OMICS A Journal of Integrative Biology Volume 24, Number 0, 2020 © Mary Ann Liebert, Inc. DOI: 10.1089/omi.2020.0150

Turning Up the Volume for Precision Herbal Medicine in Africa in an Era of COVID-19 and Planetary Biodiversity Loss

Nicholas Ekow Thomford, 1,2 Ewura Seidu Yahaya, Martins Ekor, and Charles Awortwe 4,5

Abstract

What would it take in terms of the structural reforms in science, technology, and culture to cultivate sustainable therapeutic and preventive medicine innovations against zoonotic infections such as coronavirus disease 2019 (COVID-19) in the 21st century? In May 2019, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services warned that "around one million animal and plant species are now threatened with extinction." Biodiversity is essential for drug discovery and development. We are currently facing a dual challenge in therapeutics innovation with COVID-19 and loss in planetary biodiversity. Hence, there is an urgent need for new ideas and strategies for drug discovery as well as repurposed drugs for the COVID-19 pandemic. To these ends, the existing scholarship in, and the field of precision herbal medicine provide an alternative source for discovery of novel therapeutics against the novel coronavirus. We propose that the application of precision herbal medicine in Africa could usefully contribute to current efforts for therapeutics innovation for the COVID-19 pandemic, and beyond. The pandemic calls for interdisciplinary dialogue and turning up the volume for precision herbal medicine in Africa, and importantly, in ways informed by robust systems science as well as broad public engagement to codesign medicines in the 21st century.

Keywords: precision herbal medicine, COVID-19, African traditional herbal medicine, biodiversity, planetary health, drug discovery

Perspective

THE CORONAVIRUS DISEASE 2019 (COVID-19) PANDEMIC caused by the novel coronavirus, officially known as the severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2), has spread across the globe with 675,060 deaths from 17,396,943 confirmed cases as of August 1, 2020, according to the World Health Organization (WHO). There is an urgent need for effective and safe vaccines as with novel drug discovery strategies and repurposed therapeutics to reduce morbidity and mortality of COVID-19. Hence, we begin this opinion piece with a question:

What would it take in terms of the structural reforms in science, technology, and culture to cultivate sustainable therapeutics innovations against zoonotic infections such as COVID-19 in the 21st century?

To answer, let us bring forward a broader and historical context.

First and foremost, until we examine through a critically informed lens, the human actions on the planet for the past centuries that have put wealth over planetary health, SARS-CoV-2 is unlikely to be the last zoonotic outbreak in the 21st century (Akar, 2020; Brabazon, 2020; Kickbusch et al., 2020). To this end, it is noteworthy that in May 2019, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services warned that "around one million animal and plant species are now threatened with extinction" (Díaz et al., 2019). The COVID-19 pandemic signals, in part, the effects of biodiversity loss and the blurred boundaries between human and animal habitats that have created a fertile ground for zoonotic infections and pandemics. In contrast, a collective cognizance on planetary health, biodiversity loss, and design

¹Division of Human Genetics, Department of Pathology and Institute for Infectious Disease and Molecular Medicine, Faculty of Health Sciences, University of Cape Town, Cape Town, South Africa

Sciences, University of Cape Town, Cape Town, South Africa.

Departments of ²Medical Biochemistry and ³Pharmacology, School of Medical Sciences, College of Health and Allied Sciences, University of Cape Coast, Cape Coast, Ghana.

⁴Institute of Experimental and Clinical Pharmacology, University Hospital Schleswig-Holstein, Kiel, Germany.

⁵Division of Clinical Pharmacology, Faculty of Medicine and Health Sciences, University of Stellenbosch, Cape Town, South Africa.

2 THOMFORD ET AL.

and implementation of strategic policies could turn the scale toward favorable biodiversity outcomes (Bull et al., 2020).

Biodiversity is essential for drug discovery and development particularly for antimicrobials as noted in the fungus Penicillium chrysogenum resulting in the discovery and isolation of penicillin in early 1940s (Newman and Cragg, 2016). Biodiversity has contributed immensely to the discovery of myriad compounds produced by the variety of species we share the planet with, including herbal plants with a notable success. Moreover, we have to bear in mind that COVID-19 is a zoonotic disease that jumped from animals to humans as noted earlier. It is estimated that 60% of known infectious diseases and $\sim 75\%$ new or emerging infectious diseases in people come from animals (Jones et al., 2008; Woolhouse and Gowtage-Sequeria, 2005). This indicates the need for real-time, vigilant, and planetary scale therapeutics innovation programs against zoonotic infections and new ways to buttress and empower planetary biodiversity.

Building a Systems Science Foundation for Precision Herbal Medicine

The pandemic has begun to spread in the global South including Africa by February 2020 (CDC, 2020; Massinga Loembé et al., 2020). As the scientific community continues to search for new or repurposed drugs for COVID-19, in contrast, there was an increased demand for herbal "COVID-Organics" by the Madagascar Institute of Applied Research in April 2020. However, there was and still lack of reliable pharmacological and efficacy data to substantiate the report that the herbal tonic cures COVID-19. Undoubtedly, herbal medicines including Artemisia herba-alba, Catharanthus roseus, Pelargonium sidoides, Azadirachta indica, Moringa oleifera and many more are used in folk medicine by many cultures. The current pandemic presents an opportunity for further dialogue and turning up the volume for precision herbal medicine in Africa in ways informed by robust systems science, omics technologies, and glocal (global + local) practices of herbal medicine in society.

Precision herbal medicine that emphasizes the incorporation of biomarker and systems science research with herbal medicine with an eye to rational treatment algorithms can help leverage from the large body of scholarship in personalized medicine, molecular disease targets, and environmental factors (including microbiota and lifestyle) that are all needed as part of the glocal debates in finding new therapeutics and diagnostics solutions to the COVID-19 pandemic.

We propose that an ecological approach to drug discovery that takes into account local community knowledge base and one that deploys omics systems science technologies can enable precision herbal medicine in Africa and globally and thus empower the current efforts for therapeutics innovation for the COVID-19 pandemic and beyond (Sardas et al., 2020; Thomford et al., 2018a). A systems science and multiomics approach (Pirih and Kunej, 2018) to assess the mechanism of action, efficacy, and safety of African herbal medicine could help generate the much-needed robust evidence base that is crucial in discovery of new therapeutics against the COVID-19. African herbal medicine and its bioactive phytocompounds can be screened against the virus with modern multiomics technologies (proteomics, transcriptomics, genomics, and metabolomics) to decipher their potential molecular targets, clinical and planetary health effects.

The extent of the clinical severity of COVID-19 is strongly mediated by immune response that varies among infected patients. Defined bioactive compounds modulating the immune system and response offer prospects for therapeutics innovation (Florindo et al., 2020), whereas the idea of immune boosting remains contested and calls for future research on the complex ways in which immune system interacts with the virus and patients' recovery from COVID-19. Deciphering the molecular actions of defined bioactive compounds in herbal medicines with an eye to effects on the immune pathways remains an important focus area for precision herbal medicine as exemplified by artemisinin in herbal hartemisia annua for treatment of fever, malaria, and respiratory tract infections in Africa and other continents (Cheong et al., 2020).

African countries have a long history of and engagement with African traditional herbal medicine that presents a dual opportunity for therapeutics innovation and buttressing ecosystem health especially considering the threats to planetary scale loss of biodiversity that was used to sustain novel drug discovery in the past.

Translational multiomics-based sciences and systems pharmacology offer a platform for identification of compounds through multilayered and interactive biological networks, biomarkers, and targets for innovative therapeutics for COVID-19 (Özdemir, 2015; Thomford et al., 2018b). COVID-19 being a multisystemic disease will also require novel therapeutic compounds to combat the disease over and beyond the current pandemic. Preclinical and clinical trials of mechanistically defined herbal medicines and other plant-based drugs, for example, artesunate that are currently known and used in African countries to have immunomodulatory and antiviral properties are urgently required to be undertaken as part of the precision medicine research that is necessary for COVID-19.

Similar efforts for therapeutics innovation using traditional and herbal medicines have been made against the complex and diverse clinical findings of COVID-19 around the world, including in China (Xiong et al., 2020; Xu and Zhang, 2020). Such efforts to bridge traditional therapeutics folklore in local communities would benefit from deploying systems science concepts and multiomics technologies so as to build a strong evidence base and independent replication of the findings essential for progress in global science.

It should be clear by now that addressing the COVID-19 pandemic is only a first step in the arduous and long-haul task of pandemics in the 21st century. While facing a serious biodiversity loss, we can harness a twin success by enhancing biodiversity on the planet and a deeper scientific understanding of the mechanism of action and clinical pharmacology of herbal medicines. Protecting and effective utilization of herbal medicine biodiversity (Yacoub et al., 2014) will be key to combating future diseases and pandemics. Nature in this regard cannot be continuously dismissed as it has always come to the rescue of humankind when it needed it most (Neergheen-Bhujun et al., 2017).

The success of precision herbal medicine in the COVID-19 era calls for an "all hands-on deck" approach and the collective efforts of the African scientists, local communities, health care workers, critical social sciences, and humanities scholars as well as governments. African countries have built a strong foundation in theory and practice of

systems science over the past several decades and are well poised to deliver on the scientific potentials of precision herbal medicine in a time of COVID-19 and threats to biodiversity in the current century.

Author Disclosure Statement

The authors declare they have no competing financial interests.

Funding Information

This article received no funding. Dr. Nicholas Thomford's research is supported by the National Research Foundation (NRF) of South Africa through the rated researcher's incentive funding and the International Foundation of Science (IFS), Sweden.

References

- Akar I. (2020). Post-coronavirus Disease 2019 Health Care and University: From Efficiency to Resilience. OMICS 24, DOI: 10.1089/omi.2020.0111.
- Brabazon H. (2020). The academy's neoliberal response to COVID-19: Why faculty should be wary and how we can push back. Academic Matters. https://academicmatters.ca/neoliberal-response-to-covid-19/ Accessed August 10, 2020
- Bull JW, Milner-Gulland EJ, Addison PFE, et al. (2020). Net positive outcomes for nature. Nat Ecol Evol 4, 4–7.
- CDC. (2020). Coronavirus Disease 2019 (COVID-19). https:// www.cdc.gov/coronavirus/2019-ncov/index.html Accessed August 8, 2020.
- Cheong DHJ, Tan DWS, Wong FWS, and Tran T. (2020). Antimalarial drug, artemisinin and its derivatives for the treatment of respiratory diseases. Pharmacol Res 158, 104901.
- Díaz S, Settele J, Brondízio ES, et al. (2019). Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Project Report. https://www.ipbes.net/sites/default/files/ downloads/spm_unedited_advance_for_posting_htn.pdf
- Florindo HF, Kleiner R, Vaskovich-Koubi D, et al. (2020). Immune-mediated approaches against COVID-19. Nat Nanotechnol 15, 630–645.
- Jones KE, Patel NG, Levy MA, et al. (2008). Global trends in emerging infectious diseases. Nature 451, 990–993.
- Kickbusch I, Leung GM, Bhutta ZA, Matsoso MP, Ihekweazu C, and Abbasi K. (2020). Covid-19: How a virus is turning the world upside down. BMJ 369, m1336.
- Massinga Loembé M, Tshangela A, Salyer SJ, Varma JK, Ouma AEO, and Nkengasong JN. (2020). COVID-19 in Africa: The spread and response. Nat Med 26, 999–1003.
- Neergheen-Bhujun V, Awan AT, Baran Y, et al. (2017). Biodiversity, drug discovery, and the future of global health: Introducing the biodiversity to biomedicine consortium, a call to action. J Glob Health 7, 020304.

- Newman DJ, and Cragg GM. (2016). Natural products as sources of new drugs from 1981 to 2014. J Nat Prod 79, 629–661.
- Özdemir V. (2015). OMICS 2.0: An accelerator for global science, systems medicine and responsible innovation. OMICS 19, 579–580.
- Pirih N, and Kunej T. (2018). An updated taxonomy and a graphical summary tool for optimal classification and comprehension of omics research. OMICS 22, 337–353.
- Sardas S, Buyuk AS, and Beceren A. (2020). It is time to revitalize the antibiotic pipeline: Systems ecology can help. OMICS 24, 124–128.
- Thomford NE, Dzobo K, Chimusa E, et al. (2018a). Personalized herbal medicine? A roadmap for convergence of herbal and precision medicine biomarker innovations. OMICS 22, 375–391.
- Thomford NE, Senthebane DA, Rowe A, et al. (2018b). Natural products for drug discovery in the 21st century: Innovations for novel drug discovery. Int J Mol Sci 19, 1578.
- Woolhouse ME, and Gowtage-Sequeria S. (2005). Host range and emerging and reemerging pathogens. Emerg Infect Dis 11, 1842–1847.
- Xiong X, Wang P, Su K, Cho WC, and Xing Y. (2020). Chinese herbal medicine for coronavirus disease 2019: A systematic review and meta-analysis. Pharmacol Res 160, 105056.
- Xu J, and Zhang Y. (2020). Traditional Chinese Medicine treatment of COVID-19. Complement Ther Clin Pract 39, 101165.
- Yacoub K, Cibis K, and Risch C. (2014). Chapter 1: *Biodiversity of Medicinal Plants:* Biodiversity of Natural Products and Cancer Treatment (World Scientific, Munich). pp. 1–32.

Address correspondence to:
Nicholas Ekow Thomford, PhD
Division of Human Genetics
Department of Pathology and Institute for Infectious
Disease and Molecular Medicine
Faculty of Health Sciences
University of Cape Town
Anzio Road, Observatory
Cape Town 7925
South Africa

E-mail: nicholas.thomford@uct.ac.za

Abbreviations Used

COVID-19 = coronavirus disease 2019 SARS-CoV-2 = severe acute respiratory syndrome-coronavirus-2 WHO = World Health Organization