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Traditional Fermented Foods and their Probiotic Properties – A Review

Arunavarsini K.[1], Suba Ranjani S.[2], Durga Devi L.[3], Logeshwaran Vellingiri[4], Mahenthiran R.[5]*
[1,3] PhD Research Scholar, Department of Microbiology, Dr.N.G.P. Arts and Science College, Coimbatore – 641048
[2] PG Student, Department of Microbiology, Dr.N.G.P. Arts and Science College, Coimbatore – 641048
[4] PhD Research Scholar, Department of Biotechnology, Dr.N.G.P. Arts and Science College, Coimbatore – 641048
[5*]Assistant Professor, Department of Microbiology, Dr.N.G.P. Arts and Science College, Coimbatore – 641048

ABSTRACT: Fermented foods play a major role in human health and diet because of its probiotic properties. Probiotics usually helps in promoting the good gut health. Fermented foods stay in menu of every traditional food all over the world. Mostly Lactic acid Bacteria is present in fermented foods. The current paper is reviewed about the traditional fermented foods and their probiotic properties.

KEYWORDS: Fermented foods, Gut health, Human health, Lactic acid Bacteria, Probiotic properties.

INTRODUCTION

The term "probiotics" refers to microorganisms providing benefits to humans as well as animals, with a role in the intestinal microbe balance and an important role in health maintenance. Probiotics, like lactic acid bacteria, are non-pathogenic microbes that exert health benefits to the host when administered in adequate quantity. The food industry has actively researched and promoted the application of probiotics in various products.In this market, probiotics have found integration into a variety of products, predominantly within the realm of fermented dairy foods.In this market, probiotics have found integration into a variety of products, predominantly within the realm of fermented dairy foods.Most probiotic bacteria are Gram-positive, and their main functions are related to modulation and maintenance of the intestinal tract health (e.g., Lactobacillus and Bifidobacterium) (Marco, Pavan, & Kleerebezem, 2006). Probiotics primarily inhabit the intestines of the human host, and the commensal intestinal microbiome plays a crucial role in enhancing resistance against infections, differentiating the host's immune system, and synthesizing nutrients (Ubeda & Pamer, 2012). Humans have been consuming fermented foods since ancient times, with evidence dating back to 7000 BC showcasing intentional fermentation practices in China, where clay pots were utilized to ferment rice, honey, and various other foods. However, it's plausible that the inadvertent fermentation and subsequent consumption of fermented products occurred much earlier, possibly predating intentional methods, as meals likely underwent spontaneous fermentation during storage.

HISTORY OF PROBIOTICS

Pliny the Elder, a Roman army commander, writer, and philosopher (23-79 AD), is renowned more for his comprehensive encyclopedia, 'Naturalis Historia,' than for his military achievements, offering a vast compilation of knowledge completed in 76-77 AD and considered the earliest encyclopedia with 169 chapters across 37 volumes. Within this monumental work, Pliny documented the use of soured milk in treating ailments such as diarrhea and vaginal discharge, drawing on information gathered from his extensive travels and the insights of ancient authors (Vandenplas, 2007).

During the Mongolian Empire's expansion under Ghengis Khan, a messenger, facing the villagers' discontent, inadvertently received milk instead of water in his bag during a desert crossing. Despite the unexpected provision, Ghengis Khan, upon learning the story, reportedly added sour milk to the army's supplies. This empire, spanning 22% of the Earth's total land area, became the largest contiguous territory in the world (Marshall, 1993).

The late 15th century witnessed significant global transformations, with pivotal events such as the invention of the printing press, marking a monumental milestone for humanity and signaling the commencement of the modern historical era (Dunan, 1964).

In the 14th century, Arnaldus de Villa Nova, a Catalan physician and scientist, delved into various fields including physics, chemistry, astrology, and medicine, and authored the widely circulated book 'Liber de Vinis,' the first academic source on the medicinal use of wine, advocating its application in treating ailments like dementia and sinus disorders (Johnson, 1989). Centuries later, in 1790, the

"Journal of a voyage to New South Wales" featured the first scientific journal paper discussing the combination of wine and medicines for treating rickets and dysentery (White, 1962).

Anton van Leeuwenhoek initially designed the light microscope, later enhanced by Robert Hook, unlocking the realms of the microscopic universe and pioneering the observation of bacteria, yeast, and blood elements. This breakthrough in discovering the microscopic world had a profound impact, dramatically altering the course of human history (Egerton, 2006).

Types of probiotics strains

The most common genera of probiotics are Lactobacillus, Bifidobacterium, Saccharomyces, Streptococcus, Enterococcus, Escherichia, and Bacillus, with species of Lactobacillus and Bifidobacterium being used mostly.

Bifidobacteria

Bifidobacteria, found abundantly in both environmental sources and the intestinal tracts of various animals, including humans, play a pivotal role as the primary colonizers of the infant gut microbiota. Notable species within this genus encompass *B. bifidum, B. animalis, B. breve, B. longum, and B. adolescentis*. Particularly in the gastrointestinal (GI) tract, Bifidobacteria have demonstrated positive health impacts, such as enhanced lactose digestion and potential preventive effects on diarrhea, along with alleviating symptoms associated with irritable bowel syndrome (IBS). Furthermore, these probiotics have been correlated with improved lipid levels, contributing to overall gut health.Among the myriad Bifidobacteria species, *B. breve, B. longum subsp. Infantis, B. bifidum, and B. longum subsp. Longum* are prevalent in the gastrointestinal ecosystem of human infants. Infants who receive breast milk exhibit elevated levels of these beneficial bacteria, fostering a robust intestinal barrier that offers protection against infections and potentially influencing metabolic processes. Notably, certain Bifidobacteria species, including *B. bifidum, B. infantis, B. breve, and B. longum*, demonstrate the ability to synthesize essential B vitamins, as well as vitamins C and K. Historically, these probiotics have been utilized in food processing, particularly in the cultivation of fermented dairy products, and may additionally facilitate mineral absorption by modulating stomach acidity.

Lactobacilli

Lactobacillus bacteria, renowned for their lactic acid production, have played integral roles in food processing for centuries, particularly in culturing dairy products. Their production of lactic acid and other metabolites is closely associated with the beneficial health effects attributed to Lactobacilli.Some prevalent species include L. acidophilus, L. plantarum, L. rhamnosus, L. reuteri, L. casei, L. delbrueckii subsp. Bulgaricus, L. gasseri, L. fermentum, L. johnsonii, L. paracasei, and L. salivarius. Lactobacilli significantly colonize the digestive tract, mouth, and vagina, with certain species facilitating improved lactose and micronutrient digestion. They've also demonstrated a capacity to mitigate antibiotic-associated diarrhea and vaginal infections.Moreover, Lactobacillus species hold promise for various health benefits, including potential roles in preventing or ameliorating eczema in children, reducing cholesterol levels, and aiding weight loss in obesity. Their multifaceted impacts underscore their importance not only in food production but also in enhancing human health and well-being.

Saccharomyces

Due to its potential to act as a pathogen in individuals with compromised immune systems, yeast-based probiotics, particularly those containing Saccharomyces cerevisiae, are not recommended for critically ill or immunocompromised patients. Although Saccharomyces cerevisiae has a rich history in baking and brewing, its health benefits are not as well-established as those of Saccharomyces boulardii, a closely-related yeast probiotic renowned for its efficacy in managing gastrointestinal disorders. Unlike Saccharomyces cerevisiae, Saccharomyces boulardii possesses remarkable resilience, displaying superior survival capabilities under harsh conditions such as high temperatures and low pH levels encountered in the gastrointestinal tract. Consequently, Saccharomyces boulardii stands out as one of the most extensively researched probiotics within the Saccharomyces genus, offering promising therapeutic potential for various gastrointestinal ailments. However, caution must be exercised when considering yeast-based probiotics, particularly in vulnerable patient populations, to mitigate the risk of adverse outcomes.

TYPES OF TRADITIONAL FERMENTED FOODS

Kimchi (Korea)

Kimchi, a traditional Korean dish comprising salted and fermented vegetables such as Chinese cabbage and radishes, seasoned with an array of flavorings and additional ingredients, is renowned for its complex microbial composition and potential health benefits. During its production, cabbage undergoes brining and mixing with various seasonings before fermentation occurs, either spontaneously through naturally occurring microorganisms or with the aid of starter cultures in commercial settings. Initially, the kimchi mix harbors a diverse range of bacterial species from genera like Leuconostoc, Lactobacillus, Pseudomonas, Pantoea, and Weissella. However, as fermentation progresses, the microbial community evolves, with Leuconostoc becoming the dominant genus within a few days. The specific bacterial composition varies depending on factors such as ingredient type and quantity, with garlic content positively correlating with Lactobacillus concentration and red pepper powder influencing proportions of Weissella and Leuconostoc. Additionally, archaea and yeast genera like Halococcus, Natronococcus, Saccharomyces, Candida, and Trichosporon have been identified in commercial kimchi products.

Research suggests that kimchi consumption may confer various health benefits. Animal studies have shown potential weight control effects, reductions in cholesterol levels, and modulation of gene expression related to metabolism and immunity. Inflammatory markers and cytokine production were also reduced in animal models, indicating potential anti-inflammatory properties. Moreover, in vitro studies have suggested anti-carcinogenic effects, including inhibition of gastric cancer cell growth. Human studies have demonstrated changes in gut microbiota composition following kimchi consumption, with increases in beneficial bacteria and decreases in pH observed. Furthermore, kimchi consumption has been associated with improvements in stool concentrations of Lactobacillus and Leuconostoc.

However, concerns regarding kimchi's impact on gastrointestinal health and disease have been raised. While some studies suggest potential benefits, others have indicated a possible association with gastric cancer risk, attributed to factors like nitrite, nitrate, and salt content. Notably, different types and preparations of kimchi may have varying effects on gastric cancer risk, underscoring the importance of considering ingredient composition and preparation methods.Despite the potential benefits of kimchi consumption, there is a lack of randomized controlled trials (RCTs) investigating its effects on functional bowel disorders. Further research is needed to elucidate the relationship between kimchi consumption and gastrointestinal health outcomes comprehensively.

In summary, kimchi's intricate microbial composition and diverse array of ingredients contribute to its potential health benefits, including modulation of gut microbiota and anti-inflammatory and anti-carcinogenic effects. However, the association between kimchi consumption and gastric cancer risk warrants careful consideration, highlighting the need for additional research in this area.

Kefir (Russia)

Kefir, originating from the Caucasus Mountains, is a fermented milk drink known for its creamy texture, sour taste, and subtle effervescence, made by introducing a starter culture called "kefir grains" to milk. These grains comprise a symbiotic mixture of lactose-fermenting yeasts like Kluyveromyces marxianus and non-lactose fermenting yeasts such as Saccharomyces cerevisiae and Saccharomyces unisporus, along with lactic and acetic acid-producing bacteria, enclosed within a polysaccharide and protein matrix called kefiran. Throughout fermentation, by-products including lactic acids, flavor-enhancing components like acetaldehyde, ethanol, and carbon dioxide are generated, contributing to the distinctive organoleptic properties of kefir. Besides traditional dairy-based kefir, a dairy-free alternative known as water kefir exists, made with water, sugar, and water kefir grains, though it contains different microbial cultures compared to traditional kefir.Microbial analysis reveals a rich diversity within kefir grains, encompassing species such as Lactobacillus brevis, L. paracasei, L. helveticus, L. kefiranofaciens, L. plantarum, L. kefiri, Lactococcus lactis, Streptococcus thermophiles, Acetobacter lovaniensis, Acetobacter orientalis, Saccharomyces cerevisiae, S. unisporus, Candida Kefyr, Kluyveromyces marxianus, and Leuconostoc mesenteroides. While the microbial composition may evolve during fermentation, with certain species like L. kefiri becoming predominant, regulatory bodies recommend specific microbial thresholds for both kefir grains and the final product to ensure quality and safety.

Kefir exhibits antimicrobial properties attributed to various mechanisms, including competition for nutrients with pathogens, and the production of organic acids, bacteriocins, carbon dioxide, hydrogen peroxide, ethanol, and diacetyl. These properties render kefir effective against pathogens like Candida albicans, Salmonella typhi, Salmonella enterica, Shigella sonnei, Escherichia coli, Bacillus subtilis, Enterococcus faecalis, and Staphylococcus aureus. Additionally, fermentation-derived bioactive peptides and kefiran have demonstrated immune-stimulating and anti-inflammatory effects in animal models. Antioxidant, anti-hypertensive, anti-carcinogenic, and cholesterol- and glucose-lowering effects have also been attributed to kefir based on in vitro and animal studies.

Kefir consumption influences the gut microbiota, with certain strains showing the potential to colonize the human gut and promote the growth of beneficial bacteria like Lactobacillus, Lactococcus, and Bifidobacterium while reducing the abundance of harmful bacteria. Animal studies have shown that kefir and its constituent strains can modulate microbial populations, stool consistency, and transit time, indicating potential benefits in conditions like constipation. Human studies have corroborated these findings, showing increases in Lactobacillus abundance and improvements in gastrointestinal symptoms in individuals with inflammatory bowel disease.

Clinical trials have further explored the therapeutic potential of kefir in gastrointestinal disorders. Kefir has been shown to alleviate symptoms of lactose malabsorption, potentially through the action of β-galactosidase-expressing bacteria present in kefir grains. Moreover, kefir consumption has been associated with higher rates of Helicobacter pylori eradication, lower incidence of antibiotic-associated diarrhea in children, and improved gastrointestinal function in patients with constipation. However, the heterogeneous nature of kefir batches, owing to variations in microbial composition, poses a challenge in standardizing its effects across studies. Therefore, further high-quality randomized controlled trials are warranted to elucidate the precise impact of kefir on gut microbiota and its therapeutic potential in various gastrointestinal disorders.

Sauerkraut (Germany)

Sauerkraut, originating from ancient times around the 4th century BC, is a widely consumed preserved cabbage dish with a long history of use in various cultures, including Germany, other European and Asian countries, and the United States. Its production involves a simple process of combining shredded cabbage with salt (typically 2.3%-3.0%) and allowing it to undergo spontaneous fermentation, primarily facilitated by microorganisms like Leuconostoc spp., Lactobacillus spp., and Pediococcus spp., resulting in a low pH environment that preserves the cabbage.Microbial analysis of sauerkraut, both homemade and commercially available, reveals a diverse array of bacteria including Bifidobacterium dentium, Enterococcus faecalis, various species of Lactobacillus, Staphylococcus epidermidis, Weissella confusa, Lactococcus lactis, and members of the Enterobacteriaceae family. Studies have shown that the addition of specific starter cultures, such as Lactobacillus casei 11MZ-5-1, can influence the microbial composition of sauerkraut, leading to variations in microbial diversity and predominance of certain bacterial species.

Certain Lactobacillus strains isolated from sauerkraut demonstrate probiotic potential, exhibiting tolerance to low pH, adherence to intestinal cells, and antimicrobial activity against pathogens. For example, Lactobacillus paracasei HD1.7, commonly found in sauerkraut, produces bacteriocins that aid in preservation. Furthermore, sauerkraut consumption has been associated with increased activity of detoxifying enzymes in the liver and kidney, as well as the generation of conjugated linoleic acid, which has demonstrated anti-carcinogenic and anti-atherosclerotic effects in animal studies.In addition to its microbial content, sauerkraut contains various phytochemicals derived from the breakdown of glucosinolates, such as kaempferol, isothiocyanates, and indole-3-carbinol. While the specific health effects of these compounds are not fully understood, kaempferol has been shown to possess antioxidant properties, while isothiocyanates exhibit antimicrobial activity against a range of pathogens.

Despite its potential health benefits, sauerkraut's association with gastrointestinal health is still being explored. One clinical trial investigated the effects of sauerkraut consumption on irritable bowel syndrome (IBS) symptoms and microbiota composition in patients with IBS. While both pasteurized and unpasteurized sauerkraut led to a reduction in IBS severity scores, there were no significant differences in symptoms between the two groups, suggesting that the health benefits may not be solely attributed to live microbes. However, further research is needed to clarify the mechanisms underlying these effects.Interestingly, some studies have suggested a potential association between sauerkraut intake and certain gastrointestinal cancers. For example, a case-control study in Chinese participants found that higher intake of sauerkraut was associated with an increased risk of laryngeal cancer (odds ratio (OR) 7.27). However, the exact mechanisms underlying this association remain unclear, and conflicting evidence exists regarding the role of sauerkraut's salt and potassium content in relation to cancer risk.

In summary, sauerkraut offers a unique combination of microbial diversity and phytochemical content, which may contribute to its potential health benefits, including improved gastrointestinal function and potential anticarcinogenic effects. However, further research is needed to elucidate the specific mechanisms and optimal consumption patterns for maximizing these health benefits while minimizing potential risks.

Kombucha (China)

Kombucha, a fermented tea beverage with roots dating back to ancient China around 220 BC, has been consumed for centuries and gained popularity during the Qin Dynasty. Its tradition spread to Russia and Eastern Europe, where similar fermented tea beverages became prevalent. In contemporary society, various commercial kombucha products are available, yet detailed reports on their microbial and metabolite composition, as well as production methods, are scarce.

The traditional method of preparing kombucha involves aerobic fermentation of black or green tea, along with white sugar, by a symbiotic culture of bacteria and yeast (SCOBY). During fermentation, yeast convert sucrose into ethanol, organic acids, and carbon dioxide, while acetic acid bacteria further metabolize ethanol into acetic acid and acetaldehyde. The composition of kombucha can vary significantly depending on factors such as the SCOBY composition, type and concentration of tea and sugar, oxygen levels, fermentation duration, temperature, and storage conditions. The acidic nature of kombucha, primarily due to high acetic acid concentrations, has been demonstrated to inhibit the growth of pathogenic bacteria, including Helicobacter pylori, Escherichia coli, Salmonella typhimurium, and Campylobacter jejuni, even under neutral pH and thermal denaturation conditions.

The SCOBY(symbiotic culture of bacteria and yeast) typically consists of acetic acid bacteria (such as Acetobacter and Gluconobacter), lactic acid bacteria (including Lactobacillus and Lactococcus), and various yeasts (like Saccharomyces and Zygosaccharomyces). Studies employing high-throughput sequencing analysis have identified Candida and Zygosaccharomyces as predominant yeasts in fermented kombucha, while Komagataeibacter, Lyngbya, Gluconobacter, Lactobacilli, and Bifidobacteria are among the most abundant bacterial genera.Animal studies have suggested potential physiological benefits of kombucha consumption, including effects on blood glucose levels, oxidative stress, weight loss in diabetes, nephrotoxicity, hypercholesterolemia, and gastric ulceration. Compounds like d-saccharic acid-1,4-lactone (DSL), produced during fermentation, are hypothesized to contribute to these effects, exhibiting antioxidant and protective properties. Additionally, kombucha fermentation enhances the polyphenol and flavonoid content of tea, thereby increasing its antioxidant capacity.

Despite being rich in beneficial microbes and demonstrating antimicrobial effects in vitro, there is a notable absence of published studies investigating the impact of kombucha consumption on gastrointestinal microbiota composition or function in animals or humans. Furthermore, while animal studies suggest potential physiological benefits, such effects in humans remain largely unexplored. Current literature lacks randomized controlled trials (RCTs) evaluating the effects of kombucha on gastrointestinal disorders or microbiota, including functional bowel disorders.In summary, while kombucha has been traditionally consumed and shows promise in animal studies, particularly regarding its physiological effects, its impact on human gastrointestinal health and microbiota remains understudied. Further research, particularly well-designed clinical trials, is warranted to elucidate the potential benefits and mechanisms of action of kombucha consumption in humans.

Wine (America)

Wine, deriving its name from the fruit primarily used in its fermentation, exhibits a delicate balance influenced significantly by pH levels. With a pH near neutral, around 7, fermentation and microbial activity thrive, crucial for the transformation of grape sugars into alcohol and organic acids. Conversely, pH levels below 3.5 hinder microbial growth, limiting fermentation to select strains, often including Staphylococcus cerevisiae. These bacteria play a pivotal role in the conversion process, metabolizing sugars into alcohol compounds and organic acids. This microbial interaction not only facilitates fermentation but also contributes to the formation of diverse chemical compounds like aldehydes and esters, enhancing flavor complexity and extending shelf life. Additionally, various factors such as temperature, oxygen exposure, and grape variety further influence the fermentation process and the resulting characteristics of the wine. The intricate interplay of these elements underscores the art and science behind winemaking, where microbial cultures act as both catalysts and custodians of flavor development and preservation. Alcoholic beverages stand as one of the most economically and culturally significant fermented food products worldwide, interwoven into diverse cultural practices and traditions across continents. From religious rituals to social gatherings, alcohol holds a ubiquitous presence, embracing a rich tapestry of rituals, conventions, and entertainment on a global scale. Whether it be the longstanding tradition of wine consumption in Europe or the burgeoning single-malt whisky industry in Japan, each region offers unique insights into the art and culture of alcohol production and consumption.

Across Latin America, Africa, and Asia, alcohol consumption is deeply ingrained in ritualistic practices, serving as a conduit for social bonding and spiritual expression. Conversely, in regions like Europe and the Mediterranean, wine holds a revered status, deeply integrated into culinary customs and social gatherings. The history and significance of alcoholic beverages vary greatly from one culture to another, shaping societal norms and traditions over centuries.

While cereals and potatoes serve as common substrates for alcohol production, the process varies depending on cultural preferences and available resources. In Asia, for instance, where grapes and fruits are typically consumed unfermented, traditional alcoholic beverages often derive from grains and tubers. Here, the use of amylolytic starters and solid-state fermentation techniques are essential for saccharification, converting starches into fermentable sugars.Japan, in particular, has emerged as a notable player in the global whisky market, renowned for its meticulous craftsmanship and adherence to tradition. Despite lacking a historical association with malted barley, Japanese distillers have mastered the art of whisky production, leveraging innovative techniques and a deep appreciation for quality.In essence, the world of alcoholic beverages reflects a tapestry of cultural diversity and innovation, where tradition intertwines with modernity to create a rich tapestry of flavors and customs. From the vineyards of Europe to the distilleries of Japan, each sip tells a story of heritage, craftsmanship, and the timeless allure of fermented libations.

CONCLUSION

The presence of functional microorganisms in certain fermented foods and beverages confers health benefits, leading to their global marketing under various labels such as health foods, functional foods, therapeutic foods, nutraceutical foods, and bio-foods. However, the shift from traditional dietary habits to commercial fast foods, driven by urbanization and lifestyle changes, has resulted in a decline in the production and consumption of traditional fermented foods, particularly in Asia and Africa. This decline, coupled with reliance on fewer providers, poses a threat to the biodiversity of microorganisms involved in fermentation processes. To address this, we propose conducting detailed studies involving clinical trials and animal models to validate the health claims associated with common fermented foods worldwide. Additionally, the introduction of new fermented food products containing well-validated functional microorganisms holds potential for emerging in the global food market.Lactic acid bacteria (LAB) play a crucial role in food fermentation, as they produce compounds beneficial for human and animal health. LAB derived from single or mixed cultures in fermented foods serve as probiotics, aiding in maintaining gut microbiota balance and enhancing digestive tract health. Furthermore, these microorganisms contribute to bolstering the immune system against pathogenic bacteria. Various genera, including Lactobacillus, Bifidobacterium, Bacillus, Pediococcus, and several yeasts, are utilized as probiotics, underscoring their significance in promoting health through fermented foods.Throughout human history, fermented foods have held significant importance, initially serving to extend the shelf life of seasonal foods. Beyond preservation, fermented foods offer numerous health benefits, a notion recognized as far back as Metchnikoff's time. Today, scientific research increasingly supports the health advantages of fermented foods, highlighting their role in easier digestion, increased vitamin and antioxidant content, and potential impacts on gut microbiota composition.Given the mounting evidence linking gut microbiota to physical health and metabolic diseases, there is growing interest in using foods to positively influence gut microbiota. This review provides valuable insights into identifying microbial strains that effectively produce beneficial components in various food matrices, offering a foundation for developing novel fermented foods aimed at enhancing health and well-being.

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