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Foods as Nutraceuticals with Special Reference to COVID-19 Recovery: A Review

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Abstract

The COVID-19 pandemic has heightened global interest in foods as nutraceuticals, particularly their function in immunity, inflammation control, and recovery from infection. Nutraceuticals are bioactive compounds derived from food, such as vitamins, minerals, polyphenols, probiotics, omega-3 fatty acids, dairy-derived proteins, and traditional botanicals, that offer physiological benefits beyond basic nutrition. This review synthesizes research from the past decade on foods with nutraceutical potential, their mechanisms of action, and their relevance in supporting recovery from COVID-19. We highlight micronutrients (vitamin D, vitamin C, zinc), polyphenols (curcumin, quercetin), omega-3 fatty acids, probiotics, lactoferrin, and botanicals like Nigella sativa and honey. The collective evidence suggests that foods rich in nutraceuticals may improve immune resilience, lessen inflammatory burden, and hasten recovery when incorporated into balanced diets. Although several clinical trials show promising results, most have been small-scale, and large randomized controlled trials are still needed to confirm their efficacy. Nevertheless, dietary strategies based on nutraceuticals offer a safe, supplementary, and sustainable approach to COVID-19 recovery.

Keywords: Nutraceuticals, Functional Foods, COVID-19 Recovery, Immunomodulation, Polyphenols, Probiotics, Vitamin D, Omega-3 Fatty Acids, Curcumin, Quercetin

Introduction

The term “nutraceuticals” was first coined to describe natural, bioactive compounds found in foods that provide health benefits beyond basic caloric or nutrient intake [1]. Over the last decade, nutraceuticals have been extensively studied for their roles in preventing chronic diseases, supporting immunity, and improving quality of life. The COVID-19 pandemic renewed interest in these compounds, as nutritional strategies were explored for their potential to reduce infection severity, support immune defenses, and enhance recovery [2].

COVID-19, caused by the SARS-CoV-2 virus, has a range of manifestations, from asymptomatic infection to severe pneumonia, acute respiratory distress syndrome, and long-term complications known as “long COVID.” While vaccines and antiviral drugs are central to disease management, nutrition is recognized as a crucial factor in a person's susceptibility, disease progression, and recovery outcomes [3]. Diets rich in bioactive compounds may offer supportive benefits by modulating immune function, reducing oxidative stress, and promoting tissue repair during recovery. This review examines key categories of foods that act as nutraceuticals, their mechanisms, and the clinical evidence supporting their roles in COVID-19 recovery.

Vitamins and Minerals as Nutraceuticals

Vitamin D

Vitamin D is widely known for its role in calcium balance, but its immune-modulating properties have become equally important in infectious disease research. Vitamin D receptors are found on T-cells, B-cells, and antigen-presenting cells, allowing the vitamin to regulate both innate and adaptive immune responses [4]. Deficiency is linked to a higher susceptibility to respiratory tract infections [5].

Foods high in vitamin D include fatty fish, fortified dairy products, and egg yolks. Observational studies during the COVID-19 pandemic showed a correlation between low vitamin D levels and a greater risk of severe infection [6]. A pilot randomized trial found that calcifediol supplementation reduced ICU admissions in hospitalized COVID-19 patients [7]. Mechanistically, vitamin D modulates the renin–angiotensin system and decreases pro-inflammatory cytokines such as IL-6, which are elevated in severe cases of COVID-19.

Vitamin C

Vitamin C is a powerful antioxidant and supports immune defense by enhancing white blood cell function and protecting epithelial barriers [8]. Dietary sources include citrus fruits, guava, berries, and peppers. Previous studies on respiratory infections have shown that adequate vitamin C intake can reduce the duration and severity of colds [9].

In the context of COVID-19, intravenous vitamin C was evaluated in several clinical trials, though results were mixed. A large outpatient trial found no significant improvement in symptom duration with high-dose vitamin C alone [10]. Despite inconsistent outcomes, maintaining adequate intake from fruits and vegetables is still recommended for individuals recovering from the illness.

Zinc

Zinc is essential for antiviral immunity, as it stabilizes cellular membranes, inhibits viral RNA polymerase activity, and regulates cytokine production [11]. Rich dietary sources include legumes, nuts, seeds, and meat. Meta-analyses conducted before the pandemic found that zinc supplementation reduced the duration of common cold symptoms [12].

Clinical studies on COVID-19 suggest that zinc supplementation might improve outcomes when used with standard therapy, although high-dose zinc on its own showed limited effectiveness [10]. However, correcting a zinc deficiency remains crucial during recovery.

Polyphenols as Immunomodulators

Curcumin

Curcumin, the yellow compound in turmeric (Curcuma longa), has long been recognized for its anti-inflammatory and antioxidant properties. It inhibits NF-κB activation, reduces cytokine release, and boosts antioxidant enzyme expression [13]. Piperine from black pepper enhances curcumin's bioavailability, making dietary combinations particularly effective.

Small clinical trials reported that curcumin-piperine supplementation as an addition to standard care in COVID-19 patients led to faster symptom resolution and reduced inflammatory markers

[14]. Beyond COVID-19, curcumin has shown effectiveness in inflammatory diseases, providing a solid basis for its therapeutic role.

Quercetin

Quercetin, a flavonoid found in abundance in apples, onions, and capers, has antiviral, antioxidant, and immunomodulatory properties [15]. It can interfere with viral entry and replication pathways and modulate inflammatory signals.

Pilot clinical trials in COVID-19 outpatients found that quercetin supplementation, especially in specific formulations, was linked to faster viral clearance and improved recovery markers [16]. While the data is preliminary, quercetin-rich foods represent a safe dietary strategy to support immune recovery.

Omega-3 Fatty Acids

Omega-3 polyunsaturated fatty acids (PUFAs), primarily eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), are found in fatty fish, flaxseed, and walnuts. They act as precursors for specialized pro-resolving mediators (SPMs), which help to resolve inflammation [17].

Chronic inflammation is a characteristic of severe COVID-19, and omega-3 PUFAs may help to mitigate cytokine storms by promoting pro-resolving pathways. Observational studies suggest that higher omega-3 status correlates with reduced severity of respiratory distress [18]. Therefore, including fatty fish and plant-based sources of omega-3s in recovery diets may aid convalescence.

Probiotics and Fermented Foods

The gut-lung axis highlights the connection between intestinal microbiota and respiratory immunity. A decrease in beneficial Lactobacillus and Bifidobacterium species has been observed in COVID-19 patients [19].

Fermented foods like yogurt, kefir, sauerkraut, and kimchi naturally contain live cultures that can help restore a healthy microbiota balance. Randomized clinical trials using specific probiotic formulations have shown reduced symptom burden and faster viral clearance in COVID-19 outpatients [20]. However, effects are strain-specific, highlighting the need for careful selection of probiotic products.

Dairy Bioactives: Lactoferrin

Lactoferrin is an iron-binding glycoprotein found in milk and colostrum. It has broad antiviral, antibacterial, and immunomodulatory activities [21]. Lactoferrin may block viral entry by binding to heparan sulfate proteoglycans and modulate cytokine responses.

Experimental studies have shown lactoferrin's inhibitory activity against coronaviruses, and early clinical evaluations suggested a possible benefit in COVID-19 [22]. Although subsequent trials provided mixed results, consuming dairy products remains valuable for recovery due to their protein and micronutrient content.

Botanicals and Functional Foods

Honey

Honey has antimicrobial, antioxidant, and anti-inflammatory properties. It soothes mucosal linings, reduces cough frequency, and enhances innate immune defense [23]. Clinical studies before the pandemic showed honey's benefits in upper respiratory infections [24]. In COVID-19, honey has been suggested as a supplementary dietary agent to ease throat irritation and support recovery.

Nigella Sativa (Black Seed)

Nigella sativa, commonly known as black seed, contains thymoquinone, which has antioxidant, anti-inflammatory, and immunomodulatory effects [25]. Traditionally, it has been used to treat respiratory conditions, and experimental studies have shown its antiviral properties. Clinical trials combining Nigella sativa with honey suggested faster symptom resolution in COVID-19 patients [26].

Discussion

The combined evidence highlights the importance of foods with nutraceutical potential in supporting COVID-19 recovery. While many studies are preliminary, certain compounds like vitamin D, probiotics, curcumin, and quercetin show promising results in clinical trials. However, most findings require confirmation through large-scale, double-blind, placebo-controlled studies.

From a dietary perspective, a whole-food approach remains the safest strategy. Diets rich in fruits, vegetables, legumes, fermented foods, fish, and dairy naturally provide bioactive compounds that may help with immune resilience and recovery. Such dietary patterns, particularly the Mediterranean diet, have been consistently linked with reduced inflammation and better outcomes in chronic diseases, making them a sensible foundation for a recovery diet.

Conclusion

Foods as nutraceuticals represent a promising supplemental approach to COVID-19 recovery. By providing immune-supporting vitamins and minerals, anti-inflammatory polyphenols, microbiota-modulating probiotics, and traditional functional foods, nutraceuticals may shorten the duration of recovery, reduce symptom severity, and support overall well-being. While supplementation can be considered for individuals with deficiencies, the main focus should be on dietary diversity and food-based strategies. Future research must concentrate on long-term outcomes, optimal dosages, and the role of nutraceutical-rich diets in preventing post-COVID complications.

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