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## Original Research Article

# Diet and Nutrition Recommendations during the COVID-19 Pandemic

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### ABSTRACT

Coronavirus disease of 2019 (COVID-19) is caused by coronavirus 2 (SARS-CoV-2), has affected the lives of people worldwide. This document aims to provide guidance on managing asymptomatic, symptomatic mild to moderate illness home quarantine patient's diet and Nutrition needs. Specially in this time of pandemic, optimum Diet and Nutrition care becomes extremely necessary to manage the illness effectively. Dietary intervention can definitely decrease the severity and disease load of the country. In this time, Healthy positive lifestyle modification is of utmost importance which includes the Healthy diet and Nutrition food habits, meeting nutrition requirements as per medical issues, incorporation of physical activity and relaxation techniques for mental and emotional health.

This review summarizes, evidence based literature, nutritional guidelines to support recovery in COVID-19 patients. In this article, we have tried to work out the dietary recommendations with all the macro and micronutrients for patients suffering from asymptomatic to symptomatic mild to moderate COVID-19 illness, advised home quarantine. A healthy diet containing a variety of macronutrients and micronutrients can provide a significant amount of minerals, vitamins, antioxidants, and bioactive compounds, which can help in better outcomes in COVID-19 positive patients.

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## 1. Introduction

In 2003, many cases of Severe Acute Respiratory syndrome-coronavirus (SARS-CoV) was diagnosed with acute atypical pneumonia and diffuse alveolar damage (DAD) representing a nearly 10% mortality rate.<sup>1</sup> Then in 2012, a new human coronavirus, Middle East respiratory syndrome-coronavirus (MERS-CoV), was represented 34% case fatality rate in humans.<sup>2</sup>

More recent strain of human coronavirus, SARS-CoV-2 (also known as 2019-nCoV), has caught the world's attention with its rapid global spread, March 11, 2020, World Health Organization declared Corona virus Disease (COVID-19) a pandemic. The latest figures of active cases on 18th november 2020, were 89,12,907, the death toll was 1,30,993, According to the health ministry, 4,46,805 cases were still active, while 83,35,109 people have been cured or

discharged.

Pathogenic Mechanism of Coronavirus-Induced Cell Damage.

The mortality rate associated with COVID-19 is attributed to Acute atypical pneumonia, diffuse alveolar damage leading to deposition of fibrous tissue, denudation of airways, severe haemorrhage, and elevated macrophage infiltration. This may be accompanied by watery diarrhoea, dehydration, and vomiting.<sup>3-5</sup> With COVID-19 wide range of signs and symptoms associated, with no approved vaccination till date. Further research has proved that late-term disease progression is unrelated to viremia and more associated with the immunopathological mechanism.<sup>6,7</sup> Viral clearance then subsequent recovery requires activation of effective host immune response. Inflammatory and immune response signaling, and the presence of oxidative compounds, such as reactive oxygen species (ROS), plays major roles in the pathogenic mechanism of cell damage by

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CoVs through oxidative stress.<sup>8</sup>

Oxidative stress is important phenomenon, defined as interruption or deregulation of the signaling and redox system that can be caused by imbalance in the production of oxidant and antioxidant species.<sup>9</sup> In COVID-19 during pathological events, there may be an increase in the production of oxidant species not neutralized by the antioxidant system, hence oxidative stress increases, which promotes cellular damage via protein denaturation, later leads to changes in the functions of nucleic acids, lipid peroxidation, and ultimately cell death.<sup>10–12</sup> Oxidative stress also promote viral pathogenesis through stimulating inflammation, increased viral replication and loss of immune function. In severe cases with co-morbidities this is followed by increase in reactive oxygen species and cytokine release, which leads to lung injury.<sup>13</sup> many studies have proved that RNA viruses make changes in antioxidant defense system, so affects enzymes like superoxide dismutase (SOD), catalase (CAT), reduces levels of antioxidant molecules such as carotenoids, ascorbic acid, and glutathione (GSH).<sup>14–16</sup> So dietary interventions should be such that to include these compounds more in the diet.

### 1.1. Research about some important compounds for COVID-19

Vitamin D is formed by interaction of UVB radiation coming in contact with skin's 7-dehydrocholesterol followed by a thermal reaction. The oral vitamin D or vitamin D<sub>3</sub> turns into 25(OH)D in the liver and then into 1,25(OH)<sub>2</sub>D (calcitriol) hormonal metabolite. Vitamin D improves cellular innate immunity in part by inducing 1,25-dihydroxyvitamin D into antimicrobial peptides, like human cathelicidin, LL-37, and defensins.<sup>10</sup>

Vitamin D may play an important role in decreasing the development of pro-inflammatory Th1 cytokines, also known as tumor necrosis factor  $\alpha$  and interferon  $\gamma$ . Vitamin D administration also decreases the production of pro-inflammatory cytokines and increase the production of anti-inflammatory cytokines also plays an important role in improving the production of anti-oxidation-related genes like glutathione reductase. The increased production of glutathione spares the use of ascorbic acid (vitamin C), which also has antimicrobial properties, and has been suggested for COVID-19 prevention and treatment.<sup>12</sup>

Vitamin C aids the body as a pro-oxidant for immune cells, antioxidant for lung epithelial cells, and immunosuppressive effects. Vitamin E functions primarily as an un-specific, chain-breaking antioxidant that bans the spread of lipid peroxidation. Vitamin E is a radical peroxy scavenger which protects the polyunsaturated fats in lipoproteins and plasma membranes.<sup>17</sup>

### 1.2. Antioxidants

Glutathione is one of the most powerful antioxidant which scavenges damaging free radicals also involved in tissue repair and builds proteins responsible for immune system. N-Acetylcysteine, promotes the production of glutathione many Studies in animal models of other viral infections have shown that NAC increased cellular defence and repair hence reduced the severity and duration of symptoms.<sup>18</sup>

Quercetin is another bioflavonoid, In Animal and laboratory studies proved it can inhibit a wide range of virus infections like coronavirus SARS CoV. Quercetin promote antioxidant capacity and protects lung tissue. Based on these studies, compounds that have antioxidant actions can be helpful in the treatment of infections promoted by coronavirus.<sup>19</sup> Zinc has inhibitory effect on previous corona viruses by inhibiting RNA polymerase activity. Zinc ionophores have been shown to block the replication of SARS-CoV and other viruses. Research shows that quercetin and epigallocatechin-gallate also have zinc ionophore activity.<sup>10</sup> Studies have shown that turmeric (curcumin), nuts, and propolis can improve the immune system. Some essential oils have like Cinnamomum zeylanicum leaf oil (cinnamon), Citrus bergamia (bergamot), Cymbopogon flexuosus (lemongrass) and Thymus vulgaris (Red Thyme) have shown anti influenza activity. Both quercetin and resveratrol have the ability to inhibit mTOR and decrease airway inflammation, which is important with this novel virus. Studies have shown that turmeric (curcumin), nuts, and propolis can improve the immune system. Some essential oils have been shown to exhibit anti-influenza activities. These include Cinnamomum zeylanicum leaf oil (cinnamon), Citrus bergamia (bergamot), Cymbopogon flexuosus (lemongrass) and Thymus vulgaris (Red Thyme).<sup>11</sup>

Berberine (BBR) is a natural isoquinoline alkaloid with low toxicity. It is present in several medicinal plants, such as Berberis vulgaris, Coptis chinensis, Hydrastis canadensis, Xanthoriza simplicissima, Coptidis rhizoma, Phellodendron amurense, and Chelidonium majus. Berberine exhibits biochemical and pharmacological activities, with potent antiviral properties. In recent years, many scientific reports have reported immunostimulating and anti-inflammatory activity and Recent research suggests that BBR and its derivatives are active plant biomolecules that can be applied successfully for antiviral pharmacological strategies, possibly and hopefully also against SARS-CoV-2, which is currently a major problem worldwide.<sup>20,21</sup>

## 2. HERBS

Ayurveda, Chinese traditional medicine and naturopathy promote use of many herbs in treatment of COVID-19.

Some of the promising immunity-boosting herbs are garlic, black cumin, ginger, and liquorice. Fumigation of homes, by Ayurvedic herbs such as garlic (*Allium sativum*) peel, turmeric (*Curcuma longa*) powder, Carom (*Trachyspermum ammi*) seeds is used for disinfection<sup>18</sup>. Studies have proved that Garlic stimulates NK cells, macrophages, lymphocytes and eosinophils, by modulation of cytokine secretion, immunoglobulin synthesis, phagocytosis and macrophage activation.<sup>9</sup> Glycyrrhiza radix (Liquorice) was found to Inhibit SARS-CoV-1 and increase cytotoxicity. Zingiber officinalis (Ginger) has Anti-avian influenza virus H9N2 activity in both chick embryos and cell models.<sup>10</sup> Eucalyptus polybractea (Eucalyptus) can Inhibit avian influenza virus H1N9 in aerosol and vapor form.<sup>5</sup> Ginger and Garlic inactivate avian influenza virus (H9N2) activity in both MDCK cells and chick embryos.<sup>13,22</sup>

Tulsi has anti-inflammatory effects, increases the anti-oxidant activity and protects the cells and its membrane from being damaged by the toxic substances.<sup>23</sup> Flavonoids present in green tea have been shown to inhibit the viral enzyme, 3CL protease, and to inhibit previous SAR-CoV activity in cells. Further a diet rich in brightly colored fruits and vegetables is presented as a strong consideration for patients with COVID-19 due to carotenoids antioxidant properties.<sup>10</sup> Mushroom have been found to have multiple powerful antiviral actions against several viruses that cause influenza and other infections.<sup>11</sup>

For COVID-19 these herbs have shown encouraging results like Harsingar (*Nyctanthes arbor-tristis*), giloy (*Tinospora cordifolia*), neem (*Azadirachta indica*), aloe vera (*Aloe barbadensis miller*), cannabis (*Cannabis sativa*), turmeric (*Curcuma longa*), ginger (*Zingiber officinale*), ashwagandha (*Withania somnifera*), red onion (*Allium cepa*), tulsi (*Ocimum sanctum*), and black pepper (*Piper nigrum*). The pharmacological importance and immunologic actions of these plants are well documented in the literature.<sup>24</sup>

A recent study suggests that the COVID-19 protease (6LU7) can be inhibited by the extracts of Indian herbal plants. Based on the binding affinity, the inhibition potential of these plants can be ranked as; harsingar > aloe vera > giloy > turmeric > neem > ashwagandha > red onion > tulsi > cannabis > black pepper. The highest inhibition potentials are obtained for the extracts of Harsingar and Alovera. The complete study can be accessed at (<https://arxiv.org/ftp/arxiv/papers/2004/2004.03411.pdf>)

### 2.1. Healthy gut microbiota

Healthy gut microbiota is essential to reduce inflammation and improve the immune system's function. Nutritional strategies should be adopted, especially now, during COVID-19 which maintains the healthy environment for gut bacteria and including both probiotic and prebiotic in the diet. A high fiber plant-based diet should be recommended, given their favorable effect on the microbiome and gut transit time that may improve constipation.<sup>10–12,17,18,25</sup>

## 3. Lifestyle

Stress and anxiety may alters the immune system responses within the body. In today's time extra information might cause distress so studies have shown that limiting screen time may have positive effects on immunity and disease outcome. Sleep, both duration and ideal cycle, gives the body an opportunity to heal and rest, in critical illnesses (Kamdar, Needham, & Collop, 2012). Exercising helps blood circulation, raise the levels of antibodies, better immune response by increasing white blood cells to fight off infections. Exercise can help with the prevention of blood clots, a symptom for COVID-19 patients.<sup>6</sup>

### 3.1. General Recommendations

Dietary Approaches for Asymptomatic or Mild Symptomatic home Quarantined Patients

When the body becomes inflamed, it triggers an abnormal immune response that instead of just attacking the virus, affects the rest of the body's healthy cells and tissue, and may lead in hyperglycemia. So include the right kind of carbohydrate in your diet, prefer food with low glycemic index food like Quinoa, Steel-cut oatmeal or Oat Grouts, Vegetables, whole Fruits, Beans, Lentils, whole Grains like millets are an excellent option. It will be best to check portion of wheat and white rice.

Include Starchy vegetables in moderation like Potatoes, Sweet Potato, Corn, green peas and other root vegetables like radish, turnips etc. Green vegetables have varied health benefits, So its advised to increase the intake of cabbage, cauliflower, broccoli, carrots, greens, peppers, Drumsticks, Eggplant, Mushroom, beans and tomatoes.

Try to avoid processed foods, like Sugar, White pasta, White bread, Cookies, Pastries; ready to eat Breakfast cereals, bakery products like Pastries and sweets, Fruit juices, Soft drinks.

Its advisable to include healthy protein in your diet like quinoa, seeds, nut, peanuts, Pulses, dried beans, chickpea, split peas, lean meat, chicken, eggs is advised. If you are unable to digest animal protein you can shift to plant based proteins. Dairy can be included if acceptance of the patient is good.

Fats: heart-healthy fats are advised, like canola, olive oil, flaxseed oil, sesame oil, nuts and seeds, fatty fish such as

salmon, tuna, and mackerel. Use oils when cooking food instead of butter, cream, Ghee, or margarine.

### 3.2. Fruits and Vegetable Intake

Veggitables are loaded with nutrients, like high levels of vitamin, C, B, K, folate, iron, potassium, Zinc, calcium, beta-carotene, antioxidants etc. They have unique properties that boost the immune system. Consume your daily share cruciferous and leafy vegetables which could stimulate a gene that boosts immunity. Include red and orange colored vegetable for Vitamin A content, which helps to regulate the immune system. For Vitamin C kale, broccoli, eggplant, bell peppers, beetroots, spinach, cauliflower, Cabbage, Lemon, oranges and bell peppers in your diet. Fruits like oranges, papaya, kiwi, and guava are rich in vitamin C and should be included in diet.

Berries can also be included in the diet. Elderly people should consume Spirulina and Curcumin, as they are extremely rich in vitamin C and minerals.<sup>26</sup>

Quercetin's as discussed, Major sources are leafy green vegetables, dill, peppers, apples, grapes, fennel leaf, red onion, oregano, chili pepper, green tea, and black tea.<sup>27</sup>

### 3.3. Have Nuts and Nuts and seeds

Beans and legumes contain zinc and Vitamin E. Hazel nuts, almonds, peanut butter, sunflower seeds, and Flax seeds should be consumed to get the daily dose of vitamin E. foods rich in omega-3 fatty acids are beans, flax seeds, nuts so they are extremely important for immune functioning.<sup>26-29</sup>

Include Guduchi, Amla, Haridra (Gargling with warm water added with turmeric powder (Curcuma longa) and a pinch of salt or Turmeric (Curcuma longa), Frequent sippilng of Tulsi water, Ashwagandha root powder 3-5gm twice a day with warm water in daily diet. Its advisable to apply Nasal application of sesame oil / coconut oil or Ghee in both the nostrils. Spices like Cumin, Turmeric, Coriander) and Garlic are recommended in cooking preparations for their immune boosting properties. Herbal teas / decoction (Kadha) made from Tulsi, Moringa, Ginger, Dalchini (Cinnamon), Kalimirch (Black pepper), and Munakka (Raisin) is advised if there is Cough or congesion.<sup>30</sup>

Water intake is important for maintaining the hydration levels of the body so, Fluid intake is advised based on weight,

For an average 40kg-60kg person advised intake is 1.5L-2.0L, for 60-80kg 2.0L-2.5L, above 80kg 2.5L-3.0L or 30-35mL/kg is advised with allowances for extra losses.

Being physically active is extremely important with taking proper sleep and staying away from digital medias. Try to follow meditation and pranayams for physical and mental well being

### 3.4. Some recommended remedies

#### 3.4.1. Anorexia and weight loss

Eat preferred nutritious meals or snacks. Increase intake of fruits and vegetables. Try to take small quantity of easily digestible semi liquid preparation. Vitamins and mineral supplements may improve on appetite and food. Try to include optimum protein and healthy fat in diet. recommended protein intake is Protein 1.2-1.7gms/kg/day with energy recommendations of 30-35cal /Kg/day

#### 3.4.2. Fatigue

Try to Include protein at every meal to sustain energy released from food. Try to avoid processed, simple carbohydrate meals specially sweets and sugary food. Maintaining hydration and Eating small frequent meals might be of help. Vitamin and Micronutrient supplement may be considered for patients with inadequate food intake.

### 3.5. Pulmonary congestion and excessive sputum production:

Try to Increase intake of Fruits and Vegetables including citrus fruits and green leafy vegetables, Increase intake of warm drinks including clear broth soups, meaning soups without cream or dairy, and warm decaffeinated tea. Spices like Kali mirch, Jeera (cumin), Haldi (Turmeric), Lehsun (Garlic) and Dhaniya (Coriander) are useful in cooking preparations for antioxidant activity. Herbal teas (Kadha) made from Ginger, Tulsi (Basil), Dalchini (Cinnamon), Kalimirch (Black pepper) is advised in Cough. Its important to avoid Some any food allergens like eggs, fish, milk, nuts, peanuts, shellfish, wheat, soy. Foods with histamine can increase allergic reaction so avoid processed meats like hot dogs and bacon, vinegar, cheese, yogurt, sour cream, buttermilk, smoked fish, sardines, alcoholic beverages. In sore throat or dry cough or steam inhalation with Tulsi, fresh Mint leaves or Ajwain (Caraway seeds) can be practiced. Eucalyptus oil can be used for steam inhalation.

Recently Even the WHO experts and colleagues from other organizations endorsed a protocol for clinical trials phase III of herbal medicine for COVID-19 and for the establishment of a data and safety monitoring board for herbal medicine clinical trials. So definitely Future aspects for more research is needed for Diet and herb's role in immunity building role and in patient outcome in COVID-19 infection. More research is needed to know about the role of food in COVID-19 prevention and Immunity-boosting food combinations should be studied.

## 4. Conflicts of Interest

All contributing authors declare no conflicts of interest.

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None.

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