Local knowledge about plants used in a high conservation value area of the Southern Yungas, Argentina

Marina Eva Acosta, Natalia Politi and Luis Rivera

Correspondence

Marina Eva Acosta[1]*, Natalia Politi[1] and Luis Rivera[1]

[1]Instituto de Ecorregiones Andinas (INECOA) (CONICET-UNJu). Grupo Conservación de la Biodiversidad en Bosques Subtropicales, San Salvador de Jujuy, Jujuy, Argentina.

*Corresponding Author: marina.acosta@fca.unju.edu.ar

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Research

Abstract

Background: A study was conducted in the locality of El Fuerte (Santa Bárbara Department, Jujuy Province, Argentina). The objectives of this work were to (1) document the ethnospecies of plants used by local people, (2) understand their consensus for use and utilitarian versatility, (3) determine harvesting sites, and (4) assess the availability of plants used based on local perceptions.

Methods: Open and semi-structured interviews were conducted to 11 collaborators, along with free listing, participant observation and species identification in the field.

Results: A total of 124 ethnospecies were identified, of which 59% are native species, used for medicinal purposes (36%) and as food (33%). The most frequently mentioned botanical families across all species were Lamiaceae (19%), Rosaceae (16%), Fabaceae (14%), Asteraceae (12%), and Myrtaceae (9%). The species with the highest consensus for use were piquillín (*Condalia* cf. *buxifolia*) and mato (*Myrcianthes pungens*) and the most versatile of use were piquillín and molle (*Schinus* sp.). The plants were obtained from environments with both high (town) and low (forest) human intervention. Local people's perceptions of the availability of some plants indicate a decrease in terms of quantity.

Conclusions: This is a first approach to study local ecological knowledge in the region, providing a general overview of the useful plants employed by its inhabitants. These findings aim to strengthen biocultural conservation of forests, promote sustainable resource management and offer economic alternatives for local people.

Keywords: useful plants, ethnoconservation, native forest, Northwestern Argentina.

Background

The Southern Yungas are subtropical mountain forests located in northwestern Argentina and southern Bolivia (Cabrera 1976). These forests harbor an outstanding biodiversity both for the high species richness and endemism and for the numerous ecosystem services they provide, such as the provision of water that is used by cities and towns and to irrigate crops (Malizia *et al*. 2012). However, approximately 45% of the original area of the Southern Yungas forest has been converted to other land uses (e.g., agricultural or urban areas) and the remaining areas are currently degraded by unsustainable economic uses and overexploitation of forest resources (Hilgert & Gil 2006, Politi *et al*. 2021). These conditions of deforestation and degradation not only affect the natural heritage but also the cultural heritage of the region, as there is a loss of local knowledge on the use of plants (Becker & Ghimire 2003).

Ethnobiology is the science that studies the relationships between humans and nature (Toledo 2002). This science has included various approaches to understand how local people use natural resources as a means of subsistence by adapting the environment to their needs (Berkes *et al.* 2000, Toledo & Barrera-Bassols 2009). Therefore, the study of Traditional or Local Ecological Knowledge (TEK), defined as the body of knowledge associated with the management and use of natural resources by local people, is a useful framework for studying socio-ecological systems (Berkes *et al.* 1995, Reyes-García & Martí Sanz 2007).

Previously, it has been suggested that people are not aware of the depletion processes of locally used species and therefore it is necessary to have studies on the perceptions of the availability of natural resources (Lucena *et al*. 2007). It has also been shown that people have knowledge and use wild species that are present and accessible from nearby environments (Ladio *et al.* 2007, Phillips & Gentry 1993). Furthermore, the local importance of a natural resource could be threatened by unsustainable use, therefore, it is necessary to understand the variations that occur over time according to biological and cultural factors (Lucena *et al*. 2007). Recording -in joint collaboration with local people- the plant species used, the various uses involved, the harvest areas and the availability of the species used in these socio-ecological systems allows to design policies and strategies for sustainable management and biodiversity conservation (Berkes *et al*. 2000, Raymond *et al.* 2010, Usher 2000).

On the other hand, utilitarian versatility, understood as the number of uses that a community assigns to a given species (Ulian *et al.* 2020) is usually related to its consensus of use or popularity (frequently used plants) (Rossi-Santos *et al.* 2018). It is related to the fact that people learn to take advantage of species used by adding new uses as long as those species are available to people (Abreu *et al.* 2015, Ferreira Junior *et al.* 2013, Rossi-Santos *et al*. 2018, Santoro *et al.* 2015,), and plants become popular or frequently used due to increased uses (Caetano *et al.* 2020, Rossi-Santos *et al.* 2018, Tardío & Pardo de Santayana 2008).

The study of the knowledge of useful plants in northwestern Argentina has been analyzed in numerous ethnobotanical studies (Acosta *et al.* 2018, 2021, Lupo & Echenique 1997, Montani & Scarpa 2016, Ramos *et al.* 2013, Roger 2022, Scarpa & Arenas 1996, Villalba & Lambaré 2019), however, there are few studies for the Southern Yungas forest (Califano 2020, Hilgert 1999, 2001, 2007, Hynes 1997, Lambaré *et al.* 2011,). The objectives of this work were to (1) document plants used by local people in the Southern Yungas forest of northwestern Argentina, (2) understand the consensus for use and the utilitarian versatility, (3) determine harvesting sites, and (4) assess the availability of the plants used based on local perceptions. It is expected that the results from this study help to enhance the value of local knowledge about plants used in a sector of the Southern Yungas forest and the products derived from native species (McMillen *et al.* 2017).

Materials and Methods

Study area

El Fuerte (24° 25' S; 64° 40' W) is a town with 600 inhabitants, it is located in the south of the Department of Santa Bárbara in the southwest of the Province of Jujuy, Argentina (Figure 1). El Fuerte has an elevation range between 1300 and 1500 m asl and belongs to the ecoregion of the Southern Yungas forest (Cabrera 1976). The area has a subtropical mountain-temperate climate with a marked dry season and rainfall concentrated in the summer. Precipitation ranges between 800 - 1050 mm per year and the mean annual temperature is 21.5 °C (Braun-Wilke 2013).

El Fuerte was founded around the year 1755 as the last protected colonial frontier site with the particularity of being a fort built of stone with mud-covered walls, unlike other forts on that frontier whose walls were made of mud bricks (Teruel & Alderete 2020). Between the years 1792 and 1795 the army troops based at El Fuerte were moved, but some families

remained in the region and soldiers and indigenous people formed the basis of the population that eventually developed the town (Teruel & Alderete 2020). In the 1990s, the lands of El Fuerte and its surroundings (11000 hectares) belonged to the logging company Forestadora del Norte that hired people from the Chaco forest region of Salta Province to harvest the forest (Teruel & Alderete 2020). In the year 2002, the company filed for bankruptcy, and the property was sent to auction and the settlers dedicated themselves mainly to subsistence cattle ranching, accompanied by other complementary activities, such as beekeeping, leather crafts and tourism (Braun-Wilke *et al.* 2000). The population is concentrated in the town and have isolated houses (known as **puestos**) located in the nearby hills to take care of the cattle (Figure 2).

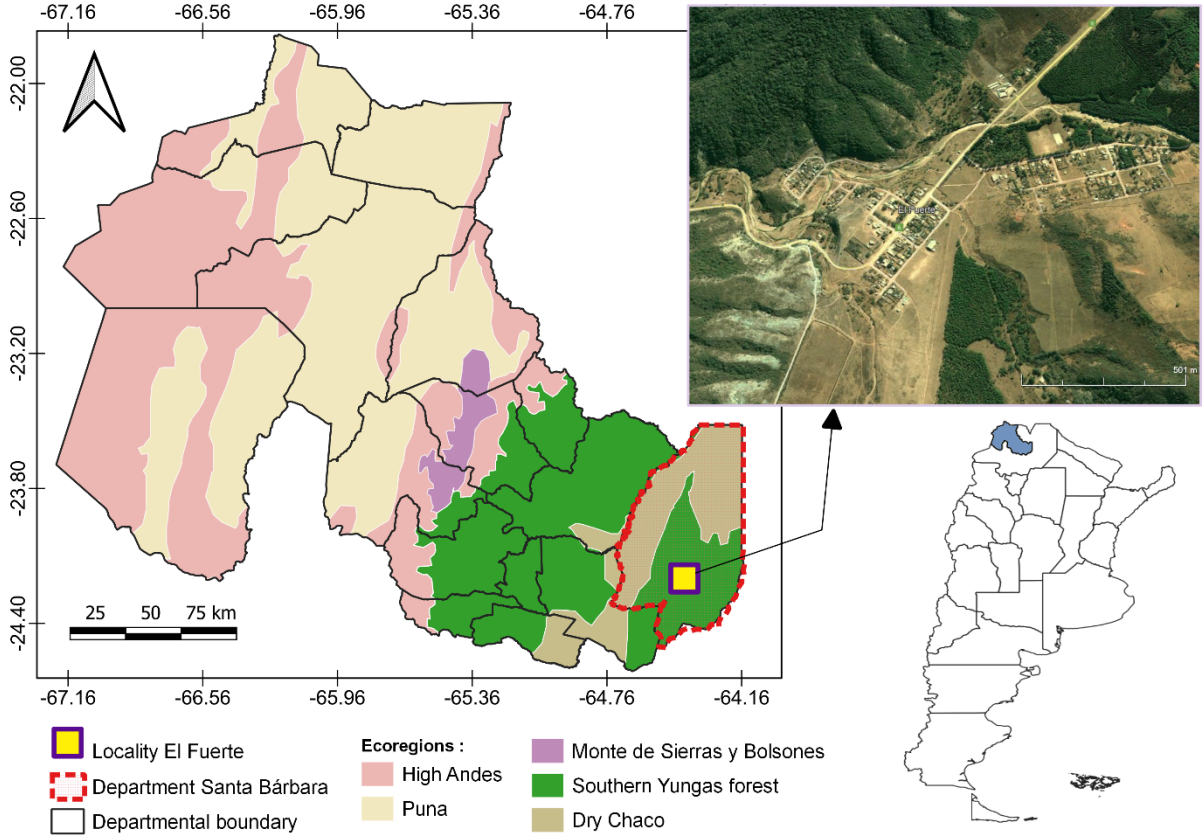

Figure 1. Location of El Fuerte in the Department of Santa Bárbara and the ecoregion types found in Jujuy Province, Argentina.

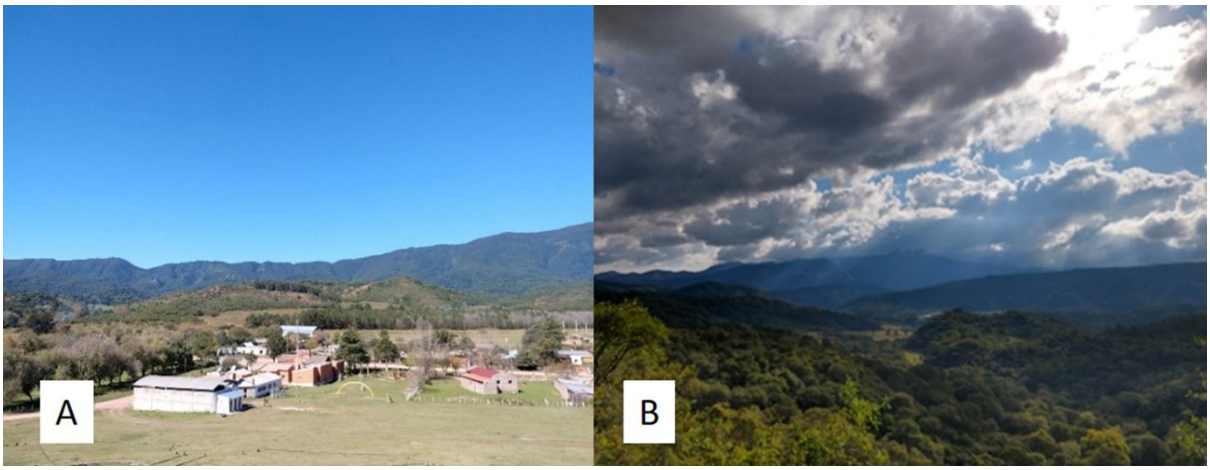

Figure 2. A- View from the lookout point of the interior of El Fuerte and the mountain range Serranía del Centinela; B- Southern Yungas forests surrounding El Fuerte.

Fieldwork and ethnobotanical data processing

From May 2022 to May 2023, eleven interviews (2% of the total inhabitants) were conducted to women (n=9) and men (n=2) of different families that live in El Fuerte. Authorization was requested from each person (hereafter, referred to as collaborator) to conduct the interviews by presenting in writing a Free Prior Informed Consent Form, following the guidelines established in the United Nations Conference on Sustainable Development (Rio+20 2012) for the regulation of access to genetic resources, the protection of traditional knowledge and their intellectual property rights and the Code of Ethics of the International Society for Ethnobiology (ISE 2006). The age of the collaborators ranged from 54 to 84 years old. The collaborators described themselves as creoles (i.e., colonial European descendants born and/or raised in the territory), with the exception of one woman who recognized herself as descendant of the original first-people Mocovies community. The selection of collaborators was carried out with the aid of two key people from the town that facilitated access and the creation of the bond of trust necessary for the development of a study of this nature, and based on the snowball design. The interviews were open and semi-structured. Free enlistments were made emphasizing the local name of the plants and participant observation (Guber 2001, Martin 2001). The name given locally to a plant is indicated as an ethnospecies. In cases of obvious variants of the same local name and plants that were assigned with more than one local name or mentioned them as synonyms by the same collaborator were considered as a single ethnospecies.

In addition, ethnobotanical tours were conducted to identify plant species, discuss the uses and collect plant material. The plant material collected was deposited in the herbarium JUA of the Facultad de Ciencias Agrarias, Universidad Nacional de Jujuy. The exomorphological characters of the plant material collected in the field, through photographs, descriptions given by each collaborator, and local names registered in other studies were used to identify each species. However, in some cases (25 ethnospecies) it was only possible to identify up to genus the plant. The references used for the taxonomic identification of the plants were: Flora Argentina (2024), Arboretum: native and exotic trees of Northwest Argentina (Grau *et al.* 2016), Guide to Native Trees of Northwest Argentina (Martínez 2016), Plants of Herbalism (Hurrell *et al.* 2011), Indigenous Trees of Northwest Argentina (Legname 1982) and previous ethnobotanical works carried out in the Southern Yungas forest (Hilgert 1999, 2001).

Data Analysis

The number of ethnospecies mentioned in the eleven interviews was calculated. Plants were identified by scientific name and the botanical family to which they belonged following the updated classification of the Flora Argentina (2024) database and the Plants of the World (2024) online database. Plant species that could not be taxonomically identified for correct systematic identification due to lack of bibliography or lack of plant material collected were grouped as unidentified. Species were classified according to their biogeographic origin as native or introduced (i.e., cultivated or exotic species). Each species was classified according to their life form following the criteria found in the Flora Argentina database in five categories: tree, shrub, herb, vine, and fern.

The parts used of each ethnospecies were classified in the following categories: entire plant, underground part (root, bulb, tuber), stem (soft and woody stem, bark, trunk), leaf, flower, fruit, and seed. It should be noted that different parts of the same ethnospecies can be used for different purposes. The classification of plants according to their usefulness was established from an etic perspective, that is, from the researcher's vision, with the exception of those flavoring plants whose category arose from an emic vision, that is, from the collaborators perspective (Martin 2001). The following categories of use were defined: edible (i.e., plants or part of the plant that are consumed as food by humans), medicinal (i.e., species with healing and/or preventive purposes for human ailments or diseases), flavor (i.e., species that are used to flavor tea or brews), firewood (i.e., plant species used as fuel for cooking or heating), construction (i.e., species used to make furniture, door handles or posts), ornamental (i.e., plants used to decorate gardens or yards and to provide shade for humans), and other (i.e., includes species used to dissipate bad vibes, as aromatic scents, to make handcrafts, for cleaning mud oven, etc.).

The importance of each ethnospecies and family mentioned in the interviews was estimated using the Consensus of Use (CU) index (Molares & Ladio 2009, Tardío & Pardo de Santayana 2008) calculated as the total number of interviews that mention use of an ethnospecies or family by the total number of interviews conducted. In addition, the versatility of use (VU) of the ethnospecies was calculated as the number of different uses recorded by each interviewee for each ethnospecies.

Based on the narratives of the different collaborators, an approximation of local perceptions regarding harvesting sites (places where the plant is collected) and availability was established. To gather the information emic categories were recorded and later recategorized in order to reorganize the information into etic categories. Two categories were established for the collection sites: 1- environments with human intervention (town) and 2- environments with little human intervention

(forest). Perceptions of plant availability was defined according to the perception of the quantity of the plant in the environment harvested (defined as a lot or little) and the perception of the difficulty of obtaining the plant (defined as easy or hard).

Results and Discussion

In this study, a total of 124 ethnospecies were recorded in the interviews, of which 30 were unidentified and 94 were taxonomically identified to species level (Supplementary material Table S1). The richness of ethnospecies recorded in this research is lower than that found in other studies carried in the Southern Yungas forest of northern Salta province, Argentina; e.g., Hynes (1997) recorded a total of 181 species in 20 interviews and Hilgert (2007) recorded 275 ethnospecies in 102 interviews. In this sense, the higher species richness recorded in other studies may be due to the greater number of interviews. Furthermore, in our study, people interviewed mentioned that they rarely wonder into the forest to collect plants, and this, perhaps, is reflecting a change in local ecological knowledge, in the number of plant species currently used, in the knowledge about them, and the relationship with the environment. Collaborators also raised concern about the lack of interest from young people to learn about plants and its uses. The decrease in visits to the forest and the transmission of knowledge to new generations contributes to the transformation or loss of the knowledge about useful plants, a pattern also found in other studies (Acosta 2018, Cano *et al*. 2016, Carretero 2005, Vandebroek & Balick 2012). Additionally, since this is not an isolated town, services such as health centers, transportation, connectivity, and human migrations to and from other towns are factors that influence the need to safeguard local ecological knowledge. This agrees with the results of a study of populations in the Southern Yungas forest of Bolivia, where the construction of roads and economic and social changes in the region influenced the loss knowledge about useful plants (Carretero 2005).

The 124 ethnospecies recorded belong to 41 botanical families, and the families with the highest number of species were Lamiaceae (19%), Rosaceae (17%), Fabaceae (14%), and Asteraceae (12%) (Figure 3a). In another study in the Southern Yungas forest of northern Salta province the five most important families used by local people also included Asteraceae (19%), Fabaceae (9%), and Lamiaceae (4%), as well as Poaceae and Solanaceae (Hilgert 2007). It is interesting to note that the families Asteraceae and Fabaceae are among the four dominant families (the other two are Poaceae and Solanaceae) of the flora of the Southern Yungas forest of northwestern Argentina (article under review). In a study carried out in the Southern Yungas forest of Bolivia, the Fabaceae family presented the highest richness of useful plants (Carretero 2005). Species of the Fabaceae family present secondary metabolites and a high level of biological activity such as tannins, flavonoids, alkaloids and terpenes, beneficial mainly in the medicinal use of these plants (Barboza *et al.* 2009, Castañeda *et al.* 2017, Hurrell *et al.* 2011, Stepp & Moerman 2001). On the other hand, the Asteraceae and Lamiaceae families are the most widespread within pharmacopoeias worldwide due to the concentration of essential oils and important organoleptic properties (Moerman *et al.* 1999). The similarities with other studies reflect the importance of the families at local and global levels due to phytochemical and organoleptic factors that influence the selection of species to be used by local people. Unlike previous studies carried out in the Southern Yungas forest, in this study a high percentage of species of the Rosaceae family was recorded due to the high frequency of introduced fruit species such as **durazno** (*Prunus persica* L.) (8 mentions by collaborators), **ciruela** (*Prunus domestica* L.) (5 mentions) and the native species **mora de campo** (*Rubus imperialis* L.) (4 mentions).

Plant biogeographic origin, life forms and parts used

Of the total number of ethnospecies that were identified to species level in this study (i.e., 95 species), 59% are native and 41% introduced. These results highlight that although there is an accelerated process of deforestation and degradation of the Southern Yungas forest local people in El Fuerte continue to use native forest resources, similar to the results found in Hilgert (2007). However, in our study native plants are not used for obtaining economic benefits, such as the use of timber tree species, contrary to the findings in the Southern Yungas of Bolivia (Hurtado and Moraes 2010). Some of the native species mentioned in the interviews are categorized according to the IUCN Red List as near threatened **lapacho** (*Handroanthus impetiginosa* (Mart. ex DC.) Mattos), **nogal** (*Juglans australis* Griseb.), **pino del cerro** (*Podocarpus parlatorei* Pilg.), **sacha pera** (*Acanthosyris falcata* Griseb.) and as threatened **mato** (*Myrcianthes pungens* (O. Berg) D. Legrand). The conservation status of these threatened species might worsen if managed unsustainable (Politi *et al*. 2015, Politi & Rivera 2019). It has been suggested that the knowledge associated with the use of threatened species could disappear at local or regional scales (García Flores *et al.* 2019). For example, **mato** is consumed as fresh fruit, while its wood has a negative connotation because local people qualify it as firewood "*not very good, it is white, it rots*" or **sacha pera** is reported as rarely seen in the region, and its fruit is barely consumed. In this sense, local perceptions about the availability of these plants, their use, and the parts utilized can be useful to compare with vegetation surveys to determine a species conservation status and to delineate sustainable harvest guidelines (Carretero 2005). It may also be key to investigate the local management of these

plants to analyze and study specific techniques and plan actions for the species recovery. Finally, it is worth to note the high percentage of use of introduced species, especially edible (fruit trees) and medicinal (ruderal plants) that grow spontaneously. This result supports the idea of a change in local ecological knowledge about plants and its uses (Acosta 2018, Cano *et al.* 2016, Carretero 2005, Vandebroek & Balick 2012).

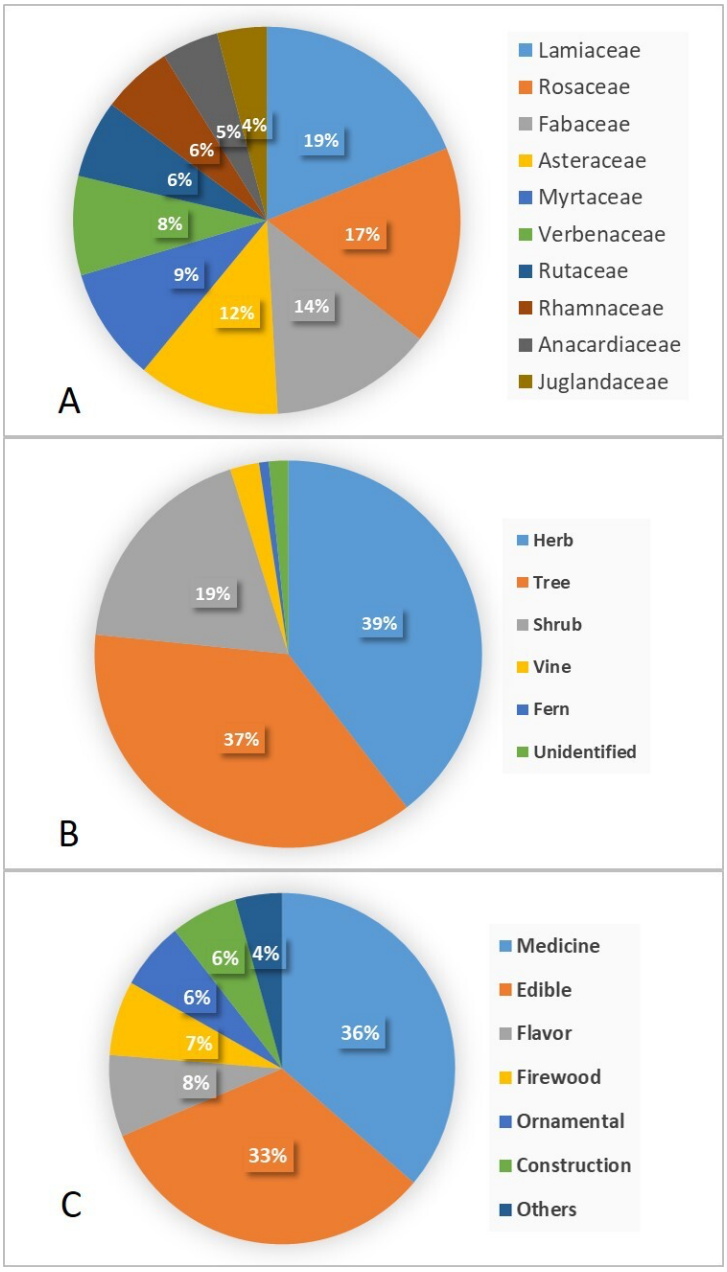

Figure 3: Ethnospecies according to (a) the ten most representative botanical families, (b) life forms, and (c) categories of use of the plants mentioned to be used in 11 interviews from El Fuerte, Jujuy province (Argentina).

Results about life forms show that 39% of the ethnospecies were herbs, 37% trees, 19% shrubs, and 5% were vines and ferns (Figure 3b). This agrees with the study of Hilgert (2007) where herbs (42%) were also found to be the most frequently used life forms by local people of northern Salta province. However, Hilgert (2007) found that shrubs (31%) were more used than trees (20%). Hurtado and Moraes (2010) in the Southern Yungas of Bolivia, found that the tree life form was most important for local people that depend on timber logging. It has been suggested that woody species (shrubs and trees) have potentially more uses because different parts of the plant (bark, wood, roots, fruits) can be used than other life forms (e.g., herbs, vines) that have little or no differentiation of their plant organs (Carretero 2005, Lino-Villalba 2022, Tardío & Pardo de Santayana 2008). In our study, the local people of El Fuerte that preserve knowledge about plant uses are elderly that do not wonder

into the forest where most native woody species are found. From our interpretation, the use of herbs might be easier to obtain and are more available in peridomestic environments as has been proposed by Phillips and Gentry (1993) that humans use native species according to the access they have to the plants. Acosta *et al.* (2018) and Ladio *et al.* (2013) found a similar pattern in medicinal and edible plants used in urban areas.

The most used parts of plants were leaves (37%), followed by fruits (24%) (Figure 4). In this study, the use of stems (19%) and underground parts (4%) were reported with lower frequency, unlike what has been reported in other studies where the use of stems (mainly of woody species) is much more significant (Hurtado & Moraes, 2010). Studying aspects related to the useful part of a species can be important when assessing the sustainability of resources (Hurtado & Moraes 2010).

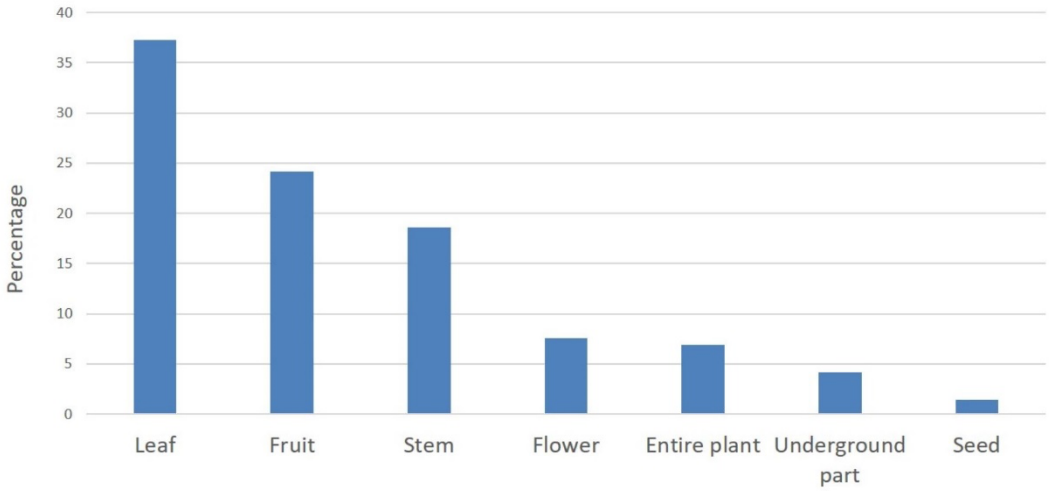

Figure 4. Percentage of consumed parts of a plant mentioned in 11 interviews from the locality of El Fuerte, Jujuy province (Argentina). Several parts of the same ethnospecies can be consumed. The category "Stem" includes woody and herbaceous stems. The category "Underground part" includes root, bulb, tuber.

Plant uses

In this study, it was found that most of the knowledge about the uses of the plants is for medicinal (36%) and edible (33%) (Figure 3c). This coincides with Hilgert (2007), where medicinal and edible plants are the most frequent. Regarding the richness of ethnospecies according to category of use, edible plants show a higher richness of introduced plants, while the rest of uses showed a greater predominance of native plants (Figure 5a). For example, there are only 56 native species of the Rosaceae family in Argentina, but it is one of the most economically important families because many taxa are cultivated for their edible fruits and seeds and for ornamental purposes. In our study, the Rosaceae family has a high frequency of use that includes introduced fruit species, such as, **durazno**, **ciruelo**, **manzana** (*Malus domestica* Borkh.), **pera** (*Pyrus communis* L.), **membrillo** (*Cydonia oblonga* Mill.), **cereza** (*Prunus* sp.) and only one native species, **mora del campo** highly valued for edible use and that are present in peridomestic places. For medicinal category, the most used plant part was leaves (56%), followed by flowers (14%), fruits and seeds (10%) (Figure 5b). Herbaceous were the life form most used for medicinal purposes (51%), followed by shrubs (25%) and trees (18%) (Figure 5c). Of the 56 ethnospecies recorded with medicinal purposes, the four species with the highest frequency use were (1) **durazno** which is used mixed with **molle** (*Schinus* sp.) tea, **durazno** buds and **cedrón** (*Aloysia citrodora* Palau) for stomach aches, (2) **menta** (*Mentha* sp.) whose leaves are prepared in tea or brewed used for liver and stomach aches, (3) **molle** leaves are used in tea or brewed as a digestive and are also used to make vapors, and (4) **tusca** (*Vachellia* sp.) bark is used as an antibiotic to heal internal wounds, for blood blows, and its leaves are used in tea for gastritis, ulcers, and to heal wounds.

The most commonly used edible life form were trees (48%) and plant organ were fruits (59%) which are generally consumed as "*fresh fruit*" (raw, as treats for children, for refreshment, occasionally or during the harvest season) or prepared as jams or jellies (Figure 5b). Of the 52 ethnospecies used for eating, the 4 species most used were two introduced fruit trees **durazno** and **ciruela** and two native species **piquillín** (*Condalia* cf. *buxifolia* Reissek) and **nogal**. In the case of **piquillín**, one of the collaborators described the following: "*It is a sweet, black fruit. You can make jam out of it, it's nice, it tastes like grapes*". Another collaborator recalled that her father would make a beverage from **piquillín** (known as aloja): "*We used to go out in*

the afternoons during the piquillín season, each of us with our own little bag. Besides coming back with purple lips, my father would make aloja". For the case of less common plants, for example, for the **apache** (*Trichocereus* cf. *thelegonoides* (Speg.) Britton & Rose), another collaborator narrated the following *"Fruit of the apache, type cardoncito"* (small columnar cacti*). "Has white flowers. It is on the way to the puestos. It has a small, sweet, pretty fruit. Used to makes jam. It is easy to find, it grows easy".*

In the case of plants used for flavoring, 13 ethnospecies were recorded, leaves are mainly used to flavor tea or brews, for example, **mato** and **menta**. Eleven ethnospecies were used for firewood, all native trees (e.g., **piquillín**, **tusca**) except an introduced species **pino** (*Pinus* sp.). Ten ethnospecies were recorded to be used for construction of furniture or poles. Only one species of the Asteraceae family could not be taxonomically identified, which receives the local name of **suncho** and is used to make the part of the house that is set aside for preparing and eating barbecues (known as quinchos). The ornamental category includes 10 ethnospecies that are used for ornamentation and shade for humans. The other category includes 6 ethnospecies: **piquillín** is used to make handcrafts, to make knife handles and souvenirs for tourists visiting El Fuerte, **romero** (*Rosmarinus* sp.) is used to cure *"aire o mal aire"* (bad vibes) by passing the plant through the body (it can also be **ruda** (*Ruta chalepensis* L.)) when you get an anthill (*"me enairé!")* or when you walk through the bush and you get hives on your face and body (Figure 5b and 5c).

Consensus of use and utilitarian versatility of the plants

The species with the highest consensus of use were **piquillín** and **mato**. The species with the most versatile of use were **piquillín** and **molle**. **Piquillín** is the most important plant in terms of consensus of use and is the most versatile species most chosen by people because it provides a wide variety of uses (Rossi-Santos *et al.* 2018, Tardío & Pardo de Santayana 2008). **Piquillín** is a species that the local people harvest the fruits to consume fresh *("in summer we go to piquilliniar*"), it is used as medicinal, as firewood of good quality (*"strong", "nice", "red*"), to make handcrafts, for poles and wood ("*the heart of the piquillín*") and the root were used to dye. The **mato** is a species that only the fruit is used as food. The **molle** is mainly used as medicinal (digestive, vapors), for the "bad vibes", as ornamental, for human shade and firewood although it is described negatively *"it is not good" "it smokes a lot".* These three species are native and are culturally important species that can be identified through their frequency of citation, consensus and utilitarian versatility. Designing strategies for the protection and conservation of biological and cultural diversity requires knowing those valuable resources for a population. However, the value attributed to a resource is not only limited to the indices of frequency of citation, consensus and utilitarian versatility, but also to the local perception of its availability (discussed in the following section). Both the indices and perceptions could influence the cultural significance of plants in a given context.

Places where plants are collected and local perceptions of plant availability

From the information provided by the collaborators, 58% of the cited plants are usually found in the town, which includes from an emic perspective the expressions *"down here", "here there is", "it grows over here", "near, in the stream*", referring to the house, the garden, the yard, the vegetable garden, roadsides, streams or close to streams. And 31% of the plants are found in the forest which includes from an emic perspective *"up there", "on the hill", "in the mountain", "where there is more humidity", or "warm places"* to refer to mountain, hill, roads to the **puestos**, where the cows are kept. The remaining 11% are plants that can be find plants in both places (Figure 6).

On the other hand, local people's perceptions of the availability of some plants indicate certain changes in terms of quantity. For example, **higo de monte** (*Vasconcellea quercifolia* A. St.-Hil.) and **viscol** (unidentified) *"there is little",* **sacha pera** *"is no longer seen",* **tuna blanca** (*Opuntia* sp.) and **tuna colorada** (*Opuntia* sp.) *"few are seen"*. On the other hand, those that are available, "*there are many",* named the **piquillín** found on roadsides and around the village, and **mato** that grows in the forest. The following speech fragments illustrate how they perceive some plants and the environments in which they grow: *"There is no mato down here... it is found in warm places, on the other side of the hill. For example, Confines mountain range (a place that is about 30 km from El Fuerte, almost on the border between Jujuy and Salta) is warmer than the town* (El Fuerte)". *"The trees that were there before...there were plenty of churqui, tusca, piquillín, molle, horco molle, cochucho around here. On the hill there were pino del cerro, cedro... here it was all fields, straw. Around here there was tipa.... it grew tall. Churqui for firewood had to be looked for from far away... here there was nothing, it was bare*".

Perceptions about the difficulty of obtaining the plant (Figure 6) referred to certain plants with the following expressions related to seasonality *"it is found at any time of the year"* (e.g., **molle**, **tusca**, **paico** (*Dysphania ambrosioides* (L.) Mosyakin & Clemants), **malvisco** (unidentified), **manzanilla** (*Matricaria chamomilla* L.), **menta**, **molulo** (*Sambucus peruviana* Kunt)), with the visual *"it is easy to see"* (e.g., **carqueja** (*Baccharis* sp.), **muña** (*Clinopodium gilliesii* (Benth.)) or *"it is easy to find"* (e.g.,

mora del campo, **piquillín**), with the development of the plant *"it grows easily, it grows by itself"* (e.g., **apache**) or *"they are always green, they resprout"* (e.g., **asta y ciervo** (unidentified), **tusca**, and with the spatial *"it grows everywhere"* (e.g., **santa lucía** (*Commelina erecta* L.)). They also mentioned **berro** (unidentified) whose plant was no longer consumed because of contamination *"we do not consume it because the streams are contaminated"*.

These results show that the town and the forest are important plant supply spaces for the local people of El Fuerte (Figure 6), a pattern that was found in other works (Acosta 2018, Molares & Ladio 2009). In addition, it is important to understand local perceptions about the availability and difficulty of obtaining the plant. It has been pointed out that the availability and visibility of a plant increases the probability its use and cultural importance (Ladio *et al.* 2007).

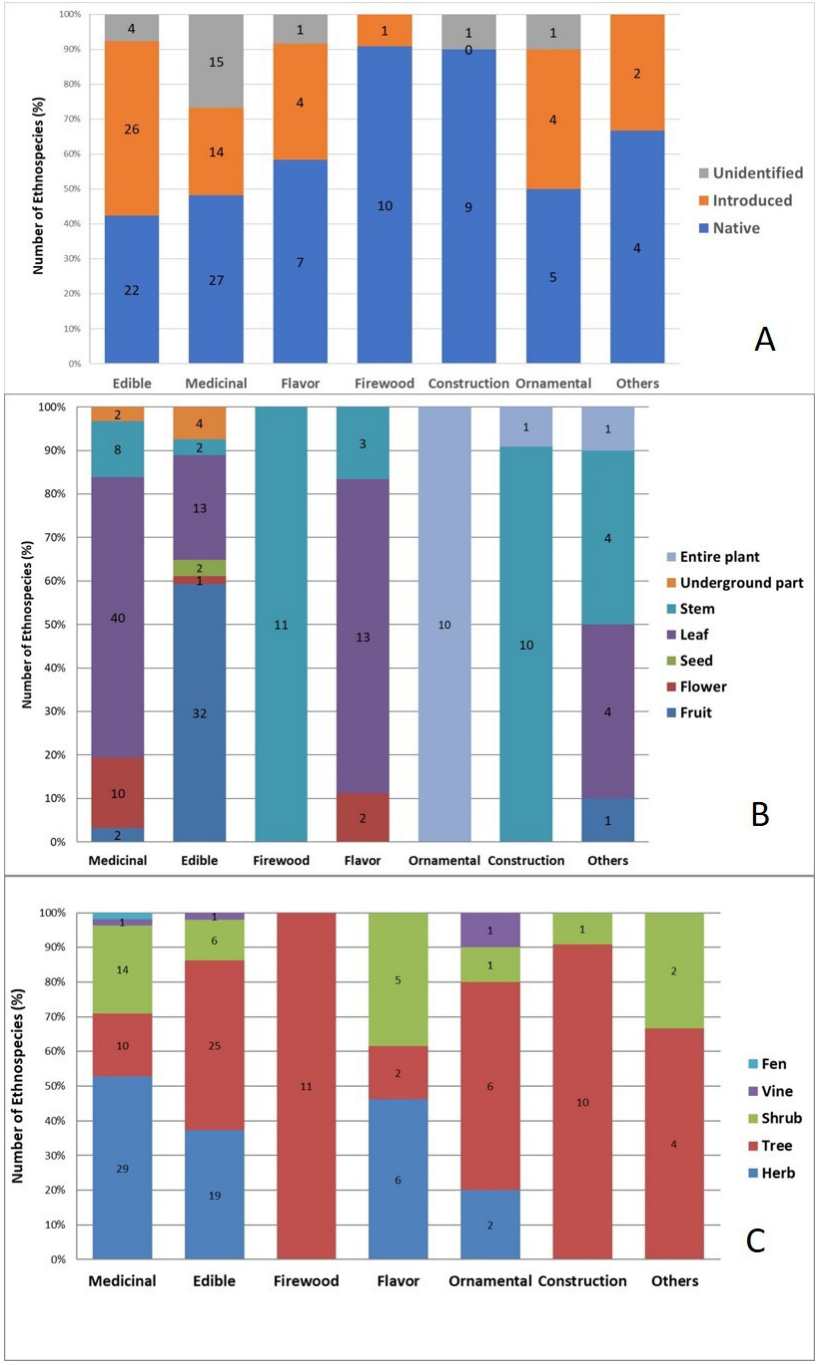

Figure 5. Ethnospecies in the different categories of use according to (a) biogeographic origin, (b) used parts, and (c) forms of life mentioned in 11 interviews from the locality of El Fuerte, Jujuy province (Argentina). The same ethnospecies can be used for several uses and several parts of it can be used.

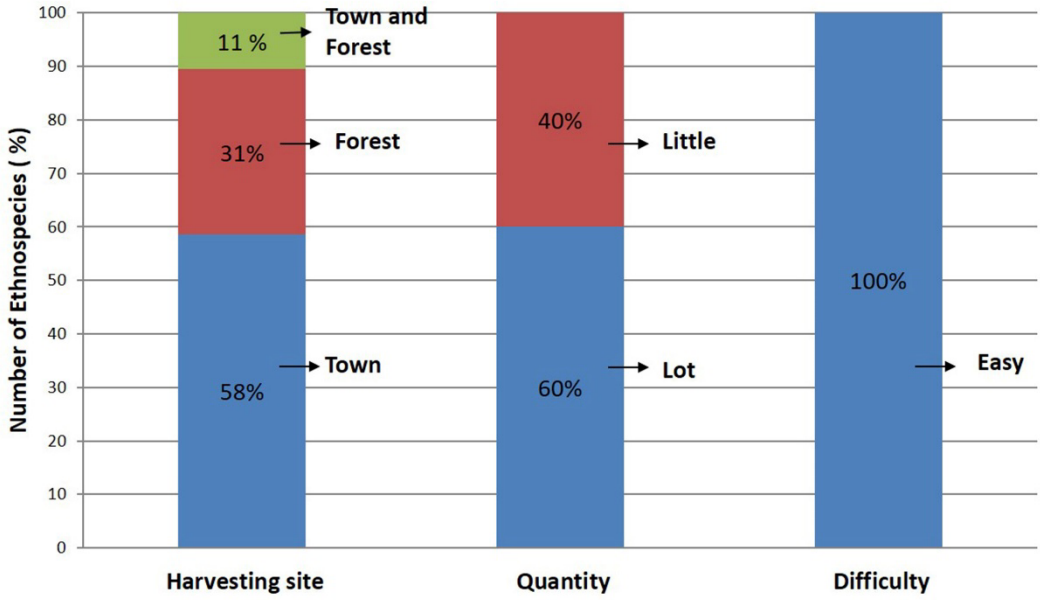

Figure 6. The graph shows the location where the ethnospecies mentioned in the interviews (n=124) are collected, the quantity according to the local perception of the availability of the cited species (n=15), and the difficulty of finding the plants according to the local perception (n=19) in 11 interviews from the locality of El Fuerte, Jujuy province (Argentina). All the plants cited in the quantity bar are found in the forest. The plants cited in the difficulty bar are collected in the village (11), in the forest (4), and both in the village and the forest (4).

Conclusions

This is a first approach to the study of local ecological knowledge for the region of El Fuerte, located in the Southern Yungas forest. These results allow us to have a general overview of the useful plants used by the local creoles (i.e., 124 ethnospecies), where each inhabitant interviewed recognizes and describes the plant uses mainly as medicinal and edible and to a lesser extent those used for flavor, firewood, construction, among others. Since herbs are the most used form of life and leaves and fruits are the most used parts, these results show a lower dependence on native forest timber resources and a preference to obtain plants or parts of them from the town. Although, there are native species such as **tusca**, **carqueja, muña** and **mora de campo** that are available in large quantities in places with little human intervention, future studies should assess if their harvest generates conservation problems.

This research also prioritizes local names and perceptions about the availability of plants and harvesting environments in order to give greater visibility to the relationship between people and plants from a local perspective. This visibility is reflected not only in the wealth of ethnospecies and diversity of uses, but also in the variety of ways of describing and classifying the environments and the perceptions about the quantity of the resource used and certain difficulties faced by the local population in its use. We hope that our results are useful to ensure the biocultural conservation of the region and encourage the use of non-timber forest resources of native forests that can be an economic alternative, for example, to promote the sale of handcrafts, regional sweets with native fruits, tea houses with medicinal plants for tourism and the promotion of sustainable management of resources among its inhabitants. We believe that our research on local perceptions reflect the interests of the people to ensure the conservation of useful native plant species and can promote in the long-term the conservation of forests.

Declarations

List of abbreviations: CU= consensus of use; UV= utilitarian versatility; e.g. = for example; i.e. = that is; INECOA= Instituto de Ecorregiones Andinas; CONICET= Consejo Nacional de Investigaciones Científicas y Técnicas; ISE= International Society for Ethnobiology;

Ethics approval and consent to participate: Ethics approval and consent to participate: This study was conducted according to the ethics guidelines of the International Society for Ethnobiology Code of Ethics. All collaborators agreed orally and in writing to participate in the survey and confirmed free and informed consent prior to data collection.

Availability of data and materials: The data used to support the findings of this study are available from the corresponding author.
Competing interests: The authors declare that they have no competing interests.
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Appendix 1

Supplementary material Table S1: Ethnospecie mentioned in eleven interviews from the locality of El Fuerte, Jujuy province (Argentina), sorted in decreasing order according to the Consensus of Use index. CU: Consensus of Use; VU: Utilitarian Versatility.

Ethnospecies	Scientific name	Botanical family	Origin	Life forms	Part used	Used	CU	VU
Piquillín	*Condalia* cf. *buxifolia* Reissek	Rhamnaceae	Native	Tree	Fruit, Stem	Edible, Firewood, Construction, Others	90,9	0,36
Mato	*Myrcianthes pungens* (O. Berg) D. Legrand	Myrtaceae	Native	Tree	Fruit, Leaf	Medicine	81,8	0,09
Durazno	*Prunus persica* (L.) Batsch	Rosaceae	Introduced	Tree	Leaf, Fruit	Edible, Medicine	72,7	0,18
Molle	*Schinus* sp.	Anacardiaceae	Native	Tree	Leaf, Entire plant	Medicine, Ornamental, Others	63,6	0,27
Tusca	*Vachellia* sp.	Fabaceae	Native	Tree	Stem, Leaf	Medicine, Firewood, Construction	63,6	0,27
Menta	*Mentha* sp.	Lamiaceae	Introduced	Herb	Leaf	Medicine, Flavor	63,6	0,18
Burro	*Aloysia polystachya* (Griseb.) Moldenke	Verbenaceae	Native	Shrub	Leaf	Medicine, Flavor	54,5	0,18
Romero	*Rosmarinus* sp.	Lamiaceae	Introduced	Shrub	Leaf, Stem, Flower	Edible, Medicine, Others	45,5	0,27
Carqueja	*Baccharis* sp.	Asteraceae	Native	Herb	Leaf	Medicine, Flavor	45,5	0,18
Cedrón pasto	*Cymbopogon* sp.	Poaceae	Introduced	Herb	Fruit	Medicine, Flavor	45,5	0,18
Manzanilla	*Matricaria chamomilla* L.	Asteraceae	Introduced	Herb	Flower, Stem, Leaf	Medicine, Flavor	45,5	0,18
Ruda	*Ruta chalepensis* L.	Rutaceae	Introduced	Shrub	Leaf, Stem, Flower	Medicine, Others	45,5	0,18

Ciruela	*Prunus domestica* L.	Rosaceae	Introduced	Tree	Fruit	Edible	45,5	0,09
Asta y ciervo/ hierba y ciervo/ yerba y ciervo	Unidentified	Unidentified	Unidentified	Herb	Leaf	Medicine	45,5	0,09
Nogal/nogal silvestre/nogal del campo	*Juglans australis* Griseb.	Juglandaceae	Native	Tree	Seed	Edible	45,5	0,09
Cedro	*Cedrela* sp.	Meliaceae	Native	Tree	Stem	Construction, Others	36,4	0,18
Yerba buena	*Mentha* sp.	Lamiaceae	Introduced	Herb	Leaf	Edible, Medicine	36,4	0,18
Mora de campo/mora silvestre	*Rubus imperialis* Cham. & Schltdl.	Rosaceae	Native	Shrub	Fruit	Edible	36,4	0,09
Palma o palmita de olor	Unidentified	Unidentified	Unidentified	Herb	Leaf	Medicine	36,4	0,09
Peperina/menta peperina	*Mentha* sp.	Lamiaceae	Introduced	Herb	Leaf	Medicine, Flavor	27.3	0,18
Algarrobo	*Neltuma* sp.	Fabaceae	Native	Tree	Stem, Fruit	Edible, Firewood, Construction	27,3	0,27
Churqui	*Vachellia* sp.	Fabaceae	Native	Tree	Stem, Underground part	Firewood, Construction, Ornamental	27,3	0,27
Cedrón arbolito/cedrón grande	*Aloysia citrodora* Palau	Verbenaceae	Native	Shrub	Leaf	Medicine, Flavor	27,3	0,18
Cochucho	*Zanthoxylum coco* Gillies ex Hook. f. & Arn.	Rutaceae	Native	Tree	Leaf, Stem	Medicine, Construction	27,3	0,18
Muña muña	*Clinopodium gilliesii* (Benth.) Kuntze	Lamiaceae	Native	Shrub	Leaf, Stem, Flower	Medicine, Flavor	27,3	0,18
Tipa	*Tipuana tipu* (Benth.) Kuntze	Fabaceae	Native	Tree	Stem	Firewood, Construction	27,3	0,18
Uvilla	*Berberis* sp.	Berberidaceae	Native	Shrub	Stem, Fruit	Edible	27,3	0,18

Aloe vera	*Aloe vera* L.	Amaryllidaceae	Introduced	Herb	Leaf	Medicine	27,3	0,09
Borraja	*Borago officinalis* L.	Boraginaceae	Native	Herb	Leaf, Flower, Stem	Medicine	27,3	0,09
Cedrón silvestre	Unidentified	Verbenaceae	Native	Shrub	Leaf	Medicine	27,3	0,09
Cola y caballo	cf *Equisetum giganteum* L.	Equisetaceae	Native	Herb	Leaf, Stem, Flower	Medicine	27,3	0,09
Cuatro canto	Unidentified	Asteraceae	Unidentified	Herb	Leaf	Medicine	27,3	0,09
Eucalipto	*Eucaliptus* sp.	Myrtaceae	Introduced	Tree	Leaf	Medicine	27,3	0,09
Hediondilla	Unidentified	Unidentified	Unidentified	Shrub	Leaf	Medicine	27,3	0,09
Manzana	*Malus domestica* Borkh.	Rosaceae	Introduced	Tree	Fruit	Edible	27,3	0,09
Membrillo	*Cydonia oblonga* Mill.	Rosaceae	Introduced	Tree	Fruit	Edible	27,3	0,09
Paico	*Dysphania ambrosioides* (L.) Mosyakin & Clemants	Chenopodiaceae	Native	Herb	Leaf	Medicine	27,3	0,09
Peral	*Pyrus communis* L.	Rosaceae	Introduced	Tree	Fruit	Edible	27,3	0,09
Pino natural/pino silvestre	*Podocarpus parlatorei* Pilg.	Podocarpaceae	Native	Tree	Fruit	Edible	27,3	0,09
Quimpe	*Lepidium didymum* L.	Brassicaceae	Native	Herb	Leaf	Medicine	27,3	0,09
Salvia	*Salvia* sp.	Lamiaceae	Unidentified	Herb	Leaf	Medicine	27,3	0,09
Toronjil	*Melissa* sp.	Lamiaceae	Introduced	Herb	Leaf	Medicine	27,3	0,09
Chañar	*Geoffroea decorticans* (Gillies ex Hook. & Arn.) Burkart	Fabaceae	Native	Tree	Fruit, Stem	Edible, Medicine, Firewood	18,2	0,27
Tola	Unidentified	Asteraceae	Native	Herb	Leaf, Stem, Flower	Medicine, Flavor, Others	18,2	0,27
Sombra de toro	*Jodina rhombilfolia* (Hook. & Arn.) Reissek	Cervantesiaceae	Native	Tree	Leaf	Medicine, Others	18,2	0,18
Calawada	Unidentified	Helecho	Native	Fern	Leaf	Medicine	18,2	0,09
Cepa caballo	Unidentified	Unidentified	Native	Herb	Leaf, Stem, Flower	Medicine	18,2	0,09
Chal chal	*Allophylus edulis* (A. St.-Hil., A. Juss. & Cambess.) Hieron. ex Niederl	Sapindaceae	Native	Tree	Fruit	Edible	18,2	0,09
Flor de mestizo	Unidentified	Unidentified	Unidentified	Unidentified	Flower	Medicine	18,2	0,09

Higo de monte/higuera/higo de campo	*Vasconcellea quercifolia* A. St.-Hil.	Caricaceae	Native	Tree	Fruit	Edible	18,2	0,09
Lavanda	*Lavandula* sp.	Lamiaceae	Introduced	Shrub	Flower, Stem, Leaf	Medicine	18,2	0,09
Limón	*Citrus limon* (L.) Osbeck	Rutaceae	Introduced	Tree	Fruit	Edible	18,2	0,09
Llantén	*Plantago* sp.	Plantaginaceae	Native	Herb	Leaf, Flower	Medicine	18,2	0,09
Malva	*Malva* sp.	Malvaceae	Unidentified	Herb	Flower, Stem, Leaf	Medicine	18,2	0,09
Malvisco	Unidentified	Malvaceae	Unidentified	Shrub	Leaf, Stem	Medicine	18,2	0,09
Mistol	*Sarcomphalus mistol* (Griseb.) Hauenschild	Rhamnaceae	Native	Tree	Fruit	Edible	18,2	0,09
Nogal de castilla	*Juglans regia* L.	Juglandaceae	Introduced	Tree	Seed	Edible	18,2	0,09
Poléo	Unidentified	Unidentified	Native	Shrub	Leaf	Medicine	18,2	0,09
Sacha pera	*Acanthosyris falcata* Griseb.	Santalaceae	Native	Tree	Fruit	Edible	18,2	0,09
Tala árbol	*Celtis* cf. *tala* Gillies ex Planch.	Cannabaceae	Native	Tree	Stem	Firewood	18,2	0,09
Viscol	Unidentified	Unidentified	Unidentified	Shrub	Underground part	Medicine	18,2	0,09
Menta anisada	*Mentha* sp.	Lamiaceae	Introduced	Herb	Leaf	Medicine, Flavor	9.1	0,18
Arca	cf. *Parasenegalia visco* (Lorentz ex Griseb.) Seigler & Ebinger	Fabaceae	Native	Tree	Stem	Firewood, Construction	9,1	0,18
Cebil	*Anadenanthera colubrina* (Vell.) Brenan var. *cebil* (Griseb.) Altschul	Fabaceae	Native	Tree	Stem	Firewood, Construction	9,1	0,18
Acacia blanca	Unidentified	Fabaceae	Unidentified	Tree	Entire plant	Ornamental	9,1	0,09
Acelga	*Beta vulgaris* L. var. *Cicla*	Chenopodiaceae	Introduced	Herb	Leaf	Edible	9,1	0,09
Achera	*Canna indica* L.	Cannaceae	Native	Herb	Leaf	Edible	9,1	0,09
Achicoria	Unidentified	Asteraceae	Unidentified	Herb	Leaf	Edible	9,1	0,09
Ajenco	Unidentified	Unidentified	Unidentified	Herb	Leaf	Medicine	9,1	0,09
Ají	*Capsicum eximium* Hunz.	Solanaceae	Native	Shrub	Fruit	Medicine	9,1	0,09

Ajo	*Allium sativum* L.	Amaryllidaceae	Introduced	Herb	Underground part	Edible	9,1	0,09
Alpa mato	*Myrcianthes pseudomato* (D. Legrand) McVaugh	Myrtaceae	Native	Tree	Fruit	Edible	9,1	0,09
Apache	*Trichocereus* cf. *thelegonoides* (Speg.)	Cactaceae	Native	Shrub	Fruit	Edible	9,1	0,09
Arrayán	Unidentified	Myrtaceae	Native	Tree	Leaf	Medicine	9,1	0,09
Arrayan barroso	cf. *Eugenia uniflora* L.	Myrtaceae	Native	Tree	Fruit	Edible	9,1	0,09
Arrayán colorado/mato arrayán	Unidentified	Myrtaceae	Native	Tree	Leaf	Flavor	9,1	0,09
Azafrán	Unidentified	Unidentified	IUnidentified	Unidentified	Underground part	Edible	9,1	0,09
Batata	*Ipomoea batatas* (L.) Lam.	Convolvulaceae	Introduced	Herb	Stem	Edible	9,1	0,09
Berro	Unidentified	Unidentified	Native	Herb	Leaf	Edible	9,1	0,09
Buscapina	cf. *Salvia* sp.	Lamiaceae	Introduced	Herb	Leaf	Medicine	9,1	0,09
Calabaza	*Cucurbita moschata* Duchesne	Cucurbitaceae	Introduced	Herb	Fruit	Edible	9,1	0,09
Cebolla	*Allium cepa* L.	Amaryllidaceae	Introduced	Herb	Underground part	Edible	9,1	0,09
Ceibo	*Erythrina* sp.	Fabaceae	Native	Tree	Entire plant	Ornamental	9,1	0,09
Cereza	*Prunus* sp.	Rosaceae	Introduced	Tree	Fruit	Edible	9,1	0,09
Chilto	*Solanum betaceum* Cav.	Solanaceae	Native	Tree	Fruit	Edible	9,1	0,09
Citronela	Unidentified	Unidentified	Unidentified	Herb	Leaf	Edible	9,1	0,09
Citrus	*Citrus* sp.	Rutaceae	Introduced	Tree	Fruit	Edible	9,1	0,09
Clavillo	*Barnadesia odorata* Griseb.	Asteraceae	Native	Shrub	Flower	Medicine	9,1	0,09
Cortadera	*Cortaderia* sp.	Poaceae	Native	Herb	Entire plant	Ornamental	9,1	0,09
Diente de león	*Taraxacum officinale* F. H. Wigg.	Asteraceae	Introduced	Herb	Leaf	Edible	9,1	0,09
Flores de zapallo	*Cucurbita maxima* Duchesne	Cucurbitaceae	Introduced	Herb	Flower	Edible	9,1	0,09
Lapacho	*Handroanthus impetiginosa* (Mart. ex DC.) Mattos	Bignonaceae	Native	Tree	Entire plant	Ornamental	9,1	0,09

Manzanilla/flor de ceniza	Unidentified	Unidentified	Unidentified	Herb	Leaf, Stem	Medicine	9,1	0,09
Mato crespo	Unidentified	Unidentified	Native	Tree	Leaf	Medicine	9,1	0,09
Meona	Unidentified	Unidentified	Unidentified	Herb	Leaf	Medicine	9,1	0,09
Molulo	*Sambucus peruviana* Kunth	Caprifoliaceae	Native	Tree	Fruit	Edible	9,1	0,09
Palán palán	*Nicotiana glauca* Graham	Solanaceae	Native	Shrub	Leaf	Medicine	9,1	0,09
Paletaria	Unidentified	Unidentified	Unidentified	Herb	Leaf	Medicine	9,1	0,09
Palo jabonero	*Koelreuteria paniculata* Laxm.	Sapindaceae	Introduced	Tree	Entire plant	Ornamental	9,1	0,09
Papa	*Solanum tuberosum* L.	Solanaceae	Introduced	Herb	Underground part	Edible	9,1	0,09
Papa del aire	*Sechium edule* (Jacq.) Sw.	Cucurbitaceae	Introduced	Climber	Fruit	Edible	9,1	0,09
Pata-pata	Unidentified	Opiliaceae?	Native	Tree	Fruit	Edible	9,1	0,09
Penisetum	*Penisetum* sp.	Poaceae	Introduced	Herb	Entire plant	Ornamental	9,1	0,09
Perejil	*Petroselinum crispum* Mill.	Apiaceae	Introduced	Herb	Leaf	Edible	9,1	0,09
Pimiento	*Capsicum annuum* L.	Fabaceae	Introduced	Herb	Fruit	Edible	9,1	0,09
Pino implantado	*Pinus* sp.	Pinaceae	Introduced	Tree	Stem	Firewood	9,1	0,09
Puerro	*Allium ampeloprasum* L.	Amaryllidaceae	Introduced	Herb	Leaf, Stem	Edible	9,1	0,09
Quebracho	*Schinopsis* sp.	Anacardiaceae	Native	Tree	Stem	Firewood	9,1	0,09
Rica rica	*Aloysia salsoloides* (Griseb.) Lu-Irving & N. O'Leary	Verbenaceae	Native	Shrub	Leaf	Flavor	9,1	0,09
Rosa	*Rosa* sp.	Rosaceae	Introduced	Shrub	Entire plant	Ornamental	9,1	0,09
Sacha tala	Unidentified	Unidentified	Native	Tree	Fruit	Edible	9,1	0,09
Saitilla	cf. *Bidens pilosa* L.	Asteraceae	Native	Herb	Underground part	Medicine	9,1	0,09
Santa lucía	*Commelina erecta* L.	Commelinaceae	Native	Herb	Flower	Medicine	9,1	0,09
Santa rita	*Bougainvillea glabra* Choisy	Nyctaginaceae	Introduced	Climber	Entire plant	Ornamental	9,1	0,09
Sarsaparrilla	Unidentified	Unidentified	Unidentified	Climber	Stem	Medicine	9,1	0,09
Suiquillo	Unidentified	Unidentified	Unidentified	Herb	Flower	Medicine	9,1	0,09
Suncho	Unidentified	Asteraceae	Unidentified	Shrub	Stem	Construction	9,1	0,09
Tala guiadora	*Celtis* cf. *iguanaea* (Jacq.) Sarg.	Cannabaceae	Native	Shrub	Fruit	Edible	9,1	0,09

Tuna blanca	*Opuntia* sp.	Cactaceae	Introduced	Herb	Stem, Fruit	Medicine, Edible	9,1	0,09
Tuna morada	*Opuntia* sp.	Cactaceae	Introduced	Herb	Fruit	Edible	9,1	0,09
Uva monterrico	*Vitis labrusca* L.	Vitaceae	Introduced	Shrub	Fruit	Edible	9,1	0,09
Verdolaga	Unidentified	Unidentified	Unidentified	Herb	Leaf	Edible	9,1	0,09
Berenjena	*Solanum melongena* L.	Solanaceae	Introduced	Herb	Fruit	Edible	9,1	0,09
Yerba paraguaya	*Lantana* sp.	Verbenaceae	Unidentified	Shrub	Leaf	Flavor	9,1	0,09