



The Covid-19 Pandemic and Fermented Products

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Abstract

Research on Covid 19 pandemic has recommended the consumption of various foods, beverages, nutritional supplements, along with the nutrients that support the immune system against the Covid-19 disease. Fermented foods are also included among the recommended foods to be consumed. In addition to increasing food variety, fermented foods promote the immune system by making foods more digestible. In other words, as an ancient method of protecting food, fermentation might alleviate the effects of Covid-19 by increasing antioxidant activity for milk, fruit, meat, cereals, fish and vegetables. This study aimed to examine the effects of fermented foods on the immune system and the factors associated with the consumption of probiotic products concerning the prevention of the disease in the Covid-19 pandemic. The keywords used were “fermented food, probiotic product, probiotic food, fermented foods and immune system, Covid-19 and probiotic products”. Yogurt, kefir, and kimchi were the probiotic products systematically reviewed in the examined studies. As a result, it has been contended that traditional fermented foods with higher antioxidant properties are consumed in countries with low mortality rates.

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INTRODUCTION

Unpredictable situations such as natural disasters, unfavorable political issues, terrorist activities, and pandemics might impact the destination preferences of individuals and cause the tourism sector to be adversely affected (Li, Blake & Cooper, 2010). Initially broke out in Wuhan, China in 2019, the coronavirus (Covid-19) pandemic caused significant economic losses to the tourism sector, with such applications as the closures of countries' borders globally. The Covid-19 disease is an infectious disease caused by the SARS-CoV-2 virus and has affected the whole world, causing tourism activities to come to a standstill.

Officially termed on February 11, 2020, and acknowledged as a global pandemic in March 2020, Covid-19 has created unprecedented social and economic impacts (Conte & Toraldo, 2020; Ruiz-Roso et al., 2020; Tashiro & Shaw, 2020; Gao et al., 2021; WHO, 2021). Patients with Covid-19 experience such symptoms as shortness of breath, loss of appetite, clouding of consciousness, chest pain, feeling of pressure, severe fever above 38°C, as well as different symptoms such as backache and headache varying according to people. Among the causes of death of individuals who died from Covid-19 are such diagnoses as respiratory failure, acute respiratory distress syndrome (ARDS), multiple organ failure, especially heart, liver, or kidney damage (WHO, 2021).

With the WHO being in the first place, national health authorities have listed warnings and recommendations such as face mask use, maintaining social distance, and personal hygiene to protect from the disease and prevent its spread. In addition to these, medical authorities have emphasized the importance of strengthening the immune system, stating that increasing food consumption in this direction has a supportive role in fighting against the pandemic (Alkhatib, 2020; Arshad et al., 2020). This study aimed to compile the research findings on the relationship between fermented foods, which are claimed to strengthen the immune system of individuals and Covid-19.

The Relationship between Fermented Foods and Health

With the emergence of the health benefits of fermented foods today, fermented products have become more preferred to enhance the immune system. In addition, the beneficial bacteria and microorganisms in the composition of fermented products, which are functional foods, have positive effects on health with changes caused by enzymes (Oktay & Özbaş, 2020). Fermentation maintains the flavor and functional properties of foods and beverages, besides increasing their shelf life (Palamutoğlu & Baş, 2020). Fermented products were displayed in Figure 1*.

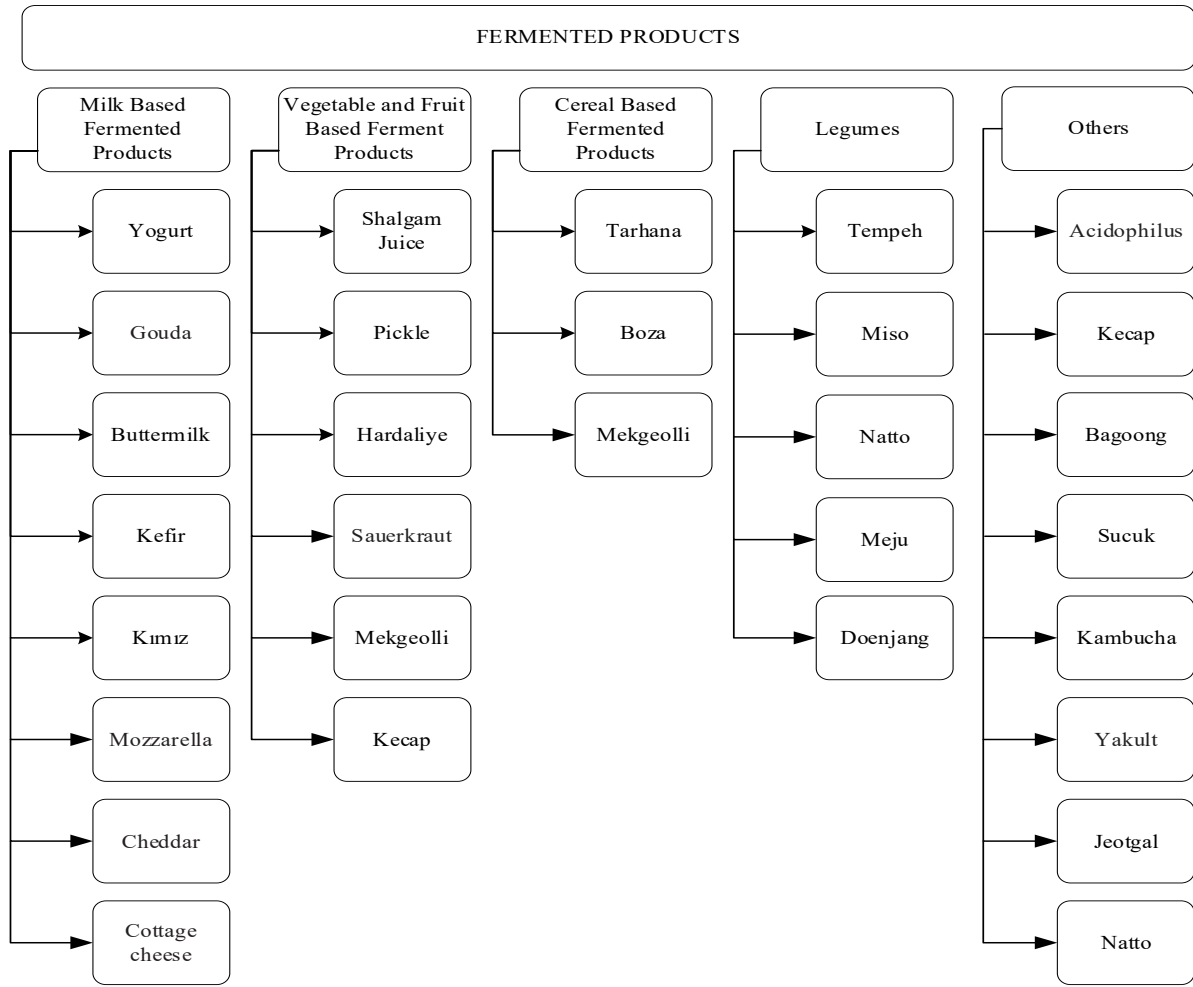


Figure 1. Fermented Products* (Röling & Van Verseveld, 1996; Röling et al., 1996; Holzapfel et al., 2003; Shimakawa et al., 2003; Özer et al., 2005; Babu et al., 2009; Almeida et al., 2012; Agmata et al., 2013; Kano et al., 2013; Yanti et al., 2016; Palamutoğlu & Baş, 2020).

*Figure 1 is created by the authors

Nutrients prepared by the fermentation method generally acquire many functional properties (Borresen et al., 2012; Chilton, Burton & Reid, 2015; Simatende et al., 2015; Nuraida, 2015; Narzary et al., 2016). In addition to increasing the nutritional value, variety, taste, and aroma of foods (Blandino et al., 2003; Nuraida, 2015), these properties help proteins, carbohydrates, vitamins and minerals to be more digestible (Sánchez et al., 2017; Sanlier, Gökçen & Sezgin, 2019). It is also noted that they have a positive effect on strengthening the immune system (Melini et al., 2019; Arshad et al., 2020; Fonseca et al., 2020; Iddir et al., 2020).

The risk of infection or contracting Covid-19 is higher in individuals with malnutrition or weak immune systems; therefore, individuals need to have strong immune systems to sustain their lives by protecting their health against Covid-19 (Calder, 2020; Rishi et al., 2020). It is stated that morbidity and mortality rates are higher in malnourished societies; however, immunity can be boosted with various foods, beverages, and nutritional supplements (Arshad et al., 2020; Błaszczyk-Bębenek et al., 2020; Jayawardena et al., 2020). Individuals are therefore recommended to consume foods that support the immune system (Muscogiuri et al., 2020) to reduce the risk of Covid-19 (Alkhatib, 2020).

This study is a compilation study that aims to present the research findings on the relationship between fermented foods and Covid-19, along with the studies offering suggestions to protect the health, enhance the immune system, and alleviate the course of the disease during the Covid-19 outbreak.

Method

The present study handles the studies examining the effects of fermented foods on the immune system and the factors related to the prevention of the disease in the Covid-19 pandemic. The studies published in the electronic databases of Science Direct, Scopus and Pubmed between 1996 and 2022 were searched to reach original research on the topic. The keywords used were “fermented food, probiotic product, probiotic food, fermented foods and immune system, covid-19 and probiotic products”. A total of 1024 articles published in English were found, and 524 were found fit for the evaluation criteria and thus examined in detail. Research titles, abstracts, and, when necessary, all articles were put to a detailed examination during the scan (Figure 2). No limitation was made for the sample group during the design process of the study.

Inclusion Criteria for Studies

Following the criteria included in the scope of the study and applied in the selection of studies, the articles must:

- be written in English,
- examine probiotic foods and fermented foods,
- examine/describe the relationship between probiotic foods and health,
- be published in the electronic databases of Sciencedirect, Scopus Pubmed, between 2019 and 2022,
- have accessible full text versions.

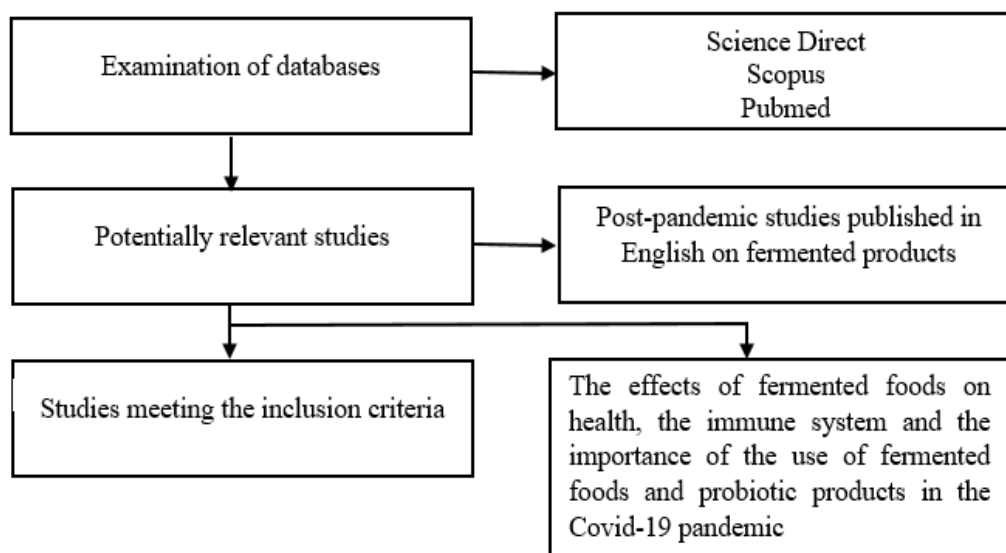


Figure 2. Examination of the databases for systematic reviews

A valid and reliable guide (Preferred Reporting Items for Systematic Reviews and Meta-Analysis Statement-PRISMA), widely used for summarizing data in systematic reviews, was used in the evaluation of the publications included in the study (Moher et al., 2009). A nine-item data evaluation form was created based on PRISMA, by which the data were analyzed. The features of this form created by the researchers are as follows:

- Title,
- Summary,
- Introduction,
- Method,
- Purpose of the study,
- Research design,
- Fermented foods included in the sample
- Findings,
- Limitations.

463 of the 524 publications accessed with the determined keywords were not included in the study due to incongruence with the purpose of the study. The findings and discussion sections of a total of 16 articles published between 2019 and 2022 that specifically focused on Covid-19 and fermented food consumption were carefully examined and evaluated.

Findings

Foods prepared through fermentation, an old form of food preservation, generally acquire many functional properties (Borresen et al., 2012; Chilton, Burton & Reid, 2015; Nuraida, 2015; Simatende et al., 2015; Narzary et al., 2016). Among these properties is that fermented foods positively impact supporting the immune system. Since most of the immune cells are in the intestines, the body's immunity is associated with the intestinal system. It is stated that the immune system might be weak when an individual's intestinal system is unhealthy. Fermented foods help make the nutrients more digestible and protect the immune system by increasing the beneficial microorganisms in the intestines (Ashraf & Shah, 2014). Fermentation increases antioxidant activity of milk, vegetables and fruit, fish, cereals and meat. It is recommended to consume fermented foods regularly, to form healthy compounds and to maintain their activities (Melini et al., 2019). Fermentation increases the level of proteins, essential amino acids, fatty acids, vitamins and other nutritional constituents. It is also effective in preventing such health conditions as obesity, high cholesterol, hypertension, diabetes, diarrhea and so on. It further increases the level of vitamins such as vitamin B9 (folate), vitamin B12, vitamin B2 (riboflavin), and vitamin K in foods (Narzary et al., 2016; Sanlier, Gökçen & Sezgin, 2019). Fermented products are also determined to have positive effects on preventing bacterial respiratory tract infections (Antunes et al., 2020; Fonseca et al., 2020; Iddir et al., 2020). Fermented foods have become an important part of nutrition in many cultures today and have recently emerged as a new and functional food with many health benefits beyond basic nutrition (Gille et al., 2018). In addition, physical activities together with fermented foods will ensure the maintenance of intestinal flora (Morris, 2018; Sanlier, Gökçen & Sezgin, 2019; Antunes et al., 2020; Iddir et al., 2020; Rebelos et al., 2020). It is stated that fermented foods reduce cholesterol levels and increase immunity in individuals by enhancing the intestinal system. Since an effective treatment method against Covid-19 has not yet been found, reducing the risk of the disease is significant to individuals. To begin with, a healthy lifestyle against the disease and a nutritional habit that might protect the health and immunity of individuals is recommended (Zabetakis et al., 2020). Besides this, Covid-19-related death rates vary by country. Despite the influence of many

determinants, this variation might be caused by nutritional habits, and mortality rates might vary depending on nutritional habits (Abedi et al., 2021; Bousquet et al., 2020a; Bousquet et al., 2020b; Bousquet et al., 2021c).

Table 1. summarizes the studies examining the effects of fermented food consumption on Covid-19 infection.

Findings on the Relationship between Fermented Foods and Covid-19	Country	Reference
It is predicted that highly fermented foods can reduce Covid-19 death rates.	Korea	(Bousquet et al., 2020a).
Consumption of fermented foods and spices can mitigate the effects of Covid-19	Korea	(Bousquet et al., 2021b).
Different fermented foods, especially kimchi, are consumed in East Asian countries where death rates are low	Korea	(Bousquet et al., 2021c).
It is stated that fermented products are safe to consume against Covid-19, besides milk and fermented dairy products.	India	(Kumar et al., 2020).
Yogurt, one of the fermented foods, can also reduce the risk of respiratory infections. Therefore, it is important to pay attention to dietary habits by following a healthy and balanced diet with high amounts of minerals, antioxidants and vitamins during Covid-19.	Italy	(Muscogiuri et al., 2020).
It is stated that fermented products occupy an important place in Korean culinary culture and that the gut microbiome during COVID-19 infection might be decisive in the course of the disease.	Korea	(Das et al., 2021).
It is maintained that the probiotics used in yogurt directly exhibit immune-boosting activities, and that the bioactive peptides found in yogurt appear to be potentially beneficial against Covid-19 infection. It is further stated that epidemiological studies and randomized controlled clinical trials should be encouraged to evaluate the exact role of yogurt consumption on COVID-19 symptoms and effects.	Chile, Cuba	(Bustamante et al., 2020).
After selecting the peptides derived from beta-lactoglobulin in the study using goat milk whey, their effects on Covid-19 and host cells are determined (by in silico analysis method). The peptides used are shown to be effective in inhibiting Covid-19. In vitro and in vivo studies are suggested.	Turkey	(Çakır et al., 2021).
The study conducted at Wuhan University with 311 Covid-19 patients reveals that there is a significant decrease in cough and sputum production in patients treated with probiotics. It is found that patients treated with probiotics have higher levels of total T cells (CD8 + T) compared to patients who do not use probiotics. This, in turn, suggests that probiotics might alleviate the decrease in immunity in severe COVID-19 patients. It is further established that probiotics might also reduce inflammation and subsequently prevent the progression of COVID-19.	China	(Li, et.al, 2021).
The food consumption of people with and without Covid disease is evaluated. No significant difference is found in the dietary habits between the two groups. It is, however, determined that those who consume yogurt and yeast dough have a lower risk of contracting COVID-19. It is further stated that this finding is insufficient to recommend the consumption of food this way. Stronger clinical studies are therefore urged to confirm such a claim.	Iran	(Mohseni et al., 2021).
When the relationship between the Covid-19 death rate and fermented vegetables was examined, statistical significance was reached. It has been determined that the high consumption of fermented products can reduce the Covid-19 death rate. Increased antioxidant activity in fermented foods may alleviate the impact of Covid-19.	Spain, France, Portugal, Germany	(Fonseca et al., 2020).

Table 1. summarizes the studies examining the effects of fermented food consumption on Covid-19 infection. (Cont.)

Lists of some probiotics that might reduce the burden of COVID-19 (<i>Lactobacillus casei</i> , <i>Lactobacillus gasseri</i> , <i>Bifidobacterium longum</i> , <i>Bifidobacterium bifidum</i> , <i>Lactobacillus rhamnosus</i> , <i>Lactobacillus plantarum</i> , <i>Bifidobacterium breve</i> , <i>Pediococcus pentosaceus</i> ve <i>Leuconostoc mesenteroides</i>) have been published, and considering these potential properties of probiotics, large food-based manufacturing companies have included these types of probiotics in their products, such as fermented beverages.	Switzerland	(Baud et al., 2020).
Cytokine storm is an important complication observed frequently in Covid patients. It is stated that probiotics might mitigate their effects.	Romania Austria	(Ailioaie, Litscher, 2021).
It is noted that kefir consumption might be effective in reducing the cytokine storm associated with Covid-19 infection.	Egypt, Saudi Arabia	(Hamida et al., 2021).
It reveals that COVID-19 causes changes in the balance of intestinal microorganisms, that the probiotics in the intestines (e.g., <i>Bifidobacterium</i> spp., <i>Lactobacillus</i> spp. and <i>Eubacterium</i> spp.) decrease significantly, and the number of pathogens (<i>Corynebacterium</i> spp., <i>Actinobacteria</i> spp., <i>Ruthenibacterium</i> spp.) increases considerably.	China	(Yu et. al., 2020).

The results of the studies generally have generally indicated positive impacts of fermented foods and probiotic foods on health. Lehtoranta et al. (2014) investigated the effect of probiotics against viral infection of respiratory tract influenza A and B viruses. The study concluded that the virus detected was three times lower in those who consumed probiotics than in the control group. Based on this study, Ahrén et al. (2021) examined two groups of children in their study comprising one control and one experimental group. Following the administration of probiotics to children in the experimental group, more gastrointestinal side effects and a higher frequency of vomiting were observed compared to the control group. For this reason, it was stated that probiotics might have varying effects in different populations, and their side effects should also be controlled (Ahrén et al., 2021).

Limitations of the Study

This systematic review study comprises 61 studies accessed by scanning the relevant databases using the keywords related to the determined topic. It is not possible to generalize about the consumption of fermented products and probiotics in terms of disease prevention due to the use of different methods and the extensive recommendations for more research on the effects of probiotics on the course of Covid-19 infection in the reviewed studies.

Conclusion and Recommendations

The measures taken by countries around the world to prevent the spread of the pandemic process have exacerbated the economic burdens of countries. The use of face masks, maintenance of social distance and personal hygiene, and an increase in consuming immune-friendly foods in line with the warnings of WHO and national health authorities have been key elements to relieve this burden in the fight against the pandemic. Many studies have indicated the safety of the consumption of fermented foods as health and therapeutic agents. This paper summarizes the studies and nutritional recommendations that include international scientific research stating that fermented foods support the individual's immune system against Covid-19. A weak immune system causes different health problems. It is stated that human nutrition is important during the Covid-19, expressed as a global pandemic. It is further expressed that individuals should enhance their immunity against Covid-19 with fermented foods. In particular, it is noted that

a strong immune system, especially in the Covid-19 pandemic, might be effective in alleviating the course of the disease, while reducing the risk of its contraction.

It is consequently asserted that fermented foods alone are not enough to prevent Covid-19 and protect the health of individuals but might enhance their immune system. However, no study has been found on fermented foods that might be effective against Covid-19 infection in clinical and medical fields. All studies were observed to be related to the indirect effects of fermented foods. No fermented products were directly recommended against Covid 19 in the reviewed studies. Despite the limited data confirming the effectiveness of probiotics on Covid-19 infection, probiotics have been recommended as a safe and complementary method against Covid-19, given their previously proven antiviral properties against different viruses in the respiratory tract. For that reason, studies are required on bacteria strains that might best serve against the current pandemic and their selection methods. Since various complex factors such as age, lifestyle, dietary habits, and genetics impact the human gut microbiota, potential standard bacterial strains for a population should also be determined. It is necessary to decipher the microbiota composition of Covid-19 patients and evaluate the infection mechanism and the way it impacts the course of the disease by conducting clinical studies. The functional benefits of fermented foods and probiotic consumption are hard to ignore. Although many researchers have stated that these might be positive effects, especially during the pandemic period, more research is urged on this issue.

Declaration

The authors of this article have equally contributed to this article and they have no conflict of interest to declare nor have they received any funding from any company.

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