Epidemiological status of coronavirus diseases and the remedy potentials of medicinal plants in Africa

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This work aims to explore the epidemiological status of coronavirus disease (COVID-19) and assemblage of various plant species that have prophylactic or therapeutic potentials on the disease. Epidemiological data were obtained from various health authorities worldwide and articles (totaling 103) published in standard journals from 2002-2020 on medicinal plants used in treating the disease and similar diseases. Epidemiological records of COVID-19 regional epidemic in Africa as of 29th July, 2020 indicated South Africa as the epicenter of the disease; its continental index case was in Egypt on 14th February, 2020. This was transmitted via an individual with traveling history from highly COVID burdened nations. Recent records revealed that the new cases of the disease have started trending locally with a person to person contact especially among those without travel history. There were about 874,036 cases in Africa with about 18,498 deaths recorded within the time frame of this study. The age groups mostly affected were 20-49 years with males’ frequency marginally surpassing that of females. Seventy-five medicinal plant species from 41 families were recorded. Identified plants are indigenous to both the tropical and subtropical regions. Their medicinal potentials for treating human viral diseases are well described in Africa. Family Lamiaceae have the highest number of plant species (14.6%) used in managing COVID-19 and other related diseases. Asteraceae (12.3%) and Apiaceae (9.7%) families ranked second and third, respectively. Further studies on these plants with promising anti-SARS-CoV 2 properties on different experimental models for subsequent development of nutraceuticals and herbal medicine is imperative.

Key words: Coronavirus, COVID-19, Africa, epidemiology, medicinal plants.

INTRODUCTION

Coronavirus disease 2019 (COVID-19) is a viral disease caused by Severe Acute Respiratory Syndrome coronavirus (SARS – COV 2) (Shereen et al., 2020). It is an enveloped, single-stranded, and a positive-sense...
ribonucleic acid (RNA) virus. A β-coronavirus family was first reported in Wuhan China in December 2019 (Sohrabi et al., 2020). The virus genomic is similar to SARS-CoV, Middle East Respiratory Syndrome Coronavirus (MERS-CoV), Mouse Hepatitis Virus (MHV) and it is characterized by fever, cough, shortness of breath followed by dyspnea, persistence pain and pressure in the chest, confusion and fatigue, diarrhea, blush lips or face followed by death (Shereen et al., 2020).

The novel coronavirus disease is one of the most dangerous respiratory diseases in recent times which may appear between 2-14 days after exposure (Sohrabi et al., 2020). The fatality of this disease is of great health concern and the transmission of the virus from person to person in most cases begins during asymptomatic stages of infection (Daibing et al., 2020; Hellewell et al., 2020; Rothen and Byrareddy, 2020).

The disease has a very high rate of transmission and the mortality is very high especially among the infected older persons and those that have comorbidities effects with other chronic diseases (Assiri et al., 2013). These underlying medical conditions include cancer, diabetes, cardiovascular diseases, chronic respiratory disease, and Human Immunodeficiency Virus (HIV) infection. These may likely lower the body’s immune system of any susceptible individuals, thereby, making them prone to severe viral and other infections (Kannan et al., 2020). The estimated mortality rate of COVID 19 is put at 3.4% globally of the number of infected persons (WHO, 2020a).

Global statistics as of 29th July, 2020 revealed that the coronavirus pandemic is in 213 countries with a total number of about 16,558,289 confirmed cases, 215,125 new cases, and 656,093 deaths (WHO, 2020a). Initially, China was the epicenter of the novel coronavirus which was exported by travelers to other parts of the globe. Presently, the United State of America (USA) has the highest number of confirmed cases globally and is the current global epicenter for COVID-19 with over 4,263,531 confirmed cases and 147,449 deaths (ECDC, 2020). The index case in Africa was reported in Egypt on 14th February, 2020. Currently, there are over 874,036 laboratory-confirmed cases in Africa with over 18,498 deaths recorded (WHO, 2020b).

Africa with her inherent weak health facilities trembles at the horrid statistics of morbidity and mortalities recorded in many advanced countries that are currently overwhelmed by the disease burden. Many of the African nations have no access to testing kits and have a lifestyle that helps to spread of the disease. Many African nations attempt to enforce lockdown as a preventive measure but failed due to hunger and poor economic conditions, thus neglecting requisite systems that can help prevent the spread of the disease. What is left for Africa is to access the readily available medicinal plants for managing cases of COVID -19. Since the spread and death cases are rapidly increasing daily despite a travel ban and lockdown policy in most countries of the world, and also with no effective anti-coronavirus drugs in the market, it is pertinent to include herbal source remedy.

Thus, this paper explores the epidemiological status of COVID-19 and presents several plants with potential for the treatment of the disease. This review also seeks to bridge the knowledge gap and present to both scientists and traditional medicine practitioners several plants that may have potential in the management of COVID-19.

METHODOLOGY

Epidemiological data were mined from the daily updates of the World Health Organization (WHO) (WHO, 2020a), Centre for Disease Control websites, Nigeria Centre for Disease Control (NCDC), and recently published journal articles. The data on confirmed cases and deaths due to COVID-19 were extracted from the European Centre for Disease Control (ECDC) while data on demographic characteristics of patients with COVID-19 cases from NCDC.

The articles published from 2002 to 2020 totaling 242 were included from Web of Science, Elsevier, Scopus, and PubMed and screened for this review; while 103 were considered suitable for use. Relevant keywords like COVID-19, plants possessing antiviral activity against coronavirus, medicinal plant used to manage SARS-CoV and similar viruses, plants used to treat respiratory diseases in Africa, plants used in treating flu in Africa were used in this study. The limitation of this work is that the activities of the plants were not tested against COVID-19 disease. The data collected were analyzed using Microsoft excel 2016 and presented as simple descriptive statistics and charts.

RESULTS

The demographic characteristics of COVID-19 medically confirmed cases in Africa between 25th February to 28th July, 2020 are displayed in Figure 1. The age group between 20-49 years recorded high cases of the disease in Africa with males’ frequency marginally surpassed that of females within this time frame. The demographic features of COVID-19 medically confirmed cases in Nigeria as of 29th July, 2020 are shown in Figure 2. Based on this record of patients with epidemiological history, the age group between 21 to 50 years were mostly affected with higher numbers of males than the females.

Figures 3 and 4 show the geographical distribution of cases and deaths due to coronavirus across the five most hit countries in Africa. The highest cases in Africa were recorded in South Africa, followed by Egypt while the lowest cases were recorded in Algeria.

Globally, as of 29th of July, USA has the highest number of cases and the highest number of deaths was from the same country (Figures 5 and 6). These cases and deaths were generally characterized by an upward trend over time. The records from the distribution of
mortality by various age groups revealed that elderly persons aged 51 and above were mostly affected. The distribution of deaths within these age ranges had a significant increase compared to those below 51 years as shown by the data from Italy and China (Figure 7).

The databases yielded 75 medicinal plant species from 41 families which were used in managing SARS CoV2 and other related diseases with Lamiaceae, Asteraceae, Apiaceae, and Myrtaceae being the most frequently used family (Figure 8). Table 1 shows medicinal plants used worldwide in treating cases of SARS-CoV and other related viral diseases. Plants of the Genus Rheum and
Polygonum were listed among the Traditional Chinese Herbal Medicine (TCHM) which has been tested and showed positive results in treating COVID-19. Tables 2-4 are medicinal plants used in treating some viral diseases, flu, influenza, and respiratory diseases. While Table 5 contains a list of phytochemicals and active compounds that have shown activities against the SARS-CoV virus.

**DISCUSSION**

The COVID-19 epidemic cases recorded in Africa were...
relatively small compared to the number recorded in Europe, Asia, and the USA. But these cases have increased sporadically since the index case in Egypt on February 14th, 2020. Age group 20 - 49 years were most affected. This may possibly lead to lower mortality as the immune system of these age groups is still very strong. The possibility of comorbidity disorder may not be rampant among the younger patients and hence a fewer number of deaths are likely to be expected. This present result is inconsistent with the one reported in one of the highly burdened nations (Courage, 2020).

Global epidemiological records revealed a geometrical increase in the number of cases in most hit countries while the distribution of deaths by various age groups...
revealed that elderly persons aged 51 and above were mostly affected (Courage, 2020). This may likely be due to the immune system wane (immunosenescence effect) among the older population (Castelo-Branco and Soveral, 2014). Also, comorbidity with other diseases can also be the likely reason for most of these deaths among the elderly. Studies have shown that underlying comorbidities might vary in different population groups or settings, at an older age, cardiovascular diseases, diabetes, chronic respiratory disease, and cancer were all associated with an increased risk of death (Jordan et al., 2020).

Medicinal plants are valuable natural resources useful for the management of several human and animal diseases. Usage of herbs in treating different viral

Figure 7. COVID 19 mortality in China (as of 11th February, 2020) and Italy (as of 17th March, 2020). Data on Coronavirus Deaths from the Stark differences in Countries’ Coronavirus Deaths Rates (Courage, 2020).

Figure 8. The plant families frequently used to treat COVID 19, related viral disease and manage respiratory diseases.
Table 1. Medicinal plants used in the treatment of coronavirus worldwide.

| Family            | Plant                                      | Part used                       | Plant activity                                                                 | References                                    |
|-------------------|--------------------------------------------|---------------------------------|-------------------------------------------------------------------------------|-----------------------------------------------|
| Polygonaceae      | Rheum officinale Baill                    | Extract of Root tuber           | Block ACE2 interaction with SARS-CoV in a dose dependent manner               | Ho et al.(2007), Li et al. (2017)             |
|                   | Polygonum multilorum                      | Extract of Root tuber           | Block ACE2 interaction with SARS-CoV in a dose dependent manner               | Ho et al.(2007), Luo et al. (2019)           |
|                   | Polygonum multilorum Thumb                | Extract of the vines            | Block ACE2 interaction with SARS-CoV in a dose dependent manner               | Ho et al. (2007) Bussmann et al. (2010)      |
| Compositae        | Artemisia annua L.                        | Ethanolic extract of whole plants| Antiviral, antiparasitic and used in treating infection of the respiratory tract| Shin-you li et al. (2005) Muthaura, Keriko, Derese, Yenesew, & Rukunga, 2011 |
| Lauraceae         | Lindera aggregata (Sims) kastern          | Chloroform leaf extract         |                                                                                   | Li et al. (2005)                             |
|                   |                                           | Ethanolic root extract          |                                                                                   | Li et al. (2005)                             |
| Rosaceae          | Rosa nutkana C.Presl                      | Crude methanolic Branches       | Affect enteric coronavirus                                                    | Eslami et al. (2011); Mccutcheon et al. (1995) |
| Caprifoliaceae    | Amelanchier alnifolia Sarg. Potentilla argute Leh. | Crude methanolic Branches       | Affect enteric coronavirus                                                    | Mccutcheon et al. (1995)                     |
| Araliaceae        | Sambucus racemosa L.                      | Crude methanolic branches tip   | Inhibit respiratory syncytial virus                                           | Mccutcheon et al. (1995)                     |
|                   | Oplopanax horridus (Sm.) Miq.             | Inner back extract              |                                                                                   | Mccutcheon et al. (1995)                     |
| Polemoniaceae     | Ipomopsis aggregate (Pursh) V.E.Grant     | Ethanolic root extract          | Affect influenza virus type 3                                                  | Mccutcheon et al. (1995); Mehrbod et al. (2018) |
| Gentianaceae      | Gentiana radiate C.Marquand                | Plant extract                   | Affect SARS-CoV cytopathic effect                                            | Wen et al. (2011)                            |
| Dioscoreaceae     | Gentiana scabra Bunge                      | Extract of dried rhizome tuber  | Affect SARS-CoV cytopathic effect                                            | Wen et al. (2011)                            |
| Leguminoseae      | Dioscorea batatas Decne.                  | Dried seed                      | Affect SARS-CoV cytopathic effect                                            | Aadir et al. (2018)                          |
|                   | Cassia tora Linn                          |                                 | Affect SARS-CoV cytopathic effect                                            | Wen et al. (2011)                            |
| Loranthaceae      | Taxillus chinensis (DC) Tiegh              | The dried stem with leaves      | Affect SARS-CoV cytopathic effect                                            | Wen et al. (2011)                            |
| Cibiotiaceae      | Cibotium barometz (L.) J.Sm                | Extract of the dried rhizome    | Affect SARS-CoV cytopathic effect                                            | Wen et al. (2011)                            |
| Caprifoliaceae    | Lonicera japonica Thunb                   | Flower bud and stem infusion    | Has antiviral activity                                                        | He et al. (2016)                              |

Diseases in Africa is a relic of old and has gotten wider acceptability globally. Plants based on traditional medicine are still dominant in Africa. Herbal remedies are inexpensive to prepare and are effective in the management of several diseases (Akhalwaya et al., 2018). With the search for drugs and vaccines for COVID 19 ongoing, a complementary or alternative therapeutical source for COVID 19 is highly needed. Africans are perhaps at a loss to what can be used in treating the ravaging pandemic. Chinese Traditional Medicine has been able to identify several medicinal plants that can be used as antivirus for SARS-CoV2 due to their previous exposure to SARS-CoV and MERS-CoV in 2002 and 2012 respectively. This paper seeks to bridge the knowledge gap and present to both scientists and
Table 2. Medicinal plants used in Africa to treat viral diseases related to SARS-CoV 2 and manage respiratory symptoms.

| Family         | Plant                                      | Method of preparation                      | Uses                                               | References                      |
|----------------|--------------------------------------------|--------------------------------------------|---------------------------------------------------|---------------------------------|
| Th             | *Mangifera indica* L.                      | Infusion drink                             | Cough                                             | (Polat and Satil, 2012)         |
| Apiaceae       | *Centella asiatica* (L) Urb.               | Macerated leaves, decoction drink          | Fever, constipation and jaundice and cough        | Tariq et al., (2015)            |
| Chenopodiaceae | *Chenopodium opulifolium* Kock & Ziz       | Decoction drink                            | Malaria and fever and cough                       | Chinsembu (2016)                |
| Curcubitaceae  | *Mormodica foetida* K. Schum               | Decoction and infusion                      | Malaria, fever, worm, cough and stomach ache and yellow fever. | Tugume and Nyakoojo (2019) |
| Lamiaceae      | *Plectanthera floribunda* Mart.            | Decoction and infusion                      | Malaria, fever, worm, cough and stomach ache and yellow fever. | Tugume and Nyakoojo (2019) |
| Melastomataceae| *Dissotis Phaeotricha* (Hochst) Hook       | Decoction, infusion drunk. Oil from seed drunk. | Malaria fever, cough, worm and fever             | Tugume and Nyakoojo (2019) |
| Meliaceae      | *Azadirachta indica* A. juss               | Decoction drink                             | Worm, malaria, fever, jaundice, cough and bronchitis | Tugume and Nyakoojo (2019) |
| Moraceae       | *Ficus natalensis* Hochst                  | Decoction drink                            | Influenza                                         | Keter and Mutiso (2012)         |
| Myrtaceae      | *Callistemon citrinus* (Curtis) Skeels     | Decoction drink mixed with Eucalyptus grandis and magnifera indica boiled and inhaled | Cough and common cold.                           | Tugume and Nyakoojo (2019) |
|                | *Eucalyptus grandis* W. Hill               | Leaves chewed, infusion drink and decoction drink | Cough                                             | York et al. (2011)             |
| Myrtaceae      | *Eucalyptus globulus* Labill                | Burning leaves in fire and inhale           | Common cold                                       | Proestos and Komaitis (2013)    |
|                | *Psidium guajava* L.                       | Decoction drink                            | Cough                                             | de Wet et al. (2010)            |
| Solanaceae     | *Datura innoxia* Mill                      | Decoction drink, infusion, macerated leaves applied on skin | Cough, asthma, skin disease                      | Vernay et al. (2008)           |
| Solanaceae     | *Nicotiana tabacum* L.                     | Leaves, leaves macerated                    | Stomach ache, common cold, influenza              | Tsouh Fokou et al. (2015)      |
| Alliaceae      | *Allium sativum* L.                        | Inhalate Fruit and seed extracts. Decoction of fruit and seed. | Common cold, malaria and dry cough                | Barkaoui et al. (2017)         |

Traditional medicine practitioners potential plants that may be useful in the management of COVID 19.

Out of the 41 families of plants, Lamiaceae has the family with the highest number of plant species used in treating SARS-COV and managing respiratory diseases. This family contains *Hyssopus officinalis* L. commonly called Hyssop. It produces aromatic flowers that have soothing expectorant and cough suppressant properties. It is also used in managing sore throat. Clinical investigation revealed that extracts of the block ACE2 interact with SARS-CoV in a dose-dependent manner (Ho et al., 2007; Li et al., 2017).

*Ocimum basilicum* L is a native to the tropical and warm temperate regions commonly called great basil. It is also an aromatic plant whose leaves are used for cooking. It possesses antiviral, antibacterial, and antifungal effect. It has an immunomodulatory, hepatoprotective effect...
Table 3. Medicinal plants used in Africa to treat viral diseases related to SARS-CoV 2 and manage respiratory symptoms

| Family     | Plant                                      | Part used and method of Preparation | Uses                              | References                  |
|------------|--------------------------------------------|-------------------------------------|-----------------------------------|-----------------------------|
| Asteraceae | *Artemisia afra* Jerk. Ex wild             | Inhale the smell of the leave        | Common cold                       | van Wyk (2008)              |
|            | *Echinops keberico* Mesfin                 | Inhale the burning root              | Common cold                       | Bulut et al. (2017)         |
| Compositeae| *Guizotia abyssinica* (CL) Cass            | Decoction of seed powder             | Dry cough                         | Mohamed, 2012; Wubetu et al. (2017) |
| Primulaceae| *Rapanea melanophloeos* (L.) Lam           | infusion                            | Cough and common cold             | Wubetu et al. (2017)        |
| Lamiaceae  | *Clerodendrum glabrum* E. Mey.             | Leaf infusion                        | Common cold and fever             | Cock et al. (2018); Wubetu et al. (2017) |
| Pittosporaceae | *Pittosporum viridiflorum* Sims.       |                                     | Antiviral agent, affect influenza virus HA surface glycoprotein | Wubetu et al. (2017) |
| Apocynaceae| *Tabernaemontana ventricosa* Hochst. Ex A.DC. |                                     | Treat respiratory diseases        | Wubetu et al. (2017)        |
| Araliaceae | *Cussonia spicata* Thunb.                  | Bulb                                | Treat respiratory diseases        | Cock et al. (2018)          |
| Amaryllidaceae | *Erinum jagus* (J. Thomps) Dandy     | leaves                              | Treatment of tuberculosis, asthma and infection | Cock et al. (2018)          |
| Asteraceae | *Agarantum corynoides* L.                  | leaves                              | Purgative, pneumonia febrifuge    | Okunade (2018)              |
| Cruciferae | *Bryophyllum pinnatum* (Lam) Oken         | leaves                              | Cold, pneumonia and respiratory tract infection | Ogbole et al. (2018)        |
| Dilleniaceae | *Tetracera alnifolia* wild                | leaves                              | Cough and toothache               | Ogbole et al. (2018)        |
| Euphorbiaceae | *Croton gratissimus* Burch               | leaves                              | Cough, fever and influenza        | Ogbole et al. (2018)        |
| Lamiaceae  | *Hoslundia opposita* Vahl                 | leaves                              | Cough and skin infection          | Ogbole et al. (2018)        |
| Poaceae    | *Eleusine indica* (L) Gaertn              | leaves                              | Diabetes and cough                | Ogbole et al. (2018)        |
| Lamiaceae  | *Hyssopus officinalis* L.                  | Aqueous extract                     | Inhibit viral replication         | Mukhtari et al. (2008)      |
| Lamiaceae  | *Ocimum basilicum* L.                      | Methanolic extract                  | Inhibit viral replication         | Kichu et al. (2015; Mukhtar et al. (2008) |
| Bignoniaceae | *Newbouldia leavis* (P.Bauv.) Seem.        | Leaves extracts                     | Cough, worm, malaria and anti-inflammatory | Yemele et al. (2015)        |
| Araceae    | *Anchomanes difformis* (Blume) Engl.      | tuber                               | Fever, worm, diuretics and common cold | Sulaiman et al. (2015)      |
| Mimosoideae | *Tetrapleur tetraperta* (Schumm. &Thonn) Taub | fruit                             | Fever, worm common cold, analgesic and anticonvulsant | De Smet (1998)               |
| Asteraceae | *Vernonia amygdalina* Delile               | leaves                              | Fever, worm and common cold       | Namukobe et al. (2011)      |
| Violaceae  | *Viola odorata* L.                         | flower                              | Cough and flu                     | Ahmad Jan et al. (2017)     |

(Aalikhani Pour et al., 2016; Aremu et al., 2010). *Plectanthera floribunda* Mart is a warm climate plant grown as leaves or root vegetables and is used medically to treat cough and respiratory diseases. Infusion drink of the leaves of *P. floribunda* reduce fever, worms, and malaria (Tugume and Nyakoojo, 2019).

*Asteraceae* accounts for 12.2% of the families of plants traditionally used for the management of viral diseases and respiratory symptoms. *Artemisia afra* Jerk. Ex wild and *Artemisia annua* are native to the tropical region; they are non-toxic plants...
Table 4. Medicinal plants used in Africa to treat viral diseases related to SARS-CoV 2 and manage respiratory symptoms.

| Family       | Plants                                      | Part Used       | Uses                                      | References                      |
|--------------|---------------------------------------------|-----------------|-------------------------------------------|---------------------------------|
| Boraginaceae | Onosma bracteata Wall                       | root            | Cough, bronchitis and flu                 | Younis et al. (2018)            |
| Ranunculaceae| Nigella sativa L                           | Oil from the seed| Diuretics, anti-inflammatory, bronchodilator, antimicrobial | Hasani-Ranjbar et al. (2009)   |
| Asteraeceae  | Artemisia annua L                          | Whole plant infusion | Malaria, anti-inflamatory and fever. | Vitalini et al. (2013)          |
| Polypodiaceae| Pyrosia lingua (Thunb) Farw.               | leaves          | Cystitis, bronchi asthma, lung-heat induced cough. | Li et al. (2005)               |
| Apiaceae     | Isatis indigotica Fortune ex Lindl.         | Root extract    | Antiviral agent                           | Guo (2018)                     |
| Asteraceae   | Torrey nucifera (L) Siebold and Zucc.      | Seed oil        | Affect the lungs, intestines and worms    | Wen et al. (2011)              |
| Asteraceae   | Daucus carota L                            | Root and seed   | Diuretic, stimulant carminative, chronic cough. | Gilca et al. (2018)           |
| Asteraeceae  | Ehinacea purpurea (L) Moench               | Root extract    | Immunostimulatory, anti-inflammatory, infectious diseases in both upper and lower respiratory systems and pruritus. | Gilca et al. (2018)           |
| Adoxaceae    | Sambucus nigra L                           | Flowers         | Diuretics stomach upset, cough            | Mccutcheon et al. (1995)       |
| Apiaceae     | Heteromorpha arborescens (Spreng.) Cham. and Schidl. | Different parts of the plant | Inflammation, pain, respiratory problems antiviral | Elisha et al. (2016); Gilca et al., 2018 |
| Taxaceae     | Torreya taxifolia (Arn.) Henkel and W. Hochst. | Seed oil        | Respiratory diseases                      | Wen et al. (2011)              |

Table 5. Some phytochemical used in management of SARS-CoV and related viral diseases.

| Family       | Plant                                      | Phytochemical      | Effect                                                                 | Reference                        |
|--------------|--------------------------------------------|--------------------|------------------------------------------------------------------------|---------------------------------|
| Saururaceae  | Houttuynia cordata                        | Quercetin          | Inhibit mouse hepatitis virus (MHV), Dengue virus type 2 (DENV type2)  | Chiow et al. (2016)             |
| Saururaceae  | Houttuynia cordata                        | Quercetin          | Inhibit mouse hepatitis virus (MHV), Dengue virus type 2 (DENV type2)  | Chiow et al. (2016)             |
| Saururaceae  | Houttuynia cordata                        | Cinanserin         | Inhibit mouse hepatitis virus (MHV), Dengue virus type 2 (DENV type2)  | Chiow et al. (2016)             |
| Polygonaceae | Rheum emodi Wall                         | Emodin (an anthraquinone) | Block S protein of SARS-CoV and Angiotensin Converting Enzyme 2 (ACE2) interaction | Ho et al. (2007)                |
| Polygonaceae | Rheum emodi Wall                         | Physcion           | Block S protein of SARS-CoV and Angiotensin Converting Enzyme 2 (ACE2) interaction | Ho et al. (2007)                |
| Polygonaceae | Rheum emodi Wall                         | Rhein              | Block S protein of SARS-CoV and Angiotensin Converting Enzyme 2 (ACE2) interaction | Ho et al. (2007)                |
| Apiaceae     | Isatis indigotica                         | Myricetin and scutellarein | Antiviral activities | Keum and Jeong (2012)           |

used traditionally for the treatment of common cold and pneumonia (Martkoplishvili and Kvavadze, 2015; Muthaura et al., 2011; Rabe and Staden, 1997; Van, 2008). Pharmacological activities of the compound from these plants have an inhibitory effect on malaria parasites, Schistosoma mansoni, Schistosoma heamatobium, and Schistosoma japonicum (van Vuuren and Muhtarhi, 2017). The
genus of *Artemisia annua* is known for its aromatic nature; its volatile secondary metabolites have been used in the management of cough and common cold (Mahomoodally et al., 2013; Markkoplanshvi and Kvavadze, 2015). Another important member of Asteraceae family is *Ageratum conyzoides*; it is a native of tropical America and considered an invasive weed in Africa. It is commonly called Billy goat weed. It contains pyrrolizidine alkaloids, lycopsamine, and echinatine which are toxic. The plant is used mostly in central Africa in managing pneumonia, to cure wounds and burn. In India, Asia, Africa and South America it is used to treat fever, rheumatism, headache and colic. The whole plant has medicinal uses. Pharmacological investigation of the plant showed it has *in vitro* inhibitory effects on *Staphylococcus aureus*, and *Escherichia coli* (Ogbalu and Williams, 2015; Okunade, 2018).

Another plant genus of the Asteraceae family is *Vernonia amygdalina* and *Echinacea purpurea*. *V. amygdalina* is a small shrub tropical plant. It is commonly called bitter leaf because of its bitter taste. It is eaten as a leafy vegetable. It has been demonstrated to have antioxidant, anti-inflammatory, anthelmintic, anti diarrheal, antihypertensive, and antidiabetic activities. The sap from the leaf has been used to treat pneumonia, bronchitis, and other respiratory diseases (Farombi and Owoeye, 2011; Ijeh and Ejike, 2011; Namukobe et al., 2011).

An isolated compound from *V. amygdalina* leaves like vernonioside has anti-inflammatory effect and is used to treat the gastrointestinal disorder (Habtamu and Melaku, 2018; Lamorde et al., 2010) while *Echinacea purpurea* is a tropical flowering plant, a native of North America. It is commonly called purple coneflower (Cai et al., 2010). Extract of *E. purpurea* has been used in the treatment of acute respiratory infections. Immunostimulant or immunomodulatory properties of *E. purpurea* have been documented Gilca et al. (2018).

Members of the Apiaceae family that are listed in Table 3 include *Centella asiatica*, *Isatis indigotica*, *Daucus carota*, and *Heteromorpha arborescens* (Davids et al., 2016). *Centella asiatica* commonly called Indian pennywort is a native of Asia. It is a culinary vegetable and medicinal herb (Roy and Bharadwaja, 2017). While *Isatis indigotica* root has antiviral, cold, anti-inflammatory, antipyretic, and antibacterial properties. It also contains several secondary metabolites that benefit human health like sucrose, amino acid, tryptophan, essential oils like Beta-sitosterol, and isatin (Guo et al., 2018).

*Daucus carota* is commonly called wild carrot; it is a flowering plant native of Europe, South West Asia, North America, and Australia. It is shown in experimental and clinical studies that it has radioprotective, antioxidant, and anti-inflammatory activities. The roots, seeds, leaves, and flowers also have medical uses. They have antibacterial, antifungal, antiviral, anti-flu anti-anxiety antispasmodic properties (Saliyan et al., 2017; Gilca et al., 2018).

*Heteromorpha arborescens* is a tropical shrub that can tolerate dry climates. An infusion of the inner back of *H. arborescens* is used in the treatment of colic, cold, and chest pain. A decoction of the root is used to treat shortness of breath, cough, and dysentery. The root is used as an aphrodisiac. The plant phytochemistry includes α-terpinene, Y- terpinene, and turreyol, which is responsible for its antiviral and anti-inflammatory activities (Elshia et al., 2016; Maroyi, 2018).

*Eucalyptus grandis* W. Hill, *Eucalyptus globulus* Labill, and *Psidium guajava* are important medicinal plants in the Myrtaceae family. Eucalyptus species are native to Australia. *E. grandis* and *E. globulus* have smooth, fibrous, stringy bark with leaves that have oily glands. It has antiviral, antitumor, antihistaminic, anticancer, and antibacterial activities (Li et al., 2017; Luiz et al., 2016).

Pharmacologically, they are inhibitory of cytochrome P450 and their hepatoprotective activities have been documented (Luiz et al., 2016). The fruits of *E. globulus* have yielded several compounds like sitosterol, betulinic acid, stigmasterol which have been used in treating mild inflammation, respiratory tract infection, and bronchitis. *Psidium guajava* commonly known as guava is a tropical plant that is grown for abundant fruits. Its leaves are used in the treatment of cough, diarrhea, dysentery, and gastroenteritis. The fruit is rich in Vitamins A and C, iron, phosphorus, calcium, and minerals. *P. guajava* has antiviral, anti-inflammatory, and antimutagenic, antinociceptive activities (Suliman et al., 2010; Zonyane et al., 2013).

*Rheum officinale* Baill commonly called Chinese rhubarb is of the family Polygonaceae; it has pharmacological activities such as anti-inflammatory, antioxidative and cathartic. The major active ingredient in the plant is emodin which has hepatoprotective activity, it slows liver fibrosis and it has been demonstrated to inhibit SARS CoV activity (Ho et al., 2007; Li et al., 2017).

Emodin has potential effect against atherosclerosis, ulcer, colitis, glomerulitis, pancreatitis, and hepatitis in experimental studies. While *Polygonus multiflorum* Thumb tuber commonly called the fleece flower is a native of northern temperate region from the family of Polygonaceae. The leaves, root tuber, and rhizomes are used as tonic and anti-aging agents; the stem is used to reduce insomnia and has antihyperglycemic activities. *P. multiflorum* Thumb showed various biological activities which include antitumor, anti-SARS-CoV, anti-HIV antialopecia activities, and showed an ability to inhibit neurodegenerative diseases (Li et al., 2017; Liu et al., 2018).

The Rosaceae family has the following plants: *Amelanchier alnifolia*, *Potentilla argute*, and *Rosa nutkana*. *Amelanchier alnifolia* is a shrub with edible berry-like fruit, a native to America. A decoction of the stems has been used in treating fever, flu and induce sweating. It has also been used as a contraceptive (Bulut
potentilla argute is a tall flowering plant, a native of Northern America. The decoction of the leaves and stems is used to manage cases of inflammation of the body and joints. It is an effective remedy for arthritis, menstrual pain, and fever. Due to the astringent nature of its tannins, it is used to treat age marks and wrinkles. It is also effective in treating bacterial infection in the mouth (Avci et al., 2006; Mccutcheon et al., 1995; Mehrbod et al., 2018).

Rosa nutkana is a tall perennial shrub of the Rosaceae family. The plant is a native of North America. Infusion of the root is used to treat sore eyes and sore throat (Eslami et al., 2011). Other plants used in treating common cold include Guizotia abyssinica (CL) Cass commonly called noog in Ethiopia (Mohamed, 2012).

Oplopanax horridus also known as devils’ club is used by the indigenous people of North America. The extract of the leaves is used as respiratory stimulant and expectorant. Recent pharmacological studies showed that O. horridus possesses anticancer, antifungal, antibacterial, and antiarthritic activities (Wu et al., 2018). Another member of the Araliaceae family that shares similar medicinal characteristic with O. horridus is Cussonia spicata, a native of the tropical region commonly known as spiked cabbage tree. The root decoction is used to treat fever, venereal diseases, diuretic, and also used as a laxative (Tetyana et al., 2002).

Gentia radix is the dried rhizome of Gentiana lutea L. It is used to increase appetite during recovery from acute atonic dyspepsia. Extract of the dried rhizome of G. lutea and G. scabra has shown good outcomes on the treatment of the cytopathic effect SARS-CoV (Prakash et al., 2017).

Torreya taxifolia native of America and commonly called Florida nutmeg is an endangered species of medicinal plant which is very active in treating respiratory diseases (Ernst et al., 2015). Lindera aggregat (Sims). kastern is a tropical plant, a member of Linderaceae family. It is used medicinally as a febrifuge especially in Asia; Sambucus racemosa commonly called red elderberry has been used by native America as an emetic, anti diarrheal, cold, and cough remedy. Another North American plant that shared similar medical use in the treatment of cold and cough is Ipomopsis aggregata. Glycosides like patuletin, eupatin and eupalolin isolated from I. aggregata have diverse pharmacological activities (Juanita, 2004; Mccutcheon et al., 1995; Shokrzade et al., 2010).

 Dioscorea batatas commonly called Chinese yam is a perennial growing invasive plant. It is a temperate and subtropical plant. The root tuber can be boiled and eaten and has been used in the treatment of hyperthyroidism, nephritis, and diabetes. It contains diosgenin, a substance that can be employed in the production of contraceptives. The leaves are used in treating asthma and arthritis (Aadil et al., 2018; Bruschi et al., 2011; Iranshahy et al., 2017).

Cassia tora Linn is a medicinal plant found in India and other tropical regions. It is of the family Leguminosae which traditionally has been used in treating several viral diseases. It is also used in treating respiratory infection. Many compounds have been isolated from C. tora which include anthraquinone, glycosides, naphopyrone glycosides, and other phenolic compounds that have varieties of activities (Hebbar et al., 2004; Shadab et al., 2019).

Taxillus chinensis (DC) Danser also commonly called mulberry mistletoe is a plant in the mistletoe family Loranthaceae; it grows in China, India, and Vietnam. It is used to treat several ailments. Pharmacologically, it has antioxidant, antancer, anti-inflammatory activities and it supports the immune system. It strengthens the liver, heart, and kidney, relieves joint pains and helps to manage arthritis. Also, this plant may have potential as a candidate for the future development of anti-SARS treatments (Wen et al., 2011; Zhang et al., 2013).

Chibotium barometz also called the golden chicken fern is a tropical plant of South East Asia. It is used in traditional Chinese medicine to treat epilepsy, wound, ulcers, and cough. It also serves as an anti-rheumatic, kidney, and liver tonic. Lonicera japonicum commonly known as Japanese honeysuckle is a plant used to treat varieties of ailment in Japanese folkloric medicine. It is used to treat swelling, enteritis, upper respiratory infections including colds, influenza, swine flu, pneumonia other viral, and bacterial infections. The flower buds, leaves, and stem of L. japonicum are used medicinally. The plant potency in lowering body temperature has also been documented (He et al., 2016; Wen et al., 2011).

Nigella sativa L commonly called black cumin is a native to Indian and West Asia. The seed is used as spices in the Middle East. Oil extracted from the seed contains linoleic acid, oleic acid, palmitic acid, and some aromatic oil which includes thymoquine. The seed oil contains antioxidants, anti-inflammatory, antibacterial and antiviral activities, cholesterol-lowering activity (LDL cholesterol) anticancer properties and unconfirmed evidence showed many COVID-19 patients in Nigeria use N. sativa seed oil to treat the disease (Aftab et al., 2013; Almatrafi, 2016; Hasani-Ranjbar et al., 2009; Yimer et al., 2019).

Many phytochemicals and isolated compounds have been identified experimentally to inhibit SARS-CoV spike protein (S) interaction with human ACE 2. Examples include Emodin, phisin, and rhein isolated from Rheum and polygonum genus from the family Polygonaceae. Flavonoids like Quercetin, Quercetin, Cinacetin from Houttuynia cordata inhibitory effect on MHV and DENV which are similar to SARS-COV 2 virus (Huang et al., 2015; Yan et al., 2011). Saikosaponin, a saponin from
**CONCLUSION**

The successful management of human viral diseases is hardly achieved with the use of synthetic drugs; thus only a few antiviral drugs are available in the market for prophylactic or therapeutic use against human viral diseases. Alternative or complementary sources of antiviral agents such as phytochemicals are therefore necessary.

**CONFLICT OF INTERESTS**

The authors have not declared any conflict of interests.

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