

From Local Ancestral Practices to Universal Antiviral Uses: Medicinal Plants Used among Indigenous Communities in Ecuadorian Highlands.

Fernando Ortega

College of Health Sciences.
Universidad San Francisco de Quito.
Diego de Robles y Pampite. Círculo de Cumbayá. Quito. Ecuador.

Marleen Haboud

School of Linguistics.
Pontifical Catholic University of Ecuador.
12 de Octubre y Roca. Quito. Ecuador

Ernesto Farinango

Comunidad de Chirihuasi.
Provincia de Imbabura. Ecuador.

Luis Farinango

Comunidad de Chirihuasi. Provincia de Imbabura. Ecuador.

Abstract

This article summarizes the common uses of medicinal plants among the indigenous populations of three rural communities located in the Ecuadorian Highlands. Quichua and Spanish names of one hundred seven different medicinal plants have been provided by the elders of these communities as part of an effort to recover, maintain and share their knowledge and practices with the younger generations. Most plant species identified are used with medicinal purposes and prescribed for external and/or internal use. External use for the following ailments: skin abscesses, wounds, scabies, body pain, joint and bone pain, eye inflammation, toothache, colds, rainbow skin lesions, malaire, fright, among others. Internal use for: stomach pain, "internal" fever, body aches, anemia, diarrhea, menstruation cramps, cough, urinary inflammatory processes, "attacks and fainting", and other disorders. At least four of the species advised for respiratory constrains have antiviral activity probably also useful to treat COVID 19.

Key words: Andean ethnobotany, community active participation, COVID 19, medicinal plants, traditional knowledge.

It is widely known that most of the world's population depends on traditional, alternative, and complementary medicines for their health care (WHO, 2019). Since ancient times, rural population worldwide have turned to medicinal plants as the primary source for solving their health problems. Currently, several products of the contemporary Western pharmacopoeia are derived from active ingredients found in medicinal plants. The World Intellectual Property Organization (WIPO) created in 1967, relates intellectual property to five expressions of the human relationship between culture and nature: biological diversity, traditional knowledge, folklore, environmental protection, and human rights. When relating Intellectual Property and Traditional Cultural Expressions, WIPO declares that: "*The cultural heritage of a community or nation lies at the heart of its identity and links its past with its present and future*" (WIPO, 2008, p. 56).

Referring particularly to the rights of communities, indigenous people, and nationalities, the 2008 Ecuadorian Constitution recognizes the rights of environment and indigenous people to maintain, protect, and develop collective knowledge, their ancestral sciences, comprising their medicines, and practices of traditional medicine, including: "*the right to recover, promote and protect ritual and sacred places, as well as plants...*" (Asamblea Constituyente, 2008, p. 41).

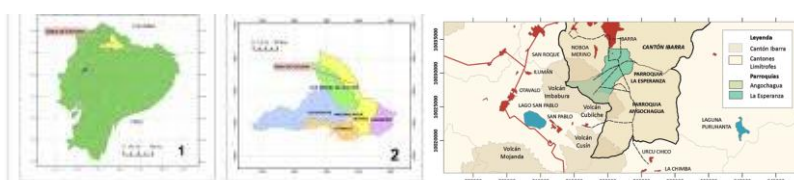
To solve health problems, for centuries the indigenous communities of Ecuador have maintained, knowledge, and ancestral practices of health, through the intergenerational oral transmission of their traditions, however, the intense and sustained cultural contact with the dominant Spanish-speaking society constitutes a serious risk factor

threatening the loss of their indigenous cultural and linguistic traditions, which together help to maintain the knowledge of the resources in the natural environment and how to employ them in the treatment of illnesses.

Today, after more than five hundred years of extensive cultural intermixing in Ecuador, the use of herbal medicine among the people living in the highlands, constitutes a dynamic reality that is in constant evolution, complementing local ancestral knowledge with new contributions arriving from European ethnomedicine since the conquest and colonial periods (XVI-XIX centuries), as well as from other more recent cultural contacts with native people living in different ecological niches, such as those in the Amazon and Pacific coastal regions.

The Andean ethnomedicine is currently being recovered and strengthened by groups of young indigenous people in the province of Imbabura, who are aware of the cultural and linguistic value of their ancestral knowledge. This province, which is situated in northern Ecuadorean highlands (0° 21' 27" N; 78° 6' 40" W), is the settlement place for the three communities of this study: Chirihuasi, El Abra and Cashaloma (La Esperanza, Imbabura). At an altitude between 2600 and 3600 meters high, the weather in the area is temperate, the flora and fauna correspond to a mountain forest climate, the biological diversity is high, and the soils are appropriate for agriculture and the pasturing of livestock.

Figure # 1.- Maps of Ecuador, Imbabura Province, La Esperanza District, and the communities of the study: Chirihuasi, El Abra and Cashaloma.



Since the colonial period, there have been several documents testifying the use of medicinal plants in the territory of Ecuador: De Velasco, (1977), Cordero, (1950), León, (1974), Villavicencio, (1973), White, (1982), Naranjo, (1980), Ortega, (1983), and Sánchez-Parga, (1982). The first publication regarding the use of herbal medicine in La Esperanza, Imbabura was conducted in the 1993 (Kothari, 1993), followed by twenty-five years without any further research activity.

In 2010, a group of students from the School of Linguistics, Pontifical Catholic University of Ecuador (PUCE), visited the community of Chirihuasi in guided fieldwork by one of this article's authors. Because of that visit, two young members of the community, visited the university searching for professional linguistic assistance. They were seeking advice regarding their recordings of a series of stories as told by the elder members of their community in Quichua. This was the beginning of a long-standing relationship between the community and the university to document the knowledge of the elders and help ensure the survival of the endangered Quichua language still spoken in the Ecuadorian Andean region.

By 2016, a mutual interest for enhancing the use of Quichua among younger generations, motivated us to design a project with the purpose of recovering and preserving the extensive knowledge that underlines the current use of traditional medicine practiced by the members of the three communities. With such a purpose, we conformed an interdisciplinary research team with a medical doctor and anthropologist from Universidad San Francisco de Quito, USFQ, to the already strong relationship established by the sociolinguist and the two local community members.

Along with members of a sociolinguistic program (Oralidad Modernidad, OM), this team of four researchers started the fieldwork activities during the first semester of 2017. The two local members were trained in the use of a free linguistic software (Lexique-pro) and were also visited periodically by the two members from both universities and the OM members. The team planned to at least have three meetings which were to take place every three months.

The purpose of these meetings was to obtain the feedback and advice of a most knowledgeable elders of the three communities, to ensure, to the greatest extent practicable, the accuracy and comprehensiveness of the collected data. The team worked along with 21 women and 6 men, also called *Mamas* and *Taytas*, whose knowledge and skills were video recorded to build the corpus of medicinal traditions of the involved indigenous communities.

Two hundred and fourteen photographs (2 per plant) were selected out of hundreds that were collected in situ, with accompanying geographic references of the places where each of the species grows. Finally, two ethnobotanists were consulted to confirm the corresponding taxonomy of all plants.

In 2019, the results of this preliminary fieldwork study were published under the name of "Jambij Yuracuna / Plantas que curan" (Healing plants), in a bilingual Quichua-Spanish version, (Haboud et al., 2019), and presented in Quichua, Spanish and English languages in local, national and international conferences held in Ecuador, the Americas (Chile, Colombia, Costa Rica, Mexico, Illinois, Wisconsin and New York) and Europe (Spain, Switzerland and Germany). The information of such publication also included local Quichua and/or Spanish names,

each plant botanical description, family and species, plant origin (natural or cultivated), ecological context, “hot and cold” taxonomy, prescriptions, and warnings. A multilingual virtual publication in Quichua, Spanish and English is currently under review.

2. Materials and methods

2.1, Design

This is an observational, cross-sectional, descriptive research. Two local community members were trained to employ a structured questionnaire, as well as to conduct open interviews among elder members of the three communities who volunteered to participate. Both field workers were familiarized with the use of Lexique-pro linguistic software to register and store the corresponding information. In many cases, the Quichua explanation of remedy preparations was video recorded, thereby allowing the project to introduce an innovative cultural and linguistic storytelling technique.

2.2, Plant identification process

The number of species in the territory of these three communities is countless. The native vegetation is extremely varied and the indigenous population, living in this ecomiche, has been familiar with them for many centuries. As a result of this long-term contact, at least 107 plants with favorable impact in their health conditions were named and described, and it is on those plants that we have been able to focus our attention.

The identification of each plant, its leaves, flowers, stems, bulbs, roots, fruit, seeds, tubers, and other elements, as appropriate, was conducted entirely in the territory of each community by the local experts, the interviewers, and the medical anthropologist. We paid attention to each plant in their own environment. Each plant was photographed several times from different positions to better enable its characterization and recognition. In a few cases, the plants were collected during field visits to follow a more exhaustive examination among other members of the community. No plant material was exported outside of the community borders in any form at all. Plant photographs and their use descriptions were examined by the ethnobotanist to confirm their species identity and botanical family.

2.3, Plant names and classification

The names of all plants were collected in Quichua, Spanish or both. The botanical nomenclature of plant families and species is based on the Enciclopedia de Plantas Útiles del Ecuador (De la Torre et al., 2008), based on the QCA Herbarium of the School of Biological Sciences at Pontifical Catholic University of Ecuador & AAU Herbarium of the Biological Sciences Department at Aarhus University, Denmark.

Species were physically identified in the field and their names also confirmed using the available online and edited version of the Encyclopedia.

Ethnographic data were collected by the authors during daily walks in the mountains, creeks, cultivated lands and home gardens of the communities, as well as during the three meetings with the elder experts of the three communities during 2017 and 2018. On several occasions, we received information contributions from local curanderas whose homes, we visited while conducting the fieldwork. These visits also guided our observations about the selection of species, plant parts used, and the preparation techniques used for combining other plant species in the same remedy.

A chart with information on all the collected plants was generated containing data on plant family and species, local Quichua, Spanish and botanical names, parts used, traditional prescription and indications for external and internal use.

3. Results

3.1, Indigenous names vis a vis Spanish names

The names of 66 of the 107 itemized plants used in Chirihuasi, El Abra and Cashaloma (61.7% of the total) are in Quichua; the remaining 41 (38.3%) plants bear Spanish names.

We have recorded and maintained the locally used names because they are well known in the communities and in most Andean Ecuadorian region. Plant names and their botanical families were all identified in the Enciclopedia de Plantas Útiles del Ecuador.

3.2, Community consensus

Community consensus was obtained in large meetings held with the elder members of each of the three communities, which constituted expanded focus groups. We used this methodological approach to clarify and to obtain the community approval regarding the names and properties of each plant and its preparation for healing purposes.

The 107 species reported were widely known by most members of the three communities, in many cases the same plants were frequently used by different individuals for the same ailments; in other cases, however, there were variations of use among individuals. In the publication of results, we mentioned the names of each particular Mama and Tayta for each such variation, thereby enriching the scope of information as well as giving credit to individuals who use the plants in differing ways.

3.3, Plants identified

The plants reported in this study are considered as medicinal plants and are used for health purposes, although, there are some that are also considered as food. All 107 species belong to 40 different plant families. The families represented are Asteraceae with 17 species, Fabaceae 9, Solanaceae 7, Lamiaceae and Amaranthaceae 6 each, Brassicaceae and Poaceae 4 each, Piperaceae, Urticaceae and Apiaceae 3 each, Polygonaceae, Commelinaceae, Equisetaceae, Malvaceae, Apocynaceae, Rutaceae, Euphorbiaceae, Rosaceae and Oxalidaceae 2 each, with the remaining 21 families represented by only one specimen each. These numbers account for the wide diversity of medicinal flora growing naturally or cultivated in the territory of the three communities. When the last version of *Jambij Yuracuna* was in print, we already learned that there are several more medicinal plants not included in this first edition; however, those plants are also part of the ethnobotanical remedies used by in this region.

3.4, Plant uses

All identified medicinal plants are prescribed for external and/or internal use. Regarding *external use*, were species to treat skin abscesses, wounds, scabies, scaldings (18 species), fever (11), body pain due to excessive physical labor (8), joint and bone pain (5), eye inflammation (5), toothache (5), ear ache (2), stomach ache (2), colds (2), dandruff (2), ailments like “rainbow skin lesions” (5), “malaire” (2), “fright” (1), and 12 species for treating other ailments. As for *internal use* the corresponding numbers were: Stomach (abdominal) pain due to cold, heat or excessive physical labor (18 species), “internal” fever (10), worries/nerves (8), body aches (5), anemia/”not eating well” (4), diarrhea (4), headache (3), menstrual cramps (3), cough (3), urinary/kidney infection (2), cramps (1), “attacks and fainting” (1), and 6 species identified for treating other ailments.

As explained in “Jambij Yuracuna / Plantas que curan”, several species are used alone and with a particular indication. For example: **Lichiangu**, *Cynanchum cf. microphyllum*. APOCYNACEAE, is useful for lower back pain due to excessive physical labor. For coughing, three different plants can be prescribed, these are: **Tilo** *Sambucus nigra* ADOXACEAE, **Yana tifu** *Eupatorium sp.* ASTERACEAE, or **Izhu Dalea** *Dalea coerulea*. FABACEAE. In other cases, the same plant is used for various health conditions. For example: **Jana yuyu** *Sonchus oleraceus* ASTERACEAE, used for inflammatory processes after trauma, to reduce fever, and for skin spots among adolescents. It is very common that several plants are combined in the preparation of a specific remedy but use of a single species is also recommended depending on the patient’s health condition. In addition, the same species can be recommended for external (topical) or internal (oral) use. See Chart # 1, below.

Chart # 1. Type of health ailment and number of species used in oral or topical treatment.

Health concerns, ailments, symptoms	ORAL Internal use		Health concerns, ailments, symptoms	TOPICAL External use	
	N of species	%		N of species	%
Stomach pain	16	22.5	Skin lesions	18	23
Fever	10	14	Fever	9	11.5
Worries, concerns, troubles	10	14	Body aches (cold weather)	10	12.8
Anemia	5	7	Bone and joint pain	9	11.5
Body aches	6	8.4	Eye inflammation	7	8.9
Headache	4	5.6	Toothache	5	6.4
Coughing	4	5.6	Rainbow effects	5	6.4
Other ailments	16	22.5	Other ailments	15	19.2
TOTAL	71	100.0	TOTAL	78	100

Source: The authors of this article.

Living conditions prevalent in traditional rural agricultural lands, including exhausting physical labor, the lack of sanitary sewage, and dust added to the generally colder weather of the highlands, would seem to explain the frequency of symptoms such as fever, stomachache, skin lesions, body aches and infections.

The treatments of uncomplicated symptoms are performed in the homes of the individuals. The convention in the communities is to consult the mother or the grandmother of the patient to receive advice regarding any outstanding health concerns. This cultural fact is evident in the proportion of females among those community members who shared the traditional knowledge of their families – twenty-one were female while only six were male., six male and twenty-one female.

The use of medicinal plants for the treatment of Mal del Arco Iris (Rainbow effects) (5 species), Mal aire (bad air) (2 species) and Espanto (fright) (1 species) is a cultural practice that indicates the presence of these not very common complaints. Other ailments well known in the Andean region such as: Mal de ojo (evil eye), Mal viento (bad wind), and Envidia (envy), were not mentioned in these communities. For whatever reasons, it seems that nowadays those afflictions are less frequent in this rural area of Imbabura, at least in the three communities we studied.

All of the types of cultural illnesses mentioned in the previous paragraph are categorized in a Western conceptualization as psychosomatic disorders (Rado, 2011, p. 70). Nevertheless, for each one we collected a detailed cultural description of the characteristic symptoms and signs of the presence of the ailment, including physical conditions as well as emotional ones. As we could not attribute their causes to magical events, we did not regard it as appropriate to classify them into a “magical” (Bussmann & Sharon, 2006) or supernatural category.

3.5, Mal del Arco Iris (Rainbow effects)

El Arco Iris (the rainbow) is the visible, physical spectrum produced by sunlight when crossing micro drops of water suspended in the air. In the Andean region, and particularly among the indigenous population, it is also considered the origin of several somatic and emotional disorders that appear because of a disrespect to its presence. Four different types of general clinical manifestations have been attributed to such situations: depression, asthenia, musculoskeletal pain; dermatological conditions; the possibility of becoming pregnant; and the chance of the birth of dead or malformed children (Estrella, 1976).

Believe in these effects as the result of disrespect toward the rainbow is prevalent in rural areas not only in the Andes but in the coastal and Amazonian region as well. The most common description is of a dermatological lesion which stands out as a colorful rash with blisters, pustules or tumors that is difficult to cure, and easily gets over-infected. The disease occurs when the person disrespectfully passes by or stands inside the area covered by the rainbow (Estrella, 1976, p. 154), usually in a humid swamp area, whose stagnant waters leave a layer of floating oily detritus (Hermida, 1992). El Arco Iris is considered as celestial energy with supernatural powers. In the communities of the study, five plant species are used topically for controlling the dermatological manifestations of this infection: **Congona** PIPERACEAE *Peperomia galioides*, **Matico** ASTERACEAE *Aristeguietia glutinosa*, **Ruda** RUTACEAE *Ruta graveolens*, **Tabaco** SOLANACEAE *Nicotiana tabacum*, **Urcu zanahoria** APIACEAE *Arracacia sp.*

3. 6, Fever

People living at above 2500 meters of altitude can avoid the tropical infectious diseases like vector borne diseases (dengue, sika, chikungunya, onchocerciasis, or malaria) that are usually diagnosed due to fever episodes. In the highlands, however, the exposure to hot and cold temperatures, sustained physical activity during long exhausting hours of manual agricultural labor, and the precariousness of housing may cause frequent infectious complications like skin, respiratory and digestive disorders. It is unsurprising then, that 14.5% of their medicinal plants are indicated to orally treat fever by the intake of infusions, and 11.5% of plants are also used externally in topic applications of mashed fresh leaves or cooked preparations for bathing.

3. 7, Digestive disorders

The Spanish expressions dolor de barriga (abdominal pain), dolor de estómago (stomach ache), refer to several types of abdominal complaints, mostly colic pain, located in the center or upper abdomen (meso or epigastric pain), due to excessive physical activity or feeling cold due to exposure to low temperatures.

Almost one quarter (23.2%) of Chirihuasi medicinal plants are considered useful to treat this condition. Diarrheal disorders, however, were infrequently referred, likely because most of the families have potable water systems installed in their home. Diarrhea is included in “other ailments” (See Chart # 1.)

3. 8, Skin lesions

The percentage of medicinal plants used to treat skin lesions is similar to that of plants used for abdominal pain. A total of 18 species (23% of all species) are externally used in the form of plasters, dressings or cleaning

preparations to treat infected wounds and skin infectious diseases such as: scabies's, impetigo, other epidermis abrasions, ulcers or skin cuts.

3. 9, Mental health

A considerable number of natural medicinal treatments are suggested for those individuals who suffer fears, worries or uncertainties concerning social relations; socioeconomical conditions; weather changes that affect the production of their land; changes in market economy; and the uncertainty of the political future. We cannot label these conditions psychosomatic disorders; on the contrary, suffering from such illnesses demonstrate how contact with urban society and urban-rural relationships are increasing the level of stress experienced by people living in what were, until relative recently, traditional peasant societies. Ten different species were identified as serving to treat these mental health conditions. The via of administration of 15 of these plants is in the form of herbal infusions (Sp. aguitas).

3. 10, Bone and joint problems

In absolute numbers, a total of 28 uses out of 149 registered in this study are indicated for internal or external use in order to treat bone pain and joint pains (body aches). Rheumatic problems could be included among other musculoskeletal ailments. Among the three communities, the attributed causes for body aches are their usual agricultural activities that involve most members of the families, climate conditions as damp and cold weather, insufficient insulation in the home; and walking long distances on foggy or rainy winter days.

3. 11, Herbal remedies traditionally used for the treatment of gynecological conditions

A total of 12 plants, belonging to 8 families were identified. The most important families according to their use were Asteraceae (3 species), Lamiaceae (3 species), and one species of each of the following: Solanaceae, Fabaceae, Moraceae, Geraniaceae, Juglandaceae and Euphorbiaceae. Five species for external use *Rosmarinus officinalis*, *Juglans neotropica*, *Solanum nigrescens*, *Ambrosia arborescens* and *Euphorbia laurifolia*; and eight for internal use: *Mentha spicata*, *Origanum vulgare*, *Ficus carica*, *Otholobium mexicanum*, *Pelargonium zonale*, *Achyrocline sp.* and *Baccharis latifolia*.

The two most common conditions in which medicinal plants are used for obstetric ailments are: menstruation and childbirth. Five species were indicated as oral infusions to reduce menstrual cramps, and to facilitate childbirth increasing the frequency and strength of contractions of the uterus. Another three plants for external use were prescribed for easing child delivery during labor, for body cleansing (bathing) after delivery, and for eye protection when women must be exposed to external environment following delivery.

3. 12, Respiratory conditions

A common cold is seen as a minor health condition and its treatment depends on the onset of symptoms such as running nose, sneezing, and feeling weak. Coughing is the respiratory constrain that stimulates medication. During winter, which is often damp and cold, especially above 3200 meters, hot infusions are prescribed.

In Chirihuasi, El Abra and Cashaloma a total of 16 species were identified for reducing fever, 3 for coughing, 1 for common flu symptoms, 2 for eyes irritation, and another 15 were recommended to improve a weakened physical condition and to recover body energy during convalescence.

Traditional medicines, such as Andean traditional medicine, and particularly the use of ethnobotanical knowledge and practices that originated in our indigenous communities may be beneficial to identify certain plants, and their uses that could help to alleviate the symptoms of the new respiratory infection caused by viruses like the SARS-CoV-2.

The viral acute respiratory infection called COVID-19 is a global health concern since December 2019. General symptoms described in those affected individuals are fever, cough, shortness of breath and fatigue, among others. In the advanced state, the disease can progress to severe pneumonia, septic shock, respiratory failure, and death (Huang et al., 2020). Decelerating the spread of the disease has been epidemiologically recommended to reduce the impact of this pandemic on our global society. The strategy of social distancing, the wearing of masks and shields, and frequent hand by and benefit from adding a local and culturally adapted healthcare tradition.

That is ethnobotanical knowledge can inform the use of particular medicinal plants to reduce the symptoms of those who are isolating at home. COVID 19 arrived in Ecuador the last day of February 2020 and has been primarily affecting urban areas in the coastal region of the country. Rural areas are starting to report cases after 120 days of disease spreading all over the Ecuadorian territory. Because the ancestral knowledge of the communities is of extreme value at this time, relevant ethnobotanical knowledge can serve to inform deeper ethno-pharmacologic research should be reviewed and supported.

Due to their proteolytic and hemagglutinating activity, some plants used by Imbabura indigenous communities such as *Allium sativum* ALLIACEAE (clove garlic), have been tested in Belgium and Netherlands as potential antiviral elements, and also against viral replication of SARS-CoV-2 (Keyaerts *et al.*, 2007).

Similarly, the following three plants recommended in our Andean communities to treat respiratory infections, *Urtica dioica* URTICACEAE (common nettle), *Nicotiana tabacum* SOLANACEAE (tobacco), and *Glycyrriza glabra* FABACEAE (licorice), have also been tested by the same authors.

Antiviral activity of plant lectins was evaluated against coronaviruses at Rega Institute for Medical Research in Belgium. Of the 33 plant lectins tested by Keyaerts *et al.*, 15 had antiviral properties against both SARS-CoV and FIPV (Coronaviruses other than CoV2); 5 were active against SARS-CoV, and 2 showed activity against FIPV. The *N*-acetyl glucosamine-specific lectins isolated from the stinging nettle (*Urtica dioica* URTICACEAE) and from *Nicotiana tabacum* SOLANACEAE are also markedly active against the SARS-CoV. Finally, *Glycyrriza glabra*, known in the Andes as “Orozus” was found to be useful in the inhibition of viral replication, and modulation of membrane fluidity (Keyaerts *et al.*, 2007).

Interestingly, in the same article, published thirteen years ago, Keyaerts *et al.* predicted the need of new knowledge regarding the anti-viral properties of medicinal plants: “*Our findings on the selective and potent anti-coronavirus activity of plant lectins should trigger further research on the discovery of other carbohydrate-binding agents, including synthetic low-molecular-weight compounds.*”

In the same manner, *Sambucus nigra* (elderberry), *Sambucus racemosa* (red elderberry) and *Sambucus ebulus* (dwarf elderberry), ADOXACEAE (Ganjhu *et al.*, 2015), have been identified in India as inhibitors of the activity of enveloped viruses, preventing their penetration to cells. Leaves and flowers of these three species, prepared as an infusion, are recommended in the Chirihuasi community to treat respiratory conditions, such as colds, coughs, pneumonia, and to lower high fever. Additionally, decoction, of the leaves together with Western medicinal preparations, alleviates influenza (De la Torre *et al.*, 2008). Not only in Imbabura, but also in other highland provinces, such as, Pichincha, Cotopaxi, Chimborazo, Cañar, and Loja people use them regularly as part of their local traditions.

Other Andean medicinal plants also identified as useful to release respiratory track symptoms deserve similar phytochemical research for the development of drug specific to SARS-CoV-2. Ethnobotanical knowledge represents a centuries-long chain of trial-and-error cultural experimentation that should be explored to understand the effect of these prescribed traditional medicines on human ailments, such is SARS-CoV-2.

3. 13, Parts of medicinal plants used, remedy preparation and administration mode.

For each plant, the communities have identified for centuries, those parts that produce a specific effect, therefore these are the most commonly parts employed when preparing ethnobotanical remedies (see Chart 2).

Chart # 2.- Parts of medicinal plants used for remedy preparation

	NUMBER OF PLANTS	%
Leaves	45	33.8
Whole plant	35	26.3
Flowers	13	9.7
Sprouts	8	6.0
Fruit	7	5.3
Stem	7	5.3
Branch	5	3.7
Seeds	5	3.7
Root	4	3.0
Bark	1	0.7
Latex	1	0.7
Nectar	1	0.7
Stigma	1	0.7

Source: The authors of this article.

The most common preparation was the infusion, in which water is brought to a boil and poured over the herbs and allowing the infusion to stand covered for 5-10 minutes. Then, the herbs are strained off and the resulting tea is served. Other health problems were most frequently treated with decoctions; topic application of plasters; warm or fresh leaves; plant sap; ashes from the burning of the plant; or plant fluids (latex). In these preparations, the use of a single plant was more common (70 preparations) than a combination of several plants (41 preparations).

4. Conclusions

-This community-based ethnobotanical study provides very useful information about the variety of medicinal resources that are used locally by indigenous peoples for various health purposes. The knowledge described here is the result of collating 27 personal experiences of adult members of the communities, confirmed by three specialized local healers and by three community assemblies convened to locally validate their traditions, in their own ancestral language, (Quichua), and under their own cultural values and concepts.

-The use of medicinal plants in Chirihuasi, El Abra and Cashaloma is not only their cultural heritage, but also a source of inspiration and creativity for their younger generation interested in recovering part of that knowledge formerly restricted to only a few members of the older generation. Younger individuals are aware of these valuable resources and they are decided to transform them in an applied and tested resource to solving common health ailments still present today in their communities.

-Several publications and other documents about medicinal plants in Ecuador exist; but very few have taken into account the important goal of recuperating the ethnobotanical knowledge, the language, and cultural traditions associated with the practical use of local species. The efforts described here, which are in part aimed at rectifying this shortcoming, were only possible thanks to the active participation of the members of the entire community, and specially to the elders willing to pass their cultural heritage to the next generations and young individuals astonished by the cultural background they were about to lose if nothing is done. The young are conscious that the declining use of the Quichua language and the resulting diminished communication opportunities they maintain with their parents and elders, constitute the main risk factors to cultural loss.

-At the same time, this study provides scientists from diverse disciplines and institutions an opportunity to collaborate providing guidance to the demonstrated local effort. From the linguistics perspective, it highlights the importance of increasing local Quichua use, not only by allowing preservation of local expressions related to ethnobotanical practices, but also by recording grammar, pronunciation, and lexicon in the publication, and by audio and video recording storytelling scenes related to health and curing.

-Traditionally, the knowledge of and use of medicinal plants was transmitted orally from grandparents to their children. However, over the last 30 years, Quichua became an endangered language, and was replaced in many cultural contexts by Spanish, the dominant language predominantly used in schools to educate new generations. *Jambij Yuracuna* offers an opportunity to preserve and transmit knowledge and language to young and future generations.

-Anthropologists interested in the social essence of the health traditions of the community will have information on both the indigenous uses of local vegetation and the knowledge of those plants imported from Europe by the former hacienda owners. The community maintained for centuries a balanced relationship with the species of the ecotone where they live, closely observing the medicinal characteristics of each plant, and combining new patterns of agricultural production, and animal grazing to provide space in their territory for certain useful plants to survive and thrive in small natural pockets, thereby avoiding large-scale collection and potential overexploitation of this natural resource.

-From the medical and ethnobotanical perspective, the academic contribution made the correspondences between local nomenclature whether in Quichua or Spanish, with the names of each species and their corresponding botanical family. The study also assessed the status of ethnobotanical plants in the Imbabura province.

-From an ecological point of view, the study found in a geographical strip of four-square kilometers, at elevations ranging from temperate to cold high Andean zones, a wide variety of floral diversity that includes more than 107 medicinal plants.

-The challenges of a new pandemic made it feasible to interconnect cultural knowledge of these communities with botanical nomenclature and applied research already conducted on the chemical components of several plants, to demonstrate the potential fruitfulness of continuing to consider traditional patterns of flora use in the context of anti-viral studies searching for therapeutic agents for a new disease: COVID 19.

5. Bibliographic References

- Asamblea Constituyente, (2008). Constitución de la República del Ecuador. Quito: Constitución de bolsillo, (Capítulo cuarto. Derechos de las comunidades, pueblos y nacionalidades. Art. 57. No. 12. Pp. 41).
- Busmann, Rainer W. and Sharon, Douglas. (2006). Traditional medicinal plant use in Northern Peru: tracking two thousand years of healing culture. *Journal of Ethnobiology and Ethnomedicine* 2006, 2:47 doi:10.1186/1746-4269-2-47
- Cordero, Luis. (1950). Enumeración botánica. Provincias de Azuay y Cañar. Madrid.Ed. Afrodisio Aguado S.A.
- De la Torre, L., H. Navarrete, P. Muriel M., M.J. Macía& H. Balslev (eds.). (2008). Enciclopedia de las Plantas Útiles del Ecuador. Herbario QCA de la Escuela de Ciencias Biológicas de la Pontificia Universidad Católica del Ecuador & Herbario AAU del Departamento de Ciencias Biológicas de la Universidad de Aarhus. Quito & Aarhus.
- De Velasco, Juan. (1977). Historia del Reino de Quito en América Meridional. Historia Natural. Tomo I. Quito. Casa de la Cultura Ecuatoriana.
- Estrella, Eduardo. (1976). Medicina Aborigen. Quito. Editorial Época. Pp. 152.
- Ganjhu, R.K., Mudgal, P.P., Maity, H. *et al.* Herbal plants and plant preparations as remedial approach for viral diseases. *VirusDis.* **26**, 225–236 (2015). <https://doi.org/10.1007/s13337-015-0276-6>
- Haboud, M., Ortega, F., Farinango, E., Farinango, A. (2019). Jambij Yuracuna/Plantas que curan. Quito. Centro de Publicaciones de la Pontificia Universidad Católica del Ecuador.
- Hermida P. Cesar. (1992). El Mal del Arco Iris. En: La práctica médica tradicional. Cuenca. Universidad de Cuenca, IDICSA. Pp.193.
- Huang, C., Y. Wang, X. Li, L. Ren, J. Zhao, Y. Hu, L. Zhang, G. Fan, J. Xu, X. Gu. **Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China.** *Lancet*, 395 (2020), pp. 497-506, 10.1016/S0140-6736 (20) 30183-5 Article Download, PDF
- Keyaerts, E., Vijgen, L., Pannecouque, C., Van Damme, E., Peumans, W., Egberink, H., Balzarini, J., Van Ranst, M. (2007). Plant lectins are potent inhibitors of coronaviruses by interfering with two targets in the viral replication cycle. *Antivir. Res* 75, 179-187. <https://doi.org/10.1016/j.antiviral.2007.03.003>
- Kothari, Brij. (1993). Ñucanchicpanpajanpicuna – Plantas medicinales del campo. La Esperanza, Angochagua y Caranqui (Imbabura). Unión de comunidades y organizaciones indígenas de La Esperanza, Angochagua y Caranqui (UNOCIAE-C). Quito. Ediciones Abya Yala.
- León, Luis A. (1974). Capítulos sobre la Medicina en la Época Colonial, Ecuador (1531- 1822). Quito. *Terapia* 24 (1): 7-47.
- Naranjo, Plutarco. (1980). La Medicina en el Ecuador hace 5.000 años. Quito. *Revista Ecuatoriana de Medicina*. Vol. XVI No. 2.
- Ortega, Fernando. (1983). Hierbas Medicinales de Quito Urbano. Quito. Instituto de Investigaciones Nutricionales y Médico Sociales, ININMS.
- Rado, Bryan E. (2011). Etnobotánica del Distrito de Ocongate Quispicanchi – Cusco. Cusco. Universidad Nacional de San Antonio Abad del Cusco. Pp. 1-162.
- Sánchez-Parga, José. (1982). Fitoterapia y medicina tradicional: Guantualó. Quito. Cuadernos de discusión popular #5.
- Villavicencio, Gladys. (1973). Relaciones Interétnicas en Otavalo. México. Instituto Indigenista Interamericano.
- White, Alan. (1982). Hierbas del Ecuador - Herbs of Ecuador. Quito. Ediciones Libri Mundi.
- WHO, 2019, WHO global report on traditional and complementary medicine 2019. World Health Organization. [Online] Available: <https://apps.who.int/iris/handle/10665/312342>.
- WIPO, (2008), Intellectual Property Handbook. World Intellectual Property Organization. WIPO Publication: No. 489 (E). Geneva. 2008. Reviewed April 2020. Page 56. [Online] Available: https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Authors' contributions

All authors share the contributions to fieldwork, data analysis, and compilation of this manuscript.

Acknowledges

We thank the American Embassy in Ecuador, Pontificia Universidad Católica del Ecuador, and Universidad San Francisco de Quito; and Prof. William Pagliuca for editing the text of this article, and for his invaluable comments and suggestions.

Sponsoring Information

The American Embassy in Ecuador. Pontificia Universidad Católica del Ecuador, and Universidad San Francisco de Quito.