



Ethnobotanical survey on the use of aromatic and medicinal plants for children under 5 years old, in Taza, Morocco

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Research

Abstract

Background: The medicinal and aromatic plants (AMPs) use in Morocco is deeply rooted in the traditional culture and plays a key role in daily healthcare practices. The current work examines the AMPs use in Taza province (northeastern Morocco) and focus on the species most frequently used for children under 5 years old.

Methods: An ethnobotanical survey was conducted among 416 interviewed people. The data collected were analyzed using the most studied ethnobotanical indices, and the relationships between patterns of plant use and population's socio-demographic characteristics were determined. Moreover, an exploratory factor analysis by principal component analysis (PCA) was carried out in order to identify the underlying dimensions of the variables studied. Finally, a rule-based machine learning method was used, for the first time to the best of our knowledge, to determine satisfaction across the studied variables.

Results: Most respondents (99.76%) use AMPs to treat children under five. 58 species from 28 botanical families were identified, with predominance of use of the Lamiaceae family (Family Value Index: FVI =80.7%); and of *Origanum compactum* Benth (RFC = 31.97%) and *Aloysia citrodora* Palau (23.55%). The main therapeutic indication corresponds to digestive disorders (72.6%), with a main use of leaves (78.1%). The dominant preparation method is decoction (71.3%) and prevailing administration is oral mode (89.4%).

Conclusion: AMPs occupy a central place in local traditional medicine for children under five in Taza province. This study provides a structured ethnobotanical database that can support future research in phytochemistry and pharmacology, particularly regarding the safety and efficacy of pediatric uses.

Keywords: Ethnobotany, child under five years old, association rules, Taza.

Background

Aromatic and medicinal plants (AMPs) play a fundamental role in the healthcare sector and represent a crucial therapeutic resource for humans worldwide, particularly in developing countries. Indeed, they represent inexpensive, largely available, and widely accepted traditional treatments (WHO 2013), thanks to the presence of a diversity of bioactive constituents, and to a large biological potential including antimicrobial, antioxidant or anti-inflammatory activities, offering valuable alternative or complementary compounds namely against emerging antibiotic-resistant bacteria (Abass *et al.* 2024).

However, the safety and efficacy of AMPs are poorly characterized despite their widespread use. Indeed, composition of AMPs preparations differ according to plant species, geographical origin, production and processing conditions, and their effect vary among exposed populations (WHO 2025). Moreover, Toxicological studies are still lacking, and interactions with typical medications are frequently poorly described, raising questions about side effects, particularly in vulnerable targets (Hazra & Singh 2024). Therefore, the WHO emphasizes, in its Global Traditional Medicine Strategy 2025–2034, the critical need for strengthening scientific evidence, and ensuring quality, safety and regulatory mechanisms applicable to products and practices of traditional medicine (WHO 2025).

Such issues are particularly relevant in children. Indeed, physiological and developmental changes throughout childhood may affect pharmacokinetics, pharmacodynamics and tolerance of biologically active substances. Thereafter, data obtained on adults cannot systematically be extrapolated to pediatric populations. Hensel *et al.* (2024) confirmed that there is insufficient evidence for establishing AMPs' appropriate pediatric use particularly regarding dosing, safety and efficacy. Documenting the traditional use of AMPs in young children as well as critical appraisal of available scientific evidence would therefore help characterize these practices and identify knowledge gaps.

Morocco is a particularly suitable context for this type of study because of its great floristic diversity and the persistence of traditional knowledge on medicinal plants use. In Fez-Meknes region, mainly the Taza province, several ethnobotanical surveys have recently shown the important local ethnobotanical knowledge and the high number of AMPs species used in traditional healthcare practices (El Finou *et al.* 2023; Ghabbour *et al.* 2023, Ghabbour *et al.* 2024, El Aboui *et al.* 2024, Ourgha *et al.* 2025). However, these studies have mostly focused on the use of medicinal plants in general population (mainly adults) and very little is known about children 0-5 years old. Which represent a large knowledge gap and require to answer several questions, including: Which plants are used by this age group; what are their traditional indications; whether or not these uses are concordant with biological evidence available? Targeted documentation of these practices could thus be useful both for the conservation of local ethnobotanical knowledge and its interpretation in terms of scientific evidence.

In this context, the objective of this study is to document the practices related to the use of AMPs in the healthcare of children under five years old in the province of Taza, Morocco. More specifically, it seeks to identify the plant species used, their preparation methods and administration routes, as well as the main indications for their use. It also aims to describe the sociodemographic profiles of the respondents and to examine any possible associations between their characteristics and the practices reported. Finally, the study contributes to the documentation and preservation of local ethnobotanical knowledge and provides a database that can guide future research on the phytochemical characterization, biological properties and safety assessment of the species identified, without making any assumptions about their therapeutic efficacy.

Material and Methods

Study Area

Taza is a province in the Fez-Meknes region, located in northeastern Morocco (Figure 1), at approximate geographical coordinates 34° 13' N latitude and -4°00' W longitude and at an average altitude of about 509,22 meters above sea level (Meteostat 2026), within the mountain corridor where the Rif and Middle Atlas ranges meet (Kachmar *et al.* 2021). It covers an area of approximately 7100 km², with 500 971 inhabitants (High commission of planning 2024).

This province is distinguished by its marked topographic diversity, with the-Rif mountains reaching approximately 2000 m in altitude, while the Middle Atlas Mountains exceeds 3000 m in the Bouiblanc massif (Agency for Promotion and Development of the Prefectures and Provinces of the North 2011), creating a high degree of ecological heterogeneity. The climate is predominantly Mediterranean, characterized by cool, wet winters and hot, dry summers (Climate Data 2020).

This environmental diversity supports a rich spontaneous flora, including numerous species of aromatic and medicinal plants (AMPs) commonly used by local population (Ghabbour *et al.* 2024).

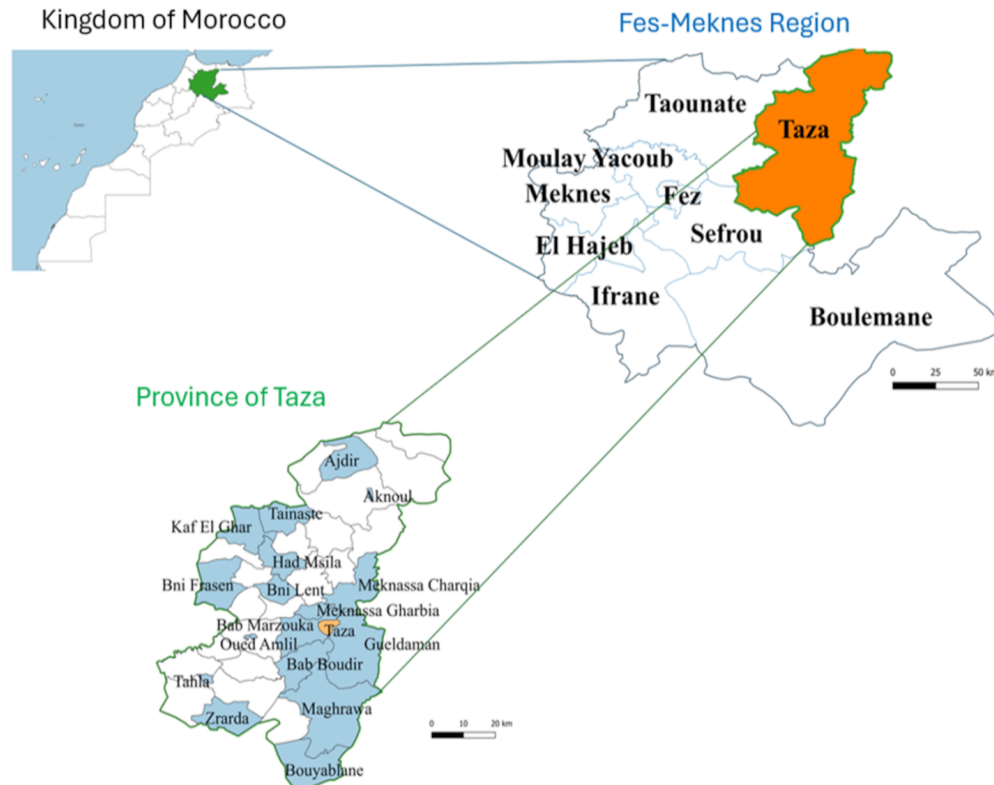


Figure 1. AMPs of the geographical location of the studied area in Morocco by ArcGIS

Data collection

The ethnobotanical survey was conducted in the province of TAZA specifically in maternity and pediatrics department, across seven urban health centers (UHC) AL-OUAHDA , UHC Al-Massira, UHC Bab Tete, UHC Bab Zitouna, UHC Bin Jradi, UHC Jiarine and UHC Bit Gholam) and several rural health centers, including Bab Marzouka, Oued Amlil, Gueldaman, Bab Mrouj, Had Msila, Aknoul, Ajdir, Tahla, Zrarda, Bni Frasen, Meknassa Gharbia, Meknassa Charqia, Maghraya, Bab Boudir, Bouyablane, Taynast, Kaf ElGhar and Bni Lent (Table 1). A total number of 416 persons were interviewed during the period from November to July 2025 using a semi structured interview focusing on the socio-demographic characteristics of the respondents (gender, age, relationship to children under five years old, geographical localization, educational level, socio-economic status, health coverage, distance from health facilities, vaccination status the children's medical and surgical histories) and the plants used for therapeutical purposes (local name, treated diseases, parts used and preparation mode).

The survey consisted of both closed and open-ended questions. Open-ended items focused on participants' ages, the specific plant species they utilized, and the health conditions these plants were used to address. Each interview lasted approximately 15 to 20 minutes (Figure 2).

The study sample included individuals who had close contact with children under five years old and who attended both urban and rural health centers within the province. The number of children under five years of age in the province of Taza is 49,830 out of 503,899 in the entire region, representing approximately 10% of the regional population. The sample size was determined using the following formula:

$$n = \frac{Z^2 \cdot p \cdot (1 - p)}{d^2}$$

Where:

n = required sample size= 416 Person in this study

Z = Z-value corresponding to the chosen confidence level (e.g., 1.96 for 95% confidence)

p = estimated proportion of the attribute or event in the population

d = acceptable margin of error (e.g., 0.05 for 5%)

The protocol applied in this study had been previously validated and approved by the laboratory council and has been employed in several published works (Benamar *et al.* 2023b, Benamar *et al.* 2024a, El Hachlafi *et al.* 2020, Jeddi *et al.* 2021).

Plant species identification

The plant species mentioned by participants were identified using their local names, with reference to key Moroccan botanical references (Bellakhdar 1997, Sijelmassi 1993) and by consulting previous ethnobotanical studies conducted in Morocco (Benamar *et al.* 2023, Jeddi *et al.* 2021, Smaili *et al.* 2023). The identification was subsequently verified by a botanist from Sidi Mohamed Ben Abdellah University (Fez, Morocco), to ensure the correct taxonomic identification of each reported species; then voucher codes ranging from 517 to 574 were assigned.

Table 1. study area survey sites and related distribution of children under 5, adapted from Health in Numbers 2022.

Type of health facility	Territorial commune of the province of Taza	Site Name	Surface area (km ²)	Number of children under 5 years old
Hospital setting=1	Territorial commune	Ibn Baja Provincial Hospital	37	36834
Urban health centers=10		AL-OUAHDA,		1536
		Al-Massira,		1079
		Bab Tete,		812
		Bab Zitouna,		1198
		Bin Jradi,		1098
		Jiarine		1511
		Bit Gholam		1383
Rural health centers=18	Territorial commune	Aknoul	5,41	702
	Territorial commune	Oued Amlil	8,61	1483
	Territorial commune	Tahla	9	2199
	Territorial commune	Bab Marzouka,	181,6	1349
	Territorial commune	Gueldaman	370,9	1406
	Territorial commune	Bab Mrouj	130	765
	Territorial commune	Had Msila	123	606
	Territorial commune	Ajdir	243	470
	Territorial commune	Zrarda,	172	605
	Territorial commune	Bni Frasen	230	875
	Territorial commune	Meknassa Gharbia	46,50	279
	Territorial commune	Meknassa Charqia	198	415
	Territorial commune	Maghrawa	716	212
	Territorial commune	Bab Boudir	158	396
	Territorial commune	Taynaste	153	273
	Territorial commune	Kaf ElGhar	144,1	584
	Territorial commune	Bni Lent	87,84	597
	Territorial commune	Bouyablane	142	171



Figure 2. Field pictures while interviewing the respondents

Data Analysis

Collected data was coded and entered into a structured database prior to analysis. Descriptive statistics were first carried out in order to summarize the sociodemographic characteristics of the respondents and the main modes of use of aromatic and medicinal plants. Categorical variables, including gender, age group, level of education, occupation, place of residence, health coverage, distance from health facilities, children's vaccination status, medical and surgical history, frequency of plant use, reasons for using traditional medicine, source of information, methods of preparation, plant parts used and therapeutic indications, were expressed in frequencies and percentages.

Ethnobotanical data were analyzed using standard quantitative indices. Relative Citation Frequency (RFC) was calculated to assess the local importance of each plant species based on the number of informants who cited it. Value in use (VU) was used to estimate the relative importance of each species based on the number of reported uses. Family Importance Value (FIV) was calculated to determine the importance of botanical families, while Plant Part Value (PPV) was used to identify the most frequently used plant parts. The level of fidelity (NF) was calculated in order to assess the degree of consensus of informants regarding the use of a given plant species for a specific therapeutic indication.

Beyond these descriptive indices, statistical analyses were carried out using IBM SPSS Statistics software. Thus, an exploratory factor analysis by principal component analysis (PCA) was carried out in order to identify the underlying dimensions of the variables studied. A Promax type oblique rotation was applied to improve the interpretation of the factors, take into account a possible correlation between the components and identify the most contributing variables to each dimension.

To further investigate the relationships between respondents' socio-demographic characteristics, their plant use practices, and their satisfaction, an association rule exploration approach was applied. This rules-based machine learning method identified the combinations of variables most strongly associated with respondents' satisfaction with the use of aromatic and medicinal plants. The Apriori algorithm was used to extract sets of frequent items from the encoded database. The target consequence was defined as Satisfaction = 1, corresponding to respondents who reported being satisfied with the use of aromatic and medicinal plants. Before the application of the Apriori algorithm, the categorical variables were transformed into binary variables indicating the presence or absence of each modality. The association rules were then generated using Python. Only association rules that resulted in Satisfaction = 1 and having greater than 99% confidence were retained in order to focus on the most robust and reliable schemes.

These rules made it possible to identify the socio-demographic and ethnobotanical factors most closely associated with satisfaction within the study population. All statistical analyses were performed using Excel 2016, SPSS, Jamovi and Python. Descriptive statistics and ethnobotanical indices were calculated with Excel and SPSS, while extraction of association rules was performed in Python using the Apriori algorithm.

Relative frequency of citation (RFC)

The Relative Frequency of Citation (RFC) measures how frequently a plant species is cited by the informants. It reflects the relative importance of a species in traditional practices.

This ethnobotanical index is calculated following the approach of Tardío and Pardo-de-Santayana (2008), by dividing the number of participants who mentioned using a particular species (FC) by the total number of participants who reported using aromatic and medicinal plants (N).

$$RFC = FC/N$$

With $0 < RFC < 1$

Family Importance Value (FIV)

This index reflects the relative significance of plant families among the species used. It is calculated following the method of Sreekeesoon and Mahomoodally (2014), by dividing the number of participants who mentioned a particular family (FC_{family}) by the total number of species cited within that family (N_s):

$$FIV = \frac{FC_{family}}{N_s}$$

Plant Part Value (PPV)

The Plant Part Value (PPV) measures how frequently each part of a plant is used. This index highlights the plant parts commonly used in traditional practices. It is determined according to Gomez-Beloz (2002):

$$PPV = \text{RU Plant Part} / \text{Total RU}$$

RU of plant: the total number of recorded uses for a specific plant part.

Total RU: the sum of all recorded uses across all plant parts.

Use Value (UV)

The Use Value (UV) of a plant species is determined as follows:

$$UV = \frac{\sum U}{N}$$

Where :

ΣU = total number of use-reports recorded for the given plant species

N = total number of informants interviewed

Fidelity Level (FL)

The fidelity level (FL), a quantitative ethnobotanical index, is used to determine the relative importance and perceived effectiveness of a plant species for the treatment of specific ailments within a given community. It expresses, in percentage terms, the degree of consensus among informants regarding the use of a particular plant for a particular disease.

The FL is calculated using the following formula:

$$FL = \frac{Ip}{Lu} \times 100$$

Where:

Ip represents the number of informants who reported the use of a given plant species for treating a specific disease,

Lu corresponds to the total number of informants who cited the same species for any medicinal purpose.

FL values range from 0 to 100%. A high FL value (greater than 60%) indicates that the plant is primarily used for a single therapeutic purpose, reflecting a strong agreement among informants. In contrast, a low FL value (below 40%) suggests that the plant is employed for multiple medicinal uses. Plant species with FL values exceeding 40% are generally considered of particular interest and may be prioritized for further phytochemical, preclinical, and clinical investigations (Friedman *et al.* 1986, El Hachlafi *et al.* 2022).

Results and Discussion

Socio-demographic data of respondents

Gender

In the study area, both women and men use aromatic and medicinal plants (AMPs) to care for children under five. However, women remain the vast majority, with 342 female respondents (82.41%) compared to 73 male respondents (17.59%). This female predominance represented mainly by mothers, with a percentage of 60.96%, can be explained by their central role in managing the household and caring for children, which leads them to develop a deeper knowledge of traditional medicine practices and to use herbal remedies more frequently.

These observations are consistent with those reported in other studies conducted in Morocco, notably in Messiwa (Al-Haouz region) by Ghanimi *et al.* (2022) and in Moulay Yacoub by El Khomsi *et al.* (2022). They also agree with other ethnobotanical studies carried out such as those by (Mehdioui & Kahouadji 2007) in the Amsittène forest (Essaouira Province) and by Benkhnigue *et al.* (2010) in the Mechraâ Bel Ksiri region (Gharb), which all highlight the predominant role of women in the transmission and mastery of traditional phytotherapeutic knowledge.

Age

In this study, the majority of interviewed people are between 20 and 50 years old. More specifically, 31.33% of respondents are between 20 and 30 years old, followed by 26.75% in the 31–40 age group, and then 20.24% for individuals aged 41 to 50. While people having more than 51 represent only 5% (Figure 3).

The observed distribution seems evident, as the current survey investigated the AMPs use specifically for early-childhood healthcare. It's therefore foreseeable that the majority of respondents are mainly the parents of treated young children, especially mothers responsible for childcare; which corresponds to young or middle-aged people. The presence of a small rate of older respondents is particularly relevant in this context, as no exclusion criteria regarding age was applied in this survey. Hence, it seems that besides the biological parents, grandparents and other family members, which are mainly old-adults or seniors, were also involved in the care of children under-fives.

Kachmar et al. (2021), also found that the majority of people using medicinal plants in northeastern Morocco were adults aged 30 to 50, even though the target treated population was different in his study

This discrepancy could be attributed to the sociocultural differences specific to the study area, such as a potential development in caregiving practices, greater involvement of young parents in their children healthcare, or a better traditional knowledge sharing, which in certain contexts is now being transferred more widely to middle generations. This finding underscores the significance of understanding the use of AMPs in its local and dynamic dimension, rather than as a uniform national model.

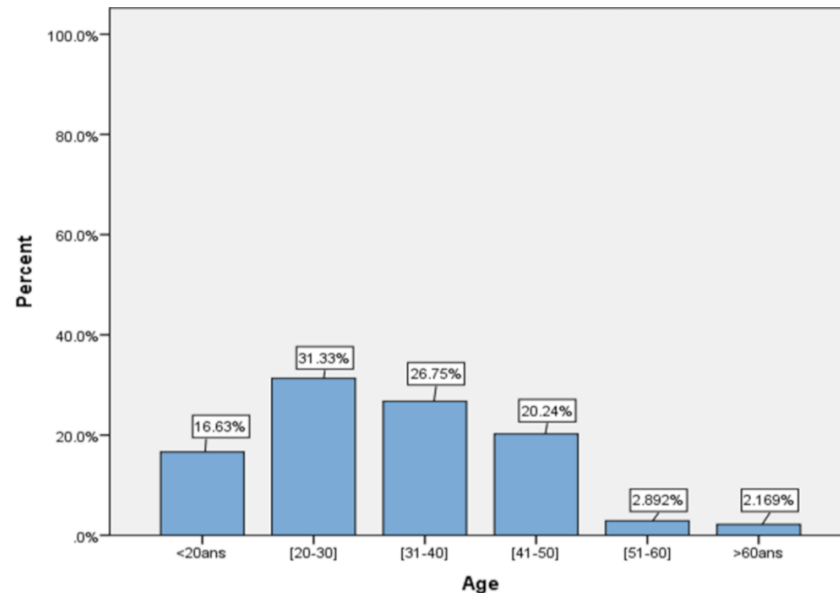


Figure 3. Distribution of participants by age group

Educational level

The majority of participants have no formal schooling (32.05%) as shown by their educational levels. They are followed by learners in primary (24.82%), university (23.61%), and then secondary school students (19.52%). This distribution represents an educational dimension that directly impacts the transmission, application, and appreciation of phytotherapeutic knowledge.

The predominance of people having no or low education level among the medicinal plants users is consistent with other studies in different Moroccan regions. In fact, such people were reported to be the most consumers of medicinal plants both in the Rif and the middle Atlas areas (Yassara et al., 2025); which confirms the importance of oral transmission to maintain ancestral traditions.

The same trend has been reported by El-Ghazouani *et al.* (2024) in other Moroccan provinces where poorly educated people, particularly women responsible for family health, hold traditional therapeutic knowledge.

This is concordant with other results worldwide reporting that the AMP's use remains deeply rooted within people with restricted access to formal education and/or modern healthcare services (Radi *et al.* 2024).

Beyond being related to educational attainment, this rootedness seems also related to the daily direct access to plant resources, the cultural perpetuation of local remedies, and trust in knowledge handed down from lords to descendants.

Moreover, respondents with the lowest levels of education also seem to be the primary custodians of this intangible heritage, whereas individuals with a high level of education are more likely to gravitate towards more biomedical-centered health practices, which confirm the findings of previous studies.

Origin

The nearly equal distribution between urban (50.60%) and rural (49.40%) participants means that the sample studied is both balanced and representative. This balance enhances the comparisons between environments and indicates that the use of medicinal plants is common practice that rises above place.

While rural territories remain the traditional storage sites of phytotherapeutic knowledge, these practices continue to spread across urban areas, especially among households with childcare responsibilities (El-Ghazouani *et al.* 2024, Radi *et al.* 2024). Within this approach, the combination of these practices between urban and rural areas has been demonstrated throughout Morocco. In the Oriental and Middle Atlas areas, city dwellers frequently use medicinal plants as a complement to modern medicine (Ben Akka *et al.* 2019, Tahraoui *et al.* 2007). Research from Fes-Meknes and Khemisset also demonstrated that the application of plant medicine continues in both areas, but in rural areas there is a wider variety of remedies which are still available in plant forms (Yassara *et al.* 2025, Radi *et al.* 2024). Other analysis conducted in the Rif region and southern Morocco further shows that the use of AMPs remains widespread among local populations. While some practices vary across communities, traditional knowledge is maintained in both rural and urban areas, highlighting the persistence of phytotherapy across different contexts (El Aboui *et al.* 2025). These convergences suggest that, regardless of whether the motivations are different (cultural heritage and proximity to the environment in rural areas–vs the search of natural alternatives and considering the social networks in urban areas), the use of medicinal plants is now a component of an overarching sociocultural continuum. This homogeneity highlights the need for awareness-raising approaches tailored to both environments to encourage safe use by young children, with a focus on tools that are affordable to families at different educational levels.

Occupation

The graph representing participants by their occupation shows that most participants were unemployed (73.49%). While 20% were employees in the public sector and only 6.5% in the private sector. This distribution reflects that the analyzed population is in mostly inactive, which can shape access to information, financial capacity, and healthcare, including a greater reliance on traditional practices, as reported in ethnobotanical studies conducted in Morocco (Chaachouay *et al.* 2019). For instance, several surveys in Morocco, showed that housewives turn out to be the most frequent users of medicinal plants for children of the same household, which could be explained by their central role in childcare, the time available to attend to family health and by the intergenerational transmission of traditional knowledge (Kachmar *et al.* 2021). Internationally, similar results have emerged in Mediterranean and North African countries including Tunisia and Algeria, where low socio-economic status, especially among women, tends to increase traditional medicine and home-based care usage (El Brahimi *et al.* 2022, Jdaïdi & Hasnaoui 2016). Such trends emphasize the effects of socioeconomic status and employment status in using alternative or complementary healthcare to treat diverse diseases. The present study highlights the predominance of participants who are not actively employed, and thus the importance of housewives and unemployed to conserve and apply traditional culture, a consideration required in public health strategies and the advancement of safe childcare practices.

Social coverage

Respondents who use AMPs for children under five years old are predominantly affiliated with the National Health Insurance Fund for Civil Servants (NHIFCS) (48.43%), followed by Mandatory Health Insurance (MHI) TADAMOUN (22.41%), the National Social Security Fund (NSSF) (18.07%), and the Royal Armed Forces (RAF) health insurance (11.08%) (Figure 4). This confirms that AMP's use concerns people both with no medical coverage and having limited access to modern healthcare services.

The predominance of AMP's users affiliated with NHIFCS indicates that AMP's use goes beyond strictly economic considerations and is deeply rooted in cultural practices. Other ethnobotanical studies performed in Morocco showed that traditional remedies are widely used also for people having healthcare facilities, mainly to manage mild and recurrent ailments within children having less than five (Chaachouay *et al.* 2019, Dusser Lauge 2017). Such findings confirm the co-existence of therapeutic pluralism between traditional and modern medicines.

Moreover, the proportion of MHI TADAMOUN beneficiaries (22%) confirms the reliance on AMPs of populations that are socially vulnerable, due to the healthcare accessibility constraints and indirect costs not reimbursed by coverage systems (Yassara *et al.* 2025). This finding is similar to those reported in other Moroccan regions, mainly rural ones, where AMPs remain affordable, and socially accepted alternative therapeutics (El-Ghazouani *et al.* 2024). While the high number of users from beneficiaries of RAF insurance and CNSS confirms transcendence of socio-professional categories and insurance schemes in AMP's using, which is concordant with the results of previous studies which reported that phytotherapy is more used as a complementary than alternative to medical care, mainly for children health (Benhidi *et al.* 2024). Our results

contradict those of Benamar *et al* (2025) who reported that the main users of phytotherapy are the populations most economically disadvantaged.

This discrepancy may reflect regional differences in access to healthcare, cultural transmission of ethnopharmacological knowledge, or perception of traditional remedies as a complement to modern medical care rather than as a substitute.

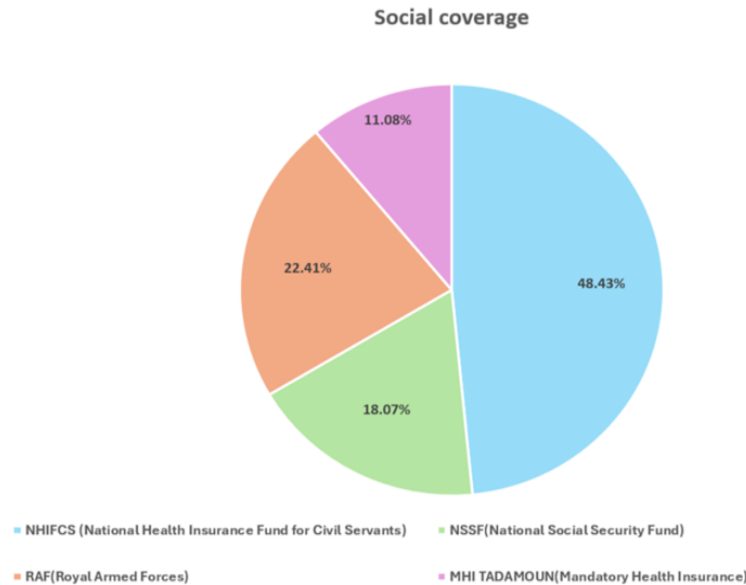


Figure 4. Distribution of participants by social coverage

Accessibility

The spatial distribution of accessibility to the medical facilities shows that over half of the participants are living within 3 km of a health facility. 26.27% of the respondents live between 3 and 6 km away, and 17.59% of them live more than 6 km away from the healthcare services. This pattern highlights generally positive accessibility but also indicates the presence of a substantial group affected by geographic distance likely impinging on access to formal healthcare, especially for children under five years old. Several studies carried in Morocco, highlighted the importance of the distance to healthcare facilities as a significant predictor for healthcare service use, especially in vulnerable households and families with young children (Tikouk & Ait Boubkr 2024). This may influence healthcare-seeking behavior, encouraging the use of accessible and culturally accepted remedies, such as AMPs, for first-line treatment of common childhood illnesses (Barkat *et al.* 2025). Therefore, not only does distance represent a logistical challenge but there is also a social factor that influences family practices, sometimes propelling them to rely on traditional treatment more heavily when access to biomedical services is limited.

The social determinant of health that shapes families' health practices shapes how they have to do it and often leads to higher dependence on traditional healthcare systems.

Medical and surgical History

In this study, most children under five years old had no prior medical (88.19%) or surgical (96.87%) history, while 11.81% had some underlying health conditions and 3.13% had already undergone surgery. That a favorable health profile does not exclude the common use of aromatic and medicinal plants, which continue to be widely used for minor childhood illnesses. Recent studies in Morocco confirm this trend: in the province of Khemisset, 66 species of medicinal plants are employed to treat common digestive and respiratory disorders (El-Ghazouani *et al.* 2024) whereas El Hilah *et al.* (2015) documented the use of 57 species for similar conditions. Such remedies are used by families as a preventive or a first-line treatment attesting to the deep cultural roots of phytotherapeutic practices. Specifically, Ait Haj Said *et al* (2015) documented the use of 36 plants species, including *Rosmarinus officinalis* and *Mentha pulegium* to treat infantile colic in Morocco, illustrating that even very young children and those without serious health issues are included in traditional plant-based care.

Vaccination status

Despite the vaccination rate among children was high (96.87 percent), a wide use of aromatic and medicinal plants (AMPs) was observed in this study. In fact, herbal medicine runs deep in Morocco: toxicological surveys show that the frequent use of medicinal plants was a practice sometimes without dose or toxicity control (Bouyahya *et al.* 2017). Furthermore, a national

study of the COVID-19 pandemic reported that 65.2% of respondents used herbal medicine, whereas a few believed in herbal medicine as substitutes for vaccines (Benhidi *et al.* 2024).

This study shows that in some parts of the population, vaccine uptake also coexists with intense trust in medicinal plants; thus representing a “hybrid” healthcare strategy that combines modern biomedical prevention with traditional practices. This coexistence is also seen internationally. Indeed, a pilot study found a significant association between the utilization of complementary medicines (herbal medicine, naturopathy, etc.) and insufficient childhood immunization schedules (Frawley *et al.* 2018). Similarly, in rural Ethiopia, the frequency use, by parents, of traditional medicines for the child less than 12 months (79.4%), was motivated by economic, cultural or access issues (Hailu *et al.* 2020). Among the Batwa and other marginalized communities in Uganda, beliefs linking illness with spiritual causes bolster trust in traditional remedies and can also deter vaccine acceptance (Kigongo *et al.* 2024).

Therefore, the findings of this study indicate that despite a very high immunization coverage has been achieved, many parents still use complementary and alternative medicines (CAMs) in addition to conventional care. Such duality provides challenges as well as opportunities for public health policies: it is important to recognize and integrate this traditional dimension, by engaging in dialogue with practitioners of herbal medicine, to promote safe practices that are consistent with vaccination strategies, thereby strengthening parental confidence in both approaches.

The high vaccination rate observed within the studied children population (96.87%) indicates a high vaccination coverage and suggests that the AMP's use is only a complementary therapeutic process and does not replace vaccination

Similarly, the tradition of herbal medicine use has been reported in Morocco and many other countries through previous studies. Benhidi *et al.* (2024) found that 65.2% of interviewed people used AMPs, during the COVID-19 pandemic, even though their positive attitude toward vaccination, and only a minority considered herbal medicine as a vaccine's alternative. Which confirm the previous belief that despite AMP's use is deeply rooted in the Moroccan culture, this does not induce rejection of modern medicine (Bouyahya *et al.* 2017).

Other studies reported the coexistence of vaccination with traditional practices worldwide. In Australia, a relationship between traditional medicine use and lower childhood vaccination without its rejection, was reported (Frawley *et al.* 2018). Thereafter, the high vaccination rate coupled to the frequent AMP's use reveals that the local healthcare model is hybrid and combine between medical prevention (vaccination) and medicinal practices.

Reliance on traditional medicine

The use of traditional practices by the majority of parents (99.76%) to treat childhood illnesses confirms that these practices are a key part of the Moroccan therapeutic culture and attests the importance of medicinal plants as a first line of intervention in homes, particularly for usual childhood ailments. This finding is similar to other studies conducted in Morocco. An ethnobotanical survey in the Moroccan Sahara Region, reported a very high use of medicinal plants among the local population, thanks to accessibility, effectiveness, and cultural validity of the traditional remedies in the study area (Chaachouay *et al.* 2019). Moreover, more than 60% of medicinal plant users, in Mechraâ Bel Ksiri region (Morocco), base their cure on experience handed down from others, and about 40% believe that they can be completely cured (Bensalek 2018). However, the widespread use of AMPs is not without risk; as some plants among those prescribed by herbalists in Fez were potentially harmful (Zeggwagh *et al.* 2013), although no serious complication was reported.

Hence, the very high practice of traditional medicine reflects that AMPs are a key part of the home healthcare system, which require not only their recognition by the policymakers but their use regulation through education and sensibilization campaigns, monitoring and training of herbalists to guaranty safe use, mainly for children less than five.

Reasons for Using Traditional Medicine

The primary reason for using traditional medicine is availability (67.8%) followed by effectiveness (49.9%), then low-priced (23.5%), prevention of drugs mis-use (33.4%) and last resort when everything failed (6.1%) (Figure 5); which demonstrates that family's healthcare decisions are based on a mixture of practical and cultural reasons. Thereafter, thanks to its high accessibility, conventional medicine represents the first line of primary care worldwide, mainly in developing countries and low-income housing, especially rural areas (WHO 2020).

Accessibility to AMPs and knowledge of herbalists contribute to the great reliance to such therapies (Chaachouay *et al.* 2019). This has been proved through several ethnobotanical studies; hence 66 medicinal plants species were reported to be used in Khemissat mainly in rural areas (Radi *et al.* 2024), 52 species are used in Haj Kaddour by 68% of its population (Benamar *et al.* 2025). Moreover, El Hachlafi *et al.* (2020) confirmed the role of AMPs in home-based care in the Rabat-Salé-Kénitra region thanks to cultural trust on these remedies and their perceived efficacy.

Other ethnobotanical studies in Taza confirm the plant's diversity and the region's richness, as well as the importance of traditional knowledge transmission from one generation to another (El Hilah *et al.* 2015, El-Ghazouani *et al.* 2024).

All these results demonstrate that the decision to use AMPs to treat children ailments depends on a cohort of economic, cultural and practical reasons, as well as safety considerations, on the one hand, and show that the healthcare model is hybrid combining traditional practices with complementary and modern medicines on the other hand. Hence, safety of the AMPs used should be considered particularly for young children.

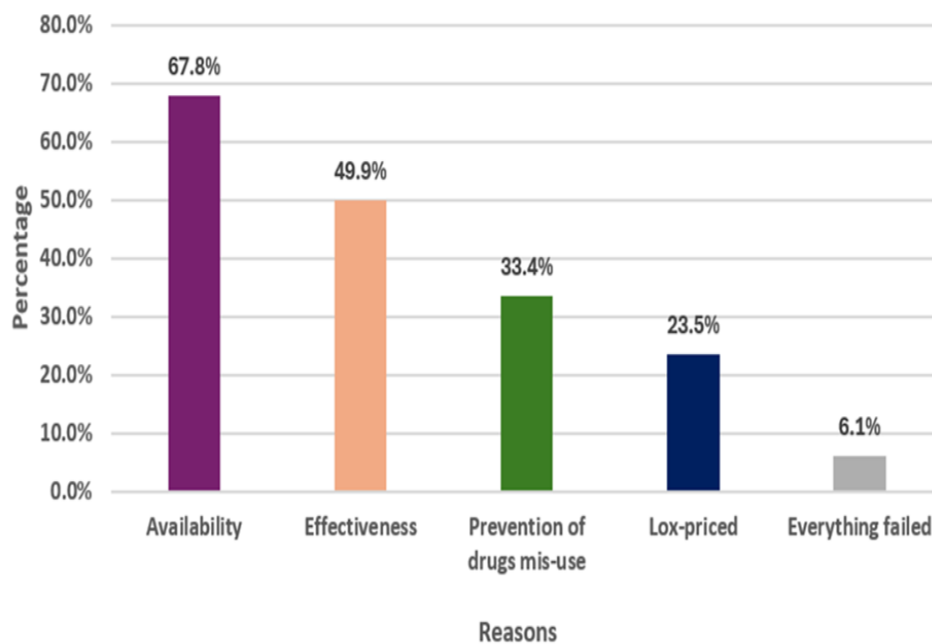


Figure 5. Distribution of participants by reasons for resorting to traditional medicine

Use frequency of medicinal plants

Use frequency of medicinal plants was occasional for 66.51% of interviewed people, frequent for 31.57% of them and very frequent for less than 2% of them. This main occasional use seems related only to the treatment of minor diseases, but not to everyday or intensive use; suggesting an important role of AMPs in healthcare practices, especially linked with children under five. These results are concordant with those of other ethnobotanical studies performed in Morocco, mainly Middle Atlas, Fez-Meknes region and some rural provinces as Taounate (North-central Morocco), that reported that 55% to 90 % of people use AMPs for healthcare purposes and highlighted the importance and periodical use of some specific plants thanks to their high ethnobotanical indices (Eddouks *et al.* 2014, Jeddi *et al.* 2021, Kachmar *et al.* 2021, El-Assri *et al.* 2021).

The superiority of sporadic or situational use of medicinal plants suggests that they represent unexpansive cures for common health problems, not usual treatments. While the daily utilization low frequency may be linked to safety concerns, such as undefined doses and potential interactions with other drugs, as reported previously (Jeddi *et al.* 2021). This shows that although their importance in the Moroccan family healthcare, AMP's use remains contextual, cultural, and reactive rather than habitual.

Therapeutic preferences in combined use

In this study, the majority of participants expressed a preference for modern medicine (76.14 %) over traditional medicine (23.86 %). The main reasons for such preference were perceived safety (70.7 %), effectiveness (52.5%) and at a lower degree concerns of AMPs toxicity (8.1%). Even though this scheme is specific to the current study, it aligns with most results concerning healthcare perception reported previously. This confirms that trusting biomedical practices is defined by the scientific oversight's perception and the herbal remedies' associated risks (WHO 2023, Zeggwagh *et al.* 2013).

Other Moroccan ethnobotanical studies have indeed reported that some medicinal plants possess potential toxicity, and that the general population has limited knowledge of these risks, which may negatively influence trust in such practices (Zeggwagh *et al.* 2013). Furthermore, although traditional medicine still plays an important role for minor symptoms and cultural practices, the strong preference for modern medicine observed in our study can be interpreted as a response to concerns regarding safety, effectiveness, and scientific regulation of care.

Source of information on use of AMPs

This graph demonstrates that most of the sources (mainly family or community experience of participants) of information on the uses of aromatic and medicinal plants (AMPs) are from people with previous family or communal familiarity, accounting for 56.6% of respondents (Figure 6). This dominance highlights the importance of informal transmission based on traditional Moroccan health practices where information mostly distributes in families and neighborhoods.

Such model of transmission, of information on using AMPs, based on observation, experience and trust has been estimated as effective to conserve this therapeutic knowledge in Taza region of Morocco (Naceiri *et al.* 2019).

Herbalists represent the second source of information (45.3%), thanks to their role of “local advisers” charged of the transmission of empirical knowledge through generations, rather than simple goods sealers. Previous studies highlighted the herbalists perceived role as healing authority’s alternative, mainly in communities having limited access to medical facilities and / or limited financial sources (Kachmar *et al.* 2021); which reveals the existence of a longstanding social trust.

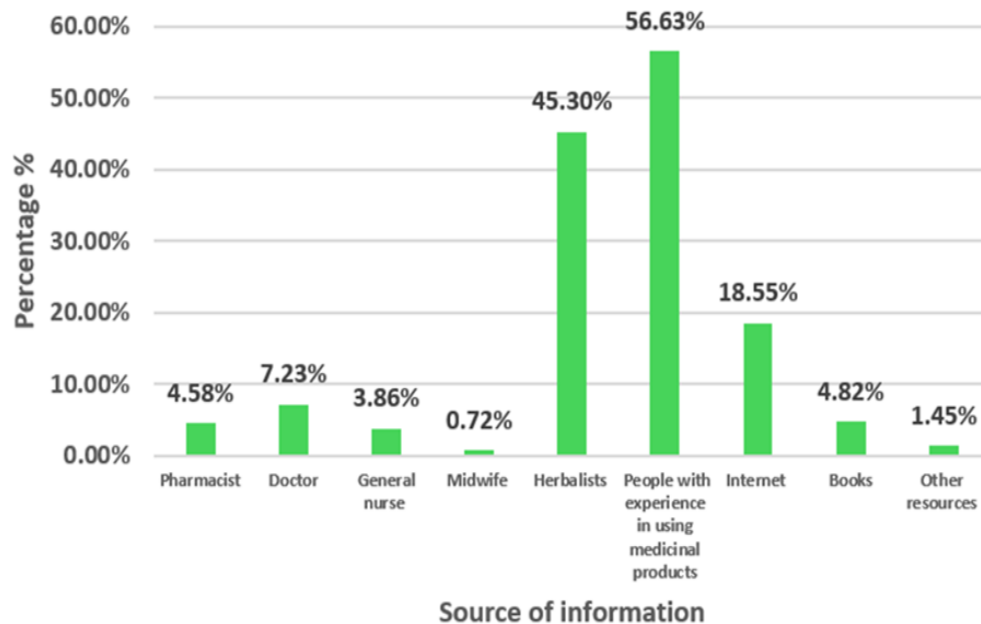


Figure 6. Distribution of participants by source of information on the use of AMPs

The third source of information was found to be internet (18.6%), which shows the emergence of a new form of health information, mainly among young parents. This trend towards usage of digital sources for health advice is already evident in other North Africa and broader Arab contexts (Alhur *et al.* 2023, WHO 2021). While internet use presents considerable potential for disseminating knowledge about aromatic and medicinal plants (AMPs), it also carries risks, including the spread of unverified or potentially harmful information. This highlights the need for the broader dissemination of scientifically validated knowledge on AMPs, to ensure their safe and effective use.

In contrast, healthcare professionals including physicians (7.2%), pharmacists (4.6%), nurses (3.9%), and midwives (0.7%) contribute slightly to information acquisition. This finding, in line with other Moroccan studies (Jeddi *et al.* 2021), emphasizes weak integration of Medicinal and aromatic plants (AMPs) into clinical debate and potentially limited training of professionals in phytotherapy. Several writes note that inadequate conversation between patients and parents regarding traditional medicines may heighten the susceptibility of drug interactions and degrade the quality of care (Tsele-Tebakang *et al.* 2023). Books (4.8%) and other sources (1.4%) make a marginal contribution to information practices, confirming the predominance

of largely oral and relational wisdom features of traditional healing cultures. In general, these findings indicate that AMPs use is still firmly anchored in community knowledge, rather than in biomedical knowledge or written sources. Though this dynamic evokes the richness of Morocco's ethnobotanical heritage, it also poses serious questions about practical safety and scientific verification of such practices. Enhancing the healthcare role in professional educational sessions, as well as reliable online resources, seems important to prepare and inform families on safe use of medicinal plants, especially in the case of little children.

Floristic analysis

The very high prevalence of aromatic and medicinal plant (AMP) use for children reported in this study (99.76%) highlights the central role of traditional medicine in child healthcare practices within the study area. Similarly high rates of AMP utilization have been reported in several ethnobotanical studies conducted in Morocco, particularly in rural and semi-rural settings, where traditional knowledge remains deeply embedded in daily healthcare practices (Hseini & Kahouadji 2007, Chaachouay *et al.* 2019, El Hachlafi *et al.* 2020).

The widespread AMP's use despite the globally favorable children's health-care system reflects AMP's accessibility and affordability, cultural continuity, and efficient knowledge transmission between successive generations.

58 plant species belonging to 28 botanical families were identified (Table 2), which is concordant with other Moroccan ethnobotanical surveys, that reported a high diversity of AMPs used in pediatric care (Fadili *et al.* 2017, Chaachouay *et al.* 2019, Benkhaira *et al.* 2021, Benamar *et al.* 2022). The Lamiaceae family showed the highest Family Importance Value (FIV = 80.7%), followed by the Verbenaceae, mainly *Aloysia citrodora* (FIV = 23.5 %) (Figure 7).

These results confirm those of other studies in diverse Moroccan regions, that reported the broad therapeutic potential of Lamiaceae species thanks to their antispasmodic, antimicrobial, and anti-inflammatory activities and their digestive properties (Benamar *et al.* 2022, Flouchi *et al.* 2020) and highlight the importance of AMPs characterized by sedative and digestive effects for children.

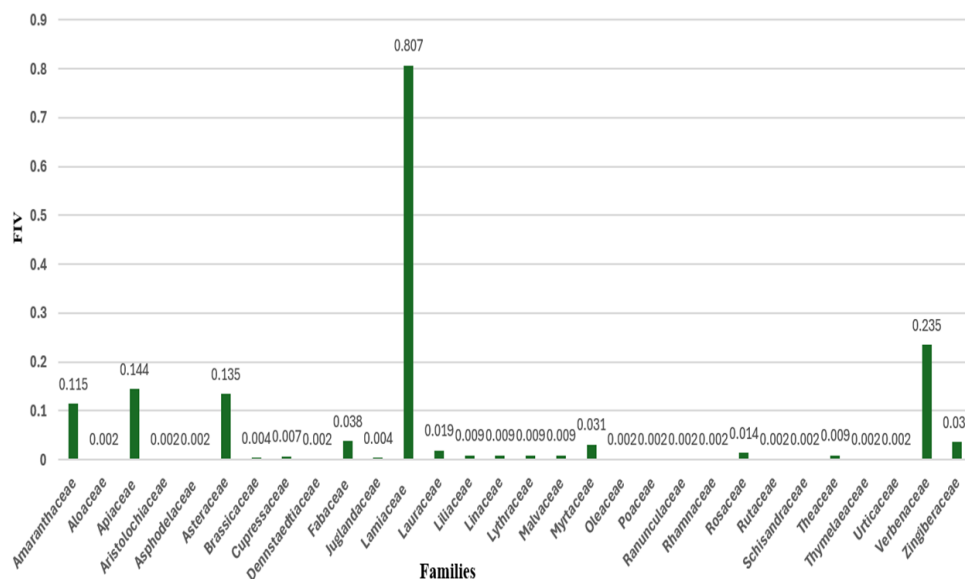


Figure 7. Distribution of cited plant families according to their Family Importance Value (FIV)

Origanum compactum Benth, *Aloysia citrodora* Palau, and *Rosmarinus officinalis* L. were the most frequently cited species according to the analysis of hierarchical clusters, which make them the most frequently used plants thanks to their high RFC (Figure 8). This finding is similar to other ethnobotanical studies in Morocco (Kachmar *et al.* 2021, Radi *et al.* 2024).

Furthermore, pharmacological studies reported their traditional therapeutic use against diverse diseases thanks to their antimicrobial, anti-inflammatory and digestive properties (Idm'hand *et al.* 2023, Radi *et al.* 2024). The high RFC shows strong consensus among the population and confirms their Moroccan ethnopharmacological importance pediatric and general healthcare practices.

The main indication for AMP's use concern digestive disorders (72.6%) (Table 2), which confirm previous findings concerning both children and global community. Several Moroccan ethnobotanical surveys reported a large use of AMPs in the treatment of gastro-intestinal troubles, such as abdominal pain, bloating, colic, and diarrhea, which are perceived as minor and suitable for traditional based remedies due to their high frequency between little children (Idm'hand *et al.* 2023). The use of herbal medicine in such cases could be linked to a perception of AMP's safety and mildness in comparison to synthetic medicines, by most of the care-givers.

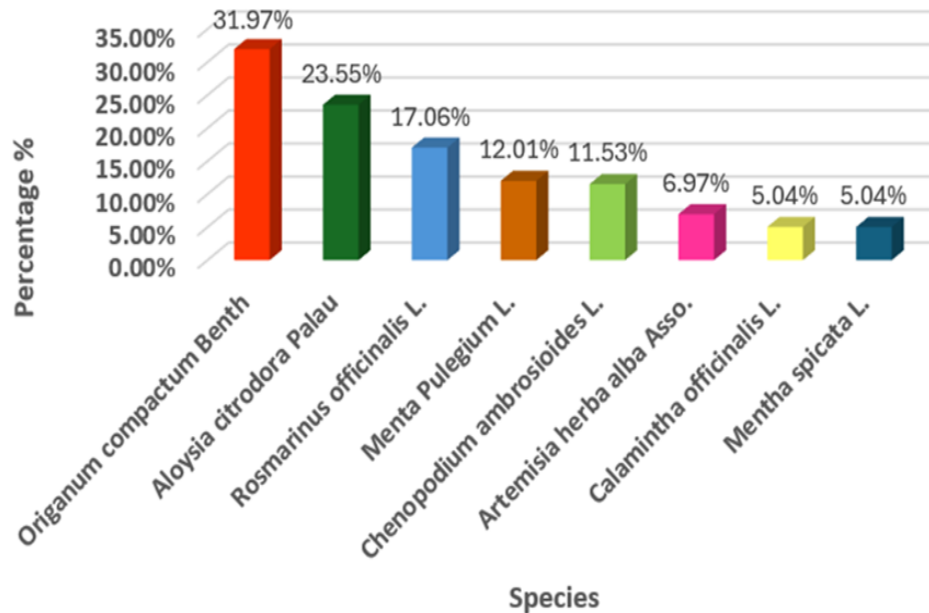


Figure 8. Distribution of the most cited species according to their Relative frequency of citation (RFC)

Leaves were the predominant used plants parts (Table 2), thanks to their availability, harvest' ease, and richness in bioactive compounds, as well as their low risk to plant sustainability, which is in line with literature, (Chaachouay *et al.* 2019, El Hachlafi *et al.* 2020). While, Decoction was the most common preparation method, followed by maceration, and the oral administration was the main route (Table 2) which is consistent with traditional practices aiming to optimize the active constituent's extraction, mainly for digestive troubles (Hseini & Kahouadji 2007), and reflects the internal nature of most treated diseases. This confirms that AMPs represent a cornerstone in healthcare, particularly for children, in the study area. It also demonstrates cultural resilience and local knowledge and underlines the need for supplementary pharmacological and toxicological studies to ensure effective and safe use of AMPs for children.

Fidelity Level, FL

The fidelity level (FL) was calculated by considering plant species which are used at least 5 times ($FC \geq 5$) for a given disease category. FL ranges from 17% to 100%, with different levels of therapeutic specificity of aromatic and medicinal plants in children under five years of age. Only one species, *Cuminum cyminum* L., has 100% FL, indicating that all informants consider it to be used for digestive disorders. Strong levels of fidelity were observed for *Foeniculum vulgare* Mill. (94%), *Carum carvi* L. (88%), *Salvia officinalis* L. (88%), *Rosmarinus officinalis* L. (85%), *Ammodaucus leucotrichus* Coss (85%), *Rosa centifolia* L. (83%), *Mentha pulegium* L. (82%), *Zingiber officinale* Roscoe (82%), *Origanum compactum* Benth (80%) and *Myrtus communis* L. (80%). This is indicative of a very high level of agreement among the respondents on whether AMPs are used for a certain category of diseases; and that the selected species have a clinical relevance in the treatment of some different types of childhood diseases.

The most common treated disease was digestive disorders with 21 species, including *Chenopodium ambrosioides* L., *Ammodaucus leucotrichus* Coss, *Cuminum cyminum* L., *Carum carvi* L., *Foeniculum vulgare* Mill., *Marrubium vulgare* L., *Artemisia herba-alba* Asso., *Chamaemelum nobile* L., *Trigonella foenum-graecum* L., *Origanum compactum* Benth, *Mentha pulegium* L., *Rosmarinus officinalis* L., *Calamintha officinalis* L., *Lavandula dentata* L., *Salvia officinalis* L., *Mentha spicata* L., *Cinnamomum zeylanicum* Nees, *Syzygium aromaticum* L., *Aloysia citrodora* Palau, *Zingiber officinale* Roscoe and *Myrtus communis* L. These results are consistent with those of Ghabbour *et al.* (2023) who reported a large number of digestive

disorders treated in the province of Taza and those of Idm 'hand *et al.* (2020) & El Brahimi *et al.* (2022), in which gastrointestinal disorders were the most prevalent indication of traditional Moroccan medicine. Thereafter, this phenomenon is probably due to the high incidence of colic, diarrhea, vomiting and abdominal pain among young children that are still most common among the causes of the use of traditional remedies in Mediterranean countries (WHO, 2023).

Respiratory diseases are the second-largest category with 11 species (*Ammodaucus leucotrichus* Coss, *Artemisia herba-alba* Asso, *Calamintha officinalis* L., *Chenopodium ambrosioides* L., *Marrubium vulgare* L., *Mentha pulegium* L., *Lavandula dentata* L., *Origanum compactum* Benth, *Rosmarinus officinalis* L., *Trigonelle foenum-graecum* L. and *Zingiber officinale* Roscoe) used in the treatment of coughs, colds and respiratory infections. Neurological diseases (ND) concern 6 species, including *Chamaemelum nobile* L., *Calamintha officinalis* L., *Lavandula dentata* L., *Salvia officinalis* L., *Aloysia citrodora* Palau and *Myrtus communis* L.

Skin conditions (SD) are treated by 5 species (*Lavandula dentata* L., *Trigonella foenum-graecum* L., *Syzygium aromaticum* L., *Rosa centifolia* L. and *Cinnamomum zeylanicum* Nees). There are 3 species for genitourinary disorders (*Foeniculum vulgare* Mill., *Lavandula dentata* L. and *Cinnamomum zeylanicum* Nees). While osteoarticular disorders (OAD) only concern two species: *Chenopodium ambrosioides* L. and *Myrtus communis* L. Finally, only one species, *Cinnamomum zeylanicum* Nees, is mentioned for cardiovascular diseases (CVD) treatment (Table 2).

The FL and CF analysis shows two different species profiles. The first one concerns plants with high FC and high FLs, such as *Origanum compactum* Benth (FC = 133; FL = 80% DD), *Aloysia citrodora* Palau (FC = 98; FL = 61% DD), *Rosmarinus officinalis* L. (FC = 71; FL = 85% DD), *Mentha pulegium* L. (FC = 50; FL = 82% for respiratory conditions) and *Myrtus communis* L. (FC = 80; FL = 80% DD). These species seem to be the most important in the local pharmacopoeia in many ways, as they have great popularity within informants and are relatively specific for some diseases. Furthermore, it is hard to find a more well-known species for some diseases. Therefore, they can be considered as priority species for phytochemical and pharmacological studies.

The second group includes species with high FL but relatively low FC, such as *Cuminum cyminum* L. (FC = 11; FL = 100% DD), *Carum carvi* L. (FC = 8; FL = 88% DD), *Salvia officinalis* L. (FC = 8; FL = 88% DD), *Foeniculum vulgare* Mill. (FC = 16; FL = 94% DD) and *Rosa centifolia* L. (FC = 6; FL = 83% SD). These species are seldom cited in general but are used in a very specific way for a particular class of diseases. This shows that FL is not a product of isn't linked to the number of citations, but rather of to the percentage of informants who associate a species with a specific indication (Friedman *et al.* 1986). Some very popular species have lower FLs, such as *Chenopodium ambrosioides* L. (FC = 48; maximum FL = 31% DD), *Calamintha officinalis* L. (FC = 21; FL = 67% DD, 48% RD and 33% ND depending on the category), *Lavandula dentata* L. (FC = 16; FL: 44% SD, 44% DD, 44% ND, 38% RD and 31% GUD) or *Cinnamomum zeylanicum* Nees (FC = 8; maximum FL = 38% GUD). For these species, the therapeutic versatility is very high, because many of them are used to treat a range of diseases.

Thus, a moderate value of FL does not mean that the species is less effective in terms of its therapeutic capacity but rather reflects a wider range of use, which is the case in other ethnobotanical studies (Heinrich *et al.* 1998, Tardío & Pardo-de-Santayana 2008).

Overall, the comparison of the FL and FC indices shows that both of them provide more information. The FC informs us about the popularity and cultural importance of a species in the community, while the FL indicates its therapeutic specificity. The combination of both indices enables to identify, on one hand, the species most commonly used in traditional pharmacopoeia and, on the other hand, those having the greatest therapeutic potential for a particular medical condition. This complements the This completes the ethnopharmacological interest of species like *Origanum compactum* Benth, *Rosmarinus officinalis* L., *Mentha pulegium* L., *Foeniculum vulgare* Mill. and *Cuminum cyminum* L., which are appropriate for pharmacological studies to validate their traditional uses.

Use Value

The use values (UV) obtained in this study highlight the relative importance of medicinal plants used in traditional care for the under-five children in Taza Province. The UV Index (Phillips & Gentry 1993) is one of the most widely used quantitative indicators in ethnobotany to assess the cultural and therapeutic importance of a species based on the frequency of citation by informants. According to these authors, a high value refers to frequent use and strong local recognition while a low value implies less use but does not prejudice the pharmacological efficacy of the plant (Phillips & Gentry 1993).

In this study, the use values range from 1 to 6 and show a great diversity in local phytotherapeutic practice. *Panicum miliaceum* L. has the highest use value (UV = 6) and is the most commonly cited species by the respondents. This exceptional value can be explained by its availability, low cost and its dual nutritional and therapeutic interest in young children. However, this is specific to the province of Taza. It shows the influence of local cultural traditions on the choice of medicinal species, as many previous ethnobotanical studies have indicated (Albuquerque *et al.* 2006). *Cinnamomum zeylanicum* Nees (UV = 3.37), *Dittrichia viscosa* L. (UV = 3.33), *Trigonella foenum-graecum* L., *Nigella sativa* L., *Lepidium sativum* L., *Allium cepa* L., *Citrus limon* (L.) Burn.f., *Illicium verum* Hook.f., *Silybum marianum* (L.) Gaertn and *Pteridium aquilinum* (L.) Kuhn have good use values. These are known for digestive, carminative, expectorant, anti-inflammatory and antimicrobial properties; digestive and respiratory disorders are most common in our study. Several pharmacological studies have demonstrated the biological activity of *Cinnamomum zeylanicum* Nees, *Nigella sativa* L., *Glycyrrhiza glabra* L. and *Zingiber officinale* Roscoe, which scientifically confirm the importance of their use (Batiha *et al.* 2020, Salehi *et al.* 2019, Sharifi-Rad *et al.* 2017). Species that are intermediate in use ($1.5 \leq UV < 3$) such as *Camellia sinensis* (L.) Kuntze, *Origanum compactum* Benth, *Rosmarinus officinalis* L., *Mentha rotundifolia* Muds, *Lavandula dentata* L., *Salvia officinalis* L., *Thymus satureioides* Coss., *Ceratonja siliqua* L., *Juglans regia* L., *Aloe succotrina* Lam., *Zingiber officinale* Roscoe and *Curcuma xanthorrhiza* Roxb. are the main nucleus true core of the pharmacopoeia. Their high number of quotations is due to their availability, accessibility as well as their therapeutic capacity. This is consistent with the findings of several ethnobotanical studies carried out in Morocco particularly in the Rif, the Middle Atlas where members of the Lamiaceae, including *Origanum compactum* Benth, *Rosmarinus officinalis* L., *Mentha* spp. and *Thymus* spp. are generally amongst the most used medicinal plants, especially for respiratory and digestive disorders (Benlamdini *et al.* 2014, Chaachouay *et al.* 2022). Other species such as *Cuminum cyminum* L., *Daphne gnidium* L., *Eucalyptus globulus* Labill., *Lavandula stoechas* L., *Lawsonia inermis* L., *Linum usitatissimum* L., *Menta Pulegium* L., *Ocimum basilicum* L., *Pimpinella anisum* L., *Raphanus sativus* L., *Rosa centifolia* L. and *Tetralinlin articulata* (Vahl) Mast have relatively low usage ($UV \leq 1.5$). As reported by Phillips and Gentry (1993), a low use value reflects a limited number of quotations, which is generally associated with a specific use for a particular condition or to a limited supply (or less important transmission of traditional knowledge). Thereafter, ethnobotanical indices reflect the cultural importance of species and not the pharmacological effectiveness of species, according to Tardío & Pardo-de-Santayana (2008).

It is to note that the different ethnobotanical indices should not be interpreted in the same manner. RFC and FIV reflect citation frequency and the local prominence of a species or botanical family, whereas the Use Value (UV) reflects the number and diversity of reported uses, and the Fidelity Level (FL) indicates the degree of agreement among informants concerning the use of a plant for a specific therapeutic category. Consequently, high UV or FL values recorded for species cited by only one or a few informants should be interpreted cautiously, as they do not necessarily indicate widespread use or clinically demonstrated effectiveness. Therefore, the conclusions drawn from Table 2 were restricted to the local cultural importance and informant consensus associated with the reported plants and should not be considered evidence of their clinical efficacy or safety in children.

The main medicinal and aromatic plant species collected in the study area were botanically identified and photographically documented. Representative photographs of these species are provided (Figure 9), offering complementary visual documentation of the plant material included in the study.

Parts of AMPs used

The study shows that leaves are the most used part of the plant (78.10%), followed by flowers (20%) and seeds (16.9%), while stems, rhizomes, bark, and fruits are used less frequently (Figure 10). The predominance of leaves in medicinal plant use is well documented across North Africa: for example, in Morocco, leaves were reported as the most frequently exploited part due to their accessibility, richness in bioactive compounds, and minimal impact on plant sustainability (Rhattas *et al.* 2016, El Hachlafi *et al.* 2020). Identically, other ethnobotanical studies conducted in Algeria have shown that the main plants parts used, in traditional medicine, are leaves and that decoction and simple preparation modes are commonly used to extract efficiently bioactive compounds (Belhouala & Benarba 2021).

Table 2. AMPs used by children under 5 years in TAZA Province and their Scientific and vernacular names, parts used, treated diseases, use and preparation modes and citation indexes (FC, RFC, FIV and UV).

Scientific name	Vernacular name	Voucher code	Parts used	Treated Diseases	Modes of		Indices					Ethnomedicinal uses recorded in the literature inside Morocco	References	
Families / Species					Preparation	Use	FC	RFC	FIV	UV	LF (%)			
Amaranthaceae														0,115
<i>Chenopodium ambrosioides</i> L.	Mkhinza	BLUMP-517	Fl, S, Rh, St, L, WP	DD; RD; SD; CVD; MD; OAD; ND; DA GDT; Others	I; D; P; R; C; Ma; Others	M; I; IN; R; TA; O; Others	48	11.53%		1.54	31% DD ; 17% RD, 17% OAD	Digestive Diseases, Osteo-articular Disorders	(Benamar <i>et al.</i> 2025, Kasali <i>et al.</i> 2021)	
Apiaceae														0.144
<i>Ammi majus</i> L.	Bachnikha	BLUMP-518	WP	RD ; Others	D	O	1	0.24%		2	100% RD	Respiratory Diseases; Digestive Diseases	(Jeddi <i>et al.</i> 2024)	
<i>Ammodaucus leucotrichus</i> Coss	Camoun Soufi	BLUMP-519	Fl; S; Rh; L; WP	RD; DD; CVD; MD; ND; DA GDT; Others	D ; R ; Ma	M, I, TA; O	20	4.80%		1.55	85% DD; 20% RD	Digestive Diseases	(Rhbibou <i>et al.</i> 2026)	
<i>Carum carvi</i> L.	Ikrawiya	BLUMP-520	Fl; S; L	DD ; MD ; ND ; Others	I ; D ; Ma	I ; TA ; Oral	8	1.92%		1.37	88% DD, 25% Others	Digestive Diseases, Osteo-articular Disorders	(Bellakhdar 1997, Eddouks <i>et al.</i> 2002, Jeddi, <i>et al.</i> 2024, Mechchate <i>et al.</i> 2020, Rhbibou <i>et al.</i> 2026)	
<i>Cuminum cyminum</i> L.	Camoun	BLUMP-521	S; L; WP	RD; DD; MD;	D, R, C; Ma;	O	11	2.64%		1.18	100% DD	Digestive Diseases, Metabolic Diseases	(Benamar <i>et al.</i> 2025, Mughal, 2022)	
<i>Daucus crinitus</i> Desf.	Bouzffour	BLUMP-522	S ; L	RD ; DD ; ND	D ; C	IN ; O	1	0.24%		3	100% RD, 100% DD, 100% ND	Digestive Disorders	(Kachmar <i>et al.</i> 2021)	
<i>Foeniculum vulgare</i> Mill.	Nafaâ	BLUMP-523	Fl; S; B; L; WP	RD; SD; DD; CVD; GUD; ND;	I' ; D ; P ; R ; C ; Ma	M, I; T A; O	16	3.84%		1.75	94% DD, 25% GUD	Respiratory Diseases Digestive Diseases; Skin Diseases; Neurological Diseases	(Jadid <i>et al.</i> 2023, Jeddi <i>et al.</i> 2024)	
<i>Petroselinum crispum</i> Mill.	Maâdnous/ Bakdounes	BLUMP-524	St; L; WP	RD; DD; CVD; Others	C ; Ma	O	2	0,48%		2,5	100% DD, 50% RD 50% CVD	Cardiovascular Diseases; Respiratory Diseases;	(Bellakhdar 1997, Benkhnigue <i>et al.</i> 2014, ElHachlafi <i>et al.</i>	

												Genitourinary Diseases;	2020, Mechchate et al. 2020, Rhbibou et al. 2026, Tahraoui et al. 2007)
<i>Pimpinella anisum</i> L.	Habbat Hlawa	BLUMP-525	S	DD	Ma	Oral	1	0.24%		1	100% DD	Digestive Diseases; Metabolic Diseases; Respiratory Diseases;	(Kachmar et al. 2021)
Asteraceae 0.135													
<i>Artemisia absinthium</i> L.	Chiba	BLUMP-526	L,	RD; SD; DD; OAD; ND; Others	D ; P, C	M ; TA	3	0.72%		2	33% DD, 33% RD, 33% SD, 33% OAD, 33%ND	Metabolic Diseases	(Benamar et al.2025, Hbika et al.2022)
<i>Artemisia herba alba</i> Asso.	Chih	BLUMP-527	Fl; S; St, Rh; L; WP	DD.; RD; SD; MD; GUD; ND; DA GDT; Others	I; D; P; R; C; Ma	M; I; IN; R TA; O	29	6.97%		1.68	62% DD, 31% RD	Digestive Disorders; Respiratory Diseases; Metabolic Diseases	(Benamar et al. 2025, El Ouardi et al. 2024)
<i>Chamaemelum nobile</i> L.	Babounj	BLUMP-528	L, WP,	RD; SD; DD; OAD; ND; DA GDT; Others	I; D; P; R; C; Ma	M; I; IN; TA; O	19	4.56%		2	68% DD, 53% ND	Genitourinary Diseases; Metabolic Diseases	(Benamar et al. 2025, Filipović et al. 2024)
<i>Dittrichia viscosa</i> L.	Bagraman	BLUMP-529	S ; L	RD; SD; DD; MD; GUD; ND; Others	D ; P ; R ; Ma	M ; IN ; TA ; O	3	0.72%		3.33	100% DD, 66% RD 33% SD, 33% GUD 33% MD, 33% ND	Digestive Disorders; Metabolic Disease; Osteo-articular Disorders; Dermatologic Diseases	(Jeddi et al. 2024, Kachmar et al. 2021, Rhbibou et al. 2026)
<i>Echinops spinosissimus</i> Turra	Warram	BLUMP-530	Rh	RD ; OAD	D	IN	1	0.24%		2	100% RD, 100% OAD	Digestive Disorders	(Mir et al. 2024)
<i>Silybum marianum</i> (L.) Gaertn	Halib chouk	BLUMP-531	S	SD; DD; OAD	D	O	1	0.24%		3	SD 100% ; DD100% ; OAD 100%	Digestive Disorders	(Marmouzi et al. 2021)
Aloaceae 0.002													
<i>Aloe succotrina</i> Lam.	Sabbar	BLUMP-532	WP	RD ; Others	P,	TA	1	0.24%		2	100% SD	Metabolic Diseases;	(El Hachlafi et al. 2020)

Brassicaceae													0,004			
<i>Lepidium sativum</i> L.	Hab rchad	BLUMP-533	S	RD ; SD ; DD	I; D	I; O	1	0,24		3		Metabolic Diseases; Cancers; Respiratory Diseases; Digestive Disorders	(Bellakhdar 1997, El Hachlafi <i>et al.</i> 2020, Fennane& Ibn Tattou 2005, Mechchate <i>et al.</i> 2020, Rhibbou <i>et al.</i> 2026, Tahraoui <i>et al.</i> 2007)			
<i>Raphanus sativus</i> L.	Lafjal	BLUMP-534	S ; L,	DD	D	IN ; O	1	0.24%		1	100% DD	Digestive Disorders	(El Khomsi <i>et al.</i> 2022)			
Cupressaceae															0.007	
<i>Tetraclinis articulata</i> (Vahl) Mast	El'ar'âr	BLUMP-535	L	RD ; DD ; Others	D ; P	I ; TA ; O	3	0.72%		1	33% RD, 33% DD	Skin Diseases	(Benamar <i>et al.</i> 2025)			
Dennstaedtiaceae															0.002	
<i>Pteridium aquilinum</i> (L.) Kuhn	Sarkhas	BLUMP-536	St ; L	RD ; SD ; DD	D	R ; O	1	0.24%		3	100% RD, 100% DD 100% SD	Metabolic Diseases; Respiratory Diseases; Digestive Disorders; Skin Diseases; Osteo-articular Diseases	(Kato-Noguchi <i>et al.</i> 2026)			
Fabaceae															0.038	
<i>Ceratonia siliqua</i> L.	Kharroub	BLUMP-537	Fl ; S ; Rh ; WP	RD ; DD	D ; C ; Ma	O	1	0.24%		2	100% RD, 100% DD	Metabolic Diseases; Respiratory Diseases; Digestive Disorders;	(Barkaoui <i>et al.</i> 2017, Bouyahya <i>et al.</i> 2017, Mechchate <i>et al.</i> 2020, Rhibbou <i>et al.</i> 2026)			
<i>Glycyrrhiza glabra</i> L.	arkasous	BLUMP-538	Fl, Brak;L,	RD ; DD ;	D ; R	I	1	0.24%		2	100% RD, 100% DD	Respiratory Diseases; Digestive Disorders Osteo-articular Diseases	(Bouayyadi <i>et al.</i> 2015, El Hachlafi <i>et al.</i> 2020, El Hilah <i>et al.</i> 2015, El Yahyaoui <i>et al.</i> 2015, Ghourri <i>et al.</i> 2013, Rhibbou <i>et al.</i> 2026)			
<i>Trigonelle foenum-graecum</i> L.	Lhalba	BLUMP-539	Fl, S, St; L	RD; SD; DD; CVD; MD; GUD; ND; DA GDT; Others	I; D, P, R, C; Ma; Others	M, I; TA; O	14	3.36%		2	71% DD, 43% RD, 21% SD	Metabolic Diseases; Digestive Disorders Genitourinary Diseases; Cardiovascular Diseases	(Fakchich & Elachouri 2014, Kachmar <i>et al.</i> 2021)			

Juglandaceae											0.004		
<i>Juglans regia</i> L.	Sswak	BLUMP-540	B ; Rh	S D ; DD ; OAD	P, R ;	I ; TA	2	0.48%		2	100% OAD, 100% 50% DD, 50% SD	Skin Diseases Respiratory Diseases; Genitourinary Diseases;	(Benamar <i>et al.</i> 2025, Rhibbou <i>et al.</i> 2026, Sharma <i>et al.</i> 2022)
Lamiaceae											0,807		
<i>Calamintha officinalis</i> L.	Manta	BLUMP-541	Fl; S; St; L; WP	RD; SD; DD; CVD; MD; GUD; OAD; ND; DA GDT	D ; R ; C ; Ma	M; I; IN; TA; O	21	5.04%		2	67% DD, 48% RD, 33% ND	Digestive Disorders, Respiratory Disorders,	(Benamar <i>et al.</i> 2025, Laftouhi <i>et al.</i> 2023)
<i>Lavandula dentata</i> L.	Lakhzama	BLUMP-542	Fl; S; St; L; WP,	RD; SD; DD; CVD; GUD; OAD; ND; DA GDT; Others	I; D; P; R; Ma; Others	M, IN; R; TA; O	16	3.84%		2.5	44% SD, 44%DD, 44% ND, 38% RD 31% GUD	Neurological Diseases; Digestive Disorders, Respiratory Disorders, Skin Diseases	(Jeddi <i>et al.</i> 2024, Nacef <i>et al.</i> 2022)
<i>Lavandula stoechas</i> L.	Halhal	BLUMP-543	L,	DD	D	O	1	0.24%		1	100% DD	Neurological Diseases; Digestive Disorders, Respiratory Disorders, Skin Diseases Cardiovascular Diseases Metabolic Diseases;	(Benamar <i>et al.</i> 2025, Rhibbou <i>et al.</i> 2026, Şahinler <i>et al.</i> 2022)
<i>Marrubium vulgare</i> L.	Marriwa	BLUMP-544	Fl; L	RD; SD; DD; GUD; DA GDT; Others	D; P; C; Ma	M, I; TA; O	9	2.16%		2.11	44% DD, 33% DAGDT, 33% RD	Digestive Disorders Respiratory Disorders Dermatological Disorders Osteo-articular Diseases Neurological Diseases;	(Jeddi <i>et al.</i> 2024)
<i>Menta pulegium</i> L.	Fliyyou	BLUMP-545	F; S; B; St; L; WP; Others	DD.; RD; SD; CVD; MD; OAD; ND; DA	I; D; P; R; C; Ma; Others	M; I; IN; TA; O; Others	50	12.01%		1.48	82% RD, 32% DD	Metabolic Diseases; Respiratory Disorders, Digee Disorders	(Eddouks <i>et al.</i> 2002, El Hachlafi <i>et al.</i> 2020, Khabbach <i>et al.</i> 2012, Mechchate <i>et al.</i> 2020,

				GDT; Others									Rhbibou <i>et al.</i> 2026, Tahraoui <i>et al.</i> 2007)
<i>Mentha rotundifolia</i> Muds	Marsita	BLUMP- 546	L,	RD; SD; DD; GUD; Others	I ; D ; MA	M ; TA	3	0.72%		2.66	100% DD, 67% RD 33% SD, 33% GUD	Digestive Disorders Respiratory Disorders Osteo-articular Disease	(Benamar <i>et al.</i> 2025, Jeddi <i>et al.</i> 2024, Salamatullah 2022)
<i>Mentha spicata</i> L.	Nâanâa	BLUMP- 547	Fl; L; WP	RD; SD; DD; CVD; MD; OAD; ND; DA GDT;	I; D; P; R; C; Ma	M; I; IN; TA; O	21	5.04%		1.61	43% DD	Digestive Disorders	(Rhbibou <i>et al.</i> 2026)
<i>Ocimum basilicum</i> L.	Lahbak	BLUMP- 548	L	RD ; DD	D	O	1	0.24%		1	100% Others	Digestive Disorders Dermatological Disorders Osteo-articular Disease Neurological Disease; Genitourinary Diseases; Cardiovascular Disease Metabolic Disease	(Bellakhdar <i>et al</i> 1997, Jeddi <i>et al.</i> 2024, Kachmar <i>et al.</i> 2021)
<i>Origanum compactum</i> Benth	Zâatar	BLUMP- 549	F; S; E; R; B; St; L; WP; B; Others	DD; RD, SD; CVD; MD; GUD; OAD; ND; DAGDT; Others	I ; D	O	133	31.97%		1.80	80% DD, 27% RD	Respiratory Disease Digestive Disorders Dermatological Disorders Osteo-articular Disease Genitourinary Diseases; Cardiovascular Diseases	(Benamar <i>et al.</i> 2025, Hayani <i>et al.</i> 2022, Jeddi <i>et al.</i> 2024, Ouknin <i>et al.</i> 2024)
<i>Rosmarinus officinalis</i> L.	Azir	BLUMP- 550	Fl; S; St; Rh; L; WP; B	DD.; RD; SD; CVD; MD; OAD; ND; DA GDT; Others	I ; D ; P ; R ; C ; M	M; I; IN; R; TA; O	71	17.06%		1.77	85% DD, 22% RD	Respiratory Disease Digestive Disorders Dermatological Disorders Osteo-articular Disease	(Jeddi <i>et al.</i> 2024)

												Genitourinary Diseases; Cardiovascular Diseases Metabolic Disease	
<i>Salvia officinalis</i> L.	Ssalmiya	BLUMP-551	St; L; WP	RD; DD; GUD; ND; DA GDT; Others	I; D; P; C; Ma	IN; TA; O	8	1.92%		1.87	88% DD, 38% ND	Metabolic Diseases Osteo-articular Diseases Genitourinary Diseases; Cardiovascular Diseases Respiratory Diseases; Digestive Disorders	(Bouayyadi <i>et al.</i> 2015, Jeddi <i>et al.</i> 2024, Orch <i>et al.</i> 2015, Tahraoui <i>et al.</i> 2007, Ziyat <i>et al.</i> 1997)
<i>Thymus satureioides</i> Coss.	Zaitra (Zaâtar Barri)	BLUMP-552	Fl; S; Rh; St; L;	RD ; DD ; OAD	D	IN; O	2	0.48%		2	100% DD, 50% RD 50% GUD	Digestive Disorders	(Jeddi <i>et al.</i> 2024)
Lauraceae 0.019													
<i>Cinnamomum zeylanicum</i> Nees.	Qarfa	BLUMP-553	Fl; S; B; Rh; L; WP	RD; SD; DD; CVD; GUD; OAD; ND; DA GDT;	D, R, C; Ma;	M; I; TA; O	8	1.92%		3.37	38% GUD, 25% DD 25% SD, 25% CVD	Circulatoir system	(El Hachlafi <i>et al.</i> 2020, El Yahyaoui <i>et al.</i> 2015, Ghourri <i>et al.</i> 2013), (Jeddi <i>et al.</i> 2024, Mechchate <i>et al.</i> 2020, Orch <i>et al.</i> 2015, Rhibbou <i>et al.</i> 2026)
Liliaceae 0.009													
<i>Allium cepa</i> L.	Bassla	BLUMP-554	L; WP	RD ; SD ; OAD ; ND	R	TA	2	0.48%		3	100% RD, 50% ND 100% OAD, 50% SD,	Digestive Diseases; Respiratory Disorders; Osteoarticular Disorders;	(Barkaoui <i>et al.</i> 2017, Benkhiguel <i>et al.</i> 2014, Bouayyadi <i>et al.</i> 2015, Chebat <i>et al.</i> 2014, Ghourri <i>et al.</i> 2013, Rhibbou <i>et al.</i> 2026, Youbi <i>et al.</i> 2016)
<i>Allium sativum</i> L.	Taoum	BLUMP-555	Rh ; L ; WP	DD ; CVD ;	C	O ; TA	2	0.48%		2	100% DD, 100% CVD	Digestive Diseases; Respiratory Disorders; Skin Diseases	(Benamer <i>et al.</i> 2025, Sasi <i>et al.</i> 2021)

Linaceae													
0.009													
<i>Linum usitatissimum</i> L.	Zarrī'at l-kettan	BLUMP-556	S	SD; CVD; Others	D ; C ; Ma	R ; TA ; O	4	0.96%		1.25	75% CVD, 25% SD	Cardiovascular Diseases ; Metabolic Diseases ;	(Benamer <i>et al.</i> 2025, Stavropoulos <i>et al.</i> 2023)
Lythraceae													
0.009													
<i>Lawsonia inermis</i> L.	l'Henna	BLUMP-557	L	Der D; OAD; ND;	P, R; Ma	TA	4	0.96%		1.25	75% OAD, 25% SD 25% ND	Skin Diseases	(Batiha <i>et al.</i> 2024, Benamar <i>et al.</i> 2025)
Malvaceae													
0.009													
<i>Tilia cordata</i> Mill.	l'Zayzafoun	BLUMP-558	L	RD ; ND	Ma	O	4	0.96%		1.75	100% RD, 75% ND	Respiratory Disorders	(Karpavičienė, 2022)
Myrtaceae													
0.031													
<i>Eucalyptus globulus</i> Labill.	Kaliptous	BLUMP-559	L	RD	D	IN	1	0.24%		1	100% RD	Respiratory Disorders	(Bellakhdar 1997, Bouyahya <i>et al.</i> 2017, El Hachlafi <i>et al.</i> 2020, El Hilah <i>et al.</i> 2015, Rhibbou <i>et al.</i> 2026)
<i>Myrtus communis</i> L.	Rayhan	BLUMP-560	Fl, L,	SD ; DD ; OAD ; ND	D ; C ; Ma	M ; R ; TA	5	1.20%		1.8	80% DD, 40% OAD 40% ND	Digestive Diseases ; Metabolic Diseases ; Skin Diseases	(Bouyahya <i>et al.</i> 2017, El Hachlafi <i>et al.</i> 2020, El Yahyaoui <i>et al.</i> 2015, Fennane& Ibn Tattou 2005, Jeddi <i>et al.</i> 2024)
<i>Syzygium aromaticum</i> L.	Qronfel	BLUMP-561	Fl; S; WP	RD ; Der D ; DD ; ND	I; D; P; R; Ma	M; R; T; Oral	7	1.68%		1.71	57% DD, 57% SD	Digestive Diseases; Metabolic Diseases; Respiratory Disorders; Genitourinary Disorders	(Bellakhdar 1997, Bouayyadi <i>et al.</i> 2015, El hachlafi <i>et al.</i> 2020, El Hilah <i>et al.</i> 2015, Rhibbou <i>et al.</i> 2026)
Oleaceae													
0.002													
<i>Olea europea</i> L. var. <i>sativa</i>	Zeitoun	BLUMP-562	L	RD ; Others	D	IN	1	0.24%		2	100% RD	Cardiovascular Diseases ; Metabolic Diseases ; Skin Diseases ; Osteoarticular Disorders ;	(Benamar <i>et al.</i> 2024b, Bouyahya <i>et al.</i> 2017, Elhrech <i>et al.</i> 2024, Fadil <i>et al.</i> 2015, Fakchich &

													Elachouri 2014, Filardo <i>et al.</i> 2024, Orch <i>et al.</i> 2015, Rhbibou <i>et al.</i> 2026)
Poaceae													0.002
<i>Panicum miliaceum</i> L.	Illan	BLUMP-563	L	SD; DD; CVD; OAD; ND	D ; P, C ; MA	M ; R ; O	1	0.24%		6	100% SD, 100% DD 100% CVD, 100% OAD,100% ND	Cardiovascular Diseases; Digestive Diseases; Metabolic Diseases	(Rajasekaran <i>et al.</i> 2021)
Ranunculaceae													0.002
<i>Nigelle sativa</i> L.	Habbat Lbaraka / Sanouj	BLUMP-564	S	SD ; RD ; DD	D	M	1	0,24%		3	100%SD, 100%RD, 100%DD	Cancer; Immune System Disorders Digestive Diseases; Metabolic Diseases; Respiratory Disorders; Skin Diseases; Osteoarticular Disorders; Genitourinary Disorders	(Bellakhdar 1997, Bouayyadi <i>et al.</i> 2015, Chebat <i>et al.</i> 2014, Ghourri <i>et al.</i> 2013, Jeddi <i>et al.</i> 2024, Orch <i>et al.</i> 2015, Rhbibou <i>et al.</i> 2026)
Rhamnaceae													0.002
<i>Ziziphus lotus</i> L.	Al-Sidr	BLUMP-565	L	RD ; SD ;	D ; Ma	IN ; O	1	0.24%		2	100% RD, 100% SD	Digestive Diseases; Skin Diseases; Osteoarticular Disorders; Genitourinary Disorders	(Jeddi <i>et al.</i> 2024, Rhbibou <i>et al.</i> 2026)
Rosaceae													0.014
<i>Rosa centifolia</i> L.	Al-ward	BLUMP-566	Fl; L	SD; DD; MD; GUD; Others	I ; D ; R ; MA	M ; TA ; Oral	6	1.44%		1.5	83% SD	Digestive Diseases; Respiratory Disorders; Skin Diseases; Neurological Disorders	(Jeddi <i>et al.</i> 2024, Meziouy <i>et al.</i> 2025, Rhbibou <i>et al.</i> 2026)

Rutaceae														0.002
<i>Citrus limon</i> (L.) Burm.f.	Lymoun	BLUMP-567	Bulb	RD ; MD ; OAD	R	O	1	0.24%		3	100% RD, 100% MD 100% OAD	Antidote to poison; Cardiovascular Diseases; Digestive Diseases; Skin Diseases. Genitourinary Disorders	(Poddar <i>et al.</i> 2020, Posadino <i>et al.</i> 2024, Zahr <i>et al.</i> 2023)	
Schisandraceae														0,002
<i>Illicium verum</i> Hook.f	Najma (badiane)	BLUMP-568	S	RD ; SD ; CVD ;	Déco	O	1	0,24%		3	100% RD, 100% DD 100% CVD	Digestive Diseases ; Respiratory Disorders	(Patra JK <i>et al.</i> 2020 Wang GW <i>et al.</i> 2011)	
Theaceae														0,009
<i>Camellia sinensis</i> (L.) Kuntze	Atay	BLUMP-569	S ; St ; L	RD; DD; CVD; GUD; DA GDT;	D ; C ; Ma	O	4	0.96%		1.75	75% DD, 25% RD 25% CVD, 25% GUD	Digestive Diseases	(Doukkali <i>et al.</i> 2015, El Hachlafi <i>et al.</i> 2020, EL Yahyaoui <i>et al.</i> 2015, Jeddi <i>et al.</i> 2024)	
Thymelaeaceae														0.002
<i>Daphne gnidium</i> L.	Lazzaz	BLUMP-570	L	SD	D	M ; R	1	0.24%		1	100% SD	Skin Diseases	(Fakchich & Elachouri 2014,Kachmar <i>et al.</i> 2021)	
Urticaceae														0.002
<i>Urtica dioica</i> L.	lAl-Qaras (hriga)	BLUMP-571		DD ; GUD	C	O	1	0.24%		2	100% DD 100% GUD	Cirulatory system ; Osteoarticular Disorders	(Jeddi <i>et al.</i> 2024)	
Verbenaceae														0.235
<i>Aloysia citrodora</i> Palau	Louiza	BLUMP-572	Fl; S; St; Rh; B; L; WP	DD; RD; SD; CVD; MD; OAD; ND; DA GDT;	I; D; P; R; C; M; Others	I; IN; R; TA; O; Others	98	23.55%		1.54	61% DD, 30% ND	Cardiovascular Diseases; Digestive Diseases; Respiratory Disorders; Genitourinary Disorders	(Bahramsoltani <i>et al.</i> 2018, Kachmar <i>et al.</i> 2021, Rhbibou <i>et al.</i> 2026)	
Zingiberaceae														0.036
<i>Curcuma xanthorrhiza</i> Roxb.	Kharkoum	BLUMP-573	S; Rh; L; WP	SD; DD; MD; OAD; ND;	D, R; C; Ma	M; O	4	0.96%		2.5	75% DD	Respiratory Disorders;	(Jeddi <i>et al.</i> 2024, Rhbibou <i>et al.</i> 2026)	

												Skin Diseases; Genitourinary Disorders	
<i>Zingiber officinale</i> Roscoe	Zanjabil (Skinjibir)	BLUMP- 574	S; Rh; St; L; WP	RD; SD; DD; CVD; MD; GUD; OAD; DA GDT;	I; D, P, R, C; Ma	M; TA; O	11	2.64%		2	82% DD, 36% RD	Cardiovascular Diseases; Digestive Diseases; Respiratory Disorders; Genitourinary Disorders	(Bouayyadi <i>et al.</i> 2015, El Yahyaoui <i>et al.</i> 2015, Fakchich & Elachouri 2014, Ghourri <i>et al.</i> 2013, Jeddi <i>et al.</i> 2024)

Legend

Treated diseases: DD: Digestive disease; RD: Respiratory Disease; SD: Skin disorder; ND: Neurological disease; MD: Metabolic disease; CVD: Cardiovascular disease; GUD: Genitourinary diseases; OAD: Osteoarticular disorders; DAGDT: Disorders of the accessory glands of the Digestive tract

Preparation mode: D: Decoction; I: Infusion; Ct: Cataplasma; R: Raw; C: Cooked; Ma: Maceration

Administration mode: O: Oral; M: Massage; I: Infusion; In: Inhalation; TA: Topical Application; R: Rinsing

Parts of plants: Fl: Flowers; S: Seed; E: Ecorces; Rh: Rhizome; B: Bark; St: Stem; L: Leaves; WP: Whole plant; Bu: Bul



Figure 9. Main plant species collected in the study area (Photographs by: Siham Khomsi and Ibtiassam Rhbibou).

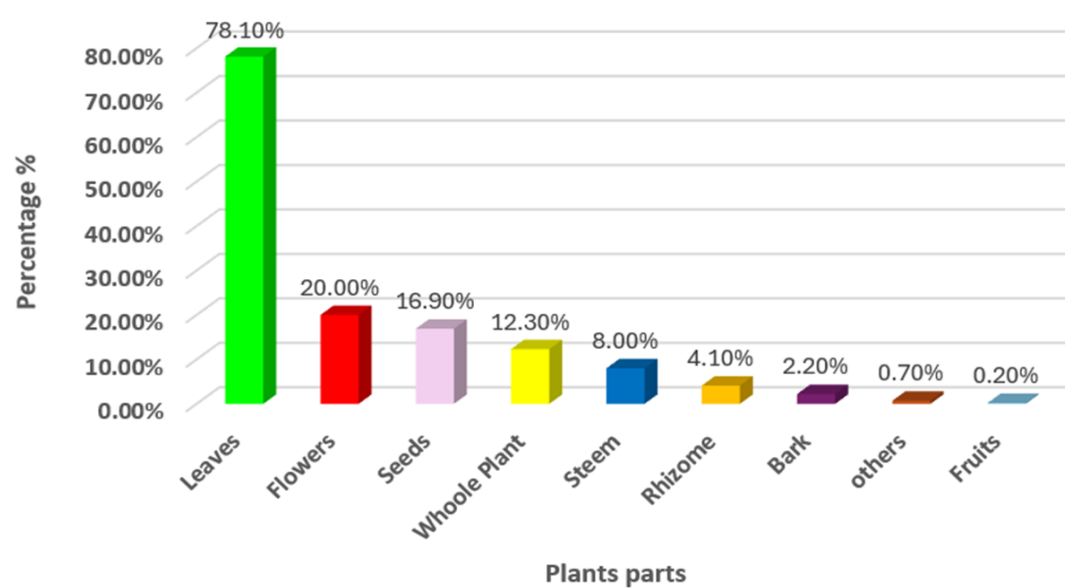


Figure 10. Percentage of plants parts used

AMPs and their preparation methods

Herbal teas were the most commonly used preparations of AMPs (76.8%), rather than powders (33.3%) and essential oils (19.8%) (Figure 11). Concerning the liquid preparations, decoction was the most prevalent preparation method (71.3%), followed by maceration (33.5%), cooking (19.5%), poultice (12.3%), raw preparation (9.4%), and infusion (8%) (Figure 12).

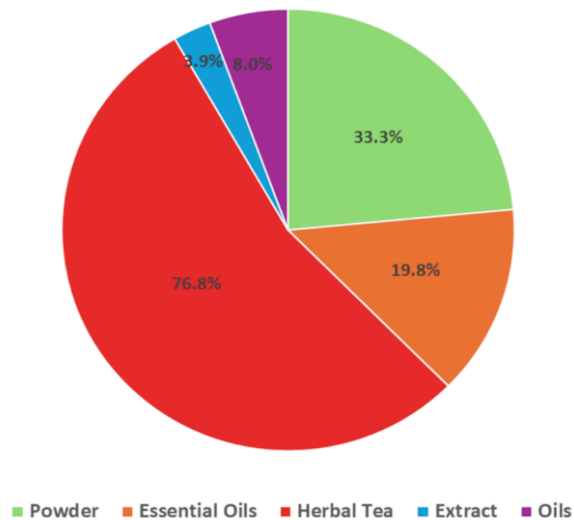


Figure 11. Forms of use of AMPs

Previous ethnobotanical studies in the Maghreb also reported that decoction and infusion were the frequently used preparation techniques, thanks to their high extraction efficiency as well as to their accessibility and compatibility (Rhattas *et al.* 2016, Chaachouay *et al.* 2019, El Hachlafi *et al.* 2020). Similar findings have been documented in other areas of North African, emphasizing the key role of basic liquid preparations in the North African traditional / Or the current mainstream conventional healthcare systems (Belhouala & Benarba 2021).

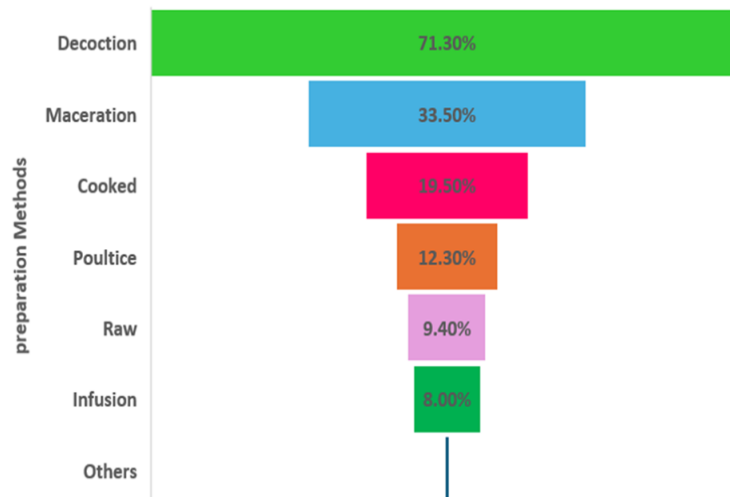


Figure 12. Preparation methods of AMPs

Doses of AMPs used

Teacups (44.3 %), spoonfuls (41.7 %), a handful (25.3 %), glass of water (12.8 %) and pinch (9.4 %) are the most common units found in the measurement of herbal remedies in the study area (Figure 13). These results show that there is an expansion of use of empirical/visual measures for dosing, rather than standardized ones. Such trend was also reported in other Moroccan ethnobotanical studies (Bouyahya *et al.* 2017), especially in the healthcare of little childhood, for which medication doses are adjusted in conjunction with the child's age, body weight and body structure. Similar practices have been observed in other parts of Africa, such as in north-eastern Tanzania, where the use of herbal plants for managing child diarrhea, by traditional healers, is only based on empirical dosing with no health guidelines, but at varying doses according to the child's age and symptom's severity (Liheluka *et al.* 2023).

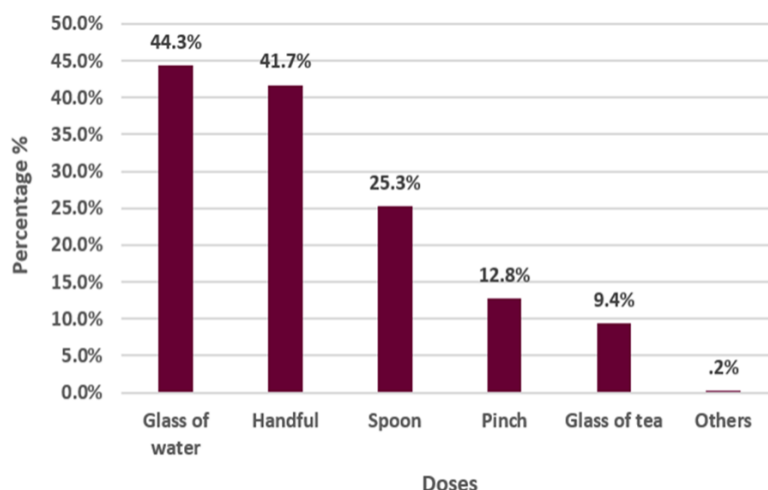


Figure 13. Doses of AMPs used

Administration method

In our study, oral administration of AMPs was the most frequent administration method for little children (89.4%), exceeding largely topical application (15.9%) or inhalation (10.6%), while massage, infusion, and rinsing were rarely used. This pattern confirms that traditional practices are embedded in the families' environment, where medicinal plants are considered natural and appropriate for children (Figure 14).

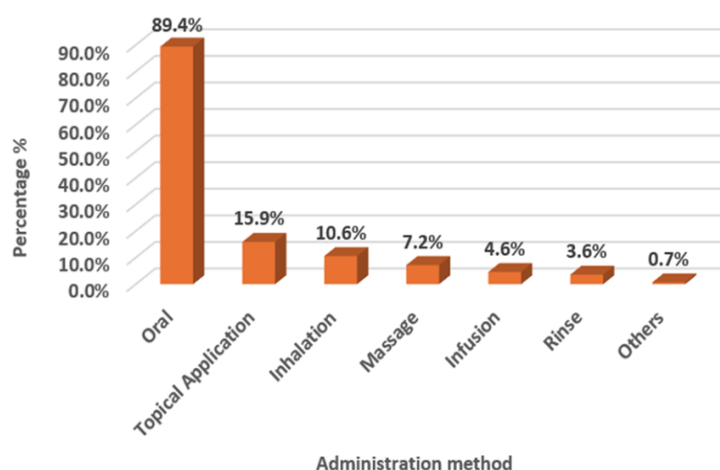


Figure 14. Administration method

These results corroborate with other ethnobotanical surveys, which reported that the common plant preparation modes are decoctions and infusions, showing that the oral administration is predominant in the Moroccan traditional medicine (Bouyahya *et al.* 2017, Salhi *et al.* 2010). Similar practices are reported elsewhere in North Africa, such as in south-west Algeria where traditional healers' advice decoction as the main preparation method and oral route as the main administration mode, that was used in about 80% of cases, reflecting that most practices are transmitted culturally and guided empirically (Belhouala *et al.* 2021).

AMPs using' Indications

The main indications for AMPs' use among little children were digestive disorders, including bloating, colic, and diarrhea, representing 72.6 % of cases (Figure 15). Which is consistent with other ethnobotanical surveys performed in diverse Moroccan areas, that reported the digestive ailments as primary AMPs using indication mainly for little children (Es Safi *et al.* 2020, Redouan *et al.* 2022, Belhaj *et al.* 2021).

The second most reported indication concern respiratory disorders (cough, colds, nasal congestion...) which affect 34.1% of children. A similar observation has been reported in other Moroccan studies (Bouyahya *et al.* 2017).

Furthermore, neurological troubles, characterized by agitation and sleep disturbance, were reported for 17.20 % of little children, and dermatological troubles (skin rash, irritation) were also reported for 15.7 % of cases. Therefore, AMPs are also reported to be used for neurological and dermatological disorders, besides the digestive disorders, globally in Morocco and particularly in the middle Atlas (Hamamouch 2020), confirming diverse uses of AMPs.

In sum, our findings show that digestive and respiratory disorders represent the main AMPs using indications among the little children. This also confirms the necessity to regulate and guide their use for such population due to their sensitivity on the one hand and to dosages variability on the other hand.

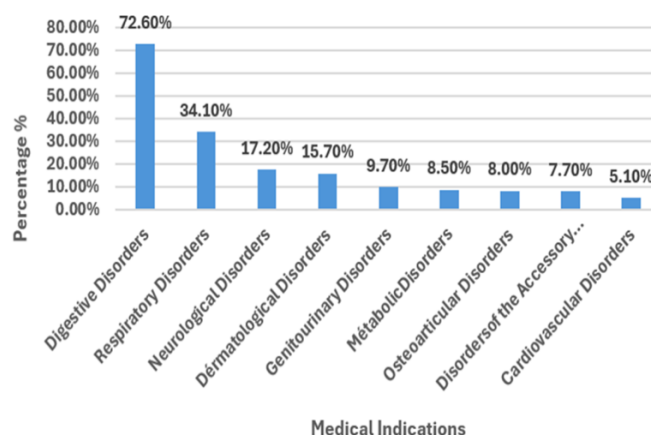


Figure 15. Medical indications for the use of AMPs

Adverse effects

AMPs use induced adverse effects for 14.94% of little children studied in this survey, with nausea and vomiting that were the most frequent (57.78%), then allergy (28.1%), digestive troubles (varying from simple diarrhea to gastric ulcers (25%)), as well as hyperthermia and sedation, while convulsions were rarely observed. (Figure 16).

This distribution showed that gastro-intestinal and allergic reactions are the most predominant side effects recorded when using AMPs for little children. Which is concordant with previous findings, even if it is limited for such population, that also reported such tendency especially in special cases as overdose, absence of standardization preparation or unsuitable administration (WHO 2013, Gardiner *et al.* 2013, Ernst *et al.* 2003).

Moreover, some studies highlighted that the perception of AMPs as “natural” contributes to underestimating the potential risk and less managing of adverse effects (WHO 2013). In the Moroccan context, surveys concerning adult populations also reported adverse effects to the AMPs using, especially digestive disorders, which highlights that traditional medicines are risky, independently to the age-groups (Sekkat *et al.* 2020).

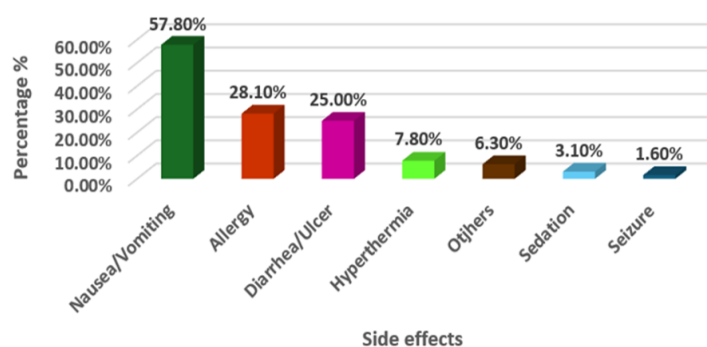


Figure 16. Main side effects noted after using aromatic and medicinal plants

Contingency table model

Results of Table 3 show that the AMPs' perceived effectiveness affects negatively the using satisfaction when deemed insufficient (Estimate = -0.105 ; $t = -5.046$; $p < 0.001$), highlighting its key importance. Moreover, adverse effects significantly reduce satisfaction (Estimate = -0.217 ; $t = -4.863$; $p < 0.001$). Thereafter, both variables are important for convincing the AMPs' users. The results robustness is confirmed by cross-analyses. AMPs' use frequency is significantly associated with satisfaction ($\chi^2 = 13.6$; $p = 0.001$); indeed, occasional users (229 satisfied, 47 unsatisfied) reported a higher level of satisfaction than the very frequent users (8 satisfied, 0 unsatisfied) (Table 3).

Combined therapies' preference is also a key factor ($\chi^2 = 11.1$; $p < 0.01$), because respondents preferring modern medicine (266 satisfied vs 50 unsatisfied) reported a higher satisfaction level than those favoring / consenting traditional medicine (96 satisfied, 3 unsatisfied).

Children's reactions toward AMPs affects the satisfaction degree of their parents ($\chi^2 = 6.74$; $p = 0.009$). The parents whose children accept AMPs (212 satisfied, 21 unsatisfied) reported higher levels of satisfaction than those whose children refuse them (150 satisfied, 32 unsatisfied).

Furthermore, the AMPs' toxicity knowledge is also associated with the satisfaction level ($\chi^2 = 5.10$; $p = 0.024$). Informed individuals (65 satisfied, 3 unsatisfied) appear to have a more favorable perception than those unaware of this toxicity (297 satisfied, 50 unsatisfied).

Perceived effectiveness is the most discriminating factor ($\chi^2 = 56.2$; $p < 0.001$). Among those judging effectiveness as "good" (196 satisfied, 3 dissatisfied) or "excellent" (28 satisfied, 2 unsatisfied), satisfaction rates are significantly higher than those reporting "insufficient" effectiveness (33 satisfied, 17 unsatisfied).

Finally, the occurrence of side effects significantly reduced satisfaction ($\chi^2 = 24.8$; $p < 0.001$). Respondents who did not experience any adverse effects (320 satisfied, 33 unsatisfied) reported much higher satisfaction than those who experienced adverse effects (42 satisfied, 29 unsatisfied).

Sociodemographic variables such as sex ($\chi^2 = 2.02$; $p = 0.155$), age ($\chi^2 = 2.06$; $p = 0.840$), educational level ($\chi^2 = 2.90$; $p = 0.408$), urban or rural origin ($\chi^2 = 0.688$; $p = 0.407$), or occupation ($\chi^2 = 3.05$; $p = 0.218$) did not have a significant influence on satisfaction. Similarly, social coverage, medical or surgical history, and distance to health-care facilities do not show a statistically significant relationship (all $p > 0.05$). In summary, satisfaction with AMP is largely determined by experiential and perceptual variables rather than socio-demographic characteristics. Perceived effectiveness ($p < 0.001$), absence of side effects ($p < 0.001$), frequency of use ($p = 0.024$ in the model; $p = 0.001$ in the chi-square test), and preference for modern medicine when used in combination ($p = 0.026$ in the model; $p < 0.01$ in the chi-square test) are the main determinants. Conversely, sex, age, origin, and educational level do not significantly affect satisfaction. These results suggest that satisfaction assessment is based on a pragmatic evaluation of the benefits and risks associated with AMPs use, rather than on individuals' social or demographic background.

Table 3. Socio-demographic characteristics of participants who used medicinal plants in the region of Taza, Morocco.

Socio-demographic Variables	Satisfaction		Chi2	p. Value
	Yes	No		
Gender				
Male	60	13	2.02	0.155
Female	302	40		
Total	362	53		
Age range				
<20 years old	61	8	2.06	0.840
[20-30ans]	112	18		
[31-40ans]	96	15		
[41-50ans]	73	11		
[51-60ans]	12	0		
>60ans years old	8	1		
Relationship				
Father	41	10	2.44	0.295
Mother	223	30		
others	98	13		

Educational Level				
Not schooled	119	14		
Primary	92	11	2.90	0.408
Secondary	70	11		
University	81	17		
Residence				
Urban	186	24	0.688	0.407
Rural	176	29		
Function				
Public	68	15	3.05	0.218
Private	25	2		
Without	269	36		
Social Coverage				
NHIFCS	175	26		
NSSF	68	7	1.17	0.760
MHI TADAMON	80	13		
RAF	39	7		
Accessibility to primary healthcare				
<3Km	203	30		
De 3 à 6Km	96	13	0.128	0.938
>6Km	63	10		
Medical History				
Yes	45	4	1.06	0.303
No	317	49		
Surgical History				
Yes	12	1	0.311	0.577
No	350	52		
Child Vaccination				
Yes	349	53	1.96	0.161
No	13	0		
Use of traditional medicine				
Yes	361	53	0.147	0.702
No	1	0		
Frequency of AMPs use				
Occasional	229	47	13.6	0.001
Frequent	125	6		
Very Frequent	8	0		
Preference when we combine				
Traditional medicine	96	3	11.1	<0.01
Modern medicine	266	50		
Age at which AMPs use began				
<1mois	31	5		
[1month-1year]	94	6	6.03	0.110
[1year-2years]	75	11		
[2years-5years]	162	31		
Children's attitude towards AMPs				
Acceptance	212	21	6.74	0.009
Refusal	150	32		
Knowledge about AMPs toxicity				
Yes	65	3	5.10	0.024
No	297	50		
Diagnosis made by the family				
Yes	292	38	2.28	0.131
No	70	15		
Diagnosis made by a healthcare professional				
Yes	63	11	0.354	0.552
No	299	42		

Diagnosis made by the herbalist	50	10	0.995	0.328
Yes	312	43		
No				
Diagnosis made by others				
Yes	7	1	5.38e-4	0.981
No	355	52		
Effectiveness of AMPs				
Insufficient	33	17		
Average	105	31	56.2	< .001
Good	196	3		
Excellent	28	2		
Side effects				
Yes	42	29	24.8	<.001
No	320	33		
Recommendation for using AMPs	346	5	263	<.001
Yes	16	48		
No				

Some differences between the p-values reported in Table 3 were observed. Such differences arise from the fact that each value was obtained from a separate bivariate chi-square test examining the relationship between satisfaction and one explanatory variable at a time. The magnitude of each p-value depends on the strength of the observed association, the distribution of satisfied and dissatisfied participants across categories, the sample size within each category, and the number of degrees of freedom. Variables showing marked differences in satisfaction proportions, such as perceived effectiveness, side effects, and recommendation of AMPs, consequently produced very small p-values ($p < 0.001$). Frequency of AMP use ($p = 0.001$), preference when traditional and modern medicines were combined ($p < 0.01$), children's attitudes toward AMPs ($p = 0.009$), and knowledge of AMP toxicity ($p = 0.024$) also showed statistically significant associations with satisfaction.

By contrast, the relatively similar distribution of satisfaction across categories of gender, age, educational level, residence, occupation, social coverage, accessibility to healthcare facilities, and medical or surgical history resulted in non-significant p-values. These p-values should not be interpreted as direct measures of the magnitude or clinical importance of the associations; they indicate only the degree of statistical evidence against the null hypothesis of independence. In addition, the chi-square analyses presented in Table 3 are unadjusted bivariate analyses, whereas the regression model in Table 4 evaluates the independent contribution of each variable while simultaneously accounting for the other predictors. Therefore, differences between the p-values in Tables 3 and 4 are expected and may result from adjustment for confounding and correlations among the explanatory variables.

Linear regression

Rationale for using regression analysis

The regression analysis was conducted as a complementary multivariable approach to the bivariate chi-square analyses presented in Table 3. Although chi-square tests can identify crude associations between each explanatory variable and satisfaction, they cannot determine whether these associations remain significant after accounting for the simultaneous influence of other variables. Regression analysis makes it possible to estimate the independent contribution of each predictor, while controlling for potential confounding and correlations among sociodemographic characteristics, AMP-use practices, perceived effectiveness, and reported side effects. It also provides information on the direction and magnitude of each association through the estimated regression coefficients.

This approach was particularly relevant because several factors associated with satisfaction may be interrelated. For example, the frequency of AMP use may be related to perceived effectiveness, adverse effects, children's attitudes, and preference for traditional or modern healthcare. By including these variables in the same model, the regression analysis helped identify which factors remained independently associated with satisfaction. It therefore provided a more comprehensive and adjusted interpretation of the determinants of satisfaction than the bivariate analyses alone.

The multiple regression model's analysis revealed that some factors affect the satisfaction of using AMPs significantly (Table 4). The regression results suggest that satisfaction with AMP use is influenced more strongly by participants' experiences and perceptions than by their basic sociodemographic characteristics. The negative association between frequency of AMP use

and satisfaction (Estimate = -0.0738 ; $p = 0.024$) may indicate that repeated use provides respondents with more opportunities to observe limitations, inconsistent effectiveness, difficulties in preparation, or undesirable effects. It is also possible that frequent users rely on AMPs for recurrent or persistent conditions that are more difficult to manage, thereby reducing their overall level of satisfaction. However, because the study was cross-sectional, the direction of this relationship cannot be established.

Table 4. Predictors of satisfaction with AMPs use: Results from a linear regression model.

Predictor	Estimate	SE	t	p
Intercept	1.05081	0.5393	1.949	0.052
Gender	0.00723	0.0489	0.148	0.882
Age	0.00379	0.0137	0.277	0.782
Relationship	-0.03224	0.0292	-1.103	0.271
Educational level	0.00466	0.0160	0.292	0.771
Origin	0.03170	0.0366	0.866	0.387
Fonction	-0.00989	0.0226	-0.438	0.662
Social Coverage	0.00970	0.0145	0.666	0.506
Accessibility	0.02132	0.0229	0.930	0.353
Medical History	0.02661	0.0483	0.551	0.582
Surgical History	0.03211	0.0922	0.348	0.728
Child Vaccination	-0.08841	0.0922	-0.959	0.338
Use of traditional medicine	0.04528	0.3241	0.140	0.889
Frequency of AMPs use	-0.07383	0.0325	-2.273	0.024
Use of Moderne Medicine	0.03891	0.0984	0.395	0.693
Preference when we combine	0.08429	0.0378	2.230	0.026
Age at which AMPs use began	0.00219	0.0162	0.135	0.893
Attitude AMPs	0.05801	0.0314	1.847	0.066
Knowledge AMPs_Tox	0.06815	0.0418	1.629	0.104
Diagnosis_Family	0.05381	0.0546	0.985	0.325
Diagnosis_healthcare professional	0.06865	0.0553	1.241	0.215
Diagnostic_Herbalist	-0.00871	0.0483	-0.180	0.857
Diagnostic_Others	0.13193	0.1185	1.113	0.266
Effectiveness of AMPs	-0.10526	0.0209	-5.046	< .001
Side Effects	-0.21691	0.0446	-4.863	< .001

Preference for modern medicine when traditional and modern approaches were combined was positively associated with satisfaction (Estimate = 0.0843 ; $p = 0.026$). This result supports the existence of therapeutic pluralism in the study population, in which AMPs are generally used as a complementary strategy rather than as a complete substitute for biomedical care. Moreover, perceived effectiveness and side effects remained the strongest independent predictors in the model (both $p < 0.001$). According to the coding adopted, movement toward less favorable effectiveness categories were associated with reduced satisfaction, while the occurrence of side effects also negatively affected participants' evaluations. These findings indicate that satisfaction is primarily based on a pragmatic assessment of the perceived benefit–risk balance of AMP use. They also emphasize the importance of providing caregivers with reliable information regarding pediatric dosage, toxicity, contraindications, and possible interactions between medicinal plants and conventional medicines.

Principal component analysis (PCA) of collected data

Principal component analysis (PCA) is a multivariate technique that analyzes observations described by several intercorrelated quantitative dependent variables (Abdi & Williams 2010). In the principal component analysis of the variables in this study, it was observed that a factorial structure was found with two components after a Promax oblique rotation with Kaiser normalization. The factor loads are shown in Table 5, and the factor space of the variable is also shown in Figure 17.

A very low correlation between the two axes of the components ($r = .041$) indicates that the two extracted dimensions are practically independent. The first component tends to be strongly positively related to occupation ($V6 = .520$), diagnosis by a health professional ($V19 = .508$), amp efficacy ($V22 = .488$), amp utilization rate ($V13 = .471$), access to primary care ($V8 =$

.468) and origin ($V5 = .454$). It is also negatively related to education ($V4 = -.537$), family diagnosis ($V18 = -.504$) and the level of recommended use of MPAs ($V24 = -.406$).

Table 5. Structure matrix after Promax rotation.

Structure matrix after Promax rotation		
Component	1	2
1	1.000	.041
2	.041	1.000

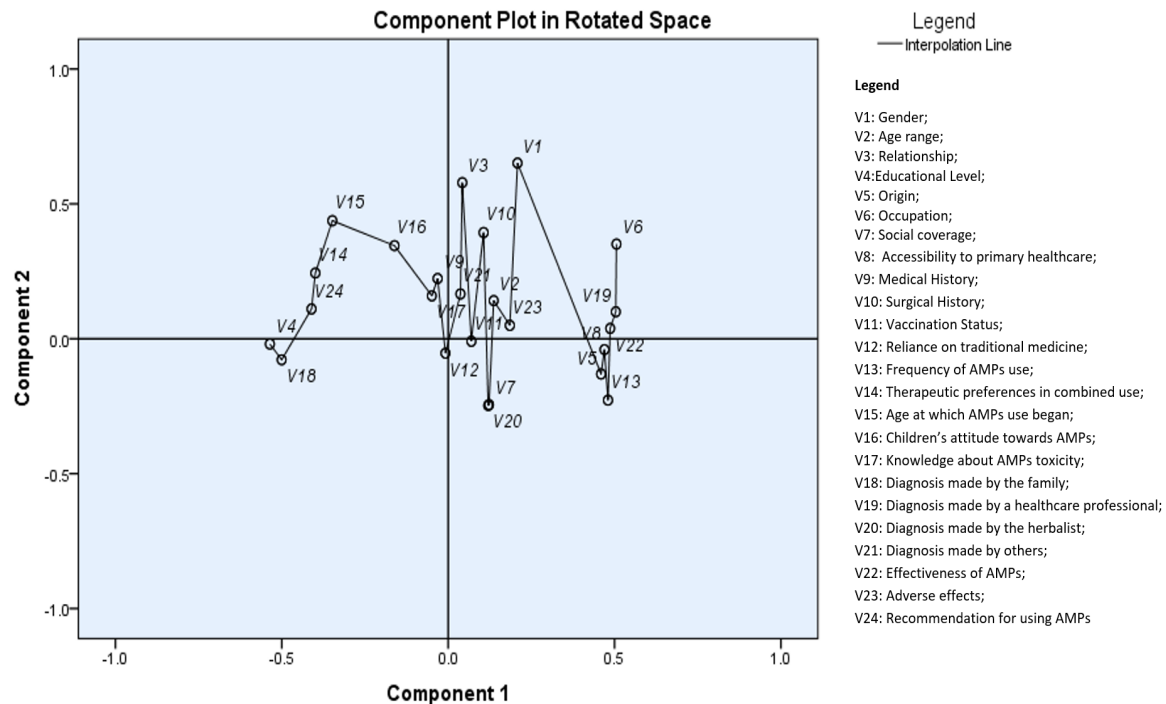


Figure 17. Projection of variables in the factorial space after Promax rotation

This first component can therefore be interpreted as a dimension related to the terms of access, use and recognition of MPAs, as opposed to structured recourse through access to care, experience of use and evaluation of effectiveness, with recourse more affected by family, educational or informal variables. The second component is mainly defined by gender ($V1 = .660$) and association with the child or patient ($V3 = .580$), while participants are more likely to contribute from the age of onset of MPA use ($V15 = .423$); surgery history ($V10 = .398$), occupation ($V6 = .372$) and children's attitude towards MPAs ($V16 = .338$). This dimension seems correlated with sociodemographic and relational factors related to the use of MPAs.

This organization is clearly observed in Figure 17, where the individual variables are separated by the two factor axes, some being strongly correlated to the first axis, and others more significantly correlated to the second axis. However, the variables $V2$, $V11$, $V12$, $V17$, $V21$ and $V23$, close to the center of the graph, have low loads and only marginally contribute to the differentiation of the two dimensions selected.

Overall, these results indicate that the use of MPAs is not explained by a single explanatory dimension, but rather by two related but relatively independent dimensions, namely 1- access, 2- use and 3- recognition of MPAs and 4- individual and relational qualities of participants. Nevertheless, the interpretation of some variables must be cautious, as they contribute little to the factorial scheme.

The PCA findings indicate that AMP-related practices in the surveyed population cannot be explained by a single underlying dimension. The very low correlation between the two extracted components after Promax rotation ($r = 0.041$) suggests that they represent almost independent aspects of AMP use. The first component was mainly associated with occupation, diagnosis by a healthcare professional, perceived effectiveness, frequency of AMP use, accessibility to primary healthcare, and place of residence. Its negative relationships with educational level, family-based diagnosis, and recommendation of

AMPs suggest a contrast between a relatively structured pattern involving healthcare access and experiential evaluation and a more informal pattern based on family transmission and traditional knowledge.

The second component was mainly defined by gender and the respondent's relationship to the child, with additional contributions from the age at which AMP use began, surgical history, occupation, and the child's attitude toward AMPs. This component therefore appears to reflect the sociodemographic and caregiving dimension of AMP use. The strong contribution of gender and parental relationship is consistent with the predominance of women, especially mothers, in the surveyed population and their central role in childcare and the transmission of ethnobotanical knowledge. Variables positioned near the center of the factorial space had relatively low loadings and contributed little to the differentiation of the two dimensions. Overall, the PCA highlights the coexistence of structural, experiential, sociocultural, and relational determinants of AMP use. Nevertheless, because PCA is exploratory, the identified components should be interpreted as patterns of correlation rather than causal relationships.

Although the PCA provided a general overview of the relationships among the studied variables, it did not reveal a clearly defined factorial structure or particularly strong and discriminating patterns. Most variables showed moderate or weak contributions to the extracted components, and the very low correlation between the two components indicated limited shared structure. Consequently, the PCA results alone were insufficient to identify the specific combinations of characteristics associated with respondents' satisfaction. For this reason, an association-rule approach based on machine learning was added as a complementary exploratory method. Unlike PCA, which summarizes linear correlations among variables, association-rule mining can detect frequent and potentially complex combinations of sociodemographic characteristics, AMP-use practices, and perceptions that occur together with satisfaction. This complementary analysis therefore provided a more detailed identification of the profiles and practices most frequently associated with satisfied respondents

Association rules between people's satisfaction and various variable

The association-rule analysis complemented the conventional statistical methods by identifying combinations of characteristics that frequently occurred among satisfied respondents. The selected rules showed high confidence values ranging from approximately 0.991 to 0.995, indicating that satisfaction was highly frequent when the specified conditions were present. The lift values ranged from approximately 1.136 to 1.141 and were consistently greater than 1, indicating that these combinations were associated with satisfaction more frequently than would be expected under statistical independence. The substantial support values, ranging from approximately 0.30 to 0.81, also show that several of these patterns concerned a meaningful proportion of the study population. (Table 6).

This result is contradictory with the PCA analysis which didn't show strong correlations between the various studied variables. This confirms that the association rules-based machine learning test is a more powerful method to reveal existing correlations between the different variables.

The strongest associations concerned variables related to gender, kinship, distance from health facilities, reasons for the use of traditional medicine, perceived efficacy and safety, source of information, recommendation of aromatic and medicinal

plants, harvest period, preservation methods and dose adjustment according to the age of the child. For example, being a woman, especially a mother, living within 3 km of a health facility and recommending the use of MPAs was strongly associated with satisfaction.

Nevertheless, these results should be interpreted cautiously. Satisfaction was already highly prevalent in the study population, which may partly explain the very high confidence values. Although the lift values were greater than 1, their magnitude indicates a moderate improvement over the baseline probability of satisfaction rather than an exceptionally strong predictive relationship. Furthermore, several rules included the recommendation of AMPs, a variable that is conceptually close to satisfaction and may therefore partly reflect the same underlying favorable attitude. Association rules reveal co-occurring patterns but do not establish temporal or causal relationships. Their main contribution is therefore exploratory: they identify combinations of practices and perceptions that may guide future confirmatory studies and targeted educational interventions on the safe use of AMPs in young children

Table 6. Model for extracting the rules of association between the satisfaction of the studied population and the different variables of the study.

History	Consequence	Support	Confidence	Lift	leverage	Conviction
{{'Female sex, parental relationship (mother), and accessibility <3 km suggests the use of AMPs'}}	{{'Satisfaction=1'}}	0.696385542	0.993127148	1.138529741	0.084732182	18.58192771
{{'Reasons for resorting to traditional medicine (availability, effectiveness, lower cost, and failure of conventional medication), with a suggestion of using aromatic and medicinal plants (AMPs'}}	{{'Satisfaction=1'}}	0.559036145	0.991452991	1.136610474	0.067191174	14.94216867
{{'Reasons for turning to modern medicine (safety, effectiveness, and concerns about toxicity), along with a tendency to use aromatic and medicinal plants (AMPs'}}	{{'Satisfaction=1'}}	0.322891566	0.992592593	1.137916922	0.039134853	17.24096386
{{'Seeking help from experienced individuals and recommending the use of aromatic and medicinal plants (AMPs'}}	{{'Satisfaction=1'}}	0.460240964	0.994791667	1.14043796	0.05667586	24.52048193
{{'Favorable attitude and suggestion to use aromatic and medicinal plants (AMPs'}}	{{'Satisfaction=1'}}	0.493975904	0.995145631	1.140843748	0.060984178	26.30843373
{{'Summer harvesting period and recommendation to use aromatic and medicinal plants (AMPs'}}	{{'Satisfaction=1'}}	0.706024096	0.993220339	1.138636576	0.08596313	18.8373494
{{'Wild aromatic and medicinal plants (AMPs) are recommended for use}}	{{'Satisfaction=1'}}	0.809638554	0.991150442	1.136263629	0.097093918	14.4313253
{{'Light-exposed storage methods are recommended for the use of aromatic and medicinal plants (AMPs'}}	{{'Satisfaction=1'}}	0.303614458	0.992125984	1.137381999	0.036672957	16.21927711
{{'Adjustment of the quantity of aromatic and medicinal plants (AMPs) according to the child's age, with a suggestion to use AMPs'}}	{{'Satisfaction=1'}}	0.65060241	0.992647059	1.137979363	0.078885179	17.3686747
{{'The reason justifying the plant part used is its year-round availability, along with a recommendation to use aromatic and medicinal plants (AMPs'}}	{{'Satisfaction=1'}}	0.354216867	0.993243243	1.138662834	0.043135433	18.90120482
{{'Preparation method by decoction, with a suggestion to use aromatic and medicinal plants (AMPs'}}	{{'Satisfaction=1'}}	0.771084337	0.990712074	1.13576108	0.092170126	13.7502008
{{' Dosage (once daily) and good effectiveness of aromatic and medicinal plants (AMPs'}}	{{'Satisfaction=1'}}	0.351807229	0.993197279	1.13861014	0.042827696	18.77349398

Conclusion

This study highlights the central role of aromatic and medicinal plants in the traditional management of little childhood illnesses in the province of Taza. Local ethnobotanical knowledge, deeply rooted in regional culture, reflects a rich region of empirical knowledge transmitted across generations and closely linked to the region's floristic diversity.

The survey identified 59 plant species belonging to 29 botanical families. According to the Family Importance Value, Lamiaceae was the most prominent family (FIV = 80.07%), followed by Verbenaceae (23.5%), Apiaceae (14.4%), Asteraceae (13.5%), and Amaranthaceae (11.5%). At the species level, *Origanum compactum* Benth (RFC = 31.97%), *Aloysia citrodora* Palau (RFC = 23.55%), and *Rosmarinus officinalis* L. (RFC = 17.06%) were the most frequently cited plants. These values indicate their cultural and ethnobotanical importance within the surveyed population but do not, by themselves, demonstrate their therapeutic efficacy or safety in children under five years of age.

Concerning the plant's parts used, the leaves were the mostly used (78.10%), followed by flowers (20%), seeds (16.9%), the whole plant (12.3%), stems (8%), and rhizomes (4%). While the most used preparation method was decoction (71.30%), followed by maceration (33.5%), then cooked preparations (19.5%). The oral route was the most predominant oral Administration of plant-based remedies (89.4%).

Furthermore, the AMPs were reported to be used for the treatment of the most frequent pathologies among little children, including digestive, respiratory neurological and dermatological diseases (at 72.6%, 43.1%, 17.2%, 15.7% respectively). The widespread reliance on the traditional remedies underscores their importance as an alternative or complementary approach to modern healthcare, particularly in areas where access to health services remains limited.

Some recorded plants show promising therapeutic potential, justifying the need for further investigations to evaluate their efficacy and safety, especially among the little children, corresponding to a sensitive pediatric population. This approach allows us to better characterize local pediatric herbal practices scientifically and guide future pharmacological and toxicological research.

Finally, this study highlights the urgency of promoting the conservation and sustainable use of medicinal plant resources in order to preserve this natural and cultural heritage for future generations.

Declarations

List of abbreviations: RFC: Relative Citation Frequency, FIV: Family Importance Value, PPV: Plant Part Value, FL: Fidelity Level, FC: citation frequency, N = total number of informants interviewed, ΣU = total number of use-reports recorded for the given plant species, N_s = total number of species cited within that family, Ip represents the number of informants who reported the use of a given plant species for treating a specific disease, Lu corresponds to the total number of informants who cited the same species for any medicinal purpose, RS: Respiratory diseases; DD: Digestive diseases; SD: Skin diseases; OAS: Osteoarticular diseases; MD: Metabolic disorder; DAGT: Disorders of the accessory glands of the Digestive tract ND: Neurological diseases; GUD: Genito-urinary diseases; CVD: Cardiovascular diseases; Dec: Decoction; Ct: Cataplasm; R: Raw; C: Cooked Pow: Powder; In: Inhalation; Inf: Infusion; Ma: Maceration. O: Oral; M: Massage; I: Infusion; In: Inhalation; TA: Topical Application; R: Rinsing

Ethics approval and consent to participate: The data were collected with respect to confidentiality, anonymity and consent. All respondents were informed about the aim of this study.

Consent for publication: The participant shown in Figure 2 gave permission to have the image published.

Availability of data and materials: The data was not deposited in public repositories.

Competing interests: The authors declare no conflict of interest.

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Author contributions: **Siham Elkhamsi:** Study design, ethnobotanical surveys conduction, methodology, writing first Draft of the manuscript, data analysis, and interpretation. **Rachid Flouchi:** Data analysis, interpretation, methodology, and investigation. **Mohamed Elfar:** Investigation, Methodology, and formal analysis. **Ibtissam Rhibbou:** Investigation, Methodology, and formal analysis. **Ibrahim Touzani:** Methodology and formal analysis. **Kawtar Fikri-Benbrahim:** Study design and supervising, manuscript review and Editing. All authors read, reviewed and approved the final version of manuscript.

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