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Fighting the Progress of COVID-19 by Enhancing Immunity: A Review of Traditional Sudanese Natural Products Containing Immune-Boosting Elements

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ABSTRACT

The World Health Organization has classified the coronavirus disease outbreak as a worldwide pandemic as a result of the COVID-19 expansion. According to medical professionals, individuals with strong immunity often outlive infections more frequently than those with poor immunity. The COVID-19 pandemic has prompted the need for novel approaches to treating the illness and its symptoms. Natural products from plants are increasingly being seen favorably in comparison to synthetic ones in the fight against diseases. As a result, in order to avoid contracting any unanticipated illnesses, individuals must increase their immunity by eating more dietary supplements and by taking drugs that have immune-boosting properties. This review aimed to give a general overview of some traditional Sudanese foods and drinks that are rich in immune-boosting elements, and accordingly, they could be safely recommended as an adjuvant dietary supplement to improve the immune system's ability to fight such infections as COVID-19. Also, this review aims to bring attention to the fact that immune boosters may be found in natural sources, which will help pharmaceutical companies by taking some of the load off of them. Electronic databases, including Google Scholar, Scopus, and the Web of Science, were searched for relevant material. The selected articles underwent independent eligibility and information extraction reviews. The review focused on certain traditional Sudanese herbs and their derivatives that are rich in immune-stimulating vitamins and minerals and therefore could possibly be recommended as immune-boosting dietary supplements to help fight COVID-19. This review highlights the fact that the pharmaceutical sector, especially community and hospital pharmacists, could play a vital role in supporting the healthcare system by encouraging their communities to add plants and their products that are rich in immune-boosting vitamins and minerals to their diet.

Keywords- COVID-19; Sudan; natural products; immune-boosting; vitamins; minerals.

I. INTRODUCTION

COVID-2019 has been of global concern since March 11, 2020, up until now. The 2019 novel coronavirus, is an enveloped positive-sense single-stranded RNA virus with a large genome that is a member of the *Coronaviridae* family (Bhat et al., 2021). The new COVID-19 infection is capable of causing severe respiratory infections characterized by fever, cough, sputum production, and other manifestations such as shortness of breath, myalgia, and fatigue, is more frequent, whereas vomiting, diarrhea, and sore throats are uncommon (Pal et al., 2020). The most common complications associated with SARS-CoV-2 infection include septic shock, ARDS, respiratory failure, and heart failure (Ferrando et al., 2020).

Individuals' immune systems shield them from infectious agents they pick up in the air or from noxious insults. SARS-CoV-2 (COVID-19) is predicted to have a similar immune response to the coronavirus that causes severe acute respiratory syndrome (SARS-CoV) due to their genomic similarity (Ceccarelli et al., 2020).

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The immunological response to SARS-CoV involves both the innate immune system and the adaptive immune system.

In the general population, there are inter-individual variations in immune function. Age, gender, level of exercise, smoking, alcohol intake, stress, menstrual cycle, obesity, diet, and other factors all affect these variations (Clemente-Suárez et al., 2021).

Because the immune system's efficacy is strongly influenced by a person's nutritional status, inadequate intake of macronutrients and/or micronutrients may cause innate immune host protection to be suppressed. Vitamins and minerals balance can provide some protection against infections and inflammatory diseases; as a result, replacing nutrient deficiencies in the diet improves immune function and infection resistance (Gröber & Holick, 2021).

Medicinal plants play an important role in the world's healthcare system, and their products are used in medicine, health supplements, and beauty. Currently, herbal products are in great demand since they are effective, inexpensive, and convenient for managing our health and wellbeing without any side effects (Jamshidi-Kia et al., 2017).

Some plants are rich in immune system-boosting vitamins, minerals, and compounds such as flavonoids and carotenoids that can enhance immune function through many activities such as anti-inflammatory action, promoting the activity of lymphocytes, increasing phagocytosis, and inducing interferon production (Tadele & Zerssa, 2021).

Due to the COVID-19 pandemic, there has been a rise in demand for nutraceutical products that boost the immune system. However, the lack of these products on the market and the huge demand have made it hard for local and international pharmaceutical companies to keep up (Lordan, 2021).

The current article will give a general overview of some traditional Sudanese foods and drinks that contain immune-boosting elements and, therefore, could be a good supplement to boost immunity and could be safely recommended as an adjuvant dietary supplement to improve the immune system's ability to fight infections. Also, this review will help make people more aware that they can use natural products to boost their immunity. It will also bring attention to the fact that immune boosters may be found in natural sources, which will help pharmaceutical companies by taking some of the load off of them.

II. COVID-19 IN SUDAN

In Sudan, the government took precautions during the pandemic to stop COVID-19 from spreading throughout the nation. However, due to a lack of effective protective measures and Sudan's open borders with neighboring countries, a significant number of citizens have been exposed to infection. There have been 63,993 confirmed cases of COVID-19 from January 3, 2020, to April 26, 2023, with 5,046 fatalities reported to the WHO (Organization, 2023).

III. THE BODY'S DEFENSE MECHANISM AGAINST COVID-19

Humans have a complex immune system made up of a number of interconnected cells, tissues, and organs that work together to defend the body against harmful illnesses and viruses like COVID-19 and the flu.

A healthy immune system is crucial for preserving good health and avoiding infections. Different immune system cells operate in various bodily regions to combat external invaders including bacteria, viruses, and parasites. The response includes both an immediate innate response and an adaptive response; therefore, having a weaker immune system can make people less able to fight off sickness, which puts them at a higher risk of complications from such infections as COVID-19 (Chowdhury et al., 2020). As long as the immune system is functioning regularly, COVID-19 and other ailments do not show up on tests (Calder, 2020).

Several ways are applicable to support the immune system, such as taking immune-boosting elements to fight COVID-19. A balanced diet rich in vitamins and minerals that are present in fresh produce, whole grains, lean protein, and healthy fats will help provide your body with the resources it requires to strengthen your immune system (Calder, 2020).

IV. VITAMINS AND MINERALS WITH IMMUNE-BOOSTING ACTIVITIES

A healthy immune system is pivotal for the prevention and complete recovery from viral infections such as COVID-19. There are many factors that contribute to a healthy immune system, including adequate sleep, regular exercise, stress management, and nutrition. The natural immune system needs nutrition to function properly, and vitamins and minerals are some of the nutritional supplements that are essential for this process (Alpert, 2017).

4.1. *Minerals with immune-boosting activities*

4.1.1. *Zinc*

Zinc is an essential mineral that is important in almost all aspects of the immune system, including the development and function of immune cells and the production of antibodies. It maintains the regular operation of the thymus and bone marrow, which are responsible for producing immune cells, and it aids in the defense against infections by skin cells and cells lining our organs. It also controls leukocyte proliferation, differentiation, maturation, and function, and it modulates inflammatory responses. Moreover, zinc is a strong antioxidant that aids in defending the body from damaging free radicals. Studies have shown that taking a zinc supplement helps lessen the intensity and length of

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respiratory infections, such as the common cold. Increased vulnerability to inflammatory and infectious disorders may result from zinc deficiency, which can weaken the immune system and lead to repeated infections and slow wound healing (Karki & Bhandari, 2022; Rana, 2021).

4.1.2. *Selenium*

Selenium is a mineral that is essential for immune function, including the production of antibodies and the function of other immune cells. It has been shown to improve both cell-mediated and humoral immune responses. A strong antioxidant like selenium helps shield the body from damaging free radicals. The initiation of immunity as well as the control of exaggerated immunological responses and chronic inflammation depend on adequate amounts of selenium (Fakhrolmobasheri et al., 2020; Rataan et al., 2022).

4.1.3. *Copper*

Numerous physiological functions, including angiogenesis, neurohormone homeostasis, gene expression, brain development, and immune system operation, depend on copper. Reduced humoral and cell-mediated immune responses are brought on by copper deficiency, which is essential to the immune system because it kills alien microorganisms (Alpert, 2017; Patel et al., 2021).

4.1.4. *Iron*

Iron is essential for immune function, including the production of red blood cells and the function of immune cells. It is necessary for immune cells' proliferation and maturation, particularly lymphocytes, to be associated with the generation of a specific response to infection. Iron is also a potent antioxidant that helps protect the body against harmful free radicals. By using proteins like transferrin and lactoferrin, the body may limit the amount of iron that pathogenic agents can ingest. In immunologically significant cases, iron deficiency may result in lowered protein synthesis, impair immune function, and increase the risk of infection (Alpert, 2017; Darbar & Saha, 2020).

4.1.5. *Magnesium*

Magnesium is the primary cation in human cells, where it is mostly found in the mitochondria. The immune system's capacity to combat infections and cancer cells is significantly influenced by the amount of magnesium in the blood. Magnesium promotes healthy immunological function, regulates the heartbeat, maintains appropriate nerve and muscle function, and strengthens bones. The production of immunoglobulins, C3 convertase, immune cell adhesion, antibody-dependent cytolysis, IgM lymphocyte binding, macrophage response to lymphokines, T helper, B cell adhesion, binding of substance P to lymphoblasts, and antigen binding to macrophage RNA all require magnesium as cofactors (Rad & Yaseri, 2022; Shakoor, Feehan, Al Dhaheri, et al., 2021).

4.2. *Vitamins with immune-boosting activities*

4.2.1. *Vitamin C*

Water-soluble vitamin C, sometimes referred to as ascorbic acid, is one of the important vitamins that enhance immunity and is necessary for the body's tissues to develop and heal. By assisting various cellular processes of the innate and adaptive immune systems, vitamin C supports immune defense (Shakoor, Feehan, Al Dhaheri, et al., 2021). Antimicrobial and natural killer cell activity, lymphocyte proliferation, chemotaxis, and delayed-type hypersensitivity were all shown to be enhanced by vitamin C supplementation. According to studies, vitamin C helps lessen the intensity and length of respiratory illnesses like the common cold. Increases in phagocytosis, lymphocyte proliferation, and neutrophil chemotaxis against external pathogens are some of the mechanisms through which vitamin C strengthens human defense against infections and colds (Alpert, 2017; Darbar & Saha, 2020).

4.2.1. *Vitamin B6*

Pyridoxine (vitamin B6) functions as a cofactor in a variety of inflammatory pathways. Vitamin B6 intake and supplementation improve some immune functions. In chronic inflammatory conditions, the B6 vitamin has an inverse association with plasma IL-6 and TNF. It is thought that taking B6 vitamin supplements can help ease COVID-19 symptoms by controlling immune responses, lowering pro-inflammatory cytokines, maintaining endothelial integrity, and preventing hypercoagulability (Shakoor, Feehan, Mikkelsen, et al., 2021). The movement of vitamin B6 to the sites of inflammation may play a contributing role in the production of metabolites with immunomodulating properties, which is one potential mechanism at play. Multiple studies suggest that increasing B6 intake via diet or supplementation improves some immune functions in those who are B6 deficient (Alpert, 2017; BourBour et al., 2020).

4.2.2. *Vitamin D*

An essential component of both innate and adaptive immunity is the fat-soluble vitamin “vitamin D”. It has a significant impact on controlling calcium and phosphorus absorption and promoting healthy immune system operation. Vitamin D also plays a crucial role in immune function, including the activation of immune cells and the production of antimicrobial peptides. A lack of vitamin D has been linked to an increased risk of respiratory infections such as the flu and pneumonia. Vitamin D has also been shown to be useful in lowering the risks of cardiovascular disease, diabetes mellitus, hypertension, cancer, and respiratory tract infections (Rad & Yaseri, 2022; Shakoor, Feehan, Al Dhaheri, et al., 2021).

4.2.3. *Vitamin A*

The maintenance of good skin, eyesight, and immunological function depends on the fat-soluble vitamin “vitamin A". It participates in immune system formation and controls cellular and humoral immunological responses. Vitamin A also plays a crucial

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Volume-2 Issue-2 || April 2023 || PP. 231-240

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role in the development and function of immune cells, including T cells, B cells, and natural killer cells. It is also a potent antioxidant that helps protect the body against harmful free radicals.(Alpert, 2017; Karki & Bhandari, 2022).

4.2.4. *Vitamin E*

Vitamin E is a fat-soluble vitamin that is essential for maintaining healthy skin and immune function. It is also a potent antioxidant that helps protect the body against harmful free radicals. Immune cells, such as T cells and B cells, need on vitamin E to operate properly. As a result of its direct effects on T cell membrane integrity, signal transduction, and cell proliferation as well as its indirect effects on inflammatory mediators produced by other immune cells, vitamin E has been found to alter T cell activity (Rad & Yaseri, 2022; Shakoor, Feehan, Al Dhaheri, et al., 2021).

V. EFFECT OF THE COVID-19 PANDEMIC ON CONSUMPTION OF IMMUNE-BOOSTING VITAMINS AND MINERALS

The uncertainty surrounding COVID-19 led to anticipatory drug purchases worldwide, raising demand to previously unheard-of levels. The pandemic harmed the global medication supply chain because of factory closures, limited availability to raw materials, and changed import and export rates of final dosage forms. The pandemic has affected the global food and drug supply chains and caused many countries to close their borders, restrict imports and exports, and limit the movement of goods and people (Tirivangani et al., 2021). The shortage of essential vitamins and minerals can have severe consequences for the health of the population, particularly during health crises such as the COVID-19 pandemic. Malnutrition and nutrient deficiencies as a result of this shortage can weaken the immune system, making individuals more vulnerable to infections such as COVID-19 (Mayasari et al., 2020; Mohsen et al., 2021).

VI. CHALLENGES IN SUDAN DUE TO THE SHORTAGE OF MEDICINES DURING THE COVID PANDEMIC

In Sudan, drug insecurity is a result of a number of interrelated causes, including the deteriorating economic situation, improper pricing policies, privatization of the pharmaceutical industry, subpar manufacturing, and a lax regulatory framework. During the Corona pandemic, Sudan was dealing with a number of challenges, including medicine shortages, which have been made worse and more apparent by the COVID-19 outbreak (Lucero-Prisno III et al., 2020). Markets were shuttered, meetings were prohibited, public transportation was halted, a curfew was imposed, and land borders were shut down. The provision of emergency medical services in Sudan was severely hampered by the chronic shortages of pharmaceuticals, medicines, and medical supplies. The increased prices in accordance with the shortage have affected people's ability to purchase their support drugs. A lack of drugs and medications has disastrous effects on the country, and the effectiveness of the system for supplying medications must be assessed, looked at, and improved (Lucero-Prisno III et al., 2020). As a result, there was a pressing need to look for an adjuvant therapy that could help fill the gap, especially for vitamins and minerals with immune-boosting components derived from natural sources (herbal foods and drinks).

VII. THE ROLE OF PHARMACISTS IN OPTIMIZING PATIENT CARE THROUGH DRUG SHORTAGE MANAGEMENT

Pharmacists play a crucial role during drug shortages due to their particular expertise and capacity to bridge supply gaps with appropriate action plans that do not compromise patient safety. Due to an insufficient supply chain and strong demand everywhere, drug shortages have become a recurrent concern in pharmacy practice (Pulk et al., 2020). Drug shortages have been a persistent issue for the medical community for decades, but the COVID-19 pandemic has made them even worse. Pharmacy staff members have responded to the drug shortages by starting local policy revisions, instituting careful antimicrobial stewardship, and enforcing quantity limitations in order to save drug supplies out of a fear that there wouldn't be enough supplies to fight the illness. Overall, the COVID-19 pandemic's record medicine shortages have spurred creativity and analytical thinking in a drive to conserve scarce resources without compromising patient safety (Lucero-Prisno III et al., 2020). Traditional medicine is just one of the numerous aspects of community health that physicians must take into account. Therefore, during the pandemic, great research-based work has been done to study different herbal products as possible candidates for fighting the progress of the COVID-19 infection (Zarei & Heydari, 2022).

VIII. SUDANESE TRADITIONAL FOODS AND DRINKS WITH PROMISING IMMUNE-BOOSTING ACTIVITIES

Natural and conventional treatments have been used for ages to cure and prevent disease, and the COVID-19 pandemic has increased interest in them because of their ability to strengthen the immune system (Huang et al., 2020). As the shortage of medical supplies, including medicines, personal protective equipment, vitamins, and minerals, has increased, there has been an increasing interest in natural products that contain immune-boosting

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Volume-2 Issue-2 || April 2023 || PP. 231-240

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vitamins and minerals to help individuals stay healthy and fight off the COVID infection (Zarei & Heydari, 2022).

Sudan has a rich cultural heritage and a diverse cuisine, and Sudanese natural foods and drinks are known for their unique flavors and nutritional value (Karar & Kuhnert, 2017). Many of these foods and drinks have been known to contain vitamins and minerals that can support and boost the immune system.

Vitamin C, vitamin D, zinc, and selenium are just a few of the immune-strengthening minerals and vitamins found in many natural products (Mitra et al., 2022). These nutrients play a critical role in supporting the immune system and helping the body fight off infections. This article reviews the immune system-boosting vitamins and minerals found in some plants and their products that are most commonly used in traditional foods and drinks in Sudan. Regarding their availability and routine usage in Sudan, a total of 16 commonly used plants have been selected to be explored for their nutritional value and compared in accordance with their content of immune-boosting vitamins and minerals, as shown in the table below:

Table 1: The list of the selected plants to be explored for nutritional value and immune-boosting vitamins

No.	**Plant**	**Latin name**	**The used part**
1	Lemon	*Citrus limon*	Fruit
2	Grapefruit	*Citrus paradisi*	Fruit
3	Orange	*Citrus sinensis*	Fruit
4	Baobab	*Adansonia digitata*	Fruit
5	Ginger	*Zingiber officinale*	Roots
6	Guddaim	*Grewia tenax*	Fruit
7	Heglig	*Balanites aegyptiaca*	Fruit
8	Nabag	*Ziziphus spina-christi*	Fruit
9	Tamarind	*Tamarindus indica*	Fruit
10	Date	*Phoenix dactylifera*	Fruit
11	Peanut	*Arachis hypogaea*	Seeds
12	Doum	*Hyphaene thebaica*	Fruit
13	Fenugreek	*Trigonella foenum-graecum*	Seeds
14	Cumin	*Nigella sativa*	Seeds
15	Turmeric	*Curcuma longa*	Roots
16	Roselle	*Hibiscus sabdariffa*	Flower

8.1. *Immune-booting minerals in the selected Sudanese plants in foods*

This review allowed the identification of many immune-boosting components in the different traditional Sudanese foods. The review is adapted to stratify the immune-boosting components and list them according to their percentages per one hundred grams of the most commonly used parts of the different plants, i.e., fruits, leaves, seeds, etc.

8.1.1. *Zinc (Zn) contents*

The many roles that zinc plays in fundamental cellular processes such DNA replication, RNA transcription, cell division, and cell activation provide the foundation of zinc's impacts on these important immunologic mediators (Khabour & Hassanein, 2021). The data collected from different sources revealed that *Nigella sativa* (cumin), *Curcuma longa* (turmeric), and *Arachis hypogaea* (peanut) have the highest content of zinc among the selected plants. Figure 1 below shows the percentage of zinc per milligram per 100 grams of plants (Ahood et al., 2019; Basak et al., 2020; Khabour & Hassanein, 2021; Lockyer, 2020; Olarewaju et al., 2022; Reddy, 2020; Singh et al., 2021; Srivastava et al., 2020; Trajkovska-Broach & Petkoska, 2022).

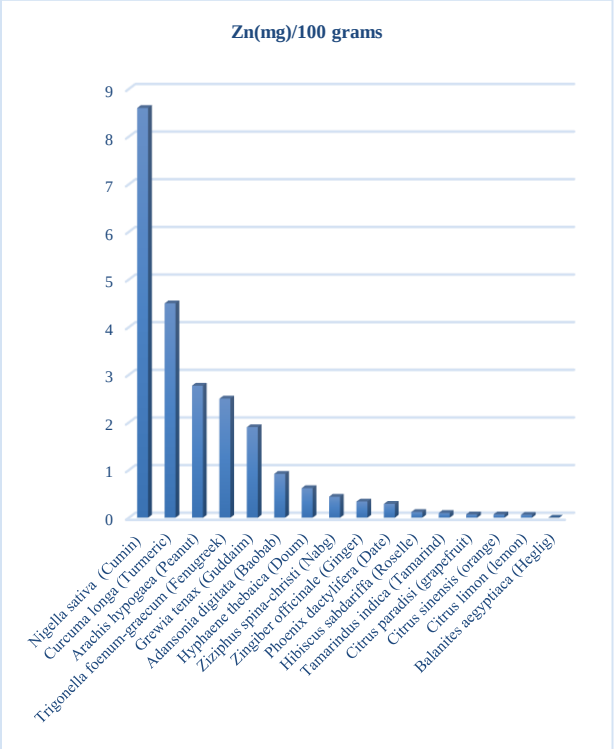

Figure 1: The zinc content of selected Sudanese plants is presented as mg per 100 grams.

8.1.2. *Selenium (Se) contents*

By controlling immune cell function and improving their response to infections and diseases, selenium has a significant impact on the immune system. The growth and activation of numerous immune cells depend on selenium, which is also involved in a number of metabolic and signaling processes (Shakoor, Feehan, Al Dhaheri, et al., 2021). Evaluation of the selenium content of different Sudanese natural foods showed variable quantities. Overall, *Nigella sativa* (cumin), *Arachis hypogaea* (peanut), and *Trigonella foenum-graecum* (fenugreek) are the richest plants in this element among the selected plants (figure 2) (Alkhatib, 2020; Galanakis et al., 2020; Khabour & Hassanein, 2021; Olarewaju et al., 2022; Tamboli et al., 2021).

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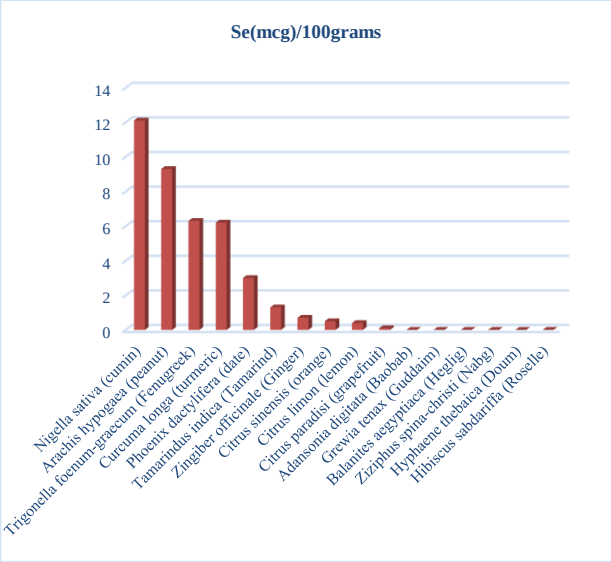

Figure 2: The selenium content of selected Sudanese plants is presented as mcg per 100 grams.

8.1.3. *Magnesium (Mg) contents*

By controlling immune cell activity and improving their response to infections and diseases, magnesium has a significant impact on the immune system. Magnesium has a role in a number of metabolic and signaling pathways and is necessary for the growth and activation of a number of immune cells (Rad & Yaseri, 2022). As shown in figure 3, the data analysis of nutritional magnesium contents in the selected plants confirmed a superior content in *Nigella sativa* (cumin), *Hyphaene thebaica* (doum), and *Curcuma longa* (turmeric) (Ahood et al., 2019; Galanakis et al., 2020; Khabour & Hassanein, 2021; Kumar Gupta & Sharma, 2014; Olarewaju et al., 2022; Trajkovska-Broach & Petkoska, 2022).

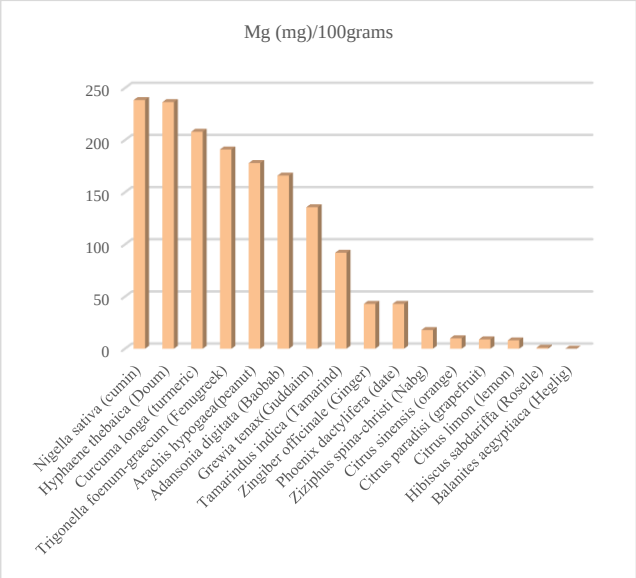

Figure 3: The magnesium content of selected Sudanese plants is presented as mg per 100 grams.

8.1.4. *Copper (Cu) contents*

The immune system requires copper to perform several functions, of which little is known about the direct mechanism of action (Alpert, 2017). Regarding copper, this review showed that *Nigella sativa* (cumin) has the highest content, with a value equal to 1.9 mg per 100 grams of plant seeds (figure 4) (Ahood et al., 2019; Galanakis et al., 2020; Gupta & Mishra, 2021; Olarewaju et al., 2022; Trajkovska-Broach & Petkoska, 2022).

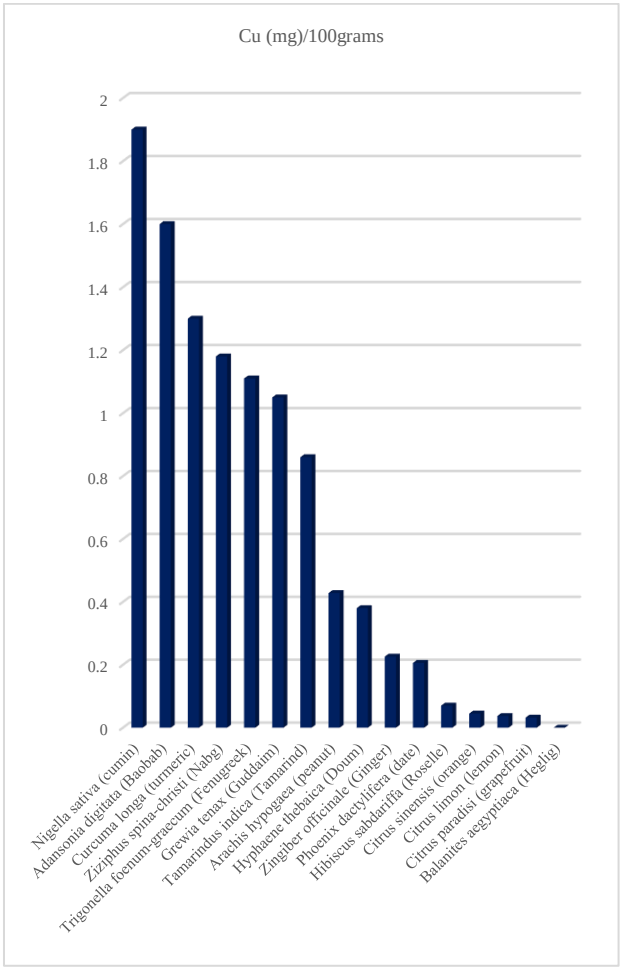

Figure 4: The copper content of selected Sudanese plants is presented as mg per 100 grams.

8.1.5. *Iron (Fe) contents*

Iron helps the immune system work properly by controlling immune cell activity and improving their ability to fight off infections and illnesses. Iron is necessary for the growth and activation of different immune cells and is engaged in a number of metabolic and signaling pathways (Rad & Yaseri, 2022). The current review showed that the Curcuma longa (turmeric) plant has the highest content of iron, followed by Hyphaene thebaica (doum), as shown in figure (5) (Ahood et al., 2019; Alkhatib, 2020; Galanakis et al., 2020; Gupta & Mishra, 2021; Kumar Gupta & Sharma, 2014; Olarewaju et al., 2022; Trajkovska-Broach & Petkoska, 2022).

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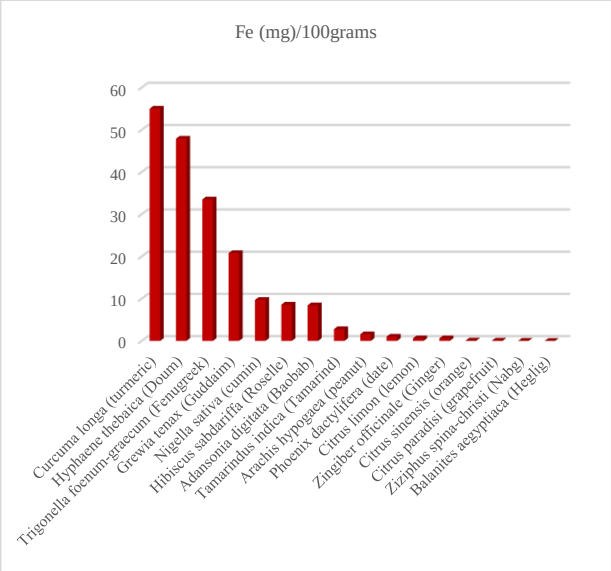

Figure 5: The iron content of selected Sudanese plants is presented as mg per 100 grams.

8.2. *Immune-booting vitamins contents Sudanese natural foods*

8.2.1. *Vitamin C contents*

White blood cells, especially phagocytes and T cells, which are crucial for battling infections and disorders, are produced and activated by vitamin C, which helps to support the immune system's function. The body is shielded from oxidative stress brought on by free radicals by vitamin C's antioxidant activity (Shakoor, Feehan, Al Dhaheri, et al., 2021). Overall, when compared with other selected plants, *Adansonia digitata* (baobab) has emerged as a promising natural source for vitamin C (figure 6) (Galanakis et al., 2020; Gupta & Mishra, 2021; Khabour & Hassanein, 2021; Kumar Gupta & Sharma, 2014; Srivastava et al., 2020; Trajkovska-Broach & Petkoska, 2022).

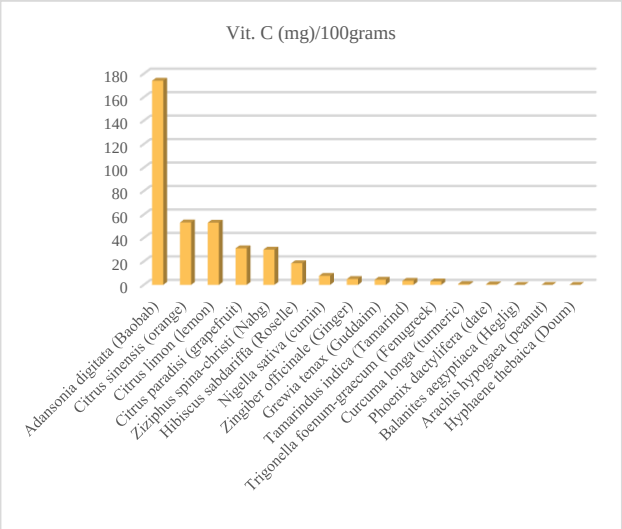

Figure 6: The vitamin C content of selected Sudanese plants is presented as mg per 100 grams.

8.2.2. *Vitamin B_6 contents*

Due to its ability to control immune cell activity and improve the immune system's response to infections and illness, vitamin B6 is crucial to health. As a necessary component for the growth and activation of various immune cells, vitamin B6 is involved in a number of metabolic and signaling pathways (Van Schoor, 2019). The results indicated that *Hyphaene thebaica* (doum) and *Grewia tenax* (guddaim) have the highest content of vitamin B6, with values equal to 10.07 and 8.2 mg per 100 grams, respectively (Ahood et al., 2019; Alkhatib, 2020; Galanakis et al., 2020; Gupta & Mishra, 2021; Kumar Gupta & Sharma, 2014; Maheshwari et al., 2022; Trajkovska-Broach & Petkoska, 2022).

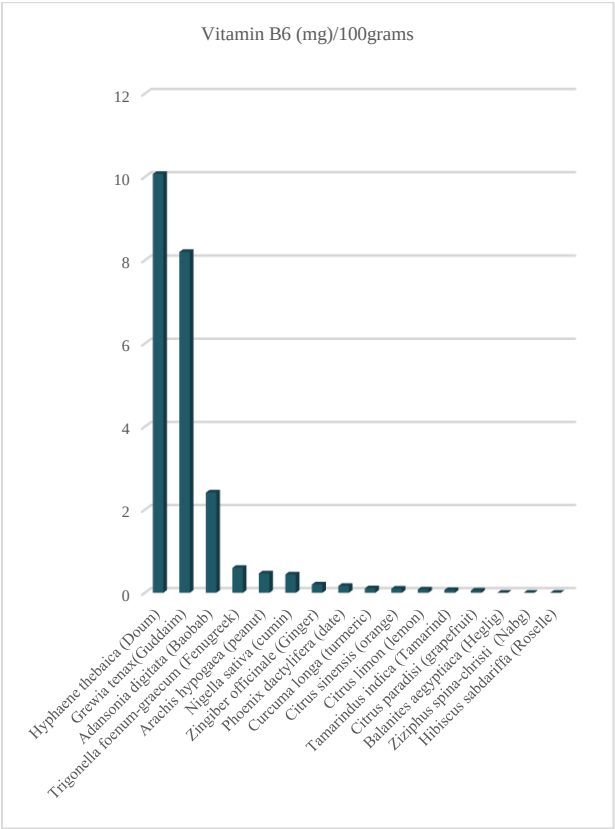

Figure 7: The vitamin B6 content of selected Sudanese plants is presented as mg per 100 grams.

8.2.3. Vitamin E contents

Due to its antioxidant properties and capacity to shield immune cells from oxidative damage, vitamin E is crucial for the immune system. Additionally, it aids in regulating the activity of immune cells, particularly T cells, which are crucial for battling infections and diseases (Shakoor, Feehan, Al Dhaheri, et al., 2021). The study also showed that the Arachis hypogaea (peanut) plant has the highest content of vitamin E, followed by Curcuma longa (turmeric) and Nigella sativa (cumin). The results are shown in figure 8 (Ahood et al., 2019; Alkhatib, 2020; Galanakis et al., 2020; Gupta & Mishra, 2021; Khabour & Hassanein, 2021; Kumar Gupta & Sharma, 2014).

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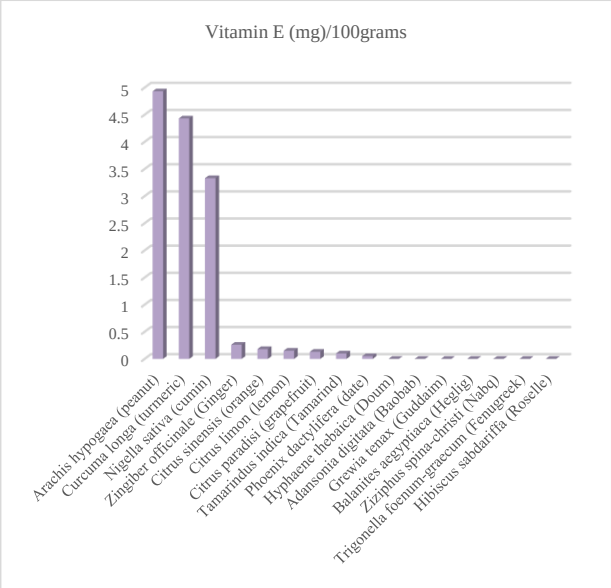

Figure 8: The vitamin E content of selected Sudanese plants is presented as mg per 100 grams.

8.2.4. Vitamin A contents

Vitamin A is essential for preserving eyesight, fostering growth and development, and safeguarding the integrity of the epithelium and mucus in the body. The immune system and disease resistance both benefit from vitamin A (Huang et al., 2018). Interestingly, this study showed that *Hyphaene thebaica* (doum) has a significant amount of vitamin A (174.0 I.U.), with a huge difference when compared with the other selected plants (Ahood et al., 2019; Alkhatib, 2020; Galanakis et al., 2020; Gupta & Mishra, 2021; Khabour & Hassanein, 2021; Kumar Gupta & Sharma, 2014; Olarewaju et al., 2022).

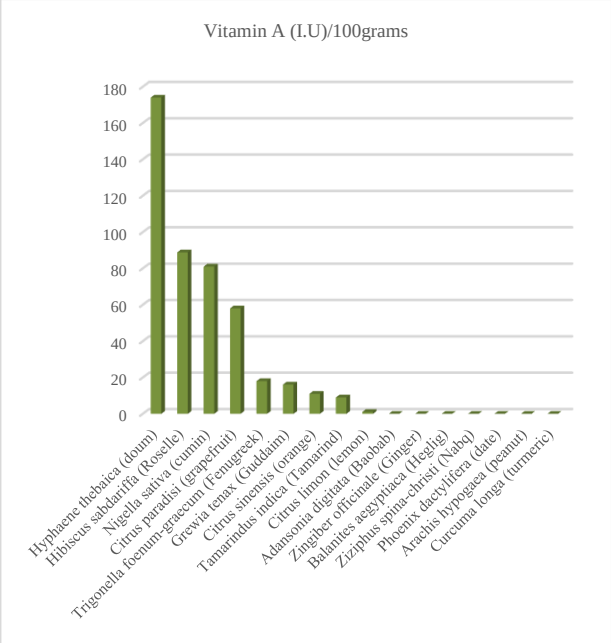

Figure 9: The vitamin A content of selected Sudanese plants is presented as I.U per 100 grams.

8.2.5. Vitamin D contents

Because it controls immune cell activity and improves the body's response to infections and diseases, vitamin D is crucial for the immune system. In order to control immune cell activity and improve their performance, it functions as both an immunomodulator and an immunostimulant (Shakoor, Feehan, Al Dhaheri, et al., 2021). The findings revealed that only *Hyphaene thebaica* (Doum) and *Adansonia digitata* (Baobab) contain vitamin D as shown in figure 10 (Ahood et al., 2019; Alkhatib, 2020; Galanakis et al., 2020; Gupta & Mishra, 2021; Khabour & Hassanein, 2021; Kumar Gupta & Sharma, 2014; Olarewaju et al., 2022).

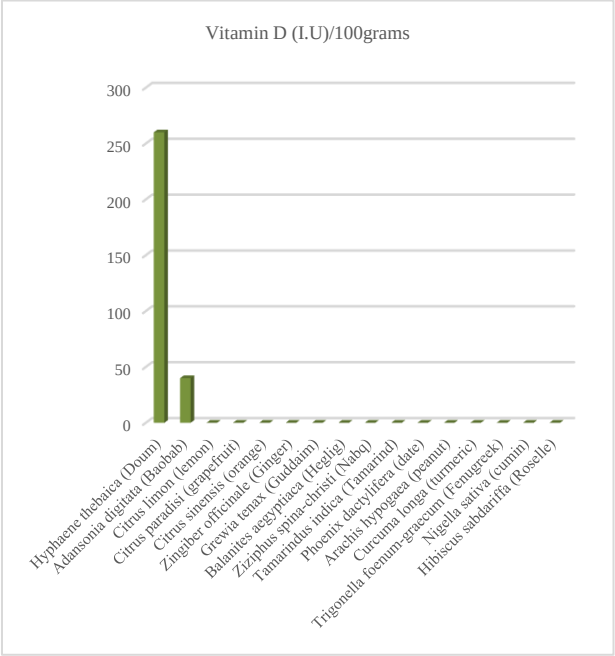

Figure 10: The selenium content of selected Sudanese plants is presented as I.U per 100 grams.

IX. CONCLUSION

The continuing tragedy of COVID-19 necessitates the rapid development of alternative remedial measures. A healthy and balanced diet rich in vitamins and minerals is essential for maintaining a strong and healthy immune system and supporting the natural immune system by activating immune cells, producing antibodies, and protecting the body against harmful free radicals. Deficiencies in these essential nutrients can impair immune function and increase the risk of infections. Our review figured-out the possible role of herbal plants, particularly those commonly used in traditional Sudanese foods and drinks, for their bioactive ingredients and contents that could possibly act as immune-boosting adjuvant therapy in the battle against COVID-19. Therefore, it is important to consume a variety of these foods rich in vitamins and minerals to support the natural immune system and maintain good health.

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AUTHOR CONTRIBUTIONS

All authors made a significant contribution to the work reported, whether that is in the conception, collection and revision of data, or taking part in drafting, revising, or critically reviewing the article. All authors gave final approval of the version to be published agreed on the journal to which the article has been submitted, and agreed to be accountable for all aspects of the work.

CONFLICT OF INTEREST

The authors declare no conflicts of interest for this work

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