Phytotherapies for COVID-19 in Latin America and the Caribbean (LAC): Implications for present and future pandemics

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Abstract

Purpose – This review aims to provide synoptic documentation on acclaimed anecdotal plant-based remedies used by Latin America and the Caribbean (LAC) communities to manage COVID-19. The theoretical approaches that form the basis for using the anecdotally claimed phytotherapies were reviewed against current scientific evidence.

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Design/methodology/approach – In this paper plant-based remedies for managing COVID-19 were searched on social and print media to identify testimonies of people from different communities in LAC countries. Information was extracted, evaluated and reviewed against current scientific evidence based on a literature search from databases such as Journal Storage (JSTOR), Excerpta Medica Database (EMBASE), SpringerLink, Scopus, ScienceDirect, PubMed, Google Scholar and Medline to explore the scientific basis for anecdotal claims.

Findings – A total of 23 medicinal plants belonging to 15 families were identified as phytotherapies used in managing COVID-19 in LAC communities.

Originality/value – The plant-based remedies contained valuable phytochemicals scientifically reported for their anti-inflammatory, antiviral, antioxidant and anticancer effects. Anecdotal information helps researchers investigate disease patterns, management and new drug discoveries. The identified acclaimed plant-based remedies are potential candidates for pharmacological evaluations for possible drug discovery for future pandemics.

Keywords Traditional therapies, Phytotherapies, Phytochemicals, COVID-19, Anecdotal claims, Pandemic, Medicinal plants, LAC

Paper type Literature review

1. Introduction

As of November 2022, COVID-19 has caused the death of over 6.5 million people globally, with Latin America and the Caribbean (LAC) having over 1 million deaths (WHO, 2022). The pandemic has severely affected the LAC societies, economies and health. Although currently, there is a high drive for the population to get vaccinated, many are still hesitant about taking the vaccines (United Nations, 2021; Marzo *et al.*, 2022). Furthermore, despite the increase in the provision of quality information from both medical and scientific literature, the pandemic has continued to cause anxieties, fear, uncertainties and stigmatization due to the many published stories in social and traditional media (Wu & McGoogan, 2020). Notwithstanding the availability of vaccines and the mobilization by governments for their populations to get vaccinated, the variations and mutations of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) have continued to drive the search for pharmacological agents with the need for hand hygiene, physical distancing and other restrictions to curb the spread and infection rates of the virus still in place (Husaini & Abubakar, 2020).

The pandemic led many communities to seek palliative means to either prevent or alleviate the symptoms of the disease. In LAC, for instance, the fear of the disease led many populations to resort to self-care, self-help and self-medication (Matias, Dominski, & Marks, 2020). Many communities employed medicinal plants and other self-help remedies to prevent the infection or ameliorate symptoms (Orisakwe, Orish, & Nwanaforo, 2020; Lim, Teh, & Tan, 2021). In LAC and many other parts of the world, the use of medicinal plants to manage various diseases is deeply rooted in cultural, religious and traditional practices. Therefore, the uncertainties and fears of COVID-19 in many LAC populations prompted the drive to seek drastic anecdotal measures and solutions to manage the disease, with medicinal plants topping the list.

Perhaps there is no time in history where anecdotal information has spread globally like during the COVID-19 pandemic, especially with the advent of social media. Although vaccines have now been effectively produced to protect against most strains of COVID-19 viruses much of the anecdotal information provided the basis for symptomatic management of COVID-19 while serving as a starting point for scientific investigations (Attah *et al.*, 2021). The ability of many medicinal plants to produce anti-viral, immunomodulatory and anti-inflammatory effects in a multimodal approach in the management of COVID-19 has been reported (Lim *et al.*, 2021).

Presently, lack of documentation, potential acculturation and declining environmental and climatic degradation are causing a decline in indigenous knowledge of plants and their associated uses. The rich ecological rainforest, cultural diversity and the widely reported potential of medicinal plants used to manage various diseases in LAC have led to many communities exploring plant-based remedies for COVID-19. This review, therefore, provides synoptic documentation on acclaimed plant-based remedies used by LAC communities in the management of COVID-19. In addition, the theoretical approaches that form the basis for using the anecdotally claimed phytotherapies were presented while encouraging further research into the claims.

1.1 Review questions

(1) What indigenous phyto-remedies are used by LAC population to manage COVID-19 infection?

(2) Is there any scientific evidence to validate indigenous use of anecdotal remedies in the management of COVID-19?

2. Methodology

The methodology for this review was adopted and modified from 2 previous studies. In the first instance, the study methodology by Orisakwe *et al.* (2020) was adopted to identify anecdotal claims by residents in LAC. In this review stage, information on acclaimed remedies was sourced from social, print and broadcast media from November 2021 to March 2022. In addition, postings from local herbalists and traditional healers were included in the study, while the demographics of claimants were extracted where available and reported. Scientific published peer-reviewed research articles, hospitals and orthodox therapies were excluded from the first stage of the review. In the second instance, the identified anecdotal plant-based remedies were reviewed based on a literature search from databases such as JSTOR, EMBASE, SpringerLink, Scopus, ScienceDirect, PubMed, Google Scholar and Medline. The methodology in the second stage was a simplified and modified version of what was described by Attah *et al.* (2021).

3. Results

Anecdotally acclaimed plant-based home remedies for the management of COVID-19 were identified from testimonies of people from different communities in seven countries of LAC (Belize, Jamaica, Haiti, Bolivia, Brazil, Colombia and Peru) (Tables 1 and 2). Information on acclaimed remedies was provided by a medical practitioner, community leaders, herbalist, a trained respiratory therapist, voodoo leaders, vendors and indigenous community leaders. The herbs/plants are prepared by boiling, steeping or being taken fresh. The typical route of administration was oral, even though a few reports indicated inhalations with the proposed mechanism of action as a decongestant, immune boosting and purifying body systems. Twenty-three medicinal plants belonging to 15 families were identified as remedies used to manage COVID-19 (Table 3). Honey and vine skin were also identified as remedies for symptomatic management of COVID-19 in LAC.

4. Discussion

The world is facing the emergence of diverse and constantly mutating viruses in addition to complicated multidrug resistant bacteria. The plant kingdom constitutes a continuous source of pharmacologically active natural compounds to treat numerous human diseases and has continued to play an essential role in providing immediate health relief in LAC, particularly during sudden pandemics like COVID-19. Over the years, studies on plant-based therapies have led to the discovery and development of several drugs, while many phytochemicals have now been validated due to extensive scientific studies (Süntar, 2019). By early Chinese guidelines, traditional and complementary remedies have been recommended to control, prevent and treat coronavirus (Jin *et al.*, 2020). Phytomedicines from a single plant may contain multiple pharmacological properties, creating many challenging but exciting phytochemical possibilities (Süntar, 2019). A paucity of information on confirmed antiviral

Table 1.
Anecdotal plant-based home remedies for COVID-19 in the Caribbean and Central America

Place claim was made city/country	Demographics of claimant	Acclaimed remedy/ plant part	Preparation/ recipe/dose	Acclaimed mechanism of action	Source
Belize City, Belize	An acclaimed renowned herbalist/healer	*Vervain (Verbena officinalis)*	Leaves are boiled for 15–20 minutes and drank as tea	Decongestant	7newsbelize (2020)
		The entire plant (root, stem and leaves)	Lime can be added		
Belize City, Belize	Medical Doctor (Internist)	*Vervain (Verbena officinalis)*	Not available	Not available	Channel5Belize (2021)
Scott's Hall and Charles Town Maroon Community, Jamaica	Community leaders	Dandelion, avocado, garlic and citrus fruits. Other herbs	Not available	Immune boaster	Thomas (2021)
Jamaica	Herbalist	Pine needles with fever grass	Not available	Not available	Hendricks (2020)
A Jamaican living in New York, USA	Respiratory therapist	Tea from turmeric, garlic and ginger	Not available	Not available	Miami Times (2020)
Port-Au-Prince, Haiti	Voodoo leaders	Tea from moringa, eucalyptus, ginger and honey	Not provided	Immune boaster	NationsNews (2020)

actions of traditional remedies in LAC exists despite the region having a rich biodiversity. The anecdotal information provided by indigenous people might have served as immediate primary healthcare for COVID-19, and while vaccines are currently available, phytochemicals from plants provide a scaffold for discovering new drugs, hence the need for exploring anecdotal claims. The plant-based remedies mentioned by indigenous LAC residents for managing COVID-19 are reviewed against current scientific evidence and presented below.

4.1 Asteraceae

4.1.1 Taraxacum officinale *(Dandelion). Taraxacum officinale* has traditionally been used to manage diarrhea, kidney disease, diabetes, fever, chronic skin disease, boils, spleen disorders, liver malfunction and as an anti-inflammatory agent (Schütz, Carle, & Schieber, 2006). Hydroxyphenylacetic acid is the most abundant phenolic compound in *T. officinale*. In addition, the plant is rich in a variety of vitamins and minerals (Bokelmann, 2022). The claim by the LAC communities that *T. officinale* could benefit persons with COVID-disease may have some substance, as reported in a few studies. For instance, *T. officinale* has been reported to have a protective effect on lung injury, a significant symptom of COVID-19. Liu, Xiong, Ping, Ju, and Zhang (2010) reported that *T. officinale* inhibits inflammatory cytokines Interleukin-6 (IL-6) and Tumor necrosis factor alpha (TNF-α) production. In animal studies, the plant increases superoxide dismutase activity while decreasing the lipopolysaccharide-induced myeloperoxidase (Liu *et al.*, 2010). Furthermore, *T. officinale* has exhibited antiviral activities on HIV-1 virus, dengue virus-2, hepatitis C virus and influenza virus type A (Flores-Ocelotl *et al.*, 2018). Inhibition of viral replication, reduction of viral nucleoprotein via inhibition of polymerase activity and decrease in reverse transcriptase activity were some of T. *officinale's* antiviral effects (Flores-Ocelotl *et al.*, 2018). *T. officinale* has also been reported to have antioxidant and scavenger effects on free radicals, hydrogen peroxide, nitric oxide

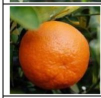
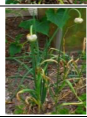
Place claim was made city/country	Demographics of claimant	Acclaimed remedy/plant part	Preparation/recipe/dose	Acclaimed mechanism of action	Source
Bolivia	Blogger	Eucalyptus leaves, followed by chamomile, wira-wira, bee honey, ginger, matico leaves and propolis (a resin-like material made by bees)	Herbal fusion taken as tea or inhaled	Respiratory diseases and boosting the immune system Also, disinfectant	Gutiérrez and Dewick (2021)
City of Belem, Brazil	Street Vendor	Cotton leaves and wormseed leaves	Cotton seed and wormseed leaves are blended, mixed with honey	Not available	Sharma (2020)
Amazon Portel, southwest of Marajo island in Para state, Brazil	Villagers	Tea of Jambu	Not available	Not available	Sarkar (2020)
Brazil		Avocados and pineapples	Smoothies, juice, eat ripe avocados	Not available	La Nación (2021)
Para state, Brazil	Kayapó indigenous people of Para state	Vine skin (name not disclosed)	The skin of the vine is boiled and drank as tea	Not available	Landau (2021)
Bogota (the Clan Tigre of the Tikuna Yoi ethnic group), Colombia	Public health assistant and herbalist	Ginger and garlic (purifiers) Bitter plant, such as the mucuraca, the dandelion, the rue (antibiotics) such as yerbaluisa, orange leaves, mallow, cotton leaves (inflammatory	Not available	Body systems purifier, anti-biotics Anti-inflammatory	Jimenez and Trivino (2020)
Pucallpa, Peru	Indigenous Shipibo community	Buddleja globosa plant (Matico) has green leaves and a tangerine-colored flower. Herbs, syrups of onion and ginger	Herbs, steeped in boiling water and the vapor/steam was used for steam inhalation Syrups of onion and ginger used to help clear congested airways	Decongestant	ABD and Armario (2020)

Table 2.
Anecdotal plant-based home remedies for COVID-19 in South America

radicals and 2,2-diphenyl-1-picrylhydrazyl (Miłek, Marcinčáková, & Legáth, 2019). Recent studies have shown that *T. Officinale* blocks protein-protein interaction of COVID-19 spike to the human ACE2 receptor (Tran, Gigl, Le, Dawid, & Lamy, 2021). The antiviral, antioxidant and anti-inflammatory properties of *T. officinale* make the plant a potential phytotherapeutic agent with potential for drug development in use for pandemics.

4.1.2 Matricaria chamomilla *(Chamomile)*. *Matricaria chamomilla* used to treat various diseases has been published in animal and human studies. The low incidence of side effects and toxicity made the plant a worthwhile complementary medicine (Parham *et al.*, 2020). The bioactive compounds in *M. chamomilla* included apigenin, phenolic compounds, terpenoids, flavonoids and matricin (Miraj & Alesaeidi, 2016). The plant inhibits the upregulation of H_2O_2-generated free radicals, may block peroxidation and protect against ethanol-induced hematological parameters disturbances and erythrocytes oxidative stress (Jabri *et al.*, 2016). *M. chamomilla*, in combination with other medicinal plants, was reported to demonstrate the

Table 3.
Family, scientific and local names for plants used for COVID-19 in Latin America and the Caribbean (LAC)

Family	Scientific name	Local names	Useful phytochemicals	Photos [Source: Wikimedia commons/ Wikipedia]	References
Asteraceae	*Taraxacum officinale*	Dandelion	Flavonoids, hydroxyphenylacetic acid.		Bokelmann (2022)
Myrtaceae	*Matricaria chamomilla*	Chamomile	Phenolic compounds, flavonoids.		Miraj and Alesaeidi (2016)
Rutaceae	*Gnaphalium graveolens ssp*	Wira-wira	Flavonoids.		Waibel *et al.* (1992)
	Eucalyptus globulus	Eucalyptus	Eucalyptol.		Elaissi *et al.* (2011), Salehi *et al.* (2019)
	Syzygium jambos	Jambu	Flavonoids, polyphenols.		Ochieng *et al.* (2022)
	Citrus X sinensis	Orange	Flavonoids, phenolic acids, essential oils.		Wahyuni *et al.* (2019), Coimbra *et al.* (2020)
	Citrus reticulata	Tangerine			
	Ruta graveolens	Rue			
Amaranthaceae	*Chenopodium ambrosioides*	Wormseed	Flavonoids, phenolic acids, phenolic amides.		Kasali *et al.* (2021)
Amaryllidaceae	*Allium cepa*	Onion	Flavonoids, phenolic, sulfur compounds.		Beigoli *et al.* (2021)
	Allium sativum	Garlic	Organosulfur compounds.		Rouf *et al.* (2020)
Pinaceae	*Pinus spp*	Pine needle	Flavonoids, several phenolic compounds.		Ha *et al.* (2020), Lee, Park, *et al.* (2021)

(*continued*)

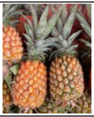
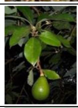
Bromeliaceae	*Ananas comosus*	Pineapples	Bromelain, flavonoids, phenolic compounds.		Hikisz and Bernasinska-Slomczewska (2021)
Lauraceae	*Persea Americana*	Avocado	Flavonoids.		Wu *et al.* (2019), Ajayi *et al.* (2017)
Malvaceae	*Gossypium spp*	Cotton plant	Flavonoids, phenols, phenolic acids.		Lima *et al.* (2021)
	Malva spp	Mallow	Flavonoids, polyphenols.		Benso *et al.* (2021)
Moringaceae	*Moringa Oleifera*	Moringa	Phenolic acids, polyphenols.		Feustel *et al.* (2017)
Phytolaccaceae	*Petiveria alliacea L*	Mucuraca	Flavonoids, polyphenols.		Luz *et al.* (2016)
Piperaceae	*Piper aduncum*	Matico	Essential oils, phenylpropanoid, flavonoids.		Taher *et al.* (2020)
Poaceae	*Cymbopogan citratus*	Fever grass	Alkaloids, flavonoids, phenolic acids.		Avoseh *et al.* (2015)
Verbenaceae	*Verbena officinalis*	Vervain	Essential oils, polyphenols, flavonoids.	 **Source(s):** Mrs. Delsie Vernon, D&S Gardens, Santa Elena, Belize	Kubica *et al.* (2020)
Zingiberaceae	*Curcuma longa*	Tumeric	Curcumin.		Ardebili *et al.* (2021)
	Zingerber offinale	Ginger	Gingerols, shogaols, phenolic acids.		Idris *et al.* (2019)

Table 3.

potential to interfere with COVID-19 propagation in Vero cells in a pilot study, making the claims for its use for COVID-19 to have some scientific backing (De Pellegrin *et al.*, 2021).

4.1.3 Gnaphalium graveolens *(Wira wira).* The genus of Gnaphalium is rich in caffeoylquinic acid derivatives, phytosterols, flavonoids, triterpenes, sesquiterpenes, anthraquinones, diterpenes and other biological compounds that give the plants their medicinal properties (Waibel, Achenbach, Torrenegra, Pedrozo, & Robles, 1992). *G. graveolens* as a bush remedy for COVID-19 has some scientific merits. Although not many studies have been done on *G. graveolens,* as a family, the genus of Gnaphalium has been reported to have anti-oxidant, anti-microbial, anti-inflammatory, anti-tussive, expectorant properties and strong scavenging activity as antioxidant (Rodríguez-Ramos & Navarrete, 2009; Zeng *et al.*, 2011). Also, the plants can produce more potent relaxant activity than aminophylline and were proposed for obstructive pulmonary disease, chronic bronchitis and bronchial asthma (Rodríguez-Ramos & Navarrete, 2009). Finally, the anti-inflammatory effect of Gnaphalium was reported to be due to the combination of flavonol glycosides and caffeoylquinic acid derivatives, which *G. graveolens* possesses (Zeng *et al.*, 2011).

4.2 Amaranthaceae

4.2.1 Chenopodium ambrosioides *(Wormseed plant).* The World Health Organization has recognized *C. ambrosioides* as one species of plant commonly used in traditional medicine (Rios *et al.*, 2017). In a recent review, Kasali, Tusiimire, Kadima, and Agaba (2021) summarized the traditional uses and phytochemical composition of *C. ambrosioides* (Table 3). The significant phytochemicals reported in *C. ambrosioides* are alkaloids, flavonoids, coumarins, glycosides, fatty acids, monoterpenes, lignans, sterols, phenolic acids and phenolic amides (Kasali *et al.*, 2021). In addition, the anti-oxidant, anti-nociceptive and anti-inflammatory effects of *C. ambrosioides* have been confirmed (Calado *et al.*, 2015). Although few studies explored the anti-viral activities of *C. ambrosioides*, the presence of phenols is worthy of note since phenols have been reported to have a broad spectrum of medicinal properties, anti-inflammatory and anti-oxidant activities and for the management of neurodegenerative, cardiovascular and diabetes mellitus (Costa *et al.*, 2017). Daglia (2012) reported the anti-viral and anti-microbial potentials of *C. ambrosioides.* The use of *C. ambrosioides* to reduce fever in COVID-19 patients was reported in Morocco (Bary & Amraoui, 2020).

4.3 Amaryllidaceae

4.3.1 Allium cepa *(Onion).* Scientific and animal studies on *Allium cepa* confirmed its pharmacological activities as anti-diabetic, immunological disorders, anti-oxidant, anti-allergic and respiratory disorders, anti-hypertensive and anti-inflammatory. *A. cepa's active compounds and the ability* to provide relief in bronchitis, coughs, common colds and asthma prompted the WHO to recommend its use (Beigoli *et al.*, 2021). In addition, the anti-thrombotic, anti-asthmatic, anti-platelet, anti-bacterial, anti-toxic and anti-carcinogenic effects of *A. cepa* have been reported (Lebdah *et al.*, 2022). The claims and utilization of *A. cepa* to manage COVID-19 related symptoms and signs by residents in LAC are therefore not without merit.

4.3.2 Allium sativum *(Garlic).* Pre-clinical and clinical studies have reported the antiviral properties and effects of *Allium sativum* against a variety of viruses including the common cold and flu (Rehman, Saif, Hanif, & Riaz, 2019; Ming, Li, Li, Tang, & He, 2021). In a recent review, Rouf *et al.* (2020) narrated that garlic and its active organosulfur compounds possess substantial antiviral activity through enhancing human immune response, inhibition of reverse transcriptase, RNA polymerase, DNA synthesis, blocking viral entry into the host cells while downregulating the mitogen-activated protein signaling pathway and extracellular-signal-regulated kinase. Therefore, the various pharmacologic properties of *A. sativum* make the plant have great potential for drug development, especially for viral prophylaxis, including COVID-19 and futuristic pandemics.

4.4 Pinaceae

4.4.1 Pinus spp. *(Pine Tree).* Folkloric evidence of the *Pine spp*. showed that the plants were used for asthma, hypertension, gastrointestinal tract disorders, hemorrhage, rheumatism and the prevention of other diseases (Lee, Park, *et al.*, 2021). However, some scientific evidence recently reported the pharmacological effects of *Pinus spp*. to include anti-inflammatory, anti-diabetic, anti-cancer, anti-microbial and anti-oxidant activities, with α-Pinene, flavonoids, saponin, several phenolic compounds (Ha *et al.*, 2020; Lee, Park, *et al.*, 2021). The anti-viral effect of *P. desiflora* against human papillomavirus and influenza A virus has been reported, thereby validating local claims (Lee, Kang, Cheong, & Park, 2021).

4.5 Bromeliaceae

4.5.1 Ananas comosus *(Pineapples)*. The most significant sulfhydryl proteolytic enzyme found in *Ananas comosus (*Pineapples) is bromelain (Owoyele, Bakare, & Ologe, 2020; Hikisz & Bernasinska-Slomczewska, 2021). Due to the reported anti-coagulatory, anti-viral, cardioprotective and anti-inflammatory pharmacologic effects of bromelain, the pineapple plant extract was suggested as a potential complementary therapy for pre and post COVID-19 management (Owoyele *et al.*, 2020; Hikisz & Bernasinska-Slomczewska, 2021). The inhibition of fibrin synthesis, the biosynthesis of kinins to prevent inflammation, and the conversion of prothrombin to thrombin make bromelain a compelling candidate to improve circulatory and cardiovascular functions by lessening coagulopathy, thereby improving circulation (Owoyele *et al.*, 2020). Although the exact anti-viral mechanisms of action of bromelain are not fully understood, a recent review strongly suggests that the plant extract is beneficial in various forms of cancers, cardiovascular diseases, inflammation disorders, coagulation disorders and infectious diseases (Hikisz & Bernasinska-Slomczewska, 2021). The claim, therefore, for the use of *A. comosus* to manage COVID-19 by the indigenous people of LAC has some scientific backings.

4.6 Lauraceae

4.6.1 Persea Americana *(Avocados)*. Wu *et al.* (2019) reported the anti-viral effects of (2 R,4 R)-1,2,4-trihydroxyheptadec-16-yne, a natural product extracted from *P. americana* that suppresses the replication of dengue virus using animal models. In general, *P. americana* has been used in complementary medicine, and the phytoconstituents are reported to demonstrate anti-oxidant, anti-bacterial, anti-viral and hepatoprotective properties (Ajayi, Awala, Olalekan, & Alabi, 2017). The composition of bioactive compounds such as steroids, monoterpenoids, flavonoids, sesquiterpenoids, carotenoids, triterpenoids and long-chain fatty acid derivatives gives it significant potential for use in pre and post COVID-19 management; hence validating local claims.

4.7 Malvaceae

4.7.1 Gossypium *(Cotton plant)*. Many varieties of the Gossypium genus are available, with the commonly cultivated species being *G. arboretum*, *G. barbadense, G. herbaceum* and *G. hirsutum*. As part of their active phytoconstituents, cotton plants contain proteins, phlorotannins, tannins, terpenes, sesquiterpenes, monoterpenes, triterpenes, flavonoids, alkaloids, phenols, steroids, fatty and phenolic acids (Lima *et al.*, 2021). Furthermore, *Gossypium* has been reported to have the potential to manage dysentery, diarrhea, genitourinary and respiratory tract infections, injuries, anti-microbial and oral candidiasis (Lima *et al.*, 2021). The most-reported species used for medicinal purposes in LAC are *G. barbadense*, *G. hirsutum* and *G. herbaceum*, while the active ingredient in the plant's defense against herbivorous insects and pathogens is gossypol (Ling *et al.*, 2016). The virucidal effects of gossypol were reported against the influenza virus where *G. barbadense* leaves extract demonstrated inhibition of viral adsorption and viral replication by the host cell (Ling *et al.*, 2016; Lima *et al.*, 2021). Although not many studies reported the antiviral activities of *Gossypium spp*, the indication by LAC indigenes is a testimony to its usefulness, at least for symptomatic management of viral activities, hence the need to further explore its usefulness as plants for future pandemics or post COVID-19 research.

4.7.2 Malva spp *(Mallow)*. The phytochemical composition of *Malva spp* includes flavonoids, polysaccharides, monoterpenes, tannins, Vitamin A, C and E, polyphenols, aromatic compounds and coumarins (Benso *et al.*, 2021). Traditionally the plant has been used to manage inflammation, gastrointestinal tract disorders, rheumatism, bronchitis, cold, cough, skin problems and wound healing, while its anti-microbial, anti-inflammatory, anti-oxidant, anti-cancer, anti-nociceptive and hepatoprotective effects have also been reported (Paul, 2016). Furthermore, the effects of *Malva spp* on the influenza virus while inhibiting the reverse transcriptase enzyme in HIV (Anuradha, Muhtari, Lone, Tripathi, & Sanjeevi, 2018). Although limited studies are available from clinical trials, the traditional use, folkloric writings and data obtained from preclinical studies validate the medicinal benefits of *M. sylvestris* hence supporting acclaimed usage for COVID-19 while encouraging further clinical studies towards drug discovery.

4.8 Moringaceae

4.8.1 Moringa oleifera *(Moringa)*. Several active compounds have been reported in *M. oleirefa*. Bioactive compounds like phenolic acids, oleic acids, ascorbic acids, alkaloids, saponins, resins, tannins, glycosides, flavonoids, carbohydrates, vitamins, carotenoids, polyphenols, etc. (Feustel *et al.*, 2017). Furthermore, the plant leaves, seeds, flowers and pods, have been used traditionally as an anti-diuretic, anti-diabetic, anti-hypertensive, anti-pyretic, malnutrition, anti-inflammatory and anti-oxidant activities. Furthermore, scientific evaluations of *M. oleifera* have shown the plant to be anti-inflammatory, anti-cancer, anti-fungal, anti-bacterial, anti-hypertensive and hepatoprotective (Biswas, Nandy, Mukherjee, Pandey, & Dey, 2020; Mphuthi & Husaini, 2022). Potent anti-viral activity of *M. oleifera* on New Castle Disease, Aphthovirus (Foot-and-mouth disease virus), Epstein Barr Virus, Hepatitis B Virus, Herpes Simplex Virus and Human Immunodeficiency Virus has been reported (Biswas *et al.*, 2020). Immune boosting, inhibition of targeted viral protein or enzymes used for replication, inhibition of viral activation, decreased cytokine IL-6 and translated surface antigens (HBsAg) (Feustel *et al.*, 2017; Biswas *et al.*, 2020). *M. oleifera* has recently been suggested as a potential preventative and therapeutic agent against COVID-19, validating indigenous usage in LAC (Sen, Bhaumik, Debnath, & Debnath, 2021). Most of the secondary phytoconstituents of *M. oleifera* that displayed drug-likeness did not show predictable toxicity.

4.9 Myrtaceae

4.9.1 Eucalyptus spp *(Eucalyptus)*. Several species of Eucalyptus have been identified; however, *E. globulus, E. smithii and E. polybractea* have been primarily reported as sources of cosmetic, nutraceutical and pharmaceutical products (Salehi *et al.*, 2019). The primary constituent of Eucalyptus oil is eucalyptol, with prominent bioactivities such as anti-inflammatory, anti-septic, anti-microbial and anti-oxidant effects (Elaissi *et al.*, 2011). In addition to its use for colds, congestion and cough, Eucalyptus oil has been used to boost the immune and respiratory tract system, reduce inflammation, lower blood glucose, protect skin health, act as an antibacterial and anxiolytic (Nordqvist, 2017). Eucalyptus oil demonstrated significant antiviral activity against influenza virus and herpes simplex virus type 1 (Elaissi *et al.*, 2011; Vimalanathan & Hudson, 2014). The acclaimed usage by indigenous LAC residents to relieve the symptoms of COVID-19, especially as an anti-inflammatory agent, immune booster and possibly reduce respiratory congestion while clearing the airways, is validated by scientific inquiry. Rational use of Eucalyptus oil can improve the general immunity of the body and especially the immune function of the respiratory tract in animal studies (Shao *et al.*, 2020). Because most COVID-19 patients exhibit respiratory tract disorders due to hyper-inflammation associated with increased circulating cytokines, Eucalyptus oil might be a reasonable consideration for symptomatic relive and clearing of the airways (Asif, Saleem, Saadullah, Yaseen, & Al Zarzour, 2020).

4.9.2 Syzygium jambos *(Jambu, water apple)*. Plants from the Syzygium genus, including *S. jambos,* have traditionally been used to manage toothache, leprosy, syphilis, wounds and gastrointestinal tract disorders (Chua, Lim, Ling, Chye, & Koh, 2019). The presence of triterpenoids, sterols, tannins, flavonoids and polyphenols have been reported as part of the secondary metabolites found in *S. jambos* (Ochieng, Ben Bakrim, Bitchagno, Mahmoud, & Sobeh, 2022). In addition, the plant extracts have been reported to exhibit hepatoprotective, anti-cancer, analgesics, anti-inflammatory properties and a broad spectrum of anti-bacterial effects (Subbulakshmi, Satish, & Shabaraya, 2021). Furthermore, the anti-viral effects of *S. jambos* were reported where the leaf extracts demonstrated significant antiviral effects against different types of herpes simplex virus and the virus involved in vesicular stomatitis (Athikomkulchai, Lipipun, Leelawittayanont, Khanboon, & Ruangrungsi, 2008). The combined anti-inflammatory and anti-viral activities of *S. jambos* and its low toxicity make it a candidate for exploring its potential for use in COVID-19 and future pandemics. The reports support the use of *the S. jambos* plant by LAC residents in their bid to curb the symptoms of COVID-19.

4.10 Phytolaccaceae

4.10.1 Petiveria alliacea L *(Mucuraca).* The traditional anecdotal claims have long sustained the use of *P. alliacea* in managing the influenza virus, while scientific reports suggest the plant has a significant effect on the hepatitis C virus (Lowe, Toyang, Roy, Watson, & Bryant, 2016). Flavonoids, dibenzyl trisulfide, essential oils, steroids, coumarins, tannins, alkaloids and polyphenols are bioactive compounds in *P. alliacea* (Luz *et al.*, 2016). The virucidal effects of *P. alliacea* were linked directly to Dibenzyl trisulfide, which also showed evidence against HIV and as an anticancer agent, with inhibition of reverse transcriptase and inter-action with the mitogen-activated protein, extracellular-regulated kinases 1 and 2 proposed as the mechanism of action (Lowe *et al.*, 2015, 2021). Evidence from scientific studies coupled with traditional anecdotal use of *P. alliacea* for various ailments gives credence to the use of the plant during the COVID-19 pandemic and hence the need for further studies to ascertain the molecular mechanisms responsible for this claim in LAC.

4.11 Piperaceae

4.11.1 Piper aduncum *(Matico, spiked pepper, buddleja globose).* The pharmacological activities of extracts from *P. aduncum* have been reported to have anti-cancer, anti-tumor, anti-microbial, anti-parasitic, anti-inflammatory, insecticidal and the management of other diseases (Monzote, Scull, Cos, & Setzer, 2017). In a recent review, Taher *et al.* (2020) summarized the traditional uses of *P. aduncum* and indicated that the plant contains 23 essential oil components, benzoic acid derivatives, phenylpropanoid, flavonoids, chromenes, chalcones, sesquiterpenes and monoterpenes. Radice *et al.* (2018) reported the antiviral effects of dillapiole, a significant component of *P. aduncum's* essential oil, on the West Nile virus. The anti-viral effects of *P. aduncum* on poliovirus have also been reported (Lohézic-Le Dévéhat, Bakhtiar, Bézivin, Amoros, & Boustie, 2002). Although few studies reported the anti-viral effects of *P. aduncum*. The traditional use by LAC residents in the management of COVID-19 is not devoid of credence, hence the need to further explore the pharmacological properties of the plant's anti-viral effects for COVID-19 and future pandemics.

4.12 Poaceae

4.12.1 Cymbopogan citratus *(Fever grass, lemongrass, yerbaluisa).* The *Cymbopogan* genus has been used in medicine globally as analgesics, anti-inflammatory, anti-pyretic, antiseptics and tranquilizers, having alkaloids, flavonoids and phenolic acids as some of the secondary metabolites that give the plants their bioactive abilities (Avoseh, Oyedeji, Rungqu, Nkeh-Chungag, & Oyedeji, 2015). Significant *in vitro* and *in silico* prospective anti-dengue activities with *P. citratus* were reported (Rosmalena *et al.*, 2019), while essential oil from *C. citratus* reduced the activity of nonenveloped murine norovirus (Gilling, Kitajima, Torrey, & Bright, 2014). Furthermore, *C. citratus* has been evaluated for its antiviral activities against measles and herpes simplex virus 1 (Adibah, Nazlina, & Ahmad, 2010; Linton, Jerah, & Bin Ahmad, 2013), while recently, *C. citratus* was reported to demonstrate potential against human mastadenovirus serotype 5 (Chiamenti *et al.*, 2019). The global distribution of *Cymbopogan citratus,* availability and safety makes the plant a potential anecdotal anti-COVID-19 candidate in LAC. Further investigations into the pharmacological anti-viral mechanism of action of *Cymbopogan citratus* should be conducted to provide specific validation for its use in future pandemics.

4.13 Rutaceae spp

4.13.1 Rutaceae spp. Apart from their economic importance as aromatic oils, timber and fruits, the citrus family (Rutaceae spp) is significant as the potential for medicines and medicinal substances. In a recent review, Coimbra, Ferreira, and Duarte (2020) summarized the bioactive composition and activities of the citrus family to include anti-parasitic, anti-viral, anti-oxidant, anti-fungal, anti-inflammatory, anti-microbial, with flavonoids, coumarins, phenolic acids, sterols and essential oils forming some of the major constituents of the plants. The antiviral effects of the citrus family were demonstrated against the hepatitis C virus where the extract of *R. angustifolia* inhibited the hepatitis C virus RNA replication and viral protein synthesis via chalepin and pseudane IX, the active ingredient identified in the extract (Wahyuni, Mahfud, Permatasari, Widyawaruyanti, & Fuad, 2019). The old traditional use of the citrus family, coupled with the availability of scientific data, made the plants targets for experimentation by LAC residents to alleviate the symptoms of COVID-19 infections, which ravages the world with no solution in sight.

4.14 Verbenaceae

4.14.1 Verbena officinalis *(Vervain, Verbena).* A certified medical practitioner (Internist) in the country of Belize testified that *Verbena officinalis* was helpful in the symptomatic management of COVID-19, having used the extracts of the plant in the management of his COVID-19 infection (Channel5belize). Depression, anxiety, upper respiratory tract illnesses, gastrointestinal tract disturbances, insomnia, pain and aches were some of the purported traditional claims for *V. officinalis* (Ahmed, Ahmed Qasim, Ashraf, & Maab, 2017). *V. officinalis* extracts and metabolites have been reported to include analgesic, anti-cancer, neuroprotective, anti-inflammatory, anti-microbial and antioxidant activities, with essential oils, polyphenols, phenylpropanoid glycosides, sterols and flavonoids (Kubica, Szopa, Dominiak, Luczkiewicz, & Ekiert, 2020). Because of its wide margin of safety and antioxidant effects on the cells, a monograph of *V. officinalis* was included in the European and Chinese Pharmacopoeia (Rehecho *et al.*, 2011). The inclusion of the plant in pharmacopeias is a substantiation of its biological efficacy after several scientific investigations confirming *V. officinalis* to demonstrate anti-oxidant, anti-fungal, neuroprotective, anti-bacterial and anti-inflammatory properties hence corroborating local claims for current use in the symptomatic management of COVID-19 (Kubica *et al.*, 2020).

4.15 Zingiberaceae

4.15.1 Curcuma longa *(Tumeric).* Recent reviews on curcumin, the active ingredient in *C. longa*, showed that the natural compound has sufficient *in vitro* activity against a wide range of viruses such as adenoviruses, dengue viruses, human cytomegalovirus, herpes simplex viruses, hepatitis B virus, human papillomavirus, coxsackievirus B3, human norovirus, human immunodeficiency virus, ebola virus, human T-lymphocyte virus, Rift Valley fever virus, influenza A virus, Chikungunya virus, respiratory syncytial virus, Japanese encephalitis virus, zika virus and coronavirus (SARS-CoV) among others (Ardebili *et al.*, 2021). Interrupting viral replication via modulating host cell signaling pathways and blocking viral attachment and entry by abrogating the function of viral envelopes are some of the mechanisms of action of curcumin (Naseri *et al.*, 2017). The experimental and clinical evidence on the pharmacological effects of *C. longa* on several viruses justifies the use of the plant by many residents in LAC.

4.15.2 Zingerber offinale *(Ginger).* The residents of LAC mentioned ginger as one of the acclaimed bush remedies for COVID-19. The major phytochemicals found in ginger are gingerols, shogaols, phenolic acids and paradols, with the active compounds reported to have 4-hydroxy 2-methoxyphenyl moiety and demonstrating anti-oxidant, anti-inflammatory, anti-cancer and anti-platelet activities (Idris, Yasin, & Usman, 2019). The anti-oxidant property of garlic is due to the high concentration of phenolic compounds leading to scavenging free radicals (Daliri *et al.*, 2019). Dorra, El-Berrawy, Sallam, and Mahmoud (2019) reported that ginger extracts inhibited the growth and development of the H5N1 virus in a dose-dependent manner with varying antiviral activity. Ginger's anti-viral, anti-oxidant and anti-inflammatory properties make the spice a potential source for drug discovery in future pandemics.

5. Conclusion

Medicinal plants have a long history of patronage because of ease of availability, low cost, better tolerance and wide acceptance of safety because they come from nature. Some anecdotal information from LAC was reviewed against the backdrop of scientific research evidence. Our review showed that the anecdotal claims from medicinal plants in COVID-19 comprise primary and secondary metabolites that produce immunomodulatory, anti-inflammatory, anti-oxidant and anti-viral anti-oxidant properties, validating local indigenous claims. The absence of studies on formulations and standardization poses challenges to the use of medicinal plants in the management of COVID-19. Further studies on their unique mechanism on COVID-19, safety, quality, adverse effects, interactions and dosing need to be conducted. The enormous rich rainforest and ethnopharmacopeia of LAC make the region a potential hub for natural-based pharmaceuticals and increased predispositions for new drug discoveries. Discovering the pharmacological properties of medicinal plants and mapping their transcriptomes and genomes to produce target drugs should be the central focus of modern research in LAC.

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