

AHFES

A QUADRUPLE HELIX ATLANTIC AREA HEALTHY FOOD ECOSYSTEM FOR GROWTH OF SMES

Covid-19 and Nutrition Report

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Abbreviations and Acronyms

CoV	Coronaviruses
ACE2	Angiotensin-converting enzyme 2
SARS-CoV	Severe Acute Respiratory Syndrome Coronavirus
ROS	Reactive Oxygen Species
EGCG	Epigallocatechin-3-gallate
RBD	Receptor binding domain
PD	Protease domain
NF-κB	Nuclear factor κ B

Executive summary

Currently, the world is living with Covid-19, and has suffered repeated waves of infection. Over time there have been peaks of actions aimed at prevention, followed by the relaxation of prevention measures.

This infection affects the immune system, which causes an inflammatory response. Since our food is directly related to our health, several studies have been carried out to understand the essential components for fighting and preventing Covid-19.

This report highlights the components of the daily diet that may be beneficial for addressing Covid-19 disease. The application of these products opens opportunities for the food industry to consider developing functional products in this area.

This is likely to become established a new trend for 2022, as society continues to deal with the pandemic and it's long term outcomes.

1 Introduction

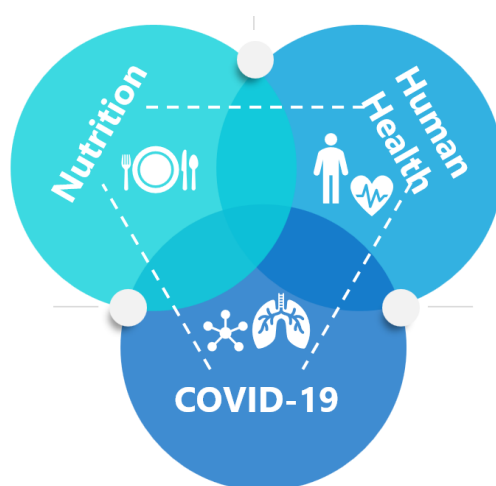
Coronaviruses (CoV) or Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV) are a large family of RNA viruses that infect and transmit from person to person. This disease presents symptoms similar to pneumonia, and its clinical manifestations can range from no symptoms to mild fever, cough and dyspnoea, respiratory failure and death.¹

This virus enters the cell via the angiotensin-converting enzyme 2 (ACE2) receptor, which predominantly infects the lower respiratory tract. Upon binding, there is a subsequent response of the immune system via inflammation-related manifestations and recruiting antigen-presenting cells. This disease is characterised by developing a series of inflammatory mediators that collectively lead to inflammation, these pro-inflammatory processes are caused by the “cytokine storm” observed in patients with COVID-19, which is quite harmful to the human body. When this process is exacerbated, it leads to severe forms of the disease.

In conclusion, Covid increases the oxidative stress on the human organism. This opens the opportunity for natural antioxidants or supplements to play a role in reducing the reactive oxygen species (ROS) and reducing the inflammatory effects of the disease.²

With the new variants of SARS-CoV2, the need arises to study the role of human nutrition in the fight against this virus.

The aim being that, in the future, the impact on our health will be lessened and will not result in the need to go into hospital due to the severity of the disease. There is no scientific evidence that any food or dietary pattern “increases” our immune system and prevents Covid-19. However, it is already known that nutrition and health are intertwined, so the prevention of Covid - 19 may be directly related to food nutrition (figure 1).



¹ American Society for Microbiology. What is COVID-19? American Society for Microbiology. 2020.

² Zabetakis I, Lordan R, Norton C, Tsoupras A. COVID-19: The Inflammation Link and the Role of Nutrition in Potential Mitigation. *Nutrients* [Internet]. 2020 May 19;12(5):28. Available from: <https://www.mdpi.com/2072-6643/12/5/1466>

Figure 1. Human Health and impact factors

It is well known that several nutrients such as copper, folate, iron, selenium, zinc and vitamins A, B6, B12, C, and D play an essential role in our immune system.

In addition, dietary supplementation of nutrients or consuming food rich in immune modulating bio compounds has been recognised as altering the clinical course in a wide range of patients, including critically ill patients, and reducing hospitalisations.

The next chapter will show data on new products developed in the healthy food market in the "fight" against Covid-19.

2. Food Nutrition and Covid-19

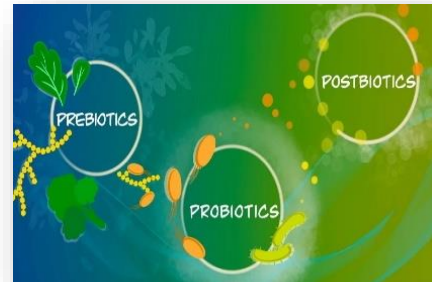
Gut Health

Several studies relate our health to the health of our intestines; and it has become increasingly evident that improving immune health through the intestine can prevent or lessen the impact of various diseases, such as Covid-19.

Many ingredients can respond to the demand for food products that support immune health through the gut. The known "probiotics" are already commercialised; however, because they are live microorganisms, this limits their useful life and prevents them from being incorporated into some formulations.

However, post-biotics, consisting of inanimate microorganisms or cellular and metabolic components are more tolerant.

These post-biotics allow the food industry to use and apply heat, low pH and other challenging conditions during the food product development process. One of the examples of the beneficial application of this post-biotics is their application in the food and beverage industry in the area of immunity.³



Polyphenols

Scientific literature highlights the pharmacological activity of plant polyphenols, whose physiological activities are antioxidant, anti-inflammatory, anticancer, antibacterial, antifungal, and antiviral. Luteolin, daidzein, apigenin, amentoflavone, quercetin, epigallocatechin, epigallocatechin gallate, and gallic acid show antiviral activity through inhibition of the proteolytic activity of SARS-CoV 3C-like protease, which plays a vital role for the viral replication. Epigallocatechin-3-gallate (EGCG) and thymoquinone, already on the market and sold as dietary supplements, stand out for their antiviral activity and ability to activate the transcription factor Nrf2.

³ Antwi J, Appiah B, Oluwakuse B, Abu BAZ. The Nutrition-COVID-19 Interplay: a Review. Curr Nutr Rep. 2021 Dec;10(4):364-374. doi: 10.1007/s13668-021-00380-2. Epub 2021 Nov 27. Erratum in: Curr Nutr Rep. 2021 Dec 14;: PMID: 34837637; PMCID: PMC8627159.



Also, within this category, curcumin could be a potential treatment option for patients with COVID-19. A recent in silico study was carried out using molecular docking with target receptors, including SARS-CoV-2 protease, the receptor-binding domain (RBD) of spike glycoprotein, and the protease domain (PD) of ACE, suggests that curcumin bind to the SARS-CoV-2 target receptor.

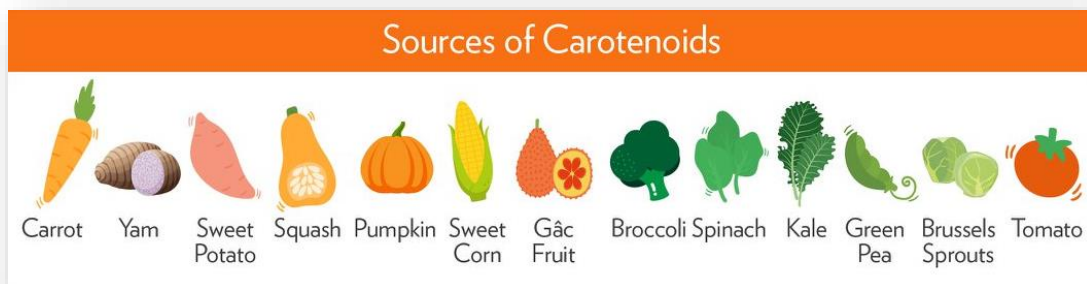
Conversely, the combination of vitamin C, curcumin, and glycyrrhizic acid promotes interferons production and regulates the inflammatory response.

This suggests that the variety of these compounds may help modulate the immune response to counteract the SARS-CoV-2 infections.^{3,4}

Additionally, several studies have shown that tea polyphenols play an essential role in regulating intestinal microbiota, which is one of the strategies used to prevent and intervene in Covid-19.⁵⁽³⁾

Carotenoids

Carotenoids are natural fat-soluble plant pigments responsible for the bright yellow and orange colours of many fruits and vegetables. More than 750 carotenoid structures have been isolated highlighting different physical properties, resources and natural characteristics.



⁴ Rattis BAC, Ramos SG, Celes MRN. Curcumin as a Potential Treatment for Covid-19. 2021;12(May):1–14.

⁵ Xiang, Q.; Cheng, L.; Zhang, R.; Liu, Y.; Wu, Z.; Zhang, X. Tea Polyphenols Prevent and Intervene in COVID-19 through Intestinal Microbiota. Foods 2022, 11, 506.

Several studies demonstrate the benefits of carotenoids to human health, such as beneficial pharmacological and biological effects, reflecting their protective nature against inflammation, oxidative damage and immune modulation. However, there are few studies regarding its impact in the case of viral diseases, and further investigation is necessary, as is the case of polyphenols.

Additionally, it can be noted that diets rich in carotenoids can protect the progression of inflammation related to the acute phase of Covid-19, thus preventing the disease.

In this way, carotenoids can be a means of combating the Covid-19 disease but to achieve this it is essential that both the scientific community and the food industry combine their efforts and develop new products to improve the human immune system in the future.^{3, 6}

Vitamin D

Vitamin D plays an important physiological role, in addition to bone homeostasis, and it also plays a vital role as an immunomodulator and in critically ill patients. There are well-documented associations between vitamin D deficiency and infection rates, renal and respiratory failure, sepsis and mortality.

Increasing the consumption of foods rich in vitamin D or supplementation is relevant during the pandemic, especially during periods of mandatory confinement, which means that sun exposure is reduced.

A consumption of 15-20 µg/day of foods rich in vitamin D is recommended.^{2,3,5}

Comparative clinical studies show that vitamin D helps reduce the severity of viral infection, but there is still not enough evidence applying to the specific case of SARS-COV2. But on the other hand, vitamin D supplementation is known to reduce mortality in side discomfort syndrome in Covid-19 patients.⁷



⁶ Khalil A, Tazeddinova D, Aljoumaa K, Kazhmukhanbetkyzy ZA, Orazov A, Toshev AD. Carotenoids: Therapeutic Strategy in the Battle against Viral Emerging Diseases, COVID-19: An Overview. *Prev Nutr Food Sci*. 2021 Sep 30;26(3):241-261

⁷ Shakoore H, Feehan J, Al Dhaheri AS, Ali HI, Platat C, Ismail LC, Apostolopoulos V, Stojanovska L. Immune-boosting role of vitamins D, C, E, zinc, selenium and omega-3 fatty acids: Could they help against COVID-19? *Maturitas*. 2021 Jan;143:1-9.

Vitamin C

Vitamin C or L-ascorbic acid, is a water-soluble vitamin that is naturally present in some foods, added to others, and available as a dietary supplement. Doses of 1-2 g/day were effective in preventing upper respiratory infections.

This compound is an essential antioxidant in the fluid on the surface of the airways of the lungs. Its immune-stimulating and antiviral properties can help improve respiratory infection symptoms. In this way, a sufficiently high dose of vitamin C can be a safe and beneficial treatment choice at an early stage of Covid-19.^{3, 5}

Zinc

Zinc plays an essential role in the recruitment of neutral granulocytes and chemotactic activity and has positive effects on NK cells, phagocytosis and the development of oxidative enhancement. Zinc has been shown to inhibit the coronavirus synthesis, replication and screening complex. This element can also interfere with replication, protein synthesis, and beneficial viral counterfeiting and therapeutic effects.⁷

3. Conclusion

Whilst the impact of food and nutrition on human health has always been acknowledged, so far, there are still not enough studies regarding the specific effects of nutrition on preventing and combating Covid-19.

However, based on the mechanism of Covid-19, initial studies indicate the critical role of polyphenols that can be applied in our daily diet, such as antioxidants, and anti-inflammatories, among others.

Additionally, it may be interesting to use foods rich in vitamins that can help prevent and fight Covid-19.

In conclusion, one of the major opportunities for the food industry is the application of functional foods created to feature vitamins and polyphenols which could be beneficial for the both the current COVID-19 pandemic and future similar pandemics.