CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Tropical AgriSciences

Ethnobotanical inventory of medicinal plants used in the El Tejar municipality, Chimaltenango, Guatemala

Bachelor thesis

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

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BACHELOR THESIS ASSIGNMENT

Marie Koryťáková

Agriculture in Tropics and Subtropics

Thesis title

Ethnobotanical inventory of medicinal plants used in the El Tejar municipality, Chimaltenango, Guatemala

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Objectives of thesis

The main aim of this bachelor thesis is inventory of medicinal plants used in folk medicine in the area of El Tejar, Chimaltenango, Guatemala.

Methodology

Informations about medicinal plants application will be collected from questionnaires which will be filled by people of El Tejar, Chimaltenango, Guatemala. Questions will be focused on knowledge about using of medicinal plants in traditional medicine (local and technical name, part use, preparation mode). Supplementary questions will be related to age, gender, level of achieved education etc. Informations will be gained from randomly chosen people from El Tejar community. Data will be elaborated by table.

The proposed extent of the thesis

30

Keywords

Ethnobotanic, medicinal plants, folk medicine, El Tejar, Chimaltenango, Guatemala

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Recommended information sources

Pöll E, Álvarez MR. 2015. Plantas autóctonas de Guatemala usadas en medicína tradicional. Guatemala C.A.: Tinta y Papel. 127p.

Pöll E, Mejía C, Szejner M. 2005. Ethnobotánica Garífuna. Guatemala C.A.: H&R Impresores, Guatemala. 129p.

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Prague on 01. 04. 2018

Declaration

I hereby declare that I have written this thesis entitled "Ethnobotanical inventory of medicinal plants used in the El Tejar municipality, Chimaltenango, Guatemala" independently, all texts in this thesis are original, and all the sources have been quoted and acknowledged by means of complete references and according to Citation rules of the FTA.

I also agree with placing this work in the library of CULS Prague and make it accessible for study purposes.

In Prague, 20th April 2018

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Marie Koryťáková

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Abstract

Traditional medicine has been practiced by healers for hundreds of years. Due to its great geographical location Guatemala has a copious biodiversity of medicinal plants which can be utilized against different types of diseases.

Nowadays, significant information about medicinal plants and traditional medicine has disappeared. Younger generations migrate to the bigger cities and more often use and prefer conventional medicine.

The current study was focused on medicinal plants used in El Tejar municipality, Chimaltenango, Guatemala.

Data was collected from 50 random people between 16 and 70 years of age (43 women, 7 men) by semi-open interviews. The results showed that 35 plant species belonging to 21 families are used as medicinally in this part of Chimaltenango. The most mentioned families are Asteraceae (6 species, 17.7 %) and Lamiaceae (6 species, 17.7 %). Prevailing health problems are gastrointestinal disorders (25.2 %) and respiration problems (17 %). The most often used parts are leaves (49 %) and preparation is largely by infusion (76.3 %). According to "MUV" index the most important species are *Dysphania ambrosioides* L. (26 %), *Aloe vera* L. (14 %) and *Matricaria chamomilla* L. (14 %). Respondents from the 41-50 age category have better knowledge about medicinal plants (usually using up to 6 plants) than other respondents from different age categories. They inherit knowledge verbally from the elder generation or from healers.

People who live in this part of Chimaltenango still use cures with the aid of medicinal plants, but the knowledge is being forgotten. Therefore, the current study is important as it will help to preserve at least some part of the information recorded in the El Tejar municipality, Chimaltenango, Guatemala.

Key words: *Aloe vera,* Asteraceae, *Dysphania ambrosioides*, Ethnobotany, Traditional medicine

Abstrakt

Tradiční medicínu léčitelé praktikují po stovky let. Díky skvělému zeměpisnému umístění má Guatemala bohatou biodiverzitu léčivých rostlin, které mohou být použity při léčbě různých nemocí.

V současné době důležité informace o léčivých rostlinách a tradiční medicíně upadají v zapomnění. Mladší generace migruje do větších měst a čím dál častěji upřednostňuje medicínu konvenční.

Tato studie byla zaměřena na léčivé rostliny používané v obci El Tejar, Chimaltenango, Guatemala.

Data byla získána od 50 náhodně vybraných osob ve věku mezi 16 a 70 lety (43 žen, 7 mužů). Výsledky ukazují, že v této oblasti Chimaltenanga respondenti používají jako léčivých 35 rostlinných druhů patřících do 21 čeledí. Nejčastěji zmiňovaná byla čeleď Asteraceae (6 druhů, 17,7 %) a Lamiaceae (6 druhů, 17,7 %). Převládajícími potížemi jsou onemocnění zažívacího systému (25,2 %) a dýchací problémy (17 %). Nejčastěji používané části rostlin představují listy (49 %), a jako nejběžnější způsob zpracování převažuje výluh (76,3 %). Podle indexu "MUV" jsou nejdůležitějšími druhy *Dysphania ambrosioides* L. (26 %), *Aloe vera* L. (14 %) a *Matricaria chamomilla* L. (14 %). Dotazované osoby ve věkové kategorii od 41 do 50 let mají lepší znalosti o léčivých rostlinách (běžně jich používají 6) než dotazovaní z jiných věkových kategorií. Informace se dědí ústně od starší generace nebo od léčitelů.

Lidé žijící v této oblasti Chimaltenanga léčbu za pomoci přírodních léčiv stále praktikují. Vědomosti se ale pomalu vytrácí a proto je tato studie důležtá pro zachování alespoň části informací získaných v obci El Tejar, Chimaltenango, Guatemala.

Klíčová slova: *Aloe vera,* Asteraceae, *Dysphania ambrosioides*, ethnobotanika, tradiční medicína

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1. Introduction

Ethnobotany is a science which studies the relationship between people and plants. According to FAO (2017), this kind of medicine relies on plants and traditional knowledge about them. Also, it is the standard medicinal treatment for three quarters of the world´s population. Nowadays, plants are used less often than in the past, but they are still important in a significant part of the world. According to WHO (2015), 90 % people in developing countries use plants as a primary choice and around the whole world, 65 % of people still use folk medicine. The use of traditional medicine is prevalent among the rural population, which includes more than 50 % of Guatemala's population. A significant part of the urban population in Guatemala also uses it (INE 2013).

Indigenous people in Guatemala have been using knowledge about medicinal plants and their effects for centuries. After the discovery of the American continent, some medicinal plants started to be used worldwide. In Guatemala 700 medicinal plants were recorded, 250 of them were used against infections (CEMAT 1970) as infection was and still is one of the most common health problems in Guatemala (Canigueral & Sanz-Biset 2015).

Knowledge about medicinal plants is available from the older generation but it is not collected and kept, rather the information is passed down through families verbally. Due to the lack of interest of young people nowadays, traditional knowledge is very often lost. Traditional medicine is not of interest to the younger generation and they migrate to the bigger cities where they can make use of the services and help of doctors and hospitals. This knowledge also has a high value for the scientific world. In developed countries, around 25 % of drugs are based on plant derivatives (Bodeker & Burford 2007). People use medicinal plants for many reasons - for example effectivity, low price, availability, no medical centre nearby, no medical insurance.

To maintain the pool of knowledge about medicinal plants in traditional medicine from respondents in El Tejar municipality, Chimaltenango, Guatemala it is necessary keep the information in written form, especially for the next generation of residents.

2. Aim of the thesis

The main aim of this study was to make an ethnobotanical inventory of medicinal plants used in traditional medicine in the El Tejar municipality, Chimaltenango, Guatemala. The aim was based on the following hypothesis:

I. The younger generation is less interested in traditional medicine and doesn't transfer information about medicinal plants.

II. Inhabitants of rural zones use traditional medicine more often than people from urban zones and have more knowledge about medicinal plants.

3. Literature review

3.1. Guatemala

Guatemala is a maritime country situated in the northern part of Central America. It is 107th biggest country in the world and has a total area of 108,889 sq. km. Neighbouring countries are Mexico, Belize, Honduras and El Salvador. The longest border (about 958 km) is with Mexico from the north, the shortest is 199 km in the south with El Salvador. From the west, it is surrounded by the Pacific Ocean and from the east by the Atlantic Ocean. It has a total of 400 km of coastline.

The climate in Guatemala is generally tropical and hot, cooler in the highlands and humid in the lowlands. Throughout the whole country there are mountains with narrow coastal plains and coastal lowlands create a typical microclimate. The mean elevation is 759 m. The highest point is Volcan Tajumulco (4,211 m), the lowest point is the Pacific Ocean.

In the terms of land use, 41.2 % is agricultural (18.2 % permanent pasture, 14.2 % is arable, 8.8 % with permanent crops), forests cover 33.6 % of the land. The remaining 25.5 % pertains to others. Irrigated land takes 3,375 sq. km (The World Factbook 2015).

3.1.1. Demographics

In 2013 Guatemala was, with its 15,438,383 inhabitants, the 71st most populated country (INE 2013). According to the World Bank the total population in 2015 was 16,342,897. Population growth rose in the period from 1997 to 2015. In 2015, 2.918 million people lived in the capital city (The World DataBank 2016).

In Guatemala, the gender ratio is 48.8 % men and 51.2 % women. From the view of ethnicity, the population comprises 39.8 % Native Americans, about 41.5 % Mestizo, 11.0 % K'iche, 7.8 % Kaqchikel, 7.9 % Mam, 6.3 % Q'eqchi, 8.6 % other Mayan, indigenous non-Mayan 0.2 % and 0.1 % other (2001 Census). Half the people live in rural areas, the rest in urban zones.

In total, 60 % of the population use Spanish, and the rest speak Amerindian languages (23 of them are officially recognized), including Quiche, Kekchi, Kaqchikel, Garifuna, Mam and Xinca. Declared religions are Roman Catholic, Protestant and indigenous Mayan beliefs.

Guatemala is the country with the greatest population in Central America and with the highest fertility rate and population growth rate in Latin America. Guatemala´s population is the youngest in Latin America, almost half of habitants are under age of 19. The reproductive-age population is large and birth rate high (The World Factbook 2015).

3.2. Ethnobotany

The term "ethno-botany" was introduced by the American botanist John William Harshberger in 1895. The term was defined as "the study of plants used by primitive and aboriginal people" (Davis 1995). Hershberger's concept of ethnobotany has been transformed many times over the past century (Turner 2011). In 1874 Stephen Powers first tried to name the uses of medicinal plants by California Indians "aboriginal botany" (Ford 2011). These days ethnobotany is defined as a sub-field of botanical (Cotton 1996) and ethnological sciences (Anderson et al. 2011), which pursues the relationship between ethnic groups and plants used for purposes such as medicine, food, materials for construction, firewood and other applications (Martin 1995).

The role of ethnobotanists is particularly important for preserving information for future generations of inhabitants and for research, because much of this information and knowledge is being lost. This fact is also important for modern medicine, as modern medicine is based on traditional medicine and knowledge (Diksha & Amla 2011). Ethnobotanical study is a combination of disciplines such as anthropology, ecology, economy, evolution, genetics (Albuquerque & Hanazaki 2009), linguistics (Martin 2004), pharmacology, public health, and other disciplines (Gomez-Beloz 2002).

Ethnobotanical research starts at the very beginning with direct observation of how the people use plants in their everyday lives (Martin 1995). After observation follows the interview - these are important principal tools for obtaining ethnobotanical information (Vlková 2014). The scientific strictness of ethnobotany has increased in the past two decades because of the adoption of quantitative methods (Philips 1996).

3.3. Medicinal ethnobotany

Medicinal ethnobotany could be described as a study of the medicinal use of flora in a determinate region, area or ecosystem and includes collection, documentation and preservation of culture (Cáceres 1998). For healing wounds, curing diseases or pain relief, native American healers used to employ a large variety of natural substances. We can differentiate two kinds of information; some which is usually known throughout all

cultures, the other is used only in local tribes (Fišerová 2017). By way of illustration, some experimentation with medicinal plants and materials is done by indigenous people, and if they find a plant that is ordinarily used in another territory, it enters their pharmacology (Bonvillain 1999). Nevertheless, in Guatemala there is not much study into flora and floristic diversity. It is probable that knowledge about traditional remedies will vanish in the future if we do not record it. In general, the indigenous people of Guatemala continue to use plants for food, medicine, ornaments and for religious rites (McVean 2006).

3.3.1. Medicinal plants

Therapeutic systems always trade on plant compounds (Fišerová 2017). Medicinal plants are used chiefly for their active substances which are the product of metabolism and, in the case of its own metabolism, are produced and stored. The most important active substances are alkaloids, bitter substances, etheric oils, glycosides, tannins, mucilage's, saponins, minerals, flavonoids and vitamins (Pöll & Álvarez 2015). A few of them are further described below.

Alkaloids are a large group whose substances have impact on the nervous system and repeated usage can cause addiction. To achieve beneficial physiological effects, they have to be administered at specific concentrations. Alkaloids include: ephedrine, which is a stimulant of the central nervous system, increases blood pressure and narrows blood vessels; hallucinogenic mescaline, which has intoxicating effects; colchicine applied during the treatment of leukaemia; lobeline, which is used against asthma; atropine and hyoscyamine; chitin which is antimalarial and reduces cardiac activity; morphine and codeine; ergotamine and psilocybin used in psychiatry.

Bitter substances are characterized by their bitter taste, have a stimulating effect on the digestive tract, the creation of gastric juice and raise appetite.

Glycosides include salicin, arbutin, cumarin, thioglycosides and hydrogen cyanide. The benefit for the human body provided just in physiological doses. They are called "botanical agents" and work against fungi and bacteria.

Tannins have a positive effect when treating skin and gastrointestinal diseases or they are used for treatment of diarrhoea, frostbite, inflammatory bowel and gastric catarrh. Their common characteristic is mucosal protein precipitation.

Mucilage's are present in plant vacuoles, mullein flowered or ribwort as a storage substance. They have the ability to reduce irritation.

Saponins protect plants against fungi and microbes.

Vitamins are part of biocatalyst, regulatory proteins and enzymes and they are essential for the human body (Bulánková 2005).

3.4. Traditional medicine

The World Health Organisation (2015) defines traditional medicine as "the sum total of the knowledge, skills, and practices based on the theories, beliefs, and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness".

The importance of medicinal plants is evident from the reality that the use of plant remedies has been carried out for generations and passed from one to another generation (Kumalasari 2006). During the study of Achí Mayan in Guatemala the author found that in 76 % of cases, knowledge about medicinal plants was passed on from relatives (Turreira-García et al. 2015). This fact points out the magnitude of traditional medicine through the cultures and societies.

4. Methodology

4.1. Study area

The ethnobotany study was conducted in the Kaqchikel community of El Tejar municipality, Chimaltenango department, situated in the south of Guatemala (14°39′N latitude and 90°48′W longitude), Fig.1. El Tejar has a population of 23,100 people, who belong to 2 tribes (Kaqchikel, Poqomam). The study was carried out in the Kaqchikel ethnic group, which is predominant in El Tejar and uses two languages, Spanish as an official language and Kaqchikel as a traditional language. The current Kaqchikel population accounts for 8 % of the total Guatemalan population (INE 2013). El Tejar has been inhabited for a long time by people who have a long tradition of using plants as medicine. The use of plants by people has continued over generations to the present day.

According to the Köppen climate classification, El Tejar has a subtropical highland climate and an elevation of 1782.95 metres above sea level. The average annual precipitation is 1162 mm - the highest being in June (251 mm) and September (236 mm). The rainy season is from May to October, whereas the yearly average temperature is 17.7°C (Climate-data 2015).

The main source of economy is agriculture, in which the majority of residents work (28.8 %). They are focused on the growing and processing of coffee beans (*Coffea* spp.), maize (*Zea mays* L.), beans (*Phaseolus* spp.), tomatoes (*Solanum lycopersicum* L.) and peas (*Pisum sativum* L.). Breeding cattle (*Bos*), horses (*Equus*) and pigs (*Sus*) is also important. The second economic source is domestic service, where 25.3 % of residents work (INE 2013).

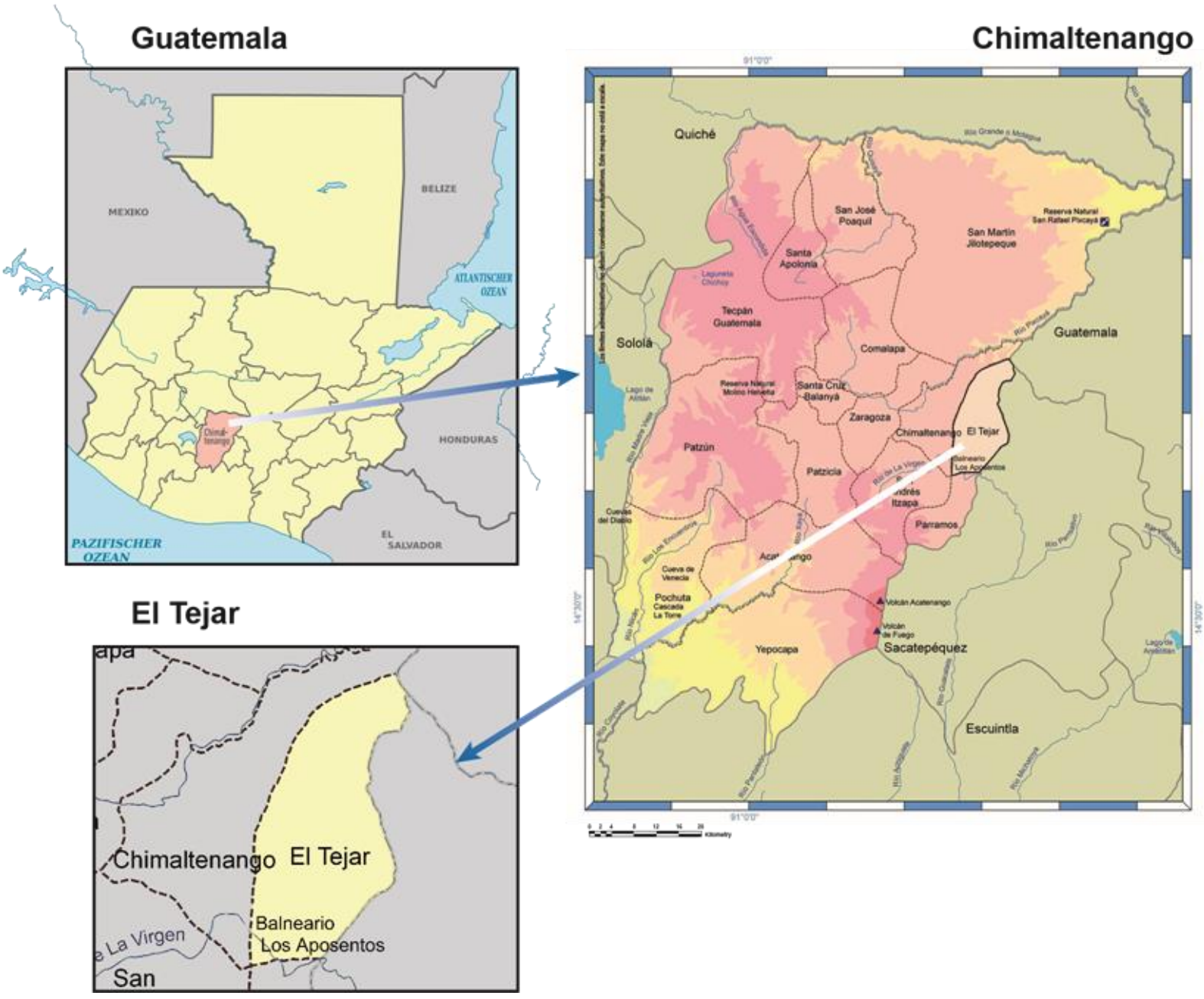


Fig. 1. Map of Guatemala, Chimaltenango and El Tejar municipality

4.2. Data collection

For this ethnobotanical task, we obtained permission from the local community authority to use the information in our study. Ethnobotanical research was conducted in collaboration with interpreters and specialist advisers from Universidad de San Carlos de Guatemala. The data was collected from June to July 2016 by semi-open interviews (Annexes 1.: Questionnaire) with 50 interviewees (43 women, 7 men) between 16 and 70 years of age. All the interviews were conducted in Spanish and included questions focused on the utilization of medicinal plants (e.g. which medicinal plants they know and their local names, how often they use them and for how long they have been using them, how they prepare plants for medicinal application, which part of the plants they use, dosages of medicinal plants and their parts, combinations of different medicinal plants). Respondents were also asked some personal questions regarding their age, sex, level of education and ways of obtaining information. All interviews were conducted in Technología para la Salud (TPS) and in respondents' homes (Figure 2-4). Demographics data are presented in Table 2.

The plant material was collected by the authors and identified following "Plantas autóctonas de Guatemala usadas en medicina tradicional" (Pöll & Álvarez 2015) and with the help of experts from Universidad de San Carlos de Guatemala and Universidad de Valle de Guatemala. The scientific names were identified according to The International Plant Names Index and collection of medicinal plants in TPS (Figure 5).

Fig. 2. TPS (Institute for Health, where interviews were conducted)

Fig. 3. Interview with women from Kaqchikel ethnic group in TPS

Fig. 4. Women respondents from Kaqchikel ethnic group in TPS

Fig. 5. Garden with medicinal plants in TPS

4.3. Data analysis

Obtained data and information was analysed by 3 quantitative ethnobotanical indices: Use reports (UR), Frequency of citation (FC) and Medicinal use value (MUV). The analysed data is presented in Table 1.

Use reports (UR) - the use recorded for every species. This shows how many utilizations a certain plant has (Bibi et al. 2015).

Frequency of citation (FC) - number of people who mention a plant (Vitalini et al. 2013).

Medicinal use value (MUV) – is actually a modification of the Use Value. The formula was obtained by (Tardío & Pardo-De-Santayana 2008) and (Savikin et al. 2013). The medicinal use value was calculated with little modification. It is a good measurement to estimate all the possible uses of a plant without considering its RFC. It gives us the relative importance of a species, considering the number of uses mentioned by an interviewee for a particular wild medicinal plant species. It was calculated using the following formula:

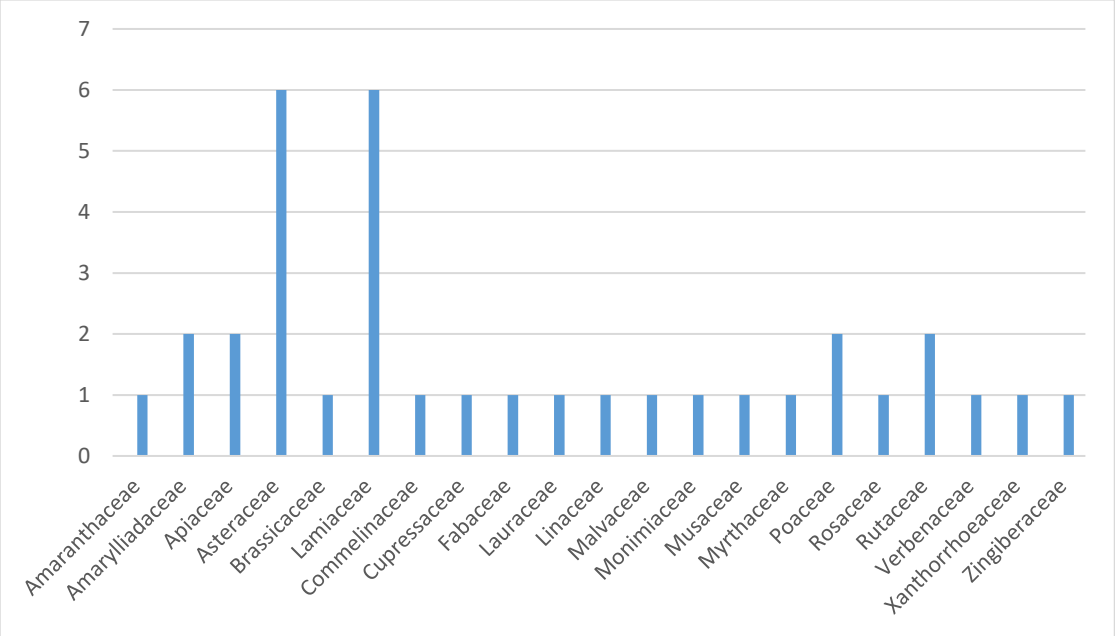
$$\mathbf{MUV = \sum Mui/N}$$

Where 'MU' is the number of mentioned medicinal uses cited by each interviewee for a given plant species and 'N' is the total number if interviewees included in the survey. In this case N = 50. MUV does not provide any information on the single or multiple uses of a species (Bibi et al. 2015).

5. Results

5.1. Diversity of medicinal plants

A total of 35 plant species belonging to 33 genera and 21 botanical families were reported to be used for treating human ailments in El Tejar, Chimaltenango, Guatemala. Of all mentioned plants 56 % are perennial. The family Asteraceae had the highest representation (6 species, 17.7 %) together with Lamiaceae (6 species, 17.7 %), other botanical families were represented by 1 or 2 species (Graph 1).



Graph 1. Most dominant plant families of medicinal plants used in El Tejar municipality, Chimaltenango, Guatemala

According to "UR" index, *Dysphania ambrosioides* has the highest value (UR=13), *Aloe vera* (UR =7) and *Matricaria chamomilla* (UR=7).

In the case of "FC" index, the most important plants were *Matricaria chamomilla* (FC=21), *Tagetes lucida* (FC=12) and *Dysphania ambrosioides* (FC=9), Table 1.

Table 1 Table of inventory of medicinal plants, El Tejar, Chimaltenango, Guatemala

Family/species	Local name	Code	Part use	Therapeutic use	Preparation mode(s), (oral/topical)	UR*	FC*	MUV*
Amaranthaceae								
Dysphania ambrosioides (L.) Mosyakin & Clemants	Apazote	Gu.Amt01	whole plant	1, 2, 4, 9	infusion (oral), ointment (topical)	13	9	0.26
Amaryllidaceae								
Allium cepa L.	Cebolla	Gu.Am01	Whole plant	3	infusion (oral)	1	1	0.02
Allium sativum L.	Ajo	Gu.Am02	fruit	3, 9	raw fruit (oral, topical)	2	4	0.04
Apiaceae								
Anethum graveolens L.	Ileldo, Eneldo	Gu.Ap01	leaves	1, 2, 3	infusion (oral)	3	4	0.06
Apium graveolens L.	Apio	Gu.Ap02	leaves, stem, root	2, 6	infusion (oral)	2	1	0.04
Asteraceae								
Artemisia absinthium L.	Ajenjo	Gu.As01	leaves, seeds	2	infusion (oral)	2	3	0.04
Matricaria chamomilla L.	Manzanilla	Gu.As02	bloom, seeds	1, 2, 7, 8	infusion (oral)	7	21	0.14
Pluchea carolinensis (Jacq.) D. Don	Rosa Santa María, Siguapate, Santa María, Chalché	Gu.As03	bloom	2	infusion (oral)	1	1	0.02
Tagetes lucida Cav.	Pericón	Gu.As04	whole plant	1, 2, 5, 7, 8	infusion (oral)	6	12	0.12
Taraxacum campylodes G.E.Haglund	Diente de Lion	Gu.As05	leaves	6	infusion (oral)	1	1	0.02
Taraxacum officinale F.H.Wigg.	Amargon	Gu.As06	leaves	6	infusion (oral)	1	1	0.02
Brassicaceae								
Nasturtium officinale R.Br.	Berro	Gu.Br01	leaves	2	infusion (oral)	2	1	0.04
Commelinaceae								
Tradescantia zebrina Bosse	Hierba de pollo, Yerba del pollo	Gu.Co01	leaves	1	infusion (oral)	1	1	0.02

Family/species	Local name	Code	Part use	Therapeutic use	Preparation mode(s), (oral/topical)	UR*	FC*	MUV*
Cupressaceae								
Cupressus sempervirens L.	Ciprés	Gu.Cu01	seeds, leaves	1, 3	gargle (oral)	2	3	0.04
Fabaceae								
Glycyrrhiza glabra L.	Orosuzo	Gu.Fa01	leaves, stem, root	3	infusion (oral)	1	1	0.02
Lamiaceae								
Mentha spicata L.	Hierbabuena, Menta	Gu.La01	leaves	2, 3, 9	infusion (oral)	5	4	0.1
Ocimum basilicum L.	Albahaca	Gu.La02	leaves	1, 7	infusion, fresh leaves (oral)	3	5	0.06
Origanum vulgare L.	Oregano	Gu.La03	leaves	10	infusion (oral)	1	2	0.02
Rosmarinus officinalis L.	Romero	Gu.La04	whole plant	1, 3, 9	infusion (oral)	4	4	0.08
Salvia officinalis L.	Salvasanta, Salviasanta	Gu.La05	leaves	2	infusion (oral)	1	1	0.02
Thymus vulgaris L.	Tomillo	Gu.La06	whole plant	3	infusion (oral)	1	2	0.02
Lauraceae								
Persea americana Mill.	Aguacate	Gu.Lau01	leaves, fruit	1	ointment (topical)	1	1	0.02
Linaceae								
Linum usitatissimum L.	Linasa	Gu.Li01	leaves, seeds	2	infusion (oral)	2	3	0.04
Malvaceae								
Tilia tomentosa Moench	Tilo	Gu.Ma01	leaves	2, 5, 7	infusion (oral)	4	6	0.08
Monimiaceae								
Peumus boldus Molina	Boldo	Gu.Mo01	leaves	2, 6	infusion (oral)	3	5	0.06
Musaceae								
Musa x paradisiaca L.	Platáno	Gu.Mu01	fruit	9	oral	2	2	0.04
Myrtaceae								
Eucalyptus gunnii Hook. f.	Eucalypto	Gu.My01	leaves	1, 3	infusion (oral), inhalation (oral)	5	5	0.1

Family/species	Local name	Code	Part use	Therapeutic use	Preparation mode(s), (oral/topical)	UR*	FC*	MUV*
Poaceae								
Cymbopogon citratus (DC.) Stapf	Te de lemón	Gu.Po01	leaves	1, 2, 3	infusion (oral)	6	7	0.12
Oryza sativa L.	Arroz	Gu.Po02	seeds	3	infusion (oral)	1	1	0.02
Rosaceae								
Malus domestica Borkh.	Manzana	Gu.Ro01	fruit rind	1	compress (topical)	1	1	0.02
Rutaceae								
Citrus limon (L.) Osbeck	Limón	Gu.Ru01	leaves, fruit	1, 3	infusion (oral)	3	3	0.06
Ruta chalepensis L.	Ruda	Gu.Ru02	leaves, stem	1, 2, 8	infusion (oral)	4	3	0.08
Verbenaceae								
Verbena bonariensis L.	Bebura, Berbena	Gu.Ve01	leaves	1, 3	infusion (oral)	2	2	0.04
Xanthorrhoeaceae								
Aloe vera (L.) Burm. f.	Sábila	Gu.Xa01	Leaves – sap, flesh	1, 2, 4	Ointment, hot compress (topical)	7	8	0.14
Zingiberaceae								
Zingiber officinale Roscoe	Jengibre	Gu.Zi01	root	3	infusion (oral)	1	2	0.02

Explanation of Therapeutic use:

1. Certain infectious and parasitic diseases, 2. Diseases of digestive system, 3. Diseases of the nervous system, 4. Diseases of the skin, 5. Certain conditions originating in the perinatal period, 6. Body detoxification, 7. Mental and behavioural disorders, 8. Diseases of the eye, 9. Diseases of the musculoskeletal system, 10. Diseases of the circulatory system

5.2. Application and preparation of medicinal plants

Diseases were classified into 10 categories according to the International Classification of Diseases (ICD) by The World Health Organization (2016), Table 1. The most frequently mentioned illnesses were gastrointestinal disorders (21.1 %), respiration ailments (17.1 %) and different types of pain (10.5 %). In use, medicinal plants are applied in several ways (Graph 2). The most commonly applied form of use was infusion (76.3 %). This method is simple and is suitable primarily for leaves. It is possible to use this method for most medicinal plants. Another favourite method of use was in the form of an ointment (7.9 %), which is used topically on the skin. It is a melted mixture of herbs and paraffin / beeswax / wax or vegetable oil (coconut, olive, sesame etc.). Other common methods of preparation of medicinal plants include inhalation, hot or cold compress, gargling, or simply consuming fresh leaves and fruit. The most often used parts are leaves (49 %) followed by the whole plant or seeds (each 11 %), Graph 3.

In the area of El Tejar municipality the most common preparation methods of medicinal plants are used; such as infusion, inhalation, ointment, hot or cold compress, gargle or medicinal plants are consumed as raw fruit or fresh leaves.

Infusion is similar to making tea. Boiling water (100°C) is poured over herbs in a suitable container and allowed stand for 10 minutes. There are two ways to use the resulting infusion. The first is like a tea, where you can drink it hot or lukewarm. The second way is to use the infusion as a wash, but you must be careful about the temperature. For a wash, a lukewarm or cold infusion is optimal.

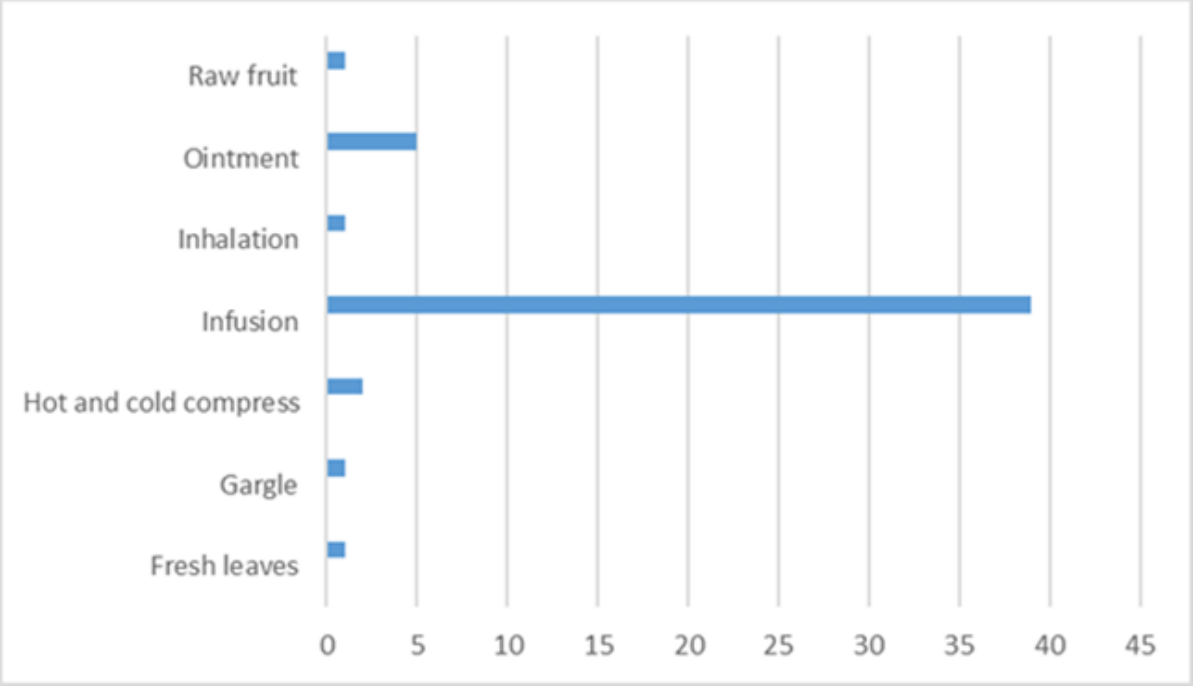
Inhalation is a way to treat respiration problems. Parts of plants - mostly leaves, flowers or achenes are boiled in water and the steam is inhaled. It is also possible to use a combination of herbs and salt or just salt. The inhalation process is effective when done under a blanket or similar cover, inhaling though the mouth and exhaling through the nose.

Ointment is used topically on skin. It is melted mixture of herbs and paraffin, beeswax, wax or vegetable oil (coconut, olive, sesame etc.). It is a good and easy way to treat scars, burns or bites.

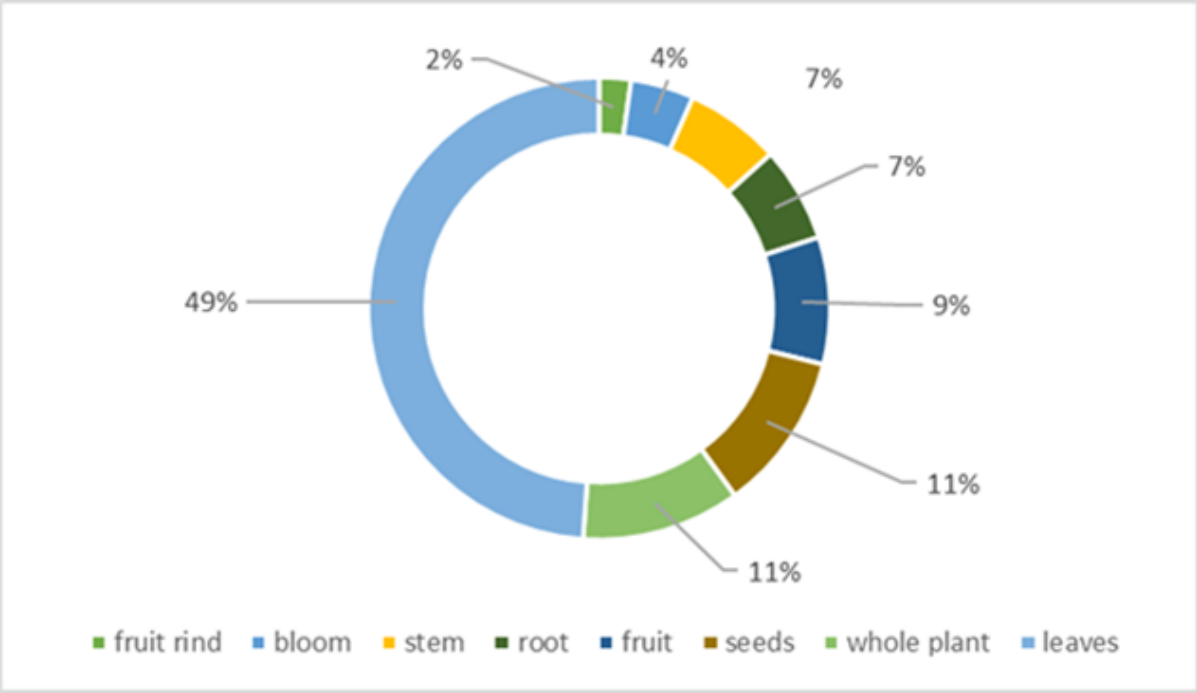
Hot and cold compresses are in direct contact with the skin. Ordinarily, fresh or dried plants are used. It is possible to put fresh plants directly on the skin and cover with textile. Another method is to soak textile in a prepared infusion and apply it to the skin.

Another preparation method is gargle. Gargle is a mouthwash, which is used in the case of problems with tonsils, dental hygiene or for a sore throat. Usually it is a strong decoction from an arbitrary plant and part of plant. The most frequently used gargle is one prepared from the cypress tree which is antibacterial and has a favourable effect on the tonsils. Tonsillitis can be also treated by gargling with a camomile and salt mixture or *Ruta chalapensis* L.

The consumption of raw fruit or fresh leaves is a part of everyday life as well as a cure. It is the easiest and oldest traditional way to prevent ailments and protect the body ahead of illness (Pöll & Álvarez 2015).



Graph 2. Application of medicinal plants



Graph 3. Used parts of plant

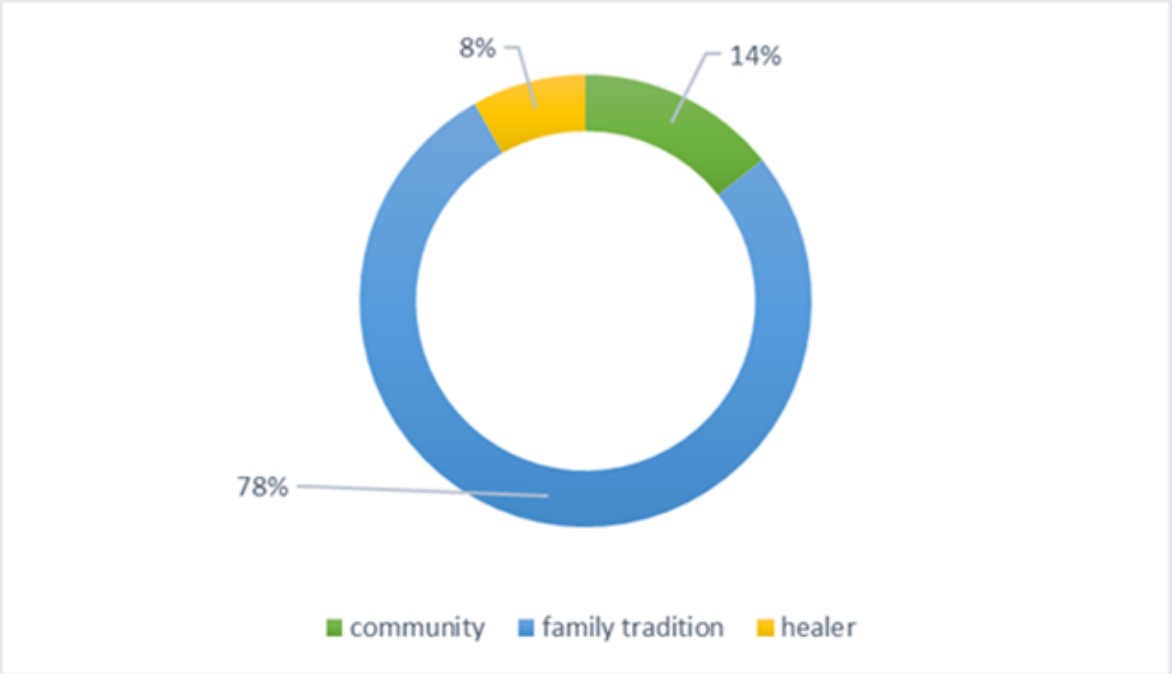
According to the "MUV" index, the most commonly used plants were *Dysphania ambrosioides* (MUV=0.26), *Aloe vera* (MUV=0.14) and *Matricaria chamomilla* (MUV=0.14). The most mentioned health problems treated by named medicinal plants are gastrointestinal disorders (stomach problems, gastritis, colic, colon, diarrhoea, ulcers, constipation; 25.2 %) and respiration ailments (cough, lung and respiration problems, bronchitis; 17 %), Table 1.

5.3. Indigenous knowledge of community

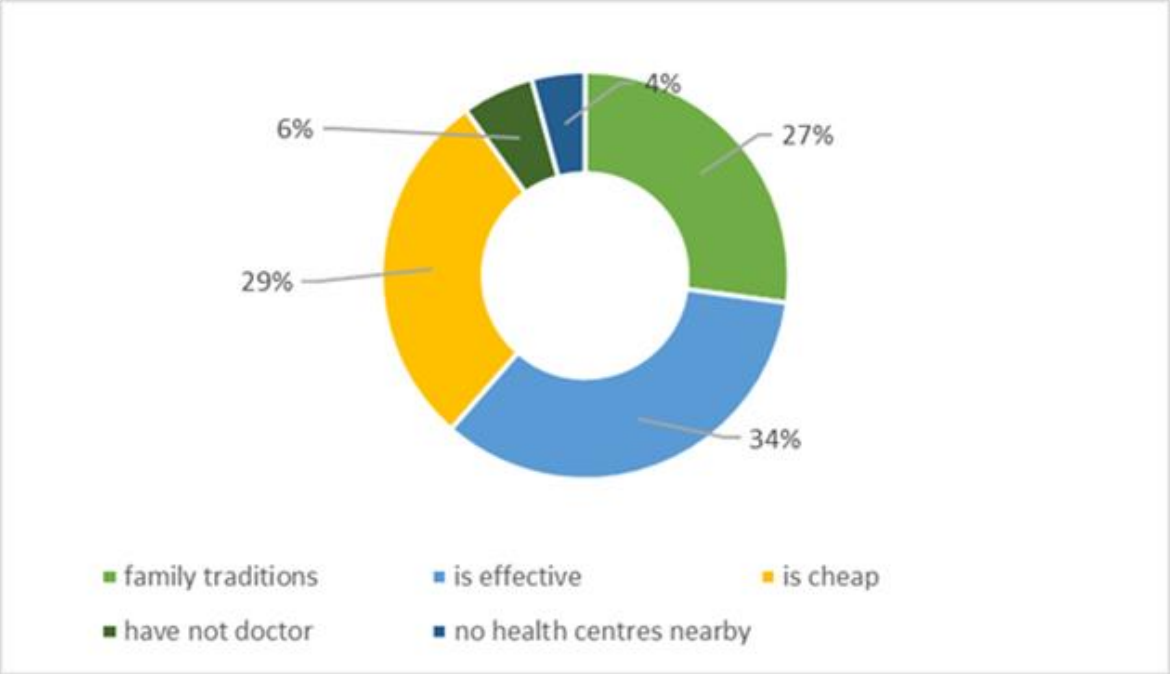
The respondents were able to obtain their knowledge from 3 sources, which were; verbal information from their family members as a family tradition (78 %), information from the local community (14 %) or from a healer (8 %), Graph 4. Demographic data of respondents are in Table 2 below.

As a reason for using medicinal treatment, respondents mentioned firstly the effectivity of medicinal plants (34 %) followed by low price (29 %), Graph 5. Respondents were divided in to 6 age groups. The average number of known medicinal plants increased with their age. There were differences in the number of medicinal plants reported by younger (>20-30 years old) and elder (41-60< years old) generations. One of the important reasons for this fact was the time they had been using medicinal plants.

Elderly interviewees mentioned that they had been using medicinal plants for more than 10 years, in contrast with younger participants, who had been using traditional medicine less than 10 years.

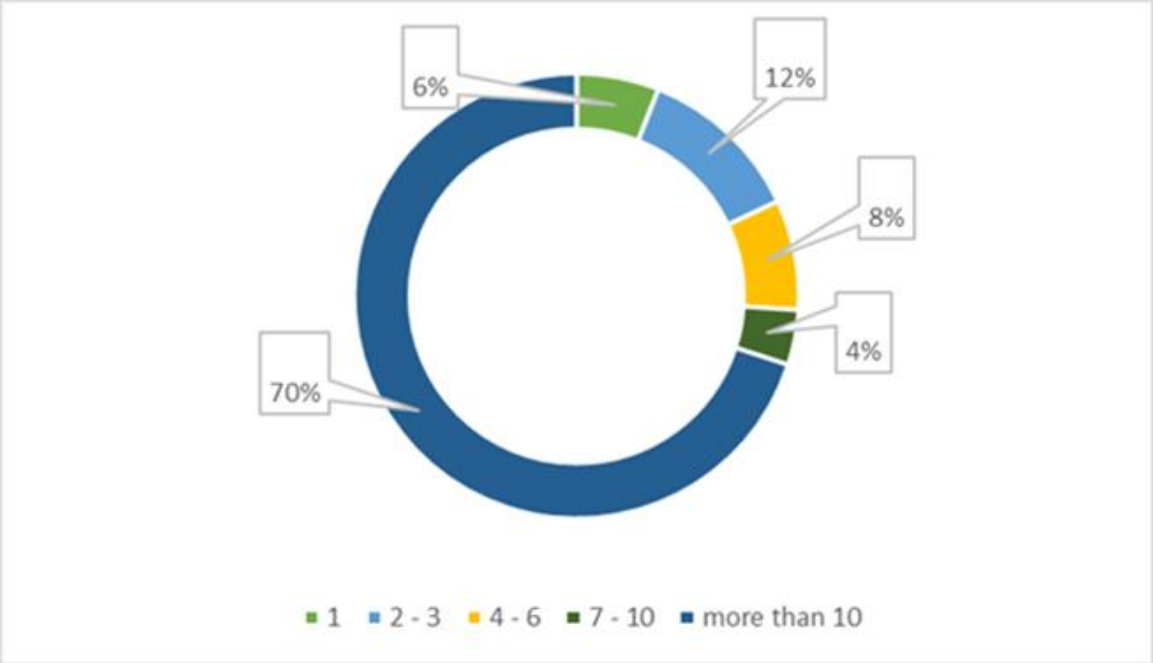


Graph 4. Method of obtaining knowledge about medicinal plants



Graph 5. Reason for using natural medicine

For the same reasons, there were differences in the numbers of known medicinal plants. Respondents who mentioned 10 and more years of practicing traditional medicine were able to name more medicinal plants (up to 6 plants), respondents with shorter practice mentioned less of them. On average it was 2-6 plants (Graph 6).



Graph 6. Distribution of number of years respondents have used medicinal plants

Table 2 Demographic data of participants in the El Tejar municipality, Chimaltenango, Guatemala

		Number	%
Gender	Female	43	86
	Male	7	14
Age groups	>20	5	10
	21-30	11	22
	31-40	9	18
	41-50	12	24
	51-60	10	20
	60>	3	6
Residence	Rural	48	96
	Urban	2	4

6. Discussion

Diversity of medicinal plants

The results showed that the 50 respondents together used 35 plant species. Study from San Andres, Peten, Guatemala recorded 81 species of medicinal plants used in this area (Comerford 1996). On the other hand, in Guatemala was identified 408 plants used just for the treatment of gastrointestinal disorders (Caceres 1993). A study carried out in Baja Verapaz in Guatemala reported 44 plant species (Fišerová 2017), which is just about 9 plants more than in our study. Compared to a study from Bolivia it is almost half the number. They interviewed 60 people and recorded 60 plants (Cussy-Poma et al. 2017). In a study in the province of Orlleana, which is area in Ecuador - where are medicinal plants widely used (Torre et al. 2008), 68 different plants were recorded (Dvořáková 2017) and in the Imbabura province (also in Ecuador) respondents mentioned 71 plant species (Dostalíková 2017). The reason is probably that in Guatemala people use less medicinal plants and they are more familiar with conventional medicine. From this fact is possible to conclude that total used biodiversity of medicinal plants in El Tejar municipality is smaller than in other studied areas. It could mean, that medicinal plants biodiversity is large, but used insufficiently in the area of our survey.

Frequently used plants families are Asteraceae and Lamiaceae but in different studies of ethnobotany, we find that results about Lamiaceae, Rutaceae, Apiaceae or Asteraceae are dominant too (Bibi et al. 2015; Clement 2010). In a study from the nearby island of Trinidad by author Clement (2010), the most dominant species were also Asteraceae and Lamiaceae. Another supporting study is for example the study of Bennett and Prance (2000), which presents Lamiaceae and Asteraceae as the most dominant plant families. Lamiaceae and Asteraceae families together represented 21 % of the 216 species known in the north of South America. In a study by de la Torre et al. (2008) carried out in Ecuador, Asteraceae was the botanical family with the highest number of species used for their healing effects. Lamiaceae is often used in different parts of the world in traditional medicine because it contains terpene oils in the epidermal cells, which have antimicrobial and antioxidant properties (Kuhnt et al. 1995). The above-mentioned studies support our results that the families Asteraceae and Lamiaceae are commonly dominant.

Application and preparation of medicinal plants

Respondents from El Tejar, Chimaltenango, Guatemala mentioned gastrointestinal disorder and respiratory problems as the main complaints they treat with plant remedies. Different studies from Ecuador by Paredes et al. (2015) support findings in this survey, because they showed that gastrointestinal diseases are the most treated problems using medicinal plants in this country. The higher occurrences of respiratory problems can be caused by tropical weather and poor insulation of houses (Bussmann & Sharon 2006). A study by Zipfel (2010) showed, that a higher number of plant remedies were used against respiratory diseases in mountain regions.

Predominant methods of preparation in this study were infusion (76.3 %) and ointment (7.9 %). A study in Pakistan made by Bibi et al. (2015) also describes infusion as a favoured and common method of preparation. Infusion is an easy process, takes just a little time to prepare and it is suitable for a large number of plants. The popularity of infusion is also a result of the optimal results in the treatment of disease (Zambrano-Intriago et al. 2015). During warming, chemical compounds in the plant easily loosen and they are accessible to the body (Song et al. 2004).

Respondents determined that the most commonly used parts of plants were leaves (49 %), seeds (11 %) and whole plant (11 %). A study about endemic medicinal plants in Norther Balochistan, Pakistan (Bibi et al. 2015) showed similar results, where leaves, seeds and whole plant was also the most common used parts. In many communities in tropical areas, leaves are the preferred part of plant, because they are available continually and also because secondary metabolites with biological activity are mainly stored in these parts (Angulo et al. 2012). The reason for this inference in case of leaves is simple picking and preparation, a plant stays alive and can grow and provide other leaves and fruit. In the case of seeds, it is for their content of oils and the whole plant is used in the case of small plants or the different parts of whole plant are prepared by different ways.

During the preparation of medicinal plants, is important to take plant chemicals and compounds into consideration. It is crucial to use a preferred effective method of extraction which extracts the chemicals from the plant. For example, for some active plant chemicals, we must choose extraction by hot water (tea), because they are not soluble in cold water (Aibinu & Adelowotan 2008).

Medicinal plants with highest "MUV" index are closely analysed below:

A. vera was mentioned by our respondents because of its positive effect when treating problems such as headache, skin problems or problems with parasites. The method of use can be oral (Clement 2010) or topical. *A. vera* inhibits inflammation and improves wound healing. Mannose-6-phosphate is a major sugar in the Aloe gel, which is for some authors the reason for its being an active growth substance (Davis et al. 1994). In a study of twenty-seven patients with burn wounds Aloe vera gel was compared with the healing effects of Vaseline gauze. The outcome was that Aloe vera gel healed faster (Visuthikosol et al. 1995). The healing plant's anti-inflammatory powers were also valid in another study with mice (Davis R. 1988).

M. chamomilla is also used for treating psychological problems (stress, sleeping problems), is effective against various kinds of pain (muscle pain and cramps, eye pain, bone pain) and to a certain extent is an analgesic, bactericide and insecticide. A positive effect on the prevention of hyperglycaemia and diabetes was also recorded (Kato et al. 2008). It is also a remedy against stomach aches or diarrhoea (de la Motte et al. 1997; Mehmood et al. 2015). It is similarly important to focus attention on in vitro studies, which show that biological activities of medicinal plants mentioned by respondents, for example *M. chamomilla,* is spread over the whole world and contains beneficial essential oils. More than 120 chemical ingredients (secondary metabolites) have been identified in camomile, including potential pharmacological activity compounds, flavonoids and terpenoids (Cussy-Poma et al. 2015).

D. ambrosioides is used in the case of skin problems, inflammation, haemorrhoids and hangover. Just as *A. vera* treats problems with parasites, *M. chamomilla* can be used for its bactericidal and insecticidal effects and during problems with different kinds of pain (muscles/eye/bone). The extract is used as a remedy against intestinal parasites, decoction of seeds and leaves is used for healing ulcers, insect bites, haemorrhoids and burns (Pöll & Álvarez 2015). In South American countries it is also traditionally used *Chenopodium ambrosioide* against gastrointestinal disorders or respiratory problems (Cussy-Poma et al. 2015).

The short conclusion of this part of the discussion is that the most common health problems are respiratory and gastrointestinal diseases, the favoured method of preparation

is by infusion, used part of plants are leaves, seeds or whole plant. The most commonly used plants by "MUV" and problems, which they heal are in agreement with other authors.

Indigenous knowledge of community

In recent literature the terms traditional and indigenous are used in the same meaning (Berkes 1993). Both terms are synonymous with "local" and "folk knowledge" (Brodt 2001). Author Rijal (2008) said, that the practical aspect of traditional knowledge is linked with observation and implementation.

It is possible to say, that higher age is related to extensive knowledge about medicinal plants and a greater number of known plants (Silva et al. 2011). Homes are also important for learning traditional plant knowledge and medicine. This fact, explained Lozada et al. (2006), is due to the fact that medicines are chiefly prepared or grown there. Especially for children, who "copy adult over child", sharing information through social learning is important, because it is the best way to acquire knowledge (Hopper et al. 2010; Wood et al. 2012). In our research, women respondents prevailed, and a greater familiarity of plant remedies was also recorded by elder women. This fact corresponds with a study from Pakistan, where the author stated that more of the people who are interested in knowledge about medicinal plants are women aged over 60 years (Bibi et al. 2015). Lulekal et al. (2008) also talk about the relationship between higher age and higher number of medicinal plants known, and mention that more medicinal plants were reported by people older than 40 years.

Summary, older persons and especially older women know or use more medicinal plants, than others age groups.

7. Conclusion

Traditional medicine in Guatemala is still an important part of inhabitants' everyday lives. The main assignment of this study was to make an inventory of medicinal plants, their healing effects and methods of use utilized in the El Tejar municipality by local people. Older respondents knew and used a wider variety of medicinal plants. Knowledge about traditional remedies is passed down through generations in most families, however younger generations are losing sympathy with and interest in the traditions, which we confirm with first hypothesis. People in rural areas utilize traditional medicine more often than people in urban areas, which agrees with second hypothesis. According to results, respondents in the El Tejar municipality used a smaller biodiversity of plants than in other countries, but it was still a significant amount of plant remedies. The medicinal plants they used most commonly were from the Asteraceae and Lamiaceae families. During the research it was found that 35 plant species were used for treatment. Prevalent health problems were respiratory and gastrointestinal disorders. Plant remedies were obtained mainly by infusion or making ointment from leaves, seeds or by using the whole plant. The plants they used most commonly by "MUV" were *A. vera, M. chamomilla* and *D. ambrosioides*. Mainly older women used traditional knowledge and the application of medicinal plants. It is necessary to carry out more ethnobotanical studies and inventories to preserve this knowledge for future generations and to perform phytochemical and pharmacological studies to analyse plants and their potential for use for medical purposes, as well as it is important to protect the rich Guatemalan biodiversity, which is natural heritage.

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Annexes 1.: Questionnaire

Universidad Checa de Ciencias de la Vida
Doctorado en Desarrollo Rural Sostenible
Trabajo de investigación sobre medicina tradicional

Encuesta a **Usuarios** de Plantas Medicinales

Favor de responder a las siguientes preguntas, que servirán para conocer en que medida se conservan las tradiciones de las comunidades indígenas, en especial en lo que se refiere al uso de las plantas medicinales.

I. Datos Generales

1. Localidad: ___El Tejar, Chimatenango_____ 2. zona: __urbana __rural 3. Ocupación principal: _____

Sexo: Masculino __ Femenino___ 5. Edad: ->20 21-30 31-40 41-50 51-60 61<+

II. Uso de Plantas medicinales:

1.-¿Utiliza plantas medicinales para resolver problemas de salud?: si_____ no_____
2.- ¿Utiliza esas plantas medicinales como primera medida para tratar las enfermedades? si_____ no_____
3.- ¿Por qué razón utiliza la medicina tradicional /natural? Marcar una o mas

a) es barato b) es tradición familiar c) tiene alta efectividad d) no cuenta con centros de salud cercano e) no tiene seguro médico f) otro_____

5.- ¿Cuánto tiempo lleva utilizando plantas medicinales o haciendo uso de ellas?

>1 año 2-3 años 4-6 años 7-10 años +10 años

6.- ¿Cómo empezó a utilizar la medicina natural ? Por: Tradición familiar ___ comunidad ___ curandero ___ mercado ____ escuela ____
otro _____
7.-¿según su conocimiento o percepción cree que existe una reducción del número de plantas usadas actualmente? Si____ no____

7.1.- si es sí, ¿Qué porcentaje considera que se ha perdido? * 0 es nada 100 es mucho: _____%

8.- ¿visita al curandero para determinar el uso de las plantas? si_____ no____

9.- ¿Cómo consigue las plantas? las recolecta_____ las cultiva_____ las compra_____ Otra forma_____

9.1.- ¿Si las compra en qué lugar lo hace?: farmacia _____ herbolaria _____ Mercados _____ otros (tiendas, súper) _____

9.-¿Qué tan lejos y accesible se encuentra el lugar de recolección de las plantas de su comunidad?_____

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Trabajo de investigación sobre medicina tradicional

Encuesta a **Usuarios** de Plantas Medicinales

10. Mencione las plantas medicinales que utiliza regularmente:

Nombre común	Nombre científico (No llenar)	Parte utililzada	Verde o seca	Problema a resolver (¿Para que la usa?)	Forma de uso (Tintura, te, tizania, emplasto, otra forma) ¿Cómo se usa?	Dosis del tratamiento (Cantidad de planta medicinal por día y como se mide esa cantidad)	Tiempo de tratamiento (duración en días, semanas o meses)	¿Cómo determinó la dosis?	Combinaciones con otras plantas (o usos para otras enfermedades de la misma planta)	Contradicción o recomendaciones de uso