Review article

Effect of food and key micronutrients on Covid-19: A review

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ABSTRACT

Humanity has faced different pandemics in history. The Covid-19 pandemic has made a new course in the world caused by SARS-CoV-2 that can be transmitted to humans. Finding alternative methods to prevent and control the disease through food and some micronutrients is important. This review summarizes the effect of food and key micronutrients on Covid-19. There are currently no reports of the feasibility of transmission through the food sector. However, malnutrition and deficiency of some nutrients can lead to disorders of the immune system. Coronavirus may be transferred through raw and uncooked foods; more safety and preventive measures are needed. Furthermore, sufficient intake of omega-3 fatty acids, minerals and vitamins is required for proper immune system function. Therefore, a healthy diet is required for prevent Covid-19. Personal hygiene and employee awareness is the two most important features in the prevention of Covid-19. Further studies are needed to confirm these results.

1. Introduction

In 2019 Wuhan, a central city in China, emergence of a new coronavirus (2019-nCoV) was reported (Chen et al., 2020). It was presented that presumably bats are the source of several emerging viruses. These viruses (CoVs) severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS), porcine epidemic diarrhea (PED) and severe acute diarrhea syndrome (SADS) might cause serious illness (Banerjee et al., 2019). Historically, enzootic infections in animals (mammals and birds) through coronaviruses (CoVs) were reported. In the last few decades there are reports that CoVs are capable of infecting humans. CoVs can also cause disease humans to different degrees (upper and lower respiratory tract infections and severe respiratory illnesses) (Schoeman and Fielding, 2019). Overall, 2019-nCoV genome has 89% similarity with SARS of bat and 82% with SARS-CoV of human (Chan et al., 2020; Zhang et al., 2020). SARS-CoV-2 is a highly contagious infectious disease caused by a new coronavirus. CoVs can be transmitted from person to person through close contact. Each person infected with the virus can infect an average of about 3 other people (Zhu et al., 2020; Cohen and Normile, 2020; Li et al., 2020; Alimohamadi and Sepandi, 2020). It was reported that in the absence of specific treatment for this new virus, finding other procedures to hamper and control the outbreak of the virus is needed. Eating a balanced and healthy diet that contains all the essential nutrients is necessary for maintaining. Balance in micronutrients is a key factor in maintaining an immune system. The importance of healthy eating in increasing immunity and reducing disease has been known for many years. Several studies reported that a lack of certain nutrients reduces the function of the immune system and thus increases the likelihood of infections. Aim of this paper is to review key food-based micronutrients in Covid-19. Remove word interventions.

2. Food safety

As of April 21, 2020, there is no report that foodstuff is a probable route for the new coronavirus SARS-CoV-2 transmission by the European Food Safety Authority (EFSA) and the United States Food and Drug Administration (FDA) (Rizou et al., 2020). In prior prevalence through MERS and SARS-CoV, food was not a transmission route (EFSA, 2020; FDA, 2020a). It was reported that conditions of the stomach at pH < 3.5, destroyed SARS-CoV (Darnell et al., 2004). Virus outbreak, may cross the barrier of animal species and make humans sick. Therefore, some traditions of eating and cooking may be a risk factor for Re-outbreak of the virus (Lu et al., 2015; Cheng et al., 2007). The German Federal Institute for Risk Assessment (BfR: German: Bundesinstitut für Risikobewertung) reported that coronavirus may be transferred from an infected person to fresh food products or food packaging. Furthermore, the virus can be transferred from frozen food to humans (BfR, 2020). SARS-CoV-2 is highly resistant at 4 °C, and is resistant at ~20 °C for up to 2 years (WHO, 2020).
Actions such as active packaging, good hygienic practices, sanitation, and Control Points (HACCP) are necessary to reduce the risk of Covid-19 disease. However, the food safety execution handling systems including Good other viral respiratory diseases such as MERS-CoV and SARS-CoV. on food packages and surfaces are investigated based on data present for packages and surfaces. The transmission and survival of SARS-CoV-2 via/ on food packages and surfaces. It was reported that SARS-CoV-2 is inactivated (Chin et al., 2020). Therefore, cooking temperatures at >70 °C are sufficient for viral inactivation (BFR, 2020), to be after the sentence on transferring virus from the hands or food. It should be noted, people involved in food preparation should adopt standard hygiene practices include careful touching raw animal products to prevent transmission of contaminate, washing raw foodstuffs before eating, cooking eggs or meat perfectly, and cover the face with a mask when sneezing or coughing (Safefood, 2020). It was reported that Covid-19 survival on plastic and stainless steel up to 3 and 2 days, respectively, at 21–23 °C and 40% relative humidity. The Covid-19 virus was not detected on cardboard and copper, after 24 and 4 h, respectively (Van Doremalen et al., 2020).

To date, there have been no reports of Covid-19 survival on food packages and surfaces. The transmission and survival of SARS-CoV-2 via/on food packages and surfaces are investigated based on data present for other viral respiratory diseases such as MERS-CoV and SARS-CoV. However, the food safety execution handling systems including Good Manufacturing Practices (GMP), and Hazard Analysis and Critical Control Points (HACCP) are necessary to reduce the risk of Covid-19 disease. Actions such as active packaging, good hygienic practices, sanitation, and cleaning are also needed from farm to fork (Olaimat et al., 2020). The FDA (2020b), created instructions for consumers during food preparation, shopping and handling. However, food handlers such as consumers and employees of food establishments should abide by good hygienic and sanitation practices to avoid Covid-19 transmission and observe all provisions of the food safety system (Olaimat et al., 2020). In an online poll, data from 3000 respondents to questions on personal protection and food hygiene were investigated. It was reported that most people adopted the recommended personal protection and hygiene measures to avoid disease by Covid-19. In order to avoid disease by Covid-19 should be continued preventive recommendations and sufficient risk advice. It was reported that some substantial fault can lead to disease by Covid-19, including: ineffective materials for environment or food sanitation and cleaning (28%), not wearing a mask in public places (6%) and improper hand disinfection and washing (10–12%) (de AFF Finger et al., 2021). In a research report, a multi-country survey of 16 countries with the participation of 825 food companies was conducted. It was reported that personal hygiene and employee awareness is the two most important features in the prevention of Covid-19 (Djekic et al., 2021).

To slow down the spreading of the virus during the COVID-19 pandemic, people around the world have to change their behaviors. Hygiene measures and health regulations include social (physical) distancing, self-isolation, and observance with personal hygiene laws, particularly orderly and thorough hand washing. In an online survey (1434 participants) it was found that in the group of direct questioning, 94.5% of the contributors claimed to observance proper hand hygiene laws while in the group of indirect questioning a significantly lower estimate of only 78.1% was observed (Mietth et al., 2021). In a research study, hygiene measures and health regulations of 7,403 university students in ten countries were surveyed. It was reported that compliance related to hygiene (hand washing, coughing behaviours) is uniformly distinct from compliance related to social distancing behaviours. Treating public health compliance as a single concept obscures the dimensionality of compliance behaviours, perhaps resulting in worse prediction of individual compliance behaviour and difficulties in developing effective public health recommendations. Varied sorts of treatments may be required to affect these different behaviours (Wismans et al., 2020).

In addition to food safety practices, people should be made aware of the benefits of a healthy diet with evidence-based nutrients that may prevent viral illness. The remainder of this review will focus on the evidence supporting these nutrients.

3. Vitamin A

Vitamin (Vit) A is an unsaturated nutritional organic compound (Damodaran et al., 2007). It was reported that Vit A has important functions for body growth, preservation of the immune system and vision (Tanumihardjo, 2011). Usually Vit A is a yellow, fat-soluble substance in the form of retinol in foods (Rafeeq et al., 2020; Semba, 1998). The carotenes such as α-carotene, β-carotene, γ-carotene, and xanthophyll, are absorbed when eating vegetarian food (Karabacak and Karabacak, 2019; DeMan et al., 1999). Many of the body's defense mechanisms versus disease depend on providing sufficient amounts of Vit A. Vit A affects various aspects of the immune system, including: creation and mucosal expression, apoptosis, growth, development and function of most white blood cells, immunoglobulin production and cytokine expression (Semba, 1998, 1999). It was reported that Vit A shortage is heavily involved in measles and diarrhea (Rantioche et al., 2002). Vit A and other retinoids can be decreased measles-associated mortality (Trottier et al., 2009). Several studies propose that Vit A decreases illness and fatality in various infectious illnesses, including human immune-deficiency virus (HIV) infection, measles disease, diarrheal and malaria (Villanmor et al., 2002; Semba, 1999). In a research study, effect of calcitriol (synthetic version of Vit D3) and all-trans retinoic acid (derivative of Vit A) in experimental autoimmune encephalomyelitis (EAE), and multiple sclerosis (MS) at the mice was investigated. The expression of ROR-γt and IL-17 genes was significantly reduced and the authors reported that this method could be considered as a novel plan for MS inhibition and therapy (Parastouei et al., 2018). In one study, effect of reduced Vit A content in foods on antibody responses of 40 animal feed calves inactivated with inactivated cow coronavirus (BCoV) vaccine were investigated. It was shown that reduced Vit A content in foods may endanger the efficacy of viral vaccines and calves more exposed to infectious illness (Jee et al., 2013). Vit A food sources include turkey, liver, egg yolks, milk and dairy products, spinach, lettuce, carrots, apricots, cantaloupe, cabbage and pumpkin (Çalslar, 2019; Booth et al., 1992).

4. B Vitamins

B Vitamins are essential micronutrients that are involved in carbohydrate metabolism, boosting immune system function and promoting cell growth. Vit B2, B3, B5 and B12, are essential coenzymes for energy metabolism (Riordan et al., 2012). A study reported that B2 and UV light considerably decreased the titer of the Middle East respiratory syndrome coronavirus (MERS-CoV) in human plasma products to below the limit of detection (Kell et al., 2016). The main sources of B-Vitamins in food are meat, fish, poultry, milk and dairy products, eggs, legumes and cereals (Strain et al., 2017).

5. Vitamin C

Vit C is a water soluble Vit found in raw and plant foods including citrus fruit, such as oranges, peppers, strawberries, blackcurrants, and broccoli, also Vit C were synthesized from glucose in the liver of most mammals, guinea pigs, and some fruit bats (Brand et al., 1982; Li et al., 2006). It was reported that Vit C in mmol/L concentration accumulated in white blood cells and platelets. For this reason might be significant for the functioning of immune system (Levine et al., 1996; Jafari et al., 2019; Li et al., 2006; Bergsten et al., 1990; Washko et al., 1993; Evans et al., 1982). In a research study in mice, the effects of Vit C shortage was investigated on the immune system response to illness with influenza. It was reported that Vit C was required for a sufficient immune system response in restrictive lung illness after influenza illness (Li et al., 2006). In several studies beneficial Vit C effects were investigated on
diverse infections (Hemila, 2017). Vit C can strengthen the immune system against SARS (Hemila, 2003).

6. Vitamin D

Usually foods don’t contain any Vit D and sunshine causes the production of Vit D in the human skin. Vit D is present in different levels in fatty fish, tuna, and cod liver oil; there is enrichment of food such as milk, some cereals, and some bread products with Vit D (Holick, 1996). It was reported that Vit D has been effective on infection acute in young animals (Nonnecke et al., 2014). Vit D in serum decreased the risk of many chronic diseases including cancers (McDonnell et al., 2016), diabetes (Pittas et al., 2019), chronic Respiratory Infections (Zhu et al., 2016), cardiovascular diseases (Gholami et al., 2019), and high blood pressure (Manson et al., 2019). Vit D in serum decreased the risk of viral diseases such as dengue virus infection (Arboleda and Urcuqui-Inchima, 2016), herpes virus (Brice et al., 2016), H3N2 influenza (Güü et al., 2017), HIV (Borella et al., 2014), and Viral respiratory infections (Currie et al., 2013; Aregebesola et al., 2013; Jackson et al., 2004). Recent research reinforces the finding that 10–20 μg/day of Vit D can decrease all-cause of fatality and cancer fatality in middle-aged and older peoples. Albeit doses of Vit D was more than those reviewed in the past but found no new clue that supplementation could have an effect on most non-skeletal conditions, such as disease of cardiovascular, adiposity, glucose metabolism, mood disorders, muscular function, colorectal adenomas, and tuberculosis, or on perinatal and maternal conditions. New research were scarce on cancer outcomes. Based on the results from 83 tests showed that Vit D had no significant effect on systemic inflammation biomarkers. It was reported that supplementation of Vit D might help to prevent asthma exacerbations and common upper respiratory tract infections (Autier et al., 2017). In a research study, the Vit D immunomodulatory role were analyzed specifically in viral infections and Covid-19. Vit D levels could be valuable in predicting severe forms of Multisystem Inflammatory Syndrome (MIS) in children; correction of abnormal levels of Vit D may influence the course of severe MIS (Feketea et al., 2021).

7. Vitamin E

Vit E has a hydrophobic tail and is lipid-soluble. It was reported that Vit E has beneficial effect on influenza illness in mice. Vit E is an antioxidant with an important role in lung and liver conservation. Vit E alone does not possess specific antiviral action (Mileva and Galabov, 2018); this comes from the fruits, vegetables, natural fats and oils providing Vit E (Eitenmiller and Lee, 2004). A study reported that deficiency of Vit E cause increase illness in mice hearts with a myocarditis coxsackievirus B3 (CVB3/20) (Beck et al., 1994). Various studies in fauna (animal and human) has shown that Vit E increase the strength of immune system and prevents various infectious diseases (Lee and Han, 2018).

8. Free fatty acids

In research reports, omega-6 and omega-3 long-chain polyunsaturated fatty acids (PUFAs) have demonstrated considerable effects on innate and adaptive immune system. Omega-3 include eicosapentaenoic acids (EPAs) and their metabolites are powerful intermediary of eliminate inflammation (Buckley et al., 2014; Henson, 2005). It was reported that macrophage-derived extracellular vesicles (EVs) had mediate long-lasting inhibitory affects hepatitis C virus (HCV) reitera- tion, and which can be blunted by PUFAs (Cai et al., 2018). In a research, effect of All-trans retinoic acid (ATRA) is a bioactive derived of Vit A, and docosahexaenoic acid (DHA) on 15 MS patients was investigated. It was reported that DHA and ATRA may be assistance control illness advancement by a combination of the two compounds (Mousavi Nasl-khameneh et al., 2018). In a similar study, effect of ATRA, DHA and Vit D3 on EAE at mice was investigated. It was suggested that these combinations are caused be decrease in inflammation, therapy and prevention of EAE/MS and probably other autoimmune illness (Shir-i-Shahsavar et al., 2016). The balance in fatty acid (C20 and C22 essential fatty acids) levels in AIDS patient’s probably a valuable therapeutic purpose. Omega–3 and PUFAs are known to inactivate envelope viruses (Begin et al., 1989; Leu et al., 2004).

9. Iron

Iron is a vital element for the body because a shortage of iron causes growth to stop, anemia, a lack of modulation of cytokine activities, lack of nitric oxide production, lack of immune cell proliferation, and a lack of immune system modulation (Weiss, 2002). It was reported that the innate immune response meticulously controls iron metabolism. The host and pathogen need iron (Wessling-Resnick, 2018). Successful human pathogens have mechanisms to circumvent nutritional immunity. Therefore, iron compactness and dispensation must be intently controlled (Cassat and Skaar, 2013).

10. Zinc

Zinc has an important role in growth and development, cartilage growth and multiple enzymatic reactions (O’Connor et al., 2020; Brandan-Neto et al., 1995). It was reported that oxidative stress is a significant participating factor in many chronic illnesses, and zinc plays an important role as anti-inflammatory and antioxidant (Prasad et al., 2004). Several studies also reported that zinc acts as an effective anti-inflammatory (Mariani et al., 2006, 2008). Furthermore, increase Zn (2+) concentration with pyrithione (PT) can significantly disrupt the replication of different RNA viruses, such as poliovirus and influenza (Te Velthuis et al., 2010).

11. Selenium

Selenium (Se) has an extensive range of effects, such as pleiotropic, antioxidant and anti-inflammatory. It was reported that higher Se status or Se supplementation has effects, such as antiviral effects, successful reproduction in humans and decreases the danger of autoimmune thyroid illness (Rayman, 2012). Se has a great role in redox signaling, redox homeostasis and antioxidant defense in viral infection. Se deficiency, has been associated with the multiple viruses pathogenicity (Guillen et al., 2019).

12. Conclusion

The Covid-19 pandemic created many challenges in food and nutrition. Prevention and control of the disease through ensuring food safety and supplying key micronutrients is important. In this review, key nutrients that increase the function of immune system were investigated. Therefore, ensuring food safety and providing adequate amounts of fat-soluble vits E, D, A, and water-soluble B-complex and C, and sufficient amount of minerals such as selenium, zinc, and iron and omega-3 long-chain fats through a proper diet or through dietary supplements may be effective factor in the prevention or therapy of Covid-19.

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Mileva, M., Galabov, A.S., 2018. Vitamin E and influenza virus infection. Vit. E Health Dis. 67.

Mouzavi Nah-khameneh, A., Mirshafiey, A., Naser Moghadasi, A., Chahardoli, R., Moumoudi, M., Parastouei, K., et al., 2018. Combination treatment of doxorubicin and cisplatin on the efficacy of vitamin D supplementation in preventing CMV infection in liver transplant recipients. J. Gastroenterol. Hepatol. 33 (5), 799–806.

Mousavizadeh, H., 1999. Vitamin A and immunity to viral, bacterial and protozoan infections. Nutr. Rev. 57 (11), 383–394.

Mousavizadeh, H., 1998. The role of vitamin A and related retinoids in immune function. Nutr. Rev. 56 (11), S38–S48.

Mousavizadeh, H., 1999. Vitamin A and immunity to viral, bacterial and protozoan infections. Proc. Nutr. Soc. 58 (3), 719–727.

Shiri-Shahsavari, M.R., Mirshafiey, A., Parastouei, K., Ebrahimi-Kalan, A., Yekaninejad, S., Soleymani, F., et al., 2016. A novel combination of docosahexaenoic acid, all-trans retinoic acid, and 1,25-dihydroxyvitamin D3 reduces T-bet gene expression, serum interferon Gamma, and clinical scores but promotes PPARγ gene expression in experimental autoimmune encephalomyelitis. J. Mol. Neurosci. 60 (4), 498–508.

Strain, J.J., Hughes, C., Pentieva, K., Ward, M., Hoey, L., McNulty, H., 2017. The B-Vitamins: In: Sustainable Nutrition in a Changing World. Springer, Cham, pp. 185–203.

Tanumihardjo, S.A., 2011. Vitamin A: biomarkers of nutrition for development. Am. J. Clin. Nutr. 94 (2), 665S–666S.

Te Velthuis, A.J., van den Worm, S.H., Sims, A.C., Baric, R.S., Snijder, E.J., van Hemert, M.J., 2010. Zn2+ inhibits coronavirus and arterivirus RNA polymerase activity in vitro and zinc ionophores block the replication of these viruses in cell culture. PLoS Pathog. 6 (11), e1001176.

Trotter, C., Colombo, M., Mann, K.K., Miller Jr., W.H., Ward, B.J., 2009. Retinoids inhibit measles virus through a type I IFN-dependent bystander effect. Faseb. J. 23 (9), 3203–3212.

Van Doremalen, N., Bushmaker, T., Morris, D.H., Holbrook, M.G., Gamble, A., Williamson, B.N., et al., 2020. Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. N. Engl. J. Med. 382 (16), 1564–1567.

Villanom, E., Mihos, R., Spiegelman, D., Hertzmark, E., Fataki, M., Peterson, K.E., et al., 2002. Vitamin A supplements ameliorate the adverse effect of HIV-1, malaria, and diarrheal infections on child growth. Pediatrics 109 (1) e6–e6.

Washko, P.W., Wang, Y., Levine, M., 1993. Ascorbic acid recycling in human neutrophils. J. Biol. Chem. 268 (21), 15531–15535.

Weiss, G., 2002. Iron and immunity: a double-edged sword. Eur. J. Clin. Invest. 32, 70–75.

Westling-Resnick, M., 2018. Crossing the iron gate: why and how transferrin receptors mediate viral entry. Annu. Rev. Nutr. 38, 431–458.

WHO, 2020. COVID-19 and Food Safety: Guidance for Food Businesses. https://www.who.int/publications-detail/covid-19-and-food-safety-guidance-435-for-food-businesses.

Wismans, A.B., Letina, S., Thurik, R., Wennberg, K., Baptista, R., Barrientos Marin, J., et al., 2020. Hygiene and social distancing as distinct public health related behaviours among university students during the COVID-19 pandemic. Social Psychol. Bull. 15 (4).

Zhang, N., Wang, L., Deng, X., Liang, R., Su, M., He, C., et al., 2020. Recent advances in the detection of respiratory virus infection in humans. J. Med. ViroL 92 (4), 408–417.

Zhu, M., Wang, T., Wang, C., Ji, Y., 2016. The association between vitamin D and COPD risk, severity, and exacerbation: an updated systematic review and meta-analysis. Int. J. Chronic Obstr. Palm. Dis. 11, 2597.

Zhu, N., Zhang, D., Wang, W., Li, X., Yang, B., Song, J., et al., 2020. A novel coronavirus from patients with pneumonia in China. 2019. N. Engl. J. Med.