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Common Plant Foods in Northern Nigeria with Immuno-Stimulatory Properties that Could Mitigate the Effect of COVID-19: A Review.

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ABSTRACT

Plants taken as food provide the body with nutrients that strengthen the immune system. The immune system recognizes, tolerates, and resists infections or toxins by activating specific antibodies or sensitized white blood cells. COVID-19 is a severe acute respiratory disorder that is caused by the virus SARS-CoV-2. It has been reported that innate immunity plays a role in mitigating the severity of the disease, thus strengthening the immune system is paramount to resisting the infection. This study aimed to identify and document foods commonly consumed in Northern Nigeria that are claimed to possess immune-stimulatory effects. Literature of plants that are commonly used as food was studied. Data was collected from literature searches of the PubMed, PubChem, and Google Scholar databases using keywords that include immunity, immune-stimulatory, phytochemicals, and micronutrients. Thirty commonly consumed plants belonging to eighteen families were selected based on how widely used they are in the region. They are reported to contain immune-boosting phytonutrients such as carotenoids, flavonoids, and micronutrients such as Vitamin C and Zinc, which have antioxidant and anti-inflammatory properties. The study showed that the plants that are commonly consumed in Northern Nigeria contained phytochemicals and micronutrients, which are necessary for boosting immunity and thus could be the reason for the low COVID-19 morbidity experienced in the region

Keywords: COVID-19, innate immunity, phytochemicals, micronutrients, Northern Nigeria.

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Introduction

COVID-19 is a newly emerged respiratory disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).

Most patients with COVID-19 exhibit mild

to moderate symptoms such as dry cough, sore throat, fever, fatigue, and loss of smell or taste but approximately 15% progress to severe pneumonia, and about 5% eventually develop acute respiratory distress syndrome

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failure [1]. The COVID-19 infection progresses in two phases. The first phase is the incubation and non-severe phase where a specific adaptive immune response is required to eliminate the virus and prevent the disease from progressing into the severe inflammatory phase. Thus, enhancing innate immunity at this stage is very important. The second phase is the inflammation-driven damaging phase where the virus propagates and causes inflammation to the lungs and other organs with high ACE2 expression, such as the kidneys [1, 2]. Immunity is the body's natural ability to defend itself against pathogens and resist infection. Immunity can be innate (rapid response, less specific), adaptive (slow response/more specific), or passive (natural-from birth or artificial). Innate immunity is the first line of defense against pathogens- in the body [3].

Adaptive immunity can be humoral (by production of antibodies from B-cells) or cell mediated (by production of cytokines from T-cells and trigger T-lymphocytes and macrophages to eliminate infected cells).

It has been reported that immune function can be boosted by the consumption foods containing high amounts of fiber, whole grains, unsaturated fats, and antioxidants [4]. Plants exert their immunostimulatory function by stimulating cellular or humoral immune response.

Several articles have illustrated the different

plants that are used either as medicine or as food that have the potential to treat (curative) or mitigate the effect of COVID-19 in various parts of the world [5,6,7].

Articles reviewing plants used as medicine or food that have potential to treat and manage COVID-19 in Nigeria have been published [8, 9, 10]. Due to the relatively low incidence of COVID-19 in the North as reported by Nigerian Center for Disease Control (NCDC) it became essential to explore the common foods consumed in the region to give insight to purported case numbers. The aim of this review is to present some of the common and easily accessible food plants consumed in Northern Nigeria with the phytochemicals and micronutrients they contain which potentially have immuno-stimulatory properties and may have contributed in mitigating the morbidity of COVID-19 experienced in the region.

Method

In this review, a literature search was done using popular scientific databases including PubMed, PubChem, and Google Scholar containing information gathered from several scholarly journals, books, and reports. Plants that are commonly used as staples, spices, fruits and vegetables were selected. The keywords searched include COVID-19 and the immune system, immunity, immune-boosting foods, and phytochemicals micronutrients. Articles collected were

screened, studied, and critically assessed for nutrients they contain and their use as food in the Region.

Results

From the study it was found that the plants contained different types of phytochemicals flavonoids, carotenoids, polyphenols, alkaloids and Micronutrients Vitamin A, C, B6, zinc, Magnesium, Iron, Manganese, Copper that have immune boosting properties. Most of the plants listed have the afore mentioned phytochemicals and micronutrients with a few that also contain selenium.

Table 1 shows a summary of the plants and their constituents.

Table 1: Plant foods with phytochemical constituents and micronutrients

Botanical Name	Common Name/Local Name	Family	Part Used	Phytochemical Constituents	Micronutrients
<i>Abelmoschus esculentus</i>	Okra/Kubewa	Malvaceae	Fruit, Leaf	Flavonoids, Tannins, Phenols, Steroids [15]	Magnesium, Copper Manganese, Vitamin A, B, C, E [15,33]
<i>Adansonia digitata</i>	Baobab/Kuka	Malvaceae	Leaf, fruits	Glycosides, Saponins, Steroids Flavonoids [14]	Zinc, Copper Iron Manganese [14,33]
<i>Allium cepa</i>	Onion/Albasa	Liliaceae	Bulb	Flavonoids, Saponins, Glycosides, Alkaloids [28]	Magnesium, Iron, Zinc, Copper, Manganese [29]
<i>Allium sativum</i>	Garlic/Tafarnuwa	Liliaceae	Bulb	Alkaloid, Tannin, Carotenoids, Saponin and Flavonoids [41]	Calcium, Iron, Potassium, Phosphorus, Sodium, Magnesium, Copper, Zinc [41]
<i>Arachis hypogaea</i>	Peanut/Gyada	Fabaceae	Seeds	Alkaloid, Saponin Flavonoids [42]	Magnesium, Iron, Zinc, Copper, Manganese [33]
<i>Capsicum annum</i>	Red bell pepper/Tattasai	Solanaceae	Fruit	Flavonoids, B-carotene [24]	Zinc, Magnesium, Iron, Copper, Selenium, Vitamin A, C, E [25]
<i>Capsicum Chinense</i>	Chilli/Attargu	Solanaceae	Fruit	Saponins, Flavonoids, Phenols, Alkaloids, Carotenoids [26]	Vitamin C, Zinc, Magnesium [27]

<i>Carica papaya</i>	Pawpaw/ Gwanda	Caricaceae	Fruit	Phenols, Alkaloids, Flavonoids, Steroids, Terpenoids, Carotenoids	Vitamin C, Magnesium, Iron, Potassium [49]
<i>Citrus aurantifolia</i>	Lemon/Lemun tsami	Rutaceae	Fruit	Phenols, Flavonoids, Steroids, Terpenoids, Carotenoids, Tannins, Saponins [44,45]	Vitamin A, B, C, E, Magnesium Zinc Copper selenium [46]
<i>Citrus sinensis</i>	Orange/Lemo	Rutaceae	Fruit	Phenols, Flavonoids, Steroids, Terpenoids, Carotenoids, Naringenin [45]	Magnesium, Iron, Zinc, Manganese, vitamin B, C, E [47]
<i>Cucurbita maxima</i>	Pumpkin/ Kabewa	Cucurbitaceae	Fruit, seeds	Flavonoids, Polyphenolics, Saponins, B carotene [18]	Vitamin A, C, Iron, Zinc, Copper, Manganese [18,19]
<i>Cyperus esculentus</i>	Tigernut/Aya	Cyperaceae	Tubers	Flavonoids, Alkaloids, Tannins [30]	Magnesium, Iron, Zinc, Copper, Manganese [31]
<i>Daucus carota</i>	Carrot/karas	Apiaceae	Root	Carotenoids, Phenolic compounds [43]	Vitamin C, Vitamin A, Pottassium[43]
<i>Glycine max</i>	Soy bean/Waken soya	Fabaceae,	Seeds	Flavonoids, Saponins, Glycosides, Phenols [32]	Magnesium, Iron, Zinc [32, 33]

<i>Hibiscus sabdariffa</i>	Hibiscus/ Yakuwa	Malvaceae	Leaf, Rosselle	Flavonoids, Alkaloids, Tannins Glycosides [13,33]	Iron zinc mg, Vitamin C, B, A [13]
<i>Ipomoea batatas</i>	Sweet potatoes/ Dankali	Convolvulaceae	Tubers	Flavonoids, B-carotene, Terpenoids, Tannins, Saponins, Glycosides, Alkaloids, Steroids and Phenolic acids [40]	Vitamin A, B, C Iron Magnesium []
<i>Mangifera indica</i>	Mango/ Mangworo	Anacardiaceae	Fruit	phenols, flavonoids, steroids, carotenoids [48]	Vitamin A,B,C,E, magnesium zinc copper selenium, iron, manganese [48]
<i>Moringa oliefera</i>	Moringa/ Zogale	Moringaceae	Leaf	Alkaloids, Tannins Glycosides Saponins [13]	Calcium Zinc Magnesium Vitamin A, C [13]
<i>Parkia biglobosa,</i>	Locust bean/Daddawa	Fabaceae,	Seeds, fruit	Flavonoids, B-carotene [34,35]	Magnesium, Iron, Zinc, Copper, Manganese, Vitamin B, C, E [33, 35]
<i>Pennisetum glaucum</i>	Millet/Gero	Poaceae	Grain	Tannins, Flavonoids, Terpenoids, Glycosides, Phenols and Steroids [36]	Magnesium, Iron, Zinc, Copper, Manganese [33]
<i>Sesamum radiatum</i>	Karkashi	Pedaliaceae	Leaf	Alkaloids, Flavonoids [20]	Zinc, Magnesium, Iron, Copper [21,22]

<i>Solanum lycopersicum</i>	Tomato/ Tumatir	Solanaceae	Fruit	Lycopene, B carotene, Flavonoids, Amino acids, Phenols [23]	Zinc, Magnesium, Iron, Copper, Selenium, Vitamin A, C, E [23]
<i>Sorghum bicolor</i>	Sorghum/Dawa	Poaceae	Grain	Flavonoids, Phenolic acids [37]	Magnesium, Iron, Zinc, Copper, Manganese [33]
<i>Spinacia oleracea</i>	Spinach/ alaihu	Amaranthaceae	Leaf	Glycosides, Saponins, Steroids Flavonoids [11]	Iron, Vitamin A, C, E, folic acid, Magnesium, Manganese [12]
<i>Syzygium aromaticum</i>	Kanimfari/ clove	Myrtaceae	Bud	Eugenol, Flavonoids, Steroids, Terpenoids, Saponin, Tannins, Phenols [50]	Magnesium, Zinc, Copper, Manganese, Iron [50]
<i>Tamarindus indica</i>	Tamarind/ Tsamiya	Fabaceae	Fruit	Flavonoids, B-carotene, Glycosides, Saponins, Alkaloids [16]	Calcium, Phosphorus, Vitamin A, C and Tartaric acid [17]
<i>Triticum aestivum</i>	Wheat/Alkama	Poaceae	Grain	Flavonoids, phenolic acids, carotenoids, phytosteroids, [38]	Zinc, Iron Magnesium, Calcium Vitamin B, E [39]
<i>Vigna unguiculata</i>	Beans/Wake	Fabaceae,	Seeds	Flavonoids, Alkaloids, Tannins, Saponins [32]	Magnesium, Iron, Zinc, Copper, Manganese [33]

<i>Vigna subterranea</i>	Bambara nut/ Gurjiya	Fabaceae,	Seeds	Alkaloid, Saponin Flavonoids [42]	Magnesium, Iron, Zinc, Copper, Manganese [33]
<i>Zea mays</i>	Maize/ Masara	Poaceae	Seeds	Saponins, Glycosides, Alkaloids [36]	Magnesium, Iron, Zinc, Copper, Manganese [33]
<i>Zingiber officinale</i>	Ginger/Citta	Zingiberaceae	Rhizome	Glycosides Saponin Flavonoids [13,41]	Zinc Magnesium, Vitamin A, C [13]

DISCUSSION

COVID-19 has affected all the nations of the world with prevalence varying for different parts of the world. Africa has less prevalence compared to other parts of the world with West Africa having even much less [51]. The prevalence rate in Nigeria also varied from one region to another. The National Center for Diseases Control (NCDC) data of June 30th 2022 reflects that Nigeria had a total number of 257,637 confirmed cases out of 5,279,608 tested in the country with 3144 deaths. Out of this record, 52,267 cases were from the 19 states of the North of Nigeria, which accounts for 20.3% of the country's total. [52].

Diet could be one of the major factors that could be responsible for these numbers. The consumption of high amounts of dietary saturated fat, refined carbohydrates and sugars, and low levels of fiber, unsaturated fats, and antioxidants has been reported to be a probable contributory factor to the high prevalence of COVID-19 in developed countries [4], thus moderation of the intake of overly processed foods and substitution with foods taken in their naturally occurring form which are rich in micronutrients would help build a strong immune system against COVID-19 [53].

The commonly consumed foods in Northern Nigeria are mostly whole foods that have not been overly processed and are rich in the nutrients that are required in building a strong immune system, which may be the reason for the low COVID-19 morbidity experienced.

Diet has been shown to affect the risk and severity of COVID-19 in people [54]. Diet has been linked to immunity and has been shown to improve the physical and mental health of people by reducing disease susceptibility and improving clinical outcomes during illnesses [55].

Plants contain specific nutrients, which may affect the immune system through the activation of cells, modification in the production of signaling molecules, and gene expression [56]. Foods contain various nutrients that play an important role in maintaining the normal body functions. They contain bioactive components called phytonutrients and micronutrients that play a positive role by maintaining and modulating immune function to prevent and treat diseases [57], and also have other properties such as anti-inflammatory, antioxidant, which might help in the prevention and accelerate recovery from COVID-19 infection.

These phytonutrients such as polysaccharides, flavonoids, alkaloids, saponins, terpenoids, essential oils, gallic acids have shown immune boosting activity in both *in-vitro* and *in-vivo* models. These immune boosting functions are mediated by secretion of immune molecules, activation of antigen immune specific system, promoting proliferation of immune cells, enhancement of innate immune functions or regulating the expression level of cytokines to improve specific and non-specific immune functions of the human systems [58].

Phytochemicals compounds present in food that have the capacity to alter biochemical reactions and consequently affect human health. Plants contain many phytonutrients but some of the important ones that help strengthen the immune system include flavonoids, carotenoids, terpenoids, polyphenols, ω -3 fatty acids. Phytonutrients contained in these foods are generally considered safe except in situations where they are isolated and taken in high doses or for a long period of time [59,60].

Micronutrients are vitamins and minerals such as iron, zinc, and vitamins A, E, B6, and B12 that are required in small amounts but are essential for optimum health. Deficiencies in some of these nutrients are associated with depressed immune function and increased susceptibility to infection [61].

Conclusion

The review showed that foods commonly consumed in Northern Nigeria contained phytochemicals, which are necessary for boosting the immune system against COVID-19 infection. From data reviewed the region experienced low prevalence of COVID-19 infection and food can be purported as an important factor to be responsible for this outcome.

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