Annals of R.S.C.B., ISSN: 1583-6258, Vol. 25, Issue 4, 2021, Pages. 16870-16880
Received 05 March 2021; Accepted 01 April 2021.

Healthy foods that might be helpful in fighting COVID-19

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Abstract

Coronavirus disease (COVID-19) is caused by SARS-CoV-2, which is a novel corona virus that can cause remarkable infectious disease. This virus can transfer easily from person to another. The first case was documented in December 2019, in Wuhan/ Hubei, China. The WHO declared the disease as a global pandemic on 11 March 2020. Unfortunately, the world has to try by prevention measures to contain the disease as much as possible because the medical establishments has failed so far to provide any reliable treatment for COVID-19.Enhancement of immune function is of high importance since the immune system is actually the force that preserves the integrity of the body by resisting pathological agents and microorganisms, including viruses, bacteria, fungi. Adequate nutrition should be paid enough attention to maintain body's defenses and immune mechanisms. This can be achieved by providing healthy diet and giving balanced level of vitamins, minerals, water, and calories. The prevention and management of viral infections require balanced nutrition, which is also important for enhancing the organism's immunity against viral infections. Immune dysfunction can lead to increased susceptibility to infectious diseases. Such event is expected to happen when specific nutritional deficiencies and dietary insufficiencies occur, including deficiency of vitamin C, vitamin E, vitamin A, omega-3 fatty acids, zinc, selenium, and proteins.

Introduction

COVID-19 becomes one of the major health crises in the worldwide. Historically, the world was pushed to deal with other forms of coronaviruses, such as the SARS (Severe acute respiratory syndrome) in 2002-2003 and MERS (CoV-2/ Middle East Respiratory Syndrome coronavirus-2) in 2011. The virus in question now is the Covid-19, which identified for the first time in Wuhan, China, in late December 2019(1).On March 11, 2020, the WHO declared Covid-19 as a pandemic worldwide (2).However, immunity is affected by dietary factors; and malnutrition can be regarded as a common factor of immunodeficiency around the world (3).

How to strength the immune system against COVID-19?

The immune response protects the body against infectious agents, and such response can be manifested by innate immunity and adaptive immunity. The susceptibility to infections is linked with both forms of immunity. The effectiveness of the immune response determines the level of susceptibility to infections (4). Once the pathogen enters the body and begins attacking the host, the immune system begins the battle against the invaders to protect the body. The ability of the body to fight against the pathogen is decreased when the immunity decreases, making the body more prone to illness. Suppressing the immune system will also make the body more susceptible to the attack of virus due to delay in antibody response (5). Protein-energy malnutrition is associated with immunoglobulin antibody secretion and other processes, such as cytokine production, phagocyte function, cell-mediated immunity impairment, complement system. Folic acid has an impact on the immune responses. Altered immune responses can be caused also by low level of vitamins, such as vitamin A, C, E, and B-6, in addition to certain elements, such as zinc, selenium, iron, copper, magnesium, and manganese (6). Suppressed immune system is responsible for the majority of coronavirus-related deaths. Once viral particles infect the human body with huge numbers, the response of immunity system might be delayed, allowing the virus to replicate and spread rapidly. Soon, a substantial cell death and acute respiratory distress syndrome can occur due to excessive

activation of immune system. The risk of getting severe case of COVID-19 is higher among older people due to their weak immunity (7). During the time of the crisis, the most affected populations are those who have weak immunity due to other illnesses, including diabetes, heart and lung diseases (8). The immune cells and all cells of the body need adequate nutrition to function properly and to initiate responses against pathogens. Consuming specific foods and following a healthy balanced diet might have the potential to lower the risk of infection and boost the immune system (9). During the times of increased risk, boosting the immune system should be given the priority besides maintaining proper immune function (10). It was theorized that younger patients with strong immunity are expected to recover sooner from corona virus attack. Older patients and children, however, are more prone to get severe infections due to their weak immunity (11). A healthy immune system is an essential weapon in the battle against the current pandemic of COVID-19, where the people lack a curative medicine or even effective preventive drugs (12). Enhancement of immunity by supplementation of vitamins A and D can bring positive outcomes in children following influenza vaccination (13). Additionally, enhancement of immunity by giving high doses of zinc supplementation was also an effective tool in patients with viral infection (14). Selenium supplements might be a good option to strengthen immunity after an influenza vaccination (15). Seemingly, reducing the severity of pneumonia and inflammation might be accomplished by boosting the immune response; thus reducing the incidence rate and mortality of COVID-19(16). Immunity and nutrition, infection, are all having a kind of bidirectional relationship among them and are affected by each other (17). The immune functions are dependent on polyphenolic compounds and anti-inflammatory nutrients, including beta-carotene, vitamin C, vitamin E. Antioxidants can be taken from the micro- and phytonutrients too (18). Managing COVID-19 illness by following anti-inflammatory strategy can be done by consuming certain foods, nutrients, or medicines (19).

The role of vitamins, minerals, nutrition in supporting the immune system against COVID-19

Maintaining adequate immune activity by consuming enough micronutrients is an essential step; because impairment of micronutrient balance can lead to immune system failure, which magnifies the susceptibility of the body to harmful microorganisms (20).Vitamin A, Vitamin C, Vitamin E, and Folic acid, are all required for optimal functioning of the immune system, besides other nutrients, such as Linoleic acid, Zinc, Copper, Iron, Selenium, and essential fatty acid and amino acids (21).

Vitamins and minerals

Vitamin A

The body needs this fat-soluble vitamin for protecting epithelium and mucosal integrity, promoting growth and development, and maintaining the visual and immunity functions. It has a function in regulation both cellular and humoral immune responses .Known among experts as the “anti-inflammation vitamin”, vitamin A also promotes and regulates immune system and can affect both the innate and adaptive responses, in addition to elevating the capability of the body to fight against numerous infectious diseases (22). Vitamin A supports the immune system by enhancing the functions of many major cells in fighting pathogens, such the Neutrophils, natural killer cells, T cells, B cells, and monocytes or macrophages. It also promotes antibody production, cytokine expression, lymphopoiesis, apoptosis, and production of mucins and keratins (23). This vitamin is present in many kinds of vegetables, such as carrots, spinach, and sweet potato (22). It can lower the susceptibility to infections and support the immune function. Isotretinoin-for example- is a popular form of vitamin A and is known for its ability to interfere with the down-regulation of a crucial host cellular

protein called angiotensin-converting enzyme 2 (ACE2), which the SARS-COV-2 needs to enter the body (24). The fact that a deficiency of particular nutritional element can lead to impaired immune response is well documented among researchers. Furthermore, the effectiveness of inactivated bovine coronavirus vaccines can be diminished by low vitamin A diets, which also can make calves more prone to infectious diseases. Prevention of lung infection and treatment of novel coronavirus might be accomplished by taking vitamin A (23).

Vitamin D

This vitamin belongs also to fat-soluble category, and is having an important role in both the innate and adaptive immune responses (25).A link between vitamin D deficiency and high vulnerability to acute viral respiratory infections was established by epidemiological studies (26). Vitamin D can actually decrease the risk of viral infections by stimulating certain compounds such as defensins and cathelicidins, which leads to higher levels of anti-inflammatory cytokines and inhibition of virus replication, in addition to inducing inflammation-related pneumonia and lowering the concentrations of pro-inflammatory cytokines (27). Low concentrations of 25(OH) D- a form of vitamin D - coincide with increased case-fatality rates with chronic disease comorbidity, suggesting a role for vitamin D in decreasing risk of COVID 19 (28).Vitamin D can decrease the cytokine storm induced by the innate immune system, which contributes to enhancement of cellular immunity. Both pro-inflammatory and anti-inflammatory cytokines are produced by the innate immune system when the viral and bacterial infections, such as COVID 19, attack the body (29). The majority of immune cells, including B and T lymphocytes, macrophages and monocytes, can identify the vitamin D receptors since the vitamin D is a powerful immunoregulatory. Some researchers refer to a possible conversion of 25(OH) D3 into 1, 25(OH) 2D3 by immune cells. 1, 25(OH) 2D3 is -of course- the active form of vitamin D(30).

Vitamin C

Known also as Ascorbic acid, Vitamin C supports the immune function and has a protective role. It is also essential for development and repairing all body tissues (31), and can lower the vulnerability of respiratory tract to infection in some circumstances (32). This vitamin is present majorly in citrus fruits, kiwifruits, and broccoli (22). Vitamin C supplementation might actually improve COVID -19 symptoms according to studies from the China and USA (33). Vitamin C is involved in collagen synthesis and healing process, which makes it capable of boosting the immune system and reducing the reactive oxygen species and damage caused by collagen synthesis. Vitamin C supports cytokines production against pathogens and has antioxidant capabilities (31).

Vitamin E

This vitamin occupies a special place in the list of fat-soluble vitamins due to its antioxidant abilities, which makes it able to modulate the immune functions in the body. Both the humoral and cellular immunity can be affected by Vitamin E deficiency (34).Possibly, a resistance against COVID-19 might be achieved by supplementation with vitamins D and E, (35) since infection by a bovine coronavirus is increased among cattle with low levels of Vitamins D and E(36).The level of immunity in old people might get a boost by Vitamin E according to a recent study. Both animal and human based studies have also demonstrated a crucial role for vitamin E in modulating the immune system and supporting innate and adaptive immunity responses (37).

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Vitamins B

Treatment of COVID-19 should involve the supplementation with B vitamins, which also can enhance the immune system (23) .The vitamin B9/ foliate -for example- is important for synthesis of DNA and protein in the body. A deficiency in this vitamin is expected to cause deterioration in cell-mediated immunity (38).

Zinc

Although considered as trace element, the Zinc is still having a significant role in maintenance of immune function, growth, and development. People become more vulnerable to infectious and viral diseases when the level of this element decreases in their bodies. Actually, zinc-deficient populations are at higher risk of getting serious infections, such as HIV or HCV. The zinc status of an individual can be regarded as a critical factor that has the potential to affect immunity against viral infections according to multiple studies (39).Zinc can battle pathogens in the body; thus supporting the immune system (40).In addition, Zinc deficiency has an impact on many crucial processes, such as cytokine production, phagocytosis, and intracellular killing (41). The regulation of intracellular signaling pathways in both the adaptive and innate immune cells requires zinc ions (42). Networks that bind pathogens or the so-called Neutrophil extracellular traps are all belong to pathogen-eliminating transduction pathways that also need zinc. Likewise, the cell-mediated immunity and inflammatory responses are requiring zinc since this element is involved in inflammation process (43). Cells regulating nonspecific immunity, such as natural killer cells and Neutrophils, are demanding this element to thrive and function normally. Around 750 zinc-finger transcription factors will not be structured properly without the zinc (44). To carry vital cellular functions, such as energy metabolism, DNA synthesis, RNA transcription, the body needs over 300 enzymes and coenzymes, which in turn need the zinc for their activation and inactivation (45).Interestingly, about 10% of all human proteins require this trace element as well (46). Zinc might exert antiviral effects according to previous research. The mechanism could involve: 1) suppressing viral replication and 2) boosting immune responses. Zinc can be used as an effective adjunct therapy to fight some viral species due to its antiviral properties and low cost, especially when treating respiratory tract infections .Lowering the intensity of COVID-19 and other respiratory tract infection might be accomplished by consuming a trace micronutrient like zinc, due to its aforementioned antiviral properties (39). Zinc is present with good amount in various meat products, such as lamb, beef, chicken meat, in addition to seafood, like the oysters and lobsters. Consuming vegetables with these foods is recommended to facilitate the absorption of zinc (47). Other worth mentioning sources of zinc include mushroom, celery, sunflower seeds, almonds, soy foods, black rice, black sesame, lentils and many other legumes and nuts (48).

Copper

Immune cells usually need the copper to differentiate and grow properly (49). Copper was found to have antiviral properties in-vitro studies (50). It also might stop transmission of respiratory viruses, such as those responsible for SARS and MERS outbreaks, according to a recent research (51). The body loses ability to generate superoxide anion required to kill ingested microorganisms when the copper level goes low. Such reduction in copper levels can lead to decreased levels of IL-2 and T cell proliferation too (52).

Selenium

To maintain optimal health, the body needs this micronutrient, because without it, oxidative stress will increase dramatically, leading to increased susceptibility to diseases (53). Both components of the immune system- the adaptive/acquired immune system and the non-

adaptive / innate immune system- are affected by selenium (54). Selenium has antioxidant and anti-inflammatory properties, which equip this element with multiple pleiotropic effects. Poor immune function, high mortality, and cognitive decline are expected consequences of low selenium status. In the other hand, providing selenium supplements or higher selenium concentration can strengthen the body's immune system against viruses (55).

Magnesium

Magnesium might have the potential to support body's immunity against viral infections (56). Magnesium influences multiples immune process, such as immune cell adherence, T helper-B cell adherence, Immunoglobulin M (IgM) lymphocyte binding, immunoglobulin synthesis, antibody-dependent cytolysis, and macrophage response to lymphokines. This means magnesium is essential in controlling immune function (57).

Nutrition

Enhancing the immune response and the innate antiviral immune system translates into cleaning the body from infections and resistance viral infections. Without notable side effects, antimicrobial peptides in plants can actually enhance human innate immunity and keep the human body free of disease. There are numerous kinds of effective medicinal plants with strong antiviral activity (58).

Herbs and Chinese medicine

Compounds and chemicals, such as the flavonoids, allicin, betacarotene, Oleuropein are all exist in many natural plants and are known for their antiviral, anti RNA, and anti-oxidant effects (59).Some reports asserted the usefulness of traditional Chinese medicinal plants and bioactive, such as flavonoids from litchi seeds, plant-derived phenolic compounds, Quercetin, and Kaempferol. They even might block the enzymatic activity of SARS 3-chymotrypsin-like protease (3CLpro), which actually required to replication of SARS-CoV. This hints toward possible application for these plants in treating SARS-CoV-2, especially in the supportive care institutions dedicated for patients with COVID-19 (60).Usually, the supportive care of patients with COVID-19 provides the healthcare providers with guidelines and herbal formulas when needed (61).

Spinach

Spinach and many other kinds of fruits and vegetables are rich with antioxidants that quench free radicals. These might include also ginkgo biloba, olive leaf extract, garlic, carrot, radish, citrus pulp, tomato pomace, and grape pomace, etc (62). Experts recommend spinach and other Fruits and vegetables that contain the highest micronutrients, such as carrots and peaches (63). The main dietary source of Vitamin A is actually the beta-carotene, which increases the disease-fighting cells in the body and is abundant in spinach and in other vegetables. Flavonoids, carotenoids, vitamin C, and other antioxidants and nutrients are all found in spinach, and they support proper immune function as well (64).

Tumeric

Although some people consider it as a food, turmeric is actually a Nepali spice that has the ability to support the immune system. It is known as a source of the curcumin, which is a bright-yellow compound that has antioxidant and anti-inflammatory properties, which give the turmeric its immunity boosting reputation (10).

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Mushrooms
During the epidemic of COVID-19, eating mushroom can be a good option to help the body fighting respiratory diseases, because mushroom has good amount of Vitamin D. Taking vitamin D supplements or by diet was proven to be effective in reducing production of pro-inflammatory compounds, leading to a lower risk of respiratory tract infections (65).

Broccoli
Multiple good vitamins are present with considerable amounts in broccoli, including vitamin A, C, and E. In addition, Sulforaphane and phytochemical- which are known as potent antioxidants- are also present in broccoli, and they have the potential to support the immune system and help the body fighting viruses (64).

Strawberries
Strawberries are useful for the immune system since they contain remarkable levels of bioactive phytochemical and vitamin C, which can resist the free radicals that cause damage in the cells (66).

Almond
People usually consume almond as a dried food. It can protect the body against oxidative stress due to high levels of vitamin E and antioxidants that it has. Since this dried food is rich with fiber, magnesium, and manganese, reducing cholesterol levels is expected to happen, besides boosting abilities of lymphocytes and natural killer cells of immune system (67).

Sunflower seeds
The seed of Sunflower plant is widely used and incredibly rich with multiple elements, including copper, calcium, iron, phosphorus, magnesium, and selenium, in addition to vitamin E, which can prevent cell damage caused by free radicals and strengthen the immune system (68).

Lemon/Kiwi
Although lemon and oranges are known as rich sources with vitamin C, kiwi actually has almost twice the amount of this vitamin comparing to lemons and oranges. Kiwi is not just rich with vitamin C, it also has high levels of foliate, which gives the body a nutritional boost. Other essential minerals and vitamins present in kiwi include vitamin A, B6, B12, E and iron, potassium as well as calcium. However, vitamin C is a popular immunity booster and can act as prooxidant for immune cells, defending the body against harmful viruses and other microorganisms (69).

Papaya
Since papaya contains good levels of potassium, vitamin B, foliate, and vitamin C, it can be regarded as a useful fruit for enhancing the immune system. This fruit can be grown easily in a small space, but what makes the papaya special is its high content of Papain, which is a digestive enzyme that can fight inflammation (67).

Garlic
Garlic contains sulfur compounds and is widely used herb by many people for its characteristic aroma. It has the potential to support the immune system, and many experts believe in garlic's abilities against common cold and infections due to its antiviral properties. Other health benefits for garlic might include lowering blood pressure and the risk of heart disease (67). People consider the Allicin, which is taken from freshly crushed garlic, as a

plant medicine. Allicin can react with thiol groups of multiple enzymes, including alcohol dehydrogenase, thioredoxin reductase, and RNA polymerase. This provides the Allicin with remarkable antimicrobial effects (59).

Bioactive Lipids

Arachidonic acid and other unsaturated fatty acids belong to bioactive lipids, which can be taken orally or intravenously to support the recovery process in patients infected with multiple kinds of viral disease, such as SARS-CoV-2, SARS, and MERS infections (70).

Yogurt

Good amounts of vitamin D and probiotics are present in yogurt, which is used by many people in making desserts. Probiotics were proven to have the capacity to influence immune function and decrease the risk of respiratory infections, including common cold and influenza .So, yogurt can be helpful for boosting the body's natural mechanism defenses against many pathogens (67).

Summary

People with weak immune systems and responses are more vulnerable to Covid-19's attacks and infections. Fiber –rich foods are good for the beneficial bacteria, which reside in the gut and might be related to the immune system, which is responsible for eliminating pathogens and diseases. However, weak or damaged immune system can pave the road toward getting non-contagious disease, such as diabetes, heart disease, or cancer, in addition to contagious disease, such as coronavirus. Certain immune features determine the prevalence and severity of infections, but the age has also a hand in determining the prevalence and severity of infections as well. Supporting immune function by sufficient supply of micronutrients is important throughout the life of any individual. Getting insufficient amount of certain micronutrients can accelerate development of many infections and make the body unable to resist severe infections, including COVID -19. However, diseases like COVID-19 might be managed carefully by adopting balanced diet that provides adequate amount of essential macro and micronutrients.

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Annals of R.S.C.B., ISSN: 1583-6258, Vol. 25, Issue 4, 2021, Pages. 16870-16880
Received 05 March 2021; Accepted 01 April 2021.

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