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Research Article

Peruvian Medicinal Plants and Cosmopolitan Plants with Potential use in the Treatment of Respiratory Diseases and COVID-19

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Abstract

The SARS-CoV-2 pandemic, responsible for COVID-19, has caused more than 157 million infections and more than 3.2 million deaths. A short-term solution is the production of vaccines that confer temporary or permanent immunity. However, the genetic variants of the virus, with greater contagion and lethality capacity, the economic limitations of many countries in the world to acquire vaccines, the limited and controversial effectiveness of the drugs tested, the logistical problems of conservation and distribution of vaccines, among others, lead to proposing and developing other alternatives. One of these alternatives is the use of medicinal plants, especially those plants traditionally used in the treatment of respiratory tract diseases, both in Peru and the world, without risks or collateral problems for the human being and validated with phytochemical and ethnopharmacological studies. The flora of Peru is particularly rich in these species and even more so in endemic species, potentially useful against SARS-CoV-2. The aim of this review is to highlight some Peruvian medicinal plants and species introduced and commercialized in Peru

(Cosmopolitan species) potentially useful in the treatment of respiratory diseases and COVID-19.

Keywords: Antiviral activity; Cosmopolitan plants; COVID-19; natural products; Peruvian medicinal plants; respiratory diseases

1. Introduction

The SARS-CoV-2 pandemic, the coronavirus that causes COVID-19, which originated in 2019 in Wuhan (China), has caused more than 157 million infections to date (May 7, 2021) and more than 3.2 million deaths [1]. The efforts made by various academic institutions and private laboratories around the world in the search for an efficient vaccine to combat the disease have been commendable [2,3]. Several of these vaccines have shown an immune efficiency greater than 90%, which has been quite significant [4-6]. However, the appearance of new genetic variants of the virus such as the British (14 December 2020), South African (18 December 2020), Japanese (09 January 2021), and Brazilian (12 January 2021) variants [7], which are attributed a greater infectious capacity and possibly greater lethality, have generated uncertainty in the international scientific community about the efficacy of such vaccines and the time of immunological protection that they can confer. The entire genome of SARS-CoV-2 viral strains circulating worldwide has been suggested to involve high heterogeneity [8,9].

Despite the large number of ultimate generation drugs tested in the treatment of SARS-CoV-2 such as remdesivir, favipiravir (= favilavir), lopinavir, ritonavir, among others [10], none of these have shown absolute efficacy to the point that it can be applied to a standardized treatment. In addition, many people have been conducted to use some drugs indiscriminately, even without a prescription, which may cause more harm than good to health [11,12]. Drugs like ivermectin, hydroxychloroquine, azithromycin, dexamethasone, and paracetamol have been widely published. Is possible that this disorderly form of medication, the diverse geographic environments where the virus is spreading and other factors yet to be investigated, are determining the apperance of more genetic variants of the virus.

It exits enormous asymmetry about the distribution of vaccines in the world to the detriment of countries with very poor, underdeveloped or developing economies to the point that, until February 2021, only ten countries considered first world have monopolized 90% of world vaccine production (Israel, United Kingdom, United States, Spain, Italy, Germany, Belgium, France, Canada and Netherlands) [13]. On the other hand, some vaccines need the protection of a cold chain of up to -50 ^{o}C, which implies having sophisticated refrigeration equipment; in addition, the vast majority of vaccines require up to two application doses in a three-week interval, making it difficult to apply a second dose in itinerant populations. The presence of many populations far from the main populated centers such as high-Andean and jungle populations of Peru and other countries of the world with similar geography, the mass vaccination process would be very complicated to apply massive vaccination.

Numerous ethnobotanicals and ethnopharmacological studies have demonstrated the potential of plant species in the treatment and cure of numerous

diseases that afflict humans since their origins and currently against COVID-19 [14,15]. However, in most of these studies plants of Asian and European origin have been used and in no case South American plants [15]. A notable example is traditional Chinese medicine [16-18] and traditional Indian medicine [19] in the treatment of respiratory tract diseases. In these compositions, the curative potential of most of these plants was validated with numerous phytochemical and pharmacological studies [15]. The discovery of numerous secondary metabolites with potent antiviral activity against SARS-CoV-2 [20-22] have opened a new horizon of hope in the treatment of this disease.

Given this, the use of medicinal plants, mainly used in traditional Peruvian medicine of the ancestral peoples of the coast, mountains and jungle of Peru, in the treatment of respiratory diseases, would be an important alternative, if we consider that the Flora of Peru registers more of 22,000 species and many of these endemic [23, 24]. In addition to this, the great diversity of secondary metabolites of medicinal plants would make it very difficult for SARS-CoV-2 (COVID-19) to generate resistance and consequently genetic variations, and the use of hetergeneous plant extracts to induce a synergistic effect over some specific organism [25]. Likewise, the appearance of other viral forms of the coronavirus family should be considered, as has already happened with the Severe acute respiratory sindrome (SARS), in february, 2003 [26] and Middle east respiratory syndrome coronavirus (MERS-CoV), in june, 2012 [27].

Because of the afore mentioned reasons, the objective of this review is to emphasize the importance of Peruvian medicinal plants and numerous cosmopolitan species in the treatment of SARS-CoV-2, based in the use of some plant compositions, with high content of secondary metabolites, which may be ingested as decoction, especially by rural and native populations, without risk to health, thus contributing to the solution of a serious health problem that involves all of humanity.

2. Methods

The method used was the review of relevant literature on the plant species used in traditional Peruvian medicine and species of cosmopolitan distribution and use. Likewise, it is worth highlighting the plant species studied phytochemically and pharmacologically, due to the presence of secondary metabolites with antiviral effect, especially against respiratory tract diseases and SARS-CoV-2. In most cases the Scopus database was use with articles published between 2010 to 2020, and articles published between 1993 to 2010 on the flora of Peru and medicinal plants. In this way, the authors prepared a list of plant species that can be used to prepare decoction for the initial and preventive treatment of SARS-CoV-2 and eventually to strengthen the immune system of rural and native populations.

3. Results

A list of introduced and naturalized, commercialized, and native plants, which contain secondary metabolites with potential use in the treatment of respiratory tract diseases and against SARS-CoV-2 (COVID-19), is show in table 1.

Plant species/Family	**Biological activities/ [Traditional use]**	**Secondary metabolites**	**References**
Alnus spp./Betulaceae (as *A. japonica*)	Several biological activities	Hirsutenone	[28, 29]
Alnus acuminata ssp. *arguta*	[Anti-inflammatory]	Triterpenoids and diarylheptanoids	[30]
A. acuminata (Aliso blanco and aliso colorado, aliso andino)	[Cold]	Bark, fresh	[31, 32]
Allium cepa/Alliaceae (Onion)	Plant lectin: *Allium cepa* agglutinin (ACA)		[33]
Allium sativum/Alliaceae (Garlic)		Quercetin	[34]
A. sativum/Alliaceae		Allyl disulfide and allyl trisulfide	[35]
Baccharis latifolia/Asteraceae (chilca)	[Soothe cough and bronchitis]	Limonene, b-hellandrene, sabinene, β-pinene and α-pinene	[36-38]
Bursera graveolens/Burseraceae		Burseranin, picropolygamain, lupeol and epi-lupeol	[39]
B. graveolens (Palo santo)	[Cough, flu, bronchitis, Cold]	Stems, bark and Wood, dried	[31, 32]
B. graveolens (Palo santo)	Antimicrobial activities	α-Terpinene and others (essential oil)	[40]
Capparicordis crotonoides (= *Capparis crotonoides*)/Capparaceae (satuyo, yunto)	[Bronchites, cold, colds]	Flowers, fresh	[31]
Cinchona officinalis; *C. pubescens*/Rubiaceae (cascarilla, quinuagiro)	[Colds, cough]	Flowers and leaves, dried; bark	[31, 32, 41]
C. officinalis		Chloroquine and hydroxychloroquine	[42]
Citrus x aurantifolia (= *C. aurantifolia*)/Rutaceae	Antimicrobial, anti-infammatory, anti-cancer, anti-	Alkaloids, coumarins, essential oils, flavonoids	[43]

(Lemon tree, limón criollo or limón sutil)	asthmatic and antioxidant properties	and triterpenoids. Citrus oil: Limonene, β-pinene, γ-terpinene, citral, and others	
C. aurantifolia	*Klebsiella pneumoniae*, *Pseudomonas* sp., *Staphyloccocus aureus*, *Aspergillus niger*, and *Mucor* spp.	Leaf extract	[44]
C. sinensis	SARS-CoV-2: Against protein S and viral replication	Hesperidin	[45]
C. aurantifolia	SARS-CoV-2: ACE2 inhibitor	Essential oils: Limonene	[46]
C. aurantifolia	Immunomodulatory, anti-inflammatory, and antiviral properties	Essential oils: Limonene	[47]
Coffea arabica/Rubiaceae (cafeto)	Inhibitors of SARS-CoV-2	Khainaoside C, 6-O-Caffeoylarbutin, khainaoside B, khainaoside C and vitexfolin A	[48]
C. arabica		Caffeine, theobromine and trigonelline	[49]
Cordia alliodora/Boraginaceae (Laurel)	[Bronchitis]	Bark and stems, dried	[31]
C. alliodora/Boraginaceae (Laurel)	Antimicrobial [Tonic to treat pulmonary disorders]	Several hydroquinones as alliodorin and alliodorol, and triterpenoids	[50-53]
Erythroxylon coca/Erythroxylaceae (coca)	[Cold, cough, inflammation of the throat]	Leaves, dried	[31]
E. coca		Cocaine, and other tropanes	[54]
Eucalyptus globulus/Myrtaceae (eucalipto)	[Asthma, bronchitis, cold, cough, respiration, sinusitis]	Leaves, dried	[31, 41]
E. globulus	Anti-inflammatory, anti-		[55]

	bacterial, anti-viral activities		
E. globulus	[Bronchitis, cold, cough, catarrh of the upper respiratory tract]	1,8-cineole, α-pinene and camphor	[56]
Juglands neotropica (= *J. nigra*)/Juglandaceae (Nogal)	[Asthma, bronchitis, cough]	Leaves, fresh	[31, 32, 41]
J. neotropica	*In vitro* antioxidant capacity, and *in vitro/in vivo* hypoglycemic activity	Pyran compounds, and phenols	[57]
Lablad niger (=Dolichos lablad) /Fabaceae (chileno, zarandaja, yunya)	[Protects the lungs]	Fruits, fresh	[31]
Medicago sativa/Fabaceae (alfalfa)	[Bronchitis]	Flowers and leaves, extracts	[31]
*Melilotus alba/*Fabaceae (alfalfilla)	[Colds, respiratory infections, tuberculosis]	Seeds extracts	[31]
*Nicotiana tabacum/*Solanaceae (tabaco)	Plant lectin: Nictaba		[58]
*Piper aduncum/*Piperaceae (Matico, hierba del soldado, nudillo, cordoncillo)	[Bronchitis, chills, cold, cough, tuberculosis, pharyngitis, pneumonia]	Leaves, fresh or dried	[31, 32, 41]
*P. aduncum/*Piperaceae		Monoterpenoids, sesquiterpenoids, phenylpropanoids, and others	[59-62]
*Pelargonium graveolens/*Geraniaceae (Geranium or geranio)	SARS-CoV-2: ACE2 inhibitor	Essential oils: Citronellol, geraniol and neryl acetate	[46]
Pelargonium spp.	[Used in traditional medicine in various countries]	Monoterpenes, sesquiterpenes, coumarins, tannins, phenolics acids, cinnamic acids, flavones, flavonoids and flavonols derivatives	[63]
*Plantago linearis/*Plantaginaceae (Llantén serrano)	[Bronchitis, cough]	Roots, fresh	[31, 41]

Plantago major/Plantaginaceae (Llantén)	[Bronchitis, cough]	Seeds, fresh or dried	[31, 32, 41]
P. major	[Tonic, diuretic and coughs mixture]		[64]
P. major	Anti-herpes and anti-adeno virus activities	Caffeic acid and chlorogenic acid	[65]
P. major	Wound healer, antiulcerative, antidiabetic, anti-inflammatory, anti-bacterial, and antiviral agent	Flavonoids, alkaloids, terpenoids, and others	[66]
Prosopis pallida (= *P. limensis*)/Fabaceae (algarrobo)	[Bronchitis, cough]	Seeds, dried	[31, 41]
Prosopis limensis	[Bronchitis, cough, expectorant, flu]		[67]
Psittacanthus linearis/Loranthaceae (suelda con suelda)	[In the treatment of respiratory diseases]	Kaempferol, quercetin	[68]
Sambucus nigra/Adoxaceae (sauco)	[Inhibit infectious bronchitis virus]		[69]
Salix chilensis (= *S. humboltiana*)/Salicaceae (sauce)	[Colds]	Leaves, fresh	[31, 32, 41]
Schinus molle/Anacardiaceae (molle)	[Bronchitis, chills, cold cough] Used topically (cream or ointment)	Flowers, leaves and stems, fresh	[31, 32]
Urtica dioica/(Urticaceae) (ortiga)	Plant lectin: *Urtica dioica* agglutinin (UDA)		[70, 71]
U. dioica	[In the treatment of asthma, expectorant, respiratory problems, and others]	Flavonoids: kaempferol, isorhamnetin, quercetin, isoquercitrin, astragalin, and rutin	[72]

		Phenolics: phenylpropanes, caffeic acid, chlorogenic acid and scopoletin)	
Viscum album/Viscaceae (mistletoe)	Plant lectin: ML III inhibitor of SARS-CoV		[70]
Zingiber officinale/Zingiberaceae (Ginger or kión)	SARS-CoV-2		[73]
Z. officinale		Diallyl-disulfide	[74]
Z. officinale		Citral	[75]
Z. officinale	Antiviral activity against human respiratory syncytial virus		[76]

Table 1: Secondary metabolites and plant extracts from Peruvian medicinal plants and cosmopolitan plants with potential use in the treatment of respiratory diseases and COVID-19.

3.1 Peruvian, native, and endemic plant species

Hirsutenone, an active diarylheptanoid isolated from *Alnus japonica* (Thunb.) Steud., *A. hirsuta*, *A. pendula*, *A. nepalensis*, *A. glutinosa*, *A. firma*, *A. formosana* and *A. acuminata*, showed remarkable inhibitory effect to papain-like protease of SARS-CoV-2, and catechol and *α*, *β*-unsaturated carbonyl moiety may be responsible for the inhibitory activity [28]. In *A. acuminata* ssp. *arguta* Spach, seven triterpenoids and five diarylheptanoids were isolated and characterized. The authors indicated that stem bark infusions of this species is used in the treatment of acute inflammations in traditional Mexican medicine [30]. *Alnus acuminata* (aliso andino) is a species of forest importance widely distributed in the Andes from South America to Mexico. In traditional Peruvian medicine, it is used as an anti-inflammatory and colds [31, 32].

Baccharis latifolia (R.&P.) Pers. (chilca, chilco), is an Asteraceae native to South America, widely distributed in the Andean region. The decoction of leaves and flowers is used in traditional medicine in the treatment of soothe coughs and bronchitis [36] The main compounds identified in the aerial part of *B. latifolia* are limonene, b-hellandrene, sabinene, β-pinene and α-pinene [37]. A brief review on phytochemical and therapeutic use of *B. latifolia* has been published by Sequeda-Castañeda et al. [38]. Other *Baccharis* species such as *B. genistelloides* (Lam.) Pers. (carqueja), *B. latifolia* and *B. vacciniifolia* Cuatrec. (asmachilca) are used in traditional Peruvian medicine in the treatment of bronchial asthma, cough, flu and colds, as a bronchodilator and expectorant [32, 41].

Burseranin, a new aryltetralin lignan, and picropolygamain were isolated in stem extracts (resin and oils) from *Bursera graveolens* (Kunth) Triana & Planch., together with the already characterized triterpenes, lupeol and epi-lupeol [39]. A comprehensive review on ethnopharmacological, phytochemical and pharmacological aspects of lignans from Mexican *Bursera* spp. was carried out by Marcotullio *et al.* [77]. In another study using the essential oils extracted from fallen branches of *B. graveolens*, moderate to high biological activities against *Staphilococcus aureus*, *Bacillus cereus*, *Listeria monocytogenes*, *Clostridium perfringens*, *Escherichia coli*, *Salmonella choleraesuis* and *Candida albicans* [40]. The most abundant compound in the essential oil was α-Terpinene and isocaryophillene. In traditional Peruvian medicine *B. graveolens* is used for respiratory tract diseases such as asthma, cough, flu, bronchitis and cold [31, 32].

One of the most successful studies in the treatment of diseases using plants has been the case of malaria with the alkaloid quinine, obtained from the bark of *Cinchona officinalis* L., and that currently the structural analogues of quinine, Chloroquine (Cq) and hydroxychloroquine (Hcq), in combination with azytromycin, have been reported to be more effective against SARS-CoV-2 by reducing viral load [42]. In traditional Peruvian medicine *C. officinalis* is used in the treatment of coughs and colds [31, 41] and *C. pubescens* Vahl is used in the treatment of chronic cold and flu [32].

Decoction prepared from *Cordia alliodora* (R.&P.) Oken leaves is being used traditionally in Tropical America (from Mexico to Argentina) as tonic to treat pulmonary disorders [78]. Several hydroquinones were isolated from heartwood [50] and terpenoids from leaves [51]. Likewise, the ethanol extract of stem bark showed antimicorbial activity against *Enterococcus faecalis*, *Pseudomonas aeruginosa*, *Candida albicans*, and other microorganisms [52]. In traditional Peruvian medicine *C. alliodora* is used in bronchitis treatment [31].

Coca leaves, obtaine from *Erythroxylum coca* Lam., contain the highest amounts of cocaine alkaloid and other tropanes [78], and in traditional medicine is utilized for a wide variety of conditions as digestive maladies, altitude sickness, and sexual impotence [79]. An interdisciplinary review of the *Erythroxylum* genus has recently been published [54]. In traditional Peruvian medicine *E. coca* is used in cold, cough, and throat inflammation [31].

In the “nogal peruano” or “Peruvian walnut” (*Juglands neotropica* Diels) it was determined that the lyophilized extract of dried leaves does not show any toxicit, it has good *in vitro* antioxidant capacity and *in vitro*/*in vivo* hypoglycemic activity [57]. A comprehensive review on the chemical constituents and functional uses of walnut (*Juglands* spp.), especially *Juglands regia* L. (Persian or English walnut), the most important member of the *Juglands* genus, has recently been published [80]. In traditional Peruvian medicine *J. neotropica* is used in the treatment of lung diseases such as asthma, cough and bronchitis [31, 32, 41].

Other American species such as *Nicotiana tabacum* L. (tobacco), in addition to numerous secondary metabolites, present a group of proteins that show

homology to the *N. tabacum* agglutinin or Nictaba, referred to as "inducible" lectins, and that are expressed after exposure of the plant to different stress and changing environmental conditions [81]. This tobacco lectin, that is the prototype of the familiy of Nictaba-related proteins, is expressed in leaves of *N. tabacum* induced by the plant hormone jasmonic acid methyl ester (JAME), being absent from untreated plants [58]. Nictaba is markedly active against the SARS-CoV with a selectively index of >59 [71]. Even though in traditional Peruvian medicine it is not used in the treatment of respiratory diseases, due to the presence of lectins it has a potential use against COVID-19.

In Neotropical species of *Piper*, nine different chemotypes of *P. aduncum* L. have been characterized, with significant differences in the content of dillapiole (31.5% to 97.3%) [60, 61] and the terpenoid compounds such as (E) -nerolidol and linalool [59]. In *P. aduncum* leaves, high variability has been observed in essential oils, depending on the collection sites (Ecuador, Cuba, Panama, Bolivia, and other countries), especially in the content of monoterpenoids, sesquiterpenoids or phenylpropanoids [61]. Furthermore, the Yaneshas tribe in the Peruvian Amazon used teas and steam baths from the *P. aduncum* leaves for general infections and fever [82]. A comprehensive review on their phytochemistry, biological activities and applications on *Piper* species has recently been published by Salehi *et al*. [62]. In traditional Peruvian medicine *P. aduncum* is used in the treatment of cold, cough, bronchitis, chills, pharyngitis, pneumonia, and tuberculosis [31, 32, 41].

Fruits and seeds of *Prosopis limensis* (Humb. & Bonpl. ex Willd.) Kunth (=*P. pallida*), algarrobo or carob tree, have been used in traditional medicine in the treatment of cough and bronchitis [31]. In the traditional medicine of Mórrope (Lambayeque), one of the most ancient indigenous peoples of northern Peru, the algarrobo bark is used as an infusion in the treatment of coughs and bronchitis. The *Prosopis* species are highly effective in asthma, expectorant, fever, flu, and other diseases as diabetes, malaria, rheumatism and stomachache, mainly due to their content of C-glycosyl flavones such as schaftoside, isoschaftoside, vicenin II, vitexin and isovitexin [67]. They also contain the flavonoids: apigenin, luteolin, quercetin and kaempherol, and the phenolic acids: gallic, hydroxybenzoic, chlorogenic, ferulic, caffeic and coumaric acids [67].

In the traditional medicine of the indigenous communities of the Lambayeque region (Peru) "suelda con suelda" [*Psittacanthus linearis* (Killip) J.K. Macbride], a hemi-parasitic species of the Loranthaceae family, is used as an anti-inflammatory in the treatment of respiratory tract diseases. The main isolated and characterized chemical compounds are kaempferol and quercetin [68]. Other Loranthaceae species such as *Loranthus acaciae* Zucc., native to Saudi Arabia, have shown anti-diabetic, anti-inflammatory and antioxidant activity [83].

The literature does not record studies on phytopharmacological aspects and medicinal properties of *Salix chilensis* Molina. However, a study carried out in *S. aegyptiaca* L. has been shown to have antioxidant, anxiolytic activity and

hypocholestroline effect, due to the high amounts of phenols and flavonoids such as gallic acid, caffeic acid, myricetin, catechin, quercetin as well as salicin, reported from the leaves [84]. Caffeic acid derivatives (CAFDs) have recently been reported as inhibitors of SARS-CoV-2 [48]. In traditional Peruvian medicine *S. chilensis* (= *S. humboltiana* Will.) is used in the treatment of cold, fever and flu [31, 32, 41].

Likewise, the literature does not record studies on phytopharmacological aspects and medicinal properties of *Schinus molle* L. However, several studies have demonstrated various biological effects of the *Schinus areira* L. as analgesic, anti-inflammatory, anti-rheumatic, antimicrobial, antispasmodic, and anti-depressive [85]. This species was considered a variety of *S. mole* but is currently considered a different species. In traditional Peruvian medicine *S. molle* is used in the treatment of bronchitis, cough, cold and chills, but only as a rub (topical use) [31, 32], as well as in throat inflammation (gargle) [41].

In a docking study of flavonoids derivatives (quercetin, catechin, naringenin, luteolin, hispidulin, vitexin, chrysin and kaempherol) as potent inhibitors of influenza H1N1 virus neuraminadase (NA), the results indicated that these compounds may effectively block the NA active site [86]. In this regard, it has been indicated that the species *Salvia sagittata* Ruiz & Pav, *Alcea rosea* L, *Cinchona officinalis*, *Allium cepa* L, *Sambucus peruvianus* Kunth, *Flaveria bidentis* (L.) Kuntze *Juglands nigra* L, *Tessaria integrifolia* L, *Ocimum basilicum* L, *Crescentia cujete* L, *Begonia fischeri* Schrank and *Cantua buxifolia* Juss. ex Lam, which contain quercetin and/or kaempherol [41], can be used in the treatment of influenza and potentially in the treatment of COVID-19.

Among all these species, we highlight *F. bidentis* (matagusano), an Asteraceae traditionally used in Peruvian medicine as antiparasitic and bronchial diseases and cough, mainly in children [31, 41], detecting tannins, flavonoids, leucoanthocyanidins, steroids and triterpenoids in inflorescences, stems, leaves and roots [87]. *T. integrifolia* (pájaro bobo), is another Asteraceae used in traditional Peruvian medicine for the treatment of respiratory diseases such as asthma and cough, acting as a febrifuge, anti-inflammatory, antimicrobial and expectorant [32, 41]. Likewise, showed a stronger antioxidative activity, due to the effect of phenolic compounds, flavonoids, lignans and caffeoly quinic acid [88]. *C. cujete* (calabash, huingo, tecomate or tutumo) is an American Bignoniaceae traditionally used in the treatment of colds, bronchitis, cough, and asthma, observed in the fruit's compounds similar to saponins, flavonoids, cardenolides, tannins and phenol [89]. *Alcea rosea* (syn. *Althaea rosea*) (malva real or malvarrosa), is a Malvaceae of unknown origin, widely distributed in America, Europe, Asia and Australia, whose flavonoids (dihydrokaempherol, apigenin, kaempherol-3-O-β-d-glucopyranoside, and others) have shown immune stimulant, antioxidant, and cytotoxic activities on hepatocellular carcinoma HepG-2 cell line [90]. In Peruvian traditional medicine *A. rosea* is used in the treatment of cough [31,41], and in traditional medicine of other countries, fruits and leaves are used in the treatment of cough, asthma, bronchitis, and fever, presenting as

main compounds cyclohexanol, limonene, phellandrene and β-sitosterol [91]. Likewise, *C. buxifolia* (kantuta) is a shrub of the Polemoniaceae family and is the national flower of Peru. The flowers are used as an infusion in the treatment of throat inflammation due to its quercetin content [41].

In general, in addition to the afore mentioned plants, traditional Peruvian medicine used numerous plant species, both native and introduced, in the treatment of various diseases of the respiratory tract: fever, cough, sore throat, flu, cold, pneumonia, whooping cough, and pulmonary diseases. These species are as follows: *Abelmoschus moschatus* (L.) Medik. (mishumurillo), *Achyrocline alata* (Kunth) DC. (ishpingo), *Adiantum digitatum* Hook. (culantrillo de pozo), *Adiantum poiretti* Wikström (culantrillo de pozo), *Aloe vera* (L.) Burm. (sábila), *Aloysia citriodora* Paláu (cedrón), *Alternanthera porrigens* (Jacq.) Kuntze (lancetilla), *Ambrosia peruviana* Willd. (altamisa), *Aniba roseadera* Ducke (palo de rosa), *Apium graveolens* L. (apio), *Argemone subfusiformis* Owbn. (cardo santo), *Baccharis genistelloides* (Lam.) Pers. (carqueja), *Baccharis vacciniifolia* Cuatrec. (asmachilca), *Bidens pilosa* L. (amor seco), *Bixa orellana* L. (achiote), *Borago officinalis* L. (borraja), *Buddleja polycephala* Kunth. (flor blanca), *Caesalpinia spinosa* (Molina) Kuntze (tara), *Calceolaria linearis* Ruiz & Pav. (globito), *Celtis iguanae* (Jacq.) Sarg. (palo blanco), *Centrum hediondinum* Dun. (yerba santa), *Cestrum auriculatum* L'Hér. (yerba santa), *Chenopodium ambrosioides* L. (paico), *Chuquiraga jussieui* J.F. Gmel. (amaro – huamanpinta), *Cocos nucifera* L. (coco), *Copaifera paupera* (Herzog) Dwyer (copaiba), *Costus erythrocoryne* Jacq. (caña agria), *Crescentia cujete* (huingo), *Croton lechleri* Müll.-Arg. (sangre de grado), *Cymbopogon citratus* (DC.) Stapf (hierba luisa), *Cyphomandra betaceae* (Cav.) Sendtn (berenjena), *Desmodium molliculum* (Kunth) DC. (pie de perro), *Dodonaea viscosa* Jacq. (chamana), *Ephedra americana* Humb. & Bonpl.) ex Willd. *(*diego lópez*)*, *Eryngium foetidium* L. (sachaculantro), *Equisetum giganteum* L. (cola de caballo), *Fuchsia ayavacensis* Kunth (concha lay), *Galvesia fruticosa* J.F. Gmel. (curil), *Gentianella thyrsoidea* (Hook.) Fabris (hercampuri), *Gynerium sagittatum* (Aubl.) P. Beauv. (caña brava), *Isetia krausei* Standl. (azarcito), *Krameria lappacea* (Dombey) Burdet & B.B. Simpson (ratãña), *Laccopetalum giganteum* (Wedd.) Ulbr. (pacra pacra), *Lantana glutinosa* Poepp. (maestranza), *Lantana scabiosaefolia* Kunth. (mastrando), *Lavandula angustifolia* Mill. (alucema), *Lepechinia meyenii* (Walp.) Epling (salvia de jalca), *Linum prostratum* Domb. ex Lam. (canchalagua), *Lippia alba* (Mill) N. E. Br. ex Britton & P. Wilson (mastrante), *Lobelia decurrens* Cav. (contoya), *Malachra alceifolia* Jacq. (malva), *Maytenus macrocarpa* (Ruiz & Pav.) Briq. (chuchuhuasi), *Mentha piperita* L. (menta), *Momordica charantia* L. (balsamina), *Muehlenbeckia tammifolia* Meisn. (mullaca), *Musa* spp. (plátano), *Myrcianthes discolor* (Kunth) McVaugh (lanche), *Nicandra physaloides* (L.) Gaertn. (capulí cimarrón), *Niphidium crassifolium* (L.) Lellinger (lengua de ciervo), *Ocimum basilicum* L. (albahaca), *Opuntia ficus-indica* (L.) Mill. (tuna), *Passiflora tripartita* (Juss.) Poir. (poro poro), *Peperomia hartwegiana* Miq. (congona), *Perezia multiflora* (Bonpl.) Less. (escorzonera), *Persea americana* Mill. (palto), *Phyllanthus niruri* L. (chanca piedra), *Physalis*

angulata L. (bolsa mullaca), *Physalis peruviana* L. (capulí), *Picrosia longifolia* D. Don (chicoria), *Piper nigrum* L. (pimienta negra), *Pluchea chingoyo* (Khunt) DC. (toñuz, párrano), *Plumbago scandens* L. (pega pega), *Polypodium decumanum* Willd. (cotochupa), *Portulaca oleracea* L. (verdolaga), *Prunus serotina* Ehrh. (capulí), *Rorippa nasturtium-aquaticum Rorippa nasturtium-aquaticum* L. (berro blanco), *Rubus robusta* C. Presl. (zarzamora), *Ruta graveolens* L. (ruda), *Salvia sagittata* Ruiz & Pav. (salvia real), *Satureja sericea* (C. Presl. ex Benth.) Briq. (macho romero), *Senecio canescens* (Bonpl.) Cuatrec. (vira – vira), *Senecio tephrosioides* Turcz. (huamanripa), *Solanum tuberosum* L. (papa), *Sonchus oleraceus* L. (cerraja), *Stachis arvensis* (L.) L. (supequehua), *Tagetes elliptica* Sm. (culantrillo serrano), *Tagetes erecta* L. (flor de muerto), *Tagetes filifolia* Lag. (anisquehua), *Theobroma cacao* L. (cacao), *Thymus vulgaris* L. (tomillo), *Trifolium repens* L. (trébol blanco), *Tropaeolum majus* L. (mastuerzo), *Uncaria guianensis* (Aubl.) J.F. Gmel (uña de gato), *Uncaria tomentosa* (Willd. ex Schult.) DC. (uña de gato), *Verbena littoralis* Kunth (verbena), *Verbena officinalis* L. (verbena negra), *Zea mays* L. (maíz), and others [92,31,32,93,41].

3.2 Plant species introduced, naturalized, and commercialized in Peru (Cosmopolitan species)

Citrus x aurantifolia or *Citrus aurantifolia* (Christm.) Swingle. (lemon tree, limón criollo or limón sutil) is a species widely cultivated on the north coast of Peru and widely used in the preparation of "ceviche" (typical Peruvian food with marine fish and lemon). Its medicinal importance is due to a large number of secondary metabolites such as alkaloids, coumarins, essential oils, flavonoids and triterpenoids. Likewise, for its numerous antimicrobials, anti-infammatory, anti-cancer, anti-asthmatic, and antioxidant medicinal properties [43]. In other studies, the *in vitro* antimicrobial activity of *C. aurantifolia* leaf extracts have been demonstrated in *Klebsiella pneumoniae*, *Pseudomonas* sp., *Staphyloccocus aureus*, *Aspergillus niger*, and *Mucor* spp. [44]. A recent study carried out in orange fruits (*C. sinensis*) has shown that among the flavonoids it contains, hesperidin binds to the key proteins of the SARS-CoV-2, and both protein S and with the main protease that transforms the early proteins of the virus, pp1a and pp1b, into the complex responsible for viral replication [45]. In addition, it has been confirmed by immunoblotting and qPCR analysis that lemon (*C. aurantifolia*) oils possess potent ACE2 (angiotensin-converting enzyme 2) inhibitory effects, highlighting the presence of limonene [46]. On the other hand, in-silico studies have shown that limonene, a dietary terpene of natural origin, has activity on viral proteins, which is why it has been suggested to be better studied in research on COVID-19, due to its immunomodulatory, anti-inflammatory, and antiviral properties [47].

A library of 27 caffeic-acid derivatives (CAFDs) was screened against 5 proteins of SARS-Co-2 (COVID-19 MPro, Nsp15, SARS-CoV-2 spike S2 subunit, spike open state and closed state structure) observing Khainaoside C, 6-O-Caffeoylarbutin, khainaoside B, khainaoside C and vitexfolin A as potent modulators of COVID-19. Also, Calceolarioside B, a pan inhibitor, showing strong although specific molecular interactions [48]. In addition, *Coffea arabica* L. plants contain two different kinds of alkaloids: The purine alkaloids caffeine (1,3,7-*N*-trimethylxanthine)

and theobromine (3,7-*N*-dimethylxanthine), and the pyridine alkaloid, trigonelline (1-*N*-methylnicotinic acid) [49].

The pharmacological and clinical activity of *Eucaliptus globulus* Labill. include anti-inflammatory, anti-bacterial and anti-viral activities with direct activity on the respiratory tract, the coughing reflex, and the airflow in the nasal tract [55]. Likewise, Eucalyptus oils (0.5-3.5%), obtained from the fresh leaves or the fresh terminal branchlets of various species of *Eucalyptus* as *E. globulus* have as main component 1,8-cineole (> 70%), α-pinene and camphor, and the primary use of eucalyptus oil includes the treatment of bronchitis, cold, cough, and other respiratory tract diseases [56]. *E. globulus* is widely used as a medicinal plant in Peru in the treatment of bronchitis, respiration, cold, cough, flu, sinusitis and asthma [31, 41].

Medicago sativa L., commonly known as the "father of all foods" (alfalfa), is a perennial herbaceous Fabaceae originating in Asia. This species has been widely used in traditional Chinese medicine, traditional Indian medicine (Ayurvedic) and other countries in the treatment of coughs and as antidiabetic, antioxidant, anti-asthmatic, antimicrobial, and in central nervous system disorders [94]. Among the great variety of phytochemicals reported there are the following flavonoids: quercetin, myricetin, luteolin, apigenin, medicarpin, vestitol, sativan and others [95, 96]. Likewise, the phenolic compounds: p-hydroxybenzoic acid, p-coumaric acid, salycilic acid, caffeic acid, chlorogenic acid, and others [97]. *Melilotus alba* Medik. (= *M. albus*) has been studied sido as source of phenolic compounds and antimicrobial and antioxidant potential [98]. *M. sativa* and *M. alba* are used in Peru in the treatment of bronchitis, colds, respiratory infections, and tuberculosis [31].

Plantago major L. (llantén) is a perennial medicinal plant with several chemical constituents such as flavonoids, alkaloids, terpenoids and others, effective as a wound healer, as well as antiulcerative, antidiabetic, antioxidant, anti-bacterial and antiviral agent [66]. The antiviral activity of *P. major* on herpes virus (HSV-1, HSV-2) and adenoviruses (ADV-3, ADV-8, and ADV-11) was also studied, observing that chlorogenic acid was active against all the indicated viruses, whereas caffeic acid was active against HSV-1, HSV-2 and ADV-3, and both acids with greater antiviral effect than ferulic acid and *p*-coumaric acid [65]. However, ethnobotanical study of the medicinal plants from Tlanchinol, Hidalgo, México, classified *Plantago australis* for the gastrointestinal category [99]. *Plantago major* and *P. linearis* Kunth are used in Peru in the treatment of bronchitis, cold, cough, dry cough, fever, and throat inflamation [31, 41].

Pelargonium hortorum L.H. Bailey or *Pelargonium x hortorum* (common geranium) is a hybrid species originated by crossing *P. inquinans* and *P. zonale*, widely used in gardening as a decorative plant in Peru. Roots from *P. sidoides* are used in Europe in the preparation of EPs 7630 in the treatment of acute bronchitis in adults and children, due to their high content of polymeric polyphenolic compounds [100, 101]. Likewise, it has been confirmed by immunoblotting and qPCR analysis that geranium

oils (*P. graveolens* L'Hér.) possess potent ACE2 inhibitory effects, highlighting the presence of citronellol, geraniol and neryl acetate [46]. An extensive study on the phytopharmacological importance of *Pelargonium* spp. was published by Saraswathi *et al*. [63].

Studies carried out in Infectious bronchitis virus (IBV), a pathogenic chicken coronavirus, showed that the *Sambucus nigra* L. extract inhibited IBV at an early point of virus replication [69]. *S. nigra* has been also indicated, together with *Althaea officinalis* L., *Commiphora molmol* (Engl.) Engl., *Glycyrrhiza glabra* L. and *Hedera helix* L., in five cases of positive treatment in patients with COVID-19 [102]. The literature does not record studies on *Sambucus peruviana* Kunth; however, there are several phytochemical studies and potential health effects in other *Sambucus* species, such as *S. williamsii* Hance. [103] and *S. ebulus* L. [104], showing as main components lignans, terpenoids, phenolic acids and flavonoids with antifungal, antioxidant, anti-inflammatory, and anti-cancer properties, and in the treatment of sore throat. In traditional Peruvian medicine, *S. peruviana* is used in the treatment of bronchitis, fever, cough and cold [31, 41].

Urtica dioica L. (Stinging Nettle) has been show antibacterial, antiviral, anti-inflammatory, and analgesic activities with a wide variety of secondary metabolites such as flavonoids, tannins, scopoletin, isolectins and sterols [105, 72]. The *N*-acetyl glucosamine-specific lectin isolated from *Urtica dioica* (UDA) was markedly active against the SARS-CoV with a selectivity index of > 77 [71]. This UDA prevented HIV entry and eventually select for viruses in which conserved N-glycosilation sites in GP120 envelope were deleted [106]. In the flora of Peru is *U. urens*, a species very similar morphologically to *U. dioica*, and even though in traditional Peruvian medicine it is not used in the treatment of respiratory diseases, the important content of lectins makes it potentially useful against COVID- 19.

Another plant lectin, the mistletoe lectins (ML), specifically ML II and ML III, isolated from *Viscum album* L. (mistletoe) were tested against SARS-CoV, showing only ML III antiviral activity with a selectively index of > 12.6 [70]. Numerous hemi-parasitic species of the Loranthaceae, Santalaceae, and Viscaceae families with the *Dendrophthora* and *Phoradendron* genera have been reported in the Peruvian flora [23].

Ginger or kion (*Zingiber officinale* Rosc.) has recently been incorporated by the Ministry of AYUSH (Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy) - India, which recommended a formulation composed of 15 plants, among these, *Z. officinale*, *Syzygium aromaticum* (L.) Merr. & L.M. Perry and *Cyperus rotundus* L., with synergistic antiviral effects against SARS-CoV-2 [73], three species commercialized or present in the flora of Peru. On the other hand, it has been reported that numerous plants such as *Z. officinale*, *Allium sativum* L., *Ocimum tenuiflorum* L., among others, stimulate the human immune system, although the biomolecules and how they interact with the immune system to improve resistance to diseases have not been identified [107]. Diallyl-disulfide, an organosulphur compound of garlic [74], and the

terpenoid citral [75] have been used in therapeutic applications in the treatment of SARS-CoV-2. Likewise, a trial on the benefits-risks of medicinal plants in the treatment of COVID-19 indicated a positive effect in some cases and a promising effect in other cases, and among these species, *Z. officinale* was tested. [102].

That is why table 2 shows a list of plants, mostly present in the flora of Peru, both in the coast, Andean and jungle, and numerous cosmopolitan species, used in the treatment of respiratory diseases and with potential use in the treatment of SARS-CoV-2. Table 3 provides a list of plants that can be prepared in decoction, recommending not to exceed 8 species per liter of decocotion. The information is contained in various studies [31, 32, 41, 93, 94], as well as direct consultations with traditional healers ("curanderos tradicionales") and personal experience. With certainty, it is a very great activity to test all the possible combinations of the mentioned species, without ruling out that other plant species may join this relationship.

Coast region	**Andean region**	**Jungle region**
Species native, introduced or commercialized in Peru (Spanish name)	**Species native, introduced or commercialized in Peru (Spanish name)**	**Species native, introduced or commercialized in Peru (Spanish name)**
Allium cepa (cebolla)	*A. cepa*	*A. cepa*
Allium sativum (ajo)	*A. sativum*	*A. sativum*
Zingiber officinale (kión)	*Z. officinale*	*Z. officinale*
Citrus aurantifolia (limón)	*C. aurantifolia*	*C. aurantifolia*
Piper aduncum (matico)	*Alnus acuminata* (aliso)	*Erytroxylon coca* (coca)
Bursera graveolens (palo santo)	*Cordia alliodora* (laurel)	*Uncaria tomentosa* (uña de gato)
Psittacanthus linearis (suelda con suelda)	*Sambucus peruviana* (sauco)	*C. arabica*
Prosopis limensis (algarrobo)	*Eucalyptus globulus* (eucalipto)	*Theobroma cacao* (cacao)
Ambrosia peruviana (marco)	*Cinchona officinalis* (cascarilla)	*Genipa americana* L. (huito)
Nicotiana tabacum (tabaco)	*Cantua buxifolia* (kantuta)	*Eryngium foetidum* (sachaculantro)
Plantago major (llantén)	*Juglands neotropica* (nogal)	*Malachra ruderalis* L. (malva)
Coffea arabica (cafeto)	*Plantago linearis* (llantén serrano)	*Maytenus macrocarpa* (chuchuhuasi)
Pelargonium hortorum (geranio criollo)	*C. arabica*	*Verbena littoralis* (verbena negra)
Tessaria integrifolia (pájaro bobo)	*Urtica urens* (ortiga)	*Polypodium ducumanum* (cotochupa)

Capparicordis crotonoides (Kunth) Iltis & Cornejo (satuyo)	*M. sativa*	*Tabebuia serratifolia* [= *Handroanthus serratifolius* (Vahl) (SO Grose](tahuari)
Medicago sativa (alfalfa)	*Baccharis genistelloides* (carqueja)	*Cestrum hediondinum* (yerba santa)
Cymbopogon citratus (hierba luisa)	*Baccharis vacciniifolia* (asmachilca)	*Abelmochus moschatus* (mishumurillo)
Galvesia fruticosa (curil)	*Caesalpinia spinosa* (tara)	*Musa* spp. (plátano)
Cestrum auriculatum (hierba santa)	*Calceolaria linearis* (globito)	*Costus erythrocoryne* (caña agria)
Lantana glutinosa (maestranza)	*Borrago officinalis* (borraja)	*Crescentia cujete* (huingo)
	Aphelandra cirsioides (espina de hoja)	*Trema micrantha* (atadijo)
		Scoparia dulcis (escobilla, piqui pichana)
		Tynanthus panurensis (clavo huasca)
		Physalis angulata (mullaca, capulí cimarrón)
		Canna indica (achira)

Table 2: Composition of proposed medicinal plants, introduced and native, that can be used in the geographic regions of the Peruvian coast, Andean, and jungle, in the treatment of respiratory diseases and COVID-19 [31, 32, 41, 92, 93].

S.No	**Plant species[b]**	**Preparation**	
		Spanish	**English**
1	*Allium cepa*[1,2,3]	Una cebolla de tamaño medio	One medium-sized onion
2	*Allium sativum*[1,2,3]	1-2 dientes de ajo	1-2 garlic cloves
3	*Zingiber officinale*[1,2,3]	Un rizoma de 5 cm de largo, trozado	A 5 cm long rhizome, chopped up
4	*Citrus aurantifolia*[1,2,3]	Un limón en rodajas	A sliced lemon
5	*Piper aduncum*[1]	5-10 hojas, frescas o secas	5-10 leaves, fresh or dried
6	*Bursera graveolens*[1]	5-10 g corteza y tallos pequeños, secos	5-10 g bark and small stems, dried
7	*Psittacanthus linearis*[1]	3-5 g hojas y tallos, frescas o secas	3-5 g leaves and stems, fresh or dried
8	*Prosopis limensis*[1]	3 cortezas de tallo de 10 cm de largo	Three 10 cm long stem barks

9	*Ambrosia peruviana*[1]	5 g hojas y tallos, frescos	5 g leaves and stems, fresh
10	*Nicotiana tabacum*[1]	10 g hojas, frescas o secas	10 g leaves, fresh or dried
11	*Plantago major*[1]	10 g semillas, frescas o secas	10 g seeds, fresh or dried
12	*Coffea arabica*[1,2,3]	1-5 semillas tostadas	1-5 roasted seeds
13	*Pelargonium hortorum*[1]	5 g hojas, frescas	5 g leaves, fresh
14	*Tessaria integrifolia*[1]	15 g hojas, frescas o secas	15 g leaves, fresh or dried
15	*Capparicordis crotonoides*[1]	10 flores, fresca	10 flowers, fresh
16	*Medicago sativa*[1,2]	5-10 g hojas y flores, frescas	5-10 g leaves and flowers, fresh
17	*Cymbopogon citratus*[1]	5 g raíces, hojas y tallos, frescos o secos	5 g roots, leaves and stems, fresh or dried
18	*Galvesia fruticosa*[1]	10 g hojas, tallos y flores, frescos o secos	10 g leaves, stems and flowers, fresh or dried
19	*Cestrum auriculatum*[1]	5 g hojas, frescas o secas	5 g leaves, fresh or dried
20	*Lantana glutinosa*[1]	10 g ramas terminales con hojas y flores, frescas o secas	10 g terminal branches with leaves and flowers, fresh or dried
21	*Alnus acuminata*[2]	10 g corteza, fresca	10 g bark, fresh
22	*Cordia alliodora*[2]	10 g de corteza y tallos, secos	10 g bark and stems, dried
23	*Sambucus peruviana*[2]	5-20 g tallos, hojas y flores, frescas	5-20 g stems, leaves and flowers, fresh
24	*Eucalyptus globulus*[2]	10 g hojas, secas	10 g leaves, dried
25	*Cinchona officinalis*[2]	10 g hojas y flores, secas (1 cucharada) o 50 g corteza	10 g leaves and flowers, dried (1 tablespoon) or 50 g bark
26	*Cantua buxifolia*[2]	5-10 flores, frescas o secas	5-10 flowers, fresh or dried
27	*Juglands neotropica*[2]	10 g hojas, frescas	10 g leaves, fresh
28	*Plantago linearis*[2]	2 raíces, frescas	2 roots, fresh
30	*Urtica urens*[2]	20 g hojas, frescas o secas	20 g leaves, fresh or dried
32	*Baccharis genistelloides*[2]	15 g tallos, frescos o secos	10 g stems, fresh or dried
33	*Baccharis vacciniifolia*[2]	10 g ramas terminales, frescas o secas	10 g terminal branches, fresh or dried
34	*Caesalpinia spinosa*[2]	10 g frutos, secos	10 g fruits, dried
35	*Calceolaria linearis*[2]	5 g hojas y tallos, secos	5 g leaves and stems, dried
36	*Borrago officinalis*[2]	10 g toda la planta fresca o seca	10 g whole plant, fresh or dried
37	*Erytroxylon coca*[3]	5 g hojas, secas	5 g leaves, dried
38	*Uncaria tomentosa*[3]	10 g hojas y tallos, frescos o secos	10 g leaves and stems, fresh or dried

40	*Theobroma cacao*[3]	10 g cascarilla de las semillas	10 g seed husks
41	*Genipa americana*[3]	1-2 fresh or boiled fruits	1-2 fresh or boiled fruit
42	*Eryngium foetidum*[3]	10 g hojas, frescas	10 g leaves, fresh
43	*Malachra ruderalis*[3]	5 g raíces, fresca o secas	5 g roots, fresh or dried
44	*Maytenus macrocarpa*[3]	100 g corteza, fresca o seca	100 g bark, fresh or dried
45	*Verbena littoralis*[3]	30 g planta completa, fresca o seca	30 g whole plant, fresh or dried
46	*Polypodium ducumanum*[3]	50-100 g rizoma, fresco o seco	50-100 g rhizome, fresh or dried
47	*Tabebuia serratifolia*[3]	3-5 flores, frescas o secas	3-5 flowers, fresh or dried
48	*Cestrum hediondinum*[3]	10 g hojas, frescas o secas	10 g leaves, fresh or dried
49	*Abelmochus moschatus*[3]	1-3 g semillas trituradas	1-3 g crushed seeds
50	*Musa* spp.[3]	3 cucharadas de savia en ayunas	3 tablespoons of sap on an empty stomach
51	*Costus erythrocoryne*[3]	5 g tallos, secos	5 g stems, dried
52	*Crescentia cujete*[3]	Pulpa de un fruto. Directamente una cucharada tres veces al día	Pulp of a fruit. Directly one tablespoon three times/day
53	*Canna indica*[3]	1-2 tallos, frescos. Una cucharadita	1-2 stems, fresh. A teaspoon
54	*Trema micrantha*[3]	7 hojas, secas	7 leaves, dried
55	*Tagetes erecta*[3]	5 g hojas, secas	5 g leaves, dried
56	*Physalis angulata*[3]	5-10 hojas, frescas o secas	5-10 leaves, fresh or dried
57	*Tynanthus panurensis*[3]	2 g corteza	2 g stem bark
58	*Malachra ruderalis*[3]	5 g raíz	5 g root
59	*Scoparia dulcis*[3]	10 g hojas y tallos	10 g leaves and stems
60	*Aphelandra cirsioides*[2]	5-10 g planta entera	5-10 g whole plant

Table 3: Preparation of medicinal plants, native and introduced, that can be used in the geographic regions of the Peruvian coast, Andean, and jungle, in the treatment of respiratory diseases and COVID-19[a] 19 [92, 93, 31, 32, 41, 93, 93; consultations with traditional healers and personal experiences].

[a]In all cases, a liter of boiled water is used in the preparation, then the vegetable samples are added, and it is left to boil for 15 minutes. Administration is oral, one glass three times a day for a week. All the species indicated for each geographical region of Peru or those that can be obtained in the medicinal plant market can be used. [b]Peruvian geographic regions: coast (1), Andean (2) and jungle (3). It is recommended to use between 5 to 8 species of plants in the decoction preparation.

5. Conclusion

Numerous studies have demonstrated the phytochemical and pharmacological potential of hundreds of plants in the treatment of COVID-19. However, it is important to search for other plant

species, such as those that exist in the flora of Peru, used since ancient times in the treatment of respiratory diseases, therefore with potential use in the treatment of COVID-19 and the strengthening of the immune system. A synergistic action between the Peruvian species traditionally used in the treatment of respiratory diseases and the species introduced, naturalized, or commercialized in Peru, would be an excellent alternative against COVID-19.

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The authors declare no competing finnacial interest.

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