Account

COVID-19 Pandemic: A Case for Phytomedicines

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Abstract

Coronavirus disease 2019 (COVID-19) is an infection caused by a newly discovered coronavirus which was identified in Wuhan, China. The race is on globally to repurpose drugs for COVID-19 and develop a safe and effective vaccine against the disease. There is an urgent need to search for effective remedies against COVID-19 from the rich and extensive flora of Africa and the world. A literature search was conducted to obtain information on drugs with the potential for effectiveness in the treatment of COVID-19 based mostly on outcomes of preclinical studies and a few clinical investigations. This was considered important to this perspective as some of the identified mechanisms of action may be related to potential anti-COVID-19 actions of phytomedicines. The findings from the literature search were also used to establish the need for exploration of phytomedicines in the fight against COVID-19. This perspective identifies the need to preserve the rich tradition of herbal medicine in Africa, repositioning it by inculcating all aspects of discovery, development, and chemical evaluation of pharmaceuticals from medicinal plants for effective management of prevalent diseases. The identified mechanisms of action of current drugs under consideration for the treatment of COVID-19 include preventing fusion of SARS-CoV-2 with human cells; decrease acidity in endosomes, cell membrane-derived vesicles for transportation of the virus within the host cell and within which the virus can replicate; and blockade of the production of proinflammatory cytokines. Phytomedicines may possibly elicit either one or a combination of these effects. The case for the exploration of phytomedicines against COVID-19 is strengthened by the emergence of a number of conventional drugs from medicinal plants and the emergence of botanicals with proven efficacy for some medical conditions. Caution against indiscriminate use of medicinal plants in the guise of treating COVID-19 has been highlighted and the need for reliable preclinical and clinical studies.

Keywords

COVID-19, phytomedicines, therapeutic management, strategic interventions, safety, collaboration

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ACEDHARS

The African Center of Excellence for Drug Research, Herbal Medicine Development and Regulatory Science (ACEDHARS), University of Lagos, is a Center of Excellence deeply concerned about the inadequacy of health-care facilities and delivery in sub-Saharan Africa, particularly the inadequacies of the control system used in assessing the quality of drugs and herbal medicines in the region. The Center serves as an educational and research capacity building hub for the region in drug-related studies. The vision of ACEDHARS is to preserve the rich tradition of herbal medicine in Africa, repositioning it by inculcating all aspects of discovery, development, and chemical evaluation of pharmaceuticals from medicinal plants for effective management of prevalent diseases. ACEDHARS uses

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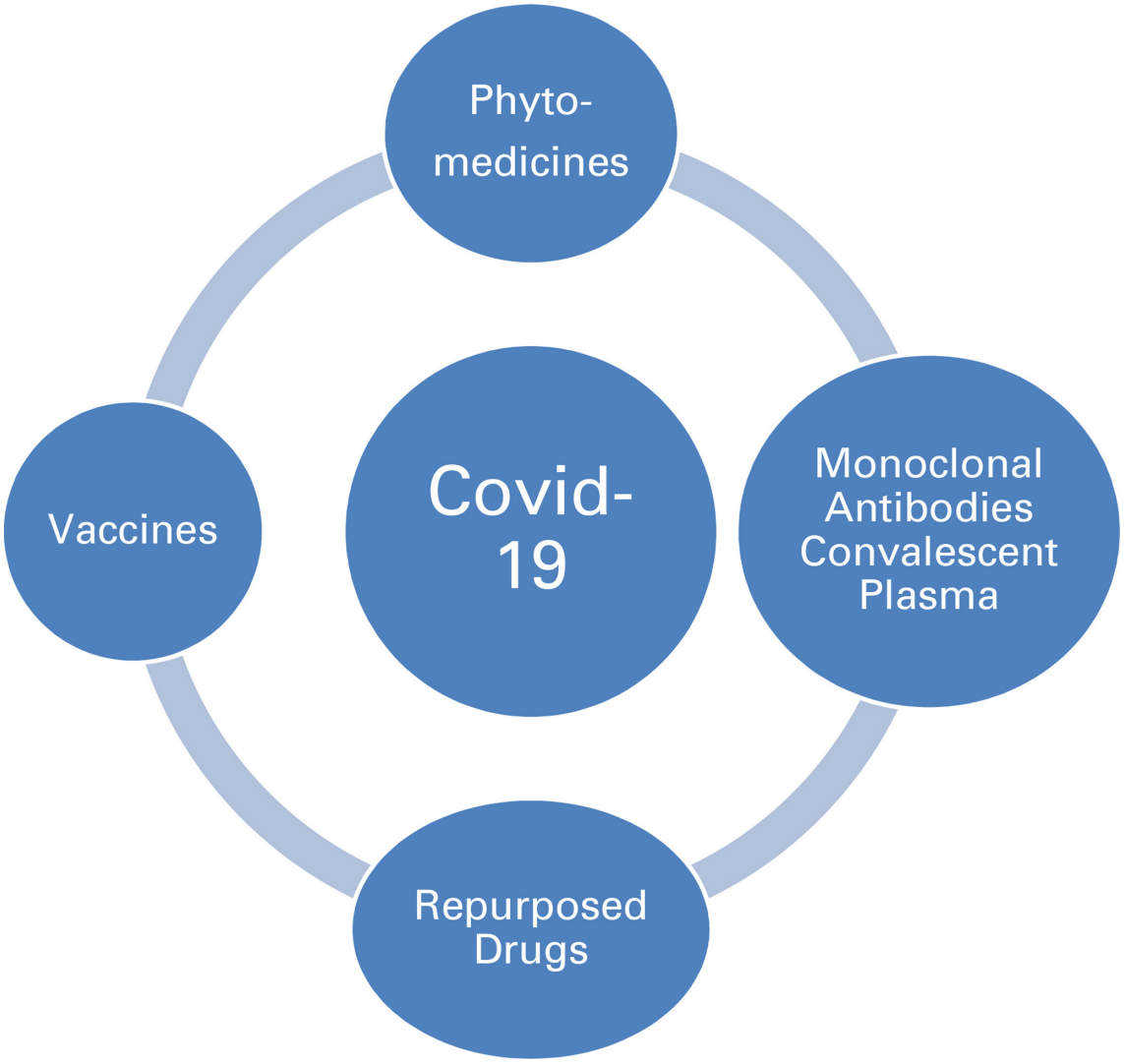

science-based methods of regulating herbal medicines for safe consumption, as well as repurposing existing drugs for effective management of prevalent diseases.

COVID-19 Pandemic

The news of an outbreak of a novel Coronavirus, COVID-19, was broken on December 31, 2019. The disease originated from Wuhan, China, and has since been recorded in virtually all the nations of the world. The World Health Organization (WHO) has thus declared COVID-19 a global pandemic. The information available as of May 14, 2020 (6:00 GMT) on worldometers.info indicate that the total global cases stood at 4 430 123 with over 50% of the cases occurring between April and May. The number of deaths recorded from the viral infection was 298 180 (6.73% of cases). The global average fatality rate of the disease was 6.5%, while 1 659 873 had recovered from the disease (recovery rate 37.47%). There were 2 472 070 active cases (55.80% of total cases). Out of these, the reported number that is considered to be in mild condition was 2 426 145, and those in either serious or critical condition was 45 925. The epidemiological information revealed that there was a global spike in cases and death rates between March 7 and March 22, 2020, and the spread has remained on the increase. The 12 nations with the highest number of reported cases in descending order are the United States, Spain, Russia, the United Kingdom, Italy, Brazil, France, Germany, Turkey, Iran, China, and India. The most impacted nation is the United States with the total number of cases being 1 430 348, and the number of reported deaths from the disease being 85 197 (28.57% of global fatality). There was a spike in the number of reported cases of the disease in Russia within April and May (242 271 cases), but the total number of deaths in Russia was low at 2212 (0.91%).

In the continent of Africa, the worldometers.info data as of May 14, 2020 (6:00 GMT) was 73 973 cases, out of which 2507 (3.39%) persons have died from the disease and 26 250 recovered (recovery rate being 35.49%). There were 45 216 active

cases (61.12% of total cases). Out of these, the reported number that is considered to be in mild condition was 44 958 and those in serious or critical condition were 258. A comparison of the cases in Africa with the global data showed that Africa has only 1.67% of the globally reported cases, the death percentage being 0.84% of the global cases and recovered percentage 1.58%. Therefore, it would be safe to say that the impact of this disease in Africa is currently low (less than 2% cases and less than 1% deaths). There are many hypotheses about this, which include (1) that Africa's climate may not be favorable to the virus (which is questionable), (2) that Africa is not undertaking massive testing for the virus due to lack of capacity to do so, and (3) that nations with universal and long-standing Bacillus Calmette-Guerin (BCG) vaccine policies, according to Miller et al,[1] have lower infection rate. On the last hypothesis, the WHO had a scientific brief on April 12, 2020, to warn against the use of BCG vaccine to combat COVID-19.[2] This report is not advocating the use of BCG vaccine, but the need to test all of these hypotheses and seek solutions relevant to the African continent. If the climate is not conducive, the tendency of the virus mutating for survival is high, and therefore, the strain(s) present in Africa must be studied. It is worth noting also that the recovery rate in Africa (35.49%) is comparable with the global recovery rate (37.47%), which may indicate that the African continent is appropriately managing the disease in comparison with the other continents and underscores the need for Africa to continue to look inward for homegrown solutions toward managing this pandemic. The top 12 cases reported in African nations in the following descending order are South Africa, Egypt, Morocco, Algeria, Ghana, Nigeria, Cameroon, Guinea, Senegal, Ivory Coast, Sudan, and Djibouti. The highest death counts in Africa are in Egypt and Algeria, with 556 and 522 deaths, respectively, while the highest total reported cases were from South Africa (12 074 cases). Death rate of the disease in South Africa was low at 219 deaths (1.81% of total reported cases). Tunisia was among the top 10 countries with the spread but experienced reduction in the number of cases between April and May, while Nigeria, which was initially in position 12 on April 19, 2020 (12:00 GMT), became the sixth most impacted in Africa.

On February 27, 2020, Nigeria confirmed its index case of COVID-19 imported into the country at the Infectious Disease (Mainland) Hospital, Yaba, Lagos State, Nigeria. This index case was diagnosed by 1 of the Centers at the University of Lagos—The Center for Human and Zoonotic Virology (CHAZVY), Central Research Laboratory, College of Medicine of the University of Lagos (CMUL)/Lagos University Teaching Hospital (LUTH). The Center is part of the Laboratory Network of the Nigerian Center for Disease Control (NCDC). The cases of this virus that have been reported in Nigeria, as captured in worldometers.info database as at May 14, 2020 (6:00 GMT), was 4971 total cases compared with 542 reported on April 19, 2020 (12:00 GMT); death cases were 164 persons (3.30%) and 1070 recoveries (21.52% of reported cases). There are 3737 active cases (75.17% of the total). Of these, 355 are considered to be in mild condition and 7 serious or critical. The death rate in Nigeria (3.30%) is less than the 6.73% of global cases and comparable with 3.39% of African cases. The recovery rate in Nigeria reduced between April 19, 2020 (12:00 GMT) report (30.63%) and the current 21.52% report, and the number of cases increased. The 21.52% is less than the African average and the global recovery rate of 35.49% and 37.47%, respectively. The need to do things differently and seek indigenous solutions is identified by these data. A comparison of cases in Nigeria with the global data revealed that 0.11% of the total global cases were reported in Nigeria and 0.06% of the global fatality cases were reported in Nigeria, while the percentage of people that recovered in Nigeria is 0.06% of the global cases. In comparison with the data in Africa, Nigeria has reported 6.72% of the African total infection rate and is now in number 6 position. The fatality reported in Nigeria is 6.54% of that reported in Africa, and the recovery rate is 4.08% of Africa. Comparison of the epidemiological information on April 19, 2020 (12:00 GMT) to that of May 14, 2020 (6:00 GMT) reveals that the incidence of the disease is worsening in Nigeria. The hypothesis advanced for the epidemiology of the disease in Africa may also hold true for Nigeria, but needs to be tested.

As of May 15, 2020 (16:00 GMT), 30 657 cases have been tested in Nigeria, with 5162 confirmed cases, 1180 discharged cases, and 167 deaths (implies 3815 active cases).[3] In all, cases of COVID-19 have been reported in 34 States and the Federal Capital Territory (FCT) in Nigeria.

Therapeutic Management of COVID-19 and Vaccine Development

The high cases of morbidity and mortality associated with COVID-19 across the world have prompted urgent efforts toward developing effective vaccines, therapies, and drugs that will save humanity from the ravaging pandemic of SARS-CoV-2. The race against time in delivering effective treatment to hospitalized patients has given an edge to drug repurposing efforts, with a focus on agents having already known pharmacokinetic and pharmacodynamics profile, and manufacturing insights by pharmaceutical companies. Searchlights are being beamed on the following drugs.

Chloroquine and Hydroxychloroquine

Both agents have been associated with antimalarial activity, with hydroxychloroquine being a more soluble and less toxic metabolite of chloroquine. The major issue with chloroquine in the past was the development of resistance to its effect by malarial parasites. These agents have been employed in the treatment of conditions, including systemic lupus erythematosus and rheumatoid arthritis, and their ability to inhibit certain coronaviruses, for example, SARS-CoV-1, has been demonstrated in time past.[4-6] Chloroquine and hydroxychloroquine have been shown to inhibit SARS-CoV-2

activity in vitro.[7-9] Clinical trials conducted in China[10] and France[11] attest to the effectiveness of chloroquine and hydroxychloroquine, respectively, in reducing morbidity and mortality associated with COVID-19. These findings prompted authorities in China and Italy to issue official guidelines recommending the use of chloroquine and hydroxychloroquine for the treatment of COVID-19 patients. Some other countries are conducting their own clinical trials to investigate the effectiveness of both drugs in COVID-19 patients. The mechanism of action of chloroquine/hydroxychloroquine includes preventing the fusion of SARS-CoV-2 with human cells at the level of its "spike" proteins interaction with a specific human cell surface enzyme (angiotensin-converting enzyme 2 [ACE2]).[6,12] This is also the basis for the possible application of monoclonal antibodies and use of convalescent (antibody rich) plasma in COVID-19 patients.[13] Identification of the produced antibodies facilitates the possibility of massive production by biotechnology companies. Chloroquine and hydroxychloroquine also decrease acidity in endosomes, cell membrane-derived vesicles for transportation of the virus within the host cell, and within which the virus can replicate.[4,13] It has also been suggested that chloroquine blocks the production of proinflammatory cytokines.[14] This is important because critically ill COVID-19 patients have been shown to experience cytokine storm leading to lung damage, fluid accumulation, and acute respiratory distress syndrome.[15] It is important to note that chloroquine and hydroxychloroquine have their associated side effects.

Ivermectin

This broad-spectrum antiparasitic agent has been shown to elicit in vitro antiviral activity against diverse viruses.[16,17] Recent insight suggests that it is an in vitro inhibitor of SARS-CoV-2, with a single treatment eliciting about 5000-fold reduction in the virus at 48 hours.[17] This derivative of avermectin (obtained from the bacterium *Streptomyces avermitilis*) has been reported to inhibit integrase protein nuclear import and human immunodeficiency virus 1 (HIV-1) replication, and limit infection by various ribonucleic acid (RNA) viruses.[16,18] These findings no doubt necessitate clinical trials of ivermectin in COVID-19 patients.

Camostat Mesylate

This is an existing Japanese drug approved for the treatment of chronic pancreatitis and postoperative reflux esophagitis. It is a protease inhibitor reported to be effective against some viral infections, as well as inhibiting fibrosis in liver and kidney disease. It has been reported to partially block infection by SARS-CoV and human coronavirus NL63 in HeLa cells and significantly inhibit infection of Calu-3 lung cells by SARS-CoV-2.[19] Aside from ACE2, SARS-CoV-2 depends on the human enzyme transmembrane protease, serine 2 (TMPRSS2) to enter host cells. Camostat has been shown to inhibit TMPRSS2. A clinical trial is ongoing on the impact of camostat mesylate on COVID-19 infection (ClinicalTrials.gov Identifier: NCT04321096; https://clinicaltrials.gov/ct2/show/NCT04321096).

Lopinavir-Ritonavir

These agents were developed to inhibit the protease of HIV responsible for the cleavage of a long protein chain during the assembly of new viruses. Lopinavir was established to be active in vitro against the severe acute respiratory syndrome (SARS) coronavirus (SARS-CoV-1) during the 2003 outbreak.[20] The combination has been said to work in marmosets infected with the Middle East respiratory syndrome (MERS) coronavirus.[13] The outcome of clinical trials on the use of this combination for the treatment of COVID-19 patients has been of mixed fortunes; hence more studies need to be conducted.

Remdesivir

This drug inhibits the crucial viral enzyme, RNA polymerase, thus halting viral replication.[13] Remdesivir previously demonstrated effectiveness against the MERS coronavirus.[21] Recent findings have shown it to be highly effective in shutting down the replication mechanism of SARS-CoV-2.[8] This discovery has prompted clinical trials of the drug in COVID-19 patients. It is important to point out that remdesivir is an intravenous drug and is expensive.[13]

Favipiravir

Favipiravir, an influenza drug, is a pyrazine derivative that inhibits viral RNA-dependent RNA polymerase.[22] This results in chain termination and prevention of RNA elongation. Favipiravir has been shown in animal studies to be effective against West Nile virus, yellow fever, foot-and-mouth disease, and other viruses.[23] It has been used for postexposure prophylaxis and treatment for Ebolavirus infection.[24] A clinical trial conducted in China revealed that the drug elicited more potent antiviral action in COVID-19 patients relative to lopinavir/ritonavir, with no significant adverse reactions.[22] Warranting caution, favipiravir has been reported to be a mutagen with the potential for teratogenicity and embryotoxicity in humans.[25]

Others

Aside from chloroquine phosphate and lopinavir-ritonavir, other antivirals included in the guidelines for the prevention, diagnosis, and treatment of novel coronavirus-induced pneumonia issued by the National Health Commission (NHC) of the People's Republic of China for tentative treatment of COVID-19 (version 6) include interferon-alpha (IFN-α), ribavirin, and arbidol.[22]

Treatment of the immune response with drugs such as anakinra, tocilizumab, ruxolitinib, baricitinib, and corticosteroids has been suggested in view of the fact that critically ill COVID-19

patients are likely to experience a cytokine storm prompting a deleterious effect of the immune system in causing further damage to the lungs with fluid accumulation.[13,15] It should be noted that chloroquine has regulatory effects on the immune system, hence its application in the treatment of rheumatoid arthritis and lupus erythematosus. However, this approach needs to be delicately applied because the immune system is also important in viral clearance from the body.

Vaccines

Vaccines stimulate the body's immune system against infectious pathogens; hence, they are one of the most effective ways of preventing diseases. However, the development of effective vaccines against COVID-19 may take several months, including the period of safety evaluation. The race for the development of a vaccine for COVID-19 has been on since the genetic sequence of SARS-CoV-2 was published on January 11, 2020; the first COVID-19 vaccine candidate entered human clinical testing on March 16, 2020.[26] News outlets on April 14, 2020 announced that the Chinese authorities have just approved 2 vaccine candidates for clinical trials. At present, 115 vaccine candidates are being explored, with 78 confirmed as active and 37 unconfirmed; 73 of 78 confirmed active projects are at the exploratory or preclinical stages.[26] It has been reported that the most advanced candidates have recently moved into clinical development, including mRNA-1273 from Moderna, Ad5-nCoV from CanSino Biologicals, INO-4800 from Inovio, and LV-SMENP-DC and pathogen-specific aAPC from Shenzhen Geno-Immune Medical Institute.[26]

Need to Look in the Direction of Medicinal Plants

The use of plants to sustain human health is as old as mankind and this is underscored by the words of the Swiss German philosopher, physician, botanist, and astrologer, Philippus Aureolus Theophrastus Bombastus von Hohenheim (Paracelsus) that "All that man needs for health and healing has been provided by God in nature, the challenge of science is to find it." Plants, with their complicated nature of secondary metabolism, have been the source of countless medicinal compounds and leads for drug discovery. Drugs employed in orthodox medicine derived from plants include taxol, docetaxel (*Taxus brevifolia*; anticancer), lovastatin (*Aspergillus terreus*; hyperlipidemia), ternatolide (*Ranunculus ternatus*; antituberculosis), artemisinin (*Artemisia annua*; antimalarial), colchicine (*Colchicum autumnale*; antigout), deserpidine (*Rauwolfia canescens*; antihypertensive), thymol (*Thymus vulgaris*; topical antifungal), tubocurarine (*Chondodendron tomentosum*; skeletal muscle relaxant), yohimbine (*Pausinystalia yohimbe*; aphrodisiac), and emetine (*Cephaelis ipecacuanha*; amoebicide, emetic). Veregen (sinecatechins; derived from Green tea—dried leaves of *Camellia sinensis*) indicated for genital/perianal warts and Fulyzaq/Crofelemer (oligomeric proanthocynidin; derived from crude plant latex of *Croton lechleri*) indicated for noninfectious diarrhea in HIV/acquired immunodeficiency syndrome patients on antiretroviral therapy are examples of US Food and Drug Administration (FDA)-approved botanicals.[27] These show the possibility of the approval of botanicals as New Drug Applications (NDAs), of acceptable quality control of botanicals, and of successful clinical trials of botanicals. Another good example is the galactolipid GOPO, a natural anti-inflammatory compound obtained from the seeds and fruits of *Rosa canina*.[28] As a promising treatment for osteoarthritis, it has been rigorously evaluated in randomized controlled clinical trials.[29,30] It has been reported that a meta-analysis of data from 3 different studies established that GOPO offers significant joint pain relief.[30] A summary of clinical studies on the efficacy of GOPO has been presented.[28]

Chloroquine is a structural analog of quinine, originally extracted from the bark of the Cinchona tree (*Cinchona officinalis*), while hydroxychloroquine is a metabolite of chloroquine with enhanced solubility and safety profiles. Both antimalarial agents have been demonstrated in vitro to inhibit viral (COVID-19) RNA increase. As mentioned earlier, clinical trials conducted in China and France yielded positive outcomes. Ivermectin (antiparasitic) is a derivative of avermectin (obtained from the bacterium *S. avermitilis*) with better potency and safety profile. In addition to previously established in vitro antiviral activity against diverse viruses, this nature-propelled anthelminthic has recently been demonstrated to inhibit the replication of SARS-CoV-2 in vitro, a finding that will certainly elicit clinical trials in COVID-19 patients. A clinical trial has been approved by the Chinese authorities (Reg. no.: ChiCTR2000029768; http://www.chictr.org.cn/showprojen.aspx?proj=49131) based on the recommendation for the combination of diammonium glycyrrhizinate (derived from glycyrrhizin—component of Licorice, *Glycyrrhiza glabra* roots) and vitamin C for the treatment of COVID-19 in China.[31] The justification for the recommendation is the long-standing use of Licorice for the treatment of coughs, colds, and disturbed digestion, and the use of diammonium glycyrrhizinate as an anti-inflammatory and antihepatitis B liver damage agent. It is worthy of note that antiviral herbal medicines and secondary metabolites from certain plants were used during the 2012 and 2013 outbreaks of MERS-CoV and SARS-CoV.[31] Medicinal plants have been used for the promotion of health by strengthening host defenses against different diseases. It has been reported that Chinese herbal medicines are also being deployed against COVID-19 based on the recommendation of the National Health Commission of China in the newest version of the diagnosis and treatment plan.

There is an urgent need to begin to search for remedies from natural products in order to discover potent anti-COVID-19 herbal remedies and natural compounds as more information unfolds about the genetic nature of SARS-CoV-2. This will, no doubt, in the more immediate term, help reduce the morbidity and mortality associated with the COVID-19 pandemic, if necessary resources and support mechanisms are

deployed in a timely manner by government and relevant agencies to support the efforts of ACEDHARS, along with others. The African biodiversity is extremely rich, and we need to explore sustainably this divinely given endowment for the health of our people and our esteemed continent.

Government Response and Need for Urgent Strategic Interventions

The Nigerian government has rightly responded by the closure of the nation's land, sea, and air borders; lockdown of States with a high number of cases; the closure of schools, churches, mosques, and public gatherings; provision of various forms of palliatives to cushion the effect of lockdown on vulnerable citizens; continued provision of information about the disease; advocacy in respect of social distancing, and handwashing, among others. These measures have gone a long way in curbing the spread of the disease because the spike in the reported cases in Nigeria happened at the same time that there was a global spike in cases (March 17 and 22, 2020). If the Nigerian government did not respond as it did, the case of COVID-19 would have been worse. There is, however, the need to respond further to this pandemic. ACEDHARS is therefore advocating: (1) improved research into in-house, homegrown solutions to COVID-19 from Nigeria and Africa; (2) financing research into the development of drug(s) from the flora of Nigeria and Africa; (3) exploration of the hypothesis that countries where BCG vaccine has been administered have lower cases and fatality, for the possibility of developing a homegrown vaccine against the infection; (4) considering the hypothesis that the African climate may be unfavorable to the virus and the possibility of the mutation of the virus, research studies into the gene sequence of the strain(s) of the virus in Nigerian cases should be funded as a way of finding homegrown solutions: drug(s) and vaccine. It may be very dangerous to wait for foreign solutions; and (5) financing research works and local production of ventilators and other personal protective equipment for management and combating the disease.

Caution Against Irrational/Indiscriminate Use of (Medicinal) Plants

There is an increasing use of herbal products and herbal medicines globally with the belief that herbal medicines are always "safe" and carry no risk because they are from natural sources.[32] However, there are concerns regarding medicinal plants and their ability to produce adverse effects. The WHO directive encourages developing countries to supplement their health programs with traditional herbal preparations provided they are proven to be nontoxic.[33] As revealed by the WHO, approximately 80% of the world's population depends on traditional medicinal systems for some aspect of primary health care.[34] Herbal prescriptions are employed for the treatment of various diseases, and the vast majority of people use these products as first-line remedies.[35] Currently, attention has been drawn to claims by the traditional herbal medicine practitioners on the availability of herbal medicines for the prevention and cure of COVID-19. As a matter of fact, there are currently irrational uses of medicinal plants with antimalarial activities for the prevention of this disease.

It is interesting to state that there are several conventional medicines that were originally derived from medicinal plants. Some of these were mentioned earlier (see Need to Look in the-Direction of Medicinal Plants section). It is now obvious that the future of pharmaceutical companies is on developing lead therapeutic molecules from natural sources. However, despite the profound therapeutic benefits possessed by these medicinal plants, some constituents of these agents have been shown to be potentially toxic, mutagenic, carcinogenic, and teratogenic.[36] *Azadirachta indica*, *Morinda lucida*, and *Enantia chlorantha* have been shown to possess mutagenic potentials in modified Ames assays,[37] while *Alstonia boonei* has been demonstrated to induce testicular and kidney damage.[38] The major concerns with herbal medicines use are the safety and efficacy of these preparations. Pharmacological and toxicological studies are often used to determine the efficacy and safety profile of these products. However, scientific investigations on herbal medicines are complex with several confounding variables. Other prominent problems associated with herbal medicines use include lack of clinical trials on these products within western pharmaceutical clinical standards, dosage specifications, problems of proper packaging, appropriateness of the level of hygiene, cost of production and level of acceptability, especially among the elites in the health care team who continue to prescribe only orthodox/conventional medicines in hospitals and clinics. ACEDHARS provides a platform to overcome these identified challenges. Overall, medicinal plants have great potential to be used in COVID-19; however, there is a need for urgent scientific investigation of promising plants for their safety and efficacy.

Need for Collaboration and Integration

The rising use of traditional/herbal medicines has informed the WHO's decision to encourage its incorporation into the National Health Care Systems (NHCS) of countries and to inspire the formulation of national policy and regulations as important indicators of the extent of incorporation of traditional/herbal medicines within an NHCS.[32] Although traditional medicines in several countries, including Nigeria, have not been integrated into conventional medical practice, studies have confirmed the efficacy of some Nigerian medicinal plants that are used in indigenous medicine. Such plants include *Rauwolfia vomitoria* for managing hypertension, stroke, insomnia, and convulsion[39]; *Ocimum gratissimum* for managing diarrheal diseases[40]; the seeds of *Citrus parasidi* for managing urinary tract infections that are resistant to the conventional antibiotics[41]; pure honey for healing infected wounds faster than eusol; dried seeds of *Carica papaya* for the management of intestinal parasitosis; *Garcinia kola* for the management of osteoarthritis; and *Aloe vera* gel for the management of

scabies.[32] However, to harness the enormous benefits of herbal medicines, research, and collaborations among scientists/clinicians within the Universities/Research Institutes on the safety and efficacy of herbal preparations is of utmost importance, to facilitate integration and the co-recognition of traditional/herbal medicine practices into the National Health Care Scheme. In this regard, the following must be addressed for the integration to be successful: (1) Western medical doctors and health care practitioners must be receptive to the ideas of traditional African medicine; (2) traditional medical practitioners must be open to sharing their products and knowledge by allowing western doctors or health care practitioners to investigate and examine them using their own systems of research and fact findings; and (3) patients must be ready to use different types of medical treatments (orthodox or traditional system as obtainable in China and India) in maintaining their health.[32]

Having a clear understanding that the safety of herbal medicine use is dependent on policy and regulation, the government, international organizations, and stakeholders should step up efforts to harmonize all structures that will ensure effective implementation of policy and regulations to guarantee the safe use of herbal medicines. There is also a need to encourage the government, as well as donor agencies to support scientific validation of the safety and efficacy of herbal medicines while promoting their rational uses. Overall, the integration of traditional (herbal) medicine into a National Health Care Scheme will enhance the safe use of herbal remedies and the appropriate practice of traditional medicine.

ACEDHARS Plan Going Forward

ACEDHARS is endowed with professionals relevant to the drug discovery and development process. The Center is committed to increasing the critical mass of expert capacity relevant to the pharmaceutical industry through education and research engagements. At this moment of great need for the nation, the continent and the world in general, the Center is committed to meaningfully and productively contributing to the fight against COVID-19 by discovering and developing potential therapeutic agents, especially from the rich African flora. ACEDHARS has activated the necessary machineries to do the following. (1) Identify African medicinal plants with high potential to yield anti-COVID-19 standardized herbal formulations and drugs (bioactive molecules) and/or lead compounds. (2) Conduct appropriate in silico, in vitro, and in vivo studies using whole extract and a bioactivity-guided fractionation approach to achieve the goal set out in 1 above. (3) Propose clinical trials of promising standardized herbal formulations and bioactive molecules on COVID-19 patients. (4) Develop natural product-based (including plant-based) disinfectants. (5) Implement other conceived initiatives useful in the fight against the COVID-19 pandemic. The Center is open to collaboration with organizations and agencies (national, continental, and international) that share our goals and aspirations.

Conclusion

The current pandemic caused by the COVID-19 virus and its effect in Nigeria/Africa have been discussed. The ACEDHARS has identified the need to search for African-based natural products as potent anti-COVID-19 herbal remedies and natural compounds to be used as a homegrown solution to the pandemic. Caution against indiscriminate use of medicinal plants for the treatment of the disease has been highlighted as there is a need for pharmacological and toxicological studies to determine the efficacy and safety profile of these products. The role of governments in financing research and the need for integration and corecognition of traditional medicine into national health care systems cannot be overemphasized. Research is ongoing at the Center for anti-COVID-19 drugs from natural products.

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