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Medicinal plants of Oaxaca, Mexico: Ethnobotany and antibacterial activity

[Plantas medicinales de Oaxaca, México: Etnobotánica y actividad antibacteriana]

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Abstract: Santiago Quiotepec, one of the oldest communities of the Tehuacán-Cuicatlán Valley (México), has a great tradition using medicinal plants. The aim of this study was to make an inventory of the medicinal species used by the inhabitants of Santiago Quiotepec and evaluate the antibacterial activity. An ethnobotanical study of medicinal plants was carried out, 60 informants mentioned that 66 species of plants are being used in the treatment of different diseases. Fifteen species were selected to evaluate the antibacterial activity in possible bacterial originated diseases treatment. The lowest values were presented in the hexane extract of *Plumbago pulchella*, with a MIC of 0.25 mg/mL over *Staphylococcus aureus* and *S. epidermidis* as well as the hexanic extract of *Echinopterys eglandulosa* showed a MIC of 0.25 mg/mL over *Pseudomona aeruginosa*.

Keywords: Antibacterial activity; Santiago Quiotepec; Medicinal plants; Ethnobotany; Tehuacán-Cuicatlán

Resumen: Santiago Quiotepec es una de las comunidades más antiguas del valle de Tehuacán-Cuicatlán (México), y tiene una gran tradición en el uso de plantas medicinales. El objetivo de este estudio fue realizar un inventario de las especies medicinales utilizadas por los habitantes de Santiago Quiotepec y evaluar la actividad antibacteriana. Se realizó un estudio etnobotánico de plantas medicinales, 60 informantes mencionaron 66 especies de plantas utilizadas en el tratamiento de diferentes enfermedades. Quince especies utilizadas en la comunidad para tratar enfermedades de posible origen bacteriano fueron seleccionadas para evaluar la actividad antibacteriana. Los valores más bajos se presentaron en el extracto hexánico de *Plumbago pulchella*, con una CMI de 0.25 mg/ml sobre *Staphylococcus aureus* y *S. epidermidis*, así como el extracto hexánico de *Echinopterys eglandulosa* mostró una CMI de 0.25 mg/mL sobre *Pseudomona aeruginosa*.

Palabras clave: Actividad antibacteriana; Santiago Quiotepec; Plantas medicinales; Etnobotánica; Tehuacán-Cuicatlán

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INTRODUCTION

Since ancient times plants have played an important role as a medicinal source for human beings. Currently, there is a great need to preserve this valuable knowledge, especially in those countries where there is a high risk of losing this practice (exposure to modern culture, rapid land degradation, modern facilities and urban development) (Kayani *et al.*, 2015).

Ethnomedicinal studies were carried out to avoid the loss of this knowledge, additionally ethno pharmacological, phytochemical and toxicological studies should be implemented to validate the traditional use. Collection, analysis and validation is of great importance in use and management strategies definition of this resources (Casas *et al*., 2001).

Tehuacán-Cuicatlán Valley, Mexico, is the region with the highest absolute richness of useful plant species (1,605 vascular plant species). Based on the number of species, the most outstanding uses are fodder (874 spp.), medicinal (396 spp.) and food (339 spp.) (Lira *et al*., 2009). There are many studies of medicinal plants in this region. Hernandez *et al*., 2003 registered 44 plant species used by the local inhabitants to treat gastrointestinal diseases in Zapotitlán de las Salinas village. The test for antibacterial activity of the more frequently used extracts showed that all species have activity against Gram-positive and Gram-negative bacteria. Canales *et al*. (2005) determined the informant consensus factor of the medicinal flora of San Rafael Coxcatlán, the inhabitants mentioned 46 medicinal plants and 16 species were selected due to their utilization in the treatment of possible bacterial origin diseases, 75% of the plants presented antibacterial activity. In addition some species of the region like *Lippia graveolens, Lantana achyranthifolia, L. camara, Cordia curassavica, C. globos, Caesalpinia melanadenia, Gymnosperma glutinosum, Yucca periculosa, Bursera morelensis* and *Psittacanthus caluculatus* are evaluated for their biological activities and phytochemical composition (Hernández *et al*., 2007; Hernández *et al*., 2008; Hernández *et al*., 2009; Serrano *et al*., 2012; Avila-Acevedo *et al*., 2012; Hernández *et al*., 2014; Hernández *et al*., 2015).

Nevertheless, only a few medicinal species of the region have been studied for their biological activities and phytochemical composition, so the aim of this study is to create an inventory of the medicinal species used by Santiago Quiotepec, Oaxaca's inhabitants and to evaluate the antibacterial activity of some species used in possible bacterial origin illnesses treatment.

Study site

Santiago Quiotepec community is located in northeast Oaxaca state, at the Cuicatlán city hall, it occupies an area of approximately 36.8 km^2, between the extreme coordinates UTM Xmax: 715000, Ymax: 1981900 and Xmin: 712300, Ymin: 1979200 (Figure No. 1), at an altitude of 545 m (García, 1981). Santiago Quiotepec is one of the oldest villages in the lower part of a depressed zone identified as the "Cañada Poblano-Oaxaqueña", in the Sierra Madre Oriental (Pérez-Negrón & Casas, 2007). It benefits from a very dry semi-arid climate since it receives an annual rainfall of only 500 mm, while its average temperature exceeds 25°C, the rains are concentrated mainly between June and September (García, 1981). The main rivers in Santiago Quiotepec are: the Sendo River, the Rio Grande, the Salado River and Cacahuatal. The Sendo River is the most important for the community since its water supplies the drinkable water network and the irrigation channels of the agricultural area. In the community, the predominant soil type is the haplic feozem, characteristic of semi-arid areas with a dark superficial layer that presents organic material. The vegetation is dominated by *Pachycereus webery*, *Neobuxbaumia tetetzo*, *Escontria chiotilla*, *Bursera sp*., *Astianthus viminalis* and *Taxodium mucronatum* (Pérez-Negrón & Casas, 2007). The community has 217 inhabitants (INEGI, 2010) of Cuicateco origin, who live mainly from agricultural activities and grazing cattle and goats, where fruit and livestock are the activities that allow obtaining monetary income.

MATERIAL AND METHODS

Ethnobotany

Data were collected between October 2016 and March 2017, obtaining 60 semi-structured interviews. Intentional sampling was used to select the informants (people on the streets were interviewed), providing personal data (name, age, occupation, time living in the community), also data referring to the use of medicinal plants (common name, uses, parts used, spatial availability, degree of management, importance and effectiveness of each species, disease symptoms). The interviews were interrupted when the number of mentioned species did not increase. Botanical techniques of collection and herborization of the species mentioned during the interviews were also carried out, for which recollection expeditions were conducted by two local authorities that knew the region flora. The specimens were collected in duplicate, recording the following data: collection number, date, location, altitude, geographical coordinates and common name. The identification of the plants was carried out in the Herbarium of FES-Iztacala (IZTA). It is important to notice that access to the community was allowed by Santiagos Quiotepec's local authorities, with informed consent from interviewed people.

Of the information obtained from the interviews, frequency (total mention) was determined and the diseases were categorized according to the symptom referred. Fifteen species that have been used to cure illnesses of possible bacterial origin (gastrointestinal, respiratory, ophtalmological, gynecological) were selected to evaluate their antibacterial activity.

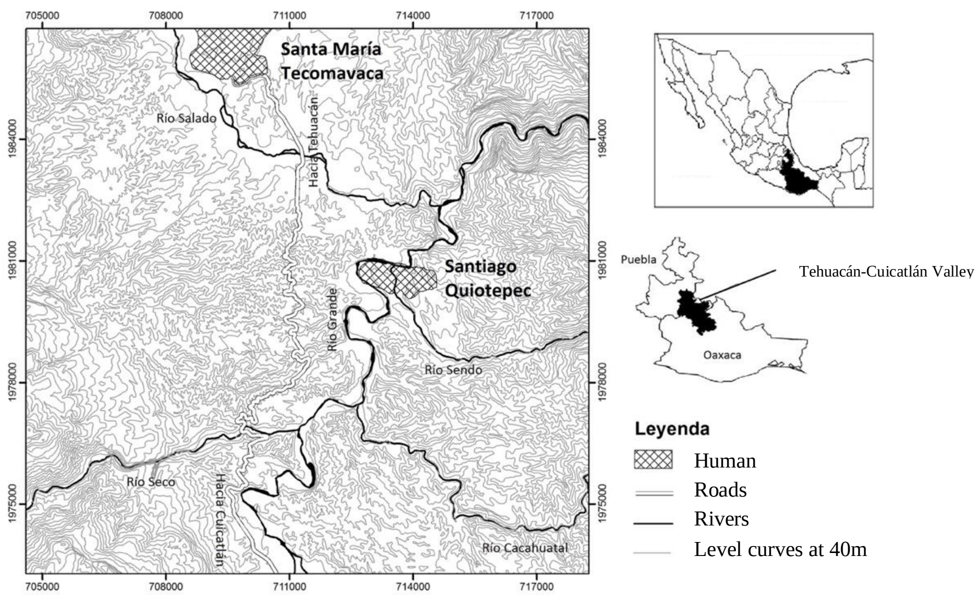

Figure No. 1
Geographic position of Santiago Quiotepec, Oaxaca

Bioassays

Depending on the part of the plant used (aerial part, fruit, cortex, and leaves) extracts were obtained using solvents of different polarity (hexane, ethyl acetate, and methanol). The extracts were filtered and successively concentrated.

The following strains of bacteria were used:
Gram-positive: *Enterococcus faecalis* ATCC 14506, 5 strains of *Staphylococcus aureus* (Clinical Case, ATCC 29213, 23MR, clinical case donated by the FES-C microbiology laboratory and clinical case donated by the University Hospital Campus Iztacala (CUSI) Clinical Analysis laboratory, 2 strains of *Staphylococcus epidermidis* (ATCC 12228, Clinical Case), and *Micrococcus luteus* ATCC 10240, Gram-negative: *Enterobacter aerogenes* ATCC 1304, *E. gergoviae* ATCC 33028, 2 strains of *Escherichia coli* (82MR, Clinical Case), *Klebsiella penumoniae* ATCC 13883, *K. oxytoca* ATCC 8724, *Pseudomona aeruginosa* ATCC 27853, *Salmonella enterica* ATCC 7251, *S. typhi* (Clinical Case), and *Serratia marcescens* ATCC 14756.

The antibacterial activity was measured by disc-diffusion and well-diffusion methods (Vanden Berghe & Vlietinck, 1991). The microorganisms were grown overnight at 37ºC in 10 mL of Mueller Hinton broth (Bioxon). Using sterile saline solution, the cultures were adjusted to a turbidity comparable to that of McFarland No. 0.05 standard. Petri dishes containing Mueller Hinton agar (Bioxon) were impregnated with the microbial suspensions. Discs

(Whatman No. 5) of 5 mm diameter impregnated with 10 µL of each extract (final doses per disc: 2 mg of extracts). Discs impregnated with hexane, ethyl acetate and methanol were used as negative controls and discs of chloramphenicol (25 g) were used as positive controls. The plates were incubated overnight at 37ºC 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 3.0 to 0.125 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 37ºC. Chloramphenicol was used as reference, and appropriate controls with no extract and solvent were used. Each experiment was repeated at least three times.

RESULTS

Ethnobotanical survey

A total of 60 informants were interviewed, 66 species of plants used in the treatment of different diseases were mentioned, which belong to 34 families and 62 genera, being Asteraceae (12%), Fabaceae (9%), Laminaceae (8%) and Euphorbiaceae (6%), the families that presented the highest number of species (Table No. 1). *Amphipterygium adstringens*, *Erethia latifolia* and *Aloe vera* were the most frequently mentioned species.

A total of 34 diseases were mentioned in the interviews, with 16% gastrointestinal diseases were the most common (stomachache, diarrhea, vomiting), 10% inflammatory process (external and internal), 7% diabetes and 6% respiratory diseases (cough, flu). In Santiago Quiotepec community, 74% of the plants reported, are used to treat some type of disease of infectious origin (gastrointestinal, inflammatory, gastritis, respiratory, gynecological, kidney, liver, dermatological, wounds and burns, odontological, fever and ophthalmological).

For each of the species mentioned in the interviews, botanical data and biological activities were obtained from bibliographic review, with special emphasis on antimicrobial activity. The species chosen to perform the evaluation of the antimicrobial activity were selected because they are used to treat bacterial origin diseases in the community of Santiago Quiotepec, and did not have previous studies: *Ehretia latifolia*, *Cedrela oaxacensis*, *Neurolaena lobata*, *Merremia dissecta*, *Jefea pringlei*, *Bidens pilosa*, *Waltheria. indica*, *Loeselia purpusii, Sida ciliaris*, *Melochia tomentosa*, *Crataegus mexicana*, *Echinopterys eglandulosa*, *Plumbago pulchella*, *Ziziphus amole*, *Rhamnus humboldtiana.* It's important to notice that all the species are native from Mexico.

Evaluation of the antibacterial activity

The Table No. 2 and Table No. 3 (A,B) presents the results obtained in the bioassays. *Cedrela oaxacensis* and *Merremia dissecta* extracts showed no activity on any bacterial strain evaluated. When 13 of the 19 strains evaluated (Gram positive and negative) were inhibited the *Plumbago pulchella* hexane extract was the most active. The *Melochia tomentosa* methanolic extract inhibited 7 of the 19 strains evaluated (mainly Gram positive). Regarding the MIC, *Plumbago pulchella* hexane extract presented the lowest values, on *Staphylococcus aureus* (23MR, ATCC 29213) and *Staphilococcus epidermidis* (ATCC 12228) strains it showed values of 0.25 mg/mL, also over *Pseudomona aeruginosa* strain *Echinopterys eglandulosa* hexanic extract showed a MIC of 0.25 mg/mL.

DISCUSSION

Medicinal plants were used by 98% of the 60 informants. A 12% of the medicinal plants belong to the Asteraceae family, it occupies a predominant place in the flora of Mexico, with its 3,057 species is one of the most diverse, and represents about 13.5% of the total floristic wealth of the country (Villaseñor, 2003; Villaseñor, 2016).

Pérez-Negrón y Casas (2007) conducted an ethnobotanical study in which they mentioned a total of 252 species of useful plants, of which 88 are used by the community of Santiago Quiotepec as medicinal plants, in the present study only 47% (41 species) of these species are included, however, 27 species that were not mentioned in that study are reported. This may be due to the exchange of information regarding the use of plants that residents have with other nearby communities.

The species that has a higher frequency of mention is *Amphipterygium adstringens* (Schltdl.) Standl. (Anacardiaceae), it's an endemic species of Mexico, the cortex is used to treat more than 40 different diseases, including stomach cancer, gastritis and gastric ulcers. Secondary metabolites have been identified in some cases of the several biological activities evaluated (Arrieta *et al*., 2003; Oviedo-Chávez *et al*., 2004; Castillo-Juárez *et al*., 2007; Rodríguez-García *et al*., 2010; Rosas-Acevedo *et al*., 2011; Rodríguez-Canales *et al*., 2016).

Of the reported plants 74% are used to treat some type of infectious diseases (caused by bacteria, fungi, parasites) in the community of Santiago Quiotepec. Infectious diseases are an important cause of morbidity and mortality in México since they are responsible for more than 20% of the deaths in rural areas (INEGI, 2004). Although significant progress has been made in microbiological research and in the control of diseases caused by infectious organisms, the emergence of drug-resistant bacteria as well as the appearance of new pathogenic strains, require the discovery of new drugs or new alternatives such as medicinal plants (Harvey *et al*., 2015; Sharma *et al*., 2016).

Of the mentioned species 73.8% have undergone antibacterial studies, evaluating their extracts on clinically relevant strains and only half of them have toxicological studies.

Of the 15 species selected to evaluated de antibacterial activity, 87% have activities on Gram-positive and Gram-negative bacterias. *Merremia dissecta* and *Cedrela oaxacensis* don't present antibacterial activity but maybe it have another biological activity on fungi, parasites or have anti inflammatory or analgesic activity.

The species with activity mainly belong to Asteraceae and Malvaceae families. Both families have reported a wide range of natural products (sesquiterpene lactones, monoterpenes, alkaloids, polyacetylenes and various phenolic compounds) (Sharma *et al*., 2016).

Some of the most active species are *Plumbago pulchella*, *Melochia tomentosa* and *Rhamnus humboldiana*. *Plumbago pulchella* hexanic extracts had better antibacterial activity. This species is used to treat skin infections in Santiago Quiotepec, the presence of naphthoquinones (plumbagina) has been reported in species of the genus *Plumbago* which has presented antimicrobial activity on *Staphylococcus aureus* and *Candida albicans* (Ribeiro de Paiva *et al*., 2003). *Melochia tomentosa* possess tumorigenic activity in rats (O´Gara *et al*., 1974), several types of alkaloids (Kapadia *et al*., 1978; Kapadia *et al*., 1980; Kapadia & Shukla, 1993) and coumarins (Shukla *et al*., 1976; Kapadia *et al*., 1977) are responsible for this activity. Several studies on *Rhamnus humboldiana* have reported the presence of toxic compounds (polyphenols) in the seeds, which can cause several neurological (Guerrero *et al*., 1987, Becerra-Verdin *et al*., 2009) and renal (Jaramillo-Juárez *et al*., 1995) effects, the antibacterial activity of quinones obtained from the fruits and roots was also evaluated, showing activity on Gram-positive and Gram-negative strains (Mitscher *et al*., 1985).

Species like *Jefea pringlei, Ehretia latifolia, Echinoperys egladulosa, Sida ciliaris, Cedrela oaxacensis* and *Loeselia purpusii* presented null biological activities in studies.

Table No. 1
Plants use in traditional medicine of Santiago Quiotepec, Oaxaca, México

Family, Species (voucher specimen)	Common name	Disease treated(1)	Plant part used	Manner of use	Route of administration(2)	Mention frequency
AMARANTHACEAE						
Amaranthus hybridus L. (JOM063)	Quelite	HR	Leaves	Boil	T	1
Dysphania ambrosioides (L.) Mosyakin & Clemants (JOM043)	Epazote	PA, PV	Leaves	Boil	O	4
AMARYLLIDACEAE						
Allium sativum L. (JOM047)	Ajo	PV, ER	Bulb	Boil	O	3
ANACARDIACEAE						
Amphipterygium adstringens (Schltdl.) Standl. (JOM001)	Cuachalalá	PS, RI, DB, EG, DM, CT, Al, HE	Bark	Boil, Poultice	O, T	38

Schinus molle L. (JOM062)	Pirul	EG	Aerial parts	Boil	O	1
ANNONACEAE						
Annona cherimola Mill. (JOM007)	Chirimoya	ER DM, AI	Fruit Leaves	Boil, Poultice	O, T	3
Annona muricata L. (JOM027)	Guanábana	CT, DB	Leaves	Boil	O	4
APOCYNACEAE						
Rauvolfia tetraphylla L. (JOM022)	Venenillo	HR	Seeds	Poultice	T	1
ASPHODELACEAE						
Aloe vera (L.) Burm.f. (JOM032)	Sábila	EG, CV, DB, ER, HE, AI	Aerial parts	Juice, Poultice	O, T	23
ASTERACEAE						
Artemisia absinthium L. (JOM046)	Ajenjo	DB	Leaves	Boil	O	2
Artemisia ludoviciana subsp. mexicana (Willd. ex Spreng.) D.D. Keck (JOM041)	Estafiate/ hierba maestra	RE	Leaves	Boil	O	6
Bidens pilosa L. (JOM044)	Santa María	AI, MP	Leaves	Boil	O, B	3
Jefea pringlei (Greenm.) Strother (JOM042)	Árnica	AI, HE	Aerial parts Leaves	Boil, Poultice	O, T	4
Matricaria chamomilla L. (JOM038)	Manzanilla	EG, AI, UT, BE	Aerial parts	Boil	O	15
Neurolaena lobata (L.) R.Br ex Cass (JOM040)	Acahuite	EG, RE	Leaves	Boil	O	7
Tagetes erecta L. (JOM014)	Flor de muerto	EG, BE	Flower	Boil	O	8
Tagetes lucida Cav. (JOM052)	Pericón	AI, MP	Leaves	Boil	O, B	2
BIGNONIACEAE						
Tecoma stans (L.) Juss. ex Kunth (JOM006)	Tronadora	EG, DB, AD	Leaves	Boil	O	11
BORAGINACEAE						
Ehretia latifolia Loisel. (JOM002)	Topoya	RI, CT, AI, HE, EG, MP	Aerial parts	Boil	O, B	25
Heliotropium angiospermum Murray (JOM030)	Hierba del alacrán	PV	Aerial parts	Boil	O	10
BURSERACEAE						
Bursera sp. (JOM051)	Palo mulato	OD, SV	Aerial parts	Boil	O	2
CACTACEAE						
Acanthocereus subinermis Britton & Rose (JOM035)	Nopal de cruz	DB	Stem	Juice	O	2
Opuntia sp. (JOM028)	Nopal	DB, CT, EG, AI	Penca	Juice	O	7
CONVOLVULACEAE						
Merremia dissecta (Jacq.) Hallier f. (JOM024)	Hierba de la araña	EG, PV	Leaves	Boil, Poultice	O, T	5
CRASSULACEAE						
Bryophyllum pinnatum (Lam.)	Belladona	OD	Leaves	Boil	O	1

(JOM016)						
CURCUBITACEAE						
Sechium edule (Jacq.) Sw (JOM056)	Chayote	CV	Leaves	Boil	O	1
EQUISETACEAE						
Equisetum hyemale L. (JOM017)	Cola de caballo	RI	Aerial parts	Boil	O	15
EUPHORBIACEAE						
Cnidoscolus tehuacanensis Beckon (JOM008)	Mala mujer	DM, OD	Leaves Latex	Poultice	T	2
Euphorbia pulcherrima Willd. ex Klotzsch (JOM036)	Nochebuen a	CV	Leaves	Boil	O	2
Jatropha neopauciflora Pax (JOM053)	Sangre de grado	HE	Leaves, Latex	Poultice	T	2
Ricinus communis L. (JOM011)	Grilla	EG	Leaves	Boil	O	4
FABACEAE						
Enterolobium cyclocarpum (Jacq.) Griseb. (JOM010)	Nacastle	PV, AI	Bark	Boil	O	5
Eysenhardtia polystachya (Ortega) Sarg. (JOM039)	Palo dulce/ palo azul	EG, DB, FD, AP, RI, AV	Bark	Boil	O	17
Leucaena leucocephala (Lam.) de Wit (JOM034)	Guaje	PA, LX	Seeds	Boil	O	3
Mimosa luisana Brandegee (JOM065)	Uña de gato	CT	Seeds	Boil	O	2
Parkinsonia praecox (Ruiz & Pav. ex Hook.) Hawkins (JOM009)	Mantecoso /Palo verde	PV, DM	Bark	Poultice	O, T	10
Prosopis laevigata (Humb. & Bonpl. ex Willd.) M.C. Johnston (JOM029)	Mezquite	EG, PV	Bark	Boil	O	2
LAMIACEAE						
Hyptis verticillata Jacq. (JOM057)	Hoja de la Martina	EG, AP	Leaves, Fruit	Boil	O	2
Marrubium vulgare L. (JOM060)	Marrubio	FE, PL	Leaves	Boil	O	2
Mentha spicata L. (JOM015)	Hierbabue na	EG, RE	Aerial parts	Boil	O	12
Ocimum basilicum L. (JOM021)	Albahaca	CV, LI	Aerial parts	Boil	O	10
Rosmarinus officinalis L. (JOM064)	Romero	MP	Leaves	Boil	B	1
LAURACEAE						
Persea americana Mill. (JOM033)	Aguacate	AI, EG, MP, LA	Leaves	Boil	O, B	13
MALPIGHIACEAE						
Echinopterys eglandulosa (A. Juss.) Small (JOM059)	Mal de ojo	OF	Flowers	Boil	T	1
MALVACEAE						
Melochia tomentosa L (JOM025).	Tapacola	EG	Aerial parts	Boil	O	2
Sida ciliaris L. (JOM045)	Abrojo	RI	Aerial parts	Boil	O	2
Waltheria indica L. (JOM031)	Cenizo	EG, DB	Aerial	Boil	O	3

			parts			
MARTYNIACEAE						
Martynia annua L. (JOM012)	Torito	CT	Seeds	Boil	O	1
MELIACEAE						
Cedrela oaxacensis C. DC. Rose (JOM019)	Cedro	CT, CV, AI, DM, PS	Bark	Boil	O	14
MYRTACEAE						
Eucalyptus sp. (JOM050)	Eucalipto	ER	Leaves	Boil	O	3
Psidium guajava L. (JOM005)	Guayaba	EG, BE, ER	Aerial parts	Boil	O	11
NYCTAGINACEAE						
Bougainvillea spectabilis Willd. (JOM003)	Bugambili a	ER	Flower	Boil	O	11
PLUMBAGINACEAE						
Plumbago pulchella Boiss (JOM066)	Hierba del negrito	CO	Leaves	Poultice	T	1
POACEAE						
Arundo donax L. (JOM055)	Carrizo	EG, MP	Aerial parts	Boil	O	2
Zea mays L. (JOM048)	Pelo de elote	RI	Hair	Boil	O	2
POLEMONIACEAE						
Loeselia purpusii Brandegee (JOM049)	Espinosillo	ER	Aerial parts	Boil	O	3
RHAMNACEAE						
Rhamnus humboldtiana Willd ex Schult. (JOM058)	Hoja de venado	AI	Leaves	Poultice	T	1
Ziziphus amole (Sessé & Moc.) M.C. Johnst. (JOM023)	Cholulo	CO	Fruit	Poultice	T	1
ROSACEAE						
Crataegus mexicana Mot & Sess, ex DC. (JOM054)	Tejocote	ER	Fruit	Boil	O	2
Eriobotrya japonica (Thunb.) Lindl. (JOM061)	Níspero	CV	Leaves	Boil	O	1
RUTACEAE						
Citrus limon (L.) Osbeck (JOM026)	Limón	AP, AX, DB, EG	Aerial parts	Boil	O	8
Citrus sinensis (L.) Osbeck (JOM037)	Naranja	ER, MP	Leaves, Fruit	Boil	O, B	5
Ruta chalepensis L. (JOM020)	Ruda	CV, EG, LI	Aerial parts	Boil	O	12
SAPOTACEAE						
Manilkara zapota (L.) P. Royen (JOM013)	Chicozapot e	PF	Leaves, Seeds	Boil	O	1
SELAGINELLACEAE						
Selaginella lepidophylla (Hook & Grev.) Spring (JOM018)	Siemprevi va	EG, RI, AI	Leaves	Boil	O	13
VERBENACEAE						
Lippia graveolens Kunth (JOM004)	Orégano de monte	BE, EG, AI	Aerial parts	Boil	O	16

(1): AD: antidepressant; AI: inflammatory; AP: appetizer; AV: abortive; AX: anxiolytic; BE: Hangover; CO: Itch; CT: cancer/ tumor; CV: cardiovascular; DB: diabetes; DM: skeletal-muscular pain; EG: gastrointestinal; ER: respiratory; FD: fertility; FE: fever; HE: wounds, cuts, burns; HR: hemorrhoids; LA: lactation; LI: clean the air; LX: llaxative;

MP: after delivery; OD: odontological; OF: ophthalmologic; PA: antiparasitic; PF: facial paralysis; PL: malaria; PS: purify the blood; PV: pickets; RE: reflux; RI: kidney; SV: smallpox; UT: menstruation.
(2): O: oral; T: topical, B: bath.

Table No. 2A
Antibacterial activity of medicinal plants of Santiago Quiotepec, Oaxaca againts Gram-positive bacteria
Inhibition zones (mm) and Minimal inhibitory concentration (mg/ml)

Specie	E	***S.a*[(1)]**	***S.a*[(2)]**	***S.a*[(3)]**	***S.a*[(4)]**	***S.a*[(5)]**
Chloramphenicol	25 µg	16.3 ± 0.5	22.3 ± 0.5	22.3 ± 0.5	20.0 ± 0.0	22.3 ± 0.5
	MIC (µg/mL)	2.0	4.0	7.0	8.0	7.0
Jefea pringlei	M	6.0 ± 0.0	na	na	na	na
	MIC	> 3.0				
Ehretia latifolia	M	na	6.0 ± 0	Na	na	na
	MIC		> 3.0			
Melochia tomentosa	M	14.6 ± 0.6	11.6 ± 0.6	13.6 ± 0.6	na	na
	MIC	> 3.0	1.5	> 3.0		
Plumbago pulchella	H	23.5 ± 0.7	21.0 ± 0.0	17.0 ± 0.0	6.5 ± 0.7	na
	MIC	0.25	0.5	0.25	0.25	
	AC	na	na	15.5 ± 0.7	na	na
	MIC			0.5		
	M	9.0 ± 0.0	10.0 ± 1.4	8.0 ± 1.4	na	na
	MIC	3.0	3.0	3.0		
Echinopterys eglandulosa	H	7.0 ± 1.0	na	8.0 ± 1.0	8.3 ± 1.15	na
	MIC	> 3.0		> 3.0	> 3.0	
	M	8.3 ± 0.6	7.3 ± 0.6	7.7 ± 0.6	na	na
	MIC	> 3.0	> 3.0	> 3.0		
Sida ciliaris	AC	na	na	na	na	Na
	MIC					
Ziziphus amole	H	na	15.0 ± 0.0	na	16.0 ± 0.1	8.3 ± 0.1
	MIC		> 3.0		> 3.0	> 3.0
	AC	na	na	Na	15.0 ± 0.0	na
	MIC				> 3.0	
	M	na	na	6.0 ± 0.0	6.0 ± 0.0	na
	MIC			> 3.0	> 3.0	
Crataegus mexicana	H	na	12.0 ± 0.0	na	10.0 ± 0	na
	MIC		> 3.0		> 3.0	
	M	6.0 ± 0.0	na	na	na	na
	MIC	> 3.0				
Bidens pilosa	AC	na	10.0 ± 0.0	6.0 ± 0.0	15.0 ± 0.0	10.0 ± 0.0
	MIC		1.0	1.5	0.75	0.5
Rhamnus humboldtiana	H	na	na	na	15.0 ± 0.0	na
	MIC				> 3.0	
	AC	na	Na	na	15.0 ± 0.0	na
	MIC				> 3.0	
	M	na	6.0 ± 0.0	na	6.0 ± 0.0	6.0 ± 0.0
	MIC		> 3.0		> 3.0	> 3.0

E: extract, H: Hexane, AC: Ethyl acetate, M: Methanol; *S.a: Staphylococcus aureus;* [(1)]: cc, [(2)]: FES-C, [(3)]: 23MR, [(4)]: ATCC 29213, [(5)]:CUSI. na: no active.

Table No. 2B
Antibacterial activity of medicinal plants of Santiago Quiotepec, Oaxaca againts Gram-positive bacteria (Inhibition zones (mm) and Minimal inhibitory concentration (mg/ml))

Specie	**E**	***S.e*[(6)]**	***S.e*[(7)]**	***M.l***	***E.f***
Chloramphenicol	25µg	18.0 ± 0.8	19.0 ± 0.0	32.0 ± 0.0	16.0 ± 0.8
	MIC (µg/mL)	2.0	2.0	2.0	3.0
Jefea pringlei	M	na	na	7.6 ± 0.6	6.0 ± 0.0
	MIC			> 3.0	> 3.0
Ehretia latifolia	M	na	na	na	6.0 ± 0.0
	MIC				> 3.0
Melochia tomentosa	M	13.0 ± 1.0	12.0 ± 1.7	16.0 ± 1.0	9.6 ± 1.1
	MIC	> 3.0	> 3.0	1.0	> 3.0
Plumbago pulchella	H	27.5 ± 2.1	22.0 ± 1.4	19.5 ± 3.5	16.5 ± 0.7
	MIC	0.25	3.0	3.0	1.5
	AC	na	24 ± 4.2	15 ± 0	12.5 ± 2.1
	MIC		2.0	2.0	2.0
	M	9.0 ± 0.0	na	na	7.3 ± 1.7
	MIC	> 3.0			> 3.0
Echinopterys eglandulosa	H	na	na	na	na
	MIC				
	M	7.6 ± 1.1	6.0 ± 0.0	na	7.7 ± 0.6
	MIC	> 3.0	> 3.0		> 3.0
Sida ciliaris	AC	6.0 ± 0.0	na	na	na
	MIC	> 3.0			
Ziziphus amole	H	na	na	na	na
	MIC				
	AC	na	na	na	na
	MIC				
	M	na	na	6.0 ± 0.0	na
	MIC			> 3.0	
Crataegus mexicana	H	na	na	na	na
	MIC				
	M	na	na	na	na
	MIC				
Bidens pilosa	AC	8.0 ± 0.0	10.0 ± 0.0	na	na
	MIC	0.75	1.5		
Rhamnus humboldtiana	H	na	na	na	na
	MIC				
	AC	na	na	na	na
	MIC				
	M	na	na	na	6.0 ± 0.0
	MIC				> 3.0

E: extract, H: Hexane, AC: Ethyl acetate, M: Methanol; *S.e: Staphylococcus epidermidis, M.l: Micrococcus luteus, E.f: Enterococcus faecalis;* [(6)]: ATCC 12228, [(7)]: FES-C. na: no active.

Table No. 3A
Antibacterial activity of medicinal plants of Santiago Quiotepec, Oaxaca againts Gram-negative bacteria (Inhibition zones (mm) and Minimal inhibitory concentration (mg/ml)

Specie	E	*E.c*(5)	*E.c*(8)	*K.o*	*K.p*
Chloramphenicol	25µg	23.0 ± 0.0	22.6 ± 0.5	20.6 ± 0.5	27.0 ± 0.0
	MIC (µg/mL)	4.0	4.0	1.0	1.0
Jefea pringlei	M	6.0 ± 0.0	na	6.0 ± 0.0	6.0 ± 0.0
	MIC	> 3.0		> 3.0	> 3.0
Ehretia latifolia	H	na	na	na	6.0 ± 0.0
	MIC				> 3.0
	AC	na	na	na	6.0 ± 0.0
	MIC				> 3.0
	M	na	na	na	6.0 ± 0.0
	MIC				> 3.0
Melochia tomentosa	H	na	na	na	6.0 ± 0.0
	MIC				3.0
	AC	na	na	na	6.0 ± 0.0
	MIC				> 3.0
Plumbago pulchella	H	7.5 ± 0.7	6.0 ± 0.0	16.5 ± 2.1	na
	MIC	1.5	3.0	3.0	
	AC	6.5 ± 0.7	6.0 ± 0.0	14.5 ± 0.7	na
	MIC	2.0	2.0	2.0	
	M	na	na	na	6.0 ± 0.0
	MIC				> 3.0
Echinopterys eglandulosa	H	na	na	na	7.3 ± 0.6
	MIC				> 3.0
	AC	na	na	na	7.0 ± 0.0
	MIC				> 3.0
	M	na	na	na	7.0 ± 0.0
	MIC				> 3.0
Waltheria indica	H	na	na	na	6.0 ± 0.0
	MIC				> 3.0
	AC	na	na	na	6.0 ± 0.0
	MIC				> 3.0
	M	na	na	na	6.0 ± 0.0
	MIC				> 3.0
Sida ciliaris	H	na	na	na	6.0 ± 0.0
	MIC				> 3.0
	AC	na	na	na	6.0 ± 0.0
	MIC				> 3.0
	M	na	na	na	6.0 ± 0.0
	MIC				> 3.0
Loeselia purpusii	H	na	na	na	6.0 ± 0.0
	MIC				> 3.0
	AC	na	na	na	6.0 ± 0.0
	MIC				> 3.0
	M	na	na	6.0 ± 0.0	6.0 ± 0.0
	MIC			> 3.0	> 3.0
Neurolaena lobata	H	na	na	na	7.3 ± 0.6
	MIC				> 3.0
	AC	na	na	na	6.6 ± 0.6
	MIC				> 3.0

	M	na	na	na	6.0 ± 0.0
	MIC				> 3.0
Ziziphus amole	H	na	Na	na	na
	MIC				
	M	na	6.0 ± 0.0	na	na
	MIC		> 3.0		
Bidens pilosa	AC	na	8.0 ± 0.0	na	na
	MIC		1.5		

E: extract, H: Hexane, AC: Ethyl acetate, M: Methanol; *E.c: Escherichia coli, K.o: Klebsiella oxytoca, K.p: Klebsiella pneumoniae,*[5]:CUSI, [8]: 82MR. na: no active.

Table No. 3B
Antibacterial activity of medicinal plants of Santiago Quiotepec, Oaxaca againts Gram-negative bacteria (Inhibition zones (mm) and Minimal inhibitory concentration (mg/ml)

Specie	**E**	***S.en***	***S.t***	***P.a***	***S.m***
Chloramphenicol	25µg	19.3 ± 0.47	20.0 ± 0.0	10.0 ± 0.5	16.0 ± 0.8
	MIC (µg/mL)	1.0	2.0	2.0	1.0
Jefea pringlei	M	na	na	na	na
	MIC				
Ehretia latifolia	H	na	na	na	na
	MIC				
	AC	na	na	na	na
	MIC				
	M	na	na	na	na
	MIC				
Melochia tomentosa	H	na	na	na	na
	MIC				
	AC	na	na	na	na
	MIC				
Plumbago pulchella	H	8.0 ± 1.4	10.5 ± 0.7	na	na
	MIC	3.0	3.0		
	AC	na	11.5 ± 0.7	na	na
	MIC		2.0		
	M	na	na	na	na
	MIC				
Echinopterys eglandulosa	H	na	na	10.0 ± 0.0	na
	MIC			0.25	
	AC	na	na	6.0 ± 0.0	na
	MIC			> 3.0	
	M	na	na	na	na
	MIC				
Waltheria indica	H	na	na	na	na
	MIC				
	AC	na	na	na	na
	MIC				
	M	na	na	na	na
	MIC				
Sida ciliaris	H	na	na	na	na
	MIC				
	AC	na	na	na	na
	MIC				
	M	na	na	na	na
	MIC				

Loeselia purpusii	H	na	na	na	na
	MIC				
	AC	na	na	na	na
	MIC				
	M	6.0 ± 0.0	na	na	na
	MIC	> 3.0			
Neurolaena lobata	H	na	na	6.0 ± 0.0	na
	MIC			> 3.0	
	AC	na	na	6.6 ± 0.6	na
	MIC			> 3.0	
	M	na	7.0 ± 0.0	6.6 ± 1.1	na
	MIC		> 3.0	> 3.0	
Ziziphus amole	H	6.0 ± 0.0	na	6.0 ± 0.0	na
	MIC	> 3.0		>3.0	
	M	6.0 ± 0.0	na	6.0 ± 0.0	6.0 ± 0.0
	MIC	> 3.0		> 3.0	> 3.0
Bidens pilosa	AC	na	na	na	na
	MIC				

E: extract, H: Hexane, AC: Ethyl acetate, M: Methanol; *S.en: Salmonella enterica, S.t: Salmonella typhi, P.a: Pseudomona aeruginosa, S.m: Serratia marcenscens*. na: no active

CONCLUSIONS

In Santiago Quiotepec community 98% of the informants use medicinal plants to cure some type of disease, being the most common the gastrointestinal diseases.

Most of the evaluated species (87%) have antibacterial activities on strains of clinical importance.

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