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Ethno-botanical study of medicinal plants used by the Yucatec maya in the Northern District of Belize

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Abstract
The knowledge of plants used in traditional medicine by the indigenous communities is fast disappearing due to various reasons. This study made an effort to document the herbal knowledge that exists in the family circles of the Yucatec Maya communities of Northern Belize. Research was carried out in four villages in the Corozal and Orange Walk Districts during 12 weeks of fieldwork. A total of 59 plant species, grouped within 57 genera and 35 families that are used in traditional medical practices were identified and studied. Plants belonging to Rutaceae, Lamiaceae and Euphorbiaceae were the most commonly used species. The growth habits of plants reported include herbs (37%), trees (25%), shrubs (15%), trees/shrubs (plants having characteristics of both trees and shrubs) (14%), and vines (9%). The most common plant part used was leaves (66%), followed by bark, whole plant and flower (each with 7%). Of the total number of medicinal plants, 20 species were used to treat infections, 16 for digestive system disorders, 9 for skin/subcutaneous cellular tissue disorders, 7 for respiratory system disorders, 6 for endocrine system disorders, 6 for culture-bound syndromes, 5 for genitourinary system disorders, 4 for musculoskeletal system disorders, 4 for circulatory system disorders, 2 for injuries and 1 for sensory system disorders. Species cited more frequently by the most herbalists are regarded to be of greater ethnobotanical importance than those cited only by a few herbalists.

Keywords: Yucatec maya, traditional medicine, plant use, herbalist

1. Introduction
In the Maya worldview, all living things are connected and plants are recognized for their healing properties [1]. Nonetheless, in northern Belize, most of the cultures and practices of the ancient Maya have been abandoned with development and urbanization. Before the arrival of the Europeans, the Maya thrived in Belize and lived in an area that stretched from Central Mexico, through to El Salvador. The modern-day Maya of Belize are descendants of the ancient Mayas that inhabited these areas. Three groups of Maya are living in Belize; these are the Q'echi' Maya, the Mopan Maya, and the Yucatec Maya. In the southern districts of Belize, Q'echi' Mayasand Mopan Mayas have maintained much of their cultural practices, but the Yucatec population that came after the Caste War has almost entirely integrated in the Corozal and Orange Walk areas to which they fled.
Northern Belize consists of Corozal District and Orange Walk District. This region has a drier more seasonal climate than the south. It is an area supporting a wide variety of ecosystems, including lowland broadleaved forest, lowland savannah, mangrove and littoral swamp [].It is ecologically diverse due to its underlying geology, with pine savannah found in well-drained acidic sand ridges, evergreen forest on calcareous sediments, and herbaceous swamps, seasonally inundated savannah and marshland in the freshwater lowlands. The Maya lowlands, which include parts of Belize, Mexico and Guatemala, have been affected by a complex mixture of both climatic change and anthropogenic disturbance. Forest clearance is associated with the appearance of crops, intensive cultivation of crops, deforestation and management of arboreal resources. These disturbances in combination pose a threat to the ethnobotanical knowledge on the ancient Maya. In addition, indigenous knowledge on usage of medicinal plants as folk remedies are getting lost due to migration from rural to urban areas, industrialization, rapid loss of natural habitats of medicinal plants and changes in life style. This highlights the importance of the documentation of medicinal plants in traditional healing in order to preserve this knowledge. Furthermore, most ethnobotanical studies are focused on professional traditional practitioners and ignore the knowledge of ordinary people in the locality. Thus it is important to investigate the traditional uses of medicinal plants by the ordinary people and to provide baseline data for future pharmacological and phytochemical studies.

Indigenous knowledge on usage of medicinal plants as folk remedies are getting lost due to migration from rural to urban areas, industrialization, rapid loss of natural habitats and changes in life style. Ethnobotanical knowledge, including the knowledge of how to grow and process plants for housing, clothing, food, medicine, storage, and fuel, is important for community members to heal common illnesses when access to medical doctors or pharmaceuticals is limited or the side effects produced by medications are undesirable. The importance of ethnobotanical studies lies in that they often lead to the discovery of crude drugs. Traditional medicine is very important in developing countries such as Belize. For instance, in Ethiopia, traditional medicine is still the main resource for approximately 80% of the people for treating health problems since it has a much lower cost than modern medical attention [6, 7].Traditional ecological knowledge is often regarded as out-dated, static and anecdotal, and often based on spiritual rather than empirical foundations. However, Yucatec Maya ethnobotany is not only empirical, but it is rapidly changing and evolving to take account of new species and their properties

n ethnobotanical study in Ethiopia report that the use of traditional medicine is influenced by culture, effectiveness of the plants against certain type of diseases, physical accessibility to the plants and economic affordability as compared to contemporary medicine. They found that the ecological diversities of the country, socio-cultural background of the different ethnic groups as well as historical developments, which are related to migration, introduction of foreign culture and religion are other factors that influence the traditional medicine system. Knowledge from herbalists is passed secretively from one generation to the next through words of mouths or by inheriting medico-spiritual manuscripts. study the ethnobotanical knowledge among the Q'eqchi' Maya of Belize found that although the bark and whole plants are sometimes used, the leaves (and/or stems) are used most often in the preparations. These are soaked in cold water or boiled to prepare the remedy, and they are either given orally or the water is used as a bath or to wet the patient's head. For treating culture-bound syndromes, the healers often perform a ritual of "smoking" the patient where certain plants are burned with various other items and the smoke is set to rise around the patient. lant parts used by the Q'eqchi' Maya included resin, fruits, seeds, vines, roots, stems, flowers, and combination of roots, stems, vines, flowers or leaves.

The modernization processes affecting knowledge acquisition and transmission are not unique to the Yucatec Maya of Northern Belize. Hence it is crucial that ethnobotanical knowledge is preserved. More research using these approaches is needed to develop and test theories regarding ethnobotanical knowledge acquisition, transmission, variation, dynamism, and loss. Hence the objective was to document use of plant resources by the Yucatec Maya using surveys, field observations and semi-structured interviews. In this study, surveys were conducted with traditional Maya healers from villages of the Orange Walk District and the Corozal District in Northern Belize to obtain ethnobotanical data on traditional medicine of the Yucatec Maya. The paper documents the knowledge of the sample population and determines the taxonomical classification of the plants collected.

2. Methodology

2.1 Data collection

Study site and Yucatec healers

Northern Belize, consisting of Corozal District and Orange Walk District, hosts a wide variety of ecosystems. Yucatec Mayas, most of which came to Belize fleeing from the Caste War, inhabited these areas. Due to population growth and the rich diversity of cultures and ethnic groups in Belize, the Yucatec Maya culture has merged with these other cultures. Study area included Yo Creek and Santa Cruz village from the Orange Walk District, and Cristo Rey and Patchakan from the Corozal District. Snowball sampling technique was used to recruit the informants. To obtain a representative sample size, the concept of species-area curve was applied to the ethnobotanical collection.

Field work and ethnobotanical data collection

Field work was carried out during January-April 2016. Sample population participated in semi-structured interviews and structured surveys regarding the use of the local flora for medicinal purposes. Standard ethnobotanical methods were employed and prior informed consent was obtained for all study participants. Questionnaires, field observations, and guided field walks were conducted. Questionnaires were used in the form of interviews, where researcher met with each participant and documented all relevant information. Participants led researcher to guided field walks where keen observations of the plants were made and documented properly. During these field observations, photographs of the parts of the plants were taken in their habitat and portions of the plants were collected for further identification.

Specimen collection and identification

During the interviews, fresh plant specimenswere collected for identification purposes. Informants were followed into the field to show the quoted species. Identification was done using relevant literature and consulting experts in the field of taxonomy.

2.2 Data analysis

Data from each study was entered in a Microsoft Excel spread sheet. Use-reports for individual plant species, scientific name, local plant name(s), plant family, name of health condition treated, plant part used, and mode of administration were recorded for the quoted plant species. Descriptive analyses such as frequency table, charts and percentage were used to properly summarize ethnobotanical data. The total number of medicinal plants collected were recorded and categorized under the different families to which they belong. Each plant species was listed, according to alphabetical order using their family names. Descriptions including the parts used, the methods of preparation, and its traditional uses were provided. A general description of the plant species was provided as well. The reported aliments were grouped into categories based on the information gathered from the interviewees. The categories were adapted from Amiguet *et al.*. These categories include "infections" (INF), "digestive system disorders" (DIG), "skin/subcutaneous cellular tissue disorders" (SKI), "respiratory system disorders" (RES), "endocrine system disorders" (END), "culture-bound syndromes" (CUL), "injuries" (INJ), "genitourinary system disorders" (GEN),"musculoskeletal system disorders" (MUS), circulatory system disorders" (CIR), and "sensory system disorders"(SEN).

Results and Discussion

The scientific name of the plant, name used by Yucatec Maya, parts used, ailments treated, and brief descriptions on the mode of preparation and administration for the plant species are presented in Table1.

Table 1: List of the medicinal plant species used by the Yucatec Maya of Northern Belize, the parts used and their medicinal uses.

Scientific Name	Maya Names	Parts Used	Ailments Treated	Method of preparation and Treatment
Aloe vera	Sabila	Leaves	Bruises and sores, hair loss, dandruff, swelling and gastritis.	For bruises and sores: Roast and whole leaf without peeling; cut in half and apply gel to affected area 2 times daily until no bruises/sores are visible. For hair loss and dandruff: peel fresh leaf and apply gelon scalp and hair then rinse. For swellings: Peel leaf and apply fresh gel on affected area and wrap with a clean cloth until swelling disappears. For gastritis: Peel leaf, cut 3 small dices and eat raw.
Spondias purpurea	Ciruela, a'ba'l	Leaves	Diarrhoea and rash	For Diarrhoea: Boil 6 leaves with 4 guava leaves in 1 litre water and drink liquid. For rash: Roast leaves, macerate and apply on affected area. Another option is tear/chop leaves in half a bucket of water, leave under the sun for half day and bathe in warm liquid.
Astronium graveolens	X'kulinsis, Kulinche'	Leaves	Itchiness, allergies and rash	Boil an entire leaf with leaflets in water and wash affected area with liquid.
Annona muricata	Guanabano	Leaves	Chickenpox and diabetes	For chickenpox: Boil a handful of leaves with pomegranate and tamarind leaves in water and bathe in liquid until symptoms disappear. For diabetes: Boil 8 leaves in half litre water and drink throughout the day 4 times a week
Tagetes erecta	Flor de muerto	Leaves	Itchiness and rash	Boil a handful of leaves in 1 litre water; use warm water to wash affected area to relieve itchiness and rash
Helianthus petiolaris	Girasol de monte	Leaves	Rheumatism	Boil leaves in water and bathe in water when warm; Boil in water and drink half glass of liquid before every bath
Artemisia ludoviciana	Sisim	Leaves	Diarrhoea and vomiting	Boil a handful of leaves in 1 litre of water and drink liquid. Another option is to grind leaves with “masa” to make a porridge and eat as food while patient has diarrhoea and vomiting
Basella alba	Espinaca	Leaves	Anaemia and eyesight loss	Fry along with eggs or eat with other foods as a staple food
Bixa orellana	Achiote, Ku'xub	Leaves, seeds	Measles and dandruff	For measles: Place seeds under hammock where baby sleeps. Leave every night until symptoms disappear. For dandruff: Boil leaves in water and wash hair with liquid 3 times a week.
Symphytum Officinale	Suelda consuelda, Suelda con suelda	Root	Fractured bones	Grate roots, mix with an egg from local chicken and apply on affected area to hold as a cast by making a sheet with a piece of cloth.
Bursera simaruba	Chaca	Leaves, bark	Fever, itchiness and poisonwood allergy	For fever: Tear fresh leave and soak in half rubbing alcohol and half water. Apply soaked leaves on forehead. Another option is to soak in water and wet head and forehead with soaked leaves and water. For itchiness and allergies: Macerate leaves and place on affected area or chop young bark and place on affected area.
Opuntia cochenillifera	Nopal, Pak'am	Stem	Fever, haemorrhoids	For fever: Peel leaves; draw a cross shape on the leaf, and apply on hands, feet, back, stomach and forehead. For haemorrhoids: Peel leaf, cut a dice and apply on anus overnight.
Hylocereus undatus	Pitahaya	Fruit	Diarrhoea	Consume 1-2 fruits daily until symptoms last
Cecropia obtusifolia	Guarumo, K'och	Leaves	Fever	Macerate 3-4 fresh leaves; place on forehead and wrap head with a clean cloth
Chenopodium ambrosioides	Epasote, Apasote	Leaves	Intestinal parasites and memory loss	Place the leaves of 1 small plant inside the pot of boiling beans; consume along with beans. Another option is to macerate the leaves and drink the liquid produced.
Kalanchoe pinnata	Siempre viva	Leaves	Swelling; allergies to insect bites, headache	Macerate leaves to make a poultice and apply on affected area
Momordica charantia	Sorosi	Whole plant	Low blood levels, chickenpox	For low blood levels: Boil whole plant in 1 litre water and drink half glass of liquid daily for 3 days. For chickenpox: Boil a few plants in 1 gallon of water and bathe with liquid.
Cucurbita moschata	Calabaza	Fruit	Hepatitis	Boil and entire fruit in 1 litre water and drink liquid or boil fruit in water without salt and eat
Cnidoscolus chayamansa	Chaya	Leaves	Menstrual cramps; low blood levels and	Boil 5 leaves in 1 litre water and drink liquid. Another option is to grind leaves and mix with pumpkin seeds

			kidney pain	(pepitos) to eat.
Ricinus comunis	Higuerilla	Leaves	Fever, cuts and wounds	For fever: Wet head with rubbing alcohol; cover head with leaves and wrap with a clean cloth. For cuts and wounds: Boil 3-4 leaves in water and wash affected area with liquid.
Phyllanthus liebmannianus	Chin-chin-ojo	Whole plant	"Ojo" in babies and infants.	Macerate leaves and mix with an egg; apply on wrist of the child and wrap with a clean piece of cloth
Chamaesyce hyssopifolia	Cura ash	Sap	Warts	Apply sap from stem onto wart daily until wart falls off
Senna occidentalis	Frijolillo	Leaves	Insomnia in babies	Soak a handful of leaves in water in the morning and use the liquid without leaves to bathe baby in the evening before putting the baby to sleep.
Bauhinia forficata	Pata de vaca	Leaves	Cough	Boil leaves with cotton and avocado leaves and drink as tea
Diphysa carthagenensis	Tzuk-tzuk	Leaves	Headache	Crush leaves and soak in water then wash/wet head with liquid
Mentha spicata	Hierba buena	Leaves	Diarrhoea, vomiting and colic in babies	Mash 2 leaves of spearmint with 2 leaves of sour orange and cinnamon and add boiling water. Adults drink liquid and babies are given by sips
Ocimum basilicum	Albahaca, xcacaltun	Seeds	Eye infection	Apply 1 small seed inside the eye to remove dirt or other foreign particles from the eye. When seed is removed, it removes dirt along with it
Plectranthus amboinicus	Oregano grueso	Leaves	Swelling, ear pain, cough and asthma	For swelling: Macerate leaves and place on affected area to relieve swelling. For ear pain: Roast leaves and macerate; place 4-5 drops of the liquid inside the ear. For cough and asthma: Macerate leaves with a few drops of warm water in a spoon. Drink a tablespoon of the liquid by sips. Another option is to boil 6 leaves with 2 garlic cloves, a small section of mashed ginger, a slice of pink onion, 2 limes and half litre water; store and drink cold for 3 days.
Melissa officinalis	Toronjil	Leaves	Vomiting	Mash 2 leaves with garlic and add ½ cup boiling water. Drink liquid.
Persea americana	Aguacate, O'n	Leaves	Cough	Boil a handful of leaves in 2 cups water and drink half a glass of the liquid in the morning and the other half in the evening. Another option is to boil young leaves along with soursop leaves in water and add honey.
Allium fistulosum	Cebollina	Whole plant	Cough	Grind 1 whole plant, and soak in boiling water; drink liquid by teaspoons throughout the day
Allium cepa	Cebolla	Stem	Cough	Slice medium-sized onion and boil in 2 cups water; add 1 garlic clove and a few teaspoons of honey; drink 1 teaspoon every once in a while throughout the day.
Bunchosia swartziana	Sip che	Leaves	Headache	Masha handful of leaves and soak in 2 litres of water; wash/wet head with liquid to relieve headache almost immediately
Abelmoschus esculentus	Ocoro	Seeds	Urinary retention	Dry a handful of seeds and grind them; soak in 1 litre boiling water; drink liquid throughout the day.
Gossypium barbadense	Algodon, Pitz	Leaves	Cough and wheezing	Roast 3 leaves (of each) of cotton, soursop, oregano and avocado; squeeze the liquid on a spoon and take liquid in sips
Cedrela odorata	Cedro, Ku-che	Bark	Hypertension; liver disease	Boil 4-5 pieces of the bark with 1 gallon of water and drink water throughout the day.
Brosimum alicastrum	Ramon, O'ox	Sap	Cavities on molar teeth	Take the sap and soak a cotton ball with the sap; place cotton ball on the affected tooth daily until breaks/disintegrates completely. Tooth starts to break into small pieces and eventually the entire tooth disintegrates
Moringa oleifera	Cura todo	Leaves, seeds, flower	Cancer, low blood level, diabetes, nervous attacks, hypertension, etc.	Use dry leaves to brew as tea; eat dried seeds for diabetes; cook flower and leaves along with beans.
Psidium guajava	Guayaba	Leaves	Diarrhoea, chicken pox and itchiness	For Diarrhoea: Boil 4-5 young leaves in 1 litre water and drink liquid. For chicken pox: Macerate leaves along with pomegranate leaves, soak in a bucket filled with water, set under the sun, and use the water to bathe patient daily until symptoms disappear. If chicken pox is present in the mouth, gargle with the same liquid.
Pimenta dioica	Pimienta gorda	Leaves	Impurities in the blood and diabetes; gastritis	For impurities in the blood and diabetes: Boil 4 leaves in 1 litre of water and add cinnamon for flavour (optional). Drink liquid throughout the day. For gastritis: follow same procedure but add basil and avocado leaves.
Syzygium aromaticum	Clavo de comida	Flower	Toothache	Chew dried flower to obtain liquid; the liquid released

				relieves toothache.
Piper amalago	Cordoncillo	Leaves	Bilis	Soak handful of leaves in drinking water and drink throughout the day.
Piper yucatenense	Makulan	Leaves	Vaginal infections	Boil 4-5 leaves in ½ bucket water; pour liquid in a bucket and have patient sit on the bucket to allow vapour to enter into the vaginal area.
Plantago major	Llanten	Leaves	Swelling	Macerate leaves and apply poultice on affected area.
Cymbopogon citratus	Sacate limon	Leaves	Fever and cough	Boil a handful of leaves in 1 litre of water and drink liquid throughout the day until symptoms disappear.
Zea mays	Maiz, Nal (Tzuk hair)	Flower- style	Urinary tract infection	Boil silk hairs (Tzuk-hair) from 1-2 corn cobs along withokra leaves and drink liquid
Microgramma nitida	Tip' te' -ak'	Bark	Stomach ache/cramps, menstrual cramps, Pasmo	Combine 10 small chips from the bark along with 5 oregano leaves, 5 garlic cloves (mashed), 6 allspice seeds, cinnamon and smoke settled on the roof above fire hearth; boil in water and drink liquid daily until stomach-ache goes.
Punica granatum	Granada	Leaves	Hypertension	Consume pulp on a regular basis to prevent and reduce high blood pressure.
Hamelia patens	Xkanaan	Leaves, flower	Diabetes, gastritis and low blood level; athlete's foot and rash.	For diabetes, gastritis and low blood level: Boil leaves and flowers from a branch in 1 litre water and drink liquid. For athlete’s foot and rash: Macerate leaves and place on affected area to relieve itchiness.
Citrus aurantium	Naranja agria	Leaves	Diarrhea and vomiting; ear pain; vaginal infections.	For Diarrhoea and vomiting: Boil 3 leaves with half garlic clove, a small piece of ginger in half litre water for 20 minutes. Drink liquid cold throughout the day until symptoms disappear. For ear pain: Roast leaves and macerate; place a few drops of the liquid inside ear. For vaginal infections: Boil the amount of leaves found in a small branch in 1gallon water; place boiling liquid in a bucket and have patient sit on top of the bucket to allow vapour to enter the vaginal area.
Zanthoxylum caribaeum	Sinanché	Thorns	Fever and headache	Remove dry thorns from branches and make small punctures on the scalp around the area where hair meets the forehead and in the back.
Ruta graveolens	Ruda	Leaves	Ojo and diarrhoea in babies	Grind fresh leaves, add water, and sieve the liquid and drink. Another option is to macerate leaves from 9 branches and soak in 1 cup of rubbing alcohol; float cup with liquid above the infant's body.
Citrus aurantiifolia	Limon	Fruit	Swelling of the foot	Cut a very ripe fruit in half and rub pulp on affected area 2-3 times a day until swelling is reduced.
Murraya paniculata	Limonaria	Leaves	Swelling	Macerate leaves to obtain extract and apply on affected area until inflammation is reduced or disappears.
Manilkara zapota	Sapote	Bark	Diarrhoea	Boil a few pieces of the bark in ½ litre water and drink liquid throughout the day while diarrhoea persists.
Cestrum nocturnum	Dama de noche	Leaves	'Pujido', infection in belly button of newborns	Take 9 leaves and apply in a cross-shape on the belly button of babies. Traditional people believe that 'pujido' is caused when the baby is exposed to a woman who is menstruating or a pregnant woman. It is characterized when babies moan, whimper or groan and when they become reddened as they exert too much effort.
Nicotiana tabacum	Tobacco, Ku'tz	Leaves	Swelling; allergies to insect bites, headache	Macerate leaves with a glass pint and apply poultice on affected area.
Urtica dioica	Ortiga	Whole plant	Mal aire, santiguar	Pull entire plant by the roots and pass plant over patient’s body several times to make the evil winds dissipate from the patient’s body.
Lippia graveolens	Oregano castillo	Leaves	Menstrual delays, stomach problems and wheezing.	For menstrual delays: Boil a few leaves in ½ litre water and drink liquid. For stomach problems: Boil leaves with 2-3 cloves, half garlic clove and smoke settled on the roof above fire hearth; drink liquid. For wheezing: Roast 2 leaves, squeeze out liquid on a spoon and add honey; drink in sips.

Traditional medicine encompasses the knowledge and practices applied in the diagnosis, prevention, and healing or treatment of an ailment affecting the physical, mental or social health of an individual. This knowledge is based on experience and is passed from generation to generation mostly in oral form. Yucatec Maya traditional knowledge is transmitted in oral form, so there are no documents that can be used to study ancient knowledge of the Yucatec Maya regarding medicinal plants. Similarly, in this study it was found that only a small percentage of participants document their knowledge in written form (21%). However, 93% of individuals reported that they share their knowledge to their children, relatives and community members verbally. The same 21% that document their traditional knowledge in

manuscripts reported to be actively involved in their communities teaching younger children and interested individuals about Yucatec Maya folk medicine. Thus, the limited knowledge of medicinal plants that exists in today's society is not attributed to the Maya healers' reluctance to share but rather to the people's lack of interest in traditional medicinal knowledge. Traditional knowledge on the use of medicinal plants is expressed in basically two forms: popular knowledge that is managed across the family circle and applied most commonly by housemakers, or knowledge possessed by traditional healers who have a vaster and profound knowledge based on herbal healing. Traditional healers can be classified based on different specialties. The "h'men" perform therapeutic activities as well as ceremonies and rituals; the "hierbatero" specializes in the use of medicinal plants and the "huesero" or "sobador" specializes in massages encompassing tendons, muscles and bones; and "parteras" tend to the reproductive health of women. In this study, data was gathered from the local knowledge managed among Yucatec Maya households.

Most participants in this study were 71 years of age or older (50%), followed by individuals 61-70 years of age (36%), 51-60 years of age(7%) and less than 31 years of age (7%).The participant demographics are summarized in Table. An important observation made during this research is that 93% of participants had been practicing the use of medicinal plants for more than 25 years, including individuals who had been practicing this for over 50 years. All participants reported learning the use of medicinal plants from their parents and elders in their family or community, indicating that this knowledge is mostly managed within households or families.

Therefore, most of these individuals do not charge for their services but rather willingly share their knowledge with anyone who seeks their assistance so that these persons can prepare the same remedies at home. Two individuals (n=14)reported that they do not charge for their services but do accept monetary contributions from their patients because the plants used to treat the ailments they tend to are hard to obtain and require an extensive preparation time. One of these herbalists specializes in snake bites while the other specializes in treating "cirro"a culture-bound syndrome.

The herbalist who specializes in treating snake bites reported that plants used in his remedies require a drying period of up to two years. Unfortunately, these remedies could not be documented in this paper because these plants could not be obtained for identification purposes as they can only be obtained in pristine forests and during the rainy season.

Table 2: Participant demographics

Variable	Percentage (%)
Age in years	
71 and above	50
61-70	36
51-60	7
41-50	0
31-40	0
30 and less	7
Gender	
Male	21
Female	79
Livelihood	
Homemaker	79
Full-time subsistence farmer	7
Full-time wage labourer	14
Placed of residence	
Only in their community	57
Other small communities	14
Other countries	29
Relative Lifestyle	
Very traditional	36
Combination between traditional and modern	64
Interest in medicinal plants	
Interested	79
Neutral	14
Uninterested	7
Variable	Percentage (%)

All healers used a variety of medicinal plants for preventing, healing and treating ailments. The informants reported 91 plant species that they use for medicinal purpose;59 plant species were recorded since the remaining had only 1 use report. Recorded species had at least 2 use reportsto ensure that they were representative of the Yucatec Maya community. A total of 59 plant species (Table), grouped within 57 genera and 35 families used in traditional medical practices were identified and studied. Families with the largest number of species used in traditional healing are Rutaceae, Euphorbiaceae and Lamiaceae (Figure 1), making them the most important in terms of frequency of usage. However, it can be observed in Figure 1 that there is a wide range of botanical families, with each family having 1-3 plant species cited.

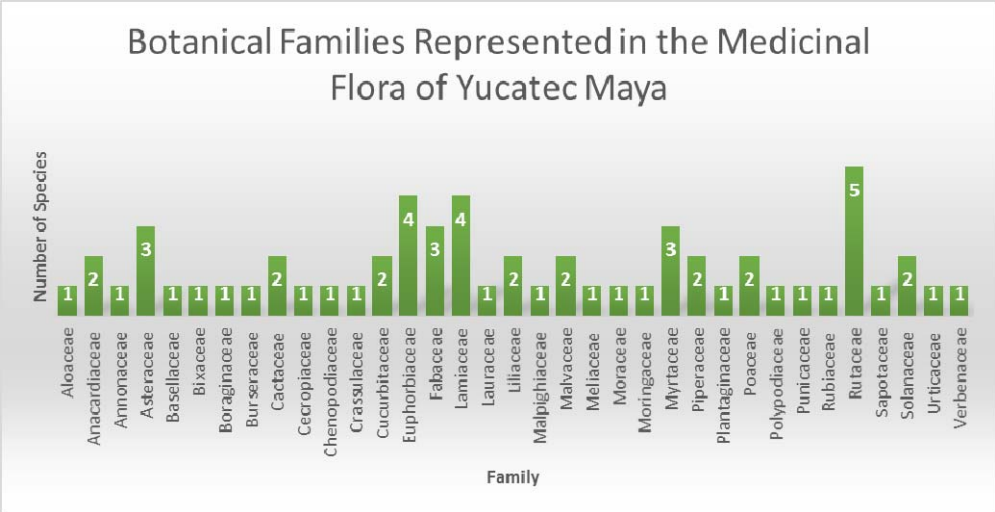

Fig 1: Ethnobotanical families represented in the medicinal flora of Yucatec Maya

Rutaceae was found to be the most commonly used plant family among participants, followed by Euphorbiaceae and Lamiaceae.Similarly, in an ethnobotanical study of the Albanian Alps in Kosovo found thatone of the predominantly quoted botanical families was LamiaceaeAsteraceae as most common plant families used in Kosovon BayramiçTurkey). The wide variety of botanical families cited by the healers can be attributed to the rich floral diversity of Northern Belize, varying from lowland swamps and broadleaf forests to mangrove forests.

Table 3: List of medicinal plant species used by the Yucatec Maya of Northern Belize with common names and their families and major ailments treated.

Family	Scientific Name	Common Names	Medicinal Uses
Aloaceae	*Aloe vera*	Aloe	DIG, INF, INJ, SKI
Anacardiaceae	*Spondias purpurea*	Purple mombin	DIG, SKI
Anacardiaceae	*Astronium graveolens*	Glassywood	SKI
Annonaceae	*Annona muricata*	Soursop	END, INF
Asteraceae	*Tagetes erecta*	Marigold	SKI
Asteraceae	*Helianthus petiolaris*	Wild sunflower	MUS
Asteraceae	*Artemisia ludoviciana*	White sagebrush	DIG
Basellaceae	*Basella alba*	Ceylon Spinach, Indian Spinach, Basella, vine spinach, vine kelp	SEN
Bixaceae	*Bixa*	Annatto	INF, SKI
Boraginaceae	*Symphytum Officinale*	Common comfrey, Knitbone	MUS
Burseraceae	*Bursera simaruba*	Gumbo Limbo	INF, SKI
Cactaceae	*Opuntia cochenillifera*	Cactus	INF, CIR
Cactaceae	*Hylocereus undatus*	Strawberry pear, Dragon fruit, Night blooming cereus	DIG
Cecropiaceae	*Cecropia obtusifolia*	Trumpet tree	INF
Chenopodiaceae	*Chenopodium ambrosioides*	Mexican weed, wormseed	INF, MUS
Crassulaceae	*Kalanchoe pinnata*	Leaf of life	INF, NER, SKI
Cucurbitaceae	*Momordica charantia*	Balsam pear, Bitter lemon	INF, SIR
Cucurbitaceae	*Cucurbita moschata*	Squash, Pumpkin	END
Euphorbiaceae	*Cnidoscolus chayamansa*	Chaya	GEN, MUS
Euphorbiaceae	*Ricinus comunis*	Castor bean plant	INF, INJ
Euphorbiaceae	*Phyllanthus liebmannianus*	Baby's tears	CUL
Euphorbiaceae	*Chamaesyce hyssopifolia*	Hyssopleaf sandmat	SKI
Fabaceae	*Senna occidentalis*	Septic weed, Yama bush	CUL
Fabaceae	*Bauhinia forficata*	Cow’s foot, Cow foot vine	RES
Fabaceae	*Diphysa carthagenensis*		NER
Lamiaceae	*Mentha spicata*	Spearmint	DIG
Lamiaceae	*Ocimum basilicum*	Basil	INF
Lamiaceae	*Plectranthus amboinicus*	Indian borage, Mexican mint	INF, RES
Lamiaceae	*Melissa officinalis*	Lemon balm, Common balm	DIG
Lauraceae	*Persea americana*	Avocado	RES
Liliaceae	*Allium fistulosum*	Welsh Onion	RES
Liliaceae	*Allium cepa*	Onion	RES
Malpighiaceae	*Bunchosia swartziana*		NER
Malvaceae	*Abelmoschus esculentus*	Okra	GEN
Malvaceae	*Gossypium barbadense*	Cotton	RES
Meliaceae	*Cedrela odorata*	Cedar	CIR, END
Moraceae	*Brosimum alicastrum*	Maya nut, Breadnut	DIG

Moringaceae	*Moringa oleifera*	Moringa	CIR, END, NER
Myrtaceae	*Psidium guajava*	Guava	DIG, INF, SKI
Myrtaceae	*Pimenta dioica*	Allspice	DIG, END
Myrtaceae	*Syzygium aromaticum*	Clove	DIG
Piperaceae	*Piper amalago*	Buttonwood, Spanish elder	CUL
Piperaceae	*Piper*	Acuyo, Mexican pepper leaf, Sacred pepper	GEN
Plantaginaceae	*Plantago major*	Broadleaf plantain	INF
Poaceae	*Cymbopogon citratus*	Lemon grass, Fever grass	INF, RES
Poaceae	*Zea mays*	Corn, Maize	GEN
Polypodiaceae	*Microgramma nitida*	Fern	DIG
Punicaceae	*Punica granatum*	Pomegranate	DIG
Rubiaceae	*Hamelia patens*	Polly Redhead, Redhead	DIG, END, INF
Rutaceae	*Citrus aurantium*	Sour orange	DIG, GEN
Rutaceae	*Zanthoxylum caribaeum*	Prickly yellow	INF, NER
Rutaceae	*Ruta graveolens*	Rue	CUL
Rutaceae	*Citrus ×aurantiifolia*	Mexican lime, key lime	INF
Rutaceae	*Murraya paniculata*	Orange jessamine, Mock orange	INF
Sapotaceae	*Manilkara zapota*	Sapodilla	DIG
Solanaceae	*Cestrum nocturnum*	Night-blooming jasmine/ jessamine, night-blooming cestrum, lady/queen of the night	CUL
Solanaceae	*Nicotiana tabacum*	Tobacco	INF, NER
Urticaceae	*Urtica dioica*	Stinging nettle	CUL
Verbenaceae	*Lippia graveolens*	Oregano	DIG, GEN

Medicinal Uses: INF= infections, DIG= digestive system disorders, SKI= skin/subcutaneous cellular tissue disorders, RES= respiratory system disorders, END= endocrine system disorders, CUL= culture-bound syndromes, INJ= injuries, GEN= genitourinary system disorders, MUS= musculoskeletal system disorders, CIR= circulatory system disorders, and SEN= sensory system disorders

The growth habits of the 59 species of medicinal plants reported include herbs (37%), trees (25%), shrubs (15%), trees/shrubs (14%), and vines (9%) (Figure 2). Herbs was the most common growth habit of plants used by the Yucatec Maya of Corozal and Orange Walkand the leaves, which are the most frequently used part of the plant to treat diseases, are easier toreach.

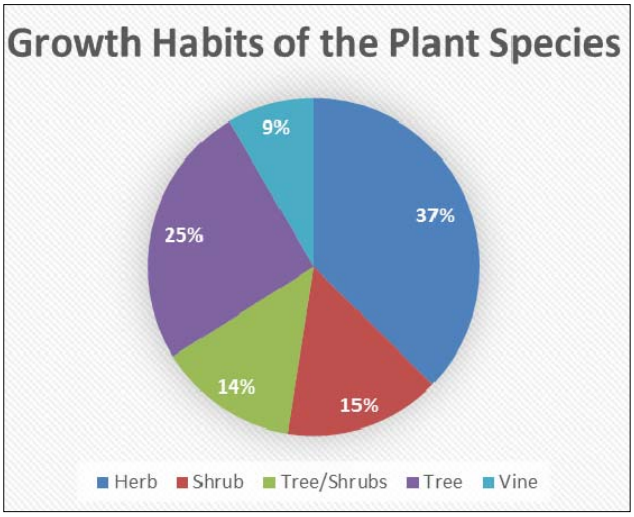

Fig 2: Classification of the 59 medicinal plant species in terms of growth habit.

Frequency analysis of the documented methods of preparation revealed that the leaf was the most common plant part used followed by bark, whole plant and flower (each with 7%). Other parts used include stem, sap, fruit, thorns, and root. (Figure 3). In addition, 100% of individuals in the present study cited leaves as the most common part of the plant used in remedies used to treat a variety of ailments.

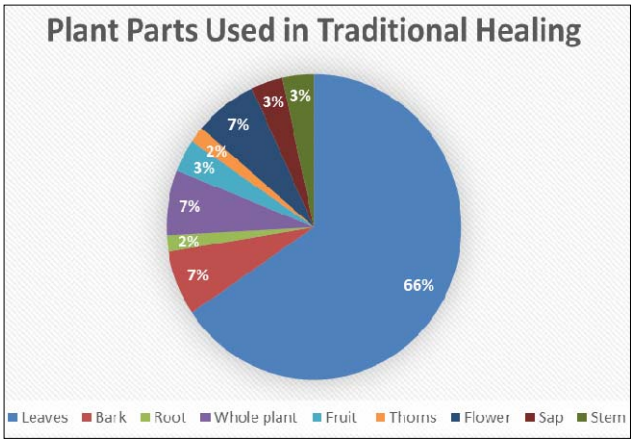

Fig 3: Plant parts used in Yucatec Maya traditional healing

The reported ailments were placed under different disease categories. The most commonly treated ailments were infections and digestive system disorders as these are common ailments affecting the Yucatec Maya communities. Infections include ailments such as fever, athlete's foot, chicken pox and swelling. Digestive system disorders include diarrhea, vomiting, dysentery and tooth ache. The frequency of a disease was calculated in terms of the number of plant species used to treat that particular ailments.

Data indicates that out of the total number of medicinal plants, 20 species were used to treat infections, 16 for digestive system disorders, 9 for skin/subcutaneous cellular tissue disorders, 7 for respiratory system disorders, 6 for endocrine system disorders, 6 for culture-bound syndromes, 5 for genitourinary system disorders, 4 for musculoskeletal system disorders, 4 for circulatory system disorders, 2 for injuries and 1 for sensory system disorders(Figure 4). Some ailments such as "cirro," and "mal de ojo," that cannot be classified under any nosological entity were classified as culture-bound syndromes.In the Yucatec Maya community, "cirro" is a condition where a small "organ" located below the navel becomes dislocated from its original position. It is diagnosed by the healerspressing their fingers under the navel. "Cirro" may be caused by lifting heavy objects or forcing the body to perform a strenuous activity (such as childbirth). It

causes air and cramps in the stomach as well as headache, nausea and vomiting. Common conditions treated in Yucatec Maya communities include diarrhoea, vomiting, fever andheadache.

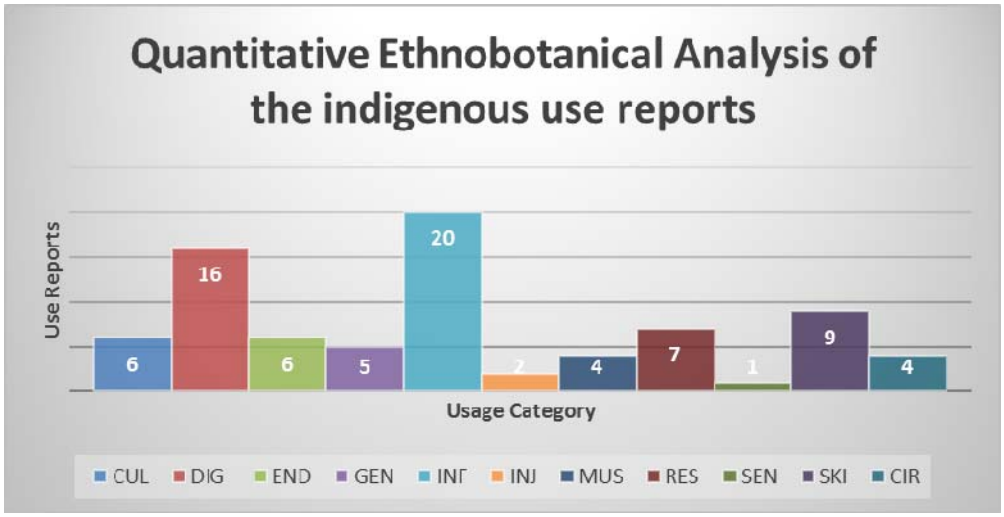

Fig 4: Distribution of plant species among the usage categories

The plant with the most frequency of usage are considered to be of most importance. The data of plants with their corresponding frequency of usage are summarized below in Table. Sour orange (*Citrus aurantium* L.) was the most commonly used plant species among all participants with 12 reports of usage. It is used to treat digestive system disorders such as diarrhoea and vomiting, and infections such as ear infection and vaginal infections. *Plectranthus amboinicus* L. (Mexican mint) and *Hamelia patens* Jacq. (Polly red head) also have a high frequency of usage with 10 use reports each. Mexican mint or "oregano grueso" is used to treat a variety of ailments such as cough, asthma, ear infections, and swellings. Polly red head (Xkanaan) is used to treat diseases such as diabetes, gastritis, athlete's foot and rash.

Table 4: Frequency of usage for plant species most commonly cited by participants

Scientific Name	Frequency of Usage
Aloe vera	8
Bursera simaruba (L.) Sarg.	9
Chenopodium ambrosioides L.	8
Ricinus comunis L.	7
Plectranthus amboinicus L.	10
Moringa Oleifera L.	7
Psidium guajava L.	8
Cymbopogon citratus	7
Hamelia patens Jacq.	10
Citrus aurantium L.	12
Zanthoxylum caribaeum Lam.	9

In Maya communities, ethnobotanical knowledge is preserved by passing it verbally from parents to children. However, younger generations lack interest in learning the use of plants for medicinal purposes. Within households, females are responsible for the general health of the family; thus the majority of the sampled population were female (79%). Males usually perform rituals and ceremonies such as "Primicias" where they pray for a successful crop season. In some rituals such as this, women are not allowed to attend. Most herbalists treat individuals within their own families and usually do not charge for their services. Also, there was a 100% agreement among all herbalists that their patients are either Yucatec Maya or Mestizo from their villages or surrounding villages.

Conclusion

The use of medicinal plants and traditional knowledge about the use, preparation, and application is still common among the Yucatec Maya. However, results show that the knowledge and practice oftraditional healing is mostly found among the elders. Also, participants reported a decline in the use of medicinal plants by younger generations and they fear that indigenous knowledge may disappear with advances in technology. Data also revealed that many wild species are under growing pressures from various anthropogenic factors and that many species have become scarce during the past 10 years. This highlights the importance of raising public awareness and at all levels to maintain the biodiversity and the ethnobotanical knowledge of the Yucatec Maya. Participants recommended the use of community outreach programs to promote the preservation of ethnobotanical knowledge and the diverse flora of Belize. Although a high diversity of plant species was recorded in this study, it is important to note that the ethnobotanical knowledge of the Yucatec Maya is far from complete.

Reference

1. Abramiuk MA, Dunham PS, Cummings LS, Yost C, Pesek T. Linking Past and Present: A preliminary paleoethnobotanical study of Maya nutritional and medicinal plant use and sustainable cultivation in the Southern Maya Mountains, Belize. Ethnobotany Research & Applications, 2011; (9):257-273.
2. National Institute of Culture and History. Maya: Institute for Social and Cultural Research 2011.
3. Amiguet VT, Arnason JT, Maquin P, Cal V, Sanchez Vindas, Poveda L. A Consensus Ethnobotany of the Q'eqchi' Maya of Southern Belize. Economic Botany, 2005; 59(1):29-42.
4. Metcalfe S, Breen A, Murray M, Furley P, Fallick A, McKenzie A. Environmental change in northern Belize since the latest Pleistocene. Journal of Quaternary Science. 2009; 24(6):627-641.
5. Rushton EA, Metcalfe SE, Whitney BS.A late-Holocene vegetation history from the Maya lowlands, Lamanai, Northern Belize. Holocene. 2013; 23(4):485-493.
6. Hopkins AL, Stepp JR, McCarty C, Gordon JS. Herbal remedy knowledge acquisition and transmission among

the Yucatec Maya in Tabi, Mexico: a cross-sectional study. Journal of Ethnobiology & Ethnomedicine. 2015; 11(1):1-10.
7. Teklehaymanot T, Giday M. Ethnobotanical study of medicinal plants used by people in Zegie Peninsula, Northwestern Ethiopia. Journal of Ethnobiology and Ethnomedicine. 2007; 3(12):1746-4269.
8. Anderson E. Yucatec Maya Botany and the “Nature” of Science. Journal of Ecological Anthropology. 2010; 14:67-73.
9. Pesek T, Abramiuk M, Garagic D, Fini N, Meerman J, Cal V. Sustaining Plants and People: Traditional Q’eqchi’ Maya Botanical Knowledge and Interactive Spatial Modeling in Prioritizing Conservation of Medicinal Plants for Culturally Relative Holistic Health Promotion. Ecohealth. 2009; 6(1):79-90.
10. Bourbonnais-Spear N, Awad R, Maquin P, Cal V, Vindas PS, Poveda, L, Arnason JT. Plant use by the Q'eqchi' Maya of Belize in ethnopsychiatry and neurological pathology. Economic Botany. 2005; 59(4):326-336.
11. Mustafa B, Hajdari A, Krasniqi F, Hoxha, E, Ademi H, Quave CL, Pieroni A. Medical ethnobotany of the Albanian Alps in Kosovo. Journal of Ethnobiology and Ethnomedicine.2012; 8**(**6):1186-1746.
12. Balick MJ, O’Brien H. Ethnobotanical and Floristic Research in Belize: Accomplishments, Challenges and Lessons Learned, Ethnobotany Research & Applications. 2004: 2:077-088.
13. Avrigo R, Balick MJ. Rainforest Remedies: One Hundred Healing Herbs of Belize. Twin Lakes, WI: Lotus Press. 1998.
14. Méndez M, Durán R, Campos S, Dorantes A. Flora medicinal: In: Biodiversidad y Desarrollo Humano en Yucatán. R. Durán y M. Méndez (eds). Ed. Centro de Investigación Científica de Yucatán. Programa de Pequeñas Donaciones del Fondo para el Medio Ambiente Mundial. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad. Secretaría de Desarrollo Urbano y Medio Ambiente de Yucatán. Mérida, Yucatán, Mé- xico. 2010, 349-352
15. Kunow M. Maya Medicine. Traditional Healing in Yucatán. Albuquerque: University of New Mexico Press, 2003.
16. Rodríguez E. Las plantas medicinales mayas: Un estudio de los factores de riesgo ambientales y sociales en Maxcanú, Yucatán. Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional Unidad Mérida, Mérida, Yucatán. 2009.
17. Bulut G, Tuzlaci E. An Ethnobotanical Study of Medicinal Plants in Bayramiç (Çanakkale-Turkey). Marmara Pharmaceutical Journal. 2005; 19(3):268-282.
18. Audet P, Walshe-Roussel B, Cal V, Caal F, Rojas M, Vindas P, Arnason J. Indigenous Ex Situ Conservation of Q'eqchi' Maya Medicinal Plant Resources at the Itzamma Garden-Indian Creek, Belize, Central America. Human Ecology: An Interdisciplinary Journal. 2013; 41(2):313-324.