The value of wild edible plants among rural communities in Chlef province (Algeria): A quantitative ethnobotanical survey

Abdelaziz Merouane, Mohammed Cheurfa, Abdallah Noui, Aicha Benbeskri

Correspondence

Abdelaziz Merouane[1,*], Mohammed Cheurfa[2], Abdallah Noui[3], Aicha Benbeskri[4]

[1]National Higher School of Saharan Agriculture, Adrar-01000, Algeria.
[2]Faculty of Nature, Life and Earth Sciences, University of Djillali Bounaama, Khemis Miliana-44225, Algeria.
[3]National Higher School of Nanoscience and Nanotechnology, Algiers-16000, Algeria.
[4]Department of Nutrition Sciences and human Nutrition, Faculty of Life and Natural Sciences, Hassiba Benbouali University, Chlef-02000, Algeria.

*Corresponding Author: a.merouane@esas-adrar.edu.dz

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Research

Abstract

Background: Traditional knowledge of wild edible plants (WEPs), which play a significant role in the dietary and cultural traditions of rural communities worldwide, has shown a worrying decline over recent decades. This research investigates the diversity, traditional uses, and cultural significance of wild edible plants in the rural community of Chlef Province, Northwest Algeria, aiming to document and analyze indigenous knowledge.

Methods: Data were collected between March and April 2023 through semi-structured interviews with 100 informants (68 female, 32 male) aged 20-70. Taxonomic identification of plants was performed, and the relative frequency of citation (RFC), frequency of citation (FC), and standardized weight index of families (SWIf) were calculated. Growth habits, plant parts used, and preparation methods were analyzed alongside cultural practices related to WEPs.

Results: The study identified 51 species of WEPs belonging to 25 families, with *Lamiaceae* (22%) and *Asteraceae* (18%) being the most represented. Aerial parts, leaves, and fruiting parts were the most commonly utilized, consumed primarily raw, cooked, or as herbal teas. Culturally significant species included *Malva sylvestris* L. (FC = 7.45%), *Scolymus hispanicus* L. (FC = 6.86%), *Cynara cardunculus* L. (FC = 6.56%), *Spinacia oleracea* L. (FC = 5.96%), *Quercus ilex* L. (FC = 5.89%), *Ceratonia siliqua* L. (FC = 5.66%), and *Laurus nobilis* L. (FC = 5.66%). The RFC index was not affected by plant parts or growth habits. The highest SWIf values were attributed to *Malvaceae* (1), *Asteraceae* (0.99), *Fagaceae* (0.79), and *Fabaceae* (0.76).

Conclusions: Despite the decline in traditional knowledge, WEPs remain integral to the local diet, valued for their unique flavors, health benefits, and historical importance. Efforts to conserve and promote these natural resources are essential for preserving the region's culinary heritage and biodiversity.

Keywords: Sustainable utilization, Gastronomic heritage, Biodiversity conservation, Natural resources

Background

Despite the wide diversity of plant species on our planet, only about 20 plant genera were domesticated and cultivated for the daily nutritional purposes of humans (Doni *et al.* 2020). Thus, the vast majority of the plant kingdom is not domesticated, and among this vast neglected portion, wild edible plants (WEPs) appear as valuable resources, holding unique potencies for nutrition, biodiversity, and adaptability to local ecosystems. The term "wild edible plants" refers to plants that grow naturally in managed or natural environments without human intervention, are not domesticated, and, importantly, have at least one edible part, such as a tuber, root, rhizome, leaf, fruit, seeds, or entire aerial part (Shaheen *et al.* 2017).

Despite advancements in modern civilization, WEPs remain widely used, especially in developing countries, for diverse purposes (Pretty *et al.* 2009). The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES, 2022) reports that nearly 20% of the global population, particularly indigenous and rural communities, relies on harvesting over 10,000 species of WEPs for nutritional and economic benefits. The use of WEPs is generally related to specific situations such as food scarcity, poverty, climatic extreme events, or political instability times (Carvalho and Barata, 2016). However, this group of plants also includes nutritionally significant food sources that can enhance dietary quality through micronutrient supplementation approach (Ickowitz *et al.* 2016).

Throughout human history, WEPs have served as an economical and accessible source of energy and nutrition, particularly among rural communities, due to their affordability compared to other food sources (Ibrahim *et al.* 2023). These spontaneous herbs contribute significantly to food availability, as they are rich in carbohydrates, fats (omega-3 fatty acids, α-linolenic acid), proteins, dietary fiber, vitamins, and minerals, including magnesium, potassium, calcium, iron, sulfur, and zinc (Alam *et al.* 2016; Ereifej *et al.* 2015; Salunkhe *et al.* 1995).

In addition to their nutrient profile, WEPs are known for their bioactive components mixture, which include phenolic compounds, flavonoids, α-tocopherol, ascorbic acid, β-carotene, and glutathione contents. These bioactive phytochemicals are well-documented for their antioxidant properties, helping protect cells from damage by neutralizing free radicals and potentially lowering the risk of chronic diseases related to oxidative stress (Alam *et al.* 2020; Alam *et al.* 2016; Ereifej *et al.* 2015; Wong *et al.* 2014). Furthermore, WEPs often possess medicinal properties rooted in traditional knowledge, making them valuable not only as nutritional resources but also as natural remedies in various cultures.

The Mediterranean Basin region harbours a complex floral diversity including a variety of edible plant species that have been widely utilized by its multicultural populations (Sánchez-Mata and Morales, 2016). Communities in this region are recognized for their healthy dietary practices, particularly the consumption of wild plants that offer significant health benefits (Azab, 2023). In Algeria, one of the Mediterranean countries, an amazing mosaic of WEPs species are used for culinary and therapeutic purposes (Mechaala *et al.* 2022; Merouane *et al.* 2022; Bouafia *et al.* 2021). While WEPs in Algeria have notable potential and considerable floristic diversity, they have not received focused attention. Existing ethnobotanical studies so far have largely concentrated on their medicinal properties, leaving a gap in studies dedicated solely to their culinary uses. Therefore, this study aims to address the knowledge gap in ethno-food uses of WEPs by investigating their biodiversity and traditional culinary uses by the rural community in Chlef province, Northwest Algeria. The research seeks to preserve local cultural heritage and support the sustainable use, conservation, and promotion of these natural resources.

Materials and Methods

Ethnographic background of the study area

The field study on Chlef province's WEPs (Fig. 1) was conducted during March-April 2023. Chlef, Algeria's sixth most populated province, had 1,356,151 Arab and Berber residents in 2020, mainly descendants of the Zenata and Maghraoua tribes. Geographically, Chlef covers 4,791 km², located between 36°10'N and 1°20'E in Northwest Algeria, about 200 km north of capital Algiers. It borders the Mediterranean Sea to the north, Tissemsilt to the south, Tipaza and Ain-Defla to the east, and Relizane and Mostaganem to the west. The climate is Mediterranean (Köppen climate classification Csa), with hot, dry summers and mild, moist winters. Based on 1991-2020 climate data from the National Centers for Environmental Information (NOAA, 2024), average annual precipitation was 388.8 mm, mainly falling from November (58.1 mm) to April (45.5 mm). Daily temperatures average ranged from 10.6°C (January) to 29°C (July-August).

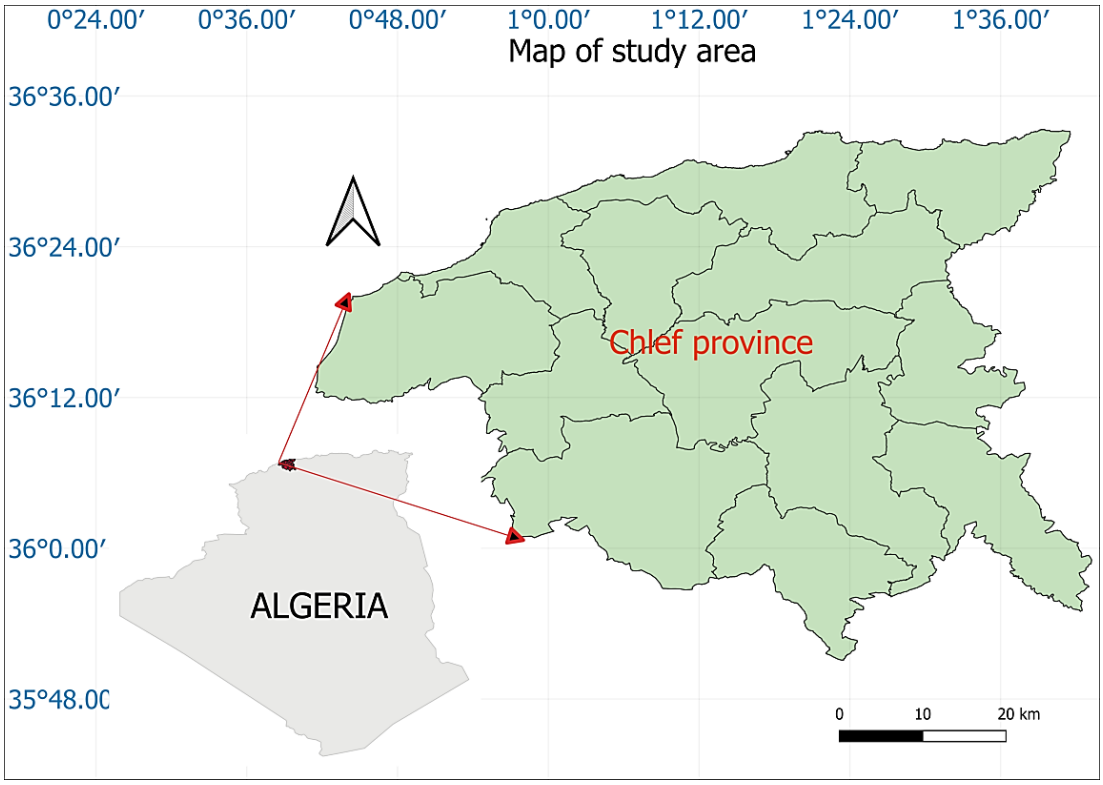

Figure 1. Map showing the studied province

Ethnobotanical data collection and plant identification

An ethnobotanical survey was conducted from March to April 2023. Information was gathered through semi-structured interviews in the local Arabic dialect. A total of 100 informants (68 female and 32 male) residing in rural area, aged between 20 and 70, participated. Concerning the ethical issues, no specific laws govern ethnobotanical research practices in Algeria. Verbal informed consent was obtained from all participants prior to the interviews. Participation was entirely voluntary, and individuals were informed of their right to withdraw from the interview process at any stage. Informants who agreed to participate in the current investigation were asked to provide insights on wild plants in their region, including details on how these plants are consumed and prepared in local cuisine.

Folk WEPs uses were documented after identifying species by informants through photographs (on mobile phones) to avoid confusion between species, probably, sharing the same common name. The interviews also collected social and demographic data (age, gender, and education level), summarized in Table 1. Taxonomic identification, family assignment, and binomial names were verified at world flora online (https://wfoplantlist.org/).

Data analysis

WEPs used in the Chlef region were documented with details including their binomial name, family, local name, part used, method of preparation, frequency of citation, relative frequency of citation, and Standardized weight index of family. The survey data was transformed into quantitative values to facilitate a clearer interpretation of the results.

Frequency of citation (FC)

The FC index represents the ratio of the number of citations of particular species to the number of citations for all species. The formula used is as follow (Faruque *et al.* 2018):

$$FC = (S/T) \times 100$$

Where S represents the number of mentions of a given species and T is the total number of times that all species were mentioned.

Relative frequency of citation (RFC)

The index of plant species was determined by dividing the number of informants who cited a specific plant species by the total number of informants interviewed. This index ranges from "0" when informant referred to a plant as useful to "1" when all informants referred to a plant as useful. The RFC was evaluated using the formula given by Essaih et al. (2024) as follow:

$$RFC = (n/N) \quad \textbf{0 ≤ RFC ≤ 1}$$

Where n represents the number of informants mentioning the use of the species and N is the total number of informants participated in the study.

Standardized weight index of family (SWIf)

The culinary SWIf was developed to assess the importance of botanical families in ethnoculinary studies, considering both the RFC of individual species and the diversity within each family. The index was calculated as the product of the average of RFC of the family and a logarithmic weight based on the number of species in the family:

$$\mathrm{SWI_f} = \frac{\sum \mathrm{RFC_s}}{\mathrm{n}} \times 1 + \ln(\mathrm{n})$$

Where ΣRFCs is the sum of relative frequency of citation of all species belonging to the same botanical family, n is the number of species belonging to the same botanical family, and (1+ln(n)) is a logarithmic weight that favors families with more species.

Statistical analysis

The Kruskal-Wallis test was performed to evaluate the differences in the RFC across different growth habits of plant species and plant parts consumed. A p value < 0.05 was considered statistically significant. The analysis and charts were generated using R software version 4.4.2 (The R foundation of statistical computing).

Results and Discussion

The structure of studied Socio-demographic details

The informants' socio-demographic factors—such as age, gender, education, and occupation—are essential for interpreting ethnobotanical findings within their social context (Eddouks *et al.* 2017). In the present survey, 100 informants participated, with women representing two-thirds (68%) and men one-third (32%). This rural group is regarded as knowledgeable about the traditional culinary uses of wild edible plants (WEPs) in Chlef province. Women's prominence as informants is significant due to their vital role in meal preparation and their ability to transform raw ingredients into cooked dishes, which extensively contributes to their knowledge of the culinary uses of WEPs. Descriptive statistics for these socio-demographic details are provided in Table 1.

Table 1. Socio-demographic details of the interviewed informants.

Variables	Category	Percentage (%)
Age class (years)	[20-30]	30
	[31-40]	24
	[41-50]	24
	[51-60]	12
	[61-70]	10
Gender	Male	32
	Female	68
Study level	Illiterate	6
	Primary	20
	Middle	8
	Secondary	30
	University	36

Among the informants surveyed, the 31-40 and 41-50 age groups were predominant, making up nearly half (48%) of the participants. Older informants, aged 61-70, were the least represented, comprising only 10%. Most participants held a university degree (36%), followed by those who have a secondary level. The educational level did not appear to significantly

influence knowledge of plants and their uses, nor the transmission of ethnobotanical knowledge (Hedidi *et al.* 2024), as most individuals acquired traditional plant knowledge from their parents within the family (Merouane *et al.* 2022).

While the current study focused on the rural areas of Chlef Province, it is widely acknowledged that the use of WEPs has been steadily declining in rural communities, particularly after the "Black Decade" of civil conflict and the subsequent restoration of security and stability across the country. This trend has been observed throughout the Mediterranean region (Pieroni, 2005; Bonet and Vallès, 2002). This declining use is attributed to changes in social, political, economic, and cultural factors (increasing availability of modern conveniences), as well as environmental factors, particularly drought, which has significantly impacted the growth and availability of non-cultivated species (Powell *et al.* 2023).

Furthermore, many segments of society, especially younger generations, have lost much of the traditional knowledge required to identify and utilize these natural foods. At the same time, some individuals who experienced poverty and hardship in the past regard the use of such plants with disdain, associating them with the struggles endured during the colonial period and the economic and security crises that persisted until the early 2000s. Despite this pessimism, there is a growing trend toward a return to nature, particularly in response to the alarming rise in lifestyle-related health issues, including obesity, heart disease, diabetes, and cancers. Additionally, in many cases, these plants are consumed to revive traditional practices, reconnect with nature, and enjoy their unique flavors, highlighting their growing importance.

Taxonomic diversity of WEPs

In the current survey, fifty one non-cultivated species were identified as part of the wild food heritage of the rural community in Chlef province (Table 2). These species are spread across 49 genera and 25 botanical families. The most prominent families are *Lamiaceae* (22% of the total species) and *Asteraceae* (18%). The *Rosaceae* family includes three species, followed by *Amaranthaceae*, *Apiaceae*, *Asparagaceae*, *Boraginaceae*, *Caryophyllaceae*, and *Poaceae*, each with two species. The remaining families each have one species. Overall, 68% of the families are represented by one species (Figure 2).

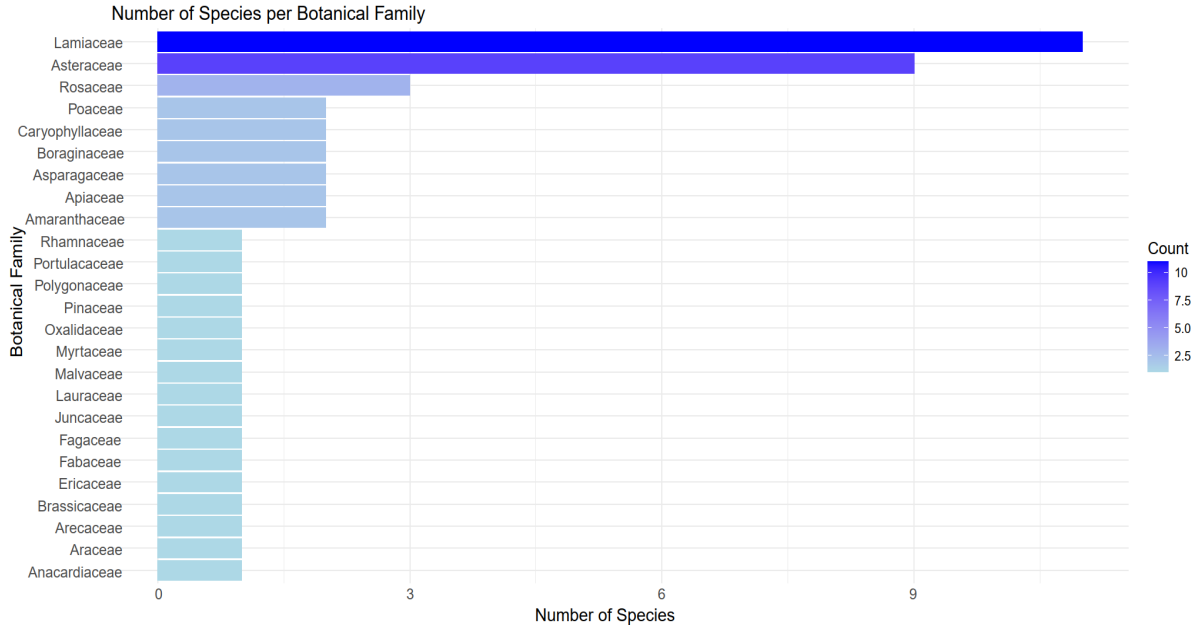

Figure 2. Botanical family representation among wild edible plants used by rural communities in Chlef province.

A previous ethnobotanical survey on plants consumed during Ramadan in Chlef province identified *Lamiaceae* as the largest family of both wild and cultivated edible plants (Merouane *et al.* 2022). This family is particularly notable for its diversity and high number of medicinal plants, as observed in several ethnobotanical studies conducted across North Algeria. These studies emphasize *Lamiaceae*'s significant role not only in local diets but also in traditional medicine, further underlining its importance in the region's cultural and ecological landscapes (Hedidi *et al.* 2024; Benarba *et al.* 2015; Boudjelal *et al.* 2013; Chermat and Gharzouli, 2015; Meddour and Meddour-Sahar, 2015; Miara *et al.* 2019). The species from this family are commonly consumed by the Algerian population in various forms, such as raw, herbal tea, for seasoning, in bread preparation, as spices, for flavoring couscous, as condiments, or as sweet nectar by children and shepherds (Table 2).

Reports focusing specifically on the traditional culinary uses of WEPs in Algeria are rare, as most ethnobotanical studies emphasize the therapeutic applications of medicinal plants. Our study represents a pioneering investigation in this context, providing detailed insights into the traditional food uses of WEPs. It not only highlights the diversity of these plants in the rural areas of Chlef province—surpassing the 38 species documented by Merouane et al. (2022)—but also documents the specific plant parts consumed and their manner of use. This approach reveals the traditional culinary heritage and underscores the strong relationship between rural communities and WEPs, highlighting their role in the local diet and culture (Kebebew and Leta, 2023). Nowadays in Algeria, WEPs are not consumed as a response to food scarcity but rather for the enjoyment of gathering them, recreating traditional practices, savoring their distinctive flavors, and benefiting from their specific health properties rather than their nutritional value. These plants are regarded as supplementary foods, consumed occasionally, while the primary diet predominantly relies on staple crops.

Our study documented 51 species of WEPs, a number that relatively aligns with findings reported in the Gumuz Regional State, Ethiopia, which documented 54 species (Anbessa *et al.* 2024), but is higher than the 43 species recorded in Amhara region, Ethiopia (Asfaw *et al.* 2023). Compared to other regions, our findings fall short of the 64 species traditionally used by the Messiwa people in Morocco (Ghanimi *et al.* 2022) and those cited in Soro District, Ethiopia (Hankiso *et al.* 2023). Notably, the Zhuang ethnic group in China reported a much higher diversity, with 163 species utilized for culinary purposes (Liu *et al.* 2023). This disparity highlights the varying degrees of WEPs use across regions and communities, influenced by diverse factors such as local biodiversity (including the impact of climate change), traditional knowledge, and dietary habits.

In our investigation, the WFO codes were assigned to all documented species (Table 2). These codes facilitate the plant identification throughout online databases, minimizes use of synonymy names and outdated nomenclature. This practice is mostly recommended in ethnobotanical surveys due to the variation of local names across different regions. Additionally, the connection of plant species to online databases enables data verification and enhances taxonomic precision.

Citation frequency and family index

In the current ethnoculinary survey, the RFC values ranged from 2% to 100% of informants, indicating the proportion of participants who recognized and cited each species. The top three RFC values were recorded for *Malva sylvestris* L. (RFC = 1), *Scolymus hispanicus* L. (RFC = 0.92), and *Cynara cardunculus* L. (RFC = 0.88). Nine species, out of the 51 documented culinary herbs, accounted for more than half (51.19%) of all citations. These species were *Malva sylvestris* L. (FC = 7.45%), *Scolymus hispanicus* L. (FC = 6.86%), *Cynara cardunculus* L. (FC = 6.56%), *Spinacia oleracea* L. (FC = 5.96%), *Quercus ilex* L. (FC = 5.89%), *Ceratonia siliqua* L. (FC = 5.66%), and *Laurus nobilis* L. (FC = 5.66%). Additionally, *Mentha pulegium* L. and *Pinus halepensis* L. both had an FC of 3.58%. The FC and RFC indexes represent parameters reflecting WEPs that are commonly known and widely consumed by the local rural community. The difference between these indexes lies in their calculation: RFC is based on the number of informants citing a species, while FC is based on the number of citations for each species.

Malva sylvestris L. is deeply rooted in the culinary and cultural traditions of the studied region, as evidenced by its common citation among informants interviewed. This WEP is valued for its abundance and significant role in traditional gastronomy. Among the Arab population, *M. sylvestris* features prominently in a dish known as “khobbiz,” which derives its name from the local term for the plant. This dish is prepared by cooking the leaves with tchicha (coarse barley semolina), creating a nutrient-rich meal. Similarly, in the Beni-Haoua district, the Berber community incorporates *M. sylvestris* into “lahchich,” a dish named after the local term for "herbs." This preparation combines tchicha with other WEPs, such as *Sonchus oleraceus, Rumex pulcher, Taraxacum erythrospermum,* and *Scolymus hispanicus*, along with cultivated ingredients like garlic, onion, and olive oil. The widespread use of *M. sylvestris* in these traditional dishes indicates its cultural significance, its role in local dietary habits, and its contribution to the preservation of ethnoculinary knowledge.

The culinary uses of *M. sylvestris* L. have been documented across various civilizations. In Morocco, the Messiwa people prepare this herb in a traditional dish cooked with spices (Ghanimi *et al.* 2022). In the Himalayas-Kashmir region, the leaves are fried and consumed as a vegetable (Hassan *et al.* 2024). Similarly, in eastern Mediterranean countries, the leaves and young stems are cooked or fried, either alone or with other ingredients, or used fresh in salads and stuffed with rice (Azab, 2023). This edible herb is evidenced, scientifically, as a rich source of phenolic compounds, which exhibit antioxidant, anticancer, and anti-inflammatory properties (Shadid *et al.* 2021; Xu *et al.* 2018).

Table 2. Wild edible plants used for culinary purpose among the rural community of Chlef region.

Family (SWI_f)	Binomial name	WFO code	Local name (Arabic/Berber)	Parts used	Traditional culinary uses	RFC	FC	GH
Amaranthaceae 0.72	*Spinacia oleracea* L.	0000437543	Essalq barhouch/Essalq abarran	Leaves	Cooked with omelet and garlic, with fried potatoes	0.80	5.96	H
	Atriplex halimus L.	0000556105	Elqtef	Leaves	Cooked as vegetables (salad or dish)	0.06	0.45	S
Anacardiaceae 0.11	*Pistacia lentiscus* L.	0000394118	Dharw/Fadhis	Leaves	To flavor the bread (placed under the bread while baking in the oven to give aroma and prevent it from burning)	0.11	0.82	S
Apiaceae 0.24	*Bunium bulbocastanum* L.	0000574803	Talghoudda	Tubers	Added to flour to prepare bread, powder with honey	0.20	1.49	H
	Daucus carota subsp. carota	0001429987	Jazar barri	Stem	The tender part is consumed by the shepherds and children.	0.09	0.67	H
Araceae 0.07	*Arisarum vulgare* O.Targ.Tozz.	0000275694	Abekkouk	Tubers	Preparation of flour from dried tubers to make bread consumed during famine	0.07	0.52	H
Arecaceae 0.04	*Chamaerops humilis* L.	0000839941	Eddoum, El-ghaz/Osran	Fruit	Consumed raw	0.04	0.30	S
Asparagaceae 0.34	*Asparagus officinalis* L.	0000634022	Sekkoum	Stem	Added with omelet, cooked with potatoes	0.38	2.83	H
	Agave americana L.	0000754119	Sabbar/Essabara	Flowers	Consumption of nectar produced in inflorescence	0.03	0.22	S
Asteraceae 0.99	*Scolymus hispanicus* L.	0000022425	Guernina/Assennan	Leaves	Cooked with other herbs and Tchicha (coarse barley semoulina) to prepare traditional recipe, Salad, cooked with egg or omelet	0.92	6.86	H
	Carlina acaulis L.	0000090349	Tafgha	Fruit	Consumed raw, cooked as vegetables	0.10	0.75	H
	Cynara cardunculus L.	0000013358	Khorchef barri/Khorchef aberhouch	Leaves	Cooked as vegetable (dishes or salad)	0.88	6.56	H

	Taraxacum erythrospermum Andrz. ex Besser	0000020721	Dars el-aajouz	Leaves	Young fresh leaves are consumed raw in salads, cooked with other herbs and Tchicha to prepare traditional recipe	0.09	0.67	H
	Sonchus oleraceus L.	0000069236	Tilfaf, Loubina	Leaves	Consumed raw as salad, young fresh leaves cooked with other herbs and Tchicha to prepare traditional recipe	0.26	1.94	H
	Carlina gummifera Less.	0000138371	Ladad	Seeds, Fruit	Seeds chewed raw, Fruit cooked as vegetable	0.04	0.30	H
	Leuzea acaulis (L.) Holub	0000007208	Karn jedy	Flowers (petals)	Cooked as vegetables for soups or salad	0.12	0.89	H
	Chamaemelum nobile L.	0000005006	Baboundj	Flowers	Herbal tea	0.36	2.68	H
	Echinops spinosissimus Turra	0000116034	Taskara/Assennan	Fruit	The tender part is consumed by the shepherds.	0.04	0.30	H
Boraginaceae 0.10	*Anchusa officinalis* L.	0000533707	Lsan thour/Iless O founas	Flowers	absorption of sweet nectar in the petals by children and shepherds	0.06	0.45	H
	Echium creticum L.	0000662748	Lsane el assil	Flowers	absorption of sweet nectar in the petals by children and shepherds	0.06	0.45	H
Brassicaceae 0.06	*Nasturtium officinale* R. Br.	0000380323	Guernounnech	Aerial parts	Consumed raw as salad	0.12	0.89	H
Caryophyllaceae 0.18	*Paronychia argentea* Lam.	0000466806	Rdjel lehmama	Leaves	Herbal tea	0.04	0.30	H
	Silene vulgaris (Moench) Garcke	0000440200	Tighigheyth	Leaves	Cooked with omelet	0.18	1.34	H
Ericaceae 0.47	*Arbutus unedo* L.	0000543204	Ellandj/Sasnou	Fruit	Consumed raw	0.47	3.50	S
Fabaceae 0.76	*Ceratonia siliqua* L.	0000165151	Kharroub/Asliwgha	Fruit	Consumed raw, Preparation of bread and couscous	0.76	5.66	T

Fagaceae 0.79	*Quercus ilex* L.	0000291202	Ballout/Ihabba	Fruit	Consumed raw as nut, preparation of bread and couscous	0.79	5.89	T
Juncaceae 0.03	*Juncus acutus* L.	0000775729	Asselbo	Stem	Placed under the bread while baking in the oven to prevent it from burning.	0.03	0.22	H
Lamiaceae 0.54	*Mentha pulegium* L.	0000241235	Flio	Aerial parts	Herbal tea, seasoning dishes (Herira, batata flio)	0.48	3.58	H
	Mentha suaveolens Ehrh.	0000241424	Timrsad/Imersadh	Aerial parts	Added to flour to prepare bread	0.02	0.15	H
	Lavandula stoechas L.	0000224244	Helhal/Ahelhal	Aerial parts	Steaming (flavouring) the couscous	0.08	0.60	S
	Thymus munbyanus Boiss. & Reut.	0000324425	Zâitra	Aerial parts	Herbal tea, seasoning of traditional recipes, steaming of couscous, added to couscous as powder	0.20	1.49	S
	Origanum vulgare L.	0000260765	Ezzaâter	Aerial parts	Herbal tea, seasoning and perfuming of traditional recipes	0.25	1.86	H
	Clinopodium nepeta (L.) Kuntze	0000892607	Ennabta / Tis'hethrine	Aerial parts	Herbal tea	0.16	1.19	H
	Lamium amplexicaule L.	0000222440	Chachiat elghrab	Flowers	absorption of sweet nectar in the petals by children and shepherds	0.06	0.45	H
	Salvia rosmarinus Spenn.	0000302167	Iklil/Leklil	Aerial parts	used as a condiment in various dishes	0.14	1.04	S
	Clinopodium vulgare subsp. arundanum (Boiss.) Nyman	0000893546	Rihane berry	Aerial parts	Herbal tea	0.06	0.45	H
	Melissa officinalis L.	0000240053	Melissa/Aberzizzo	Aerial parts	Herbal tea	0.35	2.61	H
	Lavandula dentata L.	0000224153	Helhal/Ahelhal	Aerial parts	Steaming (flavouring) the couscous	0.04	0.30	S
Lauraceae 0.76	*Laurus nobilis* L.	0000364153	Arrend	Leaves	Flavoring diverse recipes	0.76	5.66	T

Malvaceae 1	*Malva sylvestris* L.	0000449636	Khobbiz/Medjir	Aerial parts	Cooked with other herbs and Tchicha (coarse barley semoulina) to prepare traditional recipe	1	7.45	H
Myrtaceae 0.17	*Myrtus communis* L.	0000248712	Rayhan/Halmouche	Fruit	Consumed raw	0.17	1.27	S
Oxalidaceae 0.28	*Oxalis pes-caprae* L.	0000386852	Homeidha/Assammoumt	Stem	Consumed raw	0.28	2.09	H
Pinaceae 0.48	*Pinus halepensis* Mill.	0000481363	Sanawber/Aydha	Seeds	Consumed raw	0.48	3.58	T
Poaceae 0.18	*Ampelodesmos mauritanicus* (Poir.) T.Durand & Schinz	0000845816	Eddiss/ Adhels	Leaves	To flavor the bread (placed under the bread while baking in the oven to give aroma and prevent it from burning)	0.11	0.82	G
	Arundo donax L.	0000850932	Kassab/Ghalim	Leaves	Placed under the bread while baking in the oven to prevent it from burning.	0.11	0.82	G
Polygonaceae 0.10	*Rumex pulcher* L.	0000404086	Homeidha/Assammoumt	Leaves, Young stem	Cooked with other herbs and Tchicha, consumed raw by children and shepherds	0.10	0.75	H
Portulacaceae 0.32	*Portulaca oleracea* L.	0000484425	Errejila	Aerial parts	Cooked as vegetable in traditional recipes (soup for couscous)	0.32	2.38	H
Rhamnaceae 0.34	*Ziziphus spina-christi* (L.) Willd.	0001131308	Sedra/N'beg	Fruit	Consumed raw	0.34	2.53	T
Rosaceae 0.56	*Crataegus monogyna* Jacq.	0001009785	Za'arour barri/Adhmam	Fruit	Consumed raw	0.47	3.50	S
	Rubus fruticosus Lour.	0001017952	Tout barry/Abgha	Fruit	Consumed raw	0.27	2.01	C
	Prunus avium (L.) L.	1200086381	Karaz barry	Fruit	Consumed raw	0.07	0.52	T

Scolymus hispanicus L., locally known in the Chlef province as Guernina (Arab dialect) or Assennan (Berber dialect), is among the most valued wild herbs in Algeria, prized for its usage in various culinary preparations. In the studied region, the central nerve of the leaves is either cooked in an omelet or used as an ingredient in salads. In another Algerian region, El Kantara (Biskra province), it holds traditional significance in cheese-making, where it is used to coagulate milk (Mechaala *et al.* 2022). Beyond Algeria, this species is recognized as one of the most highly appreciated wild vegetables across Mediterranean countries (Polo *et al.* 2009). Another notable wild edible thistle is the wild artichoke, *Cynara cardunculus* L. (RFC = 0.88), which shares similarities with *S. hispanicus* L. in its methods of consumption among Algerian (as vegetable and in cheese-making) (Mechaala *et al.* 2022) and Moroccan (as vegetable) (Ghanimi *et al.* 2022) communities.

Spinacia oleracea L. (RFC = 0.80) is one of the valuable wild plants for the local community. It grows around farms and is gathered not only for its culinary uses but also as an additional source of income for family budgets through the local market. Locally, the leaves of this herb are commonly cut into segments, boiled in water, lightly fried with omelets or fried potatoes, and then seasoned with a bit of garlic to make a delicious green dish. The consumption of this plant is supported by its therapeutic uses in the local community, where it is believed to treat diabetes, anemia, and diarrhea (Hedidi *et al.* 2024).

Autumn marks the season for harvesting fruits from Mediterranean tree species, particularly *Quercus ilex* L. (RFC = 0.79), *Ceratonia siliqua* L. (RFC = 0.76), *Pinus halepensis* L. (RFC = 0.48), *Arbutus unedo* L., and *Crataegus monogyna* Jacq. (both with RFC = 0.47). The fruit of holm oak (Q. ilex) is widely consumed in Chlef province, especially by the residents of the Beni Haoua mountainous district. Traditionally, this achene fruit was a necessary source of starch often incorporated with wheat flour to prepare black bread and black couscous. During the autumn season, all family members participate in acorn harvesting: men shake the branches and knock off the fruits with sticks, while women and children collect them; the crop was then transported to the homes via mountain paths using mules. Due to the frequent autumn rains, the acorns were dried by placing them on reed beds suspended from the ceiling above a fire pit, allowing for fumigation and heat drying. Once fully dried, the acorns were shelled and grinded into brownish flour.

In recent decades, the use of acorns has declined significantly due to the persistence of drought and the shift toward modern lifestyles, obliging many families to abandon this traditional practice. As a result, acorns have become rare in local markets, and their prices have increased considerably. Nevertheless, they continue to be valued for their nutritional properties, health benefits, and the strong cultural attachment to traditional cuisine.

The carob (*C. siliqua*) fruit is also used in making black couscous, though the resulting product is darker and sweeter. The Aleppo pine (*P. halepensis*) produces seeds that are typically consumed as nuts or collected for their market value. The fruit of the strawberry tree (*A. unedo*) is commonly gathered and consumed by rural communities for its nutritional and therapeutic benefits. The berries of the hawthorn shrub (*C. monogyna*) are widely enjoyed, especially on the Mediterranean side of the province, by children, shepherds, and hunters. In addition, the berries of this herb are often used to treat heart failure and promote cardiovascular health (Goudjil *et al.* 2024). The culinary practices associated with these plants are common across Mediterranean countries (Sánchez-Mata and Morales, 2016), particularly in historical Andalusia (Polo *et al.* 2009), which shares many traditions with Algeria due to the long-standing historical ties between both sides of the Mediterranean basin.

Some plant species, while not directly used as culinary ingredients, play an important role in the cooking process. For instance, the leaves of *Pistacia lentiscus* L. (RFC = 0.11), *Ampelodesmos mauritanicus* (Poir.) T. Durand & Schinz (RFC = 0.11), *Arundo donax* L. (RFC = 0.11), and *Juncus acutus* L. (RFC = 0.03) are traditionally placed under bread during baking in earthen ovens to prevent burning. This practice imparts a distinctive herbal aroma to the bread known locally as “khobz el cocha” or “matlou’e.” Additionally, *Arisarum vulgare* O. Targ. Tozz. (RFC = 0.07), though rarely consumed today, was historically used during the famine of the 1940s to prepare bread, highlighting the significance of these plants in times of scarcity. Notably, *P. lentiscus* is also reported as a flavoring for breads and cookies on the island of Chios, Greece (Kremezi, 2000). Meanwhile, *A. mauritanicus*, *A. donax*, and *J. acutus*, which belong to the specific culinary heritage of the Berber community of Beni-Haoua, are cited for the first time as culinary useful plants, providing new insight into the often overlooked role of native plants in food preparation.

In the present study, the SWIf was calculated as a novel index to demonstrate the ethnoculinary importance of botanical families. The conventional indices such as the Family Use Value (FUV), based on the use values of the species members, is habitually used to notify the significance of plant families in ethnomedicinal surveys, the novel SWIf offers new approach to reveal significance of botanical families in ethnoculinary studies by combination of RFC index and number of species within

each family. To the best of our knowledge, this index has not been previously published, and we introduce it as an alternative tool to reflect the importance of botanical families in the gastronomic traditions where the FUV index is not applicable.
The SWIf values ranged from 0.03 to 1. The highest SWIf values were observed in *Malvaceae* (1), *Asteraceae* (0.99), *Fagaceae* (0.79), and *Fabaceae* (0.76). Three of these families are primarily represented by one popular species each: *Malva sylvestris* (*Malvaceae*), *Quercus ilex* (*Fagaceae*), and *Ceratonia siliqua* (*Fabaceae*), while Asteraceae includes nine species. The lowest SWIf was assigned to *Juncaceae* (*Juncus acutus*), which is rarely used locally due to the availability of alternative substitutes for bread flavoring or preventing burning, and the impact of climate change (elevation of temperature, drought) on this species, which prefers humid conditions.

Proportion of plant part used

The current survey on WEPs consumed by the rural community in Chlef province highlighted the widespread use of diverse plant parts in local culinary practices (Figure 3). Among the reported parts of wild edible food resources, aerial parts and leaves constitute half of the total plant parts consumed in this region. Species known for their edible fruits are ranked third, representing 22.64%, followed by flowers (11.32%) and stems (9.43%). Tubers and seeds contribute the least to the local diet, each accounting for 3.77%. This preference for leaves and aerial parts aligns with findings from previous ethnobotanical studies in Chlef province, where these plant parts are emphasized in both food-medicinal knowledge (Merouane *et al.* 2022) and strictly medicinal applications (Hedidi *et al.* 2024) involving wild and cultivated herbs.
The leaves are commonly used in salads and belong to a diverse group of plant taxa, predominantly from the *Asteraceae* (4 species), *Amaranthaceae* (2 species), *Caryophyllaceae* (2 species), and *Poaceae* (2 species) families. The consumption of aerial parts is mainly characterized by *Lamiaceae* species (10 species), with exception of *Lamium amplexicaule* L., which are typically used in the preparation of herbal teas. In contrast, the fruiting parts are primarily represented by wild species from the *Rosaceae* family (3/3 species) and *Asteraceae* family (3 species).

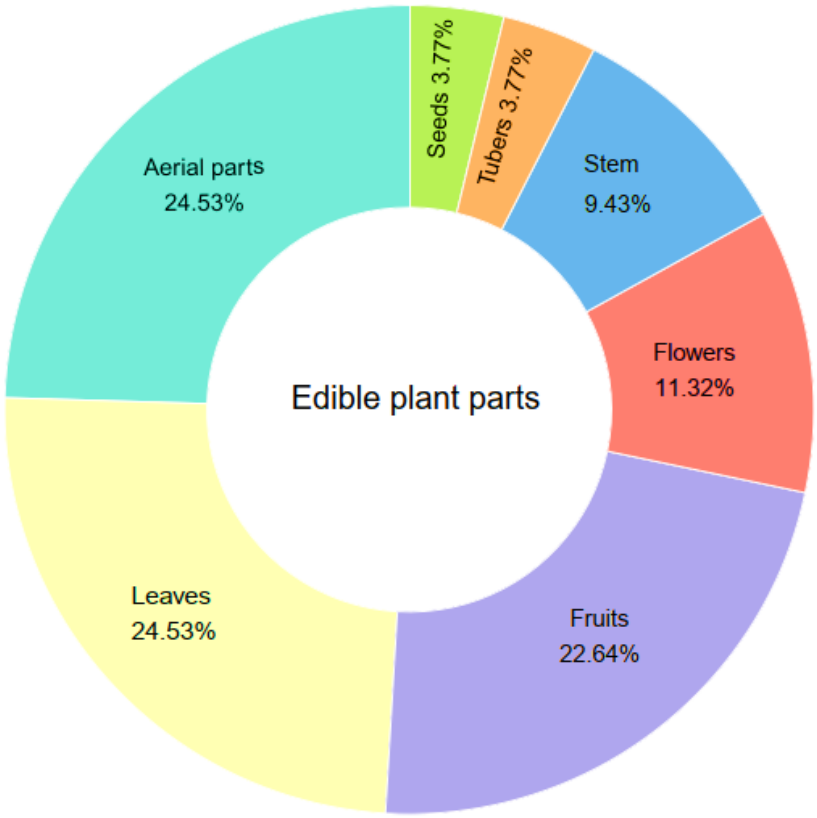

Figure 3. Percentage of wild edible plant parts consumed among rural community of Chlef province.

The limited focus on culinary uses of WEPs in Algeria makes comparisons with other Mediterranean countries essential to gain a fuller understanding of traditional practices. In this context, the leaves, aerial parts, and fruits are prominent edible components of WEPs documented by local communities in Palestine (Ali-Shtayeh *et al.* 2008), Spain (Benítez *et al.* 2023), Morocco (Ghanimi *et al.* 2022), Tunisia (Karous *et al.* 2021), and Turkey (Ulcay, 2024), demonstrating the commonality of culinary traditions across the Mediterranean region. This prevalence is likely due to their ease of collection (Karous *et al.* 2021) and their richness in bioactive phytoconstituents (Merouane *et al.* 2020).

A Kruskal-Wallis test was conducted to assess whether the RFC values varied significantly across different plant parts (e.g., leaves, stems, flowers). The results indicated that there was no statistically significant difference in RFC values between plant parts (Kruskal-Wallis chi-squared = 2.663, df = 6, p = 0.8498). This suggests that plant part alone does not appear to account for variations in the RFC values among the species studied, implying that other factors, essentially cultural, organoleptic, and nutritional features, may play a more prominent role in determining citation frequency.

Culinary preparation methods of WEPs

The culinary uses of WEPs in Chlef province are deeply ingrained in the cultural heritage of the local rural population, passed down orally and through practice across generations (Figure 4). The majority of the edible wild plants documented in this study are consumed fresh and raw (24 species), including species whose edible parts are primarily the fruit, the species consumed raw as salad (*Nasturtium officinale*) as well as popular species among children and shepherds, such as *Anchusa officinalis* L. and *Echium creticum* L. Additionally, certain plants that are not typically considered edible are incorporated into bread preparation, either as flavoring or to prevent burning; these include *Pistacia lentiscus* L., *Ampelodesmos mauritanicus* (Poir.) T.Durand & Schinz, *Arundo donax* L., and *Juncus acutus* L.

The second most common method of consumption is cooking, with 19 species identified in this category which include WEPs eaten as vegetables, such as *Portulaca oleracea* L., *Leuzea acaulis* (L.) Holub, *Carlina acaulis* L., *Atriplex halimus* L., and *Cynara cardunculus* L., as well as herbs often cooked with omelets, such as *Scolymus hispanicus* L., *Spinacia oleracea* L., *Asparagus officinalis* L., and *Silene vulgaris* (Moench) Garcke. Some species, including *Carlina acaulis* L., *Taraxacum erythrospermum* Andrz. ex Besser, *Carlina gummifera* Less., *Quercus ilex* L., *Ceratonia siliqua* L., and *Sonchus oleraceus* L., are used in both raw and cooked forms.

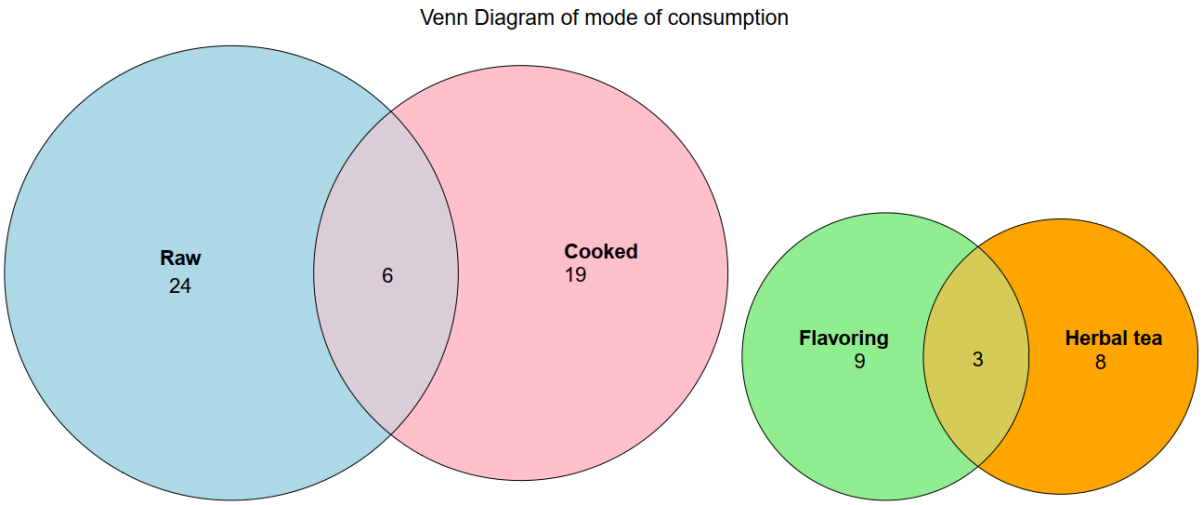

Figure 4. Preparation methods of wild edible plants in Chlef province: Values indicate the number of species.

On the other hand, eight species consumed as herbal teas are predominantly from the *Lamiaceae* family. Some of these species, such as *Mentha pulegium* L. and *Clinopodium nepeta* (L.) Kuntze, have been traditionally used as daily tea/coffee substitutes, particularly among children and families who could not afford coffee. While these plants have a culinary role, other herbal tea species, including *Melissa officinalis* L., *Origanum vulgare* L., *Thymus munbyanus* Boiss. & Reut., and *Chamaemelum nobile* L., are primarily recognized for their medicinal properties rather than nutritional value. This reflects the intertwined uses of many plants in the region. However, the widespread popularity of coffee in and tea, which are readily available in cafeterias and restaurants, has led to a significant decline in the consumption of traditional herbal drinks. This shift has been further exacerbated by the ongoing decline of wild herbs due to climatic changes, and these herbal beverages are now consumed only rarely.

The use of WEPs for flavoring is observed in nine species, with the manner of use varying depending on the plant and the dish being prepared. *Laurus nobilis* L. and *Salvia rosmarinus* Spenn. are often cooked to flavor a variety of dishes, particularly those containing meat. *Pistacia lentiscus* L. and *Ampelodesmos mauritanicus* (Poir.) T.Durand & Schinz are used beneath bread, imparting a delightful aroma. *Lavandula stoechas* L. and *Lavandula dentata* L. are boiled under couscous during steaming, lending their fragrance to this famous dish. *Mentha pulegium* L., known as pennyroyal, is used in a traditional Algiers dish called "batata flio" (potatoes with pennyroyal), which involves cooking potatoes with garlic, onion, and spices (black and red peppers). The leaves of *M. pulegium* are added and cooked briefly, enhancing the dish with their distinctive

aroma. *Origanum vulgare* L. is also used to flavor various dishes, while *Thymus munbyanus* Boiss. & Reut. is commonly used both to flavor traditional dishes and in the steaming of couscous. These three latter species are frequently used not only for flavoring but also as herbal teas.

The culinary uses of WEPs vary across communities and regions, influenced by local biodiversity, even within the same country. For instance, in Morocco, WEPs are predominantly consumed raw or cooked as vegetables in the Rif Mountains (Essaih *et al.* 2024), whereas in El-Haouz province, they are mainly used as vegetables (31%), beverages (27%), and consumed raw (20%) (Ghanimi *et al.* 2022). In central Spain, WEPs are often eaten raw, including in salad preparations, or cooked as vegetables (Tardío *et al.* 2005). Conversely, in Andalusia, WEPs are mainly consumed in raw or cooked forms, as snacks, and as seasonings (Benítez *et al.* 2023). Notably, the Chinese Zhuang ethnic group uses 42 WEP species as tea substitutes, surpassing Mediterranean records (Ghanimi *et al.* 2022; Tardío *et al.* 2005; Benítez *et al.* 2023; Ulcay, 2024) and the eight herbal teas identified in this study.

Growth habits of the WEPs

The analysis of the growth forms of WEPs consumed by the rural population of Chlef province identified five growth habits (Figure 5). Most species were herbs (31; 60.78%), followed by shrubs (21.56%), trees (11.76%), grasses (3.92%), and climbers (1.96%) (Figure 5). Growth habits vary between regions and ethnic communities, influenced by local biodiversity and traditions. Herbs were represented across 14 families, with all *Asteraceae* species classified as herbs. Shrubs spanned nine families, trees six, grasses belonged to *Poaceae*, and the sole climber, *Rubus fruticosus* Lour., belonged to *Rosaceae*.

Compared to other regions, the herb category is predominant among WEPs in the Guangxi Zhuang Autonomous Region, China (Liu *et al.* 2023), and in the occupied Kashmir Valley (Hassan *et al.* 2024). This aligns with the findings of our survey. In contrast, tree species are more dominant in WEPs surveys conducted in Ethiopia (Anbessa *et al.* 2024; Asfaw *et al.* 2023; Hankiso *et al.* 2023).

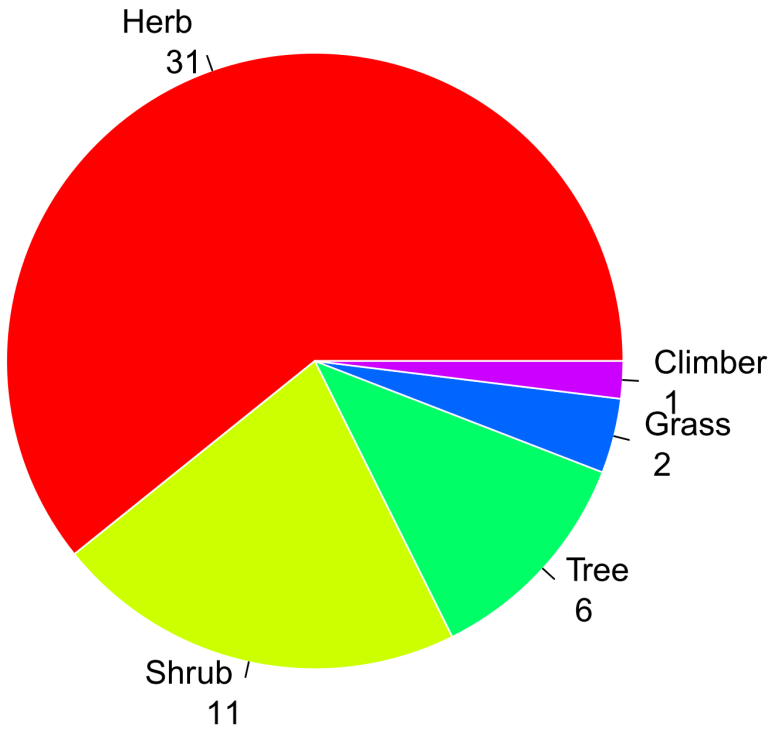

Figure 5. Growth habits of wild edible plants used by rural community of Chlef province. Values indicate number of species.

The Kruskal-Wallis test was performed to evaluate the differences in the RFC across various growth habits (Herbaceous, Shrub, Tree, Grass, and Climber). The analysis yielded a chi-squared value of 6.281 with 4 degrees of freedom and a p-value of 0.1791. This result indicates that there is no statistically significant difference in the RFC among the different growth habit categories at the 5% significance level. These findings suggest that the traditional use and frequency of citation of species do not vary significantly based on their growth habits.

Conclusion

In summary, this survey documented 51 species, predominantly herbs and shrubs, serving as reservoirs of WEPs used by the rural community in Chlef province, Northwest Algeria. The taxonomic diversity revealed the dominance of the botanical families *Lamiaceae* and Asteraceae, with notable species such as *Malva sylvestris, Scolymus hispanicus*, and *Cynara cardunculus*, which hold significant cultural and practical importance due to their widespread use. Culinary practices demonstrated the integral role of WEPs in local diets, with diverse applications including raw consumption, cooking, herbal teas, seasoning, and traditional bread-making methods. Aerial parts, leaves, and fruiting plant parts were particularly popular for these purposes.

For the first time, this study documented the culinary uses of *Artemisia mauritanica, Arundo donax*, and *Juncus acutus*, especially in bread preparation, where they are valued for their flavor-enhancing properties and their role in preventing burning. Additionally, the use of *Atriplex vulgare* during periods of scarcity highlights the adaptability of traditional knowledge to resource constraints.

The findings underscore a decline in traditional knowledge and usage, driven by socioeconomic changes, climate challenges, and evolving dietary habits. Nevertheless, increasing awareness of the health benefits of these bioresources presents an opportunity to integrate WEPs into modern diets. Furthermore, exploring their economic and medicinal potential could create sustainable income opportunities while preserving the rich ethnobotanical heritage of the region. To safeguard this traditional knowledge and ensure its transmission to future generations, it is imperative to implement initiatives focused on education, research, and conservation.

Declarations

List of abbreviations: WEPs: Wild Edible Plants, RFC: Relative Frequency of Citation, FC: Frequency of Citation, SWIf: Standardized Weight Index of Families, GH: Growth Habit.
Ethics approval and consent to participate: All informants were informed about the purpose of this study. The data were collected in accordance with confidentiality and consent protocols.
Consent for publication: Not applicable
Availability of data and materials: Not applicable
Competing interests: The authors declare that they have no competing interests.
Funding: Not applicable
Author contributions: AM: Designing and supervising the research, drafting the manuscript, data analysis. MC and AN: revising data analysis and manuscript. AB: Interviewing informants, data collection, and literature research. All authors approved the final version of the manuscript.

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