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Micronutrients in halal foods associated with improvement of the immune system against coronavirus

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Abstract

Background and objective: The novel coronavirus (COVID-19) pandemic has threated the health and economy across the world. In the absence of efficient medication for the virus, healthy diet can alleviate its symptoms. There are nutrients that may have beneficial effects against coronavirus. At this review, we discuss about the immune system modulation induced by some nutrients found in halal foods that may be effective to attenuate the viral infections such as COVID-19.

Results and conclusion: The origin of COVID-19 (meat of bat eaten by Chinese) approves that recommendations of Islam on Halal foods, which emphasizes the health and hygiene, should be addressed throughout the world. Several studies revealed that diet could affect the immune system. Some nutrients are anti-inflammatory and change the tight junctions in tissues. The antiviral food components may be useful in alleviation of COVID-19 infection. Therefore, keeping the micronutrients' balance might enhance the host response against viral infections. There is a global consensus that nutritional deficiency should be treated to reduce infections and a healthy halal diet consisting of special components like α-Lipoic acid, phytoestrogens, flavonoids, licorice root and black tea may be useful for improving the immune responses.

Keywords: Coronavirus, COVID-19, halal, health, immune system, nutritional interventions

1. Introduction

The concept of halal is considered as a kind of monitoring system for Muslims. In the current critical situation that high population of the world has been infected by zoonotic coronavirus, focusing on halal concept is helpful to bear the pandemic. In this regard, use of nutrients and nutraceuticals from halal sources would improve the immune system and health. The World Health Organization (WHO) announced the COVID-19 as a pandemic in March 2020 due to its widespread outbreak [1]. It killed thousands of people in China and the disease has quickly spread in China and other countries by human [2]. WHO reported the global rate of mortality by COVID-19 virus as 2.7% on 25 October 2020 [1]. Coronaviruses (CoVs) belong to subfamily of Orthocoronavirinae in family of Coronaviridae and order of Nidovirales. The subfamily includes α-coronavirus, β-coronavirus, γ-coronavirus, and

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δ-coronavirus [3]. Coronaviruses primarily caused enzootic infections in birds and mammals but they have infected the humans in the last decades [4].

In the last 20 years, two coronavirus pandemics have occurred as of SARS-CoV evolved and spread in China and transferred to several countries, which led to approximately 8000 cases of infection and 800 deaths. In addition, MERS-CoV began in Saudi Arabia that led to about 2500 cases of infection and 800 deaths and it currently causes infection worldwide [5]. With regard to COVID-19 infection, there has been 50,266,033 infected cases and more than 1,254,567 deaths across the globe up to November 2020 [1]. As the number of infected patients is increasing dramatically every day, development of potential inhibitors against COVID-19 is necessary. There are various foods rich for bioactive compounds, of which some sources are halal and some others are inhibited for Muslims. Due to the adverse impact of non-halal foods on human which approved by several studies, all people should be educated about eating of halal foods that are free of not-allowed components for Muslims [6,7]. As observed, the COVID-19 originated from bats that is not halal meat in Islam [8-10]. Therefore, other than supply of energy and providing the body requirement, food may be identified as source of diseases and deaths [11]. This review aimed to point out the nutrients found in halal foods that positively affect the immune system against viral infections within their recommended range.

2. Foods and their ingredients improving the body health and immune system

Several research majorly focuses on medicinal management of coronavirus diseases and little is known about their nutritional support. Nutritional intervention may recover the patients and attenuate their symptoms [12]. For instance, the Chinese scientists reported that nutritional support is a basic treatment and a part of multi-disciplinary management of symptomatic SARS-CoV-2 affected patients [13]. As mentioned, adequate intake of micronutrients enhance the host response and might protect body against viral infections. Nutritional deficiency is associated with weak immune responses particularly cell-mediated immunity, phagocyte function, cytokine production, secretory antibody response, antibody affinity, and the complement system [14,15]. Nutritional intervention may be effective in both primary and secondary prevention of infections at high-risk patients [16]. Therefore, a complete diet can provide the essential micronutrients and supplementation can be helpful if needed. Several studies have been done to find out the impact of food components in this regard [17-19] (Tables 1 and 2).

In the study of Lesourd, effect of protein and energy deficiency on immune response was monitored in undernourished adult patients. The treatment group received a complete supplement containing both macronutrients and micronutrients (trace elements). After tetanus vaccination, antibody responses were faster in those received nutritional supplement than control, which confirmed the positive impact of nourishing on adults [20]. In another study, some immunologic indexes were improved after ingestion of yogurt through a low calorie diet (1500 kcal/d) that showed the importance of calcium [18].

Zinc is one of micronutrients suggested for reduction of coronavirus intensity and may affect the respiratory tract infection due to its antiviral properties. Zinc supplementation by rhinovirus infected patients or those infected by “common cold” viruses including influenza showed promising antiviral effects with reduced burden of disease [21,22]. Importantly, amount of ionic zinc at oral and nasal mucosa (site of infection) positively correlated with its protective effect [21,23]. COVID-19 takes a similar route to enter the body and adequate concentration of zinc in the site may reduce the intensity of infection. Although, it surely needs further clinical trials [24]. Oyster is rich of zinc but it is not halal.

Therefore, Muslims can consume red and poultry meat as source of zinc, instead. The other sources are included to beans, nuts, whole grains, fortified breakfast cereals, and dairy products [25].

Vitamin D reduces the risk of getting common cold [26]. It also enhances cellular immunity [27], modulates adaptive immunity [28], and increases expression of antioxidant-related genes [29]. Several authors proposed vitamin D supplementation for prevention and treatment of COVID-19 [30-32]. Annweiler et al. in a quasi-experimental study found that vitamin D_3 supplementation during or just before COVID-19 infection was associated with less severe COVID-19 and higher survival rate in adult patients [33]. Fatty fishes such as trout, salmon, tuna, and mackerel, and fishes' liver oil are of best sources of vitamin D. Beef liver, cheese, and egg yolks have small amounts of vitamin D, primarily in the form of vitamin D_3 and its metabolite of $25(OH)D_3$. Mushrooms provide variable amounts of vitamin D_2 [34].

Clinical evidences confirm the powerful antiviral activity of vitamin C when used in sufficient quantity [35]. Severe oxidative stress due to rapid release of free radicals and cytokines is a marker of acute respiratory distress syndrome, which leads to cellular injury, organ failure and death. Thus, early intake of adequate antioxidants such as vitamin C may become an effective treatment for these patients. Although conflicting information has been published about effectiveness of vitamin C, majority of studies suggest that low serum level of vitamin C is a risk factor for worsening the disease and use of dietary sources such as fruit, fresh herbs and vegetables can play a preventive role [36-38].

Table 1- Recommended dietary allowance of the effective micronutrients in promotion of antioxidant supply and immune response in human body [39]

Period of life	**Zinc (mg/day)**		**Vitamin D (IU/day)**		**Vitamin C (mg/day)**	
	Male	Female	Male	Female	Male	Female
0-6 months	2	2	400	400	40	40
6-12 months	3	3	400	400	50	50
1-3 years	3	3	600	600	15	15
4-8 years	5	5	600	600	25	25
9-13 years	8	8	600	600	45	45
14-18 years	11	9	600	600	75	65
19 ≤ years	11	8	600 70 < years: 800	600	90	75
Pregnancy						
14-18 years		12	600	600		80
19≤ years		11	600	600		85
Lactation						
14-18 years		13	600	600		115
19≤ years		12	600	600		120

α-Lipoic acid (ALA), a naturally occurring disulfide compound, acts as a cellular coenzyme and has been used for treatment of polyneuropathies and hepatic disorders for years [40]. It plays a pivotal role in scavenging the free radicals to protect body against oxidative damage. In addition, ALA is able to enhance intracellular glutathione level [41]. Oxidative stress and glucose-6-phosphate dehydrogenase (G6PD) deficiency in host cells are important factors in infectivity of human coronavirus 229E. Addition of ALA to G6PD-knockdown cells could attenuate the susceptibility to human coronavirus 229E infection [42]. Interestingly, Baur et al. found that ALA inhibited the replication of HIV-1 [43]. As a result, ALA is a good candidate in

treatment of COVID-19. Its dietary sources are red meat, liver, kidney, spinach, broccoli, and tomato.

Nicotianamine is a metal ligand in plants such as soybean [44], which has angiotensin-converting-enzyme-2 inhibiting effect [45]. It also is a potential candidate effective against COVID-19 infection [46].

Flavonoids are important class of natural components and have several subgroups including chalcones, flavones, flavonols, and isoflavones [47]. Jo et al. suggested that anti-coronavirus activity of some flavonoids (Herbacetin, rhoifolin, and pectolinarin) is due to inhibition of 3C-like protease (3CLpro). Herbacetin, iso-bavachalcone, quercetin 3-β-d-glucoside, and helichrysetin are able to block enzymatic activity of MERS-CoV/3CLpro [48-51].

Usually, females show more robust immune responses than males against viral infections [52]. With regard, resveratrol, a phytoestrogen found in grape seeds, is a potent anti-MERS agent *in vitro* [53]. Therefore, 17β-Estradiol or phytoestrogen might be effective in treatment of COVID-19 [54].

Two important bioactive compounds in licorice root (Glycyrrhiza radix) are triterpene glycoside glycyrrhizic acid (glycyrrhizin, GL) and its aglycone (18α-glycyrrhetinic acid, GLA) [55]. Both compounds have anti-tumoral, anti-inflammatory, and antiviral properties [56]. GL was one of the first compounds found to be active against SARS-coronavirus (SARS-CoV) *in vitro* [57], and also used for treatment of SARS-infected patients [58].

Intake of "black tea" can improve the body strength to fight against coronavirus at early stages of infection [59]. Theaflavin 3,3'-O-digallate and theaflavin 3-O-gallate are two active compounds in black tea. Theaflavin and its derivatives can play a significant role in treatment of coronavirus infection [60-62].

Table 2- Food components for promotion of body health against coronavirus

Component	Mode of action	Food source	Reference
Zinc	Improving tight junctions	Red meat, poultry	[21-24]
Vitamin D	Immunomodulation	Egg yolk, supplementation	[26-28], [33]
Vitamin C	Antioxidant	Citrus fruits	[36-38]
α-Lipoic acid	Enhance intracellular glutathione	Red meat, organ meats like liver and kidney	[40-42]
Nicotianamine	Angiotensin-converting-enzyme-2 inhibiting effect	Soybean	[45,46]
Flavonoids	Inhibition of 3C-like protease	Fruits and vegetables,	[48-51]
Phytoestrogen	Potent anti-MERS agent	Soybean and flaxseed	[53,54]
Glycyrrhizin	Anti-inflammatory	Licorice root	[56-58]
Theaflavin	Inhibit the activity of SARS-CoV-2 3CL-Protease	Black tea	[60-62]

3. Incidence and spread of COVID-19 in view of halal

Some animal-based foods have been associated with the novel coronavirus pandemic, which none of them is considered as halal by Islam. Pangolin, mink and bat are of concern in this regard [63-66]. This global catastrophe, which has killed thousands of people, is a strong alarm for human to pay more attention to their edible sources. Further research is required to strongly illustrate the curing role of halal foods in viral infections.

4. Conclusion

At this study, we focused on beneficial impacts of halal-based foods and relevant evidences regarding promotion of heath in viral-infected patients. The current coronavirus (COVID-19)

pandemic is a sign careless in selection of halal food sources. Halal nutrition refers to intake of essential nutrients from halal sources, which helps the normal function of human body. Development of efficient vaccines and antiviral medicines is time-consuming. Therefore, intake of natural bioactive compounds can mitigate acute respiratory distress syndrome associated with coronavirus by different mechanisms. Obviously, clinical studies are needed to approve their significant impact in practice.

5. Conflict of interest

The authors declare no conflict of interests.

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