<i>Aristolochia fontanesii</i> Boiss. & Reut.	<u>19</u> Brzt ^s m	Spontaneous	9	9	MA

Updating taxa and families in Taza (Morocco) via survey

Family	Scientific name	VC NV	Plant statue	SUF	FUF	En RL
Asteraceae	<i>Artemisia absinthium</i> L.	<u>20</u> j̄iba:	Spontaneous	51	203	
	<i>Artemisia herba-alba</i> Asso.	<u>21</u> j̄ih	Spontaneous	105		NA
	<i>Dittrichia viscosa</i> (L.) Greuter	<u>22</u> Ma:gra:mn/ Ba:i:ra:mn	Spontaneous	21		NA
	<i>Matricaria chamomilla</i> L.	<u>23</u> Lba:bounj	Spontaneous	21		NA
	<i>Scolymus hispanicus</i> L.	<u>24</u> kerni:na:	Spontaneous	5		NA
Berberidaceae	<i>Berberis hispanica</i> Boiss. & Reut.	<u>25</u> A:yris	Spontaneous	27	27	MIA
Brassicaceae	<i>Brassica oleracea</i> subsp. <i>capitata</i> (L.) Duchesne	<u>26</u> Kra:nb	Cultivated	4	46	DD
	<i>Lepidium sativum</i> L.	<u>27</u> Hb r̄ja:d	Introduced Cultivated	42		
Cactaceae	<i>Opuntia ficus-indica</i> (L.) Mill	<u>28</u> Lha:ndia:/ Ta:ha:nda:j̄t	Introduced Naturalized Cultivated	42	42	DD
Caesalpiniaceae	<i>Ceratonia siliqua</i> L.	<u>29</u> Lxa:roub/ Tasriywa:	Spontaneous	7	7	LC
Capparaceae	<i>Capparis</i> sp.	<u>30</u> Lka:ba:r	Spontaneous	6	6	LC
Caryophyllaceae	<i>Corrigiola telephifolia</i> Pour.	<u>31</u> S'a:ryina:	Spontaneous	24	24	MA LC
Cucurbitaceae	<i>Citrullus colocynthis</i> (L.) Sch	<u>32</u> Ha:nda:l	Spontaneous	11	11	
Cupressaceae	<i>Tetraclinis articulata</i> (Vahl) Mast.	<u>33</u> Lʔrʔʔa:r/ A:mrzi:	Spontaneous	33	33	NA LC
Euphorbiaceae	<i>Croton tiglium</i> L.	<u>34</u> Ha:b Lmlouk	Imported	1	38	LC
	<i>Euphorbia resinifera</i> O. Berg	<u>35</u> ð'a:ymu:s	Spontaneous / endemic to Morocco	37		M
Fabaceae	<i>Cicer arietinum</i> L.	<u>36</u> Ha:mu:s ^s	Cultivated	1	187	
	<i>Glycine max</i> (L.) Merr.	<u>37</u> Soʒ a:	Imported	2		
	<i>Glycyrrhiza glabra</i> L.	<u>38</u> ʔʔra:q su:s	Imported	7		LC
	<i>Lupinus albus</i> L.	<u>39</u> Ti:rmi:s	Imported	23		LC
	<i>Trigonella foenum-graecum</i> L.	<u>40</u> Lha:lba:/ Rhorba:t	Introduced Cultivated	154		
Fagaceae	<i>Quercus ilex</i> L.	<u>41</u> Lblout ^s / Lkori:j̄/Dbay	Spontaneous	3	3	LC
Gentianaceae	<i>Centaurium erythraea</i> Rafn	<u>42</u> kes'a:t Lha:ya:	Spontaneous	13	13	LC

Family	Scientific name	VC NV	Plant statue	SUF	FUF	En RL
Globulariaceae	<i>Globularia alypum</i> L.	43?nLa:ma:b/ Ta:srya/ Ta:u:t	Spontaneous	15	15	NA
Illecebraceae	<i>Herniaria hirsuta</i> L.	44 Ha:ra:st Lh3a:r	Spontaneous	30	30	
Juglandaceae	<i>Juglans regia</i> L.	45 Elkorka:2s	Imported Cultivated	18	18	LC
Lamiaceae	<i>Ajuga iva</i> (L.) Schreb.	46 jndgu:ra	Spontaneous	18	763	NA
	<i>Calamintha nepeta</i> subsp. <i>spruneri</i> (Boiss.) Nyman (<i>Clinopodium nepeta</i> subsp. <i>glan-</i> <i>dulosum</i> (Req.) Govaerts)	47 Ma:nta:/ Mi:nta:	Spontaneous	52		MA
	<i>Lavandula</i> sp.	48 Lxza:ma:	Spontaneous	51		VU
	<i>Lavandula stoechas</i> L.	49 Lha:lha:l	Spontaneous	7		NA
	<i>Marrubium vulgare</i> L.	50 Ma:rri:wa:/ ma:ru:i:	Spontaneous	23		
	<i>Mentha pulegium</i> L.	51 Fli:u:/ Fri:u:	Spontaneous	90		NA LC
	<i>Mentha rotundifolia</i> Muds.	52 Mfa:jtru: Mrsi:t'a:	Spontaneous Cultivated	3		LC
	<i>Mentha spicata</i> L.	53En2sna:2s	Introduced Cultivated	4		LC
	<i>Micromeria graeca</i> (L.) Benth. ex Rechb.	54bqu:lt nhl	Spontaneous	2		NA
	<i>Ocimum basilicum</i> L.	55Lhba:q	Cultivated	1		
	<i>Origanum compactum</i> Benth.	56Z2st'a:r/ zu:i:/ Zht'a:r/ Z2st'ra:	Spontaneous	82		M
	<i>Origanum majorana</i> L.	57 Ma:rda:doj	Spontaneous	12		
	<i>Origanum vulgare</i> L.	58Z2st'a:r/ zu:i:/Zht'a:r/ Z2st'ra:	Spontaneous	27		NA LC
	<i>Rosmarinus officinalis</i> L.	59 A:zi:r/ i::zi:r	Spontaneous	151		NA
	<i>Salvia officinalis</i> L.	60 S'a:lmia:/ Mrmia:	Naturalized Introduced	206		LC
	<i>Thymus</i> sp.	61 Z2st'ra:/ zdu:jn	Spontaneous	34		
Lauraceae	<i>Cinnamomum cassia</i> Lour.	62 Qa:rfa:	Imported	50	50	

Updating taxa and families in Taza (Morocco) via survey

Family	Scientific name	VC NV	Plant statue	SUF	FUF	En RL
Linaceae	<i>Linum usitatissimum</i> L.	63Za:riʔt Lkta:n	Cultivated	4	4	
Malvaceae	<i>Hibiscus sabdariffa</i> L.	64 Ka:rka:dʔi:l	Cultivated	13	15	
	<i>Malva pusilla</i> Sm.	65Xobiza:	Cultivated	2		
Moraceae	<i>Ficus carica</i> L.	66Lka:rmu:sʔ/ Ryars/Lbakor/ ʔri:ha:	Spontaneous	2	2	LC
Moringaceae	<i>Moringa oleifera</i> Lam.	67Mu:ri:nga:	Imported	2	2	LC
Myrtaceae	<i>Eucalyptus globulus</i> Labill.	68 Lka:litu:s	Cultivated	37	93	LC
	<i>Eugenia caryophyllata</i> Thunb.	69 Lqru:nfl/	Imported	27		
	<i>Myrtus communis</i> L.	70 Ri:ha:n	Spontaneous	29		LC
Oleaceae	<i>Olea europaea</i> L. subsp. <i>europaea</i>	71Zitu:n/ Zitu:n Lbldʔi:/ Zitu:n Lbri:	Spontaneous	120	120	NA
Pedaliaceae	<i>Sesamum indicum</i> L.	72Ga:nʒla:n	Cultivated	1	1	
Poaceae	<i>Cenchrus americanus</i> (L.) Morrone / <i>Cenchrus spicatus</i> (L.) Cav.	73 I:la:n	Cultivated	2	18	
	<i>Triticum turgidum</i> L.	74Qma:h	Cultivated	3		LC
	<i>Zea mays</i> L.	75ʔʔora:	Cultivated	13		LC
Polygonaceae	<i>Emex spinosa</i> (L.) Campd	76 Hu:ma:i:dʔa:	Spontaneous	1	1	NA
Punicaceae	<i>Punica granatum</i> L.	77 Rma:n	Cultivated	39	39	LC
Ranunculaceae	<i>Nigella sativa</i> L.	78Sʔa:nu:dʒ/ Lha:ba swda:	Cultivated	21	21	
Rhamnaceae	<i>Rhamnus alaternus</i> L.	79Mli:ls	Spontaneous	1	9	NA LC
	<i>Ziziphus lotus</i> (L.) Lam.	80Sa:dʔra:/ Anba:q	Spontaneous	8		
Rosaceae	<i>Crataegus monogyna</i> Jacq.	81Zʔru:r/ Adma:m	Spontaneous	3	56	LC
	<i>Fragaria vesca</i> L.	82Fri:z	Cultivated	1		
	<i>Prunus dulcis</i> (Mill.) D.A. Webb	83 Loz Lha:r	Introduced	52		
Rubiaceae	<i>Coffea arabica</i> L.	84 Qhwa:	Imported	4	4	EN
Salicaceae	<i>Populus alba</i> L.	85Sʔfsʔa:f	Spontaneous	2	2	LC
Sapotaceae	<i>Argania spinosa</i> (L.) Skeels	86 A:rga:n	Spontaneous	1	1	MA VU
Solanaceae	<i>Capsicum annuum</i> L.	87 Lflfl Lha:r	Cultivated	4	4	LC
Urticaceae	<i>Urtica dioica</i> L.	88 Hu:rri:ga:	Spontaneous	8	8	LC

Family	Scientific name	VC NV	Plant statue	SUF	FUF	En RL
Verbenaceae	<i>Aloysia citriodora</i> Palau.	<u>89</u> Ma:lwiza:	Cultivated	36	36	
Zingiberaceae	<i>Zingiber officinale</i> Roscoe	<u>90</u> Ski:n3bi:r	Spontaneous	14	14	DD
Zygophyllaceae	<i>Peganum harmala</i> L.	<u>91</u> Lha:rm a:l	Spontaneous	1	1	
Total 48		91		2278		

Appendix 2. Other medicinal species and families based on later works from Taza Province. [References. (1): Khabbach *et al.* 2012. (2): Boulfia *et al.* 2018. (3): El Haouari *et al.* 2018. (4): El Brahimi *et al.* 2022.]. [SN: Species numbers, *: Spontaneous. En: Endimism (M: Morocco, MA: Morocco-Algeria, MIA: Morocco-Iberia-Algeria, NA: North Africa), *RL*: Red list (*LC*: Least Concern, *VU*: Vulnerable, *DD*: Data Deficient, *CE*: Critically Endangered, *NT*: Near Threatened)].

Family	<u>SN</u> Scientific name	References	En RL *
Agavaceae	<u>92</u> <i>Agave americana</i> L.	4	
Amaranthaceae	<u>93</u> <i>Beta vulgaris</i> L.	4	CE*
Anacardiaceae	<u>94</u> <i>Pistacia atlantica</i> Desf.	4,3	NA
Apiaceae	<u>95</u> <i>Ammoides pusilla</i> (Brot.)	2	NA
	<u>96</u> <i>Daucus crinitus</i> Desf.	3	MA
	<u>97</u> <i>Thapsia garganica</i> L.	3	NA
	<u>98</u> <i>Ferula communis</i> L.	3	LC*
Apocynaceae	<u>99</u> <i>Ptychotis verticillata</i> L.	3	
Asteraceae	<u>100</u> <i>Taraxacum erythrospermum</i> Andr. ex Besser	1	M
	<u>101</u> <i>Tanacetum annuum</i> L.	2,1	
	<u>102</u> <i>Achillea odorata</i> L. subsp. <i>pectinata</i> (lamk) Briq.	1	
	<u>103</u> <i>Atractylis gummifera</i> L.	4,3	LC
	<u>104</u> <i>Cnicus benedictus</i> L.	3	
	<u>105</u> <i>Conyza canadensis</i> L.	4	
	<u>106</u> <i>Cynara scolymus</i> L.	4	
	<u>107</u> <i>Cynara cardunculus</i> L.	3,1	
	<u>108</u> <i>Centaurea chamaer</i>	4	
	<u>109</u> <i>Anacyclus pyrethrum</i> L.	3	NA VU*
Asparagaceae	<u>110</u> <i>Argyranthemum frutescens</i>	4	
	<u>111</u> <i>Asparagus officinalis</i>	4	NA LC*
Boraginaceae	<u>112</u> <i>Borago officinalis</i> L.	1	NA
Brassicaceae	<u>113</u> <i>Brassica rapa</i> L.	4	
	<u>114</u> <i>Brassica napus</i> L.	3	NA
	<u>115</u> <i>Sinapis arvensis</i> L.	4	
Burseraceae	<u>116</u> <i>Commiphora Africana</i> (A. Rich.) Engl.	3	LC
	<u>117</u> <i>Boswellia sacra</i> Flueck.	3	NT
Caryophyllaceae	<u>118</u> <i>Silene vulgaris</i> (Moench) Garcke.	2	MA LC*
	<u>119</u> <i>Saponaria officinalis</i> L.	4,3	
Chenopodiaceae	<u>120</u> <i>Haloxylon scoparium</i> Pomp.	3	

Updating taxa and families in Taza (Morocco) via survey

Family	SN Scientific name	References	En RL *
Cistaceae	<u>121</u> <i>Cistus ladanifer</i> L.	2,1	M
	<u>122</u> <i>Cistus salviifolius</i> L.	2	NA
Cistaceae	<u>123</u> <i>Fumana scoparia</i> Pomel.	2	NA
Cucurbitaceae	<u>124</u> <i>Lagenaria siceraria</i> Standl	3	
Cupressaceae	<u>125</u> <i>Juniperus phoenicea</i>	4	LC
Cyperaceae	<u>126</u> <i>Cyperus rotundus</i> L.	3	LC*
Euphorbiaceae	<u>127</u> <i>Euphorbia echinus</i> Hook.f. & Coss.	3	M
Ericaceae	<u>128</u> <i>Arbutus unedo</i> L.	4,2,1	NA LC*
Fabaceae	<u>129</u> <i>Cassia senna</i> L.	3	
	<u>130</u> <i>Hispida maxim.</i>	3	
	<u>131</u> <i>Ononis natrix</i> L.	2,1	NA LC*
	<u>132</u> <i>Medicago sativa</i> L.	4	LC*
	<u>133</u> <i>Tamarindus indica</i> L.	3	LC
	<u>134</u> <i>Trifolium</i> spp.	3	LC
	<u>135</u> <i>Retama monosperma</i> (L.) Boiss	3	NA
	<u>136</u> <i>Anthyllis cytisoides</i> L.	2	MA
	<u>137</u> <i>Lens culinaris</i> Medik.	1	
	<u>138</u> <i>Retama raetam</i> (Forssk.)	4	NA
	<u>139</u> <i>Vicia ervilia</i> (L.) willd.	4,1	LC*
Fagaceae	<u>140</u> <i>Quercus suber</i> L.	3	NA LC*
Gentianaceae	<u>141</u> <i>Centaurium maritimum</i> (L.) Fritsch.	2	
Iridaceae	<u>142</u> <i>Crocus sativus</i> L.	4,3	
Juncaceae	<u>143</u> <i>Juncus acutus</i> L.	4,2,1	LC*
Lamiaceae	<u>144</u> <i>Lavandula multifida</i> L.	4,1	NA
	<u>145</u> <i>Lavandula officinalis</i> L.	4	
	<u>146</u> <i>Mentha suaveolens</i> Ehrh.	3,2,1	NA LC*
	<u>147</u> <i>Origanum</i> spp.	2	LC*
	<u>148</u> <i>Origanum elongatum</i> .	2	M
	<u>149</u> <i>Salvia verbenava</i> L.	2	
	<u>150</u> <i>Teucrium polium</i> L.	3	
	<u>151</u> <i>Teucrium polium</i> ssp. <i>Polium</i> .	2	
	<u>152</u> <i>Thymus zygis</i>	4,2,1	M
	<u>153</u> <i>Thymus manbyanus</i> ssp. <i>ciliatus</i> Bois & Rent.	2	
	<u>154</u> <i>Thymus vulgaris</i>	3	NA LC*
Lauraceae	<u>155</u> <i>Laurus nobilis</i> L.	4,3	MA LC*
Liliaceae	<u>156</u> <i>Charybdis maritima</i> (L.)	4	LC*
Lythraceae	<u>157</u> <i>Lawsonia inermis</i> L.	4,3,1	LC
Myristicaceae	<u>158</u> <i>Myristica fragrans</i> Houtt.	1	DD
Myrtaceae	<u>159</u> <i>Eucalyptus</i> spp.	4	
	<u>160</u> <i>Syzygium aromaticum</i> (L.) Merr. & Perry	4	
Papaveraceae	<u>161</u> <i>Papaver rhoeas</i> L.	4,3	NA

Family	SN Scientific name	References	En RL *
Oleaceae	<u>162</u> <i>Phillyrea angustifolia</i> L.	3	MA
	<u>163</u> <i>Phillyrea latifolia</i> L.	2,1	NA LC*
	<u>164</u> <i>Fraxinus angustifolia</i> Vahl	3	MA LC*
Poaceae	<u>165</u> <i>Arundo donax</i> L.	1	LC*
	<u>166</u> <i>Cynodon dactylon</i> (L.) Pers.	4,1	
	<u>167</u> <i>Hordeum vulgare</i> L.	4	NA
	<u>168</u> <i>Avena sativa</i> L.	3	
Pinaceae	<u>169</u> <i>Pinus halepensis</i> Mill.	1	NA LC*
Selaginellaceae	<u>170</u> <i>Pinus pinaster</i> Aiton.	4,3,2	NA LC*
	<u>171</u> <i>Selaginella</i> spp.	2	
Piperaceae	<u>172</u> <i>Piper cubeba</i> L.	3,1	
	<u>173</u> <i>Piper longum</i> L.	3	
Plantaginaceae	<u>174</u> <i>Plantago major</i> L.	2	NA LC*
Ranunculaceae	<u>175</u> <i>Clematis flammula</i> L.	2	NA
	<u>176</u> <i>Delphinium staphysagria</i> L.	3	
Rhamnaceae	<u>177</u> <i>Ziziphus zizyphus</i> H. Karst.	2	
Rosaceae	<u>178</u> <i>Rubus fruticosus</i> L.	1	
	<u>179</u> <i>Cydonia oblonga</i> Mill	1	LC
	<u>180</u> <i>Eriobotrya japonica</i> (Thunb.) Lindl.	1	
	<u>181</u> <i>Rosa centifolia</i> L.	4,3	
Rubiaceae	<u>182</u> <i>Rubia peregrina</i> L.	3	NA
Rutaceae	<u>183</u> <i>Citrus aurantium</i> L.	4	
	<u>184</u> <i>Citrus saliaefolius</i> L.	3	
	<u>185</u> <i>Ruta graveolens</i> L.	3	
	<u>186</u> <i>Ruta montana</i> L.	2,1	MA
	<u>187</u> <i>Citrus limon</i> (L.) Burm. F	4,1	LC
Salvadoraceae	<u>188</u> <i>Salvadora persica</i> L.	3	LC
Schisandraceae	<u>189</u> <i>Illicium verum</i> Hook L.	3	
Solanaceae	<u>190</u> <i>Solanum tuberosum</i> L.	1	
	<u>191</u> <i>Hyoscyamus albus</i> L.	1	NA
Tamaricaceae	<u>192</u> <i>Tamarix africana</i> Poir.	2	NA LC*
Theaceae	<u>193</u> <i>Camellia sinensis</i> (L.) Kuntze	4	DD
Thymelaeaceae	<u>194</u> <i>Daphne gnidium</i> L.	4,3,2	NA
Typhaceae	<u>195</u> <i>Typha latifolia</i> L.	1	LC*
Xanthorrhoeaceae	<u>196</u> <i>Asphodelus microcarpus</i>	4	LC
Valerianaceae	<u>197</u> <i>Valeriana Officinalis</i> L.	3	
Vitaceae	<u>198</u> <i>Vitis vinifera</i> L.	4,1	NA LC*
Zingiberaceae	<u>199</u> <i>Amomum granaparadisi</i> L.	3	
	<u>200</u> <i>Alpinia officinarum</i> Hance	3	
	<u>201</u> <i>Elettaria cardamomum</i> (L.) Maton	3	
	<u>202</u> <i>Curcuma longa</i>	4	DD