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Scientific validation of the traditional knowledge of Sikta (*Tabernaemontana sananho*, Apocynaceae) in the Canelo-Kichwa Amazonian community

Carmen X. Luzuriaga-Quichimbo[1], Trinidad Ruiz-Téllez[2], José Blanco-Salas[2] & Carlos E. Cerón Martínez[3]

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Abstract. *Tabernaemontana sananho* is a tree member of the Apocynaceae family referred to as sikta in Kichwa language. It is widely used in northern South America as painkiller, stimulant, antiseptic and is also highly valued as a sacred plant. In this work, we report the traditional knowledge and uses of sikta by the scarcely contacted Kichwa community of Pakayaku (Pastaza province, Ecuador) and further provide a scientific framework for its scientific validation. A review of the available literature revealed the presence of a wealth of biologically active indole alkaloids that potentially account for the great number of medicinal uses of sikta. This case study is illustrative of the importance of scientific validation of traditional knowledge (i) for indigenous communities —as empowering tool—, (ii) for the sake of scientific knowledge and (iii) for plant conservation.
Keywords: *Tabernaemontana*; Ecuador; Pastaza; plant uses; indole alkaloids; analgesic; psychotropic.

Validación del conocimiento tradicional de la sikta (*Tabernaemontana sananho*, Apocynaceae) en una comunidad canelo-kichwa amazónica

Resumen: *Tabernaemontana sananho* Ruiz & Pav. (*Apocynaceae*), es una planta utilizada en el norte de América del Sur, altamente valorada como sagrada, enigmática y medicinal. El objetivo de este trabajo es evaluar el conocimiento tradicional rescatado en una comunidad kichwa de la provincia de Pastaza (Ecuador) apenas contactada e investigar el conocimiento científico sobre esta especie. Describimos su uso, documentamos prácticas ancestrales que se mantienen vigentes y favorecen su conservación. Validamos muchas aplicaciones en base a publicaciones de estudios experimentales de sus alcaloides indólicos y actividad farmacológica. Este caso práctico enfatiza la importancia de sistematizar científicamente el conocimiento tradicional para reforzar el valor de la Biodiversidad y la Conservación.
Palabras clave: *Tabernaemontana*; Ecuador; Pastaza; usos; alcaloides indólicos; analgésico; psicótropo.

Introduction

Traditional indigenous knowledge has been often disregarded as unscientific due to its alleged insufficient repeatability, inability to provide data for quantitative analysis and intrinsic lack of tools to measure confidence (Ragupathy & Newmaster, 2009). As a result, indigenous communities have been often sidelined in the political decision-making process, alienating its members from the management of natural resources within their own traditional realms. Studies that validate traditional indigenous knowledge are therefore necessary as tools to empower indigenous peoples, to incorporate their knowledge to the mainstream scientific system and provide a framework for sustainable natural resource management (Gratani & *al*., 2011).

Despite the lack of recognition of traditional indigenous knowledge, an increasing body of research is raising its credibility through scientific studies. Validation of indigenous knowledge can use quantitative (Ragupathy & Newmaster, 2009), qualitative (Fassil, 2003) or both methods (Macía, 2004). In this study, we present a qualitative contribution to the validation of traditional knowledge in a scarcely contacted Canelo-Kichwa Amazonian community in Pastaza, Ecuador, of *Tabernaemontana sananho* Ruiz & Pav. (Apocynaceae), referred to as sikta in Kichwa (Quechua) language. Sikta is a highly symbolic plant species widely used in northern South America as a medicinal drug.

Sikta is a widespread small tree in the understory layer of the lowland evergreen rainforests across northern South America, from the Brazilian Amazon basin to Panama including Colombia, Ecuador, the Guianas, Peru, Surinam and Venezuela. Within Ecuador, it is cited in the provinces of Napo, Orellana, Pastaza, Morona-Santiago, Zamora-Chinchipe, the northern Sucumbíos, Carchi and Esmeraldas,

[1] Centro de Investigación Biomédicas – CENBIO, Universidad Tecnológica Equinoccial. 170147 Quito (Ecuador).
[2] Grupo de Investigación en Biología de la Conservación, Facultad de Ciencias, Universidad de Extremadura. Av. de Elvas, s/n. E-06071 Badajoz (España). E-mail: blanco_salas@unex.es
[3] Herbario Alfredo Paredes (QAP), Universidad Central del Ecuador. 17012177 Quito (Ecuador).

so it is mostly distributed over the Noroccidental province of the Amazonian biogeographical Region; this species shares its habitat with abundant and diverse *Eschweilera* (Lecythidaceae), *Iryanthera* (Myristicaceae) and *Protium* (Burseraceae) tree species (Borgtoft & *al*., 1998; Anon., 2012; Tropicos.org; Globalbioclimatics.org).

They are shrub-like small trees, repeatedly dichotomously branched, with l-2 pedunculate inflorescences in the forks. Their leaves are opposite, petiolate or less often sessile, those of a pair being equal or subequal, thick and coriaceous. They have pentamerous sympetalous white flowers; corolla lobes overlapping to the left; anthers mostly narrowly triangular, partly sterile; ovary with two open sincarpic carpels, subglobose at fructification, with a mostly fleshy, often thick wall and two narrow ridges; and fruits with many ellipsoid seeds deeply grooved on one side. The species was firstly described in Peru by Ruiz & Pavón (1798-1802; Plantillustrations.org; Figure 1). The interest of this tree resides in its use as a multipurpose remedy and symbolic plant that is "only recognized by selected persons from ancestral cultures" (Van Beer & *al*., 1984).

Figure. 1. Illustration of *T. sananho* Ruiz & Pavón (1798-1802) (http://www.plantillustrations.org).

The sikta tree produces a number of biologically active substances as byproducts of its secondary metabolism. Most of them belong to the chemical family of the indole alkaloids (Van Beer & *al*., 1984), substances whose effect is known since early times in history and that have proved highly valuable in western medicine (Monachino, 1954). Sikta is reported to act as a stimulant, be used as cure-all and bears a high symbolic value, as many indigenous peoples consider it sacred (for a summary of previously reported uses see Appendix 1). In Colombia it has been used to cure eye wounds, while in Brazil, a concoction of the roots is used against rheumatic pains (Van Beer & *al*., 1984). Leaves are used against syphilis, fever, and as a heart tonic. Roots allegedly work against abscesses, skin pathologies and colds, while the bark is employed as a contraceptive and painkiller plus as a stimulant for hunting dogs. A wide array of indigenous peoples uses the sikta tree, among them, to cite some examples, the Aguaruna of Peru (Brack Egg, 1999) and the Awa, Cofan, Secoya, Shuar, Wao or Kichwa from Ecuador (De la Torre & *al*., 2008; Luzuriaga, 2017), where sikta is in addition regarded as a highly valued sacred plant.

The Kichwa community of Pakayaku (Bobonaza river, Pastaza, Ecuador) includes approximately one thousand inhabitants widely spread over their ancestral territory, where they live in open wood cottages scattered through the forest. The community makes contact with the rest of the country only occasionally by radio or by rafting the river Bobonaza for five hours to the closest village connected by road (Canelos). Pakayaku lacks electric supply, medical attention, running water and sewage network, and therefore also TV, connection to the Internet or mobile phones. Labor division in Pakayaku is based on sex: men work as hunters and warriors, and fell trees to open a forest clearing or chakra where women later cultivate the land and prepare the staple food, the yucca. The children learn Spanish at an elementary school, while the elderly speak only Kichwa. School absenteeism is unfortunately rife.

This study aims to report the traditional knowledge and uses of sikta by the Pakayaku community and lay a framework for its scientific validation, with the objective of incorporating the indigenous knowledge to the global scientific network, raising the awareness of the non-indigenous peoples and legitimate the traditional uses of the sikta on the basis of scientific evidence.

Materials and Methods

Study area and voucher collection

The Kichwa community of Pakayaku (Bobonaza River, Pastaza, Ecuador) lies in a fairly isolated region where bio- and ethnodiversity studies are still lacking. One of us (CXLQ) was based in the Biological Station Pindo Mirador in the northern Bobonaza river basin (1º27'09''S-78º04'51''W), and since 2008 in charge of environmental monitoring and education programs involving the local population (Figure 2).

Figure. 2. Location of the study area. The Ecuadorian province of Pastaza is highlighted.

Plant collection permits were granted by the Ministry of the Environment. Plant vouchers were deposited at the QAP Herbarium (Quito, Ecuador): *Tabernaemontana sananho* Ruiz & Pavón. EC: Pastaza, Pakayaku, sector of Aychatambo, 425 m, lowland evergreen forest, 28 November 2015, C. X. Luzuriaga-Q & L. Gayas (QAP 92980). Herbarium José Alfredo Paredes, Universidad Central de Ecuador, Quito. Identification was revised by C. Cerón.

Ethnobotanical survey

Collective written research consent was granted by Mrs. Luzmila Gayas, community president of the Asembly of Pakayaku. Prior oral individual consent was obtained from the persons taking part in our survey. Our investigation consisted of a series of planned house visits and walking routes accompanied by Kichwa interpreters and local inhabitants of Pakayaku. Interviews were semi-structured and included a series of open questions aimed to encourage discussion. All interviews were recorded. Two knowledgeable elders of the Pakayaku community (hereafter n1, n2), acted as informants and agreed to reveal their wisdom of the sikta tree. The informants answered freely about several topics, namely Kichwa common name, part of the plant used, description of use, harvest season, storage (if any), concoction and treatment target. After the field wok, data were included into an MS Excel spreadsheet. All recorded uses were referred to the classification proposed by Luzuriaga (2017), which is itself based upon De la Torre & *al*. (2008). The data provided by the community were compared with the existing ethnobotanical literature from Ecuador and summarized in Appendix 1, while a summary of recorded uses in Pakayaku is provided in Appendix 2, following the classification of Pardo de Santayana & *al.* (2014).

A bibliographic study was performed to provide scientific evidence for the medicinal uses of the plant.

Results and Discussion

Our survey recorded twelve uses of sikta tree. Most of them involve the use of the plant or plant drug as an ethno-medicine to treat a series of conditions in human patients, but other uses such as to deliver strength and as a stimulant for hunting dogs were also recorded. A list of plant drugs, uses and preparation by ethno-pharmacological techniques is provided in Appendix 2.

The capacity to improve dog hunting skills is of particular interest. To our knowledge, this is the first report for Kichwa peoples of the Bobonaza river basin. Similar uses are reported from the Awaruna in Peru, an indigenous group sharing a Shuar common ancestry with the Kichwas (Luzuriaga, 2017).

Sikta trees are considered sacred by the Kichwas. The trees bear high symbolic meaning and are regarded as a bridge that links the person with the hidden forces of Nature. This high symbolic meaning attributed to sikta is also reflected in the fact that trees are not felled by the men when clearing the forest. Moreover, the location of the individual sikta trees used by the initiated adults is kept under secret. To our knowledge, this is the first time such an elevated cultural status is attributed to a *Tabernaemontana* species among the Kichwa peoples.

We documented rituals aimed to cleanse the body and soul of evil spirits. These treatments and rituals are conducted by an informed person who prescribes a series of indications that the patient must observe to eventually recover health. Most requirements involve strict fasting, with later controlled intake of a certain food such as roasted banana prepared without any salt or peppers. Fasting can endure from two weeks to three months.

The high symbolic status of sikta in the Kichwa community contrasts with the more mundane uses of *Tabernaemontana* reported for other native peoples of the northern Amazon basin (summarized in Appendix 1). The Cofan, Awa, Secoya, Wao, and Shuar of the northern provinces of Ecuador principally use the plant as a sedative, vulnerary and tonic, or as a stimulant and hallucinogenic brew in concoction with species of *Osteophloeum* (Myristicaceae) and *Brugmansia* (Solanaceae). Other uses such as animal feeding and as building material are also reported. Anti-parasitic activity is reported in the literature but was not recorded in our survey.

Ethno-medicinal preparations vary in their formulation across indigenous communities. Plant drugs employed change from one community to another as well. For instance, while the Canelo-Kichwa community of Pakayaku employs sikta roots for digestive or respiratory conditions, the Kichwas of Orellana use sikta bark or leaves to treat colds. Similarly, the Canelo-Kichwa people of Pakayaku use sikta leaves as vulnerary in post-delivery bleeding while the Kichwas of Napo employ sikta latex for the same purpose.

Towards a validation of sikta traditional uses

T. sananho is reported to be rich in indole alkaloids (Van Beer & *al*., 1984), among them coronaridine, 3-hydroxycoronaridine, (-)-heyneanine, (-)-ibogamine and voacangine, the latter being coronaridine derivatives with iboga-type basic skeleton (Figure 3). More recently, Rohini & Mahesh (2015) isolated the alkaloids TS1 and TS2 from leave extracts, with ervatamine iboga-type and monoterpene (metoxy) indole miscelaneous group basic skeletons, respectively (Figure 4).

A series of contributions report biological activity that can potentially explain the widespread uses of sikta by indigenous peoples across the northern Amazon basin to treat a wide range of conditions (Appendix 1). Van Beer & *al*. (1984) and references therein reported coronaridine activity on the autonomous and central nervous systems as a painkiller and respiratory depressant, as well as estrogenic activity that could account for the use of sikta as a contraceptive. 3-hydroxycoronaridine is reported to show antibiotic activity, while ibogamine is apparently a powerful stimulant of the central nervous system. Voacangine exhibited a slight central nervous stimulant effect.

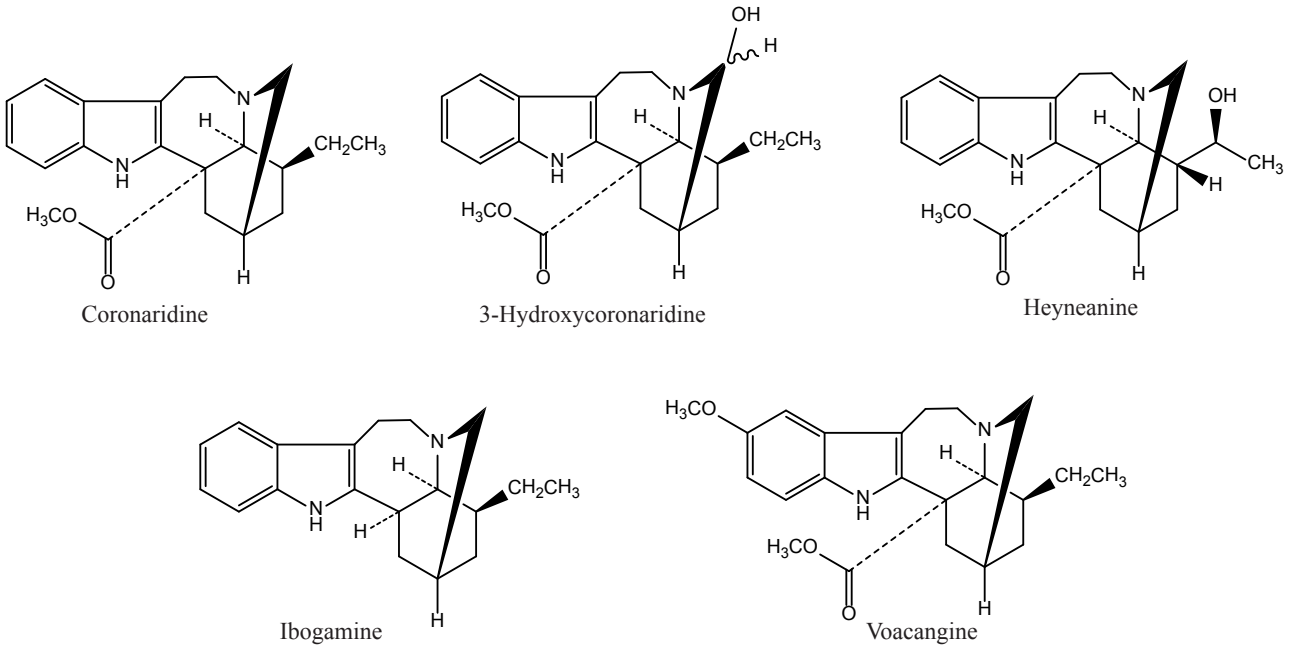

Figure. 3. Coronaridine, the iboga-type basic skeleton for 3-hidroxycoronaridine, (-)-heyneanine, (-)-ibogamine and voacangine alkaloids.

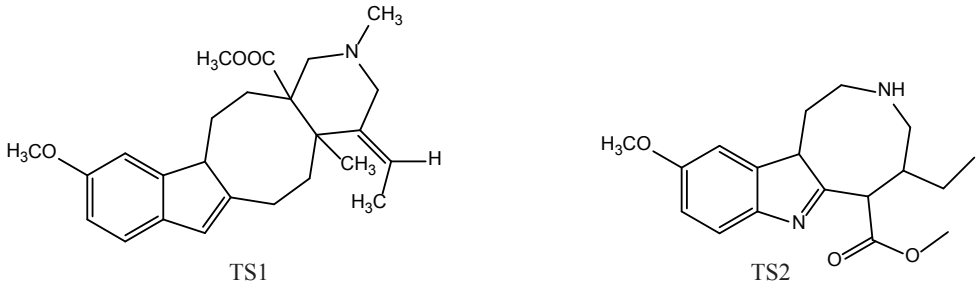

Figure. 4. TS1 (ervatamine subtype) and TS2 (monoterpene (metoxy) subtype) alkaloids described by Rohini & Mahesh (2015).

Regarding other species of *Tabernaemontana*, Rizo & *al*. (2013) found promising antitumoral activity in coronaridine and heyneanine from *T. catharinensis*. Rohini & Mahesh (2015) obtained successful results when evaluating the anti-inflammatory and anti-nociceptive activity of TS1 and TS2. Pratchayasakul & *al*. (2008) found that ibogamine from *T. divaricata* and ibogaine presented a similar effect. The revision of Dos Santos & *al.* (2017) described the anti-addictive action of these alkaloids, which opens a window for prospecting their use in drug detoxification programs. Similar activity for voacangine from *T. corymbosa* was reported by Xuan & *al*. (2006).

Indole alkaloids are reported to possess anti-inflammatory and anti-nociceptive activity (Van Beer & *al.* 1984). This could account for the relief of abdominal pain and respiratory conditions attributed to sikta by the Shuar, Wao, Cofan, and Kichwa peoples. Shuars and Kichwas brew concoctions of diverse sikta drugs to relief pain due to muscular and skeletal injury as well as general discomfort.

The combined anti-microbial and anti-parasitic activity of coronaridide from *T. divaricata* reported by Pratchayasakul & *al*. (2008) and Estevez & *al*. (2007) (leishmanicidal activity) could account for the traditional use of sikta in the treatment of infections, parasitosis and parasitic diseases, as well as for the use of sikta concoctions as a birth aid (potential effect on uterine contractions), as a vulnerary and in the puerperal hygiene of mother and child.

Bennett & Alarcón (2015) reported that the administration of stimulant substances to hunting dogs can enhance their sensory perception and therefore improve the detection and capture of prey, which opens a window for use in specialized training programs for police dogs.

The scientific validation of traditional knowledge is an important step towards the legitimization of indigenous culture in the global society. It is empowering for the indigenous people as well as a valuable contribution to contemporary science and a promotion of environmental conservation.

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Appendix 1. Synthesis of the ethnobotanical knowledge in *T. sananho*, from the indigenous communities of Ecuador based on Van Beer & *al*. (1984), Brack Egg (1999), De la Torre & *al*. (2008) and the bibliographic revision of Luzuriaga (2017).

Discipline	Organ/System	Part used	Formulation	Traditional knowledge	Indigenous population	Country or Ecuador province
Medicine	Digestive system	Bark	Cooking of shaved bark	Abdominal pain	Shuar	Morona Santiago
			Brew of shaved bark		Kichwa	Napo, Pastaza
			Brew		Wao	Orellana
		Sap	Drink with a pinch of salt			
		Bark and leaves			Kichwa Cofán	Napo, Pastaza Sucumbíos
		Bark	Mixed with other herbs	Diarrhea	Kichwa	Napo
		Fruit latex	Latex licked off of fruit		Shuar	Zamora Chinchipe
		Stem	Stem is cut		Shuar	Napo
				Intestinal gas	Kichwa	Napo, Pastaza
	Gynecology	Root	Cooking	Postpartum nausea	Kichwa	Napo
		Bark	Brew	Washing of "impurities" after childbirth	Kichwa	Napo, Pastaza
			Concoction with *Petrea maynensis* and *Usnea* sp.	Contraceptive	Kichwa	Napo
				Contraceptive	Awaruna	Peru
		Latex		Purify blood after birth	Kichwa	Napo, Pastaza
				Bleeding in childbirth	Kichwa	Napo, Pastaza
				Postpartum abdominal pains	Kichwa	Napo, Pastaza
	Respiratory system	Leaves	Boiled with tobacco in a little water then vapors inhaled through the nose	Colds	Kichwa	Orellana
				Flu		
		Bark	Brew		Shuar	Pastaza
			Shaved bark in the nose		Kichwa	Orellana
		Latex	Shaved bark in the nose			
		Bark	Brew of shaved bark		Kichwa	Napo, Pastaza
				Coughs		
			Brew taken on an empty stomach		Kichwa	Napo
		Root		Coughs	Awaruna	Peru
				Clear breathing system	Kichwa	Napo, Pastaza
	Musculature and skeleton	Bark	Brew of the shaved bark	Inflammations	Kichwa	Napo, Pastaza
		Root	Brew	Rheumatic pains		Brazil
		Root bark, leaves		Rheumatic pains	Awaruna	Peru
		Root		Skin conditions, abscesses	Awaruna	Peru
	Ocular system			Eye wounds		Colombia
	Cardiac system	Leaves		Cardiac tonic	Awaruna	Peru
	Other infectious and parasitic diseases	Bark, leaves	Scraped bark is wrapped in the leaves and left in water until the next day, then drunk as emetic	Intestinal parasites	Cofán	Sucumbíos
		Leaves		Syphilis	Awaruna	Peru
		Latex		Tupe (larvae under the skin)	Secoya	Sucumbíos
				Influenza	Kichwa	Napo, Pastaza
					Wao	Orellana
		Bark	Brew	Dysentery	Shuar	Pastaza
					Wao	Orellana

Discipline	Organ/System	Part used	Formulation	Traditional knowledge	Indigenous population	Country or Ecuador province
	Symptoms and states of undefined origin	Fruit (aryl)		Body fevers	Kichwa	Napo
		Leaves		Body fevers	Awaruna	Peru
		Latex		Stimulating	Shuar	Orellana
				Body discomfort	Cofán	Sucumbíos
	Other medicinal uses	Bark, leaves	Additive in herbal preparations	Increase efficiency	Kichwa	Napo
Veterinary	Endocrine-metabolic system	Latex	Applied to dogs nose	Gain weight	Wao	Napo
	Organ of the senses	Bark	Ground and applied to dogs nose	Improve hunting skills	Shuar	Pastaza
			Left in water, then offered to dogs		Kichwa	Orellana
		Bark	Fed to dogs	Improve fitness	Awuaruna	Peru
		Fruit	Sticky juice applied to dogs nose	Improve smell and hunting skills	Secoya	Sucumbíos
					Others	Ecuador
Toxic and harmful	Poisons, insecticides and pesticides	Bark		Hunting poison	Kichwa	Napo
					Secoya	Sucumbíos
Social, symbolic and rituals uses	Hallucinogenic, narcotic and smoking		Concoction with *Osteophloeum platyspermum* and *Brugmansia* spp.	Hallucinogenic	Kichwa	Napo
		Bark	Bark grated, brewed in cold water and applied to the nose	Luck and energy for the hunter	Shuar	Pastaza
		Leaves	Briefly cooked in water and applied	Headache	Kichwa	Napo
Other	Other	Bark	Shaved bark is cooked	Sleeping	Shuar	Morona Santiago
		Edible-Fruits / Sweet fruits		Human consumption Food	Awa	Carchi
					Cofán	Sucumbíos
					Secoya	Sucumbíos
					Kichwa	Napo, Pastaza, Sucumbíos
					Wao	Napo, Pastaza, Orellana
					Shuar	Pastaza, Morona Santiago, Zamora Chinchipe
					Not specified	Napo, Orellana, Morona Santiago, Zamora Chinchipe
		Stem sap		Non-alcoholic beverages Quench thirst	Wao	Orellana
		Fruit		Forage, in particular birds	Secoya	Sucumbíos
		Stem		Building material agricultural facilities	Wao	Napo

Appendix 2. Specific ethnobotanical uses in Pakayaku in *Tabernamontana sananho*. *Ancestral utilizations, aspects or facets not previously published. Data procedence: Informants n1 and n2.

Discipline	Target	Drug	Formulation	Use
Medicine	Digestive system	*Root	*Root is scraped and brewed in a liter of liquid. It is taken three times a day for fifteen days. Treatment is resumed after a pause.	*Gastritis 1
	Conception, pregnancy, delivery and puerperium	*Leaves	*Root is scraped and brewed in a liter of liquid. The leaves are boiled in the afternoon and the next day at four in the morning the pregnant woman is bathed.	Birth 1
	Respiratory system	*Root	*Same procedure as rituals for body cleansing with roots	Throat and lung clearing 1
	Cultural diseases	*Leaves	*Leaves are boiled and the resulting brew is used to bathe the patient at 4:00 a. m.	*Clear evil in the body 2
		*Stem and leaves	*Patient is spanked with leaves and stems throughout the body	*Against bad spirits 1
	Symptoms and states of undefined origin	*Root	*Roots of three plant species ("*three trees that are well nailed the root*") are collected and "thin barks are scraped and thrown". Then left during the night in an open space (referred to as "*enserenar*"). The next morning at four the person takes a glass of the resulting concoction, and rests during the following day, being only allowed to move once to go to the bathroom. If not getting better, repeat. At four in the afternoon a bath in the river is taken, and the next day, the person is required to fast, eating only roasted banana, without mayto nor any chili or salt. This diet must be followed for fifteen days or more, up to three months ("*well endured three months, our body is getting better*").	Catharsis 1
			*Same procedure as for rituals of body cleansing with roots	Physical discomfort 1
		*Bark	*A concoction of ten plant species, "*taking into account the sunrise and the sunset"*. Plant drugs are poured into a pot and covered with water, then boiled until dry. The resulting mixture is taken on an empty stomach when returning from work, and before eating chicha. The first day a strict diet must be observed, "*eat neither pepper nor salt*", but after that "*we de*".	Physical discomfort 2
Veterinary	Sense organ	Bark	Five bushes are scraped in virgin forest. They are planted to be able to take power, and finally they are given to the dogs	Stimulation of hunting dogs 2
Environment	Others	*Whole plant	*This plant is regarded high cultural value "*we value it is secret we do not mistreat; we do nor cut at work we take good care*"	*Environmental protection 1
Social, symbolic and rituals	Hallucinogenic, narcotic and smoking		No data	Provide strength, to blow the "bodoquera" when men go hunting into the forest 2