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Informant consensus factor and antibacterial activity of the medicinal plants used by the people of San Rafael Coxcatlán, Puebla, México

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Abstract

Using ethnobotanical techniques, the medicinal flora used by the inhabitants of San Rafael Coxcatlán, Puebla was determined. During the field work, two types of interviews were applied (free listing and semi-structured) to 60 informants, who supplied consistent information concerning the use of 46 species of medicinal plants. Further analysis showed 13 categories of different medicinal use. An informant consensus factor was calculated and 16 species were selected due to their utilization in the treatment of diseases of possible bacterial origin. Of these 16 plants, sequential extractions were made with hexane, ethyl acetate and methanol. The obtained extracts were used to assess their antibacterial activity against 14 bacterial strains; 75% of the plants presented antibacterial activity. The medicinal species *Jatropha neopauciflora* Pax (Euphorbiaceae) and *Juliania adstringens* (Schldl.) Schldl. (Julianiaceae) were those that showed the biggest activity. Moreover, these species also had the highest informant consensus factor values.

Keywords: Medicinal plants; Informant consensus factor; Antibacterial activity; Ethnobotany

1. Introduction

Mexico has a great wealth of medicinal plants and an ancestral tradition about their uses. Present estimations consider that nearly 3000 medicinal plants are used in Mexico (Linares et al., 1999), a country with a vast variety of traditions and popular practices that have great value and are necessary to rescue and study scientifically.

Different methods exist to study medicinal plants, and one of them is the so-called ethno-directed method. In this technique, plants are collected based on the knowledge and traditions of the people living in a specific area. According to Cox and Balick (1994) and Cordell (2000), this method plays a fundamental role in biodiversity prospecting. Since time does not allow us to evaluate all existing medicinal plants scientifically, the selection of the most important taxa is a prerequisite to begin ethnopharmacological, phyto-chemical and toxicological studies. For this purpose, it is necessary to determine the species that are most used to treat a particular illness. A useful tool to find these species is the informant consensus factor (Frei et al., 1998; Heinrich et al., 1998a).

Considering the above-mentioned, this work used the ethno-directed method, with the objective to make an inventory of the medicinal species used by the inhabitants of San Rafael Coxcatlán, Puebla and to evaluate the activity of the species which by consensus are most used to cure illnesses of possible bacterial origin.

2. Study site

2.1. Geographic overview and vegetation types

San Rafael Coxcatlán is a village in the municipality of Coxcatlán, and is located southeast in the Valley of Tehuacán-Cuicatlán, at coordinates 18°12′ and 18°14′ north and 97°07′ and 97°09′ west at 957 m above sea level (Fig. 1). The climate

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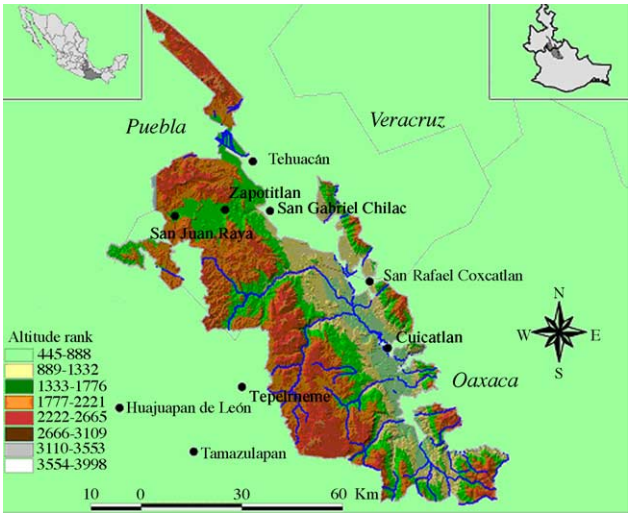

Fig. 1. Geographic position of San Rafael Coxcatlán, Puebla, México.

is Bs1(h′) w″ (w)eg (Fernández, 1999) and corresponds to dry or arid with summer rains and a mean temperature of 22°C.

The vegetation is a thorn scrub forest with species like *Bursera morelensis* Ramírez, *Bursera aptera* Ramírez, *Pachycereus weberi* (J. Coulter) Backeb, *Opuntia puberula* Pfeiffer, *Ceiba parvifolia* Rose, *Acacia cochliacantha* Humb. & Bonpl. ex Willd (Rzedowski, 1978; Fernández, 1999; Casas et al., 2001).

From a total of 374 species belonging to 249 genera and 87 botanical families found in San Rafael, Coxcatlán, of which 368 species were used in one or more ways by the local residents (Rosas, 2003). This number is larger than that reported in similar studies in the same Tehuacán-Cuicatlán Valley. As an example, Paredes (2001) reported 289 useful species for the "Zapotitlán de las Salinas" community. This larger number of useful plants in San Rafael is owed mainly to the great number of introduced plants in the homegardens of the community (Blanckaert et al., 2004), for ornamental use. Moreover, the families with most useful species were Asteraceae, Cactaceae, Solanaceae, Araceae and Euphorbiaceae, and these families correspond with the most representative families in the whole Tehuacán-Cuicatlán Valley (Rosas, 2003).

2.2. Demographic information of San Rafael, Coxcatlán

The San Rafael Coxcatlán community is relatively young. It was founded at the beginning of the twentieth century. Although the predominant ethnic group is the nahua, not all the present inhabitants are native. Some were born in small towns of Oaxaca and the south of Puebla.

A total of 298 inhabitants (151 women and 147 men) conform San Rafael's current population. The young population (22% of the total population) between 15 and 22 years old, abandon the community in search of better educational opportunities (12% in Tehuacán and/or Puebla) and better working conditions (23% found a job in the United States and 35% in Ajalpa, Tehuacán and Zinacantepec) (Population Census 2001, SS).

The most important economic activity in the area is agriculture and the main incomes come from sugar cane cultivation; other important activities in San Rafael are goat husbandry and the gathering of nutritious, medicinal, fodder, construction and fuel plants (Rosas, 2003).

3. Methods

3.1. Plant collection and ethnobotanical interviews

The ethnobotanical survey was conducted from May 2001 to April 2002. It included plant collections, informal interviews with the inhabitants and the implementation of the ethnographic method of free listing and semi-structured interviews (Weller and Romney, 1998). Interviews were conducted with 60 informants of San Rafael, Coxcatlán, including housewives (45 women) and farmers (15 men).

Each informant was interviewed in two occasions and each interview had a different format. The first interview was a free listing interview during which the informants provided us information about common names, specific uses for each medicinal plant. The second interview was a semi-structured one and was carried out 6 months after the first interview. The objective of this interview was to confirm the information obtained in the first interview. In this case, a herborized catalog and photographic images of each plant mentioned in the first interview were used.

Samples of the species mentioned by the informants were submitted to antibacterial studies, after being deposited as herbarium specimens. Taxonomic identification was performed, both, by cross-checking our specimens in the collections of the National Herbarium of Mexico at the UNAM (MEXU), and the Iztacala Herbarium (IZTA) of the UNAM, and by using floristic and taxonomic references, especially for the flora of the Tehuacán-Cuicatlán Valley (i.e., Bravo, 1930; Dávila, 1983; Dávila et al., 1993; Arias-Montes et al., 1997; Rico-Arce and Rodríguez, 1998). A complete set of plant collections was deposited in the herbarium IZTA and duplicates in the National Herbarium of Mexico (MEXU). Collections of specimens in the field were carried out with permission from the "Secretaría de Medio Ambiente y Recursos Naturales" (SGPA/DGVS/1266). It is important to mention that only non-living material was collected in this work, and that access to the community was officially agreed with the local authorities of the Municipality of San Rafael Coxcatlán before any informant was interviewed.

3.2. Informant consensus factor

To estimate use variability of the medicinal plants and to determine which plants are particularly interesting in the search for bioactive compounds, the informant consensus factor (F_{ic}) (Heinrich et al., 1998a) was calculated. This factor estimates the relationship between the "number of

use-reports in each category (n_{ur}) minus the number of taxa used (n_t)" and the "number of use-reports in each category minus 1". F_{ic} is thus calculated using the following formula:

$$F_{ic} = \frac{n_{ur} - n_t}{n_{ur} - 1}$$

The product of this factor ranges from 0 to 1. A high value (close to 1) indicates that relatively few taxa (usually species) are used by a large proportion of people, while a low value indicates that the informants disagree on the taxa to be used in the treatment within a category of illness.

3.3. Bioassays

Air-dried aerial parts (7 days at room temperature, 100 g) of the plants were successively extracted with solvents of different polarity: hexane, ethyl acetate and methanol. The extracts were filtered and concentrated.

The following strains of bacteria were used: *Vibrio cholerae* INDRE 206 (isolated from polluted water), *Vibrio cholerae* (a clinical isolate corresponding with group 01, producing enterotoxin, serotype "Inaba", biotype "El Tor"), *Vibrio cholerae* CDC V 12, *Vibrio cholerae* No. 01, *Escherichia coli* ATCC 25922, *Enterobacter agglomerans* ATCC 27155, *Salmonella typhi* ATCC 19430, *Shigella boydii* ATCC 8700, *Staphylococcus aureus* ATCC 12398, *Enterobacter aerogenes*, *Staphylococcus epidermidis*, *Bacillus subtilis* and *Sarcina lutea* (donated by the laboratory of microbiology of FES-Cuatitlán UNAM), *Yersinia enterocolitica* (donated by the Clinical Analysis Laboratory of University Hospital Campus, Iztacala).

The antibacterial activity was measured by disc-diffusion and well-diffusion methods (Vanden Berghe and Vlietinck, 1991). The microorganisms were grown overnight at 37 °C in 10 ml of Müeller Hinton broth (Bioxon). The cultures were adjusted to a turbidity comparable to that of Mc Farland no. 0.05 standard with sterile saline solution. Petri dishes containing Müeller Hinton agar (Bioxon) were impregnated with these microbial suspensions. Concentrations of 200 mg/ml of each extract were prepared, discs (Whatman no. 5) of 5 mm diameter were impregnated with 10 μl of each one (final doses per disc: 2 mg of ethyl acetate and methanol extracts). The well diffusion method was carried out by making a well in the agar (5 mm diameter) and filling it with 50 μl of the hexane extract solution. Discs impregnated with ethyl acetate and methanol were used as negative controls. For de hexane extract, wells with sterile olive oil and discs of chloramphenicol (25 μg) were used as positive controls. The plates were incubated overnight at 37 °C and the diameter of any resulting inhibition zones (mm) was measured. Each experiment was repeated at least three times.

The estimate of the minimal inhibitory concentration (MIC) was carried out by the broth dilution method (Vanden Berghe and Vlietinck, 1991). Dilutions of plant extracts from 2.0 to 0.75 mg/ml were used. The tubes were inoculated with microorganism suspension of 10^5 CFU/ml. MIC values were defined as the lowest concentration of extract that completely inhibited bacterial growth after 24 h of incubation at 37 °C. Choramphenicol was used as a reference, and appropriate controls with no extract and solvent were used. Each experiment was repeated at least three times.

4. Results

4.1. Ethnobotanical survey and informant consensus factor

During the ethnobotanical investigation, a total of 626 answers were obtained concerning the use of 46 medicinal plants (Table 1), which were grouped in 13 categories of medicinal uses (Fig. 2). These categories could be considered as a reflect of the cure concept of San Rafael's residents. Nine of these categories are more or less involved in the cure of illnesses of possible bacterial origin. Among them, those with the highest number of mentions were diarrhoea (24.4%), wounds and burns (17.09%) and tooth problems (17.09%). In the other illness groups, 1–17 mentioned species were registered (see Table 1).

The group of illnesses of possible bacterial origin that obtained the highest informant consensus factor value was that of odontologycal ailments ($F_{ic} = 0.98$). The species responsible for this high consensus was *Jatropha neopauciflora* (sangre de grado), with 43 of the 49 reported events. For the illness group of wounds and burns ($F_{ic} = 0.92$), the most important species were *Verbesina crocata* (árnica) with 36 events and *Juliania adstringens* (cuachalala) with 22 events. People in San Rafael often confuse its bark with that of *Ceiba parvifolia* (pochote), and they use them for the same purpose. For the group of urinary tract the highest

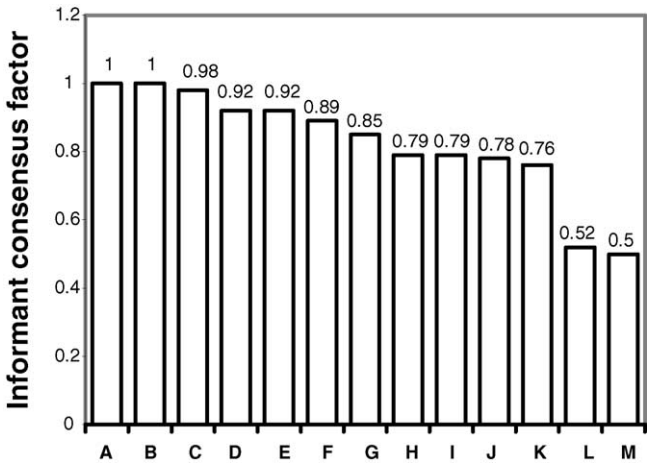

Fig. 2. Informant consensus factor for each use category. (A) Insect stings; (B) skeleton-muscular; (C) odontological, (D) wounds and burns, (E) urinary system, (F) diarrhoea, (G) respiratory systemn, (H) folk illnesses, (I) dermatological, (J) ophthalmological, (K) diabetes, (L) gynecological-androgynous, (M) gastritis.

Table 1
Plants used in traditional medicine of San Rafael Coxcatlán

Family, species (voucher specimen), common name, (Illness-events)	Plant part used	Disease treated	Manner of used
Acanthaceae			
Gypsacanthus nelsonii E.J. Lott,V. Jaram et Rzed. (MCM40)			
Tiricia[a] herb (H-5)	PA	Tiricia	The plant is adorned with paper and red balloons. The ill child is taken to dance around and hug the plant (cultural illness)
Agavaceae			
Agave stricta Salm-Dyck (MCM13)			
Magueicillo[a] (D-11)	PA	Stops bleeding	The pulpy leaf is cut and placed on the wound (topical)
Amaryllidaceae			
Aloe vera (L.) Buró. f.(ISB16)			
Sábila[b] (B-9; D-14; G-5; H-1; J-1; K-3)	PA	Eyes, burns, sprain, wounds, cough, sore throat	The pulpy leaf is opened and roasted, then placed on the affected part (topical)
		Diabetes	The pulpy leaf is blended and it is drunk on an empty stomach (oral)
Anacardiaceae			
Schinus molle L. (MCM34)			
Coabino or pirul[b] (H-8;L-4)	PA	Woman in labour	It is cooked together with the bathing water (bath)
		"aire" (evil eye)	A twig is put under clothes or behind the ear
Cyrtocarpa procera Kunth (MPF371)			
Chupandilla[a] (E-7)	C	Kidney ailments	A tea is prepared with chupandilla bark combined with biznaga and cuachalala. It is drunk cold, as if normal water (oral)
Asclepiadaceae			
Asclepias linaria Cav. (MCM31)			
Wild romero[c] (L-2; H-1)	PA	Woman in labour, fright	It is cooked together with the bathing water (bath)
		Colics	It is drunk as tea (oral)
Asteraceae			
Artemisia absinthium L. (MCM15)			
Hierba maestra[c] (F-5;H-5; L-4)	PA	Stomach-ache, woman in labour, colics, bile	Tea, one cup on an empty stomach (oral)
Flaveria trinervia (Spreng.) C. Mohr (MCM10)			
Hierba del sapo[a] (D-1; F-5; M-1)	PA	Dysentery, gastritis wounds	Tea, it is drunk cold (oral) Tea, a wound is washed with it (topical)
Gymnosperma glutinosum (Spreng.) Less (MCM30)			
Popote[a] (F-1)	PA	Diarrhoea	Tea (oral)
Matricaria recutita L. (IRA52)			
Manzanilla[c] (F-26;G-7; H-1; J-10)	PA	Diarrhoea, alfericia, sore throat, flu	Tea, drunk cold (oral)
		Eyes	Tea, the infected eyes are washed with it (topical)

Table 1 (*Continued*)

Family, species (voucher specimen), common name, (Illness-events)	Plant part used	Disease treated	Manner of used
Montanoa tomentosa Cerv. (MCM27)			
Acahuite[a] (F-11)	PA	Bebés enlechados	Leaf shoots are mixed with mother milk, warmed till boiling and fed to the baby (oral). A boy should get mother milk from a girl's mother and vice versa
Tanacetum parthenium (L.) Sch. Bip. (MCM17)			
Santa María[c] (F-7; H-1; L-1)	PA	Woman in labour	It is cooked together with the bathing water (bath)
		Diarrhoea, anger	Tea, drunk cold (oral)
Verbesina crocata (Cav.) Less (ISB341)			
Árnica[b] (D-33; G-2;I-7; L-1)	PA	Woman in labour (hips)	It is cooked together with the bathing water (bath)
		Wounds, sore throat, lumps, burns	Tea, the infected part is washed (topical)
Viguiera dentata (Cav.) Spren (MCM2)			
Chimalacate[a] (A-10; I-2; L-1)	PA	Woman in labour, baby rash	It is cooked together with the bathing water (bath)
		Ant stings	Ant stings are treated by rubbing them directly with a leaf (topical)
Bombacaceae			
Ceiba parvifolia Rose (RRL147)			
Pochote[a]	C	Diabetes, kidney, wounds, spots, tumors, gastritis	Prepared as a tea, the wounds are washed with it (topical) and it is drunk cold (oral). Dried bark is pulverized and placed directly on the wound (topical)
Boraginaceae			
Borago officinalis L. (MCM3)			
Borraja[c] (G-11)	PA	Cough, sore throat, flu	Tea, with milk, prepared very sweet and drunk at night (oral)
Burseraceae			
Bursera arida (Rose) Standley (MCM29)			
Aceitillo[a] (C-6; D-12 I-1)	L	Wounds, skin eruptions, white tongue, spots	The plant's latex is placed directly on the affected area (topical)
Cactaceae			
Hylocereus undatus (Haw.) Britton & Rose (ISB386)			
Pitahaya[b] (G-1)	PA	Flu	Tea, drunk cold (oral)
Ferocactus latispinus (Haw.) Britton & Rose (ISB384)			
Biznaga[a] (E-7)	PA	Kidneys	Tea, drunk cold (oral)
Opuntia sp.(MCM42)			
Nopal[b] (K-4)	PA	Diabetes	Blended and drunk on an empty stomach (oral)
Chenopodiaceae			
Chenopodium murale L. (MCM20)			
Chaguaquelite (I-9)[a]	PA	Alforra	The cooked plant is wrapped into a little ball and placed on the anus of the baby (topical)

Table 1 (*Continued*)

Family, species (voucher specimen), common name, (Illness-events)	Plant part used	Disease treated	Manner of used
Cyperaceae			
Cyperus hermaphroditus (Jacq.) Standl. (MCM18)			
Piomía[a] (F-1; H-1)	R	Colics Alfericia	Tea, drunk cold (oral) A cross is made from the plant's roots and hung around the neck of the ill child (folk illnesses)
Equisetaceae			
Equisetum hyemale L. (MCM16)			
Cola de iguana or Cola de caballo[c] (E-15)	PA	Kidneys	Tea, drunk cold (oral)
Euphorbiaceae			
Acalypha hederacea Torr. (MCM7)			
Hierba del pastor[a] (D-8; F-2; I-5; L-2)	PA	Woman in labour Spots, wounds, inflammation	It is cooked together with the bathing water (bath) Tea, the affected part is washed with it and then covered with a hot poultice (topical)
Cnidoscolus chayamansa McVaugh (MCM11)			
Chaya[b] (G-3; K-5)	H	Diabetes, inflammation	Tea, drunk cold (oral)
Jatropha neopauciflora Pax. (MCM6)			
Sangre de grado[a] (C-43;D-5)	L	Skin eruptions, wounds, tooth ache	Latex, directly on the affected area (topical)
Ricinus communis L. (MCM36)			
Higuerilla[a] (F-14)	H	Chest, indigestion, fever	Back and chest are smeared with fat and then covered with leaves (topical)
Julianiaceae			
Juliania adstringens (Schldl.) Schldl. (MCM14)			
Cuachalala[a] (D-22; E-17; I-5; K-3; M-3)	C	Diabetes, kidneys, wounds, spots, tumors, gastritis	Tea, wounds are washed (topical) and it is drunk cold (oral). Dried bark is pulverized and placed directly on the wound (topical)
Lamiaceae			
Mentha x piperita L. (ISB431)			
Hierbabuena[b] (F-23; G-4)	PA	Stomach, parasites, flu	Tea, drunk cold (oral)
Marrubium vulgare L. (MCM33)			
Marrubio[c] (D1; F-2; H-4)	PA	Diarrhoea, wounds, rage, pain	Tea, on an empty stomach (oral). A wound is washed with the tea (topical)
Ocimum basilicum L. (MCM22)			
Albahacar [b] (F-9; G-4; H-8)	PA	Sore throat, parasites, diarrhoea, stomach ache "Aire" or evil eye	Tea, as often as possible (oral) A twig is carried on the chest under cloths (cultural desease)
Mimosaceae			
Mimosa luisana Brandegee (MCM26)			
Uña de gato[a] (K-1)	PA	Diabetes	Tea, drunk cold (oral)

Table 1 (*Continued*)

Family, species (voucher specimen), common name, (Illness-events)	Plant part used	Disease treated	Manner of used
Prosopis laevigata (Humb. & Bonpl. ex Willd.) M.C. Johnston (RRL207)			
Mezquite[b] (F-6; J-1)	PA	Woman in labour	It is cooked together with the bathing water (bath)
		Indigestion	Tea from leaf shoots (oral)
		Eyes	Tea from leaf shoots, the eyes are washed with it (topical)
Myrtaceae			
Eucalyptus globulus Labill.(MCM41)			
Eucalipto[c] (G-12)	PA	Cough	Tea (oral)
Psidium guajava L. (ISB188)			
Guayabo[b] (F-7)	H	Diarrhoea, dysentery	Tea, drunk cold (oral)
Nyctaginaceae			
Bougainvillea spectabilis Willd. (ISB156)			
Bugambilia[b] (G-21; H-1)	F	Cough, flu	Tea from purple bractea, drunk at any hour of the day (oral)
		Child sadness	The sad child must throw the red bractea in the water and as the flowers float away, so does the sadness (folk illnesses)
Papaveraceae			
Argemone mexicana L. (MCM37)			
Chicalote[a] (J-2)	L	Perrillas (eye infection)	The latex is placed directly in the eye (topical)
Piperaceae			
Piper auritum Kunth (MCM38)			
Hoja santa[b] (L-1)	H	Abortive	Tea, on an empty stomach (oral)
Rosaceae			
Rosa centifolia L. (MCM39)			
Rosa de Castilla[c] (I-1; J-5; L-1)	F	Eyes, spots, colics	Tea (oral) and used to wash the affected part (topical)
Rutaceae			
Ruta chalapensis L. (MPF149)			
Ruda[b] (F-2; G-1; H-11; L-4)	PA	Diarrhoea, sore throat, colics	Tea, can be drunk on an empty stomach (oral)
		Tiricia, “aire” or evil eye, head ache, anger	To avoid aire or the evil eye and to cure head ache, a small twig is placed behind the ear. (folk illnesses)
Selaginellaceae			
Selaginella lepidophylla (Hook & Grev.) Spring (MCM35)			
Siempre viva o doradilla[a] (E-5)	PA	Kidneys	Tea, drunk cold (oral)
Simaroubaceae			
Castela tortuosa Liebm. (MCM9)			
Venenillo[a] (H-1; K-7)	PA	Diabetes, anger, pressure	Tea, drunk cold (oral)
Solanaceae			
Margaranthus solanaceus Schltdl. (RRL298)			
Totomache[a] (H-14; K-3)	H	Diabetes, bile	Tea, on an empty stomach (oral)
		Anger	Angry kids are given a leaf to chew on (oral)

Table 1 (*Continued*)

Family, species (voucher specimen), common name, (Illness-events)	Plant part used	Disease treated	Manner of used
Physalis sp. (ISB336)			
Tomate verde[c] (G-8)	FR	Sore throat	Leaves are fried and placed hot over the throat (topical)
Turneraceae			
Turnera diffusa Willd. (MCM32)			
Ítamo real[c] (F-7; l-1)	PA	Diarrhoea, colics	Tea, drunk cold (oral)
Verbenaceae			
Lippia graveolens Kunth (MCM8)			
Orégano[a] (F-26;G-3; L-2)	PA	Diarrhoea, chest pain, abortive, stomach ache, colics	Tea, drunk on an empty stomach and during the day (oral)

[a] Wild plants (47.8%).
[b] Homegarden plants (28.2%).
[c] Foreign plants (23.9%); C, bark; F, flower; FR, fruit, H, leaves; L, latex; PA, Aereal part; R, root. A, Insect stings; B, skeleton-muscular; C, odontological; D, wounds and burns; E, urinary system; F, diarrhoea; G, respiratory system; H, cultural affiliation; I, dermatological; J, ophthalmological; K, diabetes; L, gynecological-androgynous; M, gastritis.

value of F_{ic} was 0.92, and the plant with the most number of events (17) was, again, *Juliania adstringens*. In the group of diarrhoea ($F_{ic} = 0.89$), the most important species were *Lippia graveolens* (orégano), *Matricaria recutita* (camomile) and *Mentha piperita* (hierbabuena), with 27, 26 and 23 events respectively. For the group of breathing illnesses ($F_{ic} = 0.85$), *Bougainvillea spectabilis* (bugambilia) was the one that had the biggest record (21 events). Finally, for the group of dermatologic illnesses ($F_{ic} = 0.79$), *Chenopodium murale* (chaguaquelite) contributed with the highest number of mentions (nine events) (Fig. 2 and Table 1).

4.2. Antibacterial activity evaluation

Based on the above mentioned results, the antibacterial activity evaluation was done for a total of 16 species (Table 2). Also shown in Table 2 are the inhibition halos of different extracts over the 14 used bacterial strains. Twelve species of medicinal plants (75%) were active against at least one or more bacterial strains. In general, the activity of all plant extracts was more evident against the gram positive bacteria. As it was mentioned previously, San Rafael's people give the same use to the bark of *Juliania adstringens* and *Ceiba parvifolia* and in the antibacterial tests we find that the methanolic extract of both species showed antibacterial activity. However, the *Juliania adstringens* extract acted against more bacterial strains and had lower MIC values than the *Ceiba parvifolia* extract.

In most of the species that showed antibacterial activity, the MICs were higher than 1.0 mg/ml. The extracts with the least MIC values were from *Juliania adstringens* (0.125 mg/ml), *Jatropha neopauciflora* (0.5 mg/ml) and *Viguiera dentata* (0.375 mg/ml).

5. Discussion

An interesting characteristic of San Rafael's population is that several inhabitants are originally from other towns (Puebla and Oaxaca states). As a consequence, there has been a confluence of knowledge about medicinal plants, almost half of them (47.8%) being wild, demonstrating the close relationship among the locals and their natural environment.

San Rafael's medicinal flora (Table 1) groups in 28 plants families, with Asteraceae presenting the highest proportion of medicinal species (eight species). This agrees with Moerman et al. (1999), who claimed that the best represented floristic family of a region most often also is the most used. Different secondary metabolites presenting antibacterial activity (Murphy, 1999) have been found in Asteraceae (Heinrich et al., 1998b), justifying the medicinal use of this family.

The calculation of the informant consensus factor allowed a more objective selection of the species for the microbiological study in order to validate traditional knowledge. It was found that 75% (12 species) of the selected species presented antibacterial activity. This result is an accurate reflection of the effectiveness of the ethno-directed method in biodiversity prospecting studies. King et al., (1996) mention that it is possible to obtain at least 50% of success with the medicinal plants collected by this method.

Although they were frequently mentioned, the species *Mentha recutita*, *Mentha*×*piperita*, *Ocimum basilicum* were not considered for the microbiological tests in this work, as they were already thoroughly studied (Frei et al., 1998; Heinrich et al., 1998b; Lentz et al., 1998). The specie *Lippia graveolens* (orégano) also presented a high number of events, but its antibacterial activity has equally been confirmed previously (Hernández et al., 2003). Regarding *Equisetum hyemale, Artemisia absinthium* and *Tanacetum partenium*, they

Table 2
Antibacterial activity of some plants used in traditional medicine of San Rafael, Coxcatlán

Species	Ex	Sa	Se	Sl	Bs	V ch No-01	V ch cc	V ch agua	V ch Tor	Ec	Sb	Ye	Eae	Eag
Chlorampheni col		18.7 ± 0.6	19.7 ± 2.1	22.7 ± 0.6	25.0 ± 1.0	24.3 ± 0.6	19.3 ± 0.6	24.3 ± 0.6	22.7 ± 1.5	18.3 ± 1.1	25.0 ± 1.0	15.7 ± 0.6	24.0 ± 1.0	25.3 ± 0.6
Acalypha hederacea	H	10.0 ± 0.5	na	na	na	na	na	na	na	na	na	na	na	na
	MIC	>2.0												
Artemisia absinthium	H	na	na	na	na	7.0 ± 0.5	na	na	na	na	na	na	na	na
	M	na	na	11.7 ± 2.1	na	7.0 ± 0.5	na	na	na	na	na	na	na	na
	MIC			>2.0		>2.0								
Bursera arida	H	9.3 ± 0.8	na	na	na	na	na	na	na	na	na	na	na	na
	MIC	>2.0												
Ceiba parvifolia	M	12.0 ± 0.5	10.3 ± 0.6	na	8.7 ± 0.6	7.3 ± 0.6	na	na	na	na	na	na	na	na
	MIC	0.25	>2.0		>2.0	>2.0								
Cyrtocarpa procera	M	11.7 ± 0.6	13.0 ± 0.5	na	11.7 ± 0.6	9.7 ± 0.6	na	7.0 ± 0.5	na	na	12.3 ± 0.6	na	na	na
	MIC	1.5	1.0		1.5	1.5		1.5			0.125			
Equisetum hyemale	H	10.0 ± 0.6												
	MIC	>2.0												
Gimnosperma glutinosum	H	19.0 ± 0.5[a]	11.3 ± 0.6	na	na	na	12.3 ± 1.2	12.3 ± 0.6	10.0 ± 0.5	na	12.3 ± 0.6[a]	na	na	na
	E	11.7 ± 1.5	na	na	na	na	na	na	na	na	9.3 ± 0.6	na	na	na
	MIC	0.125	0.125				1.5	1.5	>2.0		0.25			
Jatropha neopauciflora	E	7.0 ± 0.5	10.3 ± 0.6	11.3 ± 0.6	7.0 ± 0.5	16.3 ± 0.6	na	na	12.3 ± 0.6	na	na	9.0 ± 0.5	na	na
	L	13.7 ± 0.6[a]	12.3 ± 0.6[a]	17.3 ± 1.2[a]	12.3 ± 0.6[a]	12.7 ± 0.6[a]	na	na	na	na	12.7 ± 0.6	na	na	na
	MIC	2.0	2.0	0.5	1.5	0.5					>2.0			
Juliania adstringens	E	7.3 ± 0.6	na	na	na	na	na	na	9.7 ± 0.6	na	na	na	na	na
	M	11.7 ± 0.6[a]	10.7 ± 0.6	20.3 ± 0.6	10.0 ± 1.0	9.7 ± 0.6	na	na	9.3 ± 0.6[a]	10.3 ± 0.6	na	10.7 ± 1.2	12.3 ± 0.6	10.0 ± 0.5
	MIC	0.25	>2.0	0.125	1.5	>2.0			1.5	>2.0		>2.0	2.0	>2.0
Rosa centifolia	M	10.3 ± 0.6	13.3 ± 0.6	na	na	na	na	na	na	na	na	na	na	na
	MIC	>2.0	2.0											
Tanacetum partenium	H	15.0 ± 0.5[a]	15.0 ± 0.5[a]	na	na	15.0 ± 1.0[a]	9.0 ± 0.5[a]	11.0 ± 0.5[a]	na	na	na	na	na	na
	E	13.3 ± 1.5	13.7 ± 0.6	12.3 ± 0.6[a]	13.7 ± 0.6	13.0 ± 1.0	8.7 ± 0.6	10.0 ± 0.5	14.7 ± 2.5	na	13.7 ± 0.6[a]	10.7 ± 0.6	na	na
	M	na	na	8.0 ± 0.5	na	8.0 ± 0.5	na	na	na	na	7.3 ± 0.6	na	na	na
	MIC	2.0	2.0	2.0	2.0	>2.0	>2.0	>2.0	2.00		>2.0	>2.0		
Viguiera dentata	H	9.3 ± 0.6	8.3 ± 1.2	13.7 ± 0.6	9.0 ± 0.5	8.3 ± 0.3	7.0 ± 0.5	7.7 ± 0.6	na	na	na	na	na	na
	MIC	2.0	2.0	0.375	0.375	1.5	1.5	1.5						

Ex extract; H, hexane; E, ethyl acetate; M, methanol; MIC (mg ml^{-1}); Sa, *Staphylococcus aureus*; Se, *Staphylococcus epidermidis*; Sl, *Sarcina lutea*; Bs, *Basillus subtilis*; V ch No.-01, *Vibrio cholerae*; V ch cc, *Vibrio cholerae* (clinical isolate); V ch agua, *Vibrio cholerae* (isolated from water); V ch Tor, *Vibrio cholerae* CDC V 12; Ec, *Escherichia coli;* Sb, *Shigellaboydii*; Ye, *Yersinia enterocolitica*; Eae, *Enterobacter aerogenes*; Eag, *Enterobacter agglomerans*. *Flaveria trinervia, Selaginella lepidophylla, Piper aurintium* and *Chenopodium murale* did not show antibacterial activity.

[a] Extracts where MIC and CBM were determined, in case more than one active extract was obtained.

have also been previously studied (Janssen, 1986; Argueta and Cano, 1994; Linares et al., 1999), and the results agree with the obtained in our work.

With respect to the two most important species (*Juliania adstringens*, and *Jatropha neopauciflora*, it is important to highlight that *Juliania adstringens* has been thoroughly studied phytochemically and its anti-inflammatory activity has also been evaluated (Olivera et al., 1999). In this work, its antibacterial activity was demonstrated. It is not surprising the activity shown by this plant, since other species of the same family have shown to have anti-fungal, anti-inflammatory, anti-viral and antibacterial activity (Cojocaru et al., 1986; Cáceres et al., 1987; Corthout et al., 1991; Argueta and Cano, 1994).

Several species of the genus *Jatropha* has been studied and it has been demonstrated that they present anti-inflammatory, inmmunomodulatory, anti-malaria, larvicidal, molluscicidal and antibacterial activity (Argueta and Cano, 1994; Van der Berg et al., 1995; Karmegam et al., 1997; Auvin-Guette et al., 1999; Chariandy et al., 1999; Staubmann et al., 1999; Al-Zanbagi et al., 2000, 2001; Ciccia et al., 2000; Srinivasan et al., 2001), but the particular species *Jatropha neopauciflora* has never been studied before and in this work, its antibacterial activity was demonstrated

6. Conclusion

The use of the ethno-directed method was very efficient to compile the information about San Rafael's medicinal flora. Using the informant consensus factor, it was possible to select the plants that are mainly used to alleviate illnesses of bacterial origin. The antibacterial activity of 75% of the medicinal species used in San Rafael was demonstrated.

The plants with major consent values showed the biggest antibacterial activity, reaffirming that interdisciplinary studies including ethnobotanical, botanical, phyto-chemical, pharmacological, ecological and medical data are required to redound the benefits for the traditional and western medicine.

At present, our laboratory is carrying out the purification and elucidation of the chemical compounds responsible for the antibacterial activity of the plants not studied before in order to offer a phyto-chemical support to the traditional use of the medicinal plants used to alleviate illnesses of bacterial origin.

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