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Research article

Plantas útiles en el área rural del municipio Linares, Nuevo León

Useful plants in the rural area of Linares municipality, Nuevo León

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Abstract
The useful flora and uses of plants in the rural area of *Linares*, *Nuevo León* were analyzed. A total of 180 semi-structured surveys were conducted in six *ejidos*. 75 families, 194 genera and 253 species with ethnobotanical use were recorded. The main categories of use were: ornamental (105 species), medicinal (83), food (6) and timber (25); the remaining 34 species are used as fodder, cosmetics and beliefs. Cactaceae (19), Fabaceae (15), Asteraceae (15), Poaceae (15), Lamiaceae (12), Solanaceae (6), Asparagaceae (6), and Rutaceae (4) recorded the highest number of taxa. Of the total number of identified species, 120 are native, and 133 are exotic. As for the medicinal use, *Allium sativum*, *Aloe vera*, *Echinocereus poselgeri*, *Equisetum laevigatum*, *Croton suaveolens*, *Mentha spicata*, *Litsea glaucescens* and *Ruta graveolens* were the most widely used. The main timber species were *Prosopis glandulosa*, *Vachellia farnesiana*, *Ebenopsis ebano*, *Havardia pallens*, *Quercus canbyi*, *Carya illinoinensis*, *Pinus cembroides*, *P. montezumae*, and *P. teocote*. For the Informant Consensus Factor (*ICF*), medicinal plants are mainly used to cure ailments of the respiratory, circulatory, reproductive, and digestive systems. The taxa with the highest Use Value Index (*UVI*), equal to 1 in every case, were *Dysphania ambrosioides*, *Allium cepa*, and *A. sativum*. In regard to the Fidelity Index (*FI*, %), the highest percentages corresponded to *Artemisia ludoviciana*, *Cymbopogon citratus*, and *Hedeoma drummondii*. The *Linares* rural region has a rich useful flora, which is mainly used as ornamental, medicinal, food, forage and timber.
Key words: Ethnobotany, *Linares*, northeastern Mexico, *Nuevo León*, natural resources, traditional uses of plants.

Resumen
Se estudiaron la flora útil y los usos de las plantas del área rural de Linares, Nuevo León. Se realizaron 180 encuestas semiestructuradas en seis ejidos. Se registraron 75 familias, 194 géneros y 253 especies con uso etnobotánico. Las principales categorías de uso fueron: ornamental (105 especies), medicinal (83), alimento (6) y maderable (25), las 34 especies restantes son utilizadas como forraje, cosméticos y creencias. Cactaceae (19), Fabaceae (15), Asteraceae (15), Poaceae (15), Lamiaceae (12), Solanaceae (6), Asparagaceae (6) y Rutaceae (4) registraron el mayor número de taxa. Del total de especies identificadas, 120 son nativas y 133 exóticas. Respecto al uso medicinal, *Allium sativum*, *Aloe vera*, *Echinocereus poselgeri*, *Equisetum laevigatum*, *Croton suaveolens*, *Mentha spicata*, *Litsea glaucescens* y *Ruta graveolens* resultaron las más utilizadas. Las principales especies maderables fueron: *Prosopis glandulosa*, *Vachellia farnesiana*, *Ebenopsis ebano*, *Havardia pallens*, *Quercus canbyi*, *Carya illinoinensis*, *Pinus cembroides*, *P. montezumae* y *P. teocote*. Para el Factor de Consenso del Informante (*FCI*) las medicinales se utilizan, principalmente, para curar males de los sistemas respiratorio, circulatorio, reproductivo y digestivo. Los taxa con los valores más altos del Índice de Valor de Uso (*IVU*) fueron *Dysphania ambrosioides*, *Allium*

cepa y *A. sativum*, todas con valor=1. Respecto al Índice de Fidelidad (*IF*, %), los mayores porcentajes correspondieron a *Artemisia ludoviciana*, *Cymbopogon citratus* y *Hedeoma drummondii*. La región rural de Linares posee una rica flora útil que se utiliza principalmente como ornamental, medicinal, alimenticia, forrajera y maderable.

Palabras clave: Etnobotánica, Linares, noreste de México, Nuevo León, recursos naturales, usos tradicionales de plantas.

Introduction

Mexico is a megadiverse country due to its geographic location and orography. It homes a high biological diversity, representing about 6 to 8 % of the planet's plant species (Rzedowski, 2006). Within this plant diversity, there are more than 30 000 taxa of vascular plants, at least half of which are used to satisfy human needs; from these, the medicinal ones are the most commonly used (Lira *et al*., 2016). The wide variety of climates and physiography allows the presence of great floristic richness, and consequently a great diversity of useful plants (Estrada-Castillón *et al.*, 2022).

Ethnobotany studies the relationships among different human groups and their environment, and the use and harvest of plants in different cultures through time (Casas *et al.*, 2014), and it is a useful tool for the rescue of knowledge on the use of plant resources (Zambrano-Intriago *et al.*, 2015). Through cultural transmission, shared groups are formed with certain knowledge, but also with divergences in knowledge between individuals and social groups (Ochoa and Ladio, 2015).

Ethnobotany is a field of science with a multidisciplinary nature, since it refers to the relationships between human societies and plants (Martínez, 1994), and provides them with environmental goods and services, including provision (Hurtado *et al.*, 2006). Today, the knowledge we have of plants is the historical result obtained by

our ancestors, who learned by experimenting, *i.e.,* by trial and error, and has been enriched by science to find new uses for the species (Estrada-Castillón *et al.*, 2014).

Ethnobotany in semi-arid areas has gained importance in recent decades due to the loss of traditional knowledge and the degradation of natural habitats (Estrada-Castillón *et al.*, 2017). Moreover, the availability of species strongly influences the knowledge of taxa and their uses for different purposes, especially for medicinal (Santos *et al.*, 2016) and nutritional purposes (Thomas *et al.*, 2009).

In northeastern Mexico, the management of plants by the rural population plays a key role in their existence (Estrada-Castillón *et al.*, 2012). The state of *Nuevo León* has a high diversity of plants and vegetation types such as scrublands, *chaparral*, pine-oak forest, coniferous forest, halophyte grasslands and subalpine meadows (Estrada *et al.*, 2015). Among the studies on useful plants and their uses in northeastern Mexico are those on the *Cumbres de Monterrey* National Park (Estrada *et al.*, 2007); on the medicinal plants of south-central *Nuevo León* (Estrada-Castillón *et al.*, 2012); on ethnobotany in *Rayones*, *Nuevo León* (Estrada-Castillón *et al.*, 2014); on the useful plants of *Bustamante*, *Nuevo León* (Estrada-Castillón *et al.*, 2017), on the ethnobotany of *Cuatro Ciénegas*, *Coahuila* (Estrada-Castillón *et al.,* 2021), and on ethnobotany in *Iturbide*, *Nuevo León* (Estrada-Castillón *et al*., 2022). The objective of the present study was to increase the ethnobotanical knowledge of the flora of *Linares* municipality, *Nuevo León*, by identifying the use of the different plant species and their main categories of use.

Materials and Methods

Study area

Linares municipality is located in the central-eastern part of the state of *Nuevo León* and has an area of 2 445 km^2 (INEGI, 1986). The climate is semi-warm, sub-humid with summer rains, an average annual temperature of 22 °C, and an average annual rainfall near 749 mm. The driest season is from June to August; the rainiest months are August and September (INEGI; 1986).

The flat surface of Linares municipality is covered by communities of the Tamaulipan thorny scrub (Estrada-Castillón *et al.*, 2014). In the present work, a bibliographic search was carried out to review the inventory of plants of the area (Villarreal and Estrada, 2008). Subsequently, the area around Linares was visited for the purpose of collecting plant specimens. The recorded species were photographed in order to create an ethnobotanical database.

The identification of plant taxa was carried out based on specialized literature (Villarreal and Estrada, 2008). The collected specimens were stored in the herbarium (CFNL) of the Faculty of Forest Sciences of *Universidad Autónoma de Nuevo León.* Finally, the *ejidos* among whose inhabitants ethnobotanical use surveys were carried out were selected; they were *Rancho Viejo y La Palma*, *San Francisco Tenamaxtle*, *El Fresno*, *Jesús María del Puerto*, *La Reforma* and *El Guajolote* (Figure 1).

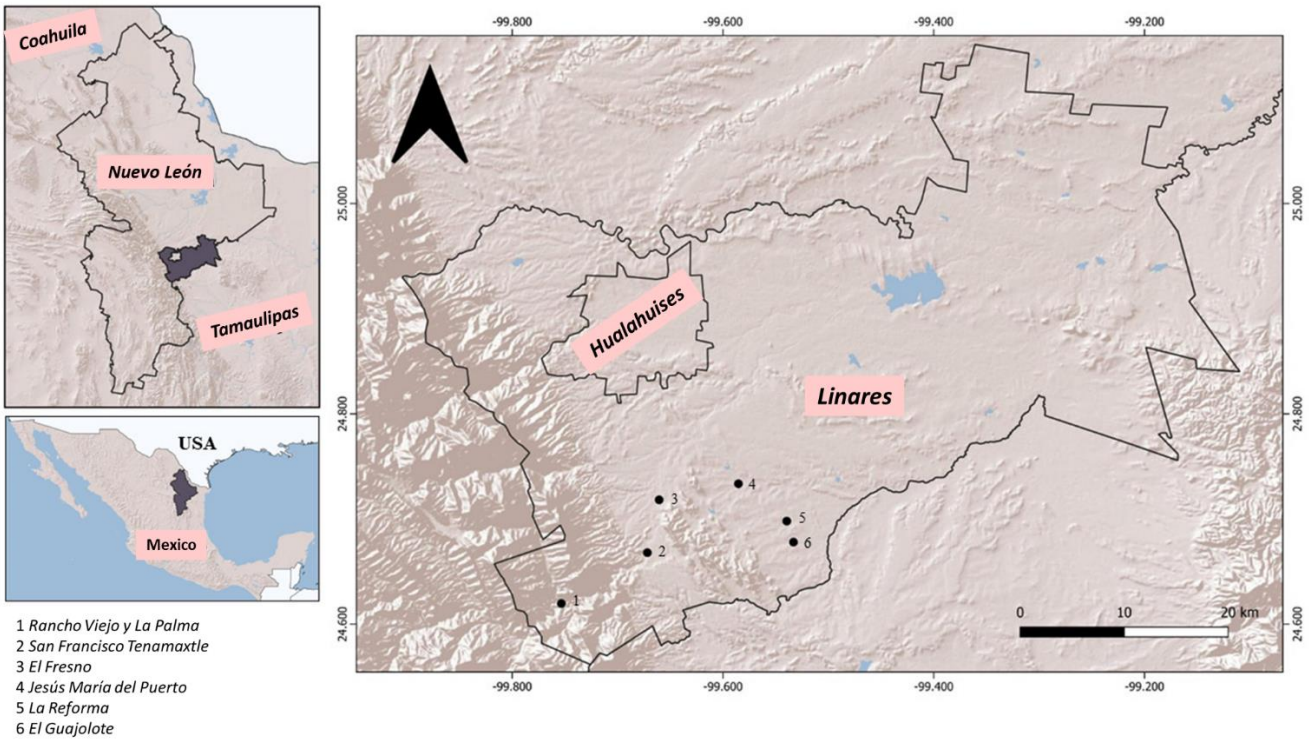

Figure 1. Location of the study area.

Laboratory work and fieldwork

Surveys

A total of 180 semi-structured surveys were conducted (interviewing 108 women and 72 men), 30 per *ejido* (Martin, 1995). The objective was to quantify the uses for each plant. The surveys were applied to men and women aged above 30 years, as it is considered that they know more species and their uses than younger people

(Estrada-Castillón *et al.*, 2014). The survey included at least four general questions relating to ethnobotanical knowledge: (1) What is the common name of the plant?, (2) How do you use it?, (3) What part of the plant do you use?, and (4) How do you prepare it? The surveys were conducted with the prior consent of each of the informants (ISE, 2006).

Data analysis

In order to find out the relationship between the age of the respondents and the number of known species of ethnobotanical use, a Pearson's correlation test was applied (Zar, 2010); in addition, an Analysis of Variance test was performed (Zar, 2010) by dividing the sample into age classes (nine, according to the Sturges rule). Information was analyzed with the statistical software PAST, version 4.03 (Hammer *et al.*, 2001).

There are three main ethnobotanical indices for analyzing the importance of medicinal species (Heinrich *et al.*, 1998; Estrada-Castillón *et al.*, 2022): the Informant Consensus Factor (*ICF*) (Heinrich *et al.*, 1998), the Use Value Index (*UVI*) (Zambrano-Intriago *et al.*, 2015), and the Fidelity Index (*FI*) (López-Gutiérrez *et al*., 2014); the first two range between 0 and 1. The first expresses the result in an interval of 0-1, values closer to 0 indicate that the plants were chosen randomly or that there is no exchange of information about the use of the plants, while values close to 1 mean that few taxa are used by most informants to treat diseases grouped into the same category. The lower the calculated value, the greater the

disagreement between informants regarding the use (Estrada-Castillón *et al.*, 2022). The *ICF* is calculated using the following Equation:

$$ICF = (nur - nt)/(nur - 1) \quad (1)$$

Where:

nur = Number of plants used for each category

nt = Number of uses cited in each category

The UVI analyzes the local relevance of each of the species (Camou-Guerrero *et al.*, 2008; Estrada-Castillón *et al.*, 2022) and is calculated using the following formula:

$$UVI = \Sigma Ui/n \quad (2)$$

Where:

Ui = Number of uses known by each informant for the species *i*

n = Total number of people interviewed

The Fidelity Index (*FI*) (Albuquerque *et al.*, 2014; Estrada-Castillón *et al*., 2022) estimates the relative importance of each medicinal species according to the degree of consensus among the informants within a category of use, *i.e.*, it refers to the consensus among informants regarding the therapeutic use of certain plant species to treat different categories of diseases and their medicinal efficacy. If a species shows greater consensus among respondents, it suggests that it is more effective

because it has undergone trial-and-error selection over time. The *FI* is expressed in percentages and is calculated with this Equation:

$$FI(\%) = Ip/Iu(100) \quad (3)$$

Where:

Ip = Number of informants who independently indicated the use of a plant for the same particular condition

Iu = Number of informants who mentioned the species for a particular disease within a category of use

Results

Relationship between age and ethnobotanical knowledge

Pearson's test showed no significant correlation (r=-0.026, n=180, p=0.729) between the age of individuals and the number of species with ethnobotanical use. The ANOVA test also showed no significant statistical differences between age classes and the number of species with ethnobotanical use (F=0.926, *g.l.*=179, p=0.496).

Diversity of families, genera, and species

A total of 253 plant species mentioned by the informants were recorded, included in 75 families and 194 genera. Figure 2 illustrates the families with the largest number of genera and species with ethnobotanical use. Of these, 47 % were native, and the remaining 53 % were exotic.

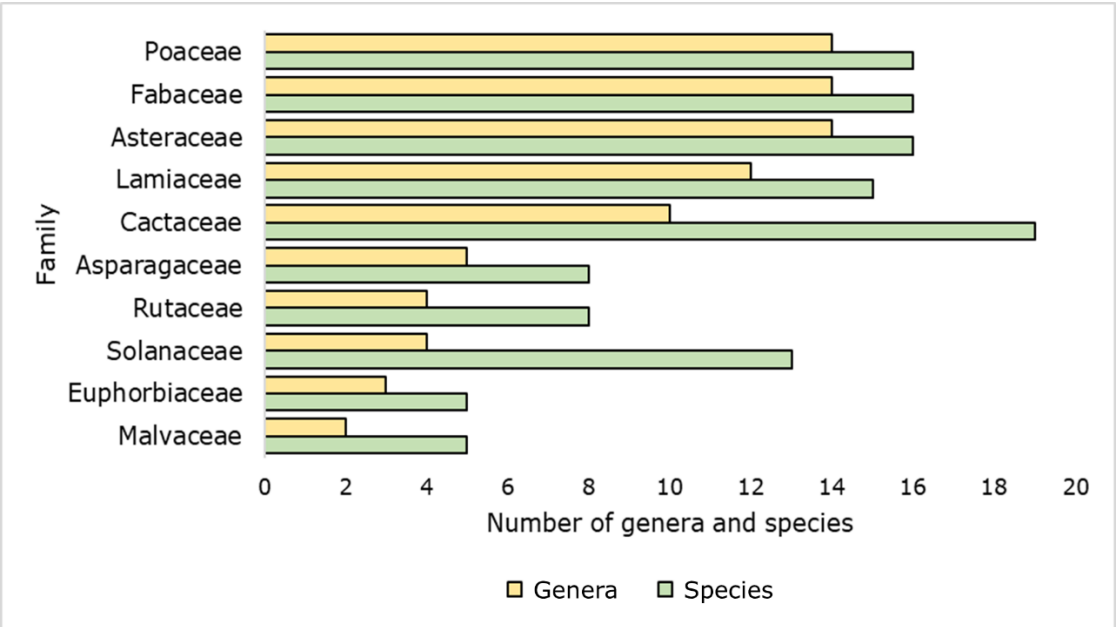

Figure 2. Families with the highest number of genera and species with ethnobotanical uses in the rural areas of *Linares* municipality, *Nuevo León*, Mexico.

Category of use

According to the number of mentions, eight categories of uses were recorded, including ornamental, medicinal and food (Figure 3).

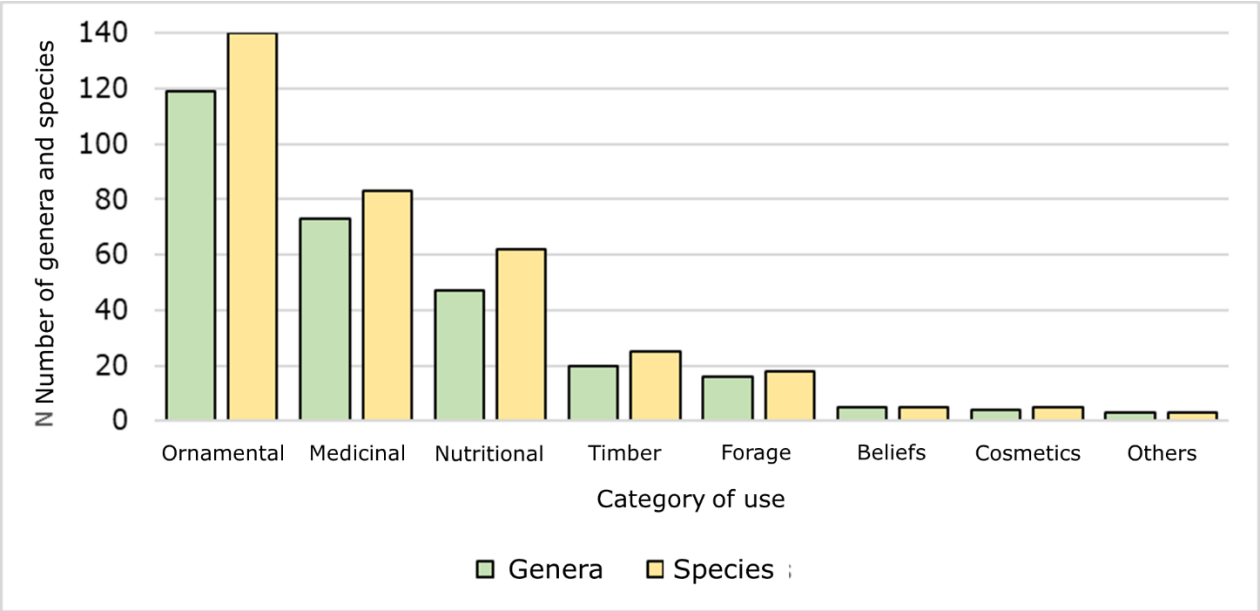

Figure 3. Main ethnobotanical use categories, number of genera and species in the rural areas of *Linares* municipality, *Nuevo León*, Mexico.

Ornamental

139 species with ornamental use belonging to 51 families and 105 genera were identified. The most representative families in terms of number of genera and species they include were Asparagaceae, Cactaceae, Crassulaceae, Fabaceae, and

Lamiaceae. The most important characteristics for the selection of ornamentals were the color and scent of the flowers, the shape and size of the plant, as well as the amount of shade it provides. Ornamental shrubs were the most abundant (59), followed by herbaceous (51) and arboreal (29) species. Native herbaceous (33) and shrub taxa (18) outnumbered herbaceous and shrub exotics (31 and 28, respectively), while a higher number of tree exotics (21) than of natives (8) was recorded. The species with the highest number of mentions were: *Rosa gallica* L., *Euphorbia milii* Des Moul., *Vinca minor* L. and *Hibiscus rosa-sinensis* L.

Medicinal

A total of 83 species with medicinal use, included in 36 families and 73 genera, were recorded. The body systems in which the treatments with these plants were applied were 13: digestive (34 species), respiratory (16), tegumentary (16), circulatory (13), endocrine (13), nervous (13), reproductory (8), urinary (8), sensory (5), osseous (4), muscular (3), lymphatic (3), and immunological (3). The main parts of the plant used were the leaves, the stems, and the fruits (Figure 4). The most common form of preparation was boiled in an infusion or tea (68 species), raw (23), anointed (13), cooked (3), and liquefied (3). The most important families in terms of genera and species used were Lamiaceae, Asteraceae and Rutaceae (Figure 5).

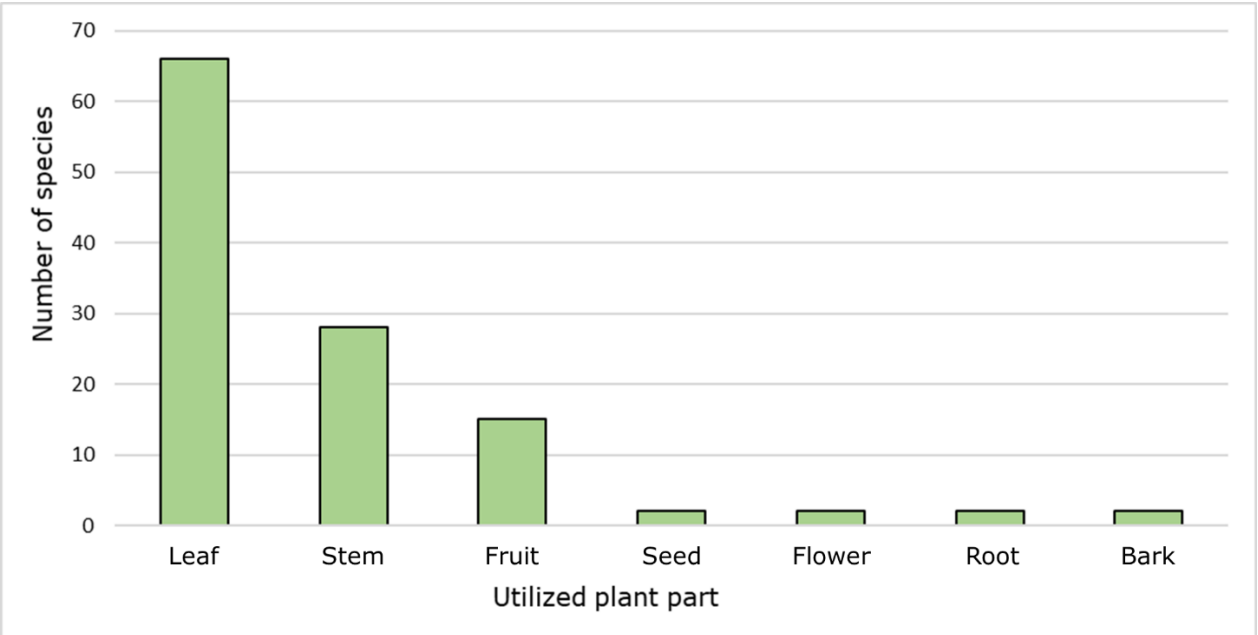

Figure 4. Main plant parts with medicinal use in the rural areas of *Linares* municipality, *Nuevo León*, Mexico.

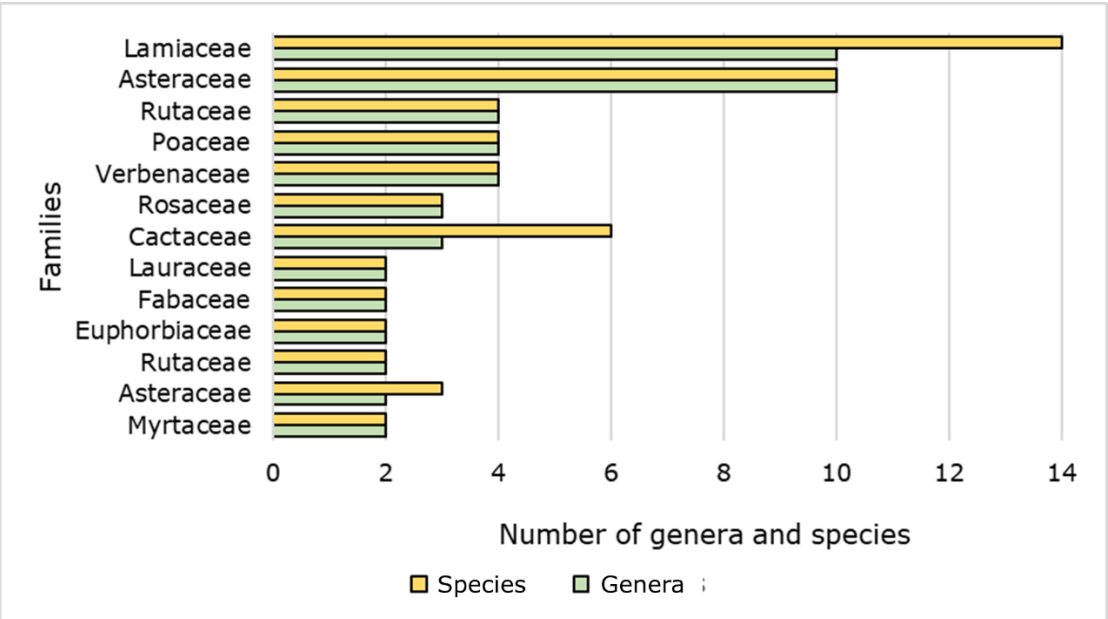

Figure 5. Main families in relation to number of genera and species with medicinal ethnobotanical use in the rural areas of *Linares* municipality, *Nuevo León*, Mexico.

48 native and 35 exotic medicinal species were identified; native herbaceous species (21) were more commonly utilized than the 20 exotic herbaceous species; likewise, native shrubs (14 species) were more commonly utilized than exotics (2), while the numbers of medicinal trees utilized were similar: 13 native and 12 exotic. The medicinal plants with the highest number of mentions were: *Croton suaveolens* Torr., *Cymbopogon citratus* (DC.) Stapf, *Bougainvillea glabra* Choisy, *Artemisia ludoviciana* Nutt. y *Mentha spicata* L.

Nutritional

The food species recorded were 62, distributed among 47 genera. The best-represented families corresponded to Solanaceae (12 species), Apiaceae (five species), Rutaceae, Lauraceae, and Lamiaceae, each with three species. Of these, the main parts used were the fruits, the leaves, and the stems (Figure 6).

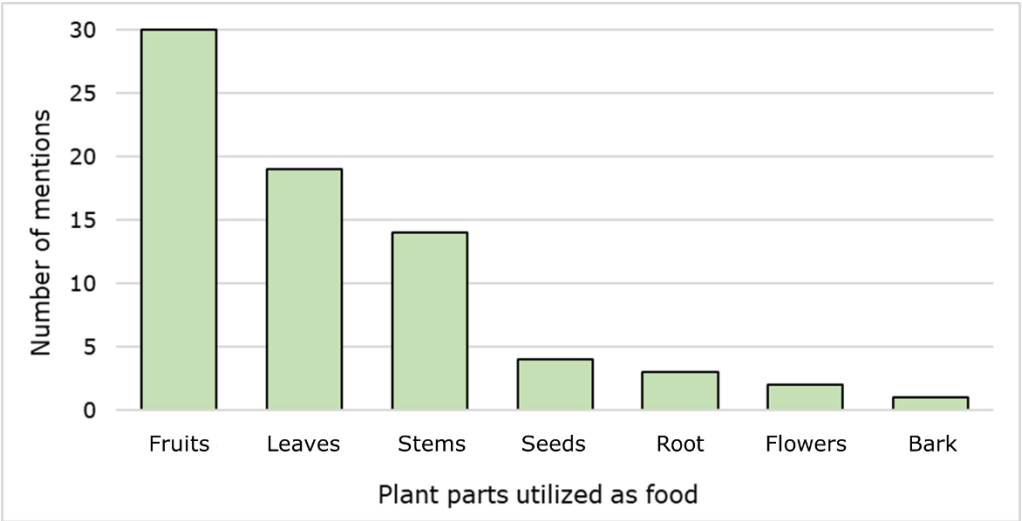

Figure 6. Number of mentions of the plant parts used as food in the rural area of *Linares* municipality, *Nuevo León*, Mexico.

The most frequent forms of use of the food plants were boiled (41 %), cooked (31 %), in infusion (12 %), fried (11 %), and ground (5 %). Of the total number of species, 34 are herbaceous, 12 are shrubs, and 16 are trees. The taxa with the highest number of mentions were: *Solanum tuberosum* L., *Lycopersicon esculentum* Mill., *Cucurbita pepo* L., *Opuntia engelmannii* Salm-Dyck ex Engelm., *Opuntia ficus-indica* (L.) Mill., *Yucca filifera* Chabaud and *Dysphania ambrosioides* (L.) Mosyakin & Clemants.

Quantitative ethnobotanical indexes

Medicinal

The plant species that are used and the importance of their medicinal properties for the people, determine the ethnobotanical value of the regional flora (Packer *et al.*, 2019; Singh *et al.*, 2020). The highest *ICF* values were obtained for the respiratory (0.93), genitourinary (0.91), circulatory (0.91), and digestive systems (0.90). Table 1 shows the values for the rest of the systems. These systems represent the main health issues recognized both by the World Health Organization (OMS, 2010) and in studies on traditional medicine (Singh *et al.*, 2020; Bhat *et al*., 2021).

Table 1. Classification of the 11 categories of systems to obtain the *ICF*.

System	Number of species mentioned (*nt*)	Total number of mentions (*nur*)	*ICF*
Respiratory	16	231	0.93
Reproductory	8	84	0.91
Circulatory	13	138	0.91
Digestive	34	339	0.90
Nervous	13	118	0.89
Sensory	5	36	0.88
Tegumentary	16	125	0.87
Muscular	3	16	0.86
Endocrine	13	73	0.83
Immunolgical	3	10	0.77
Osseous	4	10	0.66

nt = Number of species mentioned; *nur* = Total number of mentions; *ICF* = Informant Consensus Factor.

The Use Value Index (*UVI*) is interpreted as the potential use of a particular species that is utilized to cure or counteract a specific ailment. Therefore, high values determine the frequency of medicinal species (Estrada-Castillón *et al*., 2021). Table 2 shows the medicinal species with the highest *UVI* values. According to the information provided by the respondents, a total of 13 species had a 100 % *FI*, indicating that they are well-known for their healing properties (Table 3). The taxa with the highest number of mentions were *Turnera diffusa* Willd., *Artemisia ludoviciana*, *Cymbopogon citratus* y *Croton suaveolens*.

Table 2. Plant species of ethnobotanical medicinal use with the highest *UVI* values in the rural areas of *Linares*, *Nuevo León*, Mexico.

Scientific name	*UVI*	Origin
Dysphania ambrosioides (L.) Mosyakin & Clemants	1	N
Allium cepa L.	1	E
Allium sativum L.	1	E
Teucrium cubense Jacq.	0.91	N
Aloe vera (L.) Burm. f.	0.91	E
Mentha spicata L.	0.88	E
Moringa oleifera Lam.	0.87	E
Litsea glaucescens Kunth	0.5	N
Ruta graveolens L.	0.46	E

UVI = Use Value Index; N = Native; E = Exotic.

Table 3. Species with the highest *FI* values (%) recorded in the rural areas of *Linares* municipality, *Nuevo León*, Mexico.

Species	System	*Ip*	*Iu*	*FI* (%)
Artemisia ludoviciana Nutt.	Digestive	49	49	100

Cymbopogon citratus (DC.) Stapf	Respiratory	49	49	100
Hedeoma drummondii Benth.	Nervous	35	35	100
Hedeoma palmeri Hemsl.	Nervous	35	35	100
Croton suaveolens Torr.	Circulatory	46	46	100
Galphimia angustifolia Benth.	Urinary	33	33	100
Turnera diffusa Willd.	Reproductory	73	73	100
Allium sativum L.	Lymphatic	4	4	100
Equisetum laevigatum A. Braun	Lymphatic	26	26	100
Ocimum tenuiflorum Burm. f.	Lymphatic	1	1	100
Cannabis sativa L.	Muscular	6	6	100
Jatropha dioica Sessé ex Cerv.	Tegumentary	26	26	100
Matricaria recutita L.	Sensory	43	43	100
Cordia boissieri A. DC.	Osseous	26	61	43
Citrus sinensis (L.) Osbeck	Immunological	16	84	19

**Ip* = Number of informants who independently indicated the use of a plant for the same particular condition; ***Iu* = Number of informants who mentioned the species for a particular disease within a category of use. *FI* = Fidelity Index.

Timber

The main uses of timber species were for the construction of tools, bridges, houses, fences, furniture, fuel, and charcoal. The most important families used were Fabaceae (3 species), Pinaceae (3), Rutaceae (2), Boraginaceae (2), and Juglandaceae (2). The following taxa stand out: *Ebenopsis ebano* (Berland.) Barneby & J. W. Grimes, *Baccharis neglecta* Britton, *Cordia boissieri* A. DC., *Ehretia anacua* (Terán & Berland.) I. M. Johnst., *Taxodium huegelii* C. Lawson, *Prosopis*

laevigata (Humb. & Bonpl. ex Willd.) M. C. Johnst., *Vachellia rigidula* (Benth.) Seigler & Ebinger, *V. farnesiana* (L.) Wight & Arn., *Havardia pallens* (Benth.) Britton & Rose, *Quercus polymorpha* Schltdl. & Cham., *Carya illinoinensis* (Wangenh.) K. Koch, *C. myristiciformis* (F. Michx.) Nutt., *Pinus teocote* Schltdl. & Cham., *P. cembroides* Zucc., *Condalia hookeri* M. C. Johnst., *Helietta parvifolia* (A. Gray ex Hemsl.) Benth. and *Zanthoxylum fagara* (L.) Sarg. Of the 25 timber species, 18 are trees and eight are shrubs. The three taxa with the highest number of mentions were: *Prosopis laevigata* (142 mentions), *Vachellia farnesiana* (137 mentions) and *Ebenopsis ebano* (130 mentions).

Forage

29 species with ethnobotanical forage use were recorded, among which the most prominent families were Fabaceae, Poaceae, and Cactaceae. The most commonly utilized plant parts were the fruits, the leaves, and the whole plant; among of the taxa with the largest number of mentions were *Rhus virens* Lindh. ex A. Gray, *Parthenium hysterophorus* L., *Cordia boissieri*, *Opuntia engelmannii*, *O. ficus-indica*, *Ebenopsis ebano*, *Eysenhardtia texana* Scheele, *Prosopis laevigata*, *Vachellia rigidula*, *Havardia pallens*, *Leucaena leucocephala* (Benth.) Seigler & Ebinger, *Medicago sativa* L., *Phaseolus vulgaris* L., *Vachellia constricta* (Benth.) Seigler & Ebinger, *Quercus polymorpha*, *Guilandina moringa* L., *Avena sativa* L., *Cenchrus ciliaris* L., *C. echinatus* L., *Cynodon dactylon* (L.) Pers., *Dichanthium annulatum* (Forssk.) Stapf, *Hordeum vulgare* L., *Melinis repens* (Willd.) Zizka, *Panicum*

coloratum L., *Sorghum bicolor* (L.) Moench, *S. halepense* (L.) Pers., *Zea mays* L. and *Dioon edule* Lindl.

Discussion

Both native and exotic plant species are used in the rural area of the municipality of *Linares*. Much the same diversity is found in nearby areas with similar vegetation, climate, and relief within the state of *Nuevo León* (Estrada-Castillón *et al.*, 2014; Estrada-Castillón *et al.*, 2017; Estrada-Castillón *et al.*, 2021), in the northeastern area (Lara *et al.*, 2018), and in the northern macro-region (Camou-Guerrero *et al.*, 2008). Like in *Linares*, the most important families with ethnobotanical use in *Oaxaca* are Fabaceae, Asteraceae, Poaceae, Lamiaceae, and Cactaceae (Martínez-López *et al.*, 2021). Regarding the uses of the plants, there are many similarities between what is recorded in *Linares* and what is cited for some areas of northern and southern Mexico.

Ornamental taxa play an important role in the beauty of the landscape and are relevant for the conservation of species and of the cultural heritage (Siviero *et al.*, 2014); also, they contribute to stress reduction and improve human emotional well-being (Pauli *et al.*, 2016). In *Puebla*, the main uses documented for useful flora are medicinal, nutritional, and timber (Martínez *et al.*, 2007). In *Tabasco* State, Villarreal-Ibarra *et al.* (2014) declare the main conditions treated with plants those associated to the digestive, genitourinary, endocrine, circulatory and respiratory systems, which coincides with what was recorded in the present study. The plant parts most commonly used by the survey respondents were the leaves, the stems, and the fruits, which is also the case in *Guerrero* (Mendoza *et al.*, 2020). The leaves

of herbaceous plants contributed the highest percentages to the cure of ailments, in accord with the findings by Lara *et al.* (2018) in a research conducted in *Zacatecas*.

Because of its durability, the wood of *Acacia farnesiana* (L.) Willd., *Ebenopsis ebano*, *Parkinsonia aculeata* L. and *Prosopis glandulosa* Torr. is used in *Linares* for construction and fuel. Several taxa of *Quercus*, *Pinus*, *Cupressus* and *Juniperus* have the same use in Pakistan (Amjad y Arshad, 2014) and in Cameroon (Focho *et al.*, 2009).

The main native and exotic food species recorded in this study are sold for the same purposes in markets in southern Mexico (Martínez *et al.*, 2021).

The ethnobotanical indices presented relatively high values. The *ICF* ranged from 0.91 to 0.93, indicating that most informants use few species to cure diseases. The above coincides with the findings for the state of *Hidalgo*, where the values for the digestive and circulatory systems are prominent (López-Gutiérrez *et al*., 2014), as well as in certain areas of the state of *Puebla* (Vargas-Vizuet *et al.*, 2022).

The *UVI* expresses the importance of a given species for all the informants interviewed, thus, if it is mentioned by many informants, it will have a high *UVI*. In *Linares*, species with a high *UVI* were *Dysphania ambrosioides*, *Allium sativum* L. and *Aloe vera* (L.) Burm. f., these have also been cited in *Chiapas* (Lara *et al.*, 2019), although with lower *UVI* values; in *Tabasco*, *Mentha piperita* L. has been found to have a lower *UVI* (Gómez *et al.*, 2016).

The *FI* suggests that a species has undergone selection over time; thus, a high *FI* value indicates a higher probability that it will prove effective. The taxa with the highest *FI* in *Linares* were *Artemisia ludoviciana*, *Cymbopogon citratus*, *Hedeoma drummondii* Benth., *Croton torreyanus* Müll. Arg., *Turnera diffusa*, *Allium sativum* and *Equisetum hyemale* L., several of them have been reported with high *FI* values in arid and semi-arid regions of *Nuevo León* (Estrada *et al.*, 2015; Estrada-Castillón *et al.*, 2017; Estrada-Castillón *et al.*, 2021). In *Morelos*, Ortega-Cala *et al*. (2019) registers relatively high *FI* for *Matricaria chamomilla* L. (2.56), and *Mentha piperita*

(2.56), medium *FI* for *Psidium guajava* L. (1), or low *FI* for *Ruta gravelones* L. (0.16); these species were also identified in *Linares.*

Conclusions

Based on the knowledge of the use of the flora in *Linares*, it is concluded that there is a strong cultural attachment, with many of the species playing a multifunctional role; among the ethnobotanical uses recorded are ornamental, medicinal, food, forage, and timber. This study contributes to enrich the knowledge of the ethnobotanical biocultural diversity existing in *Nuevo León*, in northern and northeastern Mexico. Medicinal and food plants are relevant to primary human functions, they continue to be used to cure diseases, and together with exotic species, promote cultural changes in order to meet the new health needs of local residents. As for the edible plants, many are seasonal and are used to the present day in local and regional gastronomy.

The shrub and tree flora, especially composed of native species, has various uses for timber, particularly in construction, and as a source of firewood and charcoal. In *Linares*, according to the respondents and to the statistical analysis conducted, traditional knowledge with its adaptations continues to prevail and to be transmitted from generation to generation, remaining relatively constant among the different age classes of the population.

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Conflict of interest

The authors of this manuscript declare that they have no conflict of interest.

Contribution by author

Andrés Eduardo Estrada Castillón: research development, data analysis, plant identification, editing of the manuscript; Alexsa Fabiola Paz Medrano: fieldwork, data analysis; Laura Magdalena Scott Morales, Mauricio Cotera Correa and Renata Valdes Alameda: data analysis and revision of the manuscript; Diego Axayacatl González Cuéllar: fieldwork.

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