Journal of Stress Physiology & Biochemistry, Vol. 18, No. 3, 2022, pp. 5-16 *ISSN 1997-0838*
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REVIEW

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Potential Role of Nutrients in Immune Boosting and Aiding Against COVID- 19 Pathogenesis

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Received February 6, 2022

COVID-19 or the novel Corona Virus is highly contagious and acute disease and is caused by Severe Acute Respiratory Syndrome Coronavirus-2 or SARS-CoV-2. The pathogenesis of Corona Virus is very complex and involves the suppression of host innate and antiviral immune response, cytokine storm is described as induction of oxidative stress followed by hyper inflammation which causes tissue fibrosis, pneumonia and lung injury. Several neutraceuticals have proven their abilities against viral pathogenesis and boosting immunity. These neutraceuticals involves Vitamin C, Vitamin D, Zinc, Selenium, and Copper. To boost immunity, combination of some of the phytonutrients may be used as food supplements. It may also help provide therapeutic assistance against COVID-19, preventing spread of virus and suppression of hyper inflammation. This review speculates the significance of nutrition as a mitigation strategy to support immune function amid the COVID-19 pandemic, identifying food groups and key nutrients of importance that may affect the outcomes of respiratory infections. To survive in the current conditions of COVID-19 it is necessary to build up the immunity. An appropriate diet can make sure that a body is capable against the viral pathogenesis.

Key words: COVID-19, neutraceuticals, Vitamin C, Vitamin D, Zinc, Selenium, Copper

The corona virus disease 2019 (COVID-19) caused by the severe acute respiratory syndrome corona virus 2 (SARS-CoV-2), has rapidly expanded globally and declared pandemic by WHO. It was first reported in late 2019 from Wuhan city in China. Thus far, it has spread to all countries globally. While writing this review there was more than Two hundred eighty million confirmed cases and more than Five million deaths worldwide. In India there were more than Thirty four million positive cases and more than Four hundred seventy nine thousand reported deaths. Corona viruses are involved in birds and mammals' diseases. Corona viruses are members of the subfamily Coronavirinae in the family and the order Nidovirales. On the basis of genomic structures and phylogenetic relationships the COVID-19 belongs to genera Betacoronavirus.

There are many similarities in Human Betacoronaviruses (SARS-CoV-2, SARS-CoV, and MERS-CoV) however they also have differences in their genomic and phenotypic structure that can influence their pathogenesis. The genome size of these viruses ranges from 26-32 kb. The typical clinical symptoms include high fever, dry cough, fatigue, myalgias, Dyspnoea, sore throat and other gastrointestinal symptoms. The onset symptoms and progression of disease may vary among individuals as it depends on their immune system and already existing underlying medical conditions. Therefore, neutraceuticals may provide alternatives against COVID-19 infection due to their proven ability of immune boosting, antioxidant, antiviral and anti-inflammatory effects. In this article we will discuss a few of these nutrients which can provide a therapeutic support against COVID-19 in terms of preventing virus spread and disease progression.

Genome architecture and Mechanism of action

Corona virus is enveloped and possesses positive strand RNA in their genome. Corona virus possesses the largest genome (26Kb-32Kb) among all the known RNA viruses. Genes for the major structural proteins in all corona viruses occur in the 5'-3'order as S, E, M, and N (**figure 1**) The virus binds to the ACE (angiostatin converting enzyme) receptors on cells through its spike (S) glycoprotein. To complete its entry following this initial process this spike protein has to be primed by an enzyme called a protease TMPRSS2 (**figure 2**). The S protein has two domains S1 and S2 which bind to the receptor binding domain and catalyses the membrane fusion respectively. After the virus enters the host cell the genome is transcribed and translated for several structural and non-structural proteins. Structural protein complex is comprised of replicase (R1a/ab), envelope (E), Spike (S), membrane (M), nucleoprotein (N) and non structural protein comprised of (NSPs 1-16). The proteins are assembled inside the cell membrane and mature virus particles buds off from the cell membrane.

The existing evidence about mechanisms how it modulates the host IFN response suggests that with the help of its structural and non-structural proteins virus interferes the production of type1 (interferon) IFN and downstream signalling by ubiquitination and degradation of tumor necrosis factor receptor associated factors (TRAF) and interferon regulatory factor(IRF). Virus replication inside the cell triggers the activation of immune cells such as monocytes, macrophages, granulocytes resulting in "cytokine storm" where body starts to attack its own cells with massive secretion of interleukins such as IL-1β, IL-2, IL-6, IL-7, IL-8, IL-10, or IL-17, interferon (IFN)γ, IFNγ-inducible protein 10, monocyte chemoattractant protein 1 (MCP1), granulocyte-macrophage colony-stimulating factor (GM-CSF), macrophage inflammatory protein 1α, and tumor necrosis factor-alpha (TNFα),. This hyper inflammatory condition and severe manifestation of the infection in tissue cause tissue fibrosis and subsequently the walls of the lungs' tiny air sacs become leaky and fill with fluid, causing pneumonia.

Linking oxidative stress with Covid-19

Understanding the relationship of molecular mechanisms mediated by SARS-CoV-2 which can lead to Pneumonia is current clinical need that is essential to improving the COVID-19 prognosis and providing a rational therapy. Reactive oxygen and nitrogen species play a complex role in various diseases as well as in metabolic regulation. Because viruses replicate in living cells, such oxidative stress generated metabolites

influence the growth of viruses in addition to serve as a host defence mechanism. SARS-Cov-2 infection also enhances the reactive oxygen species which ultimately causes oxidative stress. The mechanism involves the activity of ACE2 cleaving the octapeptide angiotensin II (Ang II), earlier which is produced by ACE. As Ang II is a potent vasoconstrictor with major role in the increase of blood pressure, its processing by ACE2 bring about vasodilation, accentuated by the generation of Ang 1-7, a peptide with potent vasodilator roles which is generated during this process. The SARS-CoV-2 binding to ACE2 facilitates the entry of viruses in the cells and in turn reduces the bioavailability of ACE2. Due to the protective function of ACE2, the decrease in its levels is related to adverse clinical phenotypes, and its key major role in the pathogenesis of SARS-Cov-2 has been described Gan *et al.*, (2020). Evidence has shown that Ang II regulates nicotinamide adenine dinucleotide phosphate (NADPH) oxidase (NOX) activation Zablock *et al.*, (2013) Dikalov *et al.*, (2013) Wei *et al.*, (2006) Rincón *et al.*, (2015) when Ang II binds to angiotensin type 1 (AT1R) Doremalen *et al.*, (2020). NOX activation is one of the major contributors to the formation of ROS (including superoxide radical anion ($O_2^{\bullet-}$) and hydrogen peroxide (H_2O_2)). Therefore, the reduction in ACE2 bioavailability after SARS-CoV-2 binding allows Ang II to be available to interact with AT1R, which mediates signals to activate NADPH oxidase and induce oxidative stress and inflammatory responses, which in turn contribute to the severity of COVID-19] Oudit *et al.*, (2007) Sawalha *et al.*, (2020). Importantly, macrophages and neutrophils also play a potential pathological role during SARS-CoV-2 infection Merad *et al.*, (2020) by producing numerous ROS, including but not limited to H_2O_2, $O_2^{\bullet-}$ and hydroxyl radical ($^{\bullet}OH$) Wang *et al.*, (2020). Available evidences also suggests that SARS-Cov 2 infection activates Nuclear factor kappa B signalling pathways to induce the oxidative stress] may then be considered for acute lung injury occurring in severe COVID-19 patients. Oxidative stress affects the immune system throughout altering immune cell function and inflammatory response. Nagar *et al.*, (2018) Galley (2011).

SARS-Cov-2 infection causes oxidative stress indirectly by suppressing the host antioxidant defence. Antioxidants as a corresponding therapeutic strategy in COVID-19 has been proposed Derouiche (2020) Li *et al.*, (2020). A possible strategy could be focused on regulating the nuclear erythroid-related factor 2 (Nrf2) (such as resveratrol, sulforaphane, melatonin and vitamin D), the main transcription factor involved in stimulating the enzymatic antioxidant defence Cullinan *et al.*, (2004). Even though the use of antioxidant strategy has been proposed as adjuvant therapy in COVID-19 infection, there is no antioxidant therapy approved by regulatory agencies and organizations Prauchner (2017) although several clinical trials are currently active.

The available findings suggest that COVID-19 pathogenesis can be classified into two phases: phase-1, an asymptomatic phase where oxidative free radicals load increases and immune system suppresses and phase-2: hyper inflammation leading to acute lung injury.

Antioxidant based alternative Therapies to counteract the infection

Given the high rate of transmission of this virus between the individuals it is important to manage the phase-1 carriers because they are spreading the infection unknowingly. Therefore, administration of external antiviral or immune boosting food supplements may help to maintain the general health conditions of affected patients. Currently WHO has authorized 10 vaccines like Pfizer/BioNTech Comirnaty, the SII/COVISHIELD and AstraZeneca/AZD1222 vaccines, the Janssen/Ad26.COV 2.S developed by Johnson & Johnson, the Moderna COVID-19 vaccine (mRNA 1273), the Sinopharm COVID-19 vaccine, the Sinovac-CoronaVac, the Bharat Biotech BBV152 COVAXIN for early or limited use. In India also 2 vaccines (Covishield and Covaxin) have been approved by CDSCO (Central Drug Standard Control Organisation) but experts have already expressed their concern about the vaccine's efficacy and safety as those are already in phase-3 trials. The Pfizer and Moderna vaccines that consists synthetic mRNA, which is used to synthesize the COVID-19 spike protein. Because of highly unstable mRNA, these vaccines are prepared with a lipid

nanoparticle that protects it from being damaged prior to injection. The spike protein is the part of the virus that attaches to human cells. The spike protein alone cannot cause COVID-19. Once the spike proteins are synthesized, it enables the immune system to produce antibodies against the virus.

The Pfizer and Moderna vaccines require two shots separated by 21-28 days; the second dose of the COVID-19 vaccine acts as a booster, that triggers the immune system to produce long-lasting memory cells that stick around to protect against the virus in the future.

Additionally, there are no specific drugs for covid-19 treatment. Various evidences are available which indicate that the nutritional supplements from various herbs, spices, roots, fruits and vegetables can reduce the severity of viral infection by boosting the immune response. In this section we will discuss few nutrients and their evidence based beneficial effects (**Table 1**)

Vitamins:

Vitamin C

Synopsis of Vitamin C and its possible role in management of COVID-19

Vitamin C also known as ascorbic acid is a water-soluble nutrient that cannot be synthesized by humans. Vitamin C functions as an antioxidant that can scavenge reactive oxygen species (ROS) produced during metabolic pathways and involved in protecting biomolecules such as proteins, lipids and nucleotides from oxidative damage. Vitamin C has several pharmacological characteristics, anti-oxidant, anti-inflammatory antiviral, and immunomodulatory effects, thus making it a latent therapeutic option in management of COVID-19. The results of a study performed by Cinatl J *et al* showed that L-ascorbic acid-2-phosphate (ASC-2P) provides L-ascorbic acid with long-lasting antiviral activity against cytomegalovirus (CMV) infection which may be of beneficial if used as adjunctive treatment of CMV infection. *Cinatl et al.*, (1995).

An another study done by Jariwalla *et al.*, (2007) concluded that the nutrient mixture of ascorbic acid, green tea extract, lysine, proline, N-acetyl cysteine, selenium exerts an antiviral effect against influenza virus by lowering viral protein manufacture in infected cells and deteriorating viral enzymatic activity in cell-free particles.

Though there are multiple confirmations which showed that the consequence of vitamin C on phagocytic function of neutrophils is dependent on dose. Vitamin C supplement in a dose of 200 mg to 1 g daily for 1–4 months enhanced neutrophilic phagocytic activity. Jayachandran *et al.*, (2000) De la Fuente *et al.*, (1998). Nevertheless, administration of 2 g of vitamin C on a daily basis for 2 weeks damaged bacterial killing activity of neutrophil Shilotri *et al.*, (1977) A meta-analysis established that vitamin C supplement of more than 0.2 g/day in adults and 1–2 g/day in children reduced extent and severity of common cold Hemilä *et al.*, (2013). In vitro findings also suggest that ascorbic acid 2-glucoside and ascorbic acid function as potent immune-stimulators of antibody production in humans and that the intracellular ascorbic acid content is a key parameter for establishing the immune response of human peripheral blood lymphocytes. As we have already described that the patients, severely ill with COVID-19 have elevated cytokine levels “Cytokine storm”, and have high mortality rate due to virus-driven hyper-inflammation. The association of Vitamin C deficiency with pneumonia has been identified Infusino *et al.*, (2020). A randomised double-blind trial involving vitamin C/placebo supplementation which was conducted on 57 elderly patients with acute respiratory infections (bronchitis and bronchopneumonia) showed reduced severity of illness and lowered mortality rate Hunt *et al.*, (1994).

The total recommended daily allowance (RDA for Vitamin C is 60 mg. The best food sources of Vitamin C are fruits and vegetables. Eating a variety of these healthy foods will help people meet their daily diet. A well balanced and varied diet is essential for minimizing vitamin deficiencies as well as to avoid excess consumption of this essential vitamin. Therefore, a food supplement incorporated from the natural sources can help in alleviating immune response as well as antiviral, antioxidant effect against Covid-19 infection.

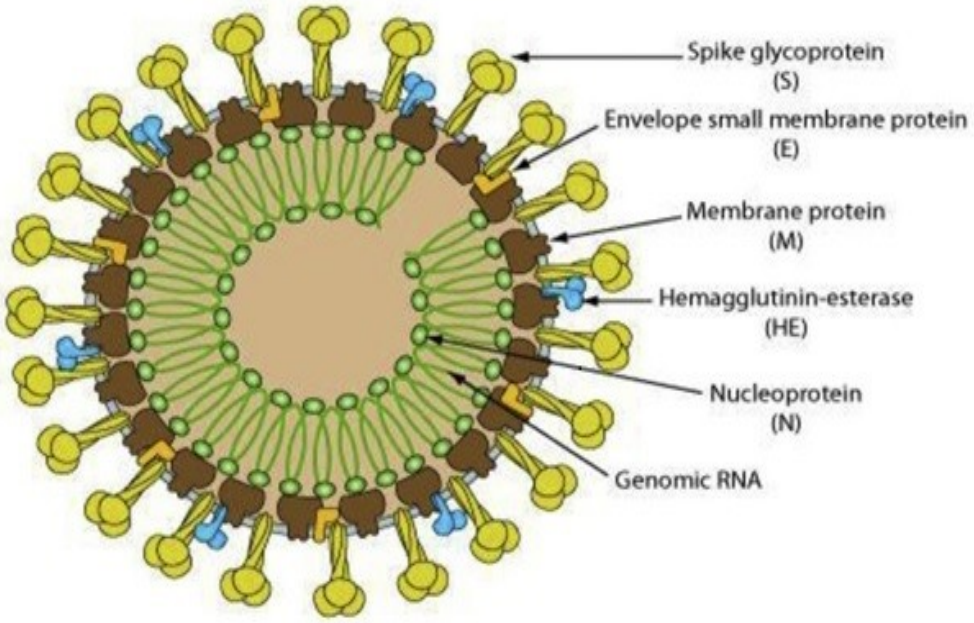

Figure 1. Structure of corona virus.

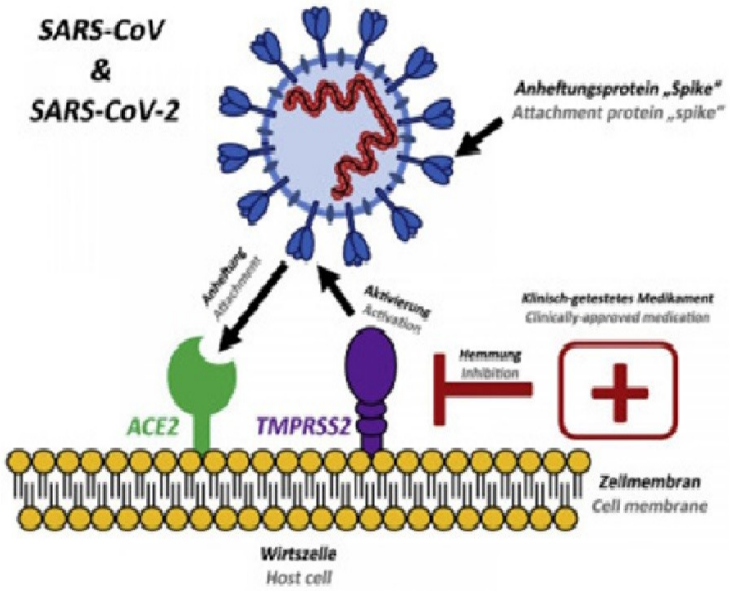

Figure 2. The attachment protein "spike" of the new coronavirus COVID-19 and SARS-CoV use the same cellular attachment factor (ACE2) and the cellular protease TMPRSS2 for their activation. Existing, clinically approved drugs directed against TMPRSS2 inhibit SARS-CoV-2 infection of lung cells. Hoffmann *et al.*, (2020).

Table 1. Nutrients and their evidence based beneficial effects

Micronutrient	Immunomodulatory properties	Deficiency symptoms	Supplementation	Food Source
Vitamin D	Preventing cytokine storms by decreasing inflammatory cytokines and nuclear factor _B (NF- κB) activation	Vitamin D deficiency/insufficiency observed in patients with COVID-19	Supplementation may be effective for Vitamin D deficient individuals. Aglipay et al.,(2017)	**Vegetable and fruit Source:** Spinach, Kale, Collards, Okra. Soybeans, oatmeal, and breakfast cereal **Animal Source:** oily fishes such as salmon, sardines, herring and mackerel
Vitamin C	Increasing antiviral cytokines, such as Interferon (IFN)-γ/TNF-α. Sawalha et. al., (2020) Attenuating excessive inflammatory response.	Scurvey, Slowly Healing Wounds, Dry, Damaged Skin.	Supplementation may be effective Decreased flu or cold symptoms due to treatment with high dose of vitamin C Decreased inflammatory mediators/ markers due to the administration of vitamin C in COVID-19 patients. Rondanelli et. al., (2018)	**Vegetable and fruit Source:** Citrus fruits, Strawberries, peppers, Blackcurrants, Broccoli, Brussels, sprouts. **Animal Source:**
Vitamin E	Vitamin E inhibits protein kinase C (PKC) activity by increasing PKC-α dephosphorylation through the activation of protein phosphatase 2A. The inhibition of PKC by vitamin E has been reported in various cells, and consequently, the inhibition of platelet aggregation; reduced proliferation of monocytes, macrophages, neutrophils, and vascular smooth muscle cells; and decreased superoxide production in neutrophils and macrophages have been observed. Traber et. al., (2007), Zingg (2015)	Weakens cellular and humoral immunity.	Supplementation may be harmful	**Vegetable and fruit Source:** Sunflower, safflower, and soybean oil, Almonds, Peanuts, Beet greens, collard greens, spinach. **Animal Source:** Eggs, Salmon, tuna
Zinc	Protection against oxidative stress and inhibition of signalling pathway of IFN-γ, TNF-α. Rondanelli et. al., (2018)	People with zinc deficiency are at high risk of acquiring infections like HCV or HIV.	Supplementation may be effective Enhanced cytokine response. Increase in zinc dosage enhances thymic functions and the yield of new CD4+ naive T cell.	Oysters, **beans**, **nuts**, certain types of **seafood** (such as crab and lobster), **whole grains**, fortified breakfast cereals, and dairy products
Copper	Exhibits antiviral properties by contributing in development and differentiation of immune cells. Sagripanti *et al.*,(1993)	Fatigue and Weakness, Frequent Sickness, Sensitivity to Cold.	Supplementations not likely to be valuable.	**Vegetable and fruit Source: shellfish**, **Animal Source: seeds** and nuts, **organ meats**, wheat-bran cereals, whole-grain products, and **chocolate**
Seleniu m	Down regulation of pro-inflammatory cytokines like IL-1β and IL-6. Promotion of NK cell activity, T cell proliferation,	Selenium insufficiency is associated with meagre immunity, cognitive decline and higher mortality	Higher selenium level in surviving COVID-19 patients compared to deceased patients Higher recovery rate from COVID-19 in patients with higher selenium levels. Schiavon *et al.*,(2020).	**Vegetable and fruit Source: Brazil nuts,** **Animal Source:** Seafood, organ meats, cereals and other **grains**, and dairy products

Vitamin D

Due to the thermal action of UVB radiation reaching 7-dehydrocholesterol in the skin, vitamin D3 is produced. Following this reaction, vitamin D3 or oral vitamin D is then converted to 25(OH)D in the liver and then, in the kidneys or other organs, to the hormonal metabolite 1,25(OH)2D (calcitriol) Holick (2007) Pike *et al.*, (2017). Calcitriol contributes to regulating the concentrations of serum calcium through a feedback loop with parathyroid hormone (PTH), and in this way modifies many important functions in the body Holick *et al.*, (2007) **.** Vitamin D has many mechanisms by which it reduces the risk of microbial infection and death, including physical barrier, cellular natural immunity, and adaptive immunity Rondanelli *et al.*, (2018). A daily intake of 20-50 µg of vitamin D was recently recommended for obese individuals, healthcare workers and smokers in order to improve their resistanceagainst COVID-19 infection McCartney *et al.*, (2020).

Vitamin D may contribute to reducing the production of pro-inflammatory T helper (Th)1 cytokines, (TNF-α and IFN-γ), and increases the expression of anti-inflammatory cytokines by macrophages Sharif *et al.*, (2019) Gombart *et al.*, (2020) . Attenuation of the 25(OH) D response to vitamin D supplementation in asthma and COPD associated with reduced molar ratios of 25(OH) D_3-to-vitamin D_3 and increased molar ratios of $1\alpha,25(OH)_2D_3$-to-$25(OH)D_3$ in serum, which suggests a dysregulation in vitamin D metabolism Jolliffe *et al.*, (2020) Laird E. *et al.*, (2020) also suggested a strong significance between the concentration of Vitamin D and mortality rate in his study.

A contradictory study done by Aglipay et al., (2017)**,** demonstrated that the effect of high-dose (2000 IU/day) vs. standard-dose (400 IU/day) vitamin D supplementation on viral upper respiratory tract infections did not show any significant difference among different groups of children. These findings do not support the routine use of high-dose vitamin D supplementation for the prevention of viral upper respiratory tract infections. Optimising vitamin D status to recommendations by national and international public health agencies will certainly have benefits for enhancing bone health and potential benefits for Covid-19. The overlap in the vitamin D associated biological pathways with the dysregulation reported to drive COVID-19 outcomes warrants further investigation.

Vitamin E

Vitamin E, comprising eight biologically active tocopherols, is a potent antioxidant with the ability to modulate host immune functions. Vitamin E is a major fat-soluble antioxidant that scavenges peroxyl radicals and ceases the oxidation of polyunsaturated fatty acids (PUFAs). In the presence of vitamin E, instead of lipid hydroperoxide, peroxyl radicals reacts with α-tocopherol, the chain reaction of peroxyl radical production is stopped, and further oxidation of PUFAs in the membrane is prevented peroxyl radicals reacts with α-tocopherol, the chain reaction of peroxyl radical production is stopped, and further oxidation of PUFAs in the membrane is prevented Traber (2007) . Vitamin E deficiency is known to impair both humoral and cellular immunity Moriguchi *et al.*, (2000). It helps in scavenging free radicals, thereby reducing the risk of lipid peroxidation and oxidant injury

However contradictory study has shown harmful effects of Vitamin E supplementation. Meydani S.N. et al,.(2020) Conducted randomized clinical trials to investigate the effect of 1-year vitamin E supplementation on respiratory infections in elderly nursing home residents and found that Supplementation with 200 IU per day vitamin E did not have any statistically significant effect on lower respiratory infections in elderly nursing home residents Meydani *et al.*, (2020).

Trace elements

Zinc (Zn)

Zinc is essential trace element which is involved in various cellular processes and possesses a variety of direct and indirect immune boosting properties. Zn deficiency is associated with increased susceptibility to infectious diseases caused by bacterial, viral, and fungal pathogens Overbeck *et al.*, (2008). Antiviral effects of Zn may be also realized through metallothioneins (MT), a family of low molecular weight, cysteine-rich proteins, which functions include storage and transfer of Zn^{2+}.

Inhibits replication of flaviviruses (e.g., yellow fever virus and HCV), as well as the alphavirus (Venezuelan equine encephalitis virus) Schoggins *et al.*, (2011).

An RCT evaluated the zinc supplementation against viral infections. This clinical trial was conducted with 103 children of pneumonia and it was found that Zinc supplementation improved clinical symptoms in children with pneumonia in fewer hours and induced a cellular immune response. Zn given in combination with IFN-α was more effective against chronic hepatitis C than a therapy with IFN-α alone Brautigan *et al.*, (1981).

During antiretroviral therapy The CD4 (+) cell count was significantly increased after zinc supplementation in HIV-infected patients with low plasma zinc levels. Addition of Zn supplementation to antiretroviral therapy in patients with HIV has resulted in significant increase of $CD4^+$ T cell count in comparison to control group treated with antiretroviral therapy alone Asdamongkol *et al.*, (2013).

However few controversial studies were also reported which has shown a marginal and statistically insignificant improvement in enrolled 610 children aged 2 to 35 months Basnet *et al.*, (2012). The addition of zinc does not improve symptom duration or cure rate in acute bacterial pneumonia in under-five children in a RCT conducted by Ganguly *et al.*, (2011).

Copper

Cu is essential trace element which play crucial role in neutralizing infectious viruses such as bronchitis virus, poliovirus, human immunodeficiency virus type 1(HIV-1) Sagripanti *et al.*, (1993). It participates in the development and differentiation of immune cells. (SARS-CoV-2) is found highly sensitive to the copper surface [6]. On copper, no viable SARS-CoV-2 was measured after 4 hours and no viable SARS-CoV-1 was measured after 8 hours in comparison to plastic and stainless steel (72 hours). In a cell-based study, Cu^{2+} was shown to block papain-like protease-2, a protein that SARS-CoV-1 requires for replication Baez-Santos *et al.*, (2015) Han *et al.*, (2005).

Kelly D.S. (1995) conducted a study to examine the effects of low-copper diets on 11 healthy men (aged 21-32 yr) during a 90-d metabolic suite study and found that Copper deficiency could lead to a decreased number of circulatory blood cells with a greater susceptibility towards infection in enrolled older people. The optimal intake level of Cu for humans is 2.6 mg/day Chambers *et al.*, (2010). Under highly controlled conditions, long-term high copper intake results in increases in some indexes of copper status, alters an index of oxidant stress and affects several indexes of immune function.

Selenium

Low levels of micronutrients such as vitamins A, E, B6, B12, zinc, and selenium have been associated with adverse clinical outcomes during viral infections Semba *et al.*, (1999). On average, you should consume 55 micrograms a day to avoid a deficiency, which can reduce your body's immunity against disease and may affect fertility Schiavon *et al.*, (2020).

Nelson H.S. *et al.*, (2001) demonstrated in his report that infection with influenza A/Bangkok/1/79 (H3N2), a relatively mild strain of the virus, caused much more severe pneumonitis in selenium (Se)-deficient mice than in Se-adequate mice. In another study done by the same group reported that the increased virulence observed in the Se-deficient mice is due to mutations in the influenza virus genome, resulting in a more virulent genotype Nelson H.S. *et al.*, (2001)

Selenium supplementation may provide a positive response to improving the immune response to viral infections, such as lethal influenza infection. The mortality of the virus-infected Se-deficient mice was 75%, along with another symptoms such as marked reduction in body weight, lower levels of TNF-α and IFN-γ and lower serum selenium concentrations, the mortality of mice maintained on feed containing 0.5 mg Se/kg in the form of sodium selenite was 25%.

Selenium plays an important role in the production of antibodies. Natural sources of selenium are corn, garlic, onion, cabbage, broccoli etc. Further clinical trials are required to evaluate the beneficial effects of selenium against COVID-19.

Neutraceuticals and probiotic supplements: A ray of hope for COVID-19

Probiotics not only support the health of the gut but also improves system functioning and regulation. These

neutraceuticals have the potential to modulate the immunity of a susceptible population, but may also pave the way towards the development of drugs which may be used to treat COVID-19.

CONCLUSIONS

While writing this review several vaccination programmes has been started to end this devastating pandemic and scientists are still working towards rolling out a safe and effective vaccine because the strain of COVID- 19 virus is being mutated repeatedly and hence challenging the efficacy of the currently available vaccines. According to WHO, currently designated variants of concern (VOCs) are Alpha, Beta, Gamma, Delta, Omicron, therefore, we must continue the essential public health actions to suppress transmission and reduce mortality rate. Nutritional therapy may be a part of patient care for survival of this life-threatening disease. In this review we have highlighted the immunomodulatory and therapeutic potential of few vitamins and trace elements. Specific micronutrient supplementation is important for the risk group such as patients with malnutrition and older adults who have a relatively weak immune system and underlying medical conditions.

CONFLICTS OF INTEREST

The authors declare that they have no potential conflicts of interest.

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