From Tradition to Therapeutic: Exploring Kimchi as a Functional Food

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Abstract

The ability of functional food to offer health advantages beyond basic nutrition, especially through the presence of probiotics and other bioactive chemicals, has drawn increasing attention. Because microbial activity during fermentation increases nutritional content, improves digestibility, and supports gut health, fermented foods are a significant category within this subject. A variety of advantageous lactic acid bacteria, vitamins, minerals, dietary fiber, and phytochemicals are all present in kimchi, a classic fermented vegetable dish made by lactic acid fermentation. The fermentation process increases the availability of nutrients and promotes the development of advantageous microorganisms that support the balance of the gut microbiota. Consuming kimchi on a regular basis has been linked to better digestion, immunological modulation, and beneficial metabolic impacts, such as controlling blood sugar and cholesterol. Because of these qualities, kimchi is positioned as a probiotic-rich, nutrient-dense functional food with both traditional and contemporary health benefits.

Keywords: *Functional Food, Fermentation, Probiotics, Kimchi*

Introduction

The Functional Food Center defines functional food as natural or processed foods that contain known or unknown biologically active compounds; these foods offer a clinically proven and documented health benefit for the prevention, management, or treatment of chronic disease in defined, effective, and non-toxic amounts [1]. The recent social and health trends are the primary drivers of the functional food market's development [2]. Functional food affects certain bodily processes and may offer (beyond basic nutrition) further health advantages or therapeutic benefits for certain illnesses once a useful ingredient is added or concentrated or an ineffective or dangerous item is removed [3]. This sort of food offers numerous health benefits, such as the ability to strengthen the immune system, lower the risk of cardiovascular issues, osteoporosis, obesity, and some forms of cancer, as well as enhance memory and physical state [4]. The functional product market is currently one of innovation, with constant product launches and fast expansion [5,6]. Foods that contain minerals, vitamins, fatty acids, dietary fiber, and biologically active ingredients like probiotics and antioxidants are considered functional foods [7]. Functional foods frequently contain probiotics because, when taken in sufficient levels, they provide health advantages [8].

The market for probiotic foods is expanding rapidly worldwide as consumers become more conscious of how food affects their health. Probiotic products currently make up between 60% and 70% of the market for functional foods [9,10]. In 2014, a consensus panel of experts defined probiotics as "live microorganisms that, when administered in adequate amounts, confer a health benefit on the host." [11]. Probiotic foods are special since they are made to provide the consumer with live microorganisms in order to improve their health. Live microorganisms have different design, development, scale-up, manufacturing, commercialization, and life cycle management problems than conventional dietary supplements [12]. The selection of probiotic strains and their survival are linked to the advantages of probiotic products. Probiotics' effectiveness is typically strain-dependent. Strains ought to be safe for ingestion by humans and resistant to bile and stomach acid [13,14]. Probiotic strains provide both intestinal and non-intestinal health benefits. Preventing diarrhea, easing the symptoms of inflammatory bowel illness, preventing gastrointestinal malignancies, and reducing lactose intake are some of the intestinal advantages intolerance and a decline in Helicobacter pylori infections [15]. Probiotic bacteria can also be found in fermented nondairy foods. Probiotic qualities can be found, for instance, in bacterial strains that were separated from cucumber and cabbage produced using conventional techniques [13,14]. Yogurt, kefir, and beaten milk all contain probiotics. Pickled cucumbers, cabbage, olives, and fermented oats are all high in Lactobacillus plantarum, which has probiotic properties [16].

According to Marco et al. (2021) [17], fermented meals and beverages are created by regulated microbial growth and the enzymatic conversion of dietary ingredients. Because some fermented foods may still include live probiotic strains after fermentation, the outcomes of these microbial growths and enzymatic activity expose fermented foods to a variety of health advantages [18]. Foods or drinks that have undergone fermentation are typically described as by the enzymatic conversion of major and minor food ingredients and regulated microbial growth [19]. Since ancient times, humans have included fermented foods in their diets. Pottery vessels used to ferment rice, honey, and fruit that were found in China around 7000 BC are among the earliest examples of the intentional use of fermentation [20]. Fermented foods have been consumed by humans, especially due to their nutritional value, organoleptic properties, and long shelf life [21]. There are two primary methods

for food fermentation. First, foods can naturally ferment; this process, often called "spontaneous fermentation," is caused by bacteria that are present in raw food. Some fermented soy products, kimchi, and sauerkraut are examples of such foods. Second, foods like natto, kefir, and kombucha can be fermented by adding starter cultures; these ferments are known as "culture-dependent ferments." Fermented vegetables are commonly consumed as sides or ingredients in a variety of meals in both the Eastern and Western worlds [22]. Napa cabbage (Brassica rapa), among other vegetables, is commonly used in East Asian cuisine, especially when making kimchi. The Korean word "kimchi" describes a range of fermented and salted greens [23]. As kimchi is a raw vegetable product fermented with lactic acid, it is also thought to be a good source of possibly beneficial LAB. The health benefits of kimchi may come from its nutrients and functional elements, which include fiber, vitamins, phytochemical, minerals, biological compounds found in kimchi ingredients like garlic, ginger, and red pepper powder, fermentation products, and the lactic acid bacteria (LAB) involved, or a combination of these [24].

Kimchi and its microbiological outlook

Kimchi is a traditional Korean fermented cuisine with a history of thousands of years. Because of the Korean Peninsula's geographical limitations, fermentation using lactic acid bacteria is a common way to preserve food during times of scarcity after harvesting fish, pork, beans, and vegetables. This has become a prominent element of Korean cuisine, and among them, Kimchi stands out as the most iconic traditional dish on the Korean Peninsula [25]. Kimchi is a traditional Korean food product that is produced by fermentation with the involvement of lactic acid bacteria (LAB), originated from raw ingredient of kimchi [26]. China also has the identical fermented food that are called pickle, which has 3000 years of evolving history, and have seperated into several sorts. Sichuan pickles, northeast sauerkraut, Fuling mustard, and so on are the most well-known varieties. Kimchi and pickles have a large audience and a huge market. In China, it is very often used as a condiment. In Korea, kimchi is an essential part of the Korean cuisine. And this condition makes its impact on human health a very important area [25]. The most common and well-liked type of kimchi in Korea is called baechu (kimchi cabbage), which is made with radish, cucumber, and other vegetables. Chives, garlic, red pepper powder, ginger, leek, green onion, salt, and jeotgal (fermented and salted seafood) or aekjeot (liquid-type jeotgal, similar to fish sauce) are other small spice ingredients [26]. Kimchi is enjoyed everyday by Korean people and has been an intrinsic element of Korean cuisine culture for millennia [27]. In fact, kimchi has many philosophical and historical components that represent the Korean way of life throughout history [28].

Kimchi is a traditional side dish that is typically served with other side dishes (banchan) in Korean restaurants and family homes. In addition to being used in recipes for various traditional cuisines like soup, porridge, and rice cake, kimchi can be consumed on its own or with rice. Many derivative foods, including kimchi stew (kimchi jjigae), kimchi pancake (kimchi buchimgae), kimchi soup (kimchi guk), kimchi dumplings (kimchi mandu), and kimchi fried rice (kimchi bokkeumbap), are made with kimchi [28]. The ingredients utilized, family tastes, local norms, etc. all influence how kimchi is prepared. The procedure includes pretreating and preparing the raw materials, combining them, packing them, and fermenting them. As kimchi ferments naturally, active starters can be introduced in the industrial setting. Cabbage and its constituents contain the primary endogenous microbes, LAB, and fermentable carbohydrates like glucose, fructose, etc. The amount of fermentation and the growth of LAB may also be directly influenced by a variety of chemical, physical, and biological variables. After the brining process, LAB

from the brined cabbage appears to be the primary natural initiators of fermentation, other microbes found in materials other than cabbage may also be involved. Maintaining facultative anaerobic conditions is crucial for promoting the growth of LAB during fermentation and reducing the growth of aerobic bacteria [29]. Numerous parameters, such as the kinds and proportions of raw materials used and the fermentation conditions (temperature, pH, salt concentration), have an impact on the quality of kimchi. At various phases of kimchi fermentation, a variety of LAB species become prominent, and the fermentation conditions fluctuate greatly [30]. LAB can be found in fermented foods. As a result, eating kimchi may enhance the microbiota in the digestive system. Numerous reviews have discussed fermented foods that include known or possible probiotics, especially LAB, and human investigations have shown that microbes in fermented meals can survive digestion and make it to the colon [31].

Health-promoting functionality of kimchi

In the past, kimchi was used as a preventive diet during the winter months when there were no fruits or vegetables. Furthermore, veggies are naturally occurring sources of probiotic LAB, making them a fermented food. It is a naturally low-calorie food that also includes dietary fiber, vitamins, minerals, and other beneficial fermented compounds [32]. Numerous vitamins and minerals, such as calcium, iron, potassium, vitamin A, vitamin C, and vitamin K, are abundant in kimchi. These dietary components contribute to the overall nutritional support of human health. As an antioxidant, vitamin C is crucial in combating free radicals and delaying cell aging, which benefits human health, skin, and eyes [33]. There are several health advantages to eating kimchi. Kimchi consumption improved the health condition of mammalian hosts (such as humans and mice) in a number of disease models or clinical trials (such as cancer, obesity, cardiovascular disorders, and impaired cognition, memory, and brain functions) [34]. Probiotics found in kimchi include yeast and lactic acid bacteria. Notably, the most prevalent and beneficial microorganisms for human health are lactic acid bacteria. According to research, the lactic acid bacteria present in kimchi have the capacity to break down cholesterol and withstand both acidic and alkaline conditions. This allows them to control the levels of nitrite and cholesterol in fermented foods while also inhibiting the growth of other bacteria [33]. When compared to fresh kimchi, consumption of fermented kimchi in the latter study showed a number of beneficial effects on some variables linked to metabolic syndrome, such as systolic and diastolic blood pressure, body fat percentage, fasting glucose, and total cholesterol, indicating that fermentation offers additional beneficial effects for improving metabolic parameters [35]. Whether they come from plants or animals, fermented foods and drinks are an essential element of the diets of people in many regions of the world, including Western and Asian nations. In addition to being significant sources of nutrients, fermented foods have the potential to improve health and prevent disease. They also contribute desired flavors and textures, reduce toxicity, and shorten cooking times [36].

Conclusion

As people become more conscious of the connection between food, health, and illness prevention, functional foods have become a significant part of contemporary diets. Probiotics are especially important among these nutrients since they have a favorable impact on gut flora and general physiological processes. Humans have been consuming fermented foods since ancient times because they are natural transporters of bioactive chemicals and helpful bacteria, making them important contributors to human health

beyond basic nourishment. Kimchi is a well-known example of a traditional fermented food that has nutritional and practical advantages. Vitamins, minerals, dietary fiber, and bioactive phytochemicals are abundant in kimchi. It is fermented by naturally occurring lactic acid bacteria and primarily made from vegetables. The fermentation process increases microbial variety and nutritional bioavailability, which amplifies the product's health-promoting advantages while also extending its shelf life and improving its sensory qualities. Having kimchi regularly has been linked to numerous health benefits, such as better metabolic health, lowered cardiovascular risk factors, strengthened immunity, and possible defense against obesity, cancer, and cognitive deterioration. These advantages result from a combination of its nutritional composition, antioxidant activity, and microbial content. Kimchi's distinct functional qualities are also impacted by its dynamic microbial community, which is shaped by the ingredients and fermentation conditions. Essentially, kimchi is a great illustration of how traditional fermented foods may meet modern nutritional and health needs. Because of its unique blend of probiotics, bioactive compounds, and cultural significance, kimchi is positioned as a major functional food with potential advantages for long-term human health and disease prevention.

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