

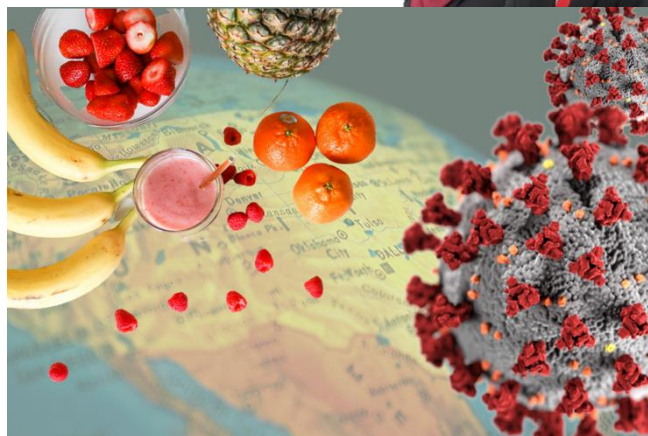
IMMUNE-BOOSTING DIETARY RECOMMENDATIONS

What Have We Learned from the COVID-19 Pandemic?

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As the world struggles with the prolonged challenges posed by the COVID-19 pandemic, the reemergence of surges in cases highlights the importance of good nutrition as one of the immune-boosting strategies to fight off the viral infection. Some evidence has shown the possible role of a well-balanced diet in supporting immune function and overall resilience against viral infections. Prioritizing healthy nutrition could contribute to individual well-being and improve a collective somatic defence against infectious diseases. This article aims to encourage dietary habits rich in essential nutrients, antioxidants, and immune-supporting elements in enhancing the immune system against ongoing challenges posed by the pandemic.



In response to the SARS-CoV-2 pandemic, many health institutions have issued dietary recommendations, emphasizing the importance of vegetables, fruits, and whole grains in maintaining a healthy diet in order to support the immune system and mitigating inflammation [1]. As such, vitamin C, beta-carotene, zinc and selenium which commonly found in fruits and vegetables contain polyphenols that exert anti-inflammatory and anti-viral effects [2]. Recent observations in COVID-19 patients indicate positive effects for those who consume more fruits, vegetables, and fibre, showing a decreased likelihood of severe COVID-19, reduced need for medication, and shorter hospital stays [3].

Apart from incorporating vegetables, fruits, and whole-grain products in the daily dietary practices, food sources from legumes, nuts, poultry and fish as well as low-fat dairy products and fermented food products are also essential. These food groups contribute to a well-rounded intake of protein, beneficial fatty acids, and calcium. Additionally, fermented dairy products promote a healthy gut flora through the action of probiotics resulting better absorption rate for essential nutrients. In addition, minimising red meat consumption, particularly saturated fatty acids, is advised, with a preference for fresh over highly processed foods. Interestingly, a human trial conducted among 64 subjects revealed that moderate coffee consumption (1-2 cups/ day) is sufficient to inhibit SARS-CoV-2 infection due to specific acid coffee components that can block the binding of the virus spike protein to human ACE2, as well as reducing the activity of certain enzymes [4]. There is also a potential antiviral activity posed by active ingredients in tea such as polyphenols to reduce cytokine storm caused by SARS-CoV-2 [5].

It also is important to note that there is no single food or food group is a cure or preventative measure against COVID-19. Instead, the emphasis should be on adapting eating patterns to a well-balance and diverse food groups with a favour towards plant-based foods to obtain important nutrients to strengthen the immune system and to prevent nutrient deficiencies associated with an increased risk of severe COVID-19 infection.

Plant-based diets and COVID-19

According to the World Health Organization (WHO), plant-based diets encompass a range of dietary patterns emphasizing foods derived from plant sources, with lower consumption or exclusion of animal products [6]. A healthy plant-based diet (PBD) prioritizes fruits, vegetables, whole grains, legumes, and nuts, while an unhealthy PBD includes items such as fruit juices, sweets, sugar-sweetened beverages, and refined grains [7].

Recent studies indicate that adopting a healthy PBD can reduce the risk of SARS-CoV-2 infection and, importantly, mitigate the risk of severe COVID-19 [8]. For instance, a case-controlled study involving healthcare workers exposed to COVID-19 patients found a significant reduction in the odds ratio of severe COVID-19 among those following a PBD or PBD/ pescatarian diet (the practice of incorporating fish and shellfish into a vegetarian diet, and may or may not include other animal products such as eggs and dairy products) [8]. In contrast, individuals ingesting low-carbohydrate and high-protein diets had a substantially higher odds ratio for moderate-to-severe COVID-19.

Additional research using data from a smartphone-based COVID-19 Symptom Study involving 592 571 participants investigating the association of diet quality with risk and severity of COVID-19 and its interaction with socioeconomic deprivation revealed that individuals following a dietary pattern characterised by plant-based foods were less likely to experience severe COVID-19 symptoms and had a lower risk of testing positive for SARS-CoV-2 [9].

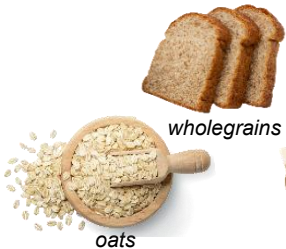
Furthermore, studies highlight the protective effects of plant-based food rich in folate, vitamin C, vitamin K, and fibre against SARS-CoV-2 infection [10-12]. On the contrary, high intake of certain dairy products, calcium, and long-chain saturated fatty acids was associated with increased infection risks [13].

Highly refined carbohydrates and ultra-processed food intake

In comparison to a high-quality diet, the dietary pattern that is characterised by high content of sugar, salt, white flour, and saturated animal fat, with low intake of antioxidants and fibre poses a detrimental risk to human health and reducing the immune-boosting capacity of the body [14]. This type of diet is typically energy-dense and have high glycaemic indexes. Many studies have demonstrated that such an imbalanced diet is linked to an increased risk of type 2 diabetes [15] and chronic inflammation [16]. Additionally, there is a consistent correlation between the consumption of long-chain saturated fatty acids and markers of inflammation, contributing to chronic systemic low-grade inflammation [17-19] which favours the cytokine storm that is associated with the severity of SARS-CoV-2 infections [20].

Ultra-processed foods (UPF), including breakfast cereals, savoury snacks, reconstituted meat products, frankfurters, and pre-packaged frozen dishes, as well as soft and/or sweetened beverages [21], also contribute to an unhealthy dietary pattern, particularly when consumed in large quantities. Increased UPF intake is associated not only with a higher risk of overweight/obesity, cardio- and cerebrovascular diseases, depression, and all-cause mortality [22], but also with an elevated risk of COVID-19 [23]. A study involving 41,012 participants from the UK Biobank revealed that individuals in the highest quartile of UPF consumption had a 22% higher likelihood of COVID-19 compared to those in the lowest quartile, even after adjusting for potential confounding factors. The detrimental effects of UPF on COVID-19 may stem from their pro-inflammatory effects due to excess simple sugars and saturated fatty acids [24] and a low intake of immune-protective vegetables and fruits; furthermore, essential micronutrients could be partially lost during the food processing.

Selected Nutrients and COVID-19

Nutrients	Role	Sources
Vitamin D	Promotes differentiation of monocytes to macrophages and increases their killing capacity; modulates the production of inflammatory cytokines; and supports antigen presentation. Furthermore, vitamin D metabolites appear to regulate production of specific antimicrobial proteins that directly kill pathogens, and thus are likely to help reduce infection including in the lungs.	 sunlight  cheese  milk  deep ocean fish (eg: salmon, kembong)  eggs
Vitamin C	Supporting epithelial barrier function, growth and function of both innate and adaptive immune cells, white blood cell migration to sites of infection, phagocytosis and microbial killing, and antibody production.	 guava  orange  strawberry  papaya  mango  tomato
Zinc	Zinc is essential for the immune system and regulates innate and adaptive immunity by influencing the proliferation and maturation of immune cells, and also acts as a modulator of immune responses and inflammation	 chicken  meat  seafood  nuts and legumes
Selenium	An essential trace element that stimulates the activity of natural killer cells.	 wholegrains  oats  nuts  tofu
Omega 3 fatty acid	An adequate intake supports the resolution of inflammation via the production of anti-inflammatory metabolites of these fatty acids, including in the respiratory tract.	 deep ocean fish (eg: kembong, sardine, salmon)  omega-3 eggs  canola oil

In conclusion, a well-balanced diet high in vegetables, legumes, fruits, and low in red meat, along with considerations for specific nutrients and dietary components like fibre and probiotics, plays a crucial role in supporting the physical barrier of the gastrointestinal and respiratory tracts thus enhancing the function of immune system. The type of fats consumed, particularly favouring monounsaturated and polyunsaturated fatty acids over long-chain saturated fatty acids, is recommended. Additionally, avoiding excessive salt, sugar-sweetened, and high-fat products is advised to mitigate the risk of obesity, a recognized factor for COVID-19 susceptibility.

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