Chapter

Some Igbo Indigenous Plants with Anti-COVID-19 Properties

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Abstract

Coronavirus (COVID-19) has shaken the world not minding the strength of the global health system leading to over 824, 000 deaths amidst the search of a cure and total prevention. The Igbo states in Nigeria has the average prevalence of 711 cases of COVID-19 with the highest 1096 (Enugu) and least 207 (Anambra) as at 26th August, 2020. This chapter studied some Igbo indigenous plants in use since the outbreak and presents Bitter kola, Garlic, Giloy, Ginger, Lime, and Turmeric which are having anti-COVID-19 properties. The authors suggest that these plants have the properties that alter the PH on the interface between the virus spike proteins and the human respiratory surfaces causing a brake on the interaction with human ACE-2 and where interaction has taken place, the replication and translation stages are disrupted. The plants thus are potential modifiers of this milieu and inhibitor of the main protease and endoribonuclease via epigenetics and homeostasis. These plants consumption should be encouraged as prophylactic or curative measures pending the discovery of a definitive cure. The chapter recommends that the search for COVID-19 cure should not be limited to conventional medicines, rather should be extended to some indigenous plants in Igbo land.

Keywords: Igbo plants, anti-COVID-19, bitter kola, garlic, giloy, ginger, lime, turmeric

1. Introduction

COVID-19 pandemic is a global threat without any confirmed treatment regimen. The global community is on the trail to get preventive and treatment measures. The pandemic burden has increased the effort of traditional/herbal medicine practitioners across the globe and, Nigeria in particular towards arriving at a cure for the novel virus. Coronavirus (SARS-COV-2), a zoonotic disease

and the seventh member of coronaviruses was named COVID-19 and officially declared a pandemic on 11th February, 2020 and 11th March, 2020 respectively [1, 2]. There is no doubt that COVID-19 has posed a challenge to the best healthcare systems around the world; giving a leeway to herbal/plant experts to demonstrate their capacity.

On 26th August 2020, using Corona Scanner Realtime coronavirus statistics App (Free online dashboard solution), the Coronavirus has infected 215 countries of the world. Global Infections are 24,092,885 with 824,194 deaths showing 3.42% death rate and 69.04% survival rate (16,634,272 recovery) with daily infection rate at 223,070 persons. Nigeria is ranking 50 on the global list of infections with 52,800 reported cases, 1007 deaths showing a 1.91% death rate, and 75.69% survival rate (39,964 recoveries) as at 1.10 pm with a daily infection rate of 460 persons.

The COVID-19 pandemic is currently recording a higher number of infections on a daily bases because many Nigerian researchers had advocated stepping up of medical laboratory testing. The increased prevalence of COVID-19 is noted because of increased testing capabilities in various countries and, Nigeria, in particular [3, 4]. Already, the community transmission of the virus has increased while spread could be attributed to the zoonotic nature [5, 6] of the COVID-19. All approaches be it, surveillance, molecular testing, immunomodulation, conventional, or phytomedicine towards stopping the COVID-19 pandemic that needs to be adopted [7, 8].

In Africa, the use of herbs and concoctions in the management of various ailments has been recorded [9], and COVID-19 cannot be exempted. The index case as announced in Nigeria by FMOH [6, 10] left many herbal medicine practitioners to go back to their various products that could be used to contain the pandemic. The first line of herbs in consideration are edible and nutritious vegetables that could be readily approved by the scientific world have been consumed without toxic effects or have been scientifically approved in the past. This is where Bitter kola (*Garcinia kola*) Garlic (*Allium sativum*), Giloy (*Tinospora cordifolia*), Ginger (*Zingiber officinale*), lime (*Citrus limonum*), and Turmeric (*Curcuma longa*) belong and can be easily assessed and verified.

2. Igbo land in the time of COVID-19

Igbo land "Ala Igbo" is the South Eastern zone of Nigeria located at 1000 m (3,300 ft) above sea level and covers the area 41,440 km^2.

South-Eastern Nigeria (Igbo land) is part of the old eastern region that was part of Biafra. This geopolitical region is made up of five (5) states- Abia, Anambra, Ebonyi, Enugu, and the Imo States, as highlighted in **Figure 1**.

The language spoken in southeastern Nigeria is the Igbo language.

As of 26th August 2020 based on NCDC COVID-19 Situation Report (situation report 180), shows that Igbo land had 3553 cases out of 53,021 cases recorded in Nigeria with lowest case fatality of 8.32% (84 out of 1010 death cases in Nigeria) as derived from **Figure 1** [11].

Though there may be other factors that may be responsible for the fatality cases, the authors observed that the indigenous people of Igbo land both home and in diaspora made use of some of their indigenous plants during the COVID-19 not minding their places of abode.

STATES	CONFIRMED CASES		DISCHARGED CASES		DEATHS		TOTAL ACTIVE CASES	DAYS SINCE LAST REPORTED CASE
	TOTAL	NEW	TOTAL	NEW	TOTAL	NEW		
Lagos	18,035	17	15,227	13	202	0	2,606	0
FCT	5,079	33	1,468	18	50	2	3,561	0
Oyo	3,060	2	1,819	87	37	0	1,204	0
Edo	2,555	2	2,263	11	100	0	192	0
Plateau	2,245	60	1,187	19	29	0	1,029	0
Rivers	2,108	18	1,910	9	57	0	141	0
Kaduna	2,085	26	1,862	30	12	0	211	0
Kano	1,722	1	1,507	0	54	0	161	0
Delta	1,719	4	1,540	22	46	0	133	0
Ogun	1,633	2	1,462	15	26	0	145	0
Ondo	1,524	9	1,305	0	31	0	188	0
Enugu	1,096	9	852	0	21	0	223	0
Ebonyi	965	0	921	0	27	0	17	1
Kwara	945	9	740	0	25	0	180	0
Katsina	771	0	457	0	24	0	290	4
Osun	771	2	670	22	16	0	85	0
Abia	759	4	669	26	7	0	83	0
Borno	740	0	663	17	36	0	41	3
Gombe	719	5	609	4	23	0	87	0
Bauchi	645	1	547	2	14	0	84	0
Imo	526	3	192	5	11	1	323	0
Benue	451	0	141	0	9	0	301	2
Nasarawa	427	6	298	0	12	0	117	0
Bayelsa	378	0	331	5	21	0	26	1
Jigawa	322	0	308	0	11	0	3	41
Akwa Ibom	271	0	220	0	8	0	43	7
Niger	239	0	168	0	12	0	59	2
Ekiti	238	3	130	5	4	0	104	0
Adamawa	217	0	159	0	15	0	43	2
Anambra	207	5	159	0	18	0	30	0
Sokoto	158	0	138	0	16	0	4	3
Kebbi	92	0	82	0	8	0	2	2
Taraba	87	0	73	0	5	0	9	1
Cross River	82	0	70	7	8	0	4	2
Zamfara	78	0	72	0	5	0	1	6
Yobe	67	0	59	0	8	0	0	27
Kogi	5	0	3	0	2	0	0	54
Total	53,021	221	40,281	317	1010	3	11,730	

Figure 1.
Nigerian states COVID-19 status as at 26th august 2020 by 11.59 pm as accessed from NCDC [11].

3. Some Igbo indigenous plants

Replace Conventional medicine utilizes active compounds mostly isolated from some medicinal plants to the extent that about 80% of the active ingredients indicate a positive correlation between their modern therapeutic uses and herbal or traditional use depending on where the plants are found [12]. Igbo indigenous plants and herbs have been used for treating and preventing several diseases, including respiratory viral infections in the past. The current novel virus also poses a challenge to which conventional or herbal medicine would be useful and no wonder some Igbo indigenous plants and herbs are listed for consideration in a bid to discover the COVID-19 management drugs and cure. Such plants understudy in this chapter is bitter kola, garlic, giloy, ginger, lime, and turmeric.

3.1 Bitter kola

Plant name: Bitter kola.
Pictorial exposition (**Figure 2**):
Botanical name: Bitter kola – *Garcinia kola.*
Indigenous (local) name: Aku ilu.
Taxonomical classification:
Kingdom: Plantae.
Division: Magnoliophyta.
Class: Magnoliopsida.
Order: Theales.
Family: Clusiaceae.
Genus: Garcinia.
Species: kola.
Part of the plant in Use: Seeds.
Phytochemical components:

Several studies have been carried out on the phytochemical components of *Garcinia kola*. Such studies have shown that *Garcinia kola* contains alkaloids, saponins, tannins, flavonoids, glycosides, sterols, and phenols. The major constituents of the plant are kolaviron, garcinia biflavonoid (GB-1a-glucoside, GB-1a, GB-1, GB-2), kolaflavonone, benzophenone, xanthone, coumarin, apigenin, quercetin, and garcinoic acid [13–17].

Hexadecanoic acid, 9-octadecanoic acid, methyl ester, linoleic acid, heptadecane-(8)-carbonic acid, formaldehyde, N, N-Diethyl, n-tetradecanoic acid amide; 3,4,8-trimethyl-2-nonenal were gotten from the seed of *Garcinia kola*. Carbohydrates were separated from the seed. The mineral composition of *G. kola* seeds extracts was also reported [18]. The seed contains an enormous amount of potassium and phosphorus. Other constituents include ash, crude protein, crude fiber, crude lipid, water-soluble oxalate, terpenoids, and fat [19].

Gas–liquid chromatography and High-Performance Liquid Chromatography was used to study these phytochemical contents of *Garcinia kola*. The seed oil was found to contain fatty acid and amino acid derivatives, namely meristic, pentadecanoic, margaric, trans-palmitoleic, cis-vaccenic, cis-oleic, cis-linoleic, α-linolenic, threonine, tyrosine, methionine, serine, histidine, and alanine [20].

Figure 2.
Bitter kola fruits on the plant and bitter kola seeds.

Based on dietary properties, the following have been found: moisture (7.2%–92.7%); crude protein (0.58%–7.8%); ash (0.33%–5.9%); crude fiber (1.23%–20.51%); crude fat (0.19%–14.5%); and NFE (10.85%–91.35%). The dominant fatty acids in the seed are oleic (38 mg/kg), linoleic (36 mg/kg), and palmitic acid (32 mg/kg). The prevalent essential amino acids are lysine (2.4 g/kg), leucine (1.9 g/kg), and valine (1.7 g/kg), and nonessential amino acids are glutamic acid (6.8 g/kg) and arginine (5.5 g/kg). The bitter kola seeds are low in anti-nutrients such as phytate or oxalate. However, high amounts of vitamin C have been recorded up to 23.1 mg/100 g. Potassium (722 mg/kg) and phosphorus (3.3–720 mg/kg) were recorded in bitter kola as the most abundant minerals in bitter kola seeds [21].

Health benefits:

The medicinal importance of bitter kola is based mainly on the photochemical components of the plants. Some of these components isolated include oleoresin, tannin, saponins, and alkaloids. Other components isolated from bitter kola seeds are bioflavonoids such as kola flavanone, and hydroxy flavonoids. Bitter kola is highly valued in African ethnic medicine because of its varied and numerous social and medicinal uses, thus making it an essential ingredient in folk medicine. Herbal Medicine has been advocated as a major contributor to the cure of many ailments [9, 22] and Bitter kola is believed to be an important source of flavonoids and chemical substances with potential therapeutic benefits especially in the treatment of diabetes [23].

Omeh et al. posit that bitter kola is cardioprotective because of the lipid reduction ability [24].

The bitter kola is commonly chewed by both rural and urban dwellers for treating gastric problems or for their typical astringent taste. The bioflavonoid kolaviron complex content of bitter kola is anti-inflammatory, neuroprotective, and antimicrobial. Kolaviron possesses anti-malarial and wound healing effects. Kolaviron is useful in the treatment of benign prostatic hyperplasia, multiple sclerosis, and AIDS. It has shown the capacity to stop Ebola virus growth in medical laboratory trials [21].

Kolaviron possesses antinociceptive (sedative) and anti-inflammatory activities, both centrally and peripherally, which justifies its folkloric use to relieve pain and inflammation. Moreover, Abarikwu [25] revealed that kolaviron could block signaling pathways implicated in lipopolysaccharide-induced inflammatory genes and equally prevent oxidative stress. It also helps in demyelination and neurotoxicity. It aids in the treatment of multiple sclerosis that can be clinically viable against ischemia/reperfusion injuries.

Bitter kola has hepatoprotective properties, promotes survival of hepatocytes, and prevents liver injuries and intoxication. In rat models, bitter kola is anti-diabetic and protecting against hyperglycemia-induced apoptosis, attenuate the level of lipid peroxidation. Bitter kola has anti-malarial activities.

Nworu et al. [26] discovered its immunomodulatory and immuno-restorative effects, making it useful in fighting immune-destructive diseases such as acquired immunodeficiency syndrome (AIDS) and other viruses which may include COVID-19.

Bitter kola wether as alcoholic or aqueous extracts has antimicrobial properties against many multidrug-resistant bacteria (gram-positive and gram-negative) and fungi [21].

Possible Toxicology:

There is speculation that only high doses of Kolavirons (400 mg/kg) can cause liver damage but its ability to inhibit cyclooxygenase (COX-2) and inducible nitric oxide synthase (iNOS) expression through downregulation of nuclear factor kappa

B (NF-κB) and activator protein-1 (AP-1) DNA binding activities shows the hepato-protective properties of Kolaviron content of bitter kola [21].

Anti-COVID-19 Properties:

Guttiferones are polyisoprenylated benzophenone derivatives of bitter kola that can inhibit the cytopathic effects of the virus responsible for HIV infection [27].

Garcinol has the same or even very similar structure to that of Guttiferone F that has similar properties. However, relatively few studies have been reported describing the design and performance of bitter kola constituents and drug delivery systems on its proposed antiviral properties. [28]. Reports of use during COVID-19 [29] are helpful in bitter kola effects against the pandemic.

3.2 Garlic

Plant name: Garlic- *Allium sativum*.
Pictorial exposition (**Figure 3**):
Botanical name: *Allium sativum*.
Indigenous (local) name: Yabasi Hausa.
Taxonomical classification:
Kingdom: Plantae.
Division: Magnoliophyta.
Class: Monocotyledonae.
Order: Liliales.
Family: Liliaceae.
Genus: Allium.
Species: Sativium.
Part of the plant in Use: Bulb.
Phytochemical components:

Garlic contains carbohydrates, glycosides, and proteins in high concentrations; alkaloids, saponins, reducing sugars, oils, and steroids in medium concentrations, while flavonoids and acidic compounds were present in low amounts [30].

Phytochemicals screening revealed the results that alkaloids, reducing sugar, flavonoids, glycosides, cardiac glycosides, tannin and phenolic compounds, saponins, amino acid & triterpenoids in aqueous extract but methanolic extract shows the absence of reducing sugar [31].

Figure 3.
Garlic plants and the bulbs.

Health benefits:

Garlic is useful in chronic cough, arthritis, and constipation. Garlic has also been mentioned to protect from epidemic diseases, and no wonder it is always reckoned during COVID-19. Many studies revealed that garlic has antioxidant, anti-inflammatory, immune-modulating, antibiotic, bacteriostatic, antifungal, antiviral, antihelminthic, antithrombic, hypotensive, hypoglycemic, and hypocholesterolemic properties [32].

Garlic has shown a virucidal effect on human rhinovirus-2, parainfluenza virus-3, HSV-1, HSV- 2, and vesicular stomatitis virus during in vitro study by Weber et al. [33].

Kang et al. [34] explored the antioxidant and reactive oxygen species scavenging property of saponins produced by garlic while Naji et al. [35] demonstrated the hepatoprotective and antioxidant property of single clove garlic in rabbits' models.

Garlic used for management of abdominal discomfort, diarrhea, otitis media, and respiratory tract infections in the eastern part of Nigeria [36] and treatment of common colds, hay fever, and asthma in Europe and India [37].

The garlic has immunomodulation, anti-inflammatory, and antioxidant with cardioprotective, and pulmonary protective properties [32].

Possible Toxicology:

Fowotade et al., [37] reported a dose-dependent increase in levels of liver enzymes AST, ALT, and ALP) as well as an increase in serum creatinine levels and dose-dependent histologic alterations in hepatic, renal, and cardiac tissues in rat models indicating toxicity at higher dozes to the liver, heart, and kidney.

Anti-COVID-19 Properties:

Garlic modulates cytokine expression in lipopolysaccharide activates human blood and inhibits NF-κB from which makes it immune-modulatory. It activates macrophages and promotes immunoglobulins. Garlic extract reduces the migration of polymorphonuclear cells through endothelial cell layers. Garlic inhibits the production of nitric oxide and prostaglandin-E2, suppresses the inducible form of nitric oxide synthase and COX-2 expression, and decreases the production of inflammatory cytokines like TNF-α, interleukin six, and interferon γ. It improves lung function in smokers and reduces tracheal exudates in horses. It is useful in inflammatory and asthma-like conditions of the lungs [37].

The exploits in pharmacologic actions in handling respiratory diseases and other viruses are possible in handling COVID-19.

3.3 Giloy

Plant name: Giloy - *Tinospora cordifolia.*
Pictorial exposition (**Figure 4**):
Botanical name: *Tinospora cordifolia.*
Indigenous (local) name: Udo akpu enyi.
Taxonomical classification:
Kingdom: Plantae.
Division: Magnoliophyta.
Class: Magnoliopsida,
Order: Ranunculaceae.
Family: Menispermeaceae.
Genus: Tinospora.
Species: cordifolia.

Part of the plant in Use: Root, Stem, Back, Leaves, and Fruits. This implies that all the parts of the plant are useful as an herbal remedy of one disease or the other depending on the preparation.

Figure 4.
Giloy leaves on the plant and Giloy stems.

Phytochemical components:

Giloy contains polysaccharides, phenolics, diterpenoids, steroids, and sesquiterpenoids [38]. Singh and Chaudhuri [39] reported that giloy has the following components:

Alkaloids – Giloy has 13 alkaloids of isoquinoline and aporphine skeletons, amine, and amide with main alkaloids that are protoberberine alkaloids berberine, corydine, magnoflorine, and palmatine.

Terpenoids – Giloy has 32 diterpenoids and their glycosides of clerodane and norclerodane skeleton, 5 sesquiterpenoids, 1 monoterpenoids, and 1 triterpenoid cycloeuphordenol. There is also a bicyclic diterpenoid (C21H24O7) from the whole plant identified as tinosporin.

Phenolics – Giloy has 4 phenylpropanoids, 3 lignans, 2 flavonoids, and 2 benzenoid derivatives.

Steroids – Giloy has 4 steroids along with δ-sitosterol and 2,3,14,20,22,25-hexahydroxyl-5-cholest-7-en-6-one.

Essential oil and aliphatic compounds – Giloy hydro distilled essential oil of fresh leaves showed the presence of alcohols (32.1%), phenols (16.6%), aldehydes (16.2%), fatty acids (15.7%), alkanes (8.3%), esters (3.2%), and terpenes (1.2%), along with hydroquinone (16.6%), 2-hexenal (14.2%), palmitic acid (14.1%) and phytol (11.4%). Also, hexane extract of giloy stems revealed methyl-9,12-octadecadienoate (23.2%), methyl 9-octadecenoate (19.7%), methyl hexadecanoate (16.3%), and methyl octadecanoic (5.5%) but Heptacosanol, octacosanol, nonacosan-15-one and cyclohexyl-11-heneicosanone were seen in the whole plant extract.

Polysaccharide – Giloy stems polysaccharide shows glucose 98.0%, arabinose 0.5%, galactose 0.3%, mannose 0.2%, rhamnose 0.2%, and xylose 0.8% units.

Others – Other compounds seen in giloy are giloinsterol, a bitter glucoside giloin, a non-glucoside bitter substance giloinin, gilo-sterol, tinosporan acetate, tinosporic acid, tinosporal acetate, tinosporone, and tinosporal. Bitter compounds found in giloy are tinosporide and cordifolide. There are also 3 furanolactone diterpenoids -C20H20O6, C20H22O8 and C26H34O11.

The giloy leaves are also rich in protein, calcium and phosphorus [40].

Health benefits:

Chemical components and products from giloy have been found to have free radical scavenging properties and decrease the activities of superoxide dismutase and glutathione peroxidase in rats [41].

Anti-inflammatory properties like that of indomethacin and nonsteroidal drugs have been found in giloy. Giloy reduces histamine-induced bronchospasm in animals. 1, 4-alpha-D-glucan derived from giloy activates macrophages, NFκB translocation, and cytokine production, and hence activates the immune system. Giloy favors HIV positive patients. Giloy helps young chicks under infectious bursal disease during conventional antiviral treatment. Vedavanthy et al. [42] demonstrated antipyretic and Gupta et al. [43] observed its antimicrobial effects. Researcher [39] analyzed the parts thus:

Leaves: Powdered leaves preparations help in treating gout, ulcers, jaundice, fever, and wounds, and to control blood glucose.

Stem: The mixture of stem extract alone or with honey is useful in treating jaundice, skin diseases, and fever. The stem starch (Sativa) can also be used as a tonic and as an antidote to snakebite and scorpion sting.

Bark: In India, the root and stem bark of the plant is used along with milk to treat cancer.

Fruits: Are used in the treatment of jaundice and rheumatism.

Roots: Roots are used as an emetic for visceral obstructions, leprosy, diarrhea, and dysentery.

Possible Toxicology:

Giloy has been described as a safe drug to use. There is no available report on its toxicity on humans though regular use of giloy in high doses can cause constipation [39].

Anti-COVID-19 Properties:

Giloy is the source of various types of bioactive compounds, including alkaloids, steroids, glycosides, and aliphatics. Giloy may have inhibitor potential as a drug for SARS-CoV-2 otherwise called COVID-19 with phytochemicals such as berberine, ß-sitosterol, octacosanol, tetrahydropalmatine, and choline with 3CL pro targets I, II of protease enzymes.

3.4 Ginger

Plant name: Ginger - *Zingiber officinale.*
Pictorial exposition (**Figure 5**):
Botanical name: *Zingiber officinale.*
Indigenous (local) name: Jinja.
Taxonomical classification.
Kingdom: Plantae.
Division: Angiosperms.
Class: Monocots.
Order: Zingiberales.
Family: Zingiberaceae.
Genus: Zingiber.
Species: officinale.
Part of plant in Use: Rhizomes.
Phytochemical components:

The phytochemical components reveal: citronellal, linalool, borneol, 10-dehydrogingerdione, 6- et 4,6, 8 ou 10-gingerdione, limonene; [6]-methyl gingediol, le [4]-gingediacetate, le [6]- gingediacetate, and le [6]-methyl-gingediacetate.

Figure 5.
Uprooted ginger plants and rhizomes.

Constituents of essential oils are: curcumene, farrnesene, gingerols, zingiberene, zingerone, car-3-ene, α-terpinene, shogaols, paradols, αterpineol, neurol, 1, 8-cineole, neral, geranial, geraniol et geranyl acetate, isovaleraldehyde, nonanol, ethylpinene, α-Pinene, α-sesquiphellandrene, β-bisabolene myrecene, β-pinene, β sequithujene, sesquiphellandrene, camphene, sabinene, cis-sequisabinene hydrate, zingiberol, gingerone, and citral (geranial et neral).

Macronutrients found are carbohydrates, fiber, and proteins (with amino acids such as cystine, phenylalanine, histidine, isoleucine, methionine, tyrosine, threonine, leucine, lysine, tryptophan, valine), lipids (including omega 3, 6 and 9 fatty acids).

Micronutrients found are sodium, magnesium, phosphorus, potassium, calcium, magnesium, manganese, phosphorus, potassium, sodium, selenium, iron, copper, zinc, selenium, iodine, vitamins A (thiamine), B1 (thiamine), B2 (Riboflavin), B3 or PP or niacin, B5, B6 (pyridoxine), B9 (folic acid), C, D, E, K1, and K2.

Other Compounds present are: Flavonoids (Flavan-3-ol, flavone, flavonol, flavanone, tannins, quercetin, rutin, fisetin, morine, gallic acid, ferulic acid, vanillic acid, hexahydrocurcumin and desmethyl-hexahydro curcumin, 3S,5S)-3,5-diacetoxy-1,7-bis(4-hydroxy-3-methoxyphenyl), allicin, alliin, ajoene, galanolactone, gingerenones, and gingediones [44].

Health benefits:

Considering many bioactive ingredients like gingerol, zingiberine, shogaol, gingerdione, hexahydrocurcumin, paradol and gingerenone A, ginger has antioxidants that help reduce oxidative stress and inhibit superoxide production.

Dried ginger possesses potent anti-inflammatory and analgesic activities.

Ginger has a better effect against swine flu (H1N1), and human respiratory syncytial virus in human respiratory tract cell lines.

There are antiretroviral sesquiterpenes in ginger.

Ginger provides a bronchodilatory effect, prevents severe damage to the lungs due to inflammation, and ameliorates allergic asthma.

Gingerol can be used to prevent and treat cancer and chronic inflammatory diseases. It has an antiparasitic effect, especially against *Ichthyophthirius multifiliis* (ciliate parasite of freshwater fish). The bioactive bitter and pungent component of ginger and its derivatives, reduced heavy menstrual bleeding in women of reproductive age; and protected rat fetuses against Gabapentin-induced hepatotoxicity. Ginger improved concentration of blood lipid and reduced body overweight, obese, and have an anti-diabetic effect [45].

Possible Toxicology:

In rats, 2500 mg/kg gave a toxic effect leading to severe hypotension and bradycardia with the induction of prenecrotic changes in cardiac tissues, but 50 mg/kg given for 28 days gave bradycardia to the rats with waviness in cardiac muscle fibers [46]. Idang et al. [47] describe the effect of ginger on some organ's histology and biochemical parameters as reversal when the administration is discontinued in rat models.

Anti-COVID-19 Properties:

The anti-inflammatory, analgesic, and antiviral activities of ginger provide the positive property that COVID-19 can be managed by ginger.

3.5 Lime

Plant name: Key Lime - *Citrus aurantifolia.*
Pictorial exposition (**Figure 6**):
Botanical name: *Citrus aurantifolia.*
Indigenous (local) name: Oroma nkirisi.
Taxonomical classification:
Kingdom: Plantae.
Division: Streptophyta.
Class: Magnoliopsida.
Order: Sapindales.
Family: Rutaceae.
Genus: Citrus.
Species: aurantifolia.
Part of the plant in Use: Fruits.
Phytochemical components:

The aqueous extracts of lime pulp revealed the presence of carbohydrates, reducing sugars, proteins, alkaloids, tannins, fixed oils, cardiac glycosides, phytosterols, phenols, steroids, and flavonoids [48].

The ethanolic pulp extracts showed only the presence of fixed oils, reducing sugars, cardiac glycosides, steroids, phytosterols, flavonoids, and amino acids.

The aqueous peel extracts showed the presence of carbohydrates, alkaloids, tannins, fixed oils, proteins, cardiac glycosides, steroids, phenols and flavonoids, and amino acids [49].

Health benefits:

It is known that due to the presence of various phytochemicals such as alkaloids, flavonoids, glycosides, saponins, steroids, anthraquinones, phenols, resins, fatty acids, and gums present in the plant extracts are responsible for the antibacterial

Figure 6.
Lime fruits on the plant and plucked fruits.

properties. The total phenolic content values have evidence of antimicrobial activity, just like the presence of steroids, flavonoids, alkaloids, tannic acid, and phenolics against both gram-positive and gram-negative bacteria [50].

Lime is popular as antioxidant activity, immunomodulation, and antibacterial activities [48].

Possible Toxicology:

It may cause burns in the mouth, throat, and stomach. It may not be perfect for chronic ulcer patients. However, it is generally less toxic [51].

Anti-COVID-19 Properties:

There is evidence that suggests that lemon essential oils have shown potent antiviral activity to other coronaviruses, such as SARS-CoV-1, and could also be the same in respect of COVID-19 by inhibition of viral infection and replication [52].

3.6 Turmeric

Plant name: Turmeric - *Curcuma longa.*
Pictorial exposition (**Figure 7**):
Botanical name: *Curcuma longa.*
Indigenous (local) name: Tumerik.
Taxonomical classification.
Kingdom: Plantae.
Division: Angiosperms.
Class: Monocots.
Order: Zingiberales.
Family: Zingiberaceae.
Genus: Curcuma.
Species: longa.
Part of the plant in Use: Rhizomes.
Phytochemical components:

The components reveal α- and β-turmerones, ar-turmerone, atlantone, cineole, d-phallandrene, α-phellandrene, curlone, zingiberene, ar-curcumene, d-sabinene, borneol, terpinolene, 1, 8-cineole, undecanol, and p-cymene [53].

Micronutrients contents are Calcium, Phosphorus, Zinc, Magnesium, Manganese, Copper, Iron, Potassium, Vitamins A, B1 (Thiamine), B2 (Riboflavin), B3 (Niacin), B5, B6, B9, Folate, C (Ascorbic Acid), E, K,

Figure 7.
Turmeric plants and rhizomes in plate.

Macronutrients found are: carbohydrates, fiber, lipids (omega 3, omega 6, and omega 9), and proteins.

Other Compounds present includes alkaloids, anthraquinones, curcumin, cyclocurcumin, cardiac glycosides, demethoxycurcumin, bis-demethoxycurcumin, tannins, terpenes, steroids, saponins, anthocyans, leucoanthocyans, saponins, quinones, and flavonoids [54].

Health benefits:

Turmeric has tremendous medicinal benefits ranging from been used as phlegmagogue, anti-inflammatory, analgesic, antipyretic, blood purifier, to healing properties.

Turmeric is antioxidant, immunomodulating, anti-inflammatory, antimicrobial, and has anticancer activities [55].

The important ingredients of *Curcuma longa* are curcumin, dihydro curcumin, and hexahydrocurcumin. Some volatile compounds like cinol, α-phellandrene, borneol, zingiberine, and different sesquiterpenes have been found in turmeric. Curcumin has been observed to be extremely effective in acute respiratory distress syndrome, COPD's, acute lung injury, and pulmonary fibrosis.

Turmeric suppresses NF-α and inhibits NF-κB, in this way acts as a potent anti-inflammatory agent. Curcuma extract acts against various pathogenic bacteria, including *Streptococcus, Staphylococcus, Klebsiella pneumonia, Helicobacter pylori, Bacillus subtilis*, and *Vibrio cholera* [55].

The revolutionary potential of turmeric is against viruses like H1N1, H6N1, respiratory syncytial virus, herpes simplex virus, parainfluenza virus type-3, coxsackievirus B3, Japanese encephalitis, hepatitis B virus, hepatitis C virus, human papillomavirus-16, and – 18. It has also been found to inhibit HIV-1 long terminal repeat directed gene expression [55].

Possible Toxicology:

Balaji and Chempakam [56] posit that curcumin and its derivatives may cause dose-dependent hepatotoxicity. They equally put that, in contrast to curcumin, other compounds in turmeric which are non-mutagenic, non-carcinogenic, non-hepatotoxic, and do not have any side-effects.

National Toxicology Program (USA) the toxic and carcinogenic properties of an organic extract of turmeric, called turmeric oleoresin from animal models after a very long time feeding. For example, rats and mice were fed diets containing several concentrations of turmeric oleoresin for three months and two years, and the possible toxic and carcinogenic effects were evaluated. In the 2-year feeding studies, turmeric oleoresin ingestion was associated with increased incidences of ulcers, hyperplasia, and inflammation of the forestomach, cecum, and colon in male rats and of the cecum in female rats. In female mice, the ingestion of diets containing turmeric oleoresin was associated with an increased incidence of thyroid gland follicular cell hyperplasia. These negative effects of curcumin were said to be mediated by several possible mechanisms showing reactive oxygen species (ROS) such as superoxide anion and hydrogen peroxide-based on the facts that:

i. ROS can induce cell malignant transformation,

ii. Cancer cells commonly have increased levels of ROS,

iii. The malignant phenotype of cancer cells can be reversed by reducing the cellular levels of ROS.

Experimental studies have demonstrated that, although low concentrations of curcumin induce antioxidant effects, while higher concentrations of this compound increase the cellular levels of ROS [57].

However, Aggarwal et al. [55] gave a counter opinion on turmeric when they worked on Curcuminoid-essential oil complex (CEC) and found non-mutagenic effects in all three mutagenic investigations studied. Therefore, following investigations of acute toxicity, repeated dose toxicity, and mutagenicity, CEC was deemed a safe, non-toxic pharmacological formulation.

Anti-COVID-19 Properties:

Soheil et al. [53] compiled other studies on the role of turmeric on some viral infections, thus:

For human immunodeficiency virus (HIV), the presence of curcumin; caused inhibition of HIV-1 LTR-directed gene expression, inhibited Tat-mediated transactivation of HIV-1 LTR and Tat protein acetylation, inhibited HIV-1 integrase while curcumin boron complexes inhibited HIV-1 and HIV-2 proteases though reported no antiviral effect in a clinical trial for HIV.

For Influenza, Curcumin inhibited hemagglutination.

For herpes simplex virus-1 (HSV-1), Curcumin, gallium-curcumin, Cu-curcumin reduced to HSV-1 replication.

For herpes simplex virus-2 (HSV-2), Curcumin gave significant protection in mouse models.

For Coxsackievirus, Curcumin caused replication inhibition through UPS dysregulation.

For hepatitis B virus (HBV), the aqueous extract suppressed HBV replication by increasing the p53 level.

For hepatitis C virus (HCV), Curcumin decreased HCV replication by suppressing the Akt-SREBP-1 pathway.

For human papillomavirus (HPV), Curcumin inhibits expression of viral oncoproteins of E6 and E7 and downregulation effect on the transcription of HPV-18.

For Japanese encephalitis virus (JEV), Curcumin reduced the production of infective viral particles.

For human T-lymphotropic virus-1 or human T-cell leukemia-lymphoma virus-1 (HTLV-1), Curcumin causes downregulation of JunD protein in HTLV-1-infected T-cell lines.

Therefore, if all these viruses can be managed by turmeric, COVID-19 management is possible with this indigenous plant through inhibition, reduced replication, and dysregulation.

4. Possible mechanisms of action of the Igbo indigenous plants against COVID-19

The SARS-CoV-2, otherwise called COVID-19, possess some protein structures by which it enters into the host cells, which is called spike (S) glycoprotein, and forms homotrimers protruding from the viral surfaces. The spike protein interacts strongly with the human ACE2 (angiotensin-converting enzyme 2) receptor [58]. Such interaction is followed by replication through some cyclic processes and translating its genomic RNA (gRNA). There is proteolysis in the presence of viral 3C-like proteinase, with more replication of gRNA. There is viral replication complex formed which consists of RNA dependent RNA polymerase (RdRp), helicase, 30-to-50 exonuclease, endoRNAse, and 20-O-ribose methyltransferase and followed by the assembly of viral components [59, 60].

The proteins (S) which are associated with replication, are the primary targets of post-entry treatment and these Igbo indigenous plants have viral proteinase targeting based on literature in this chapter on the anti-coronavirus properties thereby giving a hint on the inhibition of the viral replication process.

Though there is no empirical evidence in this chapter, the authors suggest that Bitter kola, Garlic, Giloy, Ginger, Lime, and Turmeric has the properties that alter the PH on the interface between the virus and the human respiratory surfaces causing a brake on the interaction with human ACE2 and where interaction has taken place, the replication and translation stages are disrupted. The plants, thus, are potential modifiers of this milieu and inhibitor of the main protease and endoribonuclease via epigenetics and homeostasis.

5. Preparations from Igbo indigenous plants towards COVID-19 eradication

The world awaits the declaration of a possible medicinal cure for COVID-19. WHO has confirmed no official treatment regimen for the COVID-19 cure [61]. The global community is searching from post to post for useful medicine in the management or treatment of COVID-19 and the related symptoms. The search could not neglect medicinal plants and herbs which has been used for the treatment of related or difficult to cure infections; the herbal remedy [62] as opined by Omer and lauds Tadepalli who tags alkaloids preparations of Indian herbal medicine as novel remedial approaches [32]. Jahan and Onay demonstrated the antiviral potentials medicinal plants that inhibit human coronaviruses [63] just as Mirzaie *et al*. [64] described medicinal plants as options for treatment of Coronavirus.

The preparations of the Igbo indigenous plants towards COVID-19 management and treatment may not be different from the way they are prepared for other ailments. Some studies mostly mention ginger, garlic, and lime as having antiviral properties and immune system boosting capacities [62–70]. Some prefer to describe them as part of nutrition that aid immunity towards the management of coronaviruses [71, 72].

Figure 8.
Water-based preparation containing ginger, turmeric, garlic, bitter kola, lime, and cinnamon.

Figure 9.
Alcohol-based preparation containing ginger, turmeric, bitter kola, lime, and garlic.

There are various methods of preparations available in Igbo land towards the use of these Vitamin C enriched plants [29] in the management of COVID-19 depending on the person that is making the preparation or the status of the subject who shall be taking the preparation. There are two major methods- The water-based method (**Figure 8**) or the Alcohol-based method (**Figure 9**) and the measurement of consumption. For those who are not used to alcoholic products, the Water-based one is preferred.

The preparations could also be made using a single plant or combination depending on the availability or the need. The preparations may be using whole plant parts or a particular part. Take, for instance, Giloy can be prepared using leaves, stem, roots at the same time, or just by using the ground dry leaves.

This chapter may not be enough to explain the ways of preparations available in Igbo land in the Eastern part of Nigeria but may convince someone of some selected indigenous plants capable of managing COVID-19. Though there is an exposition on this plant here, be it conventional or herbal medicine, self-medication is dangerous, and WHO has also not confirmed an acceptable treatment of COVID-19.

6. Conclusions

There are numerous indigenous plants in Igbo land, South Eastern Nigeria that is capable of managing coronavirus called COVID-19. Such plants include but not limited to Bitter kola (Aku ilu), Garlic (Yabasi Hausa), Giloy (Udo akpu enyi), Ginger (Jinja), Lime (Oroma nkirisi), and Turmeric (Tumerik).

The preparations for those plants differ depending on the Herbalist or the patient (subject) who needs the products, and there is always an important need to consult your Indigenous Herbal Doctor for advice and preparation.

The side effects and toxicity of plants under review in this chapter are at very high doses, especially in animal models, and mostly go away after withdrawal. It should be noted that every drug has side effects, especially when abused. These effects by natural plants and products can also be compared with synthetic and conventional drugs.

Bitter kola, Ginger, Garlic, Giloy, Turmeric, and Lime could be considered for use in the management and treatment of COVID-19 symptoms starting from Igbo land in South-Eastern Nigeria to across the globe towards ensuring that Coronavirus is eliminated before the targeted two years.

While encouraging the use of Igbo indigenous plants as a single or in a combination of at least four of them depending on the availability as they have anti-COVID-19 activities, which causes inhibition on the virus proteases within the milieu and via epigenetics and homeostasis, though there is no confirmed cure for the pandemic.

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Conflict of interest

The authors declare no competing interests.

Notes/Thanks/Other declarations

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