Positive Therapeutic Role of Some Selected Food and Plant on Covid-19: A Review

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Abstract

With each passing day since December 2019, more cases of the novel coronavirus (Covid-19) infection are being detected and it has spread through all continents of the world except in Antarctica. The virus is transmitted through contact with an infected environment or person, and the symptoms include fever, cough, and then the difficulty in breathing. Health care systems of so many countries are overwhelmed with limited therapeutic options available and no vaccine has yet been approved. Africa also with its poor health care systems could be the worst hit continent if other therapeutic alternatives are not explored. Hence this review looked into the source and origin of the Covid-19 infection and alternative therapeutic option through the use of available and cheap medicinal foods and plants that have been touted to alleviate similar infections. The review findings have likewise demonstrated the inhibitory activities of selected food crops and plants against human viruses similar to the novel Covid-19 virus.

Keywords: Covid-19, antiviral activity, foods, plants, therapeutics

1. Introduction

Viruses are still a source of great danger to human health. They are constantly evolving and are the causes of great infections globally. Viral diseases are infectious and the cause of most of the pandemics/epidemics in recent history. For example, the Spanish flu of 1918

29 which was described as the deadliest pandemic recorded history was caused by a very
30 deadly strain of the Influenza virus (H1N1). It infected about 500 million people with about
31 17-50 million deaths worldwide [1]. Viruses are obligate intracellular parasites with a
32 genome which could be either RNA or DNA and a protein envelope which is called
33 ‘capsid’. Viruses do not possess metabolism and therefore cannot replicate and
34 biosynthesize on their own [2]. However, on entering a living system, penetrates the host
35 cell and release its genetic material, it then reprograms the host cell and directs the
36 metabolic pathway of the host cells for its repeated replication [2]. Thus, it is aptly
37 described as “a piece of bad news wrapped in a protein coat [3].”

38 In recent times, several new viral diseases have emerged such as Human
39 Immunodeficiency Virus (HIV/AIDS), Hepatitis B, and C and dengue haemorrhagic fever,
40 all of which have resulted in numerous death worldwide [4]. Moreover, several localized
41 epidemics in recent times have also been linked to viruses such as Ebola haemorrhagic
42 fever in the tropical region of Sub-Saharan Africa caused by Ebola virus, Lassa
43 haemorrhagic fever in West Africa caused by Lassa virus [5], a severe acute respiratory
44 syndrome which broke out in China in 2003 caused by SARS-associated coronavirus
45 (SARS-CoV) and the middle east respiratory syndrome which broke out in Saudi Arabia
46 in 2012 caused by another strain of coronavirus [6]. This unique characteristic of viruses
47 makes them difficult to control despite considerable development in medical sciences and
48 as such there are still relatively few drugs for the treatment of viral diseases [7].

49 Although several antiviral drugs have been discovered and approved for use, they have a
50 narrow range of activity against many viral infections [4]. This is because viruses can
51 rapidly mutate with new strains emerging thus making them develop resistance to drugs
52 that have previously been targeted to a particular viral component [8]. Since there are

several food crops and plants that have shown antiviral effects against different viral infections, there is an urgent need to look into them as traditional/alternative medicines for therapeutic options in the absence or insufficient orthodox medications [9]. *Nigella sativa* as reported by Oyero et al. [10] can inhibit hepatitis C virus, essential oil of star anise has been demonstrated to inhibit herpes simplex virus type 1 [11], *Allium sativum* (garlic) has also been demonstrated to inhibit infectious bronchitis virus and influenza virus [12]. *Glycyrrhiza glabra* has also been reported to possess activity against hepatitis A virus, hepatitis B virus, influenza virus, and HIV-1 and also inhibit the replication of SARS-associated coronavirus in vivo [4].

Currently, the entire world is battling a Covid-19 pandemic caused by a novel coronavirus SARS-CoV2. This virus made its way to the Africa Region with confirmed cases of 23,254 and 903 deaths [13]. Like most viral infections, as of the time of writing this review work, there is no cure or vaccine for the virus. The overwhelming effect this pandemic had on the health care system of even the most advanced nations is huge such that Africa (especially Sub-Saharan Africa) may not be able to survive it. There is, therefore, a need for researchers in Africa to think outside the box to quickly nip this pandemic in the bud before its effect becomes devastating.

Some drugs have been reported to be effective for the treatment of Covid-19. Nucleoside inhibitor produced by Gilead Sciences Inc. was found to be efficacious in treating a patient with nCoV-2019 in the United States [14]. Also, Remdesivir (an adenosine analogue) which was effective against Ebola and some other RNA viruses was approved by Food and Drug Administration (FDA) on the 1st of May 2020 for emergency use in the treatment of hospitalized Covid-19 patients. Furthermore, Gautret [15] revealed a 93% recovery rate when the combination of hydroxychloroquine and azithromycin was used to treat the

patient for 8 days. However, the rapid spread of the novel coronavirus and the limited therapeutic options makes this virus a serious health challenge. There is, therefore, a need to explore the therapeutic use of alternative medicine, which has been proven effective in literature against several viral infections. This report attempts to look into some common Nigerian foods and plants with antiviral effect and their possible efficacy against the raging pandemic virus.

2. Coronaviruses and Covid-19: An overview

Coronaviruses so named because of the crown-like spikes (Fig. 1) on the outer surface of the viruses are of the family *Coronaviridae* in the Nidovirales order. They are enveloped, RNA viruses as their nucleic material is a non-segmented single-strand RNA which, are sub-grouped to alpha (α), beta (β), gamma (γ) and delta (δ) [16] ranging from 26 to 32kbs in length and from 80 to 160nm⁹ in size. Coronaviruses cause several diseases including bronchitis, hepatitis, gastroenteritis which could all lead to death in humans, birds, and other animals [17].

The former outbreaks of coronavirus are the severe acute respiratory syndrome virus (SARS-CoV) which broke out in Guangdong, China in 2002 [18] and was thought to only infect animals. Not until the Middle East Respiratory Syndrome Virus (MERS-CoV) broke out in Saudi-Arabia in 2012 [19] and was found to infect human. The recent strains of human coronaviruses were identified after intensive screenings; they are HCoV-NL63 and HCoV-HKU1 [20]. These viruses cause acute lung injury and acute respiratory distress syndrome leading to pulmonary failure and fatality in humans.

A recent outbreak is the β -coronavirus (SARS-CoV2) which broke out from Wuhan, China in 2019, where infected people suffer cough, fever, fatigue, and myalgia. They later developed pneumonia and 30% of them developed severe acute respiratory syndrome which required

admission into intensive care unit [21]. The virus has continued to spread rapidly, traversing countries and continents and was declared a pandemic by WHO on 11th of March, 2020 having infected over 3million people with over 200,000 deaths globally [13]. It infects all groups of people with more fatality among the geriatrics or people with comorbidities such as diabetes, hypertension, Parkinson's disease, chronic obstructive pulmonary disease (COPD), cardiovascular disease and cancer [22,24-25]. This SARS-CoV2 (nCoV-19) is very similar to SARS-CoV (nCoV-2002) as gene sequencing has suggested about 85% similarity. However, a single mutation (N501Y) of the spike protein of SARS-CoV2 has been suggested to be the reason for its increased binding affinity to host receptor cells. Coronavirus penetrates the cell of the host via interaction of the receptor of the host cell with the S-protein of the virus. After entry into the host cell and uncoating of the genome, the virus starts its replicative cycle [20].

SARS-CoV2 (nCoV-19) has described by WHO (2020) is transmitted via droplets, physical contact with an infected person, and aerosol transmission. Its incubation period is 1-14 days with symptoms such as fever, cough, and shortness of breath which may appear from 2-14 days after exposure [23]. This is diagnosed through viral gene checks by polymerase chain reaction (PCR), enzyme-linked immunosorbent assay (ELISA), high throughput sequencing and computed tomography (CT) scan of the lungs. The Centre for Disease Control and Prevention (CDC) mentioned in a report that specimens used for testing could be nasopharyngeal swab, sputum, lower respiratory tract secretions, blood and faeces.

3. Combating the scourge of nCoV-19 with natural therapies

With the limited therapeutic options available to combat this nCoV-19 pandemic, and its rapid spread all over the world, the need to explore natural therapies cannot be over-emphasized. During the outbreak of SARS in 2002, China used the combination of traditional Chinese herbal medicine and western medicine, which proved effective in alleviating the symptoms of SARS [24]. Herbal traditional medicine has been employed in the management and treatment of nCoV-19 infection. A report has it that 50 Covid-19 patients treated with the Chinese herbal drug Taijie Quwen granule improved significantly without any symptoms after 7 days [25]. The author reported that the drug reduced the occurrence of severe pneumonia in patients. Also, an herbal concoction “*Qingfei paidu*” used in treating 214 Covid-19 patients in China yields a positive result of more than 90% efficiency [25].

Artemisia annua, *Pyrrhosia lingua* and *Lindera aggregata* have been reported to possess antiviral effect against SARS-CoV [26]. Emodin from *Polygonum multiflorum* also inhibits the interaction between S-protein of SARS-CoV and ACE2 receptor (the receptor the virus employs to infect host cells). Phenolic compounds from black tea (tannic acid, 3-isothaflavin-3-gallate and theaflavin-3,3¹-digallate) have also been reported to inhibit the chymotrypsin-like protease of (3CL^{pro}) of SARS-CoV [26].

Since SARS-CoV has the same similarity as the novel nCoV-19, food crops and plants possessing antiviral activity can be explored as a therapeutic alternative. Among the notable food/plant, their bioactive components, a virus in which they have been used to treat and their mechanism of actions, are summarized in table 1 below. Many of these plants or foods possess antiviral activities against more than one virus. Majority of them inhibit the viruses at the viral replication phase, while some inhibit the adsorption of viral particles

to host cells thereby preventing viral entry into host cells. These antiviral foods/plants possess active components which attack viruses at different points or stages. Turmeric, for example, has an active component called curcumin which exhibits antiviral activity against viruses like herpes simplex virus, HIV, hepatitis virus and respiratory syncytial virus. The positive effect of curcumin in turmeric is to inhibit the growth and replication of viruses, which makes it a contender for antiviral drugs [47]. These foods/plants work in a cycle for effective antiviral action, unlike orthodox antivirals which are specific for a particular antiviral activity. Some common, cheap, available and accessible foods/plants with antiviral properties available in Nigeria and other countries around the world, such as *Allium sativum* (garlic), *Zingiber officinales* (ginger), *Moringa oleifera*, *Glycyrrhiza glabra* (liquorice/licorice), are discussed further.

3.1 *Allium sativum* (Garlic)

Garlic (*Allium sativum*) of the family *Liliaceae* has been utilized worldwide for culinary and therapeutic reasons with grand impacts with mending powers [48], containing an anti-toxin (allicin) and sulphides. The natural dynamic part of allicin and its derivatives have helped garlic to find utilization as a medication for heart and blood sicknesses and conditions including hypertension, elevated cholesterol [49] and cardiovascular infections. Garlic has been utilized for its antiviral, antibacterial and antifungal characteristics. Kaefer [50] reported that garlic is an ideal therapeutic option in constant bronchitis infection because it induces expectoration, thereby making the syrup of garlic an important medication for asthma and other issues of lungs.

The anti-viral action of garlic is credited to its organosulphur compounds (quercetin, allicin, diallyl, trisulfide, and ajoene) according to the report of Sharma [51]. Allicin is the

main chemical present in garlic and it is responsible for the flavour of garlic. The presence of allicin limits the raw intake of garlic due to emotional perceptions such as awful taste, bad breath and personal stench. Allicin has been demonstrated to possess broad antimicrobial activity both in-vitro and in-vivo [12]. The significant anti-microbial activity of allicin is the consequence of a chemical reaction of allicin with thiol groups of various enzymes which are necessary for microorganism surveillance [12]. It has been demonstrated that assaults of basic cold infection are prevented by allicin-containing supplements [51]. Allicin, are known to possess the ability to pass through the phospholipid membrane of the cell, inhibiting viral multiplication. Allicin can modulate the immune system in response to viral infection, it is therefore suggested that the inclusion of aged garlic in the diet can enhance immune cell function [51].

The presence of quercetin in garlic can prevent viral entry and inhibit replication [52], thereby minimizing viral infectivity. Gonzalez [53] observed that quercetin inhibits the translation process of the hepatitis C virus. Literature has it that quercetin derivatives can increase zinc uptake, which can inhibit RNA polymerase [54]. Sharma [51] mentioned that flavonoids in garlic have a strong inhibitory effect on virus multiplication. The formation of protein and genetic material in the virus has also been reported to be blocked by phytochemicals present in garlic [55].

The inhalation of essential oil of garlic has been publicized as beneficial as it alleviates or prevents the inflammation and constriction of the airways since these compounds can easily pass through the air-blood barrier via inhalation in cases of mild symptoms of the infection [56]. Lissiman et al [56] reported the efficacy of garlic in treating common cold caused by rhinoviruses and human coronaviruses due to the antiviral properties of the compound allicin/ajoene. It has also been reported that garlic acts as immunomodulator as

it possesses mitogenic activity towards human lymphocytes, splenocytes and thymocytes, thereby enhancing the immune response against viral pathogens [4]. Garlic has also been demonstrated to possess antiviral activity against the coronavirus; avian infectious bronchitis virus (IBV) in poultry in its replication phase [57]. The main protease M^{pro} (key in the proteolytic maturation of the virus) of both SARS-CoV and nCov-19 are 96% similar in their active sites, this implies that the bioactive compounds present in garlic could be effective for both viruses, in the following order of effectiveness Kaempferol > Quercetin > Allicin [29].

3.2 *Zingiber officinales* (Ginger)

Ginger (*Zingiber officinales*) Roscoe, belonging to the family Zingiberaceae is a perennial plant with a thick rhizome that is commonly used as a spice. It can be consumed in raw form, as spices, or the dried powdery form used in confectionery and brewing purposes. Ginger originated from warm tropical climates and grown in Africa, Asia, Jamaica, India, Hawaii and Mexico. Ginger is used for culinary [58] and medicinal (cold, nausea, asthma, respiratory disease and rheumatism) purpose [59]. The compounds in ginger are responsible for the distinct aroma and taste (sesquiterpene and monoterpenoid hydrocarbons) the strong smell and flavour (gingerols, shogoals, paradols and zingerone) of ginger [59]. These later components are responsible for the various bioactivities of ginger such as anti-inflammatory, antiviral, antimicrobial and antioxidant activities [59].

Fresh ginger has been found to possess antiviral activity against the human respiratory syncytial virus in both upper and lower respiratory tract cell lines producing about 70% decrease in infection [30]. It is more effective when administered before inoculation with the virus. Garlic inhibits the spread of the virus, by constraining the viral attachment and

penetration into host cell lines. Ginger has also been reported to increase the activities of antioxidant enzymes such as glutathione peroxidase and superoxide dismutase, which are suggested to be helpful in an inflammatory reaction triggered by viral infections [60].

Dorra [61] confirmed ginger to inhibit influenza virus (H5N1) in-vitro by preventing the formation of plaque. Another study reported the efficacy of a combination of honey, ginger and garlic in inhibiting the replication of influenza virus in mammalian cell lines (MDCK monolayers) and human lymphocytes. This combination also stimulates the proliferation of uninfected T-lymphocytes [62].

3.3 *Ocimum basilicum* (Basil)

Basil (*Ocimum basilicum*) also known as scent leaf or fever leaf, is a shrub of the Lamiaceae group of plants. It is local to Central Africa and Southeast Asia but also planted in Nigeria, Southern American and Asia nations [63]. It is one of the basic herbs consumed in many parts of the world as a result of its palatability and asserted therapeutic advantages in the treatment of cold, lower and upper respiratory tract infection conditions in some African nations [64].

Basil leaves have been accounted to have calming, antiparasitic, cytotoxic and pain-relieving possibilities [65]. The characteristic smell of basil is credited to its main volatile essential oil, bounded to the green basil leaves and known to be rich in aldehydes, terpenes and phenols. The aqueous and alcoholic extract of the leaves has been reported to possess antimicrobial activity against different enteric pathogens such as *Salmonella typhimurium* and *Shigella dysenteriae* [66] due to its significant constituents such as eugenol, methyl eugenol, caryophyllene.

The essential oil of basil leaves contains an important chemical compound known as eugenol, which has been reported in the literature to produce a powerful anti-viral activity [67]. Raja et al [67] reported that concentrates of basil in various forms have anti-viral activity against infections such as herpes virus and hepatitis B. Ethanolic concentrates of basil leaves in a range of 22.5mg/ml concentration restrains replication of polio type 3 infection in Vero cells. The extracted parts of this plant such as linalool, apigenin and ursolic acid show an expansive range of anti-viral action against DNA virus (adenoviruses) and RNA viruses [68]. Basil has been reported to have powerful healing properties for treating measles in kids [67].

Extracts and selected purified components of basil, has been utilized in traditional Chinese medications, they were found to have various degrees of potency against adenoviruses and enteroviruses [31] due to their wide range of anti-DNA and RNA virus activities. In this manner, the potential use of basil in crude and/or purified components in the treatment of viral infections justifies further study as a therapeutic agent in the treatment of coronavirus.

3.4 *Moringa oleifera* (Drumstick)

Moringa oleifera is a plant belonging to the family Moringaceae, a single genus family with 13 known species [69]. *M. oleifera* plant has been used for years for traditional, medicinal and industrial uses. The parts (leaves, fruits and seeds) of the plant are eaten as a vegetable and are added in a regular diet for their capacity in combating several health issues. The leaves of *M oleifera* in the fresh, cooked or dried form has been found as another food to combat malnutrition [69]. Every part of the plant is said to have beneficial properties that can serve humanity, as a medicinal and nutritional plant, this is why it's commonly called Miracle Plant [69].

268 For a very long period, Moringa has been used to treat ailments like bronchitis, catarrh,
269 chest congestion, asthma, anaemia and many others [70]. *Moringa oleifera* leaves and seed
270 flour are a good source of natural antioxidants and various phenolic compounds [71]. *M.*
271 *oleifera* acts as an antiviral, diuretic, antipyretic, anti-inflammatory, anticancer and
272 antibacterial plant [38]. *M. oleifera* possesses antiviral activity against equine herpesvirus
273 1, herpes simplex virus 1 and foot and mouth disease virus [72].

274 *M. oleifera* have also shown to have antiviral activity against HIV as it inhibits early events
275 involved in the viral replication cycle, and it also possesses immunomodulatory activity
276 thus effective in immune-boosting [37]. In a recent study on Covid-19 patients, the capsule
277 of *M. oleifera* extracts alongside some other plants were investigated as a therapeutic
278 option with a promising result which needs further investigation [73].

279 *M. oleifera* is a high source of mineral Zinc (Zn), making the plant an effective local and
280 inexpensive solution in fighting zinc deficiencies [69]. The zinc content of *M. oleifera*
281 leaves ranges in literature from 31.03 mg/kg to 32.90±0.85 mg/kg. These values are around
282 the range (25.5–31.03 mg of zinc/kg) reported by Barminas [74] to be the daily requirement
283 of zinc in the diet. The presence of Zn in high amounts is of importance in the diet of
284 animals and humans. A good dietary intake of zinc has been reported to be necessary for
285 the synthesis of DNA and RNA, insulin and function and/or structure of several enzymes
286 [75]. Zinc controls the enzymes that run and renew the cells in the body, maintaining the
287 immune functions including cellular and humoral immunity. The study of Gammoh [76]
288 reported how critical is it for zinc homeostasis to be balanced in invading pathogens and
289 protecting the body against an overreactive immune system causing autoimmune diseases.
290 Zinc has been recognized as a potential therapeutic for people suffering from immune and
291 inflammatory diseases [76].

Zinc is known for its anti-viral, antibacterial, anti-fungal and anti-cancer properties [75]. Zn ions inhibit viral entry, local replication, and spread to the organ during viral pathogenesis process [76]. The commonest metal to bind with a virus-protein is zinc. Zn^{2+} is an integral part of some viral proteins and plays an important role in their survival and pathogenesis. Zn^{2+} functions as a cofactor of viral proteins, suggesting that the accessibility of zinc ions in infected cells could be a potentially limiting factor in the virus life cycle. As discussed by Ishida [77], Zn^{2+} in virus neuropathogenesis play significant functions for HIV-1 infection, and HIV-induced central nervous system (CNS) inflammation and neurodegeneration.

Zinc lozenges or syrup resulted in a speedy recovery from the common cold and reduce its symptoms within 24 hours. Zinc supplement has been observed to ‘decreases the morbidity of low respiratory tract infection in pediatric patients in the developing world. The author confirmed a strong establishment between zinc deficiency and several infections such as human immunodeficiency virus (HIV), tuberculosis and pneumonia. Ishida [77] also reported that abnormality seen in HIV infected patients can be prevented with the inclusion of zinc in their diet since low levels of plasma zinc can predict a three-fold increase in HIV-related mortality. Therapeutic use of *M. oleifera* for its high amount of zinc could perform the same antiviral function, and this needs to be established, especially for the case of coronavirus pandemic.

3.5 *Glycyrrhiza glabra* (Licorice)

Glycyrrhiza glabra commonly referred to as liquorice/ licorice is an herbaceous perennial plant belonging to the family *Fabaceae*. It has been used for thousands of years as a flavouring agent in food and herbal remedies. The root of *Glycyrrhiza glabra* has been used as cough remedies since ancient times [78]. The dried rhizomes and roots have been

316 used traditionally as an expectorant, to alleviate symptoms of throat and bronchial infection
317 for more than 2 millenniums. Also, the report of Al-Snafi [78] indicates that the rhizomes
318 and roots of *G. glabra* have been used to treat lung infections, gastric ulcer and Addison's
319 disease. It has also been used to treat sore throat, influenza, cold, and employed as a
320 bronchodilator, anti-syphilitic [78].

321 The bioactive components in *G. glabra* are glycyrrhizin, glycyrrhetic acid, flavonoids,
322 isoflavonoids and chalcones [79]. The extracts of *G. glabra* and one of its bioactive
323 constituent's glycyrrhizin have been reported to inhibit the replication of several viruses
324 including herpes simplex virus (HSV), hepatitis A, B & C viruses, Epstein-Barr virus,
325 human immunodeficiency virus (HIV), influenza virus and SARS-associated coronavirus
326 [39]. The study of Michaelis shows that glycyrrhizin component in *G. glabra* at 100µg/mL
327 concentration is significant in inhibiting influenza virus (H5N1) [79].

328 Glycyrrhizin has also been found to inhibit viral replication, adsorption and penetration in
329 the case of SARS-associated coronavirus [40] which are early steps in the viral replication
330 cycles with better efficiency when administered during and after the adsorption period.
331 Glycyrrhizin inhibits SARS-associated coronavirus replication in-vivo, while its aglycone
332 metabolite (glycyrrhetic acid) inhibits inflammatory responses which occur as a
333 consequence of viral infection [79].

334 The summary of the review work describing the mode of infection, the therapeutic
335 approach in the treatment of an infected person is displayed in a schematic diagram shown
336 in Figure 2. This pandemic has imposed a huge burden on the economy, religion, education
337 and all social activities around the world. There is a need to revisit free, cheap and available
338 plants and food to aid the discovery of drug, vaccines, nutraceuticals or functional food
339 that will prevent and treat the coronavirus infection. Most of the plants and foods described

in this review work are cheap, accessible, and available in most parts of the world and can be easily administered.

4. Conclusions

With limited antiviral drugs and vaccine in existence and the rapid mutation of the virus leading to the constant emergence of new strains, it is a matter of urgency to continually find a natural remedy in combating these viruses. As a result, the novelty of the nCoV-19 virus also makes it very important to look into herbal therapies which have proven effective over time as orthodox therapies limited with a mixed result for therapeutic alternative against some infection. Also the combined synergistic effect of the active ingredients in plants could be beneficial in the treatments of these viral infections as each component could attack virus at different infective stages. The immune modulatory effects of some of these foods and plants could serve as protection or prevention from future infections.

Although there is no conclusive evidence on the efficacy of these reviewed plant materials against the Covid-19 infection, however, their activity against similar infections in-vitro and in-vivo can be explored as a therapeutic option for the pandemic virus and other viral ailments. Molecular techniques and agriculture may increase the usefulness of the key components useful in this or related disease(s).

Conflict of interest

No potential conflict of interest

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609 Fig. 1: A schematic diagram of the coronavirus structure (Adapted from Peiris and Poon
610 [22])

611

Table 1: Foods/plants, and their bioactive components in the treatment of the virus

FOOD/PLANT	BIOACTIVE COMPONENT	VIRUS	MECHANISM OF ACTION	REFERENCE
<i>Allium sativum</i> Garlic root and essential oil	Allicin, ajoene, diallyl disulphides, kaempferol and quercetin	Influenza virus; Newcastle disease virus	Inhibits viral multiplication	[27]
<i>Zingiber officinales</i> Fresh ginger	Gingerols, zingerol, catechin, kaempferol, naringenin, gingerols, zingiberone	SARS-CoV SARS-CoV2 Human Respiratory Syncytial Virus	Inhibits ACE2 protein; Inhibit M ^{pro} Inhibit M ^{pro} Inhibits viral replication via secretion of IFN- β	[28] [29] [30]
<i>Ocimum basilicum</i> Basil leaf extract and essential oil	Ursolic acid, apigenin, linalool	Herpes simplex virus, Adenovirus, Hepatitis B virus, Enterovirus	Inhibits viral multiplication and replication, Inhibits secretion of viral antigen	[31]
<i>Curcuma longa</i> Turmeric	Curcumin	HIV type 1 and 2 HIV Hepatitis viruses Influenza virus, Respiratory syncytial virus	Inhibit viral replication Inhibition of viral proteases Inhibits viral replication Inhibits viral entry, replication and budding	[32] [33] [34] [35]
<i>Moringa oleifera</i> Leaf extract	Niaziminin, quercetin, kaempferol	Influenza virus, HIV Equine herpes virus Type 1 and type 2 herpes simplex virus	Inhibits viral cytotoxicity and possess immunomodulatory effect Inhibits viral replication	[36] [37] [38]
<i>Glycyrrhiza glabra</i> Liquorice/Licorice extract	Glycyrrhizin, Glycyrrhetic acid, 18 β -glycyrrhetic acid	SARS-CoV Hepatitis C Herpes simplex virus 1 Influenza A	Inhibits viral adsorption, penetration and replication Inhibit virus core gene expression Inhibit viral replication Reducing endocytosis and subsequently viral uptake	[39] [40] [41] [42]
<i>Cocos nucifera</i> Coconut oil	Lauric acid, monolaurin	SARS-CoV Vesicular stomatitis virus and avian Influenza virus	Disintegrates viral membrane, inhibits virus maturation, prevents the binding of viral proteins to host cell membrane	[43] [44]

<i>Bryophyllum pinnatum</i> (Life plant), <i>Viscum album</i> (Mistletoe)	Flavones, anthocyanidins, Polyphenols	Rhinovirus, picornavirus, measles, polio, herpes simplex virus. Rhinovirus, measles, polio, herpes simplex virus, picornavirus	Inhibits viral adsorption	[7]
<i>Echinacea purpurea</i>	Cichoric acid, Caffeic acid, Akylamides	Influenza virus (H5N1, H7N7)	Inhibits binding of virus to receptor and Viral replication	[45]
<i>Scrophularia scorodona</i>	Saikosaponnins	HCoV-22E9	Inhibits viral attachment and penetration	[46]

613 *Abbreviations:*

614 *ACE2: angiotensin-converting enzyme 2*

615 *M^{pro}: main protease*

616 *Interferon β (IFN- β)*

617 *Human immunodeficiency virus: HIV*

618 *HCoV: Human coronavirus*

619 Full abbreviations/acronyms are given in the online resource 1

622 **Fig 2: Schematic diagram showing the effects of foods/plants and their products as a**
623 **therapeutic approach on the treatment of nCoV-19. Adapted from [80]**
624

625 **Online Resource 1**

626 **Abbreviations:**

627 COPD - Chronic Obstructive Pulmonary Disease

628 CT- Computed Tomography

629 ACE2- Angiotensin Converting Enzyme 2

630 IFN- β - Interferon beta

631 M^{pro}- Main Protease

632 HCov- Human Coronavirus

633 TNF- α - Tumour Necrosis Factor Alpha

634 H5N1- Avian Influenza Virus

635 HIV- Human Immunodeficiency Virus

636 HSV- Herpes Simplex Virus

637 MDCK cell- Madin-Darby Canine kidney Cells

638