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The role of bioactive compounds and nutrients in mitigating COVID-19 risks, lessons for future pandemics.

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1. List of Abbreviations, Tables and Figures

1.1 List of Abbreviations

ACE 2: Angiotensin-converting Enzyme 2

COVID-19: Corona Virus Disease 2019

CS: Cytokine Storm

EGCG: Epigallocatechin Gallate

H1N1: Influenza A Virus Subtype

HCV: Hepatitis C Virus

HIV: Human Immunodeficiency Virus

MoH: Ministry of Health

ROS: Reactive Oxygen Species

SARS-CoV-19: Severe Acute Respiratory Syndrome Corona Virus 2019.

SARS-CoV-2 Spike S: Coronavirus Spike Protein that Contains the Receptor-binding Domain that Binds to Receptors on the Cell Surface

US: United States

WHO: World Health Organization

2. ***Abstract***

The studies and findings about the effect of bioactive compounds in food against Coronavirus were used as lessons for the future pandemics which can be implemented in order to enhance development of functional foods that supports people's immunity and general health of humanity.

The researcher used an evidence based qualitative approach with two different tracks: Analysis of the existing literature on bioactive compounds used and studied by other authors as an approach in coronavirus treatment. Second track scanned the effect of intake of bioactive compounds on severity and duration of the disease.

Keywords: COVID-19, functional foods, bioavailability, cytokine storm, immunity system, functional foods.

3. *Introduction*

The dietary intake of functional ingredients during Coronavirus infection have been studied by several authors. Herbal remedies were used successfully in many countries. Several studies stressed the importance of bioactive-rich compounds found in plants, herbs and edible components such as curcumin, black pepper, aloe vera, onion and garlic, etc.

This paper investigates the recent knowledge on bioactive-rich foods as antioxidants, anti-inflammatory and antiviral in order to help in preventing severe symptoms of future infections.

One of the important lessons learned during Coronavirus is the necessity to establish a powerful immunity system through investing in the value of bioactive-rich components, either as foods or supplements.

The identification of the bioactive compounds in various foods may potentially aid in the development of various health products based on evidence and research. For example, phenolic compounds derived from plants have been determined previously as having antiviral effects against various viruses including Human Immunodeficiency Virus (HIV) and Hepatitis C Virus (HCV). The phenolic compounds act by regulating the signaling of the host cell and interacting with the viral proteases (Abd El-Aziz et al. 2020). Phenolic compounds such as gallic acid, quercetin, caffeic, benzoic acid, and ellagic acid act as coronavirus polymerase inhibitors, and were found to be safe and effective (Remali and Aizat 2020).

Phytochemicals were found to inhibit the action of Coronavirus enzymes essential to the replication of the virus, hence reduce the risk of the development of an infection (Chojnacka et al. 2020).

Bioactive compounds in some plants have a higher level of safety as compared to other pharmacological compounds. The antiviral properties of various phytochemicals including betullinic acid, luteolin, and gallates enhance the necessity for the adoption of antiviral treatments that utilize these compounds. Bioflavonoids may also enhance the functioning of the immunity to reduce inflammation and help in mitigating coronavirus. (Patil et al. 2021). Various bioactive compounds found in plants including pectolinarin, epigallocatechin, gallate, nabiximols and rhoifolin inhibit proteases and spike glycoproteins of the coronavirus more effectively as compared to presently used medications. Research results indicate that such plant-based compounds may potentially be more effective in limiting virus activity compared to the treatments presently used. It was identified that glycyrrhizic acid, amentoflavone, and mulberroside inhibit the coronavirus proteases, hence limiting virus replication. Flavonoids also enhance the functioning of the immunity system and reduce inflammation (Patil et al.

2021). Chinese herbal medicines were used against coronavirus effectively. Thirteen of the traditional Chinese medicines were found to be effective in the treatment of Coronavirus by reducing the risk of viral infection and improving the immunity system effectiveness. (Zhang et al. 2020). Adoption of herbal interventions in the management of COVID-19 is higher in Asian countries (Alam, Hussain, and Pati 2020) 2020). A survey was administered on the use of herbal treatments in the management and prevention of Coronavirus in India showed that 71.8% of the people reported using herbal treatments to enhance immunity and overcome infections. 86.15% of the people also held the perspective that the herbal medicines did not have any side effects **(**Singh, Kumar and Kumar 2021).

The nutritional approach has also proven to be effective in minimizing the adverse effects of the Coronavirus and the duration of the symptoms (Tibebeselassie and Biesalski 2021). The role of vitamins and minerals such as vitamin A, Vitamin B6, Vitamin C, vitamin D, vitamin E and Zinc in reinforcing the immunity and as anti-inflammatory was also studied. The intake of these nutrients either by food or through supplementation was found to be necessary to trigger human defence against viruses and infections.

Micronutrients are critical for an adequate function of the immune system and play a vital role in promoting health and nutritional well-being. For example, Deficiency in vitamin A has been determined to reduce the production of antibodies, hence limiting the immunity function. Vitamin B6 supplementation also improved immune function in both human and animal studies. In-vivo evidence indicates that vitamin B6 has anti-inflammatory effects while enhancing the production and differentiation of lymphocytes in rats. Deficiency in vitamin B9 is also associated with a decrease in immunity functions. Vitamin C is essential for pulmonary health. Higher levels of

vitamin C among patients being treated for pneumonia and bronchitis was associated with higher levels of leukocytes and reduced risk of developing pulmonary complications. Vitamin C hence enhances the functioning of the immunity system by enabling the production and differentiation of T-cells (Tehrani et al. 2021). Similarly, vitamin D deficiency limits the production of lymphocytes while increasing morbidity among children (De Souza Monnerat et al. 2020).

Trace elements are dietary components that are required in small amounts nevertheless, play pivotal roles in the homeostasis of the immune system. They mostly act as catalysts in enzymatic reactions in the context of viral diseases. Investigations have indicated a powerful link between an imbalance in the levels of trace elements (e.g., iron, zinc, copper, selenium, and magnesium) and disease severity (Gasmi et al. 2020; Akhtar et al. 2021). Some studies indicated that selenium deficiency may be detrimental in the context of various viral disorders including COVID-19. Cautious selenium supplementation in COVID-19 patients may be helpful to prevent disease progression. However, randomized clinical trials are needed to confirm this finding (Fakhrolmobasheri et al. 2021).

A connection was drawn between eating spices and patient outcomes in various areas. A conclusion was that people in South Eastern Asia have a lower COVID-19 morbidity rate as compared to people in Europe and US, which may be due to the high amount of spices that South Eastern Asians consume ((Alam, Hussain, and Pati 2020). A recent study conducted on primary data of 163 countries worldwide in respect to total cases, deaths, and recoveries from COVID-19 revealed a close association between the total number of COVID-19 cases per million inhabitants tested and the gram of spice supplied *per capita* per day. This study further reported that the nation with an increased number of COVID-19 cases per million inhabitants corresponded to lower consumption of spices *per capita* (Elsayed and Khan 2022). However, there is need for more

studies to determine the existence of the differences in morbidity rates and evaluate whether the observed differences are due to the level of spices in food or other external factors. This research illustrates the significance of bioactive plant extracts as a potential alternative to existing modes of treatment. This literature review has explored the nature and sources of bioactive compounds found in plants, spices and other edible materials. Besides collecting evidence from literature, an anonymous survey was conducted to compare the literature findings to the results of the study as a methodology triangulation strategy.

4. Materials and Methods

The research used an evidence based qualitative approach that focused on two different tracks in order to triangulate the results: Analysis of the existing literature in this area of research and a survey strategy was administered where data was collected using a structured interview.

4.1 Surveying the Existing Literature: on the effectiveness of various bioactive compounds, and micronutrients and their adoption in the society during the COVID-19 pandemic. The majority of the papers were published in the years 2019-2022. The samples of research papers comprise articles printed in peer reviewed journals. The papers were then surveyed to identify the aspects pertaining to the bioactive compounds found in various foods and the manner in which they interacted with the immunity system to enhance the body's response to exposure and infection severity.

4.2 The Research also administered a Survey: Data was collected using a structured interview (Appendix 1) with closed-ended question on persons who were infected with COVID-19, but were neither vaccinated before the infection nor administered any pharmacological medications during the infection. Further, and in order to increase the respondent population, some responses were collected by email.

The survey (Appendix 1) included questions related to people's health status, their food choices especially from the bioactive-foods as well as supplements and vitamins intake. It also included questions related to the duration and severity of the symptoms during infection. The first five hundred responses were analyzed as an evidence tool.

5. *Results*

This part sheds light on the plants, edible sources, herbal remedies rich in bioactive compounds and found to be useful in mitigating COVID-19. The focus is made on easily and economically available foods containing bioactive compounds and the evidence on their effectiveness against the disease.

5.1 Functional herbs, plants and foods

The literature review has explored the nature and source of bioactive compounds found in spices, plants and other edible sources. Table 1(parts a and b) describes some of the herbs and plants (non-exclusive list) under scrutiny, in alphabetical order:

[**Insert Table 1 part a near here**]

[**Insert Table 1 part b near here**]

Source developed by the author (2022)

5.2 Herbal medicines/remedies

Chinese medicinal herbs were used in Coronavirus treatment. *Shufeng Jiedu* is an herbal Chinese medicinal capsules may have a potential in COVID-19 treatment. The ability of the drug to limit the replication of the virus and reduce viral loads in the lungs was studied. The results indicated that Shufeng Jiedu led to a decline in the viral loads in the lungs, reduced inflammation and enhanced the levels of lymphocytes. Additionally, Shufeng Jiedu led to a significant decline in the number of days taken to recover from a COVID-19 infection (Lu et al. 2020).

Ephedra-glycyrrhiza**:** Historically, Chinese traditional medicines have used herbs to treat ailments related to COVID-19 including influenza and the common cold. Ephedra-glycyrrhiza, other herbal drugs, are frequently used to prevent and treat Covid-19 related symptoms (Xiaoling et al., 2021 and González-Juárez et al. 2020), since they showed antiviral, anti-inflammatory, antibacterial, antioxidant and diuretic activities. They are widely used in respiratory diseases such as asthma, influenza and colds, and could relax a range of symptoms including fever, headache, nasal congestion and cough.

African remedies: Many African countries suffering from either over-stretched or non-existent healthcare infrastructure resorted to home remedies as immediate alternative or first line defence against COVID-19. Natural spices with notable antioxidant and anti-inflammatory properties (turmeric, ginger, garlic etc.) and leaves (neem, paw, guava, etc.) were found to be beneficial (Orisakwe, Eudora and Nwanaforo2020).

5.3 Interview Results

The survey was launched in December 2020 through June 2021, just a few months after introduction of various vaccines.

Table 2 (Part 1) summarizes bio-data and presence of chronic diseases. The population of the research was composed of both genders (47% males and 53% females) of different ages, but the majority of the population (74%) was between 31 and 60 years old. As depicted in table 2, 62% of the population didn't happen to have chronic diseases. The remaining 38% had one or more.

[Insert Table 2 near here]

Source developed by the author (2022)

Table 2 (Part 2) shows the level of people who needed hospitalization, symptoms that were felt, level of severity and duration of infection

The majority felt one or more of the symptoms accompanying the infection mainly: fever, fatigue, dry cough, bone pain, sore throat, loss of taste/smell senses (olfaction/gustatory system), headache, difficulty in breathing and chest pain.

Table 2 (Part 2) also describes the level of severity and duration of the symptoms. The severity of the symptoms was described as low (symptoms were hardly felt), Moderate (symptoms were felt but still durable) and high (symptoms were sharp and could lead to hospitalization). The results showed that those who felt low symptoms were about 42% of the research population while 38% had moderate level, whereas 30% of the respondents reported that the symptom duration mostly lasted 4-6 days.

Table 2 (Part 3) presents the most consumed bioactive-rich foods and supplements during the infection as described by respondents, such as Onions and garlic, hot water and beverages, legumes, fruits, citrus fruits…etc, whereas the most highlighted supplements were vitamin D, vitamin C and Zinc.

The highest food choices were onions and garlic (88%), Hot water and beverages (84%), legumes (81%), citrus fruits (75%), followed by probiotics, herbs, ginger and aloe vera. The supplemental intake was focused on Vitamin C (82%) and vitamin D (75%).

In the second part of the analysis, the food and supplemental choices were examined and plotted against the severity and duration of the disease.

Figure 1 shows the effect of consumption of bioactive-rich foods and most common supplements on duration of the infection. It is evident from figure 1 that 69-70% of those who consumed vitamins C or D managed to recover within 1-6 days. Also, bioactive rich food choices

were supportive in overcoming the disease in shorter times. For example, 58% of people who consumed probiotics and herbs felt the symptoms for 1 to 6 days. On the other hand 51% of those who did not support their health with supplemental intake needed more than 13 days to recover.

[**Insert Figure 1 near here**]

Source developed by the author

Figure 2 represents the level of severity for people who consumed bioactive-rich foods and supplements. The results revealed that 60% of those who consumed probiotics felt low severity, while vitamin C was the best supplement in lowering severity followed by zinc and vitamin D.

[**Insert Figure 2 near here**]

Source developed by the author (2022)

6. Discussion

The triangulation methodology employed demonstrates beyond any reasonable doubt that the results arrived at through surveying the literature tally perfectly well with the respondent interview analysis. The results hence support the position that bioactive substances may have a higher level of efficacy as compared to the pharmacological treatments presently being applied.

Bioactive compounds extracted from plants are predominant in certain parts of the world (India, China and South Eastern Asia). Chinese traditional medicines have historically used herbs to treat ailments related to COVID-19 including influenza and the common cold.

A slight concern with the use of the plant based bioactive compounds relate to oral availability and bioavailability. The oral availability of the bioactive compound may reduce when mixed with food. Consequently, it may not be possible for a person to absorb the required levels of the bioactive compounds if they are eaten with food. This encourages the combination of healthy

food and supplements. It also promotes the development of nutraceuticals that contain extracts fromthese bioactive compounds with higher availability.

A further concern pertains to bioavailability. The body can only utilize nutrients that have been absorbed into the blood stream. Some of the bioactive compounds have a lower level of bioavailability compared to other pharmacological treatments. There is need for the adoption of approaches that will enhance the absorption of the bioactive compounds. For example, it has been identified that piperine enhances the absorption of other bioactive compounds. (Gautum et al. 2020)

Moreover, it may potentially be cheaper to consume the various recommended herbs including turmeric, cinnamon, garlic, ginger, honey, onion, and other herbs as compared to purchasing some of the more expensive available medications. Affordability due to potentially lower costs may enhance the availability of the bioactive compounds as compared to other alternative treatments. The use of herbs and spices may potentially allow for better health outcomes among people that may not potentially be able to meet the high cost of COVID-19 medications. Cost implications are an essential consideration due to the effect of income inequalities on access to healthcare.

The findings of the survey revealed that the majority of respondents (62%) were of good health conditions without chronic diseases whereas the remaining 38% had one or more chronic disease, which may increase stress on health burden upon infection and lead to hospitalization or severe symptoms.

Findings of the survey also revealed that the majority of the population tried to cope with the infection tension, by shifting to healthier food choices as depicted in table 2 (Part 3) . The most popular items were onion, garlic and citrus fruits as well as hot water beverages such as teas and

soups. Such healthy remedies are believed to support the general health, help reduce sore throat and chest pain. Onions and garlic may have gained their popularity due to wide knowledge about their content of anti-inflammatory and antibiotic natural effect, as well as being more economic and easily accessible.

The supplemental intake was focused on vitamins C and D as the most popular source of immunity support. The percentage of people who did not take supplements is 10% of the population, which could be related to economic issues or lack of knowledge.

The results further reveal that those who felt low level of symptoms were about 42% of the research population, which gives a reasonable indicator to a good resistance by the majority of respondents. However, those who felt moderate symptoms were 38% of the research population. Those people may lack strong immunity, consume less functional foods and may have chronic diseases. The duration of the symptoms was also used as an indicator of the strength of the infection which is then correlated to the food and supplemental choices. It was found that (30%) needed 4-6 days to overcome the symptoms.

Bioactive compounds present in functional foods play an important role to support the health of the patients by reducing the duration of the disease. As presented in figure 1 the food choices improved the health status of the infected people by reducing the severity and duration of the infection. More than half of the population who consumed probiotics, onion and garlic and herbs in their diet had the symptoms between 1 to 6 days. Supplements such as Vitamin C, D, A, B-vitamins, Omega 3, zinc and Selenium are important to support the health during or even before the infection. Many studies showed the role of micronutrient intake from food in fighting against COVID-19 (Camara et al. 2021). Supplements can help those who can’t get or absorb adequate amount of nutrients in their food and may play a vital role in the battle against the disease. About

half of the study population did not manage to get supplements, which clearly reflected on the severity and duration of their infection as described in figures 1 and 2. They needed more than 13 days, whereas about 69%-70% of those who consumed vitamin C and/or vitamin D managed to recover within 1-6 days.

The literature analysis of the various vitamins indicated their role in ensuring that the immunity system can effectively respond to potential exposure to the COVID-19 virus. Vitamins emerge as leading to better immunity response while limiting inflammation, all of which are vital in enabling the body to combat COVID-19. It also has been reported that vitamin D has been determined as significantly lowering the risk of COVID-19 during the winter months when the infection rate is high (Panyod et al. 2020; De Souza Monnerat et al. 2020).

Evidently, it can be concluded from the observations of figure 1 and figure 2 that people who did not take supplements were at higher risk of longer time infection and symptom severity, which led to hospitalization in extreme cases.

The analysis indicates that the use of food choices with or without supplements may be one of the alternative approaches to reduce health stress produced by the virus infection, especially for those who can’t get the vaccination possibly for health issues. Consequently, it may be necessary to educate the general populace on the importance of taking a diet that is rich in bioactive compounds, supplements, herbs and spices as a means of enhancing protection from COVID-19 and allowing for faster recovery and lesser infection duration.

The research also reveals that some combinations of bioactive compounds have a synergistic effect in defeating COVID-19 (Chen et al 2020). Medications can be developed based on the knowledge and findings obtained about bioactive compounds that can help in mitigating COVID-19. This is in line with several findings that indicate that consumption of bioactive-rich

foods and dietary supplements are a key tool in Severe Acute Respiratory Syndrome Corona Virus 19 (SARS-CoV-19) Infection (Flores-Félix. et al. 2021).

Based on both literature review and the results of the survey presented in this study, it is evident that bioactive compounds have numerous positive effects on the mitigation of COVID-19 including enhancing the performance of the immunity system, reducing the risk of the occurrence of CS, inhibiting the replication of the COVID-19 virus, preventing fibrosis, hence protecting the alveoli and the lungs and enhancing the blood platelet count, and consequently protecting the internal organs from failure.

7. Conclusions

Due to concerns pertaining to the wellbeing of the patients, it may be necessary to consider alternative bioactive compounds available in nature as a replacement for some of the pharmacological medications being used presently.

The research substantiates that COVID-19 pandemic can be effectively mitigated by the use of bioactive compounds found in various plants, supplements, herbs and spices in order to minimize severity and duration of the infection.

The research leads to various observations on the use of bioactive compounds in the dietary system in the context of COVID-19. The observations indicate that the dietary intake of bioactive-rich foods and supplements can reduce the risk of deterioration of a patient's health. Plants, herbs and other edible sources as well as nutritional approach can be a powerful to support the immunity as indicated by reducing severity and duration of the infection.

The literature review analysis indicates that some of the bioactive substances are more effective at binding to the enzymes and proteins of the COVID-19 virus and inhibiting viral replication than medications.

This study explores the importance of herbal extracts and balanced diet not only in fighting Coronavirus, but also futuristic pandemics.

8. *Recommended Further Research:*

- For future pandemics, the medical community may consider the findings of research during the COVID-19 era.
- Further studies could be conducted to explore the effect of the use of bioactive-rich foods to reduce the probability of infection. It is also interesting to examine the effect of bioactive-rich food on infected and vaccinated people.
- The side effects of using natural remedies could also be tested before encouraging their excessive use in order to set the limits of consumption.
- It is also recommended to raise awareness in order to encourage the shift towards healthy dietary practices using herbal remedies, healthy eating habits and smart choices will certainly empower the human body immunity.

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12. *Data availability statement:* The data collected was based on the appendix (1) interview questions which were compiled for all interviewees (more than 500 pages). Samples are available upon request.

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Appendix 1

Consent and survey

This study is about testing the impact of bioactive compounds in foods against coronavirus, an evidence based research. By responding and submitting this survey you have consented to make all the information public without mentioning you. Please add an "X" in the appropriate field

1-How old are you?				
Below 18	18-30	31-45	45-60	Above 60

2-What is you Gender?	
Male	Female

3-Do you have any Chronic disease?	
Yes	No

4-If yes, which of the following diseases do you have?		
Diabetes	Hypertension	Asthma
Heart disease	High Cholesterol	Others

5-Did you need hospitalization?			
Yes		No	

6-What symptoms did you feel during the infection among the following?					
Fever	Pain in the Bones	Fatigue	Dry Cough	Sore Throat	No Taste/Smell
Headache	Breathing Difficulty	Chest Pain		None	Others

7-What was the duration to recover (No. of days till the symptoms subsided)?				
1-3 days	4-6 days	7-9 days	10-13 days	More than 13 days

8- Evaluate the level of Severity of the symptoms as follows:	
Low Severity (symptoms were hardly felt)	
Moderate Severity (symptoms were felt but still durable)	
High Severity (symptoms were sharp and could lead to hospitalization)	

9-Which of the following bioactive-rich foods have you consumed mostly during the infection? (Bioactive-rich foods are foods that contain ingredients promoting health benefits against covid-19.)?				
Onion & Garlic	Hot water and beverages	Legumes	Citrus Fruits	Herbs

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Aloe Vera	Probiotics (Yoghurt and alike)			Ginger		Others	None
10- Have you taken any supplements?							
Vitamin C	Vitamin D	Zinc	B-vitamins	Omega 3	Selenium	Other	None

Source: Developed by the author (2022)

Table 1 (Part a): Screening of the most important plants, spices and other edible components rich in bioactive compounds used against coronavirus infection.

Name of plant / edible source	Bioactive compounds	Health benefits against COVID-19	Reference/s
Algae	Phycobiliproteins	- Enhancement of immunity. -Antiviral -Pthe progression of the infection.	(Ratha *et al.*, 2020)
Aloe Vera	Feralolide, Aloe-emodin, Eupatorin, AloesaponarinII, Chrysophanol, and Aloesaponarin I	-Activation of lymphocytes, enhancing the action of macrophages and increasing the number of killer cell which mitigate the body's response to the COVID-19 virus. - Potential inhibitors of SARS-CoV-2 main protease.	(Panyod *et al.*, 2020) (Mpania, 2020)
Basil	Quercetin, Apigenin, and Eugenol.	-Enhancement of immunity; act as anti-inflammatory, and antioxidant. -Improvement of levels of T-helper cells. -Eugenol was found to inhibit the binding of SARS-CoV-2 Spike S1 with Angiotensin-converting enzyme (ACE2). -Oral treatment with eugenol reduces lung inflammation, decreases fever, improves heart function, and enhanced locomotor activities in SARS-CoV-2 spike S1-intoxicated mice.	(Thota *et al.*, 2020) (Ramesh & Malabendu, 2022).
Black Pepper	Piperine	-Supports the bioavailability of other bioactive chemicals and drugs. - Helps combat SARS-CoV-2 due to antiviral effects. - Immunomodulatory functions.	(Gautam *et al.*, 2020)
Cinnamon	Cinnamaldehyde, Cuminaldehyde, Terpenes, and Benzaldehyde.	-Various immunity benefits. -High doses of cinnamon lead to an increase in the production of phagocytes, leading to higher levels of serum immunoglobulin. -Anti-inflammatory and provide hepaprotective benefits. -Enhances the health of the liver and the lungs.	(Thota *et al.*, 2020) (Gautam *et al.*, 2020) (Valizadeh *et al.*, 2015)
Citrus Fruits	Vitamin C, hesperidin, Flavonoids, and glycyrrhizic acid	-Orange (Citrus sinensis) and Citrus peel can become a reliable source of anti-COVID-19 bio-products. - Enhancement of the immunity system. - Anti-inflammatory - Hesperidin has a high affinity to bind with the receptors of the COVID-19 virus. - Lemon can limit pulmonary fibrosis.	(Antonio *et al.*, 2021) (Tehrani *et al.*, 2021) (Meneguzzo *et al*, 2020)
Garlic and Onions	Alliin, allicin, apigenin, organosulfur, flavonoids, quercetin, and selenium.	-Anti-fibrotic and anti-inflammatory. -Antiviral. -Enhance pulmonary health.	(Shang *et al.*, 2019) (Khubber *et al.*, 2020)
Ginger	Zingerone	- Limits pulmonary fibrosis and inflammation. -It may be effective in enhancing the outcomes of COVID-19 patients experiencing breathing difficulties. - Minimizes inflammation in the lungs and enables a gradual restoration of lung function after pulmonary	(Elsayed and Khan, 2022)

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		damage.	

Source developed by the author (2022)

Table 1 (Part b): Screening of the most important plants, spices and other edible components rich in bioactive compounds used against coronavirus infection.

Golden Milk (Milk and Turmeric Powder)	Curcumin	-Enhances immunity. -Blocks the generation of cytokines, limiting inflammation. -Mitigates the physiological effects of COVID-19. -Curcumin found in turmeric limits fibrosis of the lung tissue.	(*Singh et al*., 2020) (Jeanne, 2022).
Green Tea, Hazelnut, Plums, and Apple Peel	Epigallocatechingallate (EGCG)	-Phytochemicals act by binding the enzymes and proteins that are essential for the virus replication.	(Attia *et al.*, 2020).
Holy Basil / Tulsi	Eugenic, phenolic, linoleic acids, ursolic acid, rosmarinic acid, cirsimaritin, and apigenin	-Enhance immunity system. -Reduce the risk of viral infections. -Enhance the function of antioxidant enzymes. -Enhance concentration of hemoglobin -Boost production of antigen-specific antibodies.	(*Alam et al.*, 2020). (Singh et al., 2021).
Honey	Propolis. hesperedinin, methylglyoxal, and caffeic acid	-Propolis can prevent the COVID-19 virus from invading the host cell. -Used in the treatment of respiratory challenges, diabetes, hypertension, and cancer. -Inhibit the replication of the virus, reduce spike fusion in the host cells, and the risk of the occurrence of a CS. -Propolis has antiviral effects, ensures viral clearance within a shorter time, reduces recovery from the symptoms and morbidity.	(Berretta et al., 2020). (Al-Hatamleh *et al.*, 2020). (Ali & Kunugi, 2021).
Medicinal Mushrooms	colossolactone VIII, colossolactone E, colossolactone G, ergosterol, heliantriol F and velutin.	-Antiviral. - have the potential to inhibit the main viral protease.	(Shuang *et al.*, 2020). (Hetland *et al.*, 2020)
Neem (Indian Lilac)	Nimbolide, azadirachtin, Quercetin, and nimbolinin	- Limit the damage to the alveoli. -Anti-inflammatory -Prevent acute injury to the lung. -Minimize the adverse effects on pulmonary health.	(Nabajyoti *et al.*, 2021).
Nutmeg & Marijuana	Myristicin, cannabinoids, herbacetin, Rhiofolin, and hesperidin	-Inhibit viral replication. -Effective at docking with the virus enzymes and proteins as compared to nelfinavir, a treatments being used from COVID-19. -High oral availability.	(Attia et al., 2020). (Muthuramalingam *et al.*, 2020). (Pathak & Raghuvanshi, 2015).
Papaya	inophyllum, calanolide A & coumarins.	-Antiviral. -Anti-inflammatory -papaya may be utilized to reduce the risk of COVID-19 patients developing low blood platelet count. -Papaya extracts enhance the production of platelets, leading to reduced morbidity risk.	(Thota *et al.*, 2020).
Turmeric,	Curcumin	- Antiviral. - In a study on COVID-19 patients, lymphocyte count	(Abdelazeem *et al.*, 2022).

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Turmeric with boiling water.		was significantly higher in the group that consumed curcumin compared to the placebo group. -Powerful immune modulatory effects on cytokines production, T-cell responses, and gene expression. -Inhaling steam produced from water that contains turmeric manage respiratory system.	(Pawitan, 2022)

Source: Developed by the author (2022)

Part 1: Age						
Part 1: Age	Below 18	18-30	31-45	46-60	Above 60	
	2%	11%	33%	41%	13%	
Gender						
Male	47%	Female	53%			
Chronic Diseases						
yes	38%	No	62%			
Diabetes	Hypertension	Heart Disease	Asthma	High Cholesterol	Other	
30%	24%	18%	5%	16%	7%	
Part 2: Hospitalization						
Yes	9%	No	91%			
Symptoms						
Fever	Dry cough	Fatigue	Difficulty in breathing	Loss of taste/smell		
85%	82%	79%	74%	75%		
Headache	Pain in the bones	Sore Throat	Chest pain	None		
64%	72%	71%	71%	12%		
Duration to recover (No. of days till the Symptoms subsided)						
1-3 days	4-6 days	7-9 days	10-13 days	More than 13 days		
17%	30%	27%	18%	8%		
Severity of the symptoms						
High	Moderate	low				
42%	38%	20%				
Part 3: Bioactive-rich Foods Intake during the Infection						
Onion and Garlic	Hot water beverages	Legumes	Citrus Fruits	Herbs		
88%	84 %	81%	75%	57%		
Aloe Vera	Probiotics	Ginger	Others	None		
5%	47%	49%	7%	2%		
Supplemental intake						
Vitamin C	Vitamin D	Zinc	B-vitamins			
82%	75%	35%	14%			
Omega 3	Selenium	Other	None			
22%	2%	10%	14%			

Table 2:Bio-data, chronic diseases, severity and duration of infection among respondents, and level of bioactive-rich components consumption during the infection.

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Figure 1

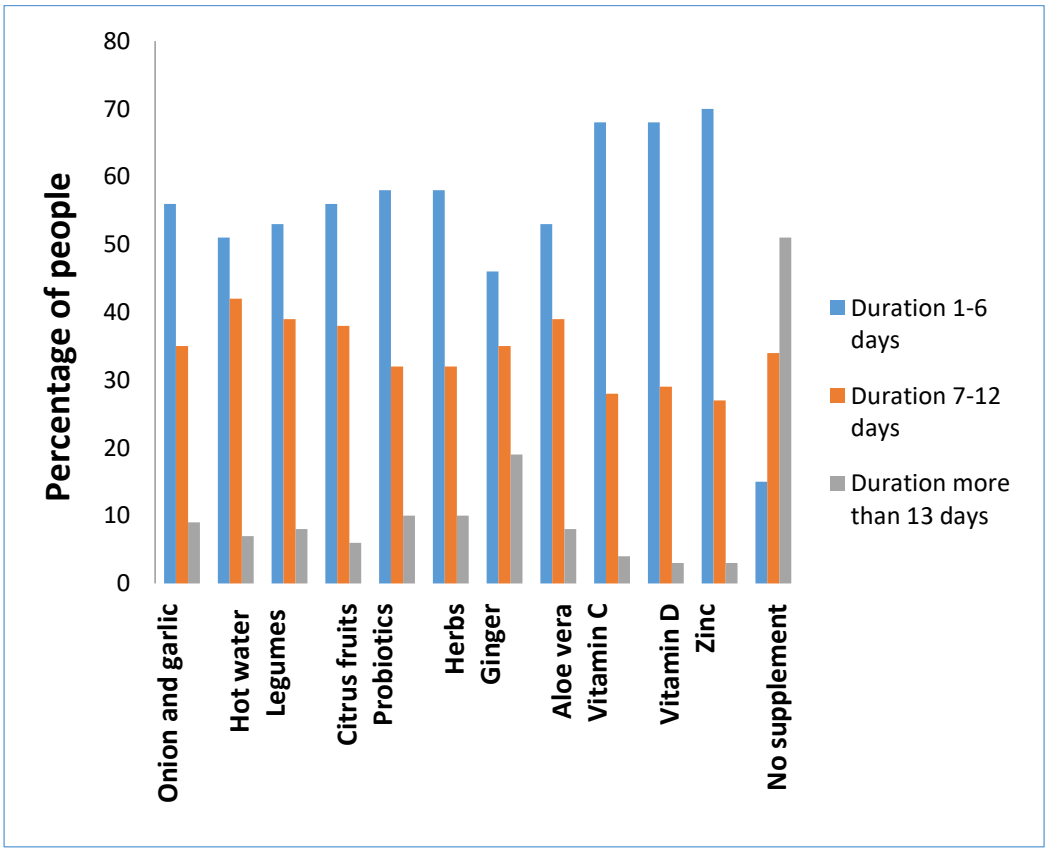

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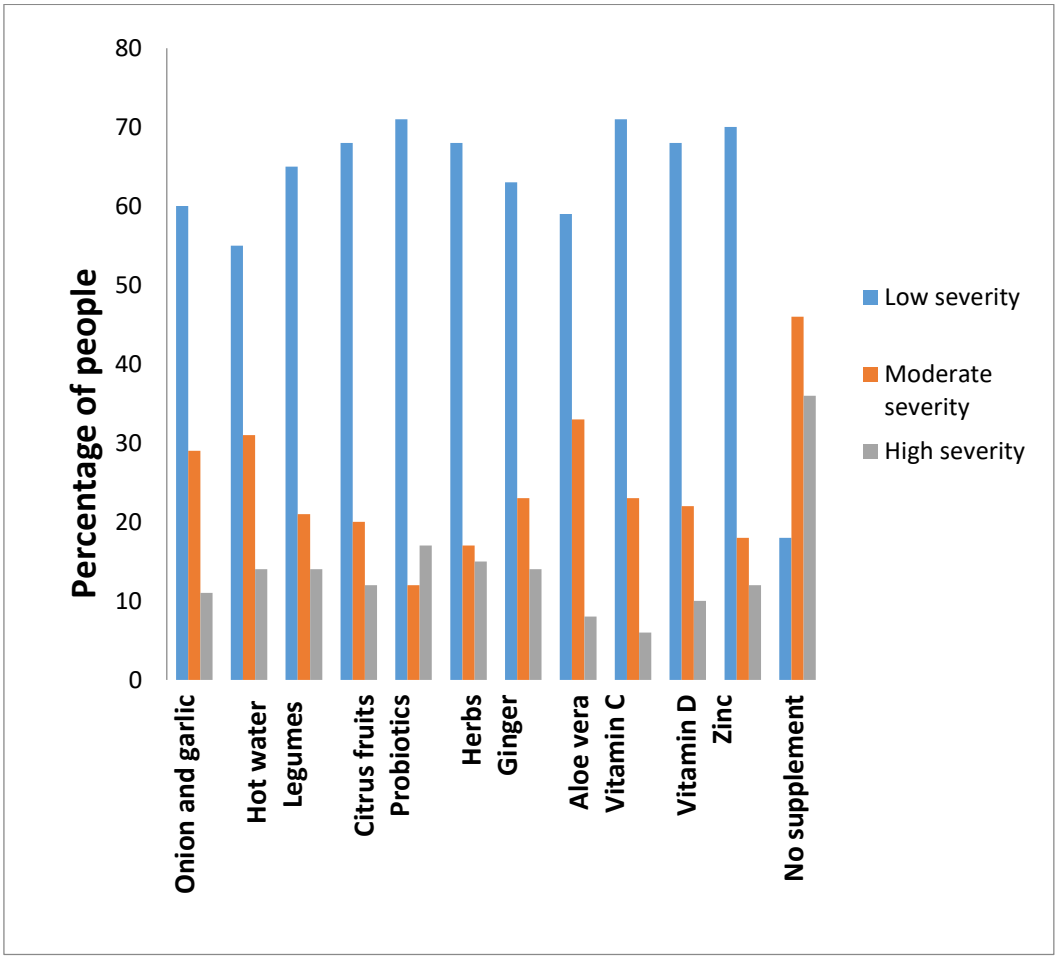
Figure 2



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1.3 List of Figures

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