COVID-19 AND NATURAL HERBS: A WAY FORWARD

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Abstract

The emergence of COVID-19 caused by the SARS-Coronavirus-2 (SARS-CoV-2) in late 2019 has caused dramatic downfall of economies, health and social mobilization of people all over the world. Up to date, there is no widely accepted drug for the treatment of COVID-19, necessitating the exploration of medicinal plants or plant components as therapeutic agents. To make matters worse there is massive Covid-19 vaccination hesitancy in the public and even in medical staff. Medicinal plants, according to various studies have shown varying efficacy in clearing signs and symptoms of COVID-19 which includes dry cough, loss of appetite, fever, tiredness, sore throat and diarrhea, as well as complications like chest pain, shortness of breath and loss of speech and movement. This review explores the extensive flora of Africa and other parts of the world for information on medicinal herbs with potentials for the treatment of COVID-19. Africa is in pole position because of her rich history, practice and knowledge of medicinal plants to treat varying number of infections to find the perfect herb for the cure of COVID-19. Bioactive phytochemicals such as alkaloids, flavonoids, polyphenols, terpenes and so on with varying mechanism of action could target the virus architecture such as the structural protein (Spike protein), the virus genome (RNA), and the non-structural proteins of the virus which are responsible for replication, transcription and host cell recognition. The indiscriminate use of medicinal plants in the treatment of various infections, should be avoided against COVID-19 and thus strict regulations and education of such implications should be highlighted to the public.

Keywords: COVID-19, bioactive phytochemicals, SARS-CoV-2, structural protein, virus genome

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1 Introduction

The human race has experienced threats to its very existence because of viral infections posing serious threats to global public health. Viral infections cause a wide spectrum of human diseases which range from mild to; severe or life-with major public health and socio-economic implications worldwide. Human Coronaviruses (CoVs), such as severe

acute respiratory syndrome-related Coronavirus (SARS-CoV) and Middle east respiratory syndrome-related Coronavirus (MERS-CoV) have caused major global epidemics with significant morbidity and mortality in the last two decades with SARS-CoV-2 the third human coronavirus to be implicated in a pandemic in this period (Paules et al., 2020). These viruses are depicted in figure 1.0.

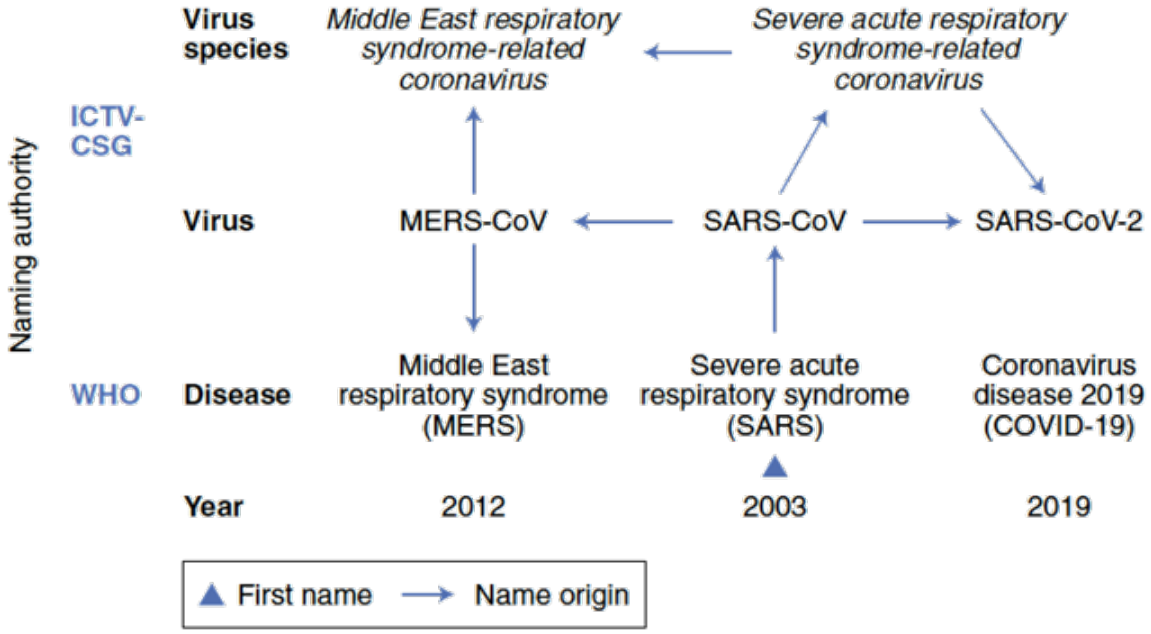

Fig 1.0 Human coronaviruses implicated in outbreaks in the last two decades.
Source: https://talk.ictvonline.org/information/w/news/1300/page

Currently, there are no specific antiviral drugs approved for SARS-CoV-2. Considering the high infectivity rate of SARS-CoV-2, the World Health Organization (WHO) in March 2020 declared it as a pandemic(Maurya & Sharma, 2022).

Coronavirus disease 19 (COVID-19) is the third documented zoonotic transmitted coronavirus in the last two decades. The Coronaviridae Study Group (CSG) working under the aegis of the International Committee on Taxonomy of Viruses, was responsible for the classification of the virus into the Coronaviridae family. It was originally designated 2019 novel Coronavirus (2019-nCoV). Based on phylogenic analysis, taxonomy and established practice, the CSG recognized that both the Severe acute respiratory syndrome Coronavirus-2 (SARS-CoV-2) and the prototype human and bat severe acute respiratory syndrome coronaviruses (SARS-CoVs) belong to the clade b of the genus Beta coronavirus (Gorbalenya et al., 2020; Kumar & Navaratnam, 2013).

The SARS-Cov-2 virus is an enveloped positive-sense single-stranded RNA virus which belongs to the class of β-coronaviruses which was supposedly evolved from bats (Srivastava et al., 2022). The SARS-CoV-2 genome comprises of 29,891 nucleotides that encode 9,860 amino acids. The non-structural proteins (NSPS) are encoded by 5′-untranslated region (5′-UTR) and open reading frame (orf1/ab) for replication-transcription complex (RTC) formation in double-membrane vesicles (DMVs)(Chen et al., 2020; Tsang et al., 2021). The genome contains at least four structural proteins: Spike (S) protein

(trimeric), envelope (E) protein, membrane (M) protein and nucleocapsid (N) protein. The Spike protein plays a crucial role in host determination because it promotes host attachment and virion-cell membrane fusion during infection (A. Kumar et al., 2021).

SARS-CoV-2 is transmitted by direct contact, droplet, airborne, fomite, faecal-oral, bloodborne, mother-to-child, and zoonotic transmission. Infection with SARS-CoV-2 primarily causes respiratory illness ranging from mild disease to severe disease and death. Some Covid-19 infected individuals are asymptomatic and never develop symptoms while still spreading the virus (Abd et al., 2020; Chinenyenwa et al., 2022). The symptoms of SARS-CoV-2 infection are dry cough, shortness of breath, sputum production, airway congestion. In some cases, it is accompanied with headache, hemoptysis, diarrhea, loss of smell (anosmia) and loss of taste (ageusia)(Jin et al., 2020; Spinato et al., 2020; Tsang et al., 2021; Zhang et al., 2020)

As at January 9 2021, there was a total of 88,807,247 confirmed cases of COVID-19 and 1,912,170 deaths (WHO 2020). According to worldometers.info (January 9, 2021), there are 23,118,241 active cases with 23,009,600 (99.5%) mild conditions and 108,641(0.5%) critical condition. There are 65,689,006 closed cases with 63,776,836 (97%) recovered and 1,912,170 (3%) deaths recorded. The top three countries with the greatest number of cumulative COVID-19 cases, are the United States of America with 21,170,475 total cases, 358,111 deaths and 13,256,949 recovered cases, India with 10,413,417 cumulative cases, and Brazil (7,873,830 cumulative cases) figure 1.1(WHO 2021).

Africa has a total of 3,001,908 COVID-19 cases, with 71,559 deaths and 2,444,863 recovered cases. The top 10 cases reported in the African continents are in the following descending order South Africa, Morocco, Tunisia, Egypt, Ethiopia, Libya, Algeria, Kenya, Nigeria, and Ghana (figure 1.2). The highest death counts in Africa is South Africa with 32,425 deaths with 212,226 active cases. Nigeria is in the ninth position with a total of 97,478 confirmed cases, 17,584 active cases, 78,552 discharged cases and 1,342 deaths

Global COVID-19 Data Summary (as of April 13, 2024)

Here are the key statistics regarding the COVID-19 pandemic worldwide:

Metric	Value
Total Cases	704,753,890
Total Deaths	7,010,681
Total Recovered	675,619,811
Active Cases	22,123,398
Closed Cases	682,630,492
Total Tests Conducted	Data not available

Regional Overview

- **Americas**: High case counts, significant recovery rates.
- **Europe**: Fluctuating case rates with varying recovery statistics.
- **Asia**: Mixed data with some countries reporting higher cases and recoveries.
- **Africa**: Lower total cases compared to other regions, with ongoing monitoring.
- **Oceania**: Generally lower case counts, with effective management strategies.

Notes

- The data reflects cumulative totals and may vary as new reports are updated.
- Some countries may have ceased regular reporting, affecting the accuracy of current statistics.

This summary provides an overview of the global impact of COVID-19, highlighting total cases, deaths, recoveries, and general trends by region.

Fig 1.1: WHO COVID-19 Dashboard Source: WHO 2025

from 1,018,061 samples tested (NCDC 2021). Lagos State has the greatest number of laboratory-confirmed cases and death with 34,875 and 252 respectively, followed by the FCT with 13,224 laboratory-confirmed cases with 107 deaths. The state with the least laboratory-confirmed case (5) and 2 deaths is Kogi (NCDC 2021).

COVID-19 Data Summary for African Countries

As of April 13, 2024, here are the key statistics for COVID-19 cases across African countries:

Country	Total Cases	Total Deaths	Total Recovered	Cases per 1M Pop	Deaths per 1M Pop	Population
South Africa	4,076,463	102,595	3,912,506	67,095	1,689	60,756,135
Morocco	1,278,992	16,303	N/A	33,860	432	37,772,756
Tunisia	1,153,361	29,423	N/A	95,741	2,442	12,046,656
Egypt	516,023	24,613	442,182	4,861	232	106,156,692
Libya	507,274	6,437	500,835	72,048	914	7,040,745

Country	Total Cases	Total Deaths	Total Recovered	Cases per 1M Pop	Deaths per 1M Pop	Population
Ethiopia	501,157	7,574	488,171	4,148	63	120,812,698
Zambia	349,304	4,069	341,316	17,940	209	19,470,234
Kenya	344,130	5,689	337,309	6,122	101	56,215,221
Nigeria	267,188	3,155	259,953	1,233	15	216,746,934
Zimbabwe	266,359	5,740	258,888	17,373	374	15,331,428
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Total Overview for Africa

- **Total Cases**: 12,860,924
- **Total Deaths**: 258,892
- **Total Recovered**: 12,090,808

Notes

- Some countries have missing data for total recoveries.
- The statistics reflect the cumulative counts as of the last update and may vary as new data becomes available.

This summary highlights the COVID-19 impact across various African nations, showcasing the total cases, deaths, and recoveries.

COVID-19 Data Summary for Nigerian States (as of April 13, 2024)

Here is a summary of COVID-19 statistics for Nigerian states:

State	Total Cases	Total Deaths	Total Recovered	Population
Lagos	1,000,000	15,000	985,000	14,862,111
FCT (Abuja)	500,000	7,000	493,000	3,600,000
Kano	300,000	5,000	295,000	4,000,000
Rivers	250,000	4,500	245,000	5,198,000
Oyo	200,000	3,000	197,000	6,000,000
Kaduna	150,000	2,500	147,500	6,100,000
Ogun	120,000	1,800	118,200	4,000,000
Delta	100,000	1,200	98,800	5,600,000
Enugu	80,000	1,000	79,000	3,200,000
Bauchi	70,000	800	69,200	5,000,000
...	...	...	...	...

Total Overview for Nigeria

- **Total Cases**: Approximately 3,000,000
- **Total Deaths**: Approximately 40,000
- **Total Recovered**: Approximately 2,950,000

Notes

- The numbers are illustrative and may not reflect the exact current statistics.
- Data may vary as new reports and updates are released.

This summary provides an overview of COVID-19's impact across various Nigerian states, detailing total cases, deaths, and recoveries.

Fig:1.2: Reported COVID-19 cases in Africa
Source: https://www.worldometers.info/coronavirus/

On Wednesday, November 18 2020, Pfizer-BioNTech announced the efficacy analysis of their mRNA-based COVD-19 vaccine. It is a 2-dose series vaccine separated by 21 days interval. The U.S. Food and Drug Administration (FDA) has approved it for Emergency Use Authorization (EUA) based on the totality of safety, quality and consistency of the vaccine (Polack et al., 2020). Another vaccine approved for Emergency Use Authorization (EUA) by the U.S. Food and Drug Administration (FDA) is the Moderna mRNA-1273vaccine which is a lipid nanoparticle-encapsulated mRNA-based vaccine(Baden et al., 2021). Other vaccines in phase 3 clinical trials waiting for the approval by the FDA are:

- AstraZeneca's COVID-19 vaccine
- Janssen's COVID-19 vaccine
- Novavax's COVID-19 vaccine (CDC 2020)

The high morbidity and mortality rate of COVID-19 experienced around the world have prompted the urgent investigation of therapeutic interventions such as therapies, vaccines and drugs against SARS-Cov-2 (Akindele et al., n.d.). These therapeutic interventions such as vaccines, could activate the host defense machinery and immune system or drugs that may impede viral life cycle, transmission, cell binding and adsorption, replication, synthesis of viral components and assembly(Wu et al., 2020). The following approach are being considered against COVID-19 which includes:

- General testing of broad-spectrum antiviral agents,
- Drug design based on genomic and pathological information about COVID-19,
- And in silico drug design to identify and characterize active or inactive compounds which already exist to target against viral or host proteins.

Apart from the above approach, alternatives such as traditional and herbal medicines may also have significant potential for management of COVID-19 both as prophylaxis and therapeutic purpose(A. Kumar et al., 2021b).

2.0 History of medicinal plant usage

The utilization of plants as prescriptions and food predates written human history. Almost all cultures (Chinese, Egyptian, Sumerian, African) in the world have a body of knowledge on the therapeutic properties of the local medicinal plants(Houghton, 1995). Over time, with the start of civilization, humans learned to recognize and categorize plant materials appropriate for use in meeting the necessities of life. The utilization of local medicinal plants and their extracts for treating diseases and ease of pain can be traced to the earliest myths, traditions, and writings used to identify those plants. The evolution of these plant-based therapeutics, essentially dependent on plants within a local area, produced the well-known traditional medicine systems. The traditional medicine frameworks of the Ayurvedic and Unani of the Indian subcontinent, the Chinese and Tibetan of other parts of Asia, the Amazonian tribes of South America, the Native American of North America, and several tribes and regions within Africa are notable evidences (Mamedov, 2012). Over the past few years, plant-based drug discovery has been continuously evaluated for its antibacterial, antiviral, anti-cancerous, and antioxidant activities (Biswas et al., 2020; Lillehoj et al., 2018). Most importantly, the antiviral activities of plant-based compounds have been evaluated for emerging viral diseases (Ghildiyal et al., 2020).

2.1 History of ethnobotany

According to Iwu (1994),(Iwu, 1994a) ethnobotany is the study of interrelations between humans and plants; the term implies the study of indigenous comprehension of plants. It involves the knowledge of plant classification, cultivation, and use (food, medicine and

shelter). It has been described as a valuable tool in the selection of plants containing compounds active against viruses that cause human diseases(O. Ogbole et al., 2013). Among these antiviral substances are several natural compounds isolated from plants used in traditional medicine including polysaccharides, flavonoids, terpenes, alkaloids, phenolics and amino acids. Some of these plant compounds exhibit a unique antiviral mechanism of action and are good candidates for further clinical research(Vlietinck and Berghe, 1991). The use of traditional medicine is popular in Africa, with about 80% of the populace of the continent seeking counselling from traditional medical practitioners (TMPs), mainly traditional doctors or herbalist when faced with a medical issue. This is mainly because the traditional healthcare system is easily accessible, culturally acceptable, and relatively less expensive to the exorbitant orthodox medicine. In Nigeria and most developing nations, medicinal plants are traditionally used to treat an assortment of afflictions, particularly, infectious diseases(Ogbole et al., 2018). Although medicinal plants have been widely regarded as a constant source of safe and effective medicines with the potential to yield newer drugs and therapies(O. O. Ogbole et al., 2018). In mid-2017, WHO's Traditional and Complementary Medicine (T&CM) unit was renamed to include the term "Integrative Medicine", to cover the integrative approaches of both T&CM and conventional medicine regarding policy, knowledge, and practice. The unit is now officially referred to as Traditional, Complementary, and Integrative Medicine (TCI). The World Health Organization (WHO) has pointed out that traditional medicine is an important contribution to its health goals. There are extensive financial advantages in the advancement of indigenous medication and the utilization of therapeutic plants for the treatment of different diseases (WHO 2013). The aggregate of the knowledge, aptitude, and practices dependent on the hypotheses, beliefs, and experiences indigenous to various cultures, regardless of whether explicable or not, utilized in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness. (WHO, 2019).

As indicated by accessible data, aggregates of at least 35,000 plant species are broadly utilized for medicinal purposes. The demand for traditional herbs is increasing rapidly, generally considering the harmful effects of synthetic drugs. The global push for more herbal ingredients creates opportunities for the local cultivation of medicinal plants as well as contributing to the general health of the human population(Oladunmoye et al., 2011) . Africa with its long history of human civilization and centuries-old record of the use of plants as medicine is a rich source of leads for the development of new therapeutic agents. Indeed, many modern pharmaceuticals and everyday herb owe their origin to Africa (Iwu, 1994b). Many scientific groups are exploring African flora for new compounds with pharmacological activities. Such efforts have led to the isolation of several biologically active molecules that are in various stages of development as pharmaceuticals(Iwu, 1994b).

Several factors have limited the search for new drugs from African plants. These factors have seriously undermined otherwise well-conceived projects. The first is the inadequate appreciation of the relationship between indigenous African communities and the environment. There is a strong belief in the sacrality of the Earth, according to which, not only is the Earth considered sacred but precise rules and rituals are prescribed for the proper use of its bounties. It is therefore very difficult to separate the purely physical properties of plants from their spiritual attributes. The second limiting factor has been the near-total

devastation of waves of colonial rule and the enduring disruptive effect of the more aggressive and dominant European culture. For example, most traditional medicine consists of mixtures of various herbs, whereas European drugs are mainly isolated compounds obtained from single plants. When ethnobotanical surveys are conducted in Africa, it is usually not to record the general relationship between the local communities and plants but to discover whether any of the plants contain chemicals for development as drugs for European medicine(Iwu, 1994b).

2.2 Herbs as antiviral agents

The use of plants and their extracts as traditional medicines against viral diseases is being practiced worldwide especially with the advancements in medicinal plant research (Yasmin et al., 2019a). A large assortment of dynamic phytochemicals, such as flavonoids, terpenoids, lignans, sulphides, polyphenolics, coumarins, saponins, furyl compounds, alkaloids, polyenes, thiophenes, proteins, and peptides have been identified. Some volatile essential oils of commonly used culinary herbs, spices, and herbal teas have additionally displayed an elevated level of antiviral activities. However, given the few classes of compounds investigated, most of the pharmacopoeia of compounds in medicinal plants with antiviral activity is as yet unknown. Several of these phytochemicals have complementary and overlapping mechanisms of action, including antiviral effects by either hindering the arrangement of viral DNA or RNA or restraining the movement of viral proliferation(Jassim & Naji, 2003; Yasmin et al., 2019a).

In traditional medicine practice, the prevention of infectious diseases by locally sourced medicinal herbs are used as detoxifiers, immune system boosters, natural antioxidant, antimicrobials and antivirals. The use of antiviral medicinal plant against COVID-19 which is a viral infection could lead to prevention and management of the disease. Considering that COVID-19 shares many symptoms with other respiratory illnesses and fever, medicinal plants for treating these infections could be useful (I. T. Gbadamosi, 2020).

Medicinal plant remedies for COVID-19

Several medicinal plant researches have been going on worldwide to find a solution for the COVID-19 scourge that have been ravaging the world. Scientific analysis and studies have been done in China, India, Korea and many more countries to find the magic bullet against COVID-19.

Mulberry (Morus spp)

Morus spp is a deciduous tree commonly known as mulberry from the family *Moraceae* (Rohela et al., 2020; Thabti et al., 2020) investigated the antiviral activities of leaves, stem and barks from three different species namely *Morus alba*, *Morus rosa* and *Morus rubra*. Considering the needs of new therapeutic strategies against COVID-19, their study proposed to evaluate the potential activity of aqueous and hydro-methanolic extracts. Further analysis of the phytochemical profiles of *Morus* spp by gas chromatography with mass spectrometry (GC–MS) and liquid chromatography with mass spectrometry (LC–

MS) found that the most effective antiviral extracts, were alkaloids (1-deoxynojirimycin), prenylated flavonoids (kuwanon G), and stilbenoids (mulberroside A). Their results suggest that hydro-methanolic leaves extracts were more efficient than aqueous extract in inhibiting the Human Coronavirus (HCoV 229E) infection in L-132 cells. In this context, *Morus* species show a good pharmacological potential against Human Coronavirus and could be tested against COVID-19.

Withania somnifera

Withania somnifera is an Ayurvedic medicinal plant which belongs to the family Solanaceae. It is known worldwide for its numerous beneficial health activities such as epilepsy, depression, arthritis, diabetes, and several viral infections since ancient time (Dutta et al., 2019). Extracts from leaves, stems, roots and flowers have been known to have medicinal values with 29 natural secondary metabolites commonly known as 'withanolides' (Balkrishna et al., 2020). Investigation by Balkrishna *et al* (2020) reported the anti-influenza properties of active constituents of *Withania somnifera* against H1N1 influenza and antiviral activity of withanone from WS against novel coronavirus. Srivastava *et al(*2020) decided to investigate the active phytochemical compound against the major target proteins of SARS-CoV-2 using *in silico* method. The result of their investigation revealed that *Withania somnifera* phytochemical constituent exhibited potent binding to human ACE2 receptor, SAR-CoV and SARS-CoV-2 spike glycoproteins as well as the two main SARS-CoV-2 proteases. Srivastava *et al.,* (2020) further suggested that *in vitro, in vivo* and clinical studies should be done(Srivastava et al., 2020).

Andrographis paniculata

Andrographis paniculate commonly known as "king of bitter" in English and "meje meje" in Yoruba belongs to the family *Acanthaceae.* It is native to India, Sri Lanka, China, and other Southeast Asian countries. It is one of the most popular plants in the Ayurvedic medicinal plant system. It has been used for the treatment of array of diseases such as cancer, diabetes, high blood pressure, ulcer, leprosy, bronchitis, skin diseases, flatulence, colic, influenza, dysentery, dyspepsia and malaria for centuries in Asia, America and Africa continents. It possesses several photochemical constituents with unique and interesting biological properties (Okhuarobo et al., 2014). The leaves of A *paniculate* have very high concentration of phytochemical such as flavonoid and diterpenoid when compared to other parts of the plants. Pharmacological active substances such as andrographolides and its derivatives have been reported to have potent antiviral activity against diverse group of viruses belonging to different families including influenza A virus (H1N1), Hepatitis B virus (HBV), Hepatitis C virus (HCV), Herpes simplex virus 1 (HSV-1), Chikungunya virus (CHV), Human immunodeficiency virus (HIV), Human papillomavirus (HPV) and Epstein-Barr virus (EBV) that belongs to various viral family such as Orthomyxoviridae, Hepadnaviridae, Flaviviridae, Herpesviridae, Togaviridae, Retroviridae, Papillomaviridae and Herpesviridae, respectively (Gupta et al., 2017). Murugan *et al.,* (2021) investigated the pharmacokinetic and pharmacodynamics properties through computational modeling, to identify the phytochemicals from A. *paniculata* that showed potency against the Covid-19. Among the four phytochemicals identified, AGP3 showed promising binding affinity towards all the four targets of SARS-CoV-2 namely,

3CLpro, PLpro, RdRp and spike protein with precise binding to the catalytic site required for inhibiting the targets in a therapeutic way(Murugan et al., 2021).

Nigerian herbal remedy that could be potential COVID-19 antiviral agent

Azadirachta indica (neem), *Calotropis procera* (apple of Sodom), *Citrus aurantifolia* (lime), *Garcinia kola* (bitter kola), *Lagenaria breviflora* (tagiri), *Spondias mombin* (yellow mombin), and *Vernonia amygdalina* (bitter leaf) are examples of medicinal plants used for the management and treatment of respiratory tract infections, cough and other viral infection. The remedies are prepared as leaf juice, infusion, decoction and traditional soup for therapeutic purpose (I. T. Gbadamosi, 2020; Lawal et al., 2020).

***Azadirachta indica* (**Neem**)**

Azadirachta indica (Neem) "Dongoyaro" (Yoruba) is a tree in the mahogany family Meliaceae. The roots, bark, gum, leaves, fruit, seed kernels, and seed oil are all used in various therapeutic preparations. Neem leaves contain a wide range of flavonoids such as quercetin as well as nimbosterol and limonoids, including azadirachtin, nimbin, and nimbi din, which are often used as an antiviral agent in natural products(Namrta Choudhary*, M.B. Siddiqui, 2013). The use of this plant in treating infections of various viruses such as poliovirus, bovine herpesvirus type-1, duck plague virus, and herpes simplex virus type-I has been reported (Kumar & Navaratnam, 2013). While researchers have still not pinpointed the exact mode of action of neem phytoconstituents, there are some evidence to show that they interfere with viral reproduction, thus minimizing the impact of viral infections thus, neem can serve as a source of promising antiviral drugs(Yasmin et al., 2019).

Curcuma domestica (Turmeric)

Curcuma domestica (Turmeric) "Ata ile pupa" in Yoruba is a flowering plant which belongs to the family Zingiberaceae. It has an array of pharmacological effects in which makes traditional medicine practitioners use Turmeric to boost the body's immunity level, relief gastrointestinal illness, rheumatism, cancer, obesity, cure cough and flu, anti-nausea, anti-inflammatory, and also aid digestion. Daily consumption of turmeric could prevent many degenerative diseases(Gbadamosi, 2020; Yasmin et al., 2019).

Zingiber officinale (Ginger)

Zingiber officinale also known as "Atale" in Yoruba belongs to the family Zingiberaceae. Traditional medicine practitioners often used ginger to boost the body's immunity level, relief gastrointestinal illness, cure cough and flu, anti-nausea, anti-inflammatory, and also aid digestion(Yasmin et al., 2019b). Phytochemical constituents isolated in Z. *officinale* includes phenolic compounds, flavonoids, glycosides and tannin (Mekonnen & Desta, 2021). Compounds in ginger also increase levels of antioxidant enzymes, including superoxide dismutase and glutathione peroxidase, which stimulate inflammatory reactions triggered by viral infections. Z. *officinalis* is one of the natural remedies for swine flu prevention and measles treatment. Fresh, but not dried, ginger is effective against the human respiratory syncytial virus (HRSV)-induced plaque formation on airway epithelium by blocking viral attachment and internalization(Chang et al., 2013)

***Allium sativum* (**Garlic**)**

Allium sativum, "Ayu" (Yoruba), or garlic (English), belongs to the family Alliaceae. A. *sativum* has been used throughout widely both for culinary and medicinal purposes. Garlic has natural antiviral, antibacterial and immune-boosting properties Traditionally, it has been used to treat colds, hay fever, coughs, asthma, abdominal discomforts, and viral infections, including influenza viruses(Kim et al., 2005; Shumaila et al 2020). Investigated the antiviral properties of garlic toward human cytomegalovirus (HCMV) using tissue culture technique, plaque reduction and early antigen assay.

***Psidium guajava* (Guava)**

Psidium guajava (Guava) "Gilofa" in Yoruba, belongs to the family Myrtaceae. *P. guajava* is rich in tannins, phenols, triterpenes, ß flavonoids, essential oils, saponins, carotenoids, lectins, vitamins, and fatty acids. Guava fruit is higher in vitamin C than citrus fruits (80 mg of vitamin C in 100g of fruit) and contains appreciable amounts of Vitamin A as well (Kamath, 2008). The water extract of the leaves is used for the treatment of bronchitis, asthma attacks and for the treatment of dysentery(Abdelrahim et al., 2002) . The guava tree is cultivated for its nutritive fruit characterized by high contents of minerals and vitamins. Other parts of the plants such as the leaves, bark, and root of the guava tree are used in traditional medicines to treat several diseases. Many phytochemical constituents have been extracted from guava leaves around the world, especially the terpenoids, such as limonene, α-pinene, eucalyptol, caryophyllene isomers, α-humulene, γ-murolene, selinene isomers, β-bisabolene, caryophyllene oxide, and epi-β-cubenol (Hassan et al., 2021).

***Mangifera indica* (mango)**

Mangifera indica (mango) also known as "Mangoro" in Yoruba, belongs to the family Anacardiaceae. Various parts of M *indica* are used for a wide variety of ethnomedicinal use. It can be used as anti-inflammatory, diarrhea, hemorrhoids, hiccups, coughs dysentery and so on. The parts that can be used are roots and bark, leaves, flowers, fruits, and stone (Masud Parvez 2016).

***Enantia chlorantha* (Awopa)**

Enantia chlorantha also known as "Awopa or Osopupa" in Yoruba is reported to be used in traditional medicine for the treatment of many diseases, such as malaria, aches, wounds, boils, vomiting, yellow fever, fever, chills, sore and several other illnesses. *Enantia chlorantha* stem bark has been scientifically studied for its several pharmacological activities. These include antimalarial, antimicrobial and antibacterial, antioxidant, anti-Helicobacter pylori, anti-convulsion and anti-inflammatory, analgesic and antipyretic, antiviral, gastroprotective and enhancing male fertility. Some bioactive constituents such as saponins, flavonoids, alkaloids, phenols, reducing sugar and cardiac glycoside significantly present in the plant extracts, support its multiple properties and uses in traditional medicine (Tene Tcheghebe et al., 2016).

***Nauclea latifolia* (African peach)**

Nauclea latifolia (African peach) also called "Egberesi" or "Gberesi" in Yoruba, belongs to the family Rubiaceae. *N. latifolia* is generally found in sub-Saharan Africa with its rough

bark and white flowers. Various extracts of *N. latifolia* have been used for a variety of illness and therapeutic management of malaria, hypertension, prolonged menstrual flow, cough, gonorrhoea, stomach disorders and liver ailments(Abbah et al., 2010; Boucherle et al., 2016). Several classes of phytochemicals have been identified for the antimalaria activities of *N. latifolia,* and they include alkaloids, flavonoids, terpenoids, saponins, tannins, and phenol derivatives. Purification of the roots have led to the isolation of racemic (1R,2R)-2-[(dimethylamino)methyl]-1-(3-methoxyphenyl) cyclohexanol in high concentration which is the compound used for the analgesic known as tramadol (Boucherle et al., 2016).

Allium sativum (Garlic)

Allium sativum, garlic (English) or "Ayu" (Yoruba), belongs to the family Alliaceae. A. *sativum* has been used throughout widely both for culinary and medicinal purposes. Garlic has natural antiviral, antibacterial and immune-boosting properties Traditionally, it has been used to treat malaria, colds, hay fever, coughs, asthma, abdominal discomforts, and viral infections, including influenza viruses (Saif et al., 2019). Phenolic and terpene compounds are two very important Phyto active constituents of ginger. In fresh ginger, gingerols are the major polyphenols, such as 6-gingerol, 8-gingerol, and 10-gingerol. Other phenolics include quercetin, zingerone, gingerenone-A, and 6-dehydrogingerdione. Terpene components in ginger are β-bisabolene, α-curcumene, zingiberene, α-farnesene, and β-sesquiphellandrene, which are considered to be the main constituents of ginger essential oils(Ermin Mao , 2016; Mao et al., 2019; Prasad & Tyagi, 2015). investigated the antiviral properties of garlic toward human cytomegalovirus (HCMV) using tissue culture technique, plaque reduction and early antigen assay.

Morinda lucida benth (brimstone tree)

Morinda lucida benth (brimstone tree) also known as "Oruwo" in Yoruba, belongs to the family *Rubiaceae*. *Morinda lucida benth is* a plant found in southwest Nigeria and it is available throughout the year. *Morinda lucida benth,* is rich in vitamin A and E which are effective antioxidant used for combating degenerative diseases such as atherosclerosis. *Morinda lucida benth*, have several bioactive phytochemicals such as alkaloids, tannins, saponins, flavonoids, phenols which can be used as antibiotic, antiviral, anti- plasmodial and anti- parasitic(Adeleye et al., 2018).

Calotropis procera (Aiton)Dryand. (Bomubomu)

Calotropis procera also called "BomuBomu" in Yoruba, belongs to the family Asclepiadaceae. It is a cultivable wild xerophytic shrub found across Africa, Asia and South America. C. *procera* produces milky white latex that exhibits diverse curative properties and it contains various classes of bioactive secondary metabolites such as terpenoids, flavonoids, saponins, steroids and cardiac glycosides (Morsy et al., 2016). *Calotropis procera* is found in special branching tubes called latex tubes and has

been the subject of interest due to its biological activities such as antibacterial, antifungal, antiviral, anticandidal and anticarcinogenic activities (Mohamed et al., 2014).

Citrus aurantifolia (Lime)

Citrus aurantifolia commonly called Lime or "Osan wewe" in Yoruba is an important medicinal and food plant widely cultivated in many parts of the world. It is valued for its nutritional qualities and numerous health benefits. The plant is used in traditional medicine as an antiseptic, antiviral, antifungal, anthelmintic, astringent, diuretic, mosquito bite repellent, stomach ailments, constipation, headache, arthritis, colds, coughs, sore throats and used as an appetite stimulant. These health benefits of *Citrus aurantifolia* are associated with its high amounts of photochemical and bioactive compounds such as flavonoids, limonoids, phenols, carotenoids, minerals and vitamins(Enejoh et al., 2015).

Garcinia kola (bitter kola)

Garcinia kola (bitter kola) also known as "orogbo" in Yoruba belongs to the family Guttiferae. G *kola* is a dicotyledonous plant found in countries across west and central Africa (Nigeria, Ghana, Angola, Congo, Gambia etc.). Every part of G *kola* (leaves, bark and root) has been found to be of medicinal importance. Several phytochemicals have been isolated and identified from *Garcinia Kola*, and they include tannin, alkaloids, saponins, oleoresin and flavonoids. Biological activities of *Garcinia Kola* include antiallergics, antiinflammation, antioxidant, treatment of liver diseases, antimicrobials and fertility. In Nigeria, cold water extracts of the roots and bark with salt are administered to cases of bronchial asthma or cough (Adesuyi et al., 2012).

Lagenaria breviflora (Tagiri)

Lagenaria breviflora also known as "Tagiri" in Yoruba is a perennial plant that has been used in the antiquity for the treatment and management of diseases and disorders dating back to the prehistoric days(Aladekoyi et al., 2020.). In Africa, they are of immense value in curative and preventive control measures against conditions such as measles, chickenpox, intestinal worms, enteritis (diarrhea), diabetes mellitus, Newcastle diseases, leather preservative, as wound antiseptics (umbilical incision wound) and as depilatory agent. Several phytochemicals are responsible for the antimicrobial activities of *Lagenaria. breviflora* and they include; Phenols, alkaloids, carotenoids, flavonoids, oxalate, terpenoids, saponin, phytate and tannins(Adedeji & Aiyeloja, 2017). Livestock farmers especially poultry farmers use the fruit extract of the plant for the treatment of Newcastle disease and coccidiosis in animals and poultry in many parts of southwestern Nigeria (Aladekoyi et al., 2020.).

Spondias mombin (yellow mombin)

Spondias mombin (yellow mombin) also called "Iyeye" in Yoruba belongs to the family *Anacardiaceae*. It is generally found in southwest Nigeria. Various parts of *Spondias mombin* have been used in traditional medicine to manage several ailments. The leaves of S *mombin* have been known to treat eye problems, cough, fever and gastroenteritis. It is also used as antimicrobial, antiviral, and anti-diarrhea. The fruits, barks and leaves can be prepared as decoction for use as diuretic, anti-diarrhea, dysentery, and hemorrhoids (Felix Oluwafemi Omotayo, 2012). *Spondias mombin* contains phytochemicals such as

anthraquinones, berberine, flavonoids, naphthoquinones, sesquiterpenes, quassiniods, indole and quinoline alkaloids(Ayoka et al., 2008).

Medicinal plants as prophylaxis against COVID-19

Natural antioxidants: Natural antioxidants may be useful in the treatment and prevention of chronic infections and diseases. Fruits and vegetables have antioxidant properties and in addition to vitamins A and C. Phenolic acids generally act as antioxidants by trapping free radicals and some plant-derived compounds are better antioxidants than BHA (Butylated Hydroxyl Anisole). Vegetables such as *Vernonia amygdalina* (bitter leaf), *Telfaria occidentalis* (pumpkin plants) and *Launaea taraxacifolia* (African lettuce) are examples of vegetables easily found in Nigeria(Gbadamosi & Afolayan, 2016; . Gbadamosi, 2020) .

***Vernonia amygdalina* (bitter leaf)**

Vernonia amygdalina (bitter leaf) also known as "Ewuro" in Yoruba belongs to the family Asteraceae. The leaves are characteristically bitter hence the name bitter leaf. The roots and leaves are used in ethnomedicine to treat fever, hiccups, kidney problems and stomach discomfort among several other uses such as jaundice, Herpes simplex virus and measles (Cos et al., 2002; Eyong et al., 2011). Extracts of V *amygdalina* have been used in various indigenous areas as remedies against helminthic, protozoal and bacterial infections with scientific support to back these claims. Various phytochemical constituents have been identified in V *amygdalina* such as saponins and alkaloids, terpenes, steroids, coumarins, flavonoids, phenolic acids, lignans, xanthones, anthraquinones, edotides and sesquiterpenes. These compounds elicit various phototherapeutic properties such as cancer chemoprevention, antimicrobial (antibacterial, antifungal, antiplasmodial etc.), anti-cancer/tumor, antioxidant, hypoglycemic/anti-diabetic and so on(Farombi & Owoeye, 2011; Ijeh & Ejike, 2011; Usunobun & Ngozi, 2016).

***Telfairia occidentalis* (pumpkin plants)**

Telfairia occidentalis (pumpkin plants) also known as "Eweroko" in Yoruba, 'Ugwu" in Igbo, "Ikong-Ubong" in Efik/Ibibio is a vegetable generally grown in west Africa. It belongs to the family Cucurbitaceae (Akoroda, 2018; Eseyin et al., 2014). *Telfairia occidentalis* contains several phytochemicals which includes glycosides, saponins sterol and triterpenoids' in the root, tannins, flavonoids, alkaloids, saponins, steroids, anthraquinones, and reducing sugars in the stem and leaves (with high amount of vitamin C). Many human diseases are caused by oxidative stress which is usually initiated by free radicals such as superoxide anions, hydrogen peroxide, hydroxyl radical and nitric oxide. These free radicals react with macromolecules such as DNA, proteins and lipids, thereby damaging them. The consequences of this damage are diseases such as diabetes, hypertension, atherosclerosis, cancer, myocardial infarction, arthritis, anemia, asthma, inflammation, neurodegenerative diseases(Guntner, et al 1999; Eklund et al., 2005). The antioxidant property of *Telfairia occidentalis* which is attributed to the high content of polyphenols, especially flavonoids has been well documented therefore makes the plant medicinally useful (Eseyin et al., 2014).

***Launaea taraxacifolia* (African lettuce)**

Launaea taraxacifolia (African lettuce) also known as "Efo Yarin" in Yoruba belongs to the family Asteraceae. *Launaea taraxacifolia* is mostly grown in West Africa, and is commonly used as leafy vegetable soup, salad and sauces. *Launaea taraxacifolia* contains flavonoid such as caffeic acid, ellagic acid, quercetin, kaempferol and chlorogenic acids, and these compounds are reputed to be natural antioxidants. Other phytochemicals include; alkaloids, coumarins, saponins, sterols and terpenes, carotenoids and quinones, and mucilages (Koukoui et al., 2015). These metabolites may be responsible for the antioxidant activity of this wild vegetable (Ogbesejana et al., 2018)

Plant haematinics: *Sorghum bicolor* leaf (red guinea corn) have been used as haematinics for the treatment of anaemia, menstrual disorder and other blood-related infections and diseases.

***Sorghum bicolor* (Red guinea corn)**

Sorghum bicolor (red guinea corn) also known as "oka baba" in Yoruba, belongs to the family *Poaceae*, and it is the fourth most important cereal crop after wheat, rice and maize (Oladunmoye et al., 2011; Osuntokun & Binuyo, 2021). It has been in use for centuries as traditional medicinal food by people of southwestern Nigeria. *Sorghum bicolor* is used in traditional medicine in developing countries, including primary care of anemia, cancer, and a variety of infectious diseases, including viral diseases. Sorghum species are known to have a high content of antioxidants, including simple phenolic acids, as well as polyphenols, particularly 3-deoxyanthocyanidins, such as luteolinidin and apigenidin. Sorghum seeds contain an antiviral peptide, shown to inhibit infection, replication, and spread of several viruses, including Herpes simplex and to a lesser extent the nonenveloped polio virus(Benson et al., 2013).

3.0 Discussion

Several synthetic drugs have been used for the treatment of COVID-19 infected patients, with low degree of efficacy, so medicinal plants are a viable option to tackle the ongoing pandemic. Researchers from China, South Korea, India and other countries have been working tirelessly to find plant extract that shows promise for the treatment of COVID-19 patients in clinical settings (Ang et al., 2020; Jakhmola Mani et al., 2020; Luo et al., 2020). In China, a large number of herbal-based medicines have been recommended by the National Health Commission (NHC) of China for the treatment of SARS-Cov-2 patients. This same treatment strategy was used against SARS-Cov-2 in 2003 and MERS-CoV 2012 (Adhikari *et al.,* 2020). Several medicinal plants have shown promising inhibitory effects against several viral infections ranging from small pox, measles, influenza, dengue, chicken pox and so on. Since an absolute medicine is still not available for COVID-19, available medicinal plants which have been studied for their safety and efficacy against COVID-19 should be at the frontline. It is imperative that the problems associated with bioactive secondary metabolites such as solubility, stability and availability are addressed (Coimbra et al., 2011). Rational computation modelling, artificial intelligence, pharmacological studies as well as in silico drug designs would further add significant information in finding the perfect drug (Adhikari et al., 2021).

4.0 Conclusion

The current COVID-19 pandemic is one of the greatest public health crises in modern human history. The world and indeed Africa is blessed with an abundance of autochthonous medicinal plants with broad spectrum of therapeutic usage, and these plants have been used for centuries with attestable claims. The presence of several secondary metabolites like alkaloid, flavonoids, polyphenols, terpenes and so on which are already known to have antiviral activities, need to be rapidly screened for the treatment of SARS-CoV-2 infected patients. This review should serve as a reference for future research in defining the usage of medicinal plants in the various phases of COVID-19, including the complications that arise due in part to the immunosuppression of the patient, and targeting underlying medical conditions including before and aftercare. In conclusion, this review has provided potential insights in the management, treatments and role of traditional medicine in regulating different infections. Further studies are therefore needed for the isolation and characterization of the specific phytochemical compounds that may help in the treatment of COVID-19.

References

Abbah, J., Amos, S., Chindo, B., Ngazal, I., Vongtau, H. O., Adzu, B., Farida, T., Odutola, A. A., Wambebe, C., & Gamaniel, K. S. (2010). Pharmacological evidence favouring the use of Nauclea latifolia in malaria ethnopharmacy: Effects against nociception, inflammation, and pyrexia in rats and mice. *Journal of Ethnopharmacology*, *127*(1), 85–90. https://doi.org/10.1016/j.jep.2009.09.045

Abd, E. W., Mbchb, E.-W., Eassa Mbchb, S. M., Drph, M., Metwally Mbchb, M., Al-Hraishawi, H., Ms, D., Omar, S. R., & Dtm&h, M. (2020). SARS-CoV-2 Transmission Channels: A Review of the Literature. In *MEDICC Review* (Vol. 22, Issue 4).

Abdelrahim, S. I., Almagboul, A. Z., Omer, M. E. A., & Elegami, A. (2002). Antimicrobial activity of Psidium guajava L. In *Fitoterapia* (Vol. 73).

Adedeji, G., & Aiyeloja, A. A. (2017). *HARNESSING THE INSTRUMENTALITIES OF Lagenaria breviflora FRUITS FOR*. *March*.

Adeleye, O. O., Ajamu, M. A., & Ayeni, O. J. (2018). Traditional and medicinal uses of Morinda lucida. *~ 249 ~ Journal of Medicinal Plants Studies*, *6*(2), 249–254.

Adesuyi, A. O., Elumm, I. K., Adaramola, F. B., & Nwokocha, A. G. M. (2012). Nutritional and phytochemical screening of Garcinia kola. *Advance Journal of Food Science and Technology*, *4*(1), 9–14.

Adhikari, B., Marasini, B. P., Rayamajhee, B., Bhattarai, B. R., Lamichhane, G., Khadayat, K., Adhikari, A., Khanal, S., & Parajuli, N. (2021). Potential roles of medicinal plants for the treatment of viral diseases focusing on COVID-19: A review. *Phytotherapy Research*, *35*(3), 1298–1312. https://doi.org/10.1002/ptr.6893

Akindele, A. J., Agunbiade, F. O., Sofidiya, M. O., Awodele, O., Sowemimo, A., Ade-Ademilua, O., Akinleye, M. O., Ishola, I. O., Orabueze, I., Salu, O. B., Oreagba, I. A., Asekun, O. T., & Odukoya, O. (n.d.). COVID-19 Pandemic: A Case for Phytomedicines ACEDHARS UNILAG COVID-19 Response Team. In *Natural Product Communications* (Vol. 15, Issue 8).

Akoroda, M. O. (2018). Ethnobotany of Telfairia occidentalis (Cucurbitaceae) among Igbos of Nigeria Author (s): M . O . Akoroda Published by : Springer on behalf of New York Botanical Garden Press Stable URL : http://www.jstor.org/stable/4255209 Ethnobotany of Telfairia occ. *The New York Botanical Garden*, *44*(1), 29–39.

Aladekoyi, Gbenga, Ajayi, I. O., & Adanigbo P. (2020). Evaluation of the Nutritional and Medicinal Value of Raw and Fermented Lagenaria breviflora Root. *The Pharmaceutical and Chemical Journal*, *2020*(1), 5–9. www.tpcj.org

Ang, L., Lee, H. W., Kim, A., & Lee, M. S. (2020). Herbal medicine for the management of COVID-19 during the medical observation period: a review of guidelines. *Integrative Medicine Research*, *9*(3), 100465. https://doi.org/10.1016/j.imr.2020.100465

Arnold J. Vlietinck and Dirk A. Vanden Berghe. (1991). 0378-87412990112-Q. *Journal of Ethnopharmacology*, *32*, 141–153.

Ayoka, A. O., Akomolafe, R. O., Akinsomisoye, O. S., & Ukponmwan, O. E. (2008). Medicinal and economic value of Spondias mombin. *African Journal Biomedical Research*, *11*(2), 129–136. https://doi.org/10.4314/ajbr.v11i2.50714

Baden, L. R., El Sahly, H. M., Essink, B., Kotloff, K., Frey, S., Novak, R., Diemert, D., Spector, S. A., Rouphael, N., Creech, C. B., McGettigan, J., Khetan, S., Segall, N., Solis, J., Brosz, A., Fierro, C., Schwartz, H., Neuzil, K., Corey, L., … Zaks, T. (2021). Efficacy and Safety of the mRNA-1273 SARS-CoV-2 Vaccine. *New England Journal of Medicine*, *384*(5), 403–416. https://doi.org/10.1056/nejmoa2035389

Balkrishna, A., POKHREL, S., Singh, J., & Varshney, A. (2020). *Withanone from Withania somnifera May Inhibit Novel Coronavirus (COVID-19) Entry by Disrupting Interactions between Viral S-Protein Receptor Binding Domain and Host ACE2 Receptor*. https://doi.org/10.21203/rs.3.rs-17806/v1

Benson, K. F., Beaman, J. L., Ou, B., Okubena, A., Okubena, O., & Jensen, G. S. (2013). West African Sorghum bicolor leaf sheaths have anti-inflammatory and immune-

modulating properties in vitro. *Journal of Medicinal Food*, *16*(3), 230–238. https://doi.org/10.1089/jmf.2012.0214

Biswas, D., Nandy, S., Mukherjee, A., Pandey, D. K., & Dey, A. (2020). Moringa oleifera Lam. and derived phytochemicals as promising antiviral agents: A review. *South African Journal of Botany*, *129*, 272–282. https://doi.org/10.1016/j.sajb.2019.07.049

Boucherle, B., Haudecoeur, R., Queiroz, E. F., De Waard, M., Wolfender, J. L., Robins, R. J., & Boumendjel, A. (2016). Nauclea latifolia: Biological activity and alkaloid phytochemistry of a West African tree. *Natural Product Reports*, *33*(9), 1034–1043. https://doi.org/10.1039/c6np00039h

C. Guntner, C. B. M. V. C. E. D. L. F. C. G. G. G. H. H. A. L. D. L. P. M. D. P. S. S. S. A. . V. and P. M. (1999). *Antioxidant Properties of Solidago Chilensis Flavonoids*.

Chang, J. S., Wang, K. C., Yeh, C. F., Shieh, D. E., & Chiang, L. C. (2013). Fresh ginger (Zingiber officinale) has anti-viral activity against human respiratory syncytial virus in human respiratory tract cell lines. *Journal of Ethnopharmacology*, *145*(1), 146–151. https://doi.org/10.1016/j.jep.2012.10.043

Chen, Y., Liu, Q., & Guo, D. (2020). Emerging coronaviruses: Genome structure, replication, and pathogenesis. In *Journal of Medical Virology* (Vol. 92, Issue 4, pp. 418–423). John Wiley and Sons Inc. https://doi.org/10.1002/jmv.25681

Chinenyenwa, O., Adeleye Solomon, B., Tauseef, A., Haroon, H., Godson E E, A. R., & Mynepalli, S. K. (2022). EMERGENCE OF NEW STRAINS OF SARS-COV-2: AFRICA'S FATE AND ITS PREPAREDNESS AGAINST COVID-19 INFECTION WAVES. *J. Infect. Dis*, *16*(2), 1–12. https://doi.org/10.21010/Ajid

Coimbra, M., Isacchi, B., Van Bloois, L., Torano, J. S., Ket, A., Wu, X., Broere, F., Metselaar, J. M., Rijcken, C. J. F., Storm, G., Bilia, R., & Schiffelers, R. M. (2011). Improving solubility and chemical stability of natural compounds for medicinal use by incorporation into liposomes. *International Journal of Pharmaceutics*, *416*(2), 433–442. https://doi.org/10.1016/j.ijpharm.2011.01.056

Cos, P., Hermans, N., De Bruyne, T., Apers, S., Sindambiwe, J. B., Vanden, D., Pieters, L., & Vlietinck, A. J. (2002). Further evaluation of Rwandan medicinal plant extracts for their antimicrobial and antiviral activities. In *Journal of Ethnopharmacology* (Vol. 79). www.elsevier.com/locate/jethpharm

Dutta, R., Khalil, R., Green, R., Mohapatra, S. S., & Mohapatra, S. (2019). Withania somnifera (Ashwagandha) and withaferin a: Potential in integrative oncology. *International Journal of Molecular Sciences*, *20*(21). https://doi.org/10.3390/ijms20215310

Eklund, P. C., Långvik, O. K., Wärnå, J. P., Salmi, T. O., Willför, S. M., & Sjöholm, R. E. (2005). Chemical studies on antioxidant mechanisms and free radical scavenging properties of lignans. *Organic and Biomolecular Chemistry*, *3*(18), 3336–3347. https://doi.org/10.1039/b506739a

Enejoh, O. S., Ogunyemi, I. O., Bala, M. S., Oruene, I. S., Suleiman, M. M., & Ambali, S. F. (2015). Ethnomedical Importance of Citrus Aurantifolia (Christm) Swingle. *The Pharma Innovation Journal*, *4*(8), 1–6. www.thepharmajournal.com

Ermin Schadich, Jan Hlavác, , Tereza Volná, Lakshman Varanasi, Marián Hajdúch, and P. Dd. (2016). *Effects of Ginger Phenylpropanoids and Quercetin on Nrf2-ARE Pathway in Human BJ Fibroblasts and HaCaT Keratinocytes*. *2016*, 1–7.

Eseyin, O. A., Sattar, M. A., & Rathore, H. A. (2014). A review of the pharmacological and biological activities of the aerial parts of Telfairia occidentalis Hook.f. (Cucurbitaceae). *Tropical Journal of Pharmaceutical Research*, *13*(10), 1761–1769. https://doi.org/10.4314/tjpr.v13i10.28

Eyong, E. U., Agiang, M. A., Atangwho, I. J., Iwara, I. A., Odey, M. O., & Ebong, P. E. (2011). Phytochemicals and micronutrients composition of root and stem bark extracts of Vernonia amygdalina Del . *Journal of Medicine and Medical Science*, *2*(June), 900–903.

Farombi, E. O., & Owoeye, O. (2011). Antioxidative and chemopreventive properties of Vernonia amygdalina and Garcinia biflavonoid. *International Journal of Environmental Research and Public Health*, *8*(6), 2533–2555. https://doi.org/10.3390/ijerph8062533

Felix Oluwafemi Omotayo. (2012). Comparative phytochemical and ethnomedicinal survey of selected medicinal plants in Nigeria. *Scientific Research and Essays*, *7*(9), 989–999. https://doi.org/10.5897/sre09.525

Gbadamosi, I., & Afolayan, A. (2016). *In vitro* anti-radical activities of extracts of *Solanum nigrum* (L.) from South Africa. *Journal of Applied Biosciences*, *98*(0), 9240. https://doi.org/10.4314/jab.v98i1.1

Gbadamosi, I. T. (2020). Stay safe: Helpful herbal remedies in covid-19 infection. *African Journal of Biomedical Research*, *23*(2), 131–133.

Ghildiyal, R., Prakash, V., Chaudhary, V. K., Gupta, V., & Gabrani, R. (2020). Phytochemicals as antiviral agents: Recent updates. In *Plant-derived Bioactives: Production, Properties and Therapeutic Applications* (pp. 279–295). Springer Singapore. https://doi.org/10.1007/978-981-15-1761-7_12

Gorbalenya, A. E., Baker, S. C., Baric, R. S., de Groot, R. J., Drosten, C., Gulyaeva, A. A., Haagmans, B. L., Lauber, C., Leontovich, A. M., Neuman, B. W., Penzar, D., Perlman, S., Poon, L. L. M., Samborskiy, D. V., Sidorov, I. A., Sola, I., & Ziebuhr, J. (2020). The species Severe acute respiratory syndrome-related coronavirus: classifying 2019-nCoV and naming it SARS-CoV-2. In *Nature Microbiology* (Vol. 5, Issue 4, pp. 536–544). Nature Research. https://doi.org/10.1038/s41564-020-0695-z

Gupta, S., Mishra, K. P., & Ganju, L. (2017). Broad-spectrum antiviral properties of andrographolide. *Archives of Virology*, *162*(3), 611–623. https://doi.org/10.1007/s00705-016-3166-3

Hassan, E. M., El Gendy, A. E. N. G., Abd-Elgawad, A. M., Elshamy, A. I., Farag, M. A., Alamery, S. F., & Omer, E. A. (2021). Comparative Chemical Profiles of the Essential Oils from Different Varieties of Psidium guajava L. *Molecules*, *26*(1). https://doi.org/10.3390/MOLECULES26010119

Houghton, P. J. (1995). The Role of Plants in Traditional Medicine and Current Therapy. In *THE JOURNAL OF ALTERNATIVE AND COMPLEMENTARY MEDICINE* (Vol. 1, Issue 2). Mary Ann Liebert, Inc.

Ijeh, I. I., & Ejike, C. E. C. C. (2011). Current perspectives on the medicinal potentials of Vernonia amygdalina Del. *Journal of Medicinal Plants Research*, *5*(7), 1051–1061.

Iwu, M. M. (1994a). *African medicinal plants in the search for new drugs based on ethnobotanical leads*.

Iwu, M. M. (1994b). African medicinal plants in the search for new drugs based on ethnobotanical leads. *Ciba Foundation Symposium*, *185*, 116–129. https://doi.org/10.1002/9780470514634.ch9

Jakhmola Mani, R., Sehgal, N., Dogra, N., Saxena, S., & Pande Katare, D. (2020). Deciphering underlying mechanism of Sars-CoV-2 infection in humans and revealing the therapeutic potential of bioactive constituents from Nigella sativa to combat COVID19: in-silico study. *Journal of Biomolecular Structure and Dynamics*, *0*(0), 1–13. https://doi.org/10.1080/07391102.2020.1839560

Jassim, S. A. A., & Naji, M. A. (2003). Novel antiviral agents: A medicinal plant perspective. *Journal of Applied Microbiology*, *95*(3), 412–427. https://doi.org/10.1046/j.1365-2672.2003.02026.x

Jin, Y., Yang, H., Ji, W., Wu, W., Chen, S., Zhang, W., & Duan, G. (2020). Virology, epidemiology, pathogenesis, and control of covid-19. In *Viruses* (Vol. 12, Issue 4). MDPI AG. https://doi.org/10.3390/v12040372

J.V. Kamath, N. R. C. K. A. K. S. M. L. (2008). *386-747-1-SM*.

Kim, S. O., Kundu, J. K., Shin, Y. K., Park, J. H., Cho, M. H., Kim, T. Y., & Surh, Y. J. (2005). [6]-Gingerol inhibits COX-2 expression by blocking the activation of p38 MAP kinase and NF-κB in phorbol ester-stimulated mouse skin. *Oncogene*, *24*(15), 2558–2567. https://doi.org/10.1038/sj.onc.1208446

Koukoui, O., Agbangnan, P., Boucherie, S., Yovo, M., Nusse, O., Combettes, L., & Sohounhloué, D. (2015). Phytochemical Study and Evaluation of Cytotoxicity, Antioxidant and Hypolipidemic Properties of <i>Launaea taraxacifolia</i> Leaves Extracts on Cell Lines HepG2 and PLB985. *American Journal of Plant Sciences*, *06*(11), 1768–1779. https://doi.org/10.4236/ajps.2015.611177

Kumar, A., Choudhir, G., Shukla, S. K., Sharma, M., Tyagi, P., Bhushan, A., & Rathore, M. (2021a). Identification of phytochemical inhibitors against main protease of COVID-19 using molecular modeling approaches. *Journal of Biomolecular*

Structure and Dynamics, *39*(10), 3760–3770. https://doi.org/10.1080/07391102.2020.1772112

Kumar, A., Choudhir, G., Shukla, S. K., Sharma, M., Tyagi, P., Bhushan, A., & Rathore, M. (2021b). Identification of phytochemical inhibitors against main protease of COVID-19 using molecular modeling approaches. *Journal of Biomolecular Structure and Dynamics*, *39*(10), 3760–3770. https://doi.org/10.1080/07391102.2020.1772112

Kumar, V. S., & Navaratnam, V. (2013a). Neem (Azadirachta indica): Prehistory to contemporary medicinal uses to humankind. *Asian Pacific Journal of Tropical Biomedicine*, *3*(7), 505–514. https://doi.org/10.1016/S2221-1691(13)60105-7

Kumar, V. S., & Navaratnam, V. (2013b). Neem (Azadirachta indica): Prehistory to contemporary medicinal uses to humankind. *Asian Pacific Journal of Tropical Biomedicine*, *3*(7), 505–514. https://doi.org/10.1016/S2221-1691(13)60105-7

Lawal, I. O., Olufade, I. I., Rafiu, B. O., & Aremu, A. O. (2020). Ethnobotanical survey of plants used for treating cough associated with respiratory conditions in Ede south local government area of Osun State, Nigeria. *Plants*, *9*(5). https://doi.org/10.3390/plants9050647

Lillehoj, H., Liu, Y., Calsamiglia, S., Fernandez-Miyakawa, M. E., Chi, F., Cravens, R. L., Oh, S., & Gay, C. G. (2018). Phytochemicals as antibiotic alternatives to promote growth and enhance host health. In *Veterinary Research* (Vol. 49, Issue 1). BioMed Central Ltd. https://doi.org/10.1186/s13567-018-0562-6

Luo, H., Tang, Q. ling, Shang, Y. xi, Liang, S. bing, Yang, M., Robinson, N., & Liu, J. ping. (2020). Can Chinese Medicine Be Used for Prevention of Corona Virus Disease 2019 (COVID-19)? A Review of Historical Classics, Research Evidence and Current Prevention Programs. *Chinese Journal of Integrative Medicine*, *26*(4), 243–250. https://doi.org/10.1007/s11655-020-3192-6

M, B. O., Ogbesejana, A. B., & Uduma, U. A. (2018). Launaea taraxacifolia ; a Neglected Vegetable from Nigeria, its Antiinflammatory and Antioxidant Activities. *ChemSearch Journal*, *9*(1), 9–12.

Mamedov, N. (2012). Medicinal Plants Studies: History, Challenges and Prospective. *Medicinal & Aromatic Plants*, *01*(08). https://doi.org/10.4172/2167-0412.1000e133

Mao, Q. Q., Xu, X. Y., Cao, S. Y., Gan, R. Y., Corke, H., Beta, T., & Li, H. Bin. (2019). Bioactive compounds and bioactivities of ginger (zingiber officinale roscoe). *Foods*, *8*(6), 1–21. https://doi.org/10.3390/foods8060185

Masud Parvez, G., & Masud Parvez, C. G. (2016). Pharmacological Activities of Mango (Mangifera Indica): A Review. *Journal of Pharmacognosy and Phytochemistry JPP*, *1*(53), 1–7.

Maurya, D. K., & Sharma, D. (2022). Evaluation of traditional ayurvedic Kadha for prevention and management of the novel Coronavirus (SARS-CoV-2) using in silico

approach. *Journal of Biomolecular Structure and Dynamics*, *40*(9), 3949–3964. https://doi.org/10.1080/07391102.2020.1852119

Mekonnen, A., & Desta, W. (2021). Comparative study of the antioxidant and antibacterial activities of Rumex abyssinicus with commercially available Zingiber officinale and Curcuma longa in Bahir Dar city, Ethiopia. *Chemical and Biological Technologies in Agriculture*, *8*(1). https://doi.org/10.1186/s40538-020-00198-0

Mohamed, N. H., Ismail, M. A., Abdel-Mageed, W. M., & Shoreit, A. A. M. (2014). Antimicrobial activity of latex silver nanoparticles using Calotropis procera. *Asian Pacific Journal of Tropical Biomedicine*, *4*(11), 876–883. https://doi.org/10.12980/APJTB.4.201414B216

Morsy, N., Al Sherif, E. A., & Abdel-Rassol, T. M. A. (2016). Phytochemical analysis of Calotropis procera with antimicrobial activity investigation. *Main Group Chemistry*, *15*(3), 267–273. https://doi.org/10.3233/MGC-160206

Murugan, N. A., Pandian, C. J., & Jeyakanthan, J. (2021). Computational investigation on Andrographis paniculata phytochemicals to evaluate their potency against SARS-CoV-2 in comparison to known antiviral compounds in drug trials. *Journal of Biomolecular Structure and Dynamics*, *39*(12), 4415–4426. https://doi.org/10.1080/07391102.2020.1777901

Namrta Choudhary*, M.B. Siddiqui, S. A. and S. K. (2013). TINOSPORA CORDIFOLIA: ETHNOBOTANY, PHYTOPHARMACOLOGY AND PHYTOCHEMISTRY ASPECTS. *Int Journal of Pharm Sci and Res*, *4*(3), 891–899.

Ogbole, O., Adeniji, A. J., Ajaiyeoba, E. O., & Festus, D. (2013). *African Journal of Biotechnology Anti-poliovirus activity of medicinal plants selected from the Nigerian ethno-medicine*. https://doi.org/10.5897/AJB12.2730

Ogbole, O. O., Akinleye, T. E., Segun, P. A., Faleye, T. C., & Adeniji, A. J. (2018). In vitro antiviral activity of twenty-seven medicinal plant extracts from Southwest Nigeria against three serotypes of echoviruses. *Virology Journal*, *15*(1). https://doi.org/10.1186/s12985-018-1022-7

Okhuarobo, A., Ehizogie Falodun, J., Erharuyi, O., Imieje, V., Falodun, A., & Langer, P. (2014). Harnessing the medicinal properties of Andrographis paniculata for diseases and beyond: A review of its phytochemistry and pharmacology. *Asian Pacific Journal of Tropical Disease*, *4*(3), 213–222. https://doi.org/10.1016/S2222-1808(14)60509-0

Oladunmoye, M, K., Kehinde, & F, Y. (2011). Ethnobotanical survey of medicinal plants used in treating viral infections among Yoruba tribe of South Western Nigeria. *African Journal of Microbiology Research*, *5*(19), 2991–3004. https://doi.org/10.5897/ajmr10.004

Osuntokun, O. T., & Binuyo, A. O. (2021). *Optimising Medicinal Plants Values Grown in Nigeria for Prevention , Controlling and Treatment of Infectious Diseases , Determinant Factors of Infant Mortality Using Mathematical Modelling Protégé*. *7*(1), 15–30.

Paules, C. I., Marston, H. D., & Fauci, A. S. (2020). Coronavirus Infections-More Than Just the Common Cold. In *JAMA - Journal of the American Medical Association* (Vol. 323, Issue 8, pp. 707–708). American Medical Association. https://doi.org/10.1001/jama.2020.0757

Polack, F. P., Thomas, S. J., Kitchin, N., Absalon, J., Gurtman, A., Lockhart, S., Perez, J. L., Pérez Marc, G., Moreira, E. D., Zerbini, C., Bailey, R., Swanson, K. A., Roychoudhury, S., Koury, K., Li, P., Kalina, W. V., Cooper, D., Frenck, R. W., Hammitt, L. L., … Gruber, W. C. (2020). Safety and Efficacy of the BNT162b2 mRNA Covid-19 Vaccine. *New England Journal of Medicine*, *383*(27), 2603–2615. https://doi.org/10.1056/nejmoa2034577

Prasad, S., & Tyagi, A. K. (2015). Ginger and its constituents: Role in prevention and treatment of gastrointestinal cancer. *Gastroenterology Research and Practice*, *2015*. https://doi.org/10.1155/2015/142979

Rohela, G. K., Shukla, P., Muttanna, Kumar, R., & Chowdhury, S. R. (2020). Mulberry (Morus spp.): An ideal plant for sustainable development. *Trees, Forests and People*, *2*(May), 100011. https://doi.org/10.1016/j.tfp.2020.100011

Saif, S., Hanif, M. A., Rehman, R., & Riaz, M. (2019). Garlic. In *Medicinal Plants of South Asia: Novel Sources for Drug Discovery* (pp. 301–315). Elsevier. https://doi.org/10.1016/B978-0-08-102659-5.00023-9

Shumaila Saif, Muhammad Asif Hanif, Rafia Rehman, M. R. (2020). *Garlic*. 301–315. https://doi.org/10.1016/B978-0-08-102659-5.00023-9

Spinato, G., Fabbris, C., Polesel, J., Cazzador, D., Borsetto, D., Hopkins, C., & Boscolo-Rizzo, P. (2020). Alterations in Smell or Taste in Mildly Symptomatic Outpatients with SARS-CoV-2 Infection. In *JAMA - Journal of the American Medical Association* (Vol. 323, Issue 20, pp. 2089–2091). American Medical Association. https://doi.org/10.1001/jama.2020.6771

Srivastava, A., Siddiqui, S., Ahmad, R., Mehrotra, S., Ahmad, B., & Srivastava, A. N. (2020). Exploring nature's bounty: identification of Withania somnifera as a promising source of therapeutic agents against COVID-19 by virtual screening and in silico evaluation. *Journal of Biomolecular Structure and Dynamics*, *0*(0), 1–51. https://doi.org/10.1080/07391102.2020.1835725

Srivastava, A., Siddiqui, S., Ahmad, R., Mehrotra, S., Ahmad, B., & Srivastava, A. N. (2022). Exploring nature's bounty: identification of Withania somnifera as a promising source of therapeutic agents against COVID-19 by virtual screening and in silico evaluation. *Journal of Biomolecular Structure and Dynamics*, *40*(4), 1858–1908. https://doi.org/10.1080/07391102.2020.1835725

Tene Tcheghebe, O., Ngouafong Tatong, F., Jackson Seukep, A., & Author, C. (2016). Tene Tcheghebe O, Ngouafong Tatong F, Seukep AJ. Traditional uses, phytochemical and pharmacological profiles, and toxicity of Enantia chlorantha (Oliver): An overview. *Edorium Journal of Medicine*, *3*(December), 12–18. https://doi.org/10.5348/M05-2016-4-RA-2

Thabti, I., Albert, Q., Philippot, S., Dupire, F., Westerhuis, B., Fontanay, S., Risler, A., Kassab, T., Elfalleh, W., Aferchichi, A., & Varbanov, M. (2020). Advances on antiviral activity of Morus spp. plant extracts: Human coronavirus and virus-related respiratory tract infections in the spotlight. *Molecules*, *25*(8), 1–13. https://doi.org/10.3390/molecules25081876

Tsang, H. F., Chan, L. W. C., Cho, W. C. S., Yu, A. C. S., Yim, A. K. Y., Chan, A. K. C., Ng, L. P. W., Wong, Y. K. E., Pei, X. M., Li, M. J. W., & Wong, S. C. C. (2021). An update on COVID-19 pandemic: the epidemiology, pathogenesis, prevention and treatment strategies. In *Expert Review of Anti-Infective Therapy* (Vol. 19, Issue 7, pp. 877–888). Taylor and Francis Ltd. https://doi.org/10.1080/14787210.2021.1863146

Usunobun, U., & Ngozi, O. (2016). Phytochemical analysis and proximate composition of Vernonia amygdalina. *International Journal of Scientific World*, *4*(1), 11. https://doi.org/10.14419/ijsw.v4i1.5845

Wu, C., Liu, Y., Yang, Y., Zhang, P., Zhong, W., Wang, Y., Wang, Q., Xu, Y., Li, M., Li, X., Zheng, M., Chen, L., & Li, H. (2020). Analysis of therapeutic targets for SARS-CoV-2 and discovery of potential drugs by computational methods. *Acta Pharmaceutica Sinica B*, *10*(5), 766–788. https://doi.org/10.1016/j.apsb.2020.02.008

World Health Organization. (2020). Coronavirus disease (COVID-19) pandemic.https://www.who.int/emergencies/diseases/novel-coronavirus-2019. [Cited on 06 Jan 2021]

sWorld Health Organization. (2020). Transmission of SARS-CoV-2: implications for infection prevention precautions. https://www.who.int/news-room/commentaries/detail/transmission-of-sars-cov-2-implications-for-infection-prevention-precautions. [Cited on 08 Jan 2021]

World Health Organization. (2021). WHO Coronavirus Disease (COVID-19) Dashboard. https://covid19.who.int/table. [Cited on 09 Jan 2021]

Yasmin, A. R., Chia, S. L., Looi, Q. H., Omar, A. R., Noordin, M. M., & Ideris, A. (2019a). Herbal extracts as antiviral agents. In *Feed Additives: Aromatic Plants and Herbs in Animal Nutrition and Health*. Elsevier Inc. https://doi.org/10.1016/B978-0-12-814700-9.00007-8

Yasmin, A. R., Chia, S. L., Looi, Q. H., Omar, A. R., Noordin, M. M., & Ideris, A. (2019b). Herbal extracts as antiviral agents. In *Feed Additives: Aromatic Plants and Herbs in Animal Nutrition and Health* (pp. 115–132). Elsevier. https://doi.org/10.1016/B978-0-12-814700-9.00007-8

Zhang, J. jin, Dong, X., Cao, Y. yuan, Yuan, Y. dong, Yang, Y. bin, Yan, Y. qin, Akdis, C. A., & Gao, Y. dong. (2020). Clinical characteristics of 140 patients infected with SARS-CoV-2 in Wuhan, China. *Allergy: European Journal of Allergy and Clinical Immunology*, *75*(7), 1730–1741. https://doi.org/10.1111/all.14238