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DIVERSITY OF MEDICINAL PLANTS USED BY THE "NAHUAXIHUTIL" ORGANIZATION OF TRADITIONAL INDIGENOUS MIDWIVES AND DOCTORS FROM IXHUATLANCILLO, VERACRUZ, MEXICO

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ABSTRACT:

Knowledge of the diversity of medicinal plants used by a certain human group, is key to understanding the relationship between man, plants and nature. In this work, the Shannon-Wiener Diversity Index was applied to determine the diversity of medicinal species in eight different environments collected by 11 midwives that belong to the "Nahuatlxihuitl" Organization of Traditional Doctors and Midwives of Ixhuatlancillo, Veracruz, Mexico. The work is based on an ethnobotanical list that provided a cognitive domain of 92 species ranked according to their importance (knowledge and use). Recorded values of diversity, equitability and richness indicated fairly diverse environments, demonstrating quantitative and qualitative differences in their use, in accordance with practices, habits and availability of those resources. This differentiated use of medicinal resources is analyzed and discussed.

KEY WORDS: Shannon-Wiener Diversity Index, medicinal plants, traditional healers, key informants.

LA DIVERSIDAD DE PLANTAS MEDICINALES UTILIZADAS POR LA ORGANIZACIÓN «NAHUAXIHUTIL» DE DOCTORES Y PARTERAS TRADICIONALES INDÍGENAS DE IXTLAHUANCILLO, VERACRUZ, MÉXICO.

RESUMEN

El conocimiento de la diversidad de las plantas medicinales utilizadas por un determinado grupo humano, es clave para el entendimiento de las relaciones hombre-planta-naturaleza. En el presente trabajo, se aplica el índice de diversidad de Shannon-Wiener, para reconocer la diversidad de especies en ocho distintos ambientes en donde se colectan las especies medicinales utilizadas por 11 parteras integradas a la Organización de Médicos y Parteras Tradicionales "Nahuatlxihuitl" de Ixhuatlancillo, Veracruz, México. El trabajo se basa en la lista etnobotánica que aportó un dominio cognitivo de 92 especies ordenadas de acuerdo con su prioridad de cita (conocimiento y uso). Se registraron valores de diversidad, equidad y riqueza, que indican ambientes medianamente diversos, manifestando diferencias cuantitativas y cualitativas sobre el uso diferenciado de los recursos de acuerdo con usos, costumbres y disponibilidad. Se analiza y discute el uso diferenciado del recurso medicinal.

PALABRAS CLAVE: Índice de diversidad Shannon-Wiener, plantas medicinales, curanderos, informantes clave.

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INTRODUCTION

The intimate relationship that has always existed between human beings and plants has allowed us to take advantage of the benefits they provide in order to satisfy a broad range of goods and services, such as healthcare, food, clothing, construction, medicines, ritual and religious practices (Kvist *et al.*, 1998; Hernández, 2001; Toledo *et al.*, 2001; Ramihantaniariyo *et al.*, 2003; Arango, 2004; Tzasna *et al.*, 2005; Secretti and Auler, 2006; Bermúdez *et al.*, 2005; Stockdale, 2005; Hurtado and Aguilar, 2006). In Mexico, the biological wealth and cultural diversity, as well as the long history of its land with respect to population, have translated into the development of a vast ethnobotanical tradition. This includes the knowledge, use and handling of a great number of plant species through complex forms of interaction between local communities and their plant environment (Caballero and Cortés, 2001); among these are the medicinal plants, which have a relevant role. It is important to note that these plants are taken from spaces that are contrasting, both ecologically and economically useful (arable lands, plots, etc.) (Hersh-Martínez and Fierro, 2000).

Plant-human interactions are complex and variable phenomena in the different ecological and cultural regions of the country occur. The comparative analysis of the ethnobotany of different ethnic groups in Mexico shows that in spite of the ecological and cultural diversity of the regions, there are common tendencies in forms of perception, classification, use and handling of plant resources by the indigenous and rural populations. The existing ethnological evidence shows that Mexican indigenous groups have developed a broad and detailed knowledge of their plant environment. This knowledge is the result of common forms of approaching the discontinuities in the plant world, which provides a starting point for analysis, both at the level of species, as well as of processes and forms of ecological organization. In the first case, studies developed by Berlin in the 70's have suggested the existence of common principles in the way of knowing, naming and classifying the discontinuities of the natural world among traditional societies, independently of their particular language and culture (Caballero and Cortés, 2001).

The study of these different ecological spaces is necessary since the main problem faced by traditional knowledge of medicinal plants is the loss of habitats due to changes in land use and the subsequent deterioration of biological and cultural diversity. Thus, there is a need to study the condition of medicinal species in their environments, from an ecological viewpoint, as an important part of the biological knowledge of indigenous groups in Mexico. As an example, we have the works of Martínez-Alfaro (1970) in Tuxtepec, Oaxaca; that of Sanabria (1986), in Yucatan; Martínez-Alfaro (2001), Toledo *et al.* (2001) and Cabrera *et al.* (2001), among the Mazatecan Indians and Ramos-Hernández *et al.* (2007) for the Los Tuxtlas region, in Veracruz, among others. Of course, the present use of diversity indexes allows for more systematic studies, as well as for greater detail and depth in these studies.

The study of medicinal plant diversity, with an ecological focus, contributes to the understanding of interactions between human beings and their environment and it's useful in explaining the use and management of medicinal resources of a certain group. This is done comparing the diversity of reported useful plants (including medicinal plants), considering the relative abundance of the plants, based on the number of times they were referred and the species-area relationship (Prance *et al.*, 1987; Boom, 1990; Begossi, 1996).

In Mexico, studies by Canales-Martínez *et al.* (2006), Hurtado and Aguilar (2006) and Matías (2009), show that the use of the Shannon-Wiener Diversity Index allows the user to infer whether the difference in diversity of the used plants depends on the use category, gender or age of user and they mention as well that women and older people tend to name more uses for the diverse plants than men and younger people. This diversity index has been broadly used in ethnobotanical works; an example of this is the study of lianas used by indigenous people from the Ecuatorian Amazon region and the relationship between a taxon and its ecological abundance and importance (Berkes and Folke, 1992; Begossi and Richardson, 1992; Begossi and Richardson, 1993; Begossi, 1995; Begossi, 1996; Hurtado and Aguilar., 2006).

Based on the above, this work has as its purpose, to record how local knowledge of medicinal plants is distributed within a group of 11 midwives that belong to the OMIT **"*Nahuatlxihuitl*"**, an organization of traditional doctors and midwives. This is based on the Shannon-Wiener ecological diversity index and validation of the use and knowledge of these medicinal species in different environments.

MATERIALS AND METHODS

Description of the Study Area. Ixhuatlancillo municipality (this is the diminutive of Ixhuatlán, which in Nahuatl means "place of the green corn leaves") is located in the highlands, at the foothills south of the ***Citlaltepetl*** volcano (Pico de Orizaba National Park), in the central zone of the state of Veracruz. This is between 18º

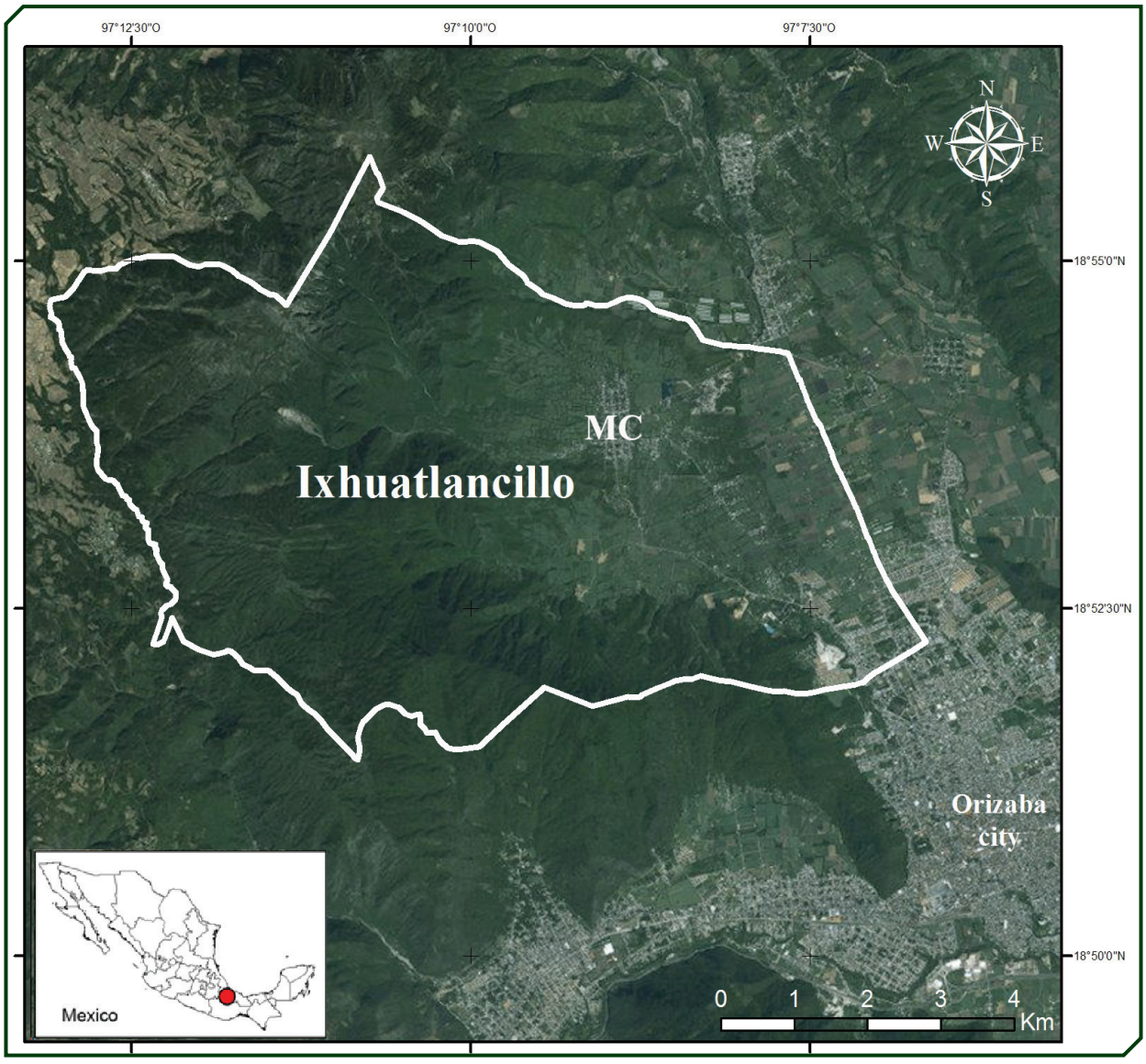

Figure 1. Study area in central Veracruz. Ixhuatlancillo and its municipal capital (MC)

51´59" and 18º 55'0" north latitude and 97º 13' 30" and 97º 09´ 30" west longitude at 1,460 meters above sea level (Figure 1). To the north, it is bounded by the La Perla and Mariano Escobedo municipalities; to the west with Orizaba and Mariano Escobedo; Orizaba, to the south with Rio Blanco and Nogales and to the west with Nogales and Maltrata. The municipality is formed by 18 localities distributed along a small 39.48 km2 area. The zone is watered by meltwater streams coming from the Pico de Orizaba, which form the Blanco river. Soils are mostly of the lithosol type, with abundant rocks, attle ("tepetate") and hard Bk and K horizons/carbonate rich horizons ("caliche") (INEGI, 2001).

The main communities in the municipality are Rancho San Isidro (seat of the municipal government or municipal capital), Rancho Pala and Rancho El Cristo. This municipality is considered to be highly marginalized (INEGI, 2000). The climate, according to the Köppen classification system, modified by Soto and García (1989), is (A) C (m), semi-hot humid, with an average temperature higher than 18º C and a mean annual rainfall of 1,500 mm.

Agriculture is the main productive and economic activity in the municipality. The main agricultural products are corn, sugar cane, coffee and ornamental flowers. In addition, there are 220 rural production units with forestry

Table 1. Description of the collection localities in the Ixhuatlancillo Municipality, Veracruz. Detailed information on the collected flora can be found in Gheno-Heredia *et al.* (2011). (*) http://mexico.pueblosamerica.com/ixhuatlancillo/localidades/ (**) Rzedoswki (1986)

LOCALITY	LOCATION WITHIN THE MUNICIPALITY (*)	ALTITUDE ABOVE SEA LEVEL (MASL)	VEGETATION TYPE (**)
1) SECTOR 1	Municipal capital	1420	Secondary vegetation derived from Tropical Sub-perennial Forest and the Mesophilous Mountain Forest.
2) SECTOR 3	Municipal capital	1420	Secondary vegetation derived from the Tropical Sub-perennial Forest and the Mesophilous Mountain Forest
3) CHORRO DE AGUA	Southwest	1494	Mesophilous Mountain Forest and highland Coniferous Forest. Secondary Vegetation derived from Mesophilous Mountain Forest.
4) RANCHO PALA	Southeast-southwest	From 1278 to 1403	Tropical Seasonal Evergreen Forest and Riparian Vegetation
5) POTRERO ATOLÁ OR RANCHO DE ATOLÁ	Northwest	1445	Fields/pastures and secondary vegetation derived from Mesophilous Mountain Forest, Tropical Evergreen Seasonal Forest and Riparian Vegetation.
6) CERRO DE TEPOXTLÁN	Northeast	1480	Tropical Evergreen Seasonal Forest, moderately preserved.
7) SAN JOSÉ DURAZNAL	Northwest of the municipality	1488	Secondary vegetation derived from Mesophilous Mountain Forest and Riparian Vegetation.
8) SAN ISIDRO OR RANCHO SAN ISIDRO	To the northeast	1360	Riparian vegetation and vegetation derived from Tropical Evergreen Seasonal Forest and relict Mesophilous Mountain Forest.

activities for wood products. Other economic activities in the municipality are rural cattle production (double purpose cattle, hogs and goats, to a lesser degree) and considerable mineral deposits, such as sand and clay.

The original vegetation in the area is confined to the hills that surround the municipal capital, since its rugged landscape makes it difficult to transform it into cultivated land; nevertheless, some slopes and areas with a low incline do not escape cultivation. The main types of vegetation in the municipality are forests of conifers in the highlands, tropical sub-deciduous forests and some relict mesophilous mountain forests (Rzedowski, 1986) (Table 1).

Description of the Participating Group. "*Nahuatlxihuitl*", the Organization of Indigenous Doctors and Midwives (OMIT) from Ixhuatlancillo, Veracruz, is formed by 19 traditional indigenous doctors (TID) and midwives whose main language is Nahuatl. They are responsible for providing primary health care in the municipality. From the total members of the OMIT, 11 midwives were selected, all of them women, that participated as key informants in the present study. They are between 26 and 86 years old, with a work experience between three to 40 years of service as traditional midwives and doctors.

The Organization is recognized within the Training Program for Traditional Midwives and Reproductive Health Care of the IMSS-Oportunidades Program (Mexican Social Security Institute), belonging to the South-Veracruz Regional Office with headquarters in Orizaba, Veracruz (Velázquez-Reyes, 2005). It is part of the Regional Support Group for Traditional Indigenous Medicine from central Veracruz (GRAMIT-centro).

Procedure. The investigation was carried out from December, 2007 to February, 2009. Once the project was presented to the organization's assembly in plenary, the members determined who would be, due to their knowledge and experience, the key informants of the work and who would also participate in the collection of medicinal species. According to the above, 11 of the organization's members, between 26 and 86 years old, were appointed. Eight areas selected by the informants were evaluated as areas for medicinal plant collection in the municipality of Ixhuatlancillo, Veracruz, Mexico. The areas were, areas 1 and 3 (of the municipal capital) and the localities in the zones near this area: Chorro de Agua to the southeast; Rancho Pala to the southeast-southwest; Potrero Atolá and Cerro de Tepoxtlán to the northeast; San José Duraznal to the northeast and San Isidro to the east.

All the collected plant species were prepared according to Lot and Chiang (1989) in order to be included in the medicinal plant collection of "Dr. Jerzy Rzedoswki Rotter", CORU Herbarium of the School of Biological, Agriculture and Livestock Sciences at the University of Veracruz in Cordoba, Veracruz (Universidad Veracruzana). The information collected on the field was processed in Windows Excel sheets, 1997-2003. The species mentioned by the informants were recorded on lines and the information of each species was placed on columns.

Each one of the individual records was considered a species mentioned by an informant. All references, according to Signorini *et al.* (2009), were complemented with the scientific name, botanical name, as well as local name(s), part(s) of plant(s) that is/are used, category of secondary use, manner of use, habitat and medicinal information.

The categories of medicinal use, following PAHO recommendations (Panamerican Health Organization, OPS, 2007), were 18 secondary categories for medicinal use (defined as the detailed use within a more general medicinal category); for example, conditions and diseases of the digestive system, subcategory, stomach ache, diarrhea, cold or hot diarrhea, among others.

Manner of use was a brief description of how the plants are used, preparations and specific characteristics.

In all cases, data from references was recorded and the order of priority in direct reports was obtained from the previous ethnofloristic inventory (Gheno-Heredia *et al.*, 2011,). In no case were fixed areas marked. All calculations were done based on the number of reported species and the total number of references for each species and each locality

Calculation of diversity using the Shannon-Wiener Index. This diversity index has been broadly used in ethnobotanical works, starting with dominant species in the different environments, taking into account richness and equitability. Taking the proportion of individuals of the ith species (in this case the number or references or informants for each species) and calculating according to the formula:

$$H' = -\sum_{i=1}^{R} p_i \ln p_i$$

Where pi is the proportion of individuals of the *ith* species (here the number of citations or informants per species) and n is the number of all recorded species, following Begossi (1996).

For this index, the equitability value or evenness may be figured in terms of the proportion with respect to the maximum possible value; this is in order to carry out comparisons between sites, based on the relationship given by H'/ Hmax', where Hmax'= ln S, being S the total number of species.

Like this, the index takes into account the number of species that are present in the study area (richness of species) and the relative number of individuals from each one of these species (abundance).

RESULTS AND DISCUSSION

The fact that all the interviewees were women and traditional midwives highlights the importance of women in health and in the life of the community. The key informants of the present study were between 26 and 86 years old, most of them between 35 and 60 years old, with a work experience between 3 to 40 years as midwives or traditional doctors.

The Shannon-Wiener Index (Table 2) was determined for the studied ecological areas. The diversity index for the whole area was 4.2 and the equitability value (H'/ Hmax') was 0.96. According to Begossi (1996), this shows a high diversity value, less than 5.95.

Table 2. Shannon-Wiener Diversity Index for medicinal plants in the collection areas.

COLLECTION AREA	NUMBER OF INFORMANTS	NUMBER OF REPORTED SPECIES (S=RICHNESS)	NUMBER OF REFERENCES	SHANNON-WIENER INDEX (H')	EQUITABILITY INDEX (H'/ HMAX')
Sector 1	11	32	527	3.28	0.83
Sector 3	11	11	66	2.24	0.85
Chorro de Agua	11	33	561	3.31	0.83
Rancho Pala	11	48	1176	3.68	0.83
Potrero Atolá	11	19	190	2.77	0.84
Cerro de Tepoxtlán	9	3	6	1.01	0.91
San José Duraznal	8	25	325	3.04	0.83
San Isidro	11	20	210	2.82	0.84

The highest values of richness and equitability correspond to the zones with the greatest number of references per species, while the lowest index (1.01) was for the zone that only reported three species. However, this does not mean that only those species exist, but that the informants only refer those species taken from that zone. This generally could show preference for certain areas, as stated by Toledo and Barrera-Bassols (2008), due to cultural more than ecological reasons.

On the other hand, areas such as Potrero-Atolá and San Isidro, had an index of 2.7, being areas where the vegetation was greatly disturbed, and this, according to Stepp (2004), is due to the fact that disrupted areas which are next to areas that are better preserved, are preferred spaces for obtaining diverse satisfiers from natural resources. In spite of the fact that eight collection zones share environmental characteristics, within them the species had differences in the cultural importance granted by the local organization. This can be explained, since biological diversity is intimately related to the cultural diversity of the people and the cultures themselves are the ones that give added value to natural resources and to the processed products used to satisfy a broad array of goods and services, such as healthcare, food, clothing, construction, medicine and ritual and religious practices (Toledo *et al*., 2001; Ramihantaniariyo *et al*., 2003; Arango, 2004; Tzasna *et al*., 2005; Bermúdez *et al*., 2005; Secretti and Auler, 2006; Stockdale, 2005; Hurtado and Aguilar, 2006; Toledo and Barrera-Bassols, 2008; Toledo and Barrera-Bassols, 2009). The above is in total agreement with this study, since the informants and their group use, name, catalogue and collect medicinal species from very diverse sites that are culturally relevant to them.

Of the total number of species and references, for each of the collection areas (Table 3), the best represented botanical families were: Asteraceae with 12 species, Solanaceae and Lamiaceae, with five species each. According to the number of recorded species, the eight most important families contributed 42.5% of the total number of species.

The predominance of the Asteraceae family coincides with what was mentioned by Moerman *et al.* (1999) with respect to the fact that the largest families are best represented and, according to Rzedowski and Rzedowski (2005), the Asteraceae is one of the largest families of vascular plants, as far as the number of genera and species, besides the fact that several of its species have secondary metabolites. They also coincide with the most important families of "weeds", which, according to Villegas (1969), and mentioned by Hurtado and Aguilar (2006), highlights the "weed-like" characteristics of many species used as medicine, which thrive in disturbed zones such as fields and pastures, edges of roads, stream banks and on rocks, among other places. This is logical if we consider that 86.3% of the recorded species are found in this type of zones and only 13.7% correspond to species that were "domesticated" or "promoted" in patios and plots ("solares").

The medicinal plants of Ixhuatlancillo are especially used because of their cultural importance, for self-consumption and some are prescribed during family or community consultations, but not in commercial activities. However, according to Galeano (2000), the selective extraction and

Table 3. Main botanical families per number of references mentioned by key informants from Ixhuatlancillo, Veracruz.

	SPECIES	NUMBER OF MENTIONS
1	*Ageratum houstonianum* P. Mill.	56
2	Ricinus communis L.	44
3	*Sida rhombifolia L.*	42
4	*Lepidium virginucum*L.	40
5	*Acalypha arvensis* Poepp. & Endl.	36
6	*Cestrum nocturnum* L.	33
7	*Chenopodium ambroisoides* L.	31
8	*Commelina diffusa* Burm. F	27
9	*Plantago lanceolata* L.	25
10	*Psidium guajava L.*	24
11	*Urtica urens* L.	22
12	*Urtica mexicana* Liebm.	22
13	*Ocimun seolli* Benth.	21
14	*Polygonum acuminatum Kunth.*	20
15	*Equisetum hyemale L.*	20
16	*Sambucus nigra var. canadensis (L.) Bolli*	18
17	*Erytrina americana L.*	18
18	*Ruta graveolens* L.	16
19	*Platanus mexicana* Moric.	15
20	*Leucaena leucocephala* (Lam) de Wit.	15
21	*Iresine diffusa* Humb. & Bonpl.ex. Willd.	15
22	*Cuscuta corymbosa* Ruiz *et.* Pavon	15
23	*Brugmansia x candida Pers.*	15
24	*Stellaria ovata Willd. Ex Schltdl.*	14
25	*Rannunculus petiolaris* Kunth ex DC.	14
26	*Eupatorium morifolium* Mill.	14
27	*Verbena litoralis* Kunth	12
28	*Taraxacum officinale* F.H. Wigg	12
29	*Salvia polystachia* Ort.	12
30	*Polypodium aureum L.*	12
31	*Chenopodium sp.*	11
32	*Bacopa procumbens* (Miller) Greenman	11
33	*Tagetes filifolia* Lag.	10
34	*Piper umbellatum L.*	10
35	*Piper sanctum* (Micq) Schldl.	10
36	*Liquidambar macrophylla* Oersted	10
37	*Kalanchoe pinnata* Pers.	10
38	*Cestrum sp.*	10
39	*Oxalis corniculata* L.	9

Table 3. Cont.

	SPECIES	NUMBER OF MENTIONS
40	*Datura stramonium L.*	9
41	*Bidens pilosa* L	9
42	*Struthanthus quercicola* (Schelecht. & Cham)Blume	8
43	*Selaginella lepidophyla* Spring.	8
44	*Plantago major* L.	8
45	*Plantago australis* L.	8
46	*Senecio salignus DC*	7
47	*Junglans* sp.	7
48	zacate p/ leche o zacate chichi	6
49	*Salvia tiliifolia* Vehl.	6
50	*Rumex obtusifolia* L.	6
51	*Persea americana* Miller	6
52	*Nephrolepis pectinata* (Willd.) Schott	6
53	*Cirsium mexicanum* DC.	6
54	*Amaranthus viridis* L.	6
55	*Polygala paniculata* L.	5
56	*Malva parvilfora* L.	5
57	*Titonia diversifolia* (Hemsl.) A. Gray	4
58	*Pseudoelephantopus spicatus* (B. Juss. Ex Aubl.) Rohr. Ex Glisson	4
59	*Polypodium sp.*	4
60	*Phytolacca icosandra* L.	4
61	*Mimosa albida* Humb. & Bonpl. ex Willd.	4
62	*Mentha rodindifolia* (L.) Huds.	4
63	*Fragaria mexicana* Schltr.	4
64	*Crataegus pubescens* (Kunth) Steudel	4
65	*Ageratina sp.*	4
66	*Sphaeropteris horrida* (Liebm.) R.M. Tryon	3
67	*Solanum torvum* Sw.	3
68	*Smilax dominguensis* Willd.	3
69	*Euphorbia cotinifolia* L.	3
70	*Artemisia ludiviciana* Nutt.	3
71	*Smilax cordifolia* Humb. & Bonpl.	2
72	*Siparuna andina* (Tull.) A. DC	2
73	*Physalis gracilis* Miers.	2
74	*Phaseolus coccineus* L.	2
75	*Onothera rosae* L'Hr.ex Aiton	2
76	*Malvaviscus arboreus* Cav.	2
77	*Citrus sinensis* (L.) Osbeck	2
78	*Buddleia americana* L.	2

Table 3. Cont.

	SPECIES	NUMBER OF MENTIONS
79	*Bocconia frutescens* L.	2
80	*Arundo donax* L.	2
81	*Arthrostemma ciliatum* Pav. Ex D. Don	2
82	*Sapium nitidum* Alain	1
83	*Mousonia deppeana* (Schlecht. & Cham) Hanst.	1
84	*Leonorus sibiricus* L.	1
85	*Lantana camara* L.	1
86	*Gnapaleum luteo-album* L.	1
87	*Fraxinus velutina* Torr.	1
88	*Eichhornia crassipes* (Mart.) Solms	1
89	*Citrus sp.*	1
90	*Annona globiflora* L.	1
91	*Amaranthus hibridus* L.	1
92	*Ageratum sp.*	1

over-exploitation of plants could happen in some collection areas, since the organized midwives from Ixhuatlancillo organization recognize special environments for species such as *Ageratum houstonianum* and *Lepidium virginicum*. According to the last author, over-exploitation may happen in subsistence activities in different categories of use. This same author proposes that the influence of ecological characteristics of the areas where the resources are obtained, may be used as a tool to evaluate the impact of use on the population of some species and families.

All the studies carried out by other authors in different environments and with different human groups show the need to carry out an adequate management of habitats where medicinal plants are collected, since some species may disappear (Paz and Miño *et al*., 1991; Phillips and Gentry, 1993a and b).

In this study, species were reported from preserved, as well as from modified environments (Table 4). From the areas with less disturbance, the following stand out: Rancho Pala (RP), Chorro de Agua (CHA) and San José Duraznal (SJDZ), which contributed with the greatest number of species and references. The case of Sector 1 is relevant, since being an area that is located within the municipal capital, it presents a great number of species and references. This is due to the fact that in this area, there are many "traspatios" or backyards (small areas next to the house) and "solares" or plots (areas measuring 1 to 3 hectares, adjacent to the house), which are rich in medicinal species that are tolerated or promoted.

In the case of preserved environments, we can see that the traditional midwives, members of the "***Nahuatlxihuitl***" organization search for medicinal species that are culturally relevant in wooded zones, above all the arboreal species such as *Liquidambar macrophylla* Oersted and *Sapium nitidum* Alain, as well as *Smilax dominguensis* Willd, which are preferably found in the moderately preserved areas. The above coincides with what was mentioned by Kvist *et al*. (1998), for some very select species, such as those used for women's ailments, which are preferably collected in the forest, or with what was said by Albuquerque and Pavia-de Lucena (2005), who stated that, in addition to the cultural reasons, such as recognition and classification of the main groups of ailments and diseases, there are preferred ecological areas for the collection of these species. Both authors mention the importance of these cultural reasons, linked to the manner in which these resources are used.

On the other hand, in another area, such as Potrero Atolá, several species of grasses (gramineous plants) may be found, which are used for feeding cattle, but without medicinal use. In the case of San Isidro, where medicinal plants are found, the interviewees stated that the zone was rarely visited because it was "far away" from their homes and they didn't "like" to go all the way over there, except when there was no other alternative, like if they needed very specific plants such as "gordolobo-llorón" (*Bocconia frutescens* L.), which grows well in that place.

Table 4. Species richness per collection area.

	SECTOR 1		SECTOR 3
1	*Ricinus communis* L.	1	*Cestrum nocturnum* L.
2	*Urtica mexicana* Liebm	2	*Urtica urens* L.
3	Chenopodium sp.	3	*Ageratum houstonianum* P. Mill.
4	*Bacopa procumbens* (Miller) Greenman	4	*Ocimum seolli* Benth.
5	*Chenopodium ambroisoides* L.	5	*Sida rhombifolia* L.
6	*Lepidium virginicum* L.	6	*Plantago lanceolata* L.
7	*Acalypha arvensis* Poepp. & Endl.	7	*Pseudoelephantopus spicatus* (Juss. ex Aubl.) Rohr ex Gleason
8	*Commelina diffusa* Burm. f.	8	*Plantago australis* L.
9	*Ageratum houstonianum* P. Mill.	9	*Platanus mexicana* Moric.
10	*Ruta graveolens* L.	10	*Tagetes filifolia* Lag.
11	*Eupatorium morifolium* Mill.	11	*Sphaeropteris horrida* (Liebm.) R.M. Tryon
12	*Ocimum seolli* Benth.		
13	*Sida rhombifolia* L.		
14	*Verbena litoralis* Kunth		
15	*Salvia polystachia* Cav.		
16	*Sambucus nigra var. canadensis* (L.) Bolli		
17	*Brugmansia candida* Pers.		
18	*Kalanchoe pinnata* Pers.		
19	*Cuscuta corymbosa* Ruiz *et.* Pavon		
20	Polypodium sp.		
21	*Phytolaca icosandra* L.		
22	*Plantago major* L.		
23	*Amaranthus viridis* L.		
24	*Taraxacum officinale* F.H. Wigg		
25	*Bidens pilosa* L.		
25	*Ranunculus petiolaris* Kunth ex DC.		
27	*Rumex obtusifolia* L.		
28	zacate chichi		
29	*Annona globiflora Schldl.*		
30	*Leonorus sibiricus* L.		
31	*Malva parviflora* L.		
32	*Buddleia americana* L.		
	CHORRO DE AGUA		**RANCHO PALA**
1	*Cestrum nocturnum* L.	1	*Cestrum nocturnum* L.
2	*Ricinus communis L.*	2	*Ricinus communis L.*
3	*Chenopodium ambroisoides* L.	3	*Lepidium virginucum*L.
4	*Lepidium virginucum* L.	4	*Acalypha arvensis* Poepp. & Endl.
5	*Acalypha arvensis* Poepp. & Endl.	5	*Psidium guajava L.*
6	*Commelina diffusa* Burm. f.	6	*Ageratum houstonianum* P. Mill.
7	*Ageratum houstonianum* P. Mill.	7	*Sida rhombifolia L.*
8	*Sida rhombifolia L.*	8	*Senecio salignus* DC.
9	*Ocimum seolli* Benth.	9	*Stellaria ovata* Willd. Ex Schltdl.
10	*Eupatorium morifolium* Mill.	10	*Sambucus nigra var. canadensis* (L.) Bolli
11	*Erithryna americana* L.	11	*Verbena litoralis* Kunth

Table 4. Cont.

	CHORRO DE AGUA		RANCHO PALA
12	*Plantago lanceolata* L.	12	*Erytrina americana* L.
13	*Leucaena leucocephala* (Lam) de Wit.	13	*Nephrolepis pectinata* (Willd.) Schott.
14	*Piper sanctum* (Micq) Schldl.	14	*Salvia tilifolia* Vehl.
15	*Cuscuta corymbosa* Ruiz *et.* Pavon	15	*Persea americana* Mill.
16	*Piper umbellatum* L.	16	*Salvia polystachia* Cav.
17	*Polypodium aureum* L.	17	*Cuscuta corymbosa* Ruiz *et.* Pavon
18	*Plantago australis* L.	18	*Polygonum acuminatum* Kunth.
19	*Taraxacum officinale F.H. Wigg*	19	*Plantago lanceolata* L.
20	*Platanus mexicana* Moric.	20	*Iresine diffusa* Humb. & Bonpl. ex Willd.
21	*Ranunculus petiolaris* Kunth	21	*Piper sanctum* (Micq) Schldl.
22	*Oxalis corniculata* L.	22	*Piper umbellatum* L.
23	*Amaranthus viridis* L.	23	*Brugmansia candida* Pers.
24	*Cirsium mexicanum* DC.	24	*Leucaena leucocephala* (Lam) de Wit.
25	*Crataegus pubescens* (C. Presl) C. Presl	25	*Malva parvilfora* L.
26	*Selaginella lepidophylla* Spring.	26	*Polypodium aureum* L.
27	*Citrus sinensis* (L.) Osbeck	27	*Mentha rodindifolia* (L.) Huds.
28	*Rumex obtusifolia* L.	28	*Artemisia ludiviciana* Nutt.
29	*Tagetes filifolia* Lag.	29	*Bidens pilosa* L.
30	*Fragaria mexicana* Schltdl.	30	*Oxalis corniculata* L.
31	*Siparuna andina* (Tul.) A. DC.	31	*Platanus mexicana* Moric.
32	*Solanum torvum* Sw.	32	*Taraxacum officinale* F.H. Wigg
33	*Sphaeropteris horrida* (Liebm.) R.M. Tryon	33	*Mimosa albida* Humb. & Bonpl. ex Willd.
		34	*Tithonia tubiformis* (Jacq.) Cass.
		35	*Malvaviscus arboreus* Cav.
		36	*Smilax cordifolia* Humb. & Bonpl.
		37	Zacate p/ leche o zacate chichi
		38	*Oenothera rosea* L´Hér. ex Ait.
		39	*Physalis gracilis* Miers.
		40	*Cirsium mexicanum* DC.
		41	*Tagetes filifolia* Lag.
		42	*Arundo donax* L.
		43	*Fragaria mexicana* Schltdl.
		44	*Amaranthus hibridus* L.
		45	*Fraxinus velutina* Torr.
		46	*Eichhornia crassipes* (Mart.) Solms
		47	*Sphaeropteris horrida* (Liebm.) R.M. Tryon
		48	*Buddleia americana* L.
	POTRERO ATOLA		**CERRO TEPOXTLAN**
1	*Commelina diffusa* Burm. f.	1	*Psidim guajava* L.
2	*Ageratum houstonianum* P. Mill.	2	*Leucaena leucocephala*(Lam) de Wit.
3	*Psidium guajava* L.	3	*Smilax dominguensis* Willd.
4	*Sida rhombifolia* L.		
5	*Stellaria ovata* D.F.K. Schltdl.		
6	*Polygonum acuminatum* Kunth.		
7	*Liquidambar macrophylla* Oersted.		

Table 4. Cont.

	POTRERO ATOLA	CERRO TEPOXTLAN
8	*Polygala paniculata* L.	
9	*Iresine diffusa* Humb. et Bonpl. ex Willd	
10	*Struthanthus crassipes*(Oliv.) Eichler	
11	Xihuapaxihuitl	
12	*Ranunculus petiolaris* Kunth	
13	*Bidens pilosa* L.	
14	Zacate chichi o zacate p/ leche	
15	*Mimosa albida* Humb. & Bonpl. ex Willd.	
16	*Arthrostemma ciliatum* Pav. ex D. Don	
17	*Sapium nitidum* (Monach.) Lundell	
18	*Moussonia deppeana* (Schlecht. & Cham.) Hanst.	
19	*Siparuna andina* (Tul.) A. DC.	

	SAN JOSÉ DURAZNAL		SAN ISIDRO
1	*Urtica mexicana* Liembm.	1	*Urtica urens* L.
2	*Ricinus communis* L.	2	*Lepidium virginicum* L.
3	*Acalypha arvensis* Poepp. & Endl.	3	*Chenopodium ambrosioides* L.
4	*Ageratum houstonianum* P. Mill.	4	*Ageratum houstonianum* P. Mill.
5	*Ruta graveolens* L.	5	*Liquidambar macrophylla* Oersted
6	*Juglans sp.*	6	*Iresine diffusa* Humb. & Bonpl. ex Willd.
7	*Sida rhombifolia* L.	7	*Kalanchoe pinnata* Pers.
8	*Sambucus nigra var. canadensis* (L.) Bolli	8	*Brugmansia candida* Pers.
9	*Erythrina americana* L.	9	*Plantago lanceolata* L.
10	*Polygonum acuminatum* Kunth.	10	*Struthanthus crassipes*(Oliv.) Eichler
11	*Iresine diffusa* Humb. Et Bonpl. Ex Weilld.	11	*Plantago major* L.
12	*Plantago lanceolata* L.	12	*Platanus mexicana* Moric.
13	*Plantago australis* L.	13	*Bocconia frutescens* L.
14	*Polypodium aureum* L.	14	*Tithonia tubiformis* (Jacq.) Cass.
15	*Oxalis corniculata* L.	15	*Ranunculus petiolaris* Kunth
16	*Taraxacum officinale* F.H. Wigg.	16	*Tagetes filifolia* Lag.
17	*Ranunculus petiolaris* Kunth.	17	*Lantana camara* L.
18	*Platanus mexicana* Moric.	18	*Phaseolus coccineus* L.
19	*Selaginella lepidophyla* Spring.	19	"Shenetiki"
20	*Fragaria mexicana*Schltdl.	20	*Solanum torvum* Sw.
21	*Cirsium mexicanum* DC.		
22	*Crataegus pubescens* (Kunth) Steudel.		
23	*Rumex obtusifolia* L.		
24	*Tagetes filifolia* Lag.		
25	*Solanum torvum* Sw.		

There is a high correlation between areas, the number of species and the number of mentioned species (R^2= 0.98). Thus, it is acknowledged that a group of medicinal plants obtained by the 11 traditional midwives group, from preserved environments up to very modified ones, including of course gardens, patios, backyards, markets, and community plots, or those purchased by neighbors and relatives within the inhabited zones, are species whose cultivation has been promoted, avoiding the collections in far-away places. This is in agreement with what was reported by Galeano (2000), Marín-Corba *et al*. (2005), Secretti and Auler (2006), and Canales-Martínez *et al*.

(2006). However, there are also species that grow in the "intermediate" areas, between preserved and secondary vegetation. In Ixhuatlancillo, 19 and 20 species were recorded that corresponded to these areas; this agrees with what was reported by Mesa-Jiménez (1996), and Castaneda and Stepp (2007), with respect to the fact that edges of vegetation are areas that contribute to a great wealth of species to human groups, who look for useful plants for precise ecological reasons, as well as for cultural ones, in these transition zones between the naked ground and the preserved vegetation. It is also a fact that collection zones for medicinal plants are frequently isolated areas surrounded by land that is used for agriculture and cattle farming.

Nevertheless, we must not forget that often, users of this resource would rather use species from particular zones. This is part of what Toledo (2002) and Toledo and Barrera-Bassols (2009) would place in the context of the cosmos-corpus-praxis, stating that tradition shows that some species are more effective than others as a function of the area in which they grow. This directs the search for these species towards specific zones, even in other municipalities, as observed by Pinedo-Vásquez *et al*. (1990), Phillips and Gentry (1993 a) and Galeano (2000).

Like this, the presence and differentiated references of medicinal species used by the participant traditional midwives, validate the use and specific knowledge they have, given that, even when the sites have a similar diversity, they contribute plants in different manners. The distribution of this knowledge, more or less homogenous, depends in many cases on the age of the informants and on their rootedness to the study area or municipality. In this way, the information recorded in Ixhuatlancillo has a positive correlation between the age of the informants and the number of species that were reported or mentioned (R^2= 0.97). This may reflect the existence of micro-sites that are culturally selected for the collection of medicinal species and, at the same time, shows that if the diversity index depends on the richness (S) and equitability (E), in the case of this study, values above 2 for the areas selected as providers of medicinal species were, from the ethnobotanical point of view, very rich for the midwives members of the "***Nahuaxihuitl***" Organization of Ixhuatlancillo.

It can be seen that to a lesser equitability, there may be a greater diversity of knowledge on the use or uses of plants. According to Ramos-Hernández *et al*. (2007), a homogenous distribution may be an indicator of greater equitability in the community, and a high equitability and low richness would mean that only the most important plants are being mentioned by the informants. However, for the present study, we must not forget that the informants are members of an organization of indigenous traditional doctors, with broad knowledge and well-known prestige in their community. Some of them are traditional midwives who use and have used medicinal plants in primary healthcare for their families. And just as Matías (2009) reports, the informants who have over 40 years of experience, generally have a deep knowledge of the plants.

Contrary to what is said by Begossi (1996), in Ixhuatlancillo there is no loss of knowledge on medicinal plants among the younger generations. In the OMIT-"Nahuaxihuitl", women between 25 and 35 years old participate as "volunteer promoters" of the institutional program IMSS-PROSPERA, some of which are "midwives apprentices" and have a more general knowledge on the medicinal plant species of the region. From them, a great number of species were recorded, those that are more commonly used. On the other hand, the TID who are between 40 and 60 years old, mention plants that are more specific to their praxis as midwives and to their general cosmovision.

Thus, the practice of traditional medicine (in this case, the acquisition of medicinal species) may be understood, according to Zuloaga (2005), based on the relationships that are inherent to health, nature and culture. Another element is the cosmovision of health and disease the participating group might have, generally different to that of western culture, such as the concepts of the "cold or hot" nature of remedies and diseases, as well as the characteristics that are intrinsic to regional traditional medicine and to healing techniques whose transmission is from parents to children and generally in an oral manner.

It is worth mentioning that the lack of written records of these phenomena may lead to the medium or long term loss of this traditional knowledge. However, participative community work and that which is socially responsible, has led the organization to recognize and understand that their medicinal knowledge may be systematized and preserved in a written manner. The use of the Shannon-Wiener ecological index gives specific weight to this type of ethnobotanical work, to the benefit of indigenous groups who have this knowledge and as a basis for subsequent phytochemical and pharmacological studies.

CONCLUSIONS

The participant traditional midwives of The "***Nahuatlxihuitl***" Organization of Traditional Doctors and Midwives, from Ixhuatlancillo, Veracruz, Mexico,

have a differentiated preference for the use of areas surrounding the municipal capital, for the collection of medicinal species. This is based on ecological and cultural considerations, as well as on the accessibility of resources.

There is a defined pattern with a direct relationship between the collection areas that provide medicinal species, and the number of references per species in each one of these areas. Thus, we infer the existence of knowledge on the use and availability of medicinal species through the manifested knowledge of the 11 participant midwives of the "***Nahuatlxihuitl***" group.

The results show that there is diversity in the knowledge and use of areas where the medicinal species are obtained, mainly in those with preserved vegetation and some areas within the urban zones, such as backyards and plots.

The Shannon-Wiener ecological diversity index, when applied to ethnobotanical data referred by key informants, is useful to explain the distribution of the species used by the participant members of the organization. The information obtained through this index provides important estimation elements for proposals towards management and conservation of specific areas with vegetation that provides the ethnomedicinal resource.

Having an estimation of the diversity of knowledge in collection areas may contribute to the preservation of relationships between the traditional medical practice of the organization and the area or areas that provide them. This allows for a sustainable use of the medicinal resources with high pharmacological potential, in the medium and long term. For this, it is necessary to consider demographic studies that provide data on the intrinsic rate of population growth.

We may conclude that this knowledge is not at risk, thanks to the dynamism of the group and to the interest that the "apprentices" have in incorporating it into their cosmos-corpus-praxis, no podemos soslayar el hecho de que los problemas socioeconómicos de los últimos años y la migración, entre otros hechos, puede afectar a mediano y largo plazo la conservación del conocimiento sobre especies medicinales y su entorno.

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