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Original article

Medicinal plants used by rural communities in the arid zone of Viesca and Parras Coahuila in northeast Mexico

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ABSTRACT

This study is the first record of medicinal plants in the southwest of the Coahuila state, an arid zone where extreme dry conditions prevail. One hundred twenty-two residents (in sixteen communities) were interviewed. The residents were questioned with a questionnaire-guided ethnomedical survey protocol about the various plants used. Seventy-seven species of medicinal plants belonging to 36 botanical families were cited. The highest use-value (UV) was calculated for *Lippia graveolens* Kunth (0.30); *Aloe vera* (L.) Burm.f. (0.20); *Eucalyptus abdita* Brooker & Hopper, *Chamaemelum nobile* (L.) All. (0.16); *Mentha spicata* L. (0.15) and *Salvia officinalis* L. (0.10). Informant consensus factor (ICF) about usages of medicinal plants ranges from 0.41 to 0.80; the highest level of agreement was determined between the informants and Respiratory System Diseases (0.80). The highest fidelity level (FL) values (100%) were identified in *Flourensia cernua DC.*, *Artisia ludoviciana* Nutt., and *Parthenium incanum* Kunth to Gastro-intestinal System Diseases; *Eucalyptus abdita* Brooker & Hopper, *Bougainvillea berberidifolia* Heimerl, and *Lippia graveolens* Kunth to Respiratory System Diseases (RSD) and *Cyclolepis genistoides* D.Don and *Ephedra antisyphilitica* Berland. ex C.A.Mey. to Obstetrics, Gynecology and Urinary tract Diseases. These last two medicinal plant species ("palo azul" and "pitoreal") used by the rural communities in Viesca in the treatment of urinary tract infections and kidney stones have not been reported previously. These findings can provide new research directions for further phytochemical studies. The present study revealed that the residents are rich in ethno-medicinal knowledge and actively use medicinal plants to treat various diseases. New phytochemical and pharmacological research are needed to confirm the therapeutic potential and safety of the identified plants.

1. Introduction

Since ancient times, humans have used plants to treat diseases; scientific investigations of plant material have proved the therapeutic efficacy of plants over time (Sharma et al., 2017; Torres-León et al., 2017). The health benefits are due to an immense diversity of specialized metabolites or phytochemicals (alkaloids, terpenoids, or phenolic compounds) (Chakraborty, 2018).

Approximately 30,000 vascular plant species represent Mexican Flora (Calzada and Bautista, 2020); the country has an ancestral tradition of using medicinal plants as first aid remedies. The first book of medicinal plants (Cruz-Badiano Codexes) was written on

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the American continent in Nahuatl in the 16th century by Martín de la Cruz (translated into Latin by Juan Badiano) (INAH, 2022). Currently, an important number of plants are used to manufacture infusions, plasters, syrups, creams, "temazcales" (steam baths), or essential oils (Bautista-Hernández et al., 2022). However, research on medicinal plants has focused on the center and south of the country (Chiapas, Oaxaca, and Veracruz) (Sharma et al., 2017), and there is little scientific literature on the uses of medicinal plants in the Coahuila state (an arid zone in northern Mexico) (Estrada-Castillón et al., 2021, 2018, 2012). Arid lands are 60 % of the area of Mexico; approximately 50 % of Mexican dryland flora is endemic and accompanied by ample local and traditional knowledge (Ramírez-Rodríguez et al., 2020). Some articles have been published on Mexican drylands Cactaceae fruits (Ramírez-Rodríguez et al., 2020), *Larrea tridentata* "Creosote bush" (Arteaga et al., 2005; Martins et al., 2013), and *Lippia graveolens* Kunth "Mexican oregano" (Bautista-Hernández et al., 2022, 2021).

Natural products of arid zone plants represent an alternative for treating diseases, particularly in communities with limited access to health services (Calzada and Bautista, 2020). In recent years in Mexico, new government strategies have emerged to rescue knowledge about medicinal plants; new projects are being developed to document and investigate the uses and applications of medicinal plants. In this sense, the National Council of Science and Technology (CONACYT) has promoted the creation of new Ethnobiological Gardens. Our research center (@cijeuadec) is building the ethnobiological garden in Coahuila state, and its headquarter is located within the study area in Viesca, 72 km from Torreon city. In northern Mexico, although most of the population is covered by some health scheme, the global urban–rural divide in rural areas creates inequality in access to public health (Carrillo-Balam et al., 2020).

Additionally, communities live far away from the nearest health care areas in arid zones. The Viesca region's closest hospitals are in the cities of "Matamoros" and "Parras de la Fuente," 53 and 76 km away, respectively. Registering the local knowledge of medicinal plants can enhance its inclusion in formal health systems (Bolson et al., 2015). This region is of interest for an ethnobiological study for three reasons: 1) no previous research has been conducted in a specific location, 2) plants from arid zones may possess unknown phytochemicals with high biological potential and high added value, and 3) communities in this region may have practices still in use and with potential for implementation in health systems. In this study, we report the traditional knowledge of medicinal plants from communities in southwest Coahuila state, in northeast Mexico.

2. Material and methods

2.1. Area and climatic conditions

This study was conducted in southwest Coahuila state, northeast Mexico (Viesca and Parras de la Fuente). The study area is situated 72 km from Torreón city (13R UTM zone, UTM coordinates 675000E, 2850000 N, and 775000E, 2725000 N) and comprised the rural communities of "Bajío de ahuichila", "Boquillas del refugio", "Cuatro de Marzo", "El amparo", "Emiliano Zapata", "La mancha", "Eulalio Gutiérrez", "La fe", "Tomás Garrido Canabal", "San Isidro", "San José del Aguaje", "Saucillo", "Tanque aguilereño", "Venustiano Carranza", "Villa del Bilbao" and "Villa de Viesca" (Fig. 1).

The study region is an arid zone with extreme dryness and reduced vegetation cover. The climatic conditions of the study region were determined using a professional wireless weather station with a touch panel (WA1091, USA). This station is installed in the Research Center and Ethnobiological Garden (CIJE) (Fig. 1). According to data (February to October 2021), the regional climate is dry, warm, and very dry; the mean rainfall was 18.75 mm, and the mean temperature was 25.92 °C, with a maximum monthly average of 38.53 °C and a minimum of 11.71 °C. The humidity and dew point averages were 35.07 % and 7.52 °C.

2.2. Ethical statement

This research was developed according to the International Society of Ethnobiology code of ethics, and Free Prior Informed Consent (FPIC) was obtained in writing from the communities. This research was approved and funded by the Secretary of Public Education of Mexico (SEP) (UACOAH-PTC-533) and the Mexican Council for Science and Technology CONACYT (FORDECYT- 304976). According to local laws, the CIJE has government permits for biodiversity conservation, research, and use (SMA-UMA-JB-0006-COA). All work conducted was carried out under the stipulations of the Nagoya Protocol.

2.3. Data collection

After obtaining permission from the representatives of the communities to conduct the study, field visits were carried out in all 16 communities of Viesca and Parras during the period of October 2020–November 2021. A total of 122 residents of the communities were interviewed individually. These consisted of 84 women and 38 men, with an age range between 20 and 89 years. The highest number of people was between 60 and 89 years old (41.3 %), followed by 40 and 59 years old (34.7 %). The anonymity of the interviewees was ensured. Information on the plants used in traditional medicine, preparation, and medicinal uses was requested through a structured face-to-face questionnaire (Printed). Information on preparation techniques, recommended doses, administration forms, and curative properties were also consulted. The information was recorded in Spanish since it is the only language in the region.

Informants with more knowledge about medicinal plants were invited to visit the localities to identify the named plants and collect specimens *in situ* (The plants were donated voluntarily). Field forms with plant names, registration data, vouchers, and locations (GPS) were filled out. The specimens were extracted, collected, and herborized in the Medicinal Plant Garden of Universidad Autonoma de Coahuila (CIJE). These plant samples were then dried and finally identified with the help of information provided by the informants, consultation of local flora (CONABIO, 2021), and specialists of the CIJE and the Botanical Reference Center of the Universidad Autonoma Agraria Antonio Narro (CREB-UAAAN). Herbarium vouchers were intercalated in the herbarium of the Research Center and Ethnobiological Garden (CIJE-UAdeC), Universidad Autonoma de Coahuila, Viesca, Coahuila, Mexico. Full botanical plant names were checked (The Plant List, 2013; UNAM, 2021).

2.4. Data análisis

Qualitative data were organized by categorizing descriptions of sickness into biomedical categories of use for the assignment of user reports. According to Bolson et al. (2015), the mentioned medicinal uses were classified according to British National Formulary (BNF) (British Medical Association, 2009). The medicinal uses mentioned by the surveyed people were grouped into ten categories from the traditional use of diseases, symptoms, and effects (Table 1).

2.5. Quantitative factors

Following completion of fieldwork, all questionnaires were processed for data analysis, and the information from the surveys was transferred to Excel sheets. Data were tabulated and analyzed

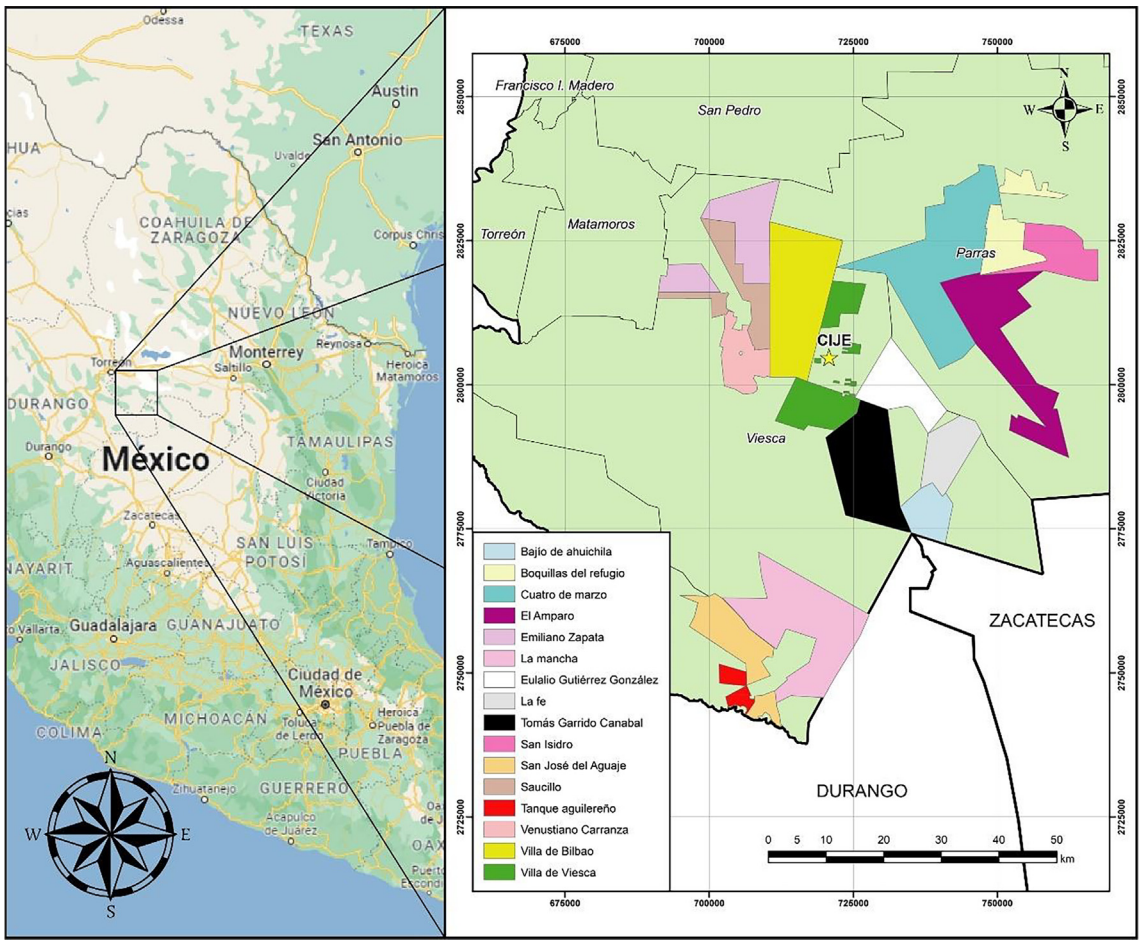

Fig. 1. Graphic location of the study area. The star shows the location of the Research Center and Ethnobiological Garden (CIJE).

using three quantitative ethnobotanical methods: use value (UV), informant consensus factor (ICF), and level of fidelity (FL) (Chander et al., 2014).

The use-value (UV) shows the importance of each species among all the mentioned species. The UV of an ethnospecies (species based on folk names) was calculated according to Rossato et al. (1999) with the following formula; UV=$\sum$ number of uses of a species mentioned /total number of informants. The informant consensus factor (ICF) is used to indicate the homogeneity of the ethnomedicinal information of a plant. It is used to treat a particular category of diseases (Mechaala et al., 2021). ICF = (Number of use reports for each disease category - Number of species used for each disease category) / (Number of use reports for each disease category −1). Finally, the fidelity level (FL) is used to determine the plants most used by informants in a disease category (Mechaala et al., 2021); FL (%) = ((number of informants for a disease category)/(total number of informants for any disease category)) × 100.

3. Results

3.1. Medicinal plant diversity

Seventy-seven species of plants were mentioned to treat different human ailments in the study region (Table 2). The plants were distributed in 36 botanical families. The largest number of plant species come from Asteraceae (n = 13), followed by Lamiaceae (n = 8), Fabaceae (n = 5), Cactaceae (n = 4), Rutaceae (n = 4), Malvaceae (n = 4), Apiaceae (n = 3), Asparagaceae (n = 2), Solanacea (n = 2), Lauraceae (n = 2), Nyctaginaceae (n = 2), Scrophulariaceae (n = 2), Myrtaceae (n = 2) and Onagraceae (n = 2). Herbaceous plants were the most species-rich group (HE = 51.9 %), followed by trees (AR = 20.7 %), shrub (SH = 16.8 %), cacti (CA = 5.2 %), succulents (SU = 2.5 %), vegetables (VE = 1.3 %) and roots (RO = 1.3 %). The most used part of the medicinal plant were the leaves (LE = 39.8 %), followed by the stems (ST = 28.7 %), the whole plant (EP = 15.7 %), the flowers (FL = 9.2 %), the fruits (FR = 0.9 %), the seeds (SE = 0.9 %) and shoots (SH = 0.9 %) (See Table 2).

3.2. Use in traditional medicine

As shown in Table 2, the decoction is the most widely used preparation method (DE = 54 %); according to the informants, the parts of the plants are generally boiled in water. The infusion or preparation of tea was the second most used preparation method (IN = 27 %); in this method, hot water is used as a solvent. The third use trend was the maceration of plant parts (using water as solvent) (MA = 13.9 %). Finally, the preparation as a salad (SA), toasting (TP), and chewing (CH) were the least used methods with 1.0 %.

The plants used for treating and preventing ailments and diseases were grouped into ten categories according to the British Medical Association (2009) (Table 1). The form of administration, dose, and duration of treatment are the intellectual property of the informants and is therefore not included in this manuscript (following FPIC, the study results were presented; this printed information will be delivered free of charge to the communities). The results showed that the largest number of medicinal plant spe-

Table 1
Categories and traditional use of diseases, symptoms, and effects mentioned.

Category of disease[a]	Traditional uses transcribed from the interviews
Gastro-intestinal System Diseases (DSD)	Stomach problems (Intestinal parasites, nausea, pain, diarrhea); Intestinal problems (Indigestion, loss of appetite, induced appetite, ulcers Gastritis, constipation, malta fever, stomach cleansing, inflammation, nausea).
Respiratory System Diseases (RSD)	*Common cold* (cough with phlegm and nasal congestion); *Influenza; Lung problems; and Bronchitis.*
Skin, Eye, Ear, Nose, and Oropharynx Diseases (SST)	*Skin problems* (Infections, rashes, allergies, blemishes, and skin whitening); *Healing* (Wounds, ulcers); *Skin irritations* (itching, antiseptic); *Burns; Contusions*; *Conjunctivitis* (Air in the eyes); *Labyrinthitis; Varicose veins; Improve eyesight; and Ear pain.*
Cardiovascular System Diseases (CSD)	*Heart problems; Control high blood pressure; blood Circulation* (Hypertensión); *and* Cholesterol.
Obstetrics, Gynecology, and Urinary tract Diseases (GUS)	*Menopause; Hormones; Kidney stones; Cysts; and Gonorrhea.*
Musculoskeletal and Joint Diseases (MCT)	*Bone injuries; Rheumatism; Knee pain; Antispasmodic; Tooth cleaning; and Tooth pain.*
Infectious Diseases (IPD)	*Fever; Internal infections* (Bacteria); *External infections* (Fungi); *Infestations* (Lice and nits); *Hepatitis; and Gum inflammation.*
Central Nervous System Diseases (CNS)	*Calming* (Calms nerves, helps sleep and relaxant) and *Analgesic* (migraine).
Malignant diseases (NEP)	*Anemia and Diabetes*
Immunological, poisoning and others (IPO)	*Immunity; Insect bite; and Snakebite.*

cies were used to treat ailments of the gastrointestinal system (DSD = 29 spp.); followed by the skin, eyes, ears, nose, and oropharynx (SST = 20 spp.), Cardiovascular system (CSD = 19 spp.); respiratory system (RSD = 40 spp.); obstetrics, gynecology, and urinary tract (GUS = 15 spp.); Central Nervous System (NSD = 11 spp.); musculoskeletal and Joint (MCT = 8 spp.); Infectious diseases (IPD = 8 spp.); Immunological, poisoning, and others (IPO = 3 spp.) and malignant diseases (NEP = 1 spp.) (Fig. 2).

3.3. Quantitative factors

In scientific studies on traditional knowledge, a quantitative analysis guarantees the reliability of the ethnobotanical studies' results (consensus analysis). Table 2 shows the UV values determined in the plants used in traditional medicine in the southwest of the state of Coahuila, an arid zone in northeast Mexico. The highest UV values were calculated for *Lippia graveolens* Kunth (0.30); *Aloe vera* (L.) Burm.f. (0.20); *Eucalyptus abdita* Brooker & Hopper, *Chamaemelum nobile* (L.) All. (0.16); *Mentha spicata* L. (0.15); *Salvia officinalis* L. (0.10); *Allium sativum* L., *Larrea tridentata* (Sessé & Moc. ex DC.) Coville, *Flourensia cernua DC.*, *Ephedra antisyphilitica* Berland. ex C.A.Mey. (0.09); *Heterotheca inuloides* Cass, *Lophophora williamsii* (Lem. ex Salm-Dyck) J.M. Coult., *Jatropha dioica* Sessé (0.08); *Parthenium incanum* Kunth, *Moringa oleifera* Lam., *Ruta graveolens* L. (0.06), and *Ocimum basilicum* L., *Parthenium hysterophorus* L., *Opuntia ficus-indica* (L.) Mill. (0.05).

The ICF product is used for data analysis in ethnobotany (Upadhyay et al., 2011). The ICF product ranges from 0 to 1. A high FIC value shows a high level of consensus among the informants, while a low value indicates disagreement (Bolson et al., 2015). Table 3 shows the ICF values for each disease category. Respiratory system diseases (RDS) had the highest ICF value (0.80). Diseases of the skin, eyes, ears, nose, and oropharynx (SST), musculoskeletal and joint diseases (MCT), Obstetrics, gynecology and urinary tract diseases (GUS), and diseases of the gastrointestinal system (DSD), presented very similar ICF values (0.69, 0.68, 0.67 and 0.66, respectively).

FL determines the plants most used by informants to treat a particular disease category (Mechaala et al., 2021). Equal 100 % FL values indicate that all informants (in a specific category) mentioned the plant to treat only that disease category. FL values less than 100 % indicate that the plant is used in other disease categories (Ullah et al., 2014). Table 4 shows the FL values for the most frequently cited plants in each disease category. The highest FL values (100 %) were identified in seven plants. *Flourensia cernua* DC., *Artisia ludoviciana* Nutt., and *Parthenium incanum* Kunth in Gastro-intestinal System Diseases; *Eucalyptus abdita* Brooker & Hopper, *Bougainvillea berberidifolia* Heimerl and *Lippia graveolens* Kunth in Respiratory System Diseases (RSD); *Cyclolepis genistoides* D.Don and *Ephedra antisyphilitica* Berland. ex C.A.Mey. to Obstetrics, Gynecology, and Urinary tract Diseases; in the category Skin, Eye, Ear, Nose, and Oropharynx Diseases, the highest FL values were for *Heterotheca inuloides* Cass (90 %) *and Jatropha dioica* Sessé (80 %); in the category Cardiovascular System Diseases, *Moringa oleífera* Lam. showed the highest value of FL (57 %); in the categories Musculoskeletal and Joint Diseases and Infectious Diseases the highest values of FL were for *Lophophora williamsii* (90 %) and *Parthenium hysterophorus* (67 %).

4. Discussion

For the first time, the medicinal uses of 77 plant species were documented in the arid southwestern region of the Coahuila state in Mexico. These plant species are used for the treatment of diseases grouped under ten categories. Reported uses of various medicinal plants were compared to previously published scientific literature (Bautista-Hernández et al., 2021; de Rodríguez et al., 2019; Estrada-Castillón et al., 2021; Palacios-Espinosa et al., 2021).

Some of the plants documented in this study, such as *Larrea tridentata* (Arteaga et al., 2005; Martins et al., 2013) and *Lippia graveolens* Kunth (Bautista-Hernández et al., 2021) have reports of previous investigations in the laboratory for the evaluation of biological properties. These reports have been generated mainly due to their wide distribution in the extensive Chihuahua desert. However, the novelty of this research is to report for the first time the plants used for medicinal purposes, specifically in southwest Coahuila state, in northeast Mexico.

The endemism or endangered status of all reported plant species was revised in the official Mexican standard (NOM-059, 2010). According to the standard, none of the plants has the category of endemic species. The plants *Peniocereus greggii* (Engelm.) Britton & Rose and *Lophophora williamsii* (Lem. ex Salm-Dyck) J. M. Coult. are subject to special protection.

According to the quantitative results, *Lippia graveolens* Kunth is the most used species in the region, showing the highest use values (0.30). This result may be due to the wide distribution of the plant in the study area. Many rural communities in the region collect wild *Lippia graveolens* Kunth for economic purposes. The plant is used for culinary purposes and the extraction of essential oil rich in phytochemicals such as terpene (Carvacrol, thymol, β-caryophyllene, and p-cymene) and flavonoids (O-hexoside, pinocembrin) compounds (Bautista-Hernández et al., 2021).

Recently, Estrada-Castillón et al. (2021) reported for the first time the UV for medicinal plants used in the Cuatro Cienegas Valley in the state of Coahuila (located 187.25 km north of the study area). The authors' results are consistent with the present study, plants such as *Larrea tridentata* (Sessé & Moc. ex DC.) Coville, *Jatropha dioica* Sessé, *Artemisia ludoviciana* Nutt, *Opuntia ficus-indica*

Table 2
UV, Use Categories, and preparation methods of medicinal plants used in the southwest of the Coahuila state, northeast of Mexico.

Scientific name	Family	Local name	Habit	Parts used	Preparation method	Use categories	Use Value (UV)
Allium sativum L.	Amaryllidaceae	Ajo	HE	ST	MA	CSD, RSD, SST, DSD, IPO, IPD	0.09
Ocimum basilicum L.	Lamiaceae	Albahaca	SH	EP	IN	DSD, NSD, RSD, SST	0.05
Echinocereus viereckii Werderm	Cactaceae	Alicoche	CA	ST	MA	SST	0.01
Heterotheca inuloides Cass	Asteraceae	Árnica Amarilla	HE	EP	DE	SST, DSD	0.08
Senecio formosus Kunth	Asteraceae	Árnica Morada	HE	EP	DE	DSD, SST, MCT	0.04
Beta vulgaris L.	Amaranthaceae	Betabel	VE	EP	DE	CSD	0.01
Bougainvillea berberidifolia Heimerl	Nyctaginaceae	Bugambilea	AR	FL	IN	RSD	0.05
Krameria grayi Rose & Painter	Malpighiaceae	Calderona	HE	EP	DE, IN	CSD	0.02
Cinnamomum verum J.Presl	Lauraceae	Canela	AR	EP	IN	RSD	0.02
Leucophyllum frutescens (Berland.) I.M. Johnst.	Scrophulariaceae	Cenizo	SH	EP	DE	NSD, DSD, CSD	0.03
Argemone munita Durand & Hilg.	Papaveraceae	Chicalote	HE	EP	DE	SST, RSD	0.02
Conium maculatum L.	Apiaceae	Cicurra	HE	ST, LE	MA	MCT	0.01
Coriandrum sativum L.	Apiaceae	Cilantro	HE	LE	DE	DSD	0.01
Plumbago scandens L.	Plumbaginaceae	Ciricua	HE	EP	DE	DSD, IPD, MCT, RSD	0.01
Taraxacum officinale F.H. Wigg.	Asteraceae	Diente De Leon	HE	FL	DE	RSD	0.01
Artemisia ludoviciana Nutt.	Asteraceae	Estafiate	HE	LE, ST	IN	DSD	0.02
Eucalyptus abdita Brooker & Hopper	Myrtaceae	Eucalipto	AR	LE	IN	RSD	0.16
Astragalus nitidiflorus Jimenez & Pau	Fabaceae	Garbancillo	HE	LE, ST	MA	DSD	0.01
Larrea tridentata (Sessé & Moc. ex DC.) Coville	Zygophyllaceae	Gobernadora	HE	LE, ST, FL	DE	SST, GUS, IPD, CSD	0.09
Verbascum thapsus L.	Scrophulariaceae	Gordolobo	HE	LE, ST	IN	RSD	0.02
Parthenium hysterophorus L.	Asteraceae	Hierba Amargosa	HE	EP	DE	IPD, RSD, NSD	0.05
Allionia choisyi Standl.	Nyctaginaceae	Hierba de la Hormiga	HE	LE, ST	IN	GUS	0.01
Epilobium hirsutum L.	Onagraceae	Hierba De San Antonio	HE	LE, ST	DE	NSD	0.01
Hypericum perforatum L.	Hypericaceae	Hierba de San Juan	HE	LE, ST, FL	DE, MA	NSD	0.01
Gutierrezia sarothrae (Pursh) Britton & Rusby	Asteraceae	Hierba de San Nicolas	HE	LE, ST	DE	GUS	0.01
Abutilon coahuilae Kearney	Malvaceae	Hierba del buen día	HE	LE, ST	DE	IPO, IPD	0.02
Oenothera tetraptera Cav.	Onagraceae	Hierba Del Golpe	HE	EP	DE	MCT	0.02
Sphaeralcea angustifolia (Cav.) G.Don	Malvaceae	Hierba del Negro, trompillo	HE	LE, ST	DE	RSD, SST	0.02
Eryngium carlinae F.Delaroche	Apiaceae	Hierba del Sapo	HE	LE, ST, FL	DE	CSD	0.01
Galium mexicanum Kunth	Rubiaceae	Hierba Esculcona	HE	LE	IN	DSD, IPD	0.02
Mentha spicata L.	Lamiaceae	Hierbabuena	HE	LE, ST	IN	DSD, NSD	0.15
Psidium guajava L.	Myrtaceae	Guayaba	AR	LE	DE, IN	CSD	0.02
Ficus carica L.	Moraceae	Higuera	AR	LE	DE	CSD	0.01
Nicotiana glauca Graham	Solanaceae	Hojas de Virginio	SH	LE	IN	NSD, RSD	0.02
Flourensia cernua DC.	Fabaceae	Hojasén	HE	LE, ST	IN, DE	DSD	0.09
Mikania glomerata Spreng.	Asteraceae	Huaco	HE	LE	MA	SST	0.01
Echinocereus pectinatus subsp. Pectinatus	Orchidaceae	Huevo de Toro	SH	ST, FL	DE	DSD	0.01
Peniocereus greggii (Engelm.) Britton & Rose	Cactaceae	Huevo de Venado	SH	ST, RO	SA	CSD	0.01
Hibiscus sabdariffa L.	Malvaceae	Jamaica	HE	FL	IN, DE	GUS	0.02
Zingiber officinale Roscoe	Zingiberaceae	Jengibre	RO	RO	DE	RSD, CSD	0.03
Brickellia cavanillesii (Cass.) A.Gray	Asteraceae	La prodigiosa	HE	ST	DE	SST	0.01
Laurus nobilis L.	Lauraceae	Laurel	AR	LE	DE	MCT, DSD	0.03
Lavandula angustifolia Mill.	Lamiaceae	Lavanda	HE	EP	IN	DSD	0.02
Dracaena trifasciata Baker	Asparagaceae	Lengua de Suegra	CA	LE	MA	GUS, MCT	0.02
Citrus limon (L.) Osbeck	Rutaceae	Limón	AR	LE	DE	RSD	0.02
Agave asperrima Jacobi	Asparagaceae	Maguey de cerro	CA	RO	DE	NSD, CSD, DSD	0.02
Solanum rostratum Dunal	Solanaceae	Mala Mujer	HE	ST	DE	GUS	0.01
Malva sylvestris L.	Malvaceae	Malva	HE	LE	DE	SST	0.01
Chamaemelum nobile (L.) All.	Asteraceae	Manzanilla	HE	EP	DE, IN	SST, GUS, DSD, MCT	0.16
Parthenium incanum Kunth	Asteraceae	Mariola	SH	LE	DE	DSD	0.06
Prosopis glandulosa Torr.	Fabaceae	Mezquite injerto	AR	SH	IN	SST, CDS, NDS	0.03
Moringa oleifera Lam.	Moringaceae	Moringa	HE	LE, SE	DE, IN	CSD, DSD	0.06
Justicia spicigera Schltdl.	Acanthaceae	Muicle	HE	LE, ST	DE	GUS	0.01
Citrus aurantium L.	Rutaceae	Naranjo	AR	LE	DE	RSD	0.02
Azadirachta indica A.Juss.	Meliaceae	Nim	AR	LE, ST	DE	NEP	0.02
Juglans regia L.	Juglandaceae	Nogal	AR	LE	DE	DSD, SST, CSD	0.03
Opuntia ficus-indica (L.) Mill.	Cactaceae	Nopal	SH	EP	IN, MA	DSD, CSD, SST	0.05
Fouquieria splendens Engelm.	Fouquieriaceae	Ocotillo	SH	ST	DE	SST	0.02
Lippia graveolens Kunth	Lamiaceae	Orégano	HE	LE, ST	DE, IN	RSD	0.30
Cyclolepis genistoides D.Don	Asteraceae	Palo Azul	SH	ST	DE	GUS	0.04
Bauhinia forficata Link	Asteraceae	Pata de Res	AR	LE, ST	DE	DSD	0.02
Lophophora williamsii (Lem. ex Salm-Dyck) J.M. Coult.	Cactaceae	Peyote	CA	ST, FL	MA	MCT, CSD	0.08

(*continued on next page*)

Table 2 (*continued*)

Scientific name	Family	Local name	Habit	Parts used	Preparation method	Use categories	Use Value (UV)
Ephedra antisyphilitica Berland. ex C.A. Mey.	Ephedraceae	Pitorreal	SH	ST	IN, DE	GUS	0.09
Mentha pulegium L.	Lamiaceae	Poleo	HE	EP	DE	DSD, SND	0.03
Parkinsonia aculata L.	Fabaceae	Retama o palo verde	SH	LE, ST	DE, IN	GUS	0.02
Rosmarinus officinalis L	Lamiaceae	Romero	HE	LE, FL	MA	SST, DSD,	0.03
Rosa gallica L.	Rosaceae	Rosa de Castilla	SH	FL, LE	TP, DE	DSD, IPD	0.02
Ruta graveolens L.	Rutaceae	Ruda	HE	LE	MA, DE	DSD, GUS, NSD, SST	0.06
Aloe vera (L.) Burm.f.	Xanthorrhoeaceae	Sábila	SU	LE	MA	SST, RSD, DSD	0.20
Salvia officinalis L.	Lamiaceae	Salvilla	HE	EP	DE, IN	DSD, GUS	0.10
Jatropha dioica Sessé	Euphorbiaceae	Sangre de Drago	AR	ST	CH	DSD, GUS, IPD	0.08
Selaginella lepidophylla (Hook. & Grev.) Spring	Crassulaceae	Siempre viva	SU	EP	DE, IN	GUS, SST	0.02
Tamarindus indica L.	Fabaceae	Tamarindo	AR	FR	DE	CSD	0.01
Gymnosperma glutinosum (Spreng.) Less.	Asteraceae	Tatalencho	SH	LE	DE	CSD	0.01
Thymus adamovicii Velen.	Lamiaceae	Tomillo	HE	LE, ST	IN	RSD	0.01
Pouteria sapota (Jacq.) H.E.Moore & Stearn	Sapotaceae	Zapote	AR	LE	IN, DE	CSD	0.02
Casimiroa edulis La Llave	Rutaceae	Zapote Blanco	AR	LE	MA	IPO	0.01

Habit: (SH) shrub, (AR) tree, (HE) herbaceous, (CA) cactus, (SU) succulent, (VE) vegetable, and (RO) root.
Parts Used: (LE) leaves, (RO) root, (ST) stem, (FR) fruits, (FL) floral parts, (EP) entire plant, (SE) seed, (SH) shoots.
Preparation Method: (IN) Infusion, (DE) decoction, (MA) maceration, (SA) salad, (TP) toasted poder, (CH) Chewed.

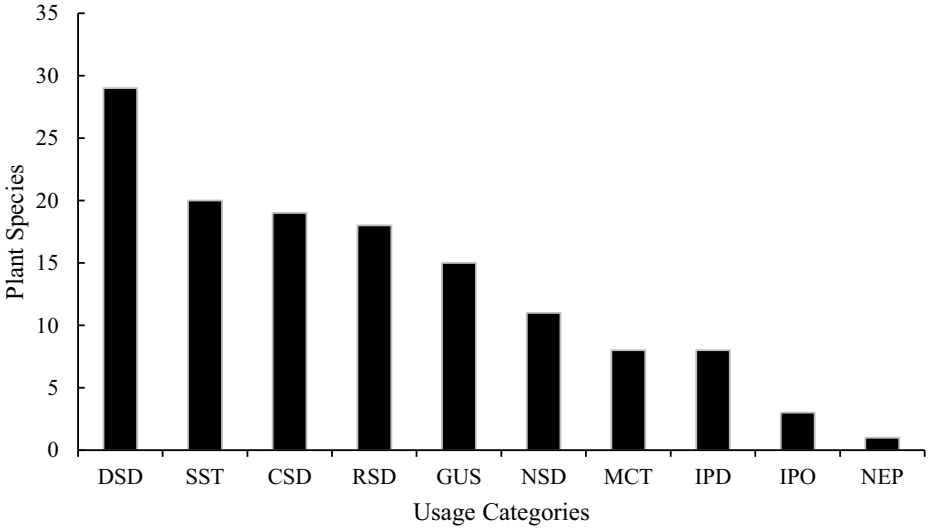

Fig. 2. Most frequently treated diseases in southwest Coahuila state, northeast Mexico. Category of Disease: (DSD) Gastro-intestinal System Diseases; (RSD) Respiratory System Diseases; (SST) Skin, Eye, Ear, Nose, and Oropharynx Diseases; (CSD) Cardiovascular System Diseases; (GUS) Obstetrics, Gynecology, and Urinary-tract Diseases; (MCT) Musculoskeletal and Joint Diseases; (IPD) Infectious Diseases; (NSD) Central Nervous System Diseases; (NEP) Malignant Diseases; (IPO) Immunological, poisoning, and others.

(L.) Mill., *Flourensia cernua* DC. and *Aloe vera* (L.) Burm.f. share some of the highest UV values in both studies; the differences may be due to the long distance between the study regions.

The ICF values show a high level of concordance between the informants and the categorized diseases Respiratory System Diseases (0.80), Skin, Eye, Ear, Nose and Oropharynx Diseases (0.69), Musculoskeletal and Joint Diseases (0.68), Obstetrics, Gynecology and Urinary tract Diseases (0.67) and Gastro-intestinal System Diseases (0.66). The high level of consensus among the informants shows that the ethnobotanical uses of medicinal plants (for treating and preventing these diseases and ailments) continue to treat the prevalent diseases in the study area. These results corroborate that medicinal practices with plants continue to be active in the communities. This result can be attributed to factors such as the difficulty of getting to the hospitals in the big cities; In the study region, there is a sub-health post with less equipped; the closest hospitals are in the cities of "Matamoros" and "Parras de la Fuente," 53 and 76 km away, respectively (Fig. 1). The great distances in the arid zone where the study was conducted have caused people to actively use traditional medicine as an alternative to the modern medicinal system. In addition, easy access to plants is an economic factor that encourages their use. However, according to the communities, modernity is causing a decrease in the use of plants by new generations. In this region, transferring traditional knowledge to new generations could be dangerous (younger generations may not be interested in the traditional healing system).

Table 3
Informant consensus factor (ICF) values for the ailments category.

Category of disease	Nt	Nur	ICF
Respiratory System Diseases (RSD)	18	87	0.80
Skin, Eye, Ear, Nose, and Oropharynx Diseases (SST)	20	63	0.69
Musculoskeletal and Joint Diseases (MCT)	8	23	0.68
Obstetrics, Gynecology, and Urinary tract Diseases (GUS)	15	44	0.67
Gastro-intestinal System Diseases (DSD)	29	83	0.66
Cardiovascular System Diseases (CSD)	19	34	0.46
Infectious Diseases (IPD)	8	13	0.42
Central Nervous System Diseases (NSD)	11	18	0.41

Table 4
FL values for the most named medicinal plants in each category.

Category of disease	Medicinal plants		FL (%)
	Scientific name	Local name	
Gastro-intestinal System Diseases (DSD)	*Flourensia cernua* DC.	Hojasén	100
	Parthenium incanum Kunth	Mariola	100
	Artisia ludoviciana Nutt.	Estafiate	100
	Mentha spicata L.	Hierba Buena	83
	Salvia officinalis L.	Salvilla	58
Respiratory System Diseases (RSD)	*Eucalyptus abdita* Brooker & Hopper	Eucalipto	100
	Bougainvillea berberidifolia Heimerl	Buganvilia	100
	Lippia graveolens Kunth	Orégano	100
Skin, Eye, Ear, Nose, and Oropharynx Diseases (SST)	*Heterotheca inuloides* Cass	Árnica Amarilla	90
	Jatropha dioica Sessé	Sangre de Drago	80
	Aloe vera (L.) Burm.f.	Sábila	58
	Chamelum nobile (L.) All.	Manzanilla	21
Cardiovascular System Diseases (CSD)	*Moringa oleifera* Lam.	Moringa	57
Obstetrics, Gynecology, and Urinary tract Diseases (GUS)	*Cyclolepis genistoides* D. Don	Palo Azul	100
	Ephedra antisyphilitica Berland. ex C.A.Mey.	Pitorreal	100
	Larrea tridentata (Sessé & Moc. ex DC.) Coville	Gobernadora	44
	Chamelum nobile (L.) All	Manzanilla	29
Musculoskeletal and Joint Diseases (MCT)	*Lophophora williamsii* (Lem. ex Salm-Dyck) J.M. Coult.	Peyote	90
	Aloe vera (L.) Burm.f.	Sábila	17
Infectious Diseases (IPD)	*Parthenium hysterophorus* L.	Hierba Amargosa	67

The dialogue with the communities revealed that knowledge about the use of plants is generally transmitted in an unsystematic way through the dialogue of experiences by older people (parents and grandparents) with the new generations. This behavior has already been identified previously in other parts of the world (Angmo et al., 2012; Bolson et al., 2015). The transmission of traditional knowledge will be an interesting factor to evaluate in future research. This rich, popular knowledge may disappear from the unsystematic transmission to new generations.

The FL values for the most named medicinal plants in each category are in accordance with what was reported in plants of the chihuahua desert; *Flourensia cernua* DC. extracts have been investigated in diseases of the gastric system (de Rodríguez et al., 2019); *Artisia ludoviciana* Nutt. popularly known as "estafiate" has been traditionally used to treat Gastro-intestinal System Diseases such as gastritis (Argueta et al., 1994). Recently, Palacios-Espinosa et al. (2021) demonstrated that *A. ludoviciana* Nutt. has gastroprotective and anti-*Helicobacter pylori* activity; *H. Pylori* is the main etiologic agent responsible for gastritis. *Lippia graveolens* Kunth has shown antiviral activity against the human respiratory syncytial virus (HRSV), which causes infections of the lungs and respiratory tract (Pilau et al., 2011). Recently, Torres-León et al. 2020, revealed using molecular docking (*in silico*) that the bioactive compounds found in *Lippia graveolens* Kunth can inhibit the main proteins of the coronavirus that causes COVID-19. *Eucalyptus abdita* Brooker & Hopper has proven effects against colds, influenza, other respiratory infections, rhinitis, and sinusitis (Pereira et al., 2014). According to the search carried out in scientific databases such as Scopus and the Web Of Science, the other plants identified in the present study do not have reports. However, plant species such as *Parthenium incanum* Kunth, *Heterotheca inuloides* Cass and *Parthenium hysterophorus* L. are registered in the library of traditional Mexican medicine (UNAM/INPI, 2009). Although, according to the information consulted there are no scientific studies that support the medicinal properties. Other plants like *Cyclolepis genistoides* D.Don and *Ephedra antisyphilitica* Berland. ex C.A.Mey. have not been registered in scientific publications or information bases, this research may be the first report of the medicinal use of these plants. According to the information provided by the community, the plants of *Cyclolepis genistoides* D.Don "Palo Azul" and *Ephedra antisyphilitica* Berland. ex C.A. Mey. "Pitoreal" have recognized benefits in the treatment of urinary tract infection and kidney stones. These findings can provide new research directions and guidance for further pharmacological and phytochemical studies.

Access to medicines for low-income people is a problem for public health systems in the world. Government entities could use this research to develop policies on the use of medicinal plants (new drugs made from medicinal plants). Medicinal plant-based products can be a sustainable alternative to avoid the irrational use of synthetic drugs. However, strict legal control (to prevent toxic effects or the over-exploitation of plant species) with complete scientific studies must be developed. The development of new scientific research is essential to verify plant species' medicinal properties and efficiency in treating diseases. The plants identified in traditional medicine are potential candidates for developing subsequent ethnopharmacological studies determining their biological properties. The result of future studies would provide compelling support for the clinical use of plants in modern medicine (Chand et al., 2022). Despite the restrictions due to the COVID-19 pandemic, the communities collaborated in the research and showed great interest in feedback. Consequently, we commit to transferring all future research results through medicinal plant workshops and continued collaboration.

This study showed that medicinal plants used in southwest Coahuila, an arid zone in northeast Mexico, have a high potential for valorization. The biodiversity generated by adaptation to difficult climatic conditions can enhance the discovery of potent bioactive molecules. Unfortunately, there is no research in the study area, and few plants are commercially exploited for their pharmacological properties. The sustainable use of biodiversity can allow national pharmaceutical technology to develop, bringing important economic and social benefits to the country. The first step is to register the traditional knowledge of the plants used in traditional medicine. New research may continue to validate the pharmacological potential of medicinal plants for drug generation.

5. Conclusion

The residents of the arid southwestern region of the Coahuila state in northeastern Mexico are rich in ethnomedicinal knowledge. The high level of consensus ensures that medicinal plants continue to be used to treat various diseases, especially respiratory (higher ICF determined). *Lippia graveolens* Kunth "oregano" was the most important plant species with the highest UV determined and is used mainly to treat respiratory diseases (FL = 100 %). *Cyclolepis genistoides* D.Don "palo azul" and *Ephedra antisyphilitica* Berland. ex C.A.Mey. "pitoreal" used by the rural communities in Viesca in the treatment of urinary tract infection and kidney stones has not been reported previously. New investigations can be developed to study the medicinal properties of the identified plants and explore their pharmacological potentials.

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CRediT authorship contribution statement

Cristian Torres-León: Methodology, Project administration, Funding acquisition, Investigation, Data curation, Writing – original draft, Writing – review & editing. **Fernanda Rebolledo Ramírez:** Investigation, Formal analysis, Data curation. **Jorge A. Aguirre-Joya:** Writing – review & editing, Funding acquisition. **Agustina Ramírez-Moreno:** Writing – review & editing, Validation. **Mónica L. Chávez-González:** Writing – review & editing, Investigation. **David R. Aguillón-Gutierrez:** Conceptualization, Writing – review & editing. **Luis Camacho-Guerra:** Software, Visualization. **Nathiely Ramírez-Guzmán:** Writing – review & editing, Investigation. **Salvador Hernández Vélez:** Resources, Funding acquisition, Supervision. **Cristóbal N. Aguilar:** Resources, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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