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The Role of Starter Culture in Producing Probiotic Yoghurt: Significance for Human Health -A Review

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ABSTRACT

Dairy starter cultures are essential microorganisms that are intentionally added to milk to create the desired outcome in most commercially produced fermented dairy products such as yogurt and cheese that are produced by lactic acid fermentation and the harmful microorganisms and chemicals in products are destroyed through the process of fermentation. Thus, the products have a better taste and ideal physiological effects. Lactic acid bacteria are one of the most applied bacteria in the production of fermented foods and are of special importance for functional foods such as probiotics. They make food durable, texture, flavor, improve food safety, enhance food physiological and hygienic value due to the presence of viable cells. Lactobacillus acidophilus, Bifidobacterium, Lactobacillus casei, Streptococcus thermophilous, Lactobacillus rhamnosus, Enterococcus faecium/Enterococcus faecalis, Saccharomyces Cerevisiae var.boulardii, Lactobacillus gasseri, Propionibacterium are microorganisms used for dairy fermentation. The beneficial effect of fermented food which contains probiotic organism consumption includes improving intestinal tract health, production of antimicrobial compound, the release of bioactive compounds, production of bacteriocins, enhancing the immune system, reducing symptoms of lactose intolerance, reducing the risk of certain cancers and ensuring food security. Thus, the importance of local bacteria diversity in milk and milk products in Ethiopia should be assessed and explored in the future.

Keywords: *Fermentation, Lactic acid bacteria, Probiotics, Starter cultures*

INTRODUCTION

Starter cultures are an essential component of most commercially produced fermented dairy foods. Simply defined, starter cultures consist of microorganisms that are inoculated directly into food materials to bring about desired and predictable changes in the final product. These changes may include enhanced preservation, improved nutritional value, modified sensory qualities, and increased economic value.

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Although many fermented foods can be made without a starter culture, the addition of concentrated microorganisms, in the form of a starter culture, provides a basis for ensuring that products are manufactured on a consistent schedule, with consistent product quality (Jeygowri et al., 2015).

Starters are formulated in individual or mixed formulations of selected strains with a particular enzymatic activity that when added in a defined concentration to a substrate change it into a food product with specific characteristics (Laranjo et al., 2017). Dairy starter cultures are microorganisms that are intentionally added to milk to create a desired outcome in the final product, most often through their growth and "fermentation" processes (Hasan et al., 2014). Starter organisms can also influence on flavor and texture of fermented products through the breakdown of proteins, fats and other milk constituents in addition to the pH effect. The lower pH of cultured products can be inhibitory to certain spoilage organisms probiotic cultures are finding their way into cultured milk products. These are organisms that have some claimed health benefits for those that consume them, including better digestion, anti-cancer compounds, and prevention of heart disease (Heller, 2001).

Probiotic cultures may be added as adjuncts or they may be directly involved in the fermentation process (Yerlikaya, 2014). They represent potential microorganisms and have been widely applied in food fermentation worldwide due to their well-known status as generally recognized as safe (GRAS) microorganisms. They are also recognized for their fermentative ability and thus enhancing food safety, improving organoleptic attributes, enriching nutrients and increasing health benefits (Rakhmanova et al., 2018). The common use of starter cultures is for the production of lactic acid from lactose (milk sugar) which in most cases causes or assists in the coagulation of milk protein by lowering its pH value (Rabah et al., 2017). Cultures that produce lactic acid are generally referred to as lactic acid bacteria (LAB) belong to numerous genus under the family of Lactobacillaceae (Cogan et al., 2007).

Lactic acid bacteria (LAB) are a group of gram-positive bacteria including the genera *Lactobacillus, Lactococcus, Leuconostoc, Pediococcus,* and *Streptococcus* (Linares et al., 2017). They are widely distributed in nature and found naturally as indigenous microflora in raw milk that play an important role in much food and feed fermentation like yogurt. Most of them are killed by heating to 70 ºC, though the lethal temperature for some is as high as 80 ºC (Akabanda et al., 2014).

The general description of the bacteria included in the group is gram-positive, non-spore forming, *catalase-negative* cocci or rods microorganisms, which produce lactic acid as the major end product during the fermentation of carbohydrates. Lactic acid bacteria are nutritionally fastidious, requiring carbohydrates, amino acids, peptides, nucleic acids and vitamins (Rattanachaikunsopon and Phumkhachorn, 2010). Lactic acid bacteria prefer lactose as a source of carbon. They ferment lactose to lactic acid. The fermentation may be pure or impure, i.e. the end product may be almost exclusively lactic acid (homofermentative fermentation), or other substances may also be produced, such as acetic acid, carbon dioxide and ethanol (Baltova & Dimitrov, 2014).

Many evidences indicated that consumption of "probiotic" microorganisms helps in maintaining a favorable microbial profile and is resulted in several therapeutic benefits (Kumar and Chordia, 2017) also yogurt has been taken in as the food which is good for health from experience for a long time (Otomi et al., 2015). In Ethiopia, there is a report of different species of associated microorganisms (LAB) from a traditionally produced fermented dairy products. The main fermented milk products include ergo (sour milk), ititu (milk curd), ayib (cottage cheese), neter kibe (spiced butter), kibe (traditional butter), aguat (whey) and arerra (sour defatted milk). In the East and southeast parts of Ethiopia, fermented (suusac) camel milk is widely consumed, while in the northwest part, fermented Metata Ayib is prepared using traditional cottage cheese with different spices (Andualem & Geremew, 2014). Therefore, the objective of this paper is to review the use of starter culture in producing probiotic dairy product, significance for health and nutrition security.

2. PROBIOTICS AND MECHANISMS OF BENEFICIAL ACTION

2.1. Probiotics

According to the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO), probiotics are defined as live microbial cultures of a single strain or mixture of different strains that beneficially affect the host, either directly or indirectly, by improving its intestinal microbial balance (FAO and WHO, 2006). Use of beneficial microorganisms in health promotion is not new, and they have been consumed by humans, when administered in adequate amounts which confer a health benefit on the host (Hill et al., 2017) especially in the form of fermented dairy foods, for many years. *Lactobacillus*, *Bifidobacterium*, *Propionibacterium*, *Streptococcus*, *Bacillu*s, *Enterococcus*, and yeasts are most commonly investigated and commercially available probiotics (Ranadheera et al., 2017).

2.2. Mechanisms of Beneficial Action

Probiotics should be nonpathogenic and nontoxic to confer health benefits and provide protection against pathogenic microorganisms using multiple mechanisms they must be able to survive in the gastrointestinal tract and be resistant to gastric juices and bile. They should exert benefits to the host through their activity in the human body. Besides, probiotics should be lacking transferable antibiotic resistance genes. Different bacterial strains of the same genus and species may exert different effects on the host (Fesseha, 2019; Heller, 2001).

Probiotics may exert their beneficial health effects by normalization of the host's microbiota, by inhibition of pathogens, by interaction with the immune system of the host, and through their own metabolic activity. Probiotics may also enhance the recovery of microbiota against detrimental outside factors. However, the molecular mechanisms behind the effects are largely unknown (Linares et al., 2017). Dairy foods (products) are the ideal system for delivering probiotics (bacteria and yeasts) to the human digestive system because of an enabling environment that promotes growth and enhances the survivability of these microorganisms (Niamah, 2017).

Probiotic bacteria have a beneficial effect on the digestive system but in some cases, they may facilitate the translocation or induce infections themselves even if the strain of probiotic bacteria is considered safe, it still can cause bacteremia as opportunistic bacteria (Zawistowska-Rojek and Tyski, 2018). According to a 2002 report jointly released by the World Health Organization and the Food and Agriculture Organization of the United Nations "probiotics may theoretically be responsible for four types of side effects: Systemic infections, Deleterious metabolic activities, Excessive immune stimulation in susceptible individuals, Gene transfer (Doron and Snydman, 2015) so it is necessary to fully understand the mechanisms of activity of probiotic bacteria

3. MICROORGANISMS USED FOR DAIRY FERMENTATION

3.1. Lactobacillus acidophilus

Lactobacillus acidophilus is a gram-positive, anaerobic or facultative anaerobic, non-motile, catalase, rod-shaped bacteria. It is a homo-fermentative bacterium that has an optimum growth temperature of 35-38°C and an optimum pH interval of 5, 5-6^{o}C. It was first isolated from children's feces by Ernst Moro in 1900 and in 1970 it was officially acknowledged as *L.acidophilus* by Hansen and Mocquat. This term means lactic acid bacteria which can show growth in an acidic environment. *L. acidophilus* produces a maximum amount of lactic acid, some acetic acid with no hydrogen and no catalase (Anjum et al., 2014).

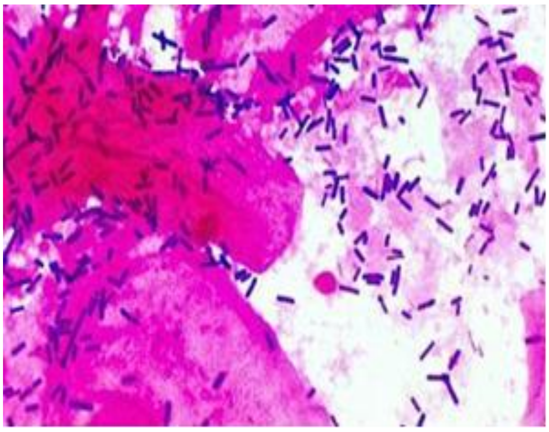

Figure 1: Gram staining of *Lactobacillus acidophilus*
Source: (Anjum et al., 2014).

Lactobacillus acidophilus group can reduce serum cholesterol, possibly through binding of the dietary cholesterol with the cells or deconjugation of bile salts in the small intestine (Sreekumar and Hosono, 2000). Group *L. acidophilus* has an antimicrobial effect due to the formation of organic acids (lactic acid, acetic acid, etc.), H2O2 and antibiotic substances (Lactocidin, Acidophilin, Acidolin, Lactocin). As a result of *L. acidophilus* traits, intestinal infections and diseases can be brought under control and negative effects of antibiotic treatment can be eliminated. *L. acidophilus* is resistant to bile acid and has a strong antibiotic effect on fecal *E. coli* strains and other intestinal pathogens (Shaghaghi et al., 2013). Due to originating from intestinal microbiota, Studies have shown that ingested *L.acidophilus*, either through a product or pure culture, can be absorbed in intestines, can adapt and survive in gastric juice for two days and longer in bile secretion and feces (Yerlikaya, 2014).

3.2. Bifidobacterium

Bifidobacterium is a genus of bacteria that is non-motile, gram-positive, non-sporulating, anaerobic bacilli. They were discovered at the turn of the twentieth century by Tissier in stools of breast-fed infants and attracted attention because of their important physiological significance to the host organism. Bifidobacteria were named after their peculiar Y-shape (Figure 2) when the genus was created to differentiate these bacteria from lactobacilli. Species that are important human gut bacteria include *Bifidobacterium bifidum*, *Bifidobacterium infantis*, *Bifidobacterium adolescentis*, and *Bifidobacterium longum* (Turroni et al., 2014).

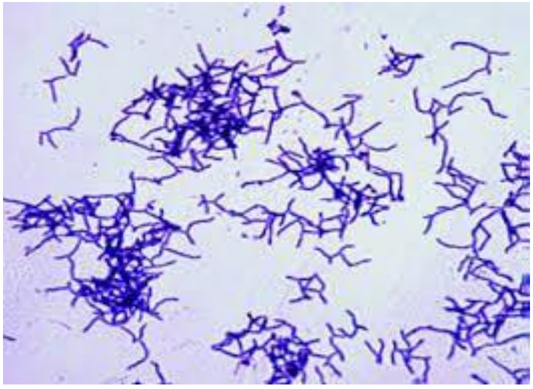

Figure 2: Gram stain of Bifidobacterium spp.
Source: (Engevik et al., 2019)

The widespread use of *Bifidobacteria* in fermented foods and dairy products has a long history, and most strains are considered commensal microorganisms with no pathogenic potential. From the safety's point of view, *Bifidobacteria* are considered to be beneficial for the host by inhibiting the growth of potentially harmful bacteria in the intestinal tract and by exhibiting beneficial effects for the host. The production of lactic acid and acetic acid contributes to the Bifidobacteria's defense against pathogens through the toxic effect of the Dissociated acids on the microorganisms and stimulation of intestinal peristalsis (Fesseha, 2019; Roy, 2005).

Bifidobacteria are known to produce thiamine, riboflavin, vitamin B_6, and vitamin K. There have also been reports of their ability to synthesize folic acid, niacin, and pyridoxine. These vitamin B complexes are slowly absorbed in the human body. Available information on the nutritional properties of fermented milks containing *Bifidobacteria* indicates that they have lower residual lactose and higher levels of free amino acids and vitamins than non-fermented milk (Otomi et al., 2015).

Additionally, they especially contain l (+)-lactic acid [produced by *Bifidobacteria* in addition to acetic acid, whereas lactobacilli produce d/l (−)-lactic acid], which is more easily metabolized by humans. Consuming bifidobacterial food products may also improve the bioavailability of certain minerals, including calcium, zinc, and iron, by lowering the gastric pH (facilitating ionization of minerals, which is necessary for their uptake) (McCartney, 2003). *Bifidobacteria* have been attributed to the induction of immunoglobulin production, improvement of food nutritional value by assimilation of substrates not metabolized by the host, anti-carcinogenic activity and folic acid synthesis. Within various probiotic bacteria, *Bifidobacterium lactis* has been studied intensively and its beneficial roles for host health have been described (Yerlikaya, 2014).

3.3. Lactobacillus casei

The *Lactobacillus casei* group, comprised mainly of the closely related *Lactobacillus casei*, *Lactobacillus paracasei*, and *Lactobacillus rhamnosus* species, are among some of the most studied species due to their commercial, industrial and applied health potential. Commercially, they are used to ferment dairy products, often producing foods with improved flavor and texture. They have also been found to produce many bioactive metabolites that can confer host benefits when consumed (Dietrich et al., 2014). *Lactobacillus* is the most common genera from which probiotics have been derived and *L casei* is a commonly utilized probiotic species. *L. casei* strains have been shown to alter the microbiota in the gut and influence the host immune response (Aktas et al., 2016).

Health benefits associated with the *Lactobacillus casei* group have been reported for a variety of health conditions, ranging from atopic dermatitis to cancer. The mechanisms by which these bacteria directly or indirectly have a beneficial effect on human health are not yet fully understood and require further study. Potential mechanisms include the production of antimicrobial substances such as bacteriocins, enhancing the epithelial barrier through attachment, competition for pathogenic binding sites, or modulation of the immune system (Aktas et al., 2016; Fesseha, 2019).

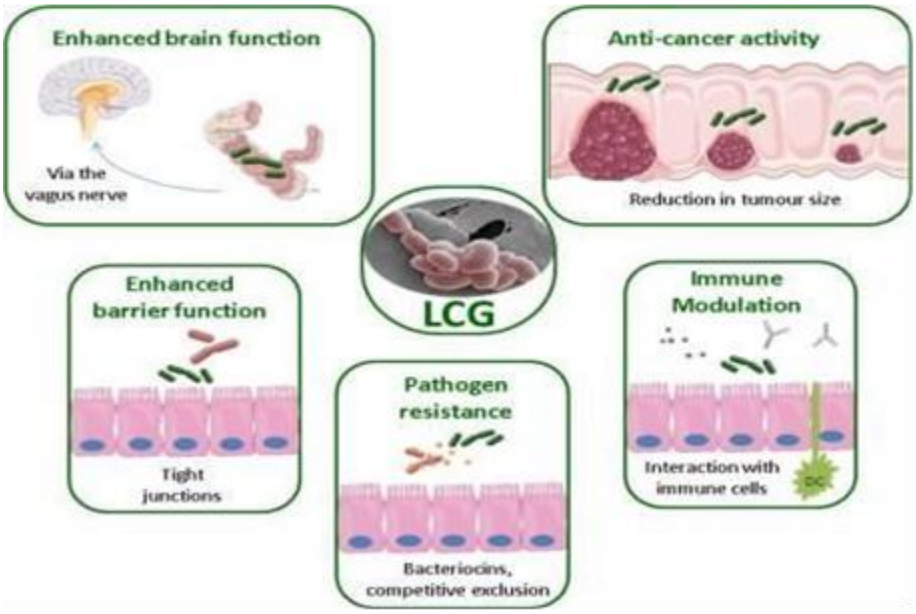

Figure 3: Health benefits associated with the *Lactobacillus casei* group
Source: (Aktas et al., 2016)

3.4. Streptococcus thermophiles

Streptococcus thermophilus is a Gram-positive bacterium showing ovoid cells occurring in pairs or short chains. It is a thermophilic bacterium with an optimal growth temperature of 42 C and an aerotolerant anaerobe organism. *S. thermophilus* belongs to the salivarius group which also includes *S.*

salivarius and *S. vestibularis* (Facklam et al., 2005). The genome of *S. thermophilus* is 1.8 Mb making it among the smallest genomes by comparison to other LAB and other *Streptococcus* strains (Uriot et al., 2017).

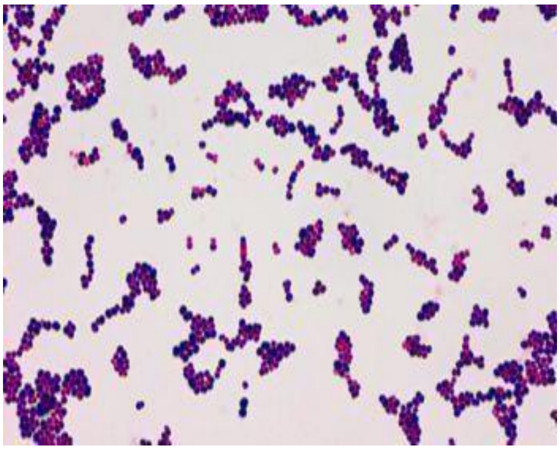

Figure 4: Gram stain *Streptococcus thermophiles* Source: (Facklam et al., 2005)

Streptococcus thermophilus has been exploited industrially for making cheese as well as yogurt. One of the most important properties of this bacterium that is being used is a production of lactase, an enzyme that converts lactose (milk sugar) into a simple sugar, which helps people who are lactose intolerant to digest milk. So, consumption of this microbe has facilitated to alleviate symptoms of lactose intolerance and other gastrointestinal problems. Due to this unique feature of the microbe, it has been added to several health supplements along with other bacteria with similar properties. Over and above, it also produces a variety of antagonistic factors that include metabolic end products, antibiotic-like substances and bactericidal proteins, termed bacteriocins which assist to prevent several types of infections from various pathogenic microbes. Besides, the bacterium is endowed with enormous important beneficial properties (Sharma et al., 2014).

3.5. Lactobacillus rhamnosus

Lactobacillus rhamnosus is a Gram-positive, non-spore forming, facultative anaerobic or microaerophilic, non-motile and catalase-negative bacterium. It belongs to mesophilic organisms, but in dependence on the strain, its cultures may grow at temperatures lower than 15°C or higher than 40°C. To grow, it requires a lot of vitamins including folic acid, riboflavin, niacin, pantothenic acid and mineral calcium (Shaghaghi et al., 2013). The optimal initial pH value for the growth is in the range from 6.4 to 4.5. It grows as rods, single rods or in short chains. The dimension of the cells is from 0.8 to 1.0 μm in width and 2.0 to 4.0 μm in length (Liptáková et al., 2008).

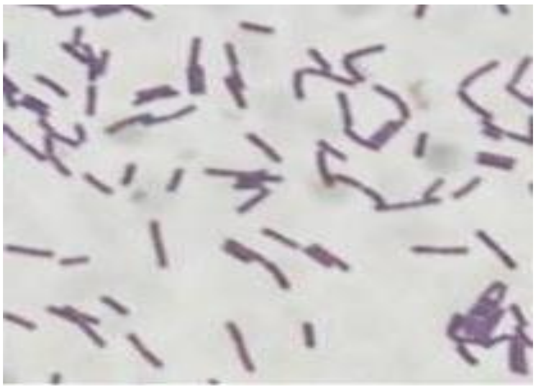

Figure 5: Gram stain *Lactobacillus rhamnosus* Source: (Liptáková et al., 2008)

Lactobacillus rhamnosus GG is a clinically documented bacterial strain that is used in many countries as a probiotic culture in different dairy products or pharmaceutical diet supplements (Korpela et al., 2016). This bacterium is considered Generally Recognized as safe (GRAS) microorganism. *L. rhamnosus* GG is a homofermentative L-(+)-lactic acid producer (Leja et al., 2009). *Lactobacillus rhamnosus* GG is one of the most researched probiotic strains worldwide, which was clinically studied and was found to enhance human natural resistance and a healthy digestive system. The strain was able to inhibit adhesion of *Clostridium histolyticum*, *Cl. difficile* and *Salmonella enterica* and it is available for consumers all over the world in numerous food products and supplements. GG was isolated from a fecal sample of a healthy human in the early 1980s (Korpela et al., 2016).

It is one of the important probiotic species for yogurt manufacture, preventing different infections due to bacteriocin production. it has been established that *Lactobacillus rhamnosus* has anticolitis and anti cardiovascular disease affects as consumption of yogurt containing this bacterium plays an effective role in reducing the incidence of cardiovascular diseases (Shaghaghi et al., 2013). The combination of *L. rhamnosus* GG with *L. rhamnosus* inhibited the growth of *Staphylococcus aureus*, *E. coli* and *S. enterica*. However, to inhibit *Cl. difficile*, the best combination was *L. rhamnosus* GG, *L. rhamnosus* LC705, and *Propionibacterium freudenreichii* JS. The combination of *L. rhamnosus* GG, *P. freudenreichii* and *L. plantarum* inhibited *clostridia* and *Listeria monocytogenes* (Liptáková et al., 2008).

3.6. Enterococcus Faecium/Enterococcus Faecalis

The genus *Enterococcus* is Gram-positive, catalase-negative, non-spore-forming, facultative anaerobic bacteria and tolerant to a wide range of conditions temperature (10-45°C), pH (4.5-10.0) and high sodium chloride concentrations that can occur both as single cocci and in chains. *Enterococci* belong to a group of organisms as lactic acid bacteria that produce bacteriocins, (Bhardwaj et al., 2013). *Enterococci* is used in food fermentation as starter cultures, being responsible for the formation of unique flavors. Some strains present probiotic properties due to health-promoting effects. Some of them may inhibit the growth of pathogenic and spoilage microorganisms, presenting a potential application in food preservation (Bhardwaj et al., 2013; Gomes et al., 2010).

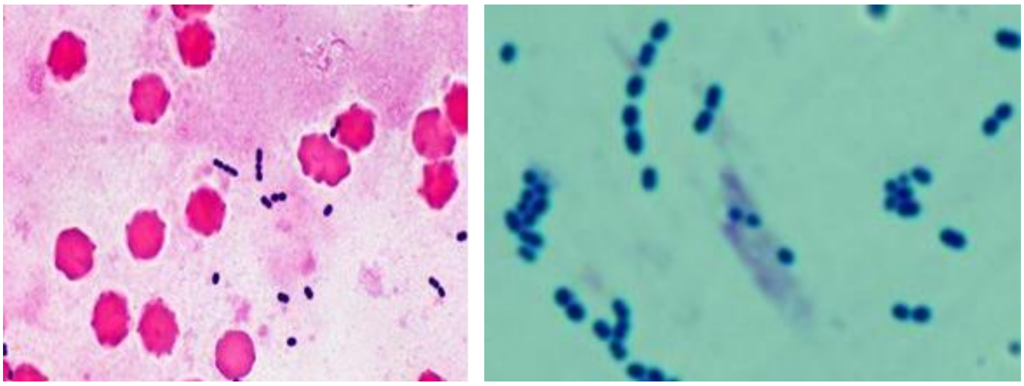

Figure 6: Gram stain of *Enterococcus Faecium/Enterococcus Faecalis*
Source: (Bhardwaj et al., 2013)

It comprises more than 20 species they are widely distributed in nature (Gomes et al., 2010). Specific strains of *E. faecium* and *E. faecalis* are the only enterococci used as probiotics or feed additives. Strains produce a wide variety of bacteriocins often called enterocins. They have been widely studied, mainly because they are active against Gram-positive foodborne pathogens, such as L. monocytogenes (Fisher & Phillips, 2009). Enterococcal bacteriocins have attracted great research interest as natural antimicrobial agents in the food industry, and as a potential drug candidate for replacing antibiotics to treat multiple drug resistance pathogens (Hanchi et al., 2018). *Enterococcus faeciums* usage on diarrhea treatment is considered to be an alternative for antibiotic use. The probiotic effect of *Enterococcus faecium* on humans arises out of reducing the absorption of cholesterol from the digestive system (Erginkaya et al., 2018; Erginkaya et al., 2007).

3.7. Saccharomyces Cerevisiae var. boulardii

It is eukaryotic, single-cell, a yeast cell, the diameter is between 2-3 μm and length is between 2.5-10.5 μm, non-sexual reproduction by budding method or sexual reproduction by cells conjugation. *S. boulardii* has an optimal high growth temperature at 37°C (Pandiyan and Kumaresan, 2013). *Saccharomyces boulardii* is non-pathogenic probiotic yeast as a live-in human gastrointestinal and used to a variety of diarrheal treatment with antibiotics and can tolerate gastric acidity and antibiotics (Asmat et al., 2018). The metabolic extract of *S. boulardii* had inhibition activity against 26 species of food-related bacteria (Niamah, 2017). This yeast secretes many enzymatic proteins, including an enzyme that inhibition for *Clostridium difficile* toxins and phosphatase enzyme (EC 3.1.3.X) that depressed activity endotoxin production from Gram-negative bacteria such as the lipopolysaccharide produced by *E. coli* (Corrado and Rodrigues, 2004).

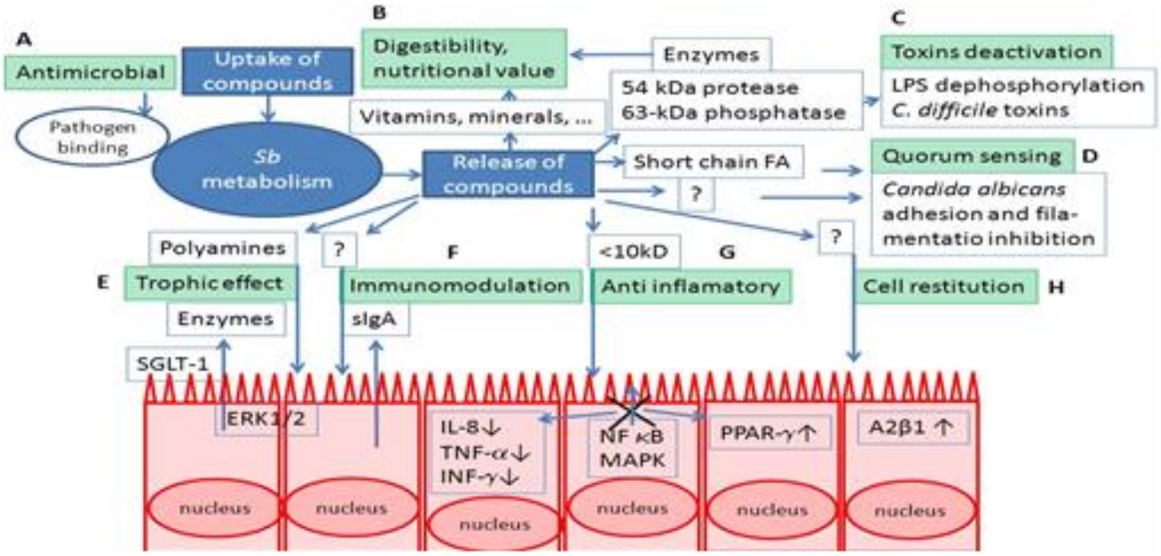

Figure 7: Importance of *Saccharomyces cerevisiae var. boulardii*
Source: (Asmat et al., 2018)

3.8. Propionibacterium Species

Microorganisms belonging to the genus Propionibacterium are Gram-positive, usually pleomorphic, non-spore-forming, non-motile, range from anaerobic to aerotolerant, generally catalase-positive and can ferment lactate to short-chain fatty acids, mainly propionate and acetate (de Freitas et al., 2015).

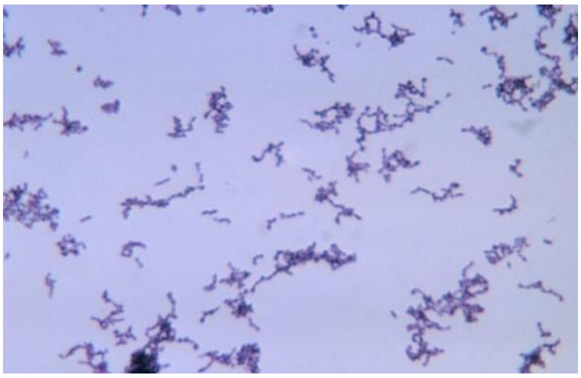

Figure 8: Gram stain of *Propionibacterium freudenreichii*
Source: (de Freitas et al., 2015)

Dairy propionibacteria are used as starters, as bio preservatives, and as beneficial additives, in the food industry. The main species, *Propionibacterium freudenreichii*, is known as GRAS (Generally Recognized as Safe, USA, FDA). In addition to another dairy species, *Propionibacterium acidipropionici*, they are included in QPS (Qualified Presumption of Safety) list. Dairy *propionibacteria* increasingly attract attention for their promising probiotic properties (Rabah et al., 2017).

These days there are clear conformation that *propionibacteria* used alone or combined with other microorganisms can exert beneficial effects in the host. Dairy *propionibacteria* have proven to possess many promising properties such as the production of useful substance like vitamin B_2, B_{12}, K, and conjugated linoleic acid, and their health-promoting effects could be attributed to one or more of the following modes of action: i) influence on gut microbial composition and exclusion of pathogens; ii) modulation of the metabolic activities of the microbiota and host, and iii) immunomodulation. The most documented probiotic effects for *propionibacteria* within these categories include bifidogenic effect in the human gut, improvement of nutrients utilization, hypocholesterolemic effect and anticarcinogenic potential immune system stimulation (Zárate, 2012).

3.9. Lactobacillus Gasseri

Lactobacillus gasseri is one of the most common homo-fermentative *Lactobacillus* species isolated from the human intestine. *L. gasseri* demonstrates good survival in the GIT and has been associated with a variety of probiotic activities and roles including reduction of fecal mutagenic enzymes, stimulation of macrophages and production of bacteriocins (Gunyakti and Asan-Ozusaglam, 2019; Itoh et al., 1995). *L. gasseri* suppresses the reabsorption of bile acids into the enterohepatic circulation and enhances the excretion of acidic steroids in feces of hypercholesterolemia rats thereby reducing the concentration of serum cholesterol in the blood (Singroha et al., 2017)

Lactobacillus gasseri elicits various health benefits through its antimicrobial activity, bacteriocin production, and immunomodulation of the innate and adaptive systems, inhibitory activity against some pathogenic and food-spoilage species and amelioration of diarrhea (Selle and Klaenhammer, 2013). *L. gasseri* was selected as having suitable probiotic and cultural characteristics for the production of fermented milk products with high nutritional and biological value (Baltova and Dimitrov, 2014). Study reported that yogurt containing *Lactobacillus gasseri* is effective against *Helicobacter pylori* (*H. pylori*), improved the pepsinogen I/II ratio in H. pylori-positive healthy volunteers and patients with *H. pylori* infection, inhibits the formation of HCL-induced acute gastric lesions through the generation of prostaglandin E2 and healing of acetic acid-induced chronic gastric ulcer (Otomi et al., 2015). It contributing to indigenous colonization includes tolerance of low pH environments, resistance to bile salts, and adhesion to the host epithelium in humans (Selle & Klaenhammer, 2013).

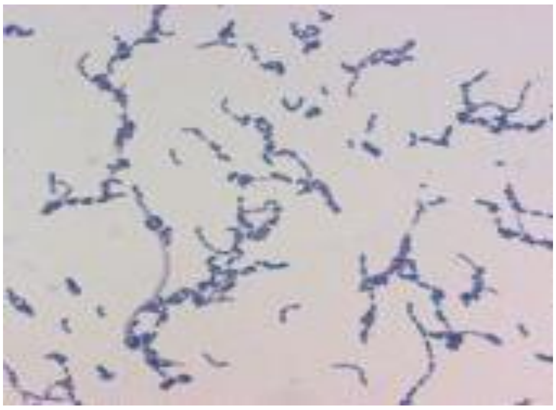

Figure 9: Gram stain of *Lactobacillus gasseri*
Source: (De Backer et al., 2007)

4. IMPORTANCE OF STARTER CULTURE

4.1. Antimicrobial Activity

Antimicrobial compounds produced by lactic acid bacteria, the preservative action of starter culture in food and beverage systems is attributed to the combined action of a range of antimicrobial metabolites produced during the fermentation process (Widyastuti & Febrisiantosa, 2014). These include many organic acids such as lactic, acetic and propionic acids produced as end products which provide an acidic environment unfavorable for the growth of many pathogenic and spoilage microorganisms. Acids are generally thought to exert their antimicrobial effect by interfering with the maintenance of cell membrane potential, inhibiting active transport, reducing intracellular pH and inhibiting a variety of metabolic functions (Rattanachaikunsopon & Phumkhachorn, 2010).

They have a very broad mode of action and inhibit both gram-positive and gram-negative bacteria as well as yeast and molds. One good example is propionic acid produced by propionic acid bacteria, which has formed the basis for some bio preservative products, given its antimicrobial action against microorganisms including yeast and molds. In addition to acids, starter strains can produce a range of other antimicrobial metabolites such as ethanol from the heterofermentative pathway, H_2O_2 produced during aerobic growth and diacetyl which is generated from excess pyruvate coming from citrate (Cizeikiene et al., 2013).

In particular, H_2O_2 can have a strong oxidizing effect on membrane lipids and cellular proteins and is produced using such enzymes as the flavoprotein oxidoreductases, NADH peroxidase, each antimicrobial compound produced during fermentation provides an additional obstacle for pathogens and spoilage bacteria to overcome before they can survive and proliferate in a food or beverage, from time of manufacture to time of consumption. Since any microorganism may produce several inhibitory substances, its antimicrobial potential is defined by the collective action of its metabolic products on undesirable (Linares et al., 2017).

4.2. Relies on Bioactive Compound

Bioactive peptides are specific fragments of milk proteins that are released by proteolytic activity from caseins predominantly and also from whey proteins. Antihypertensive, antimicrobial, antioxidative, and immune-modulatory activities have been described for peptides released as a result of the activity of LAB in fermented milk products (Linares et al., 2017). Health-promoting properties of fermented dairy products are due to the synthesis or the release from the food matrix of bioactive compounds as a result of the metabolic activity of LAB, propionic bacteria, yeast, and molds. Worth mentioning are among others, bioactive peptides, vitamins, gamma-aminobutyric acid (GABA), and oligosaccharides (Hove et al., 2015). Although milk contains vitamins, fermentation by LAB often leads to the enrichment of some of them, as it is the case for vitamin B12, folic acid, and biotin produced by propionic bacteria. Conjugated Linoleic Acid (CLA) is a native component of milk fat. Its content can be increased in fermented milk through bioconversion of unsaturated fatty acids such as linoleic and linolenic acids by different LAB. The functionality of CLA has been well documented concerning its anti-inflammatory, antiatherogenic, and antioxidant properties (Villar-Tajadura et al., 2014).

4.3. Production of Bacteriocins

Bacteriocins are ribosomally synthesized antimicrobial compounds that are produced by many different bacterial species including many members of the lactic acid bacteria (Hill et al., 2017). Some bacteriocins produced by lactic acid bacteria, such as nisin, inhibit not only closely related species but are also effective against foodborne pathogens and many other gram-positive spoilage microorganisms (Selle & Klaenhammer, 2013). For this reason, bacteriocins have attracted considerable interest for use as natural food preservatives in recent years, which have led to the discovery of an ever-increasing potential source of these protein inhibitors. Since bacteriocins are isolated from foods such as meat and dairy products, which normally contain lactic acid bacteria, they have unknowingly been consumed for centuries. A study of 40 wide type strains of *Lactococcus lactic* showed that 35 of them are produced nisin (Ross et al., 2002).

Nisin is the only bacteriocin with GRAS (Generally Regarded as Safe) status for use in specific foods and this was awarded as a result of a history of 25 years of safe use in many European countries and was further supported by the accumulated data indicating its nontoxic, non-allergenic nature. Other bacteriocins without GRAS status will require premarket approval. Therefore, bacteriocinogenic starters, particularly if used in natural fermentations, will most likely afford the best opportunities for the application of bacteriocins soon (Rattanachaikunsopon & Phumkhachorn, 2010).

4.4. Alleviation of Lactose Intolerance

Intestinal lactase deficiency leads to Lactose intolerance (LI) and this condition is found across the globe (Gayathri and Vasudha, 2018) the inability of adults to digest lactose or milk sugar, is prevalent worldwide. Consumption of lactose by those lacking adequate levels of lactase produced in the small intestine can result in symptoms of diarrhea, bloating, abdominal pain and flatulence. Milk with cells of *L. acidophilus* aids the digestion of lactose by such persons (Fassio et al., 2018). It has been documented that many lactose-intolerant individuals are better able to consume fermented dairy products, such as yoghurt, with fewer symptoms than the same amount of unfermented milk. Yoghurt was found to be helpful in the digestion of lactose because the lactic acid bacteria used to make yoghurt produce lactase and digest the lactose (Panesar, 2011).

4.5. Anticarcinogenic Effect

It has been reported that fermented milk products can protect against certain types of cancers. Some epidemiological support is also there. Consumption of yoghurt, Gouda cheese, buttermilk protects against breast cancer. Animal studies have shown that lactic acid bacteria exert anticarcinogenic effect either by prevention of cancer initiation or by suppression of initiated cancer (Rakhmanova et al., 2018). Anticarcinogenic effects of yoghurt and milk fermented with *L. acidophilus* have been reported in mice. Different potential mechanisms by which lactic acid bacteria exert antitumor effects have been suggested such as changes in ported that *L. acidophilus* has exhibited the ability to lower serum cholesterol levels (Hasan et al., 2014). This promotes the potential healthful aspects of dairy products fermented with *L. acidophilus* (or other lactic acid bacteria) since hypercholesterolemia is considered to be one of the major factors contributing to cardiovascular disease. However, some strains may likely demonstrate this property while others do not (Panesar, 2011).

4.6. Immune System Stimulation

The immune system provides the primary defense against microbial pathogens that have entered our bodies. The immune-stimulatory effects of yoghurt are believed to be due to its bacterial components (Hasan et al., 2014). Studies have shown an effect of yoghurt or lactic acid bacteria on enhancing levels of certain immune reactive cells or factors. Milk components such as whey protein, calcium, certain vitamins, and trace elements are also capable of influencing the immune system. Studies have shown that cytokine production, phagocytic activity, antibody production, T-cell production, etc. are increased with yoghurt consumption or with lactic acid bacteria (Panesar, 2011).

4.7. Food Security and Cultural Importance

The fermentation of food plays an important role in ensuring the food security of millions of people around the world, particularly marginalized and vulnerable groups (Marshall & Mejia, 2011) This is achieved through improved food preservation, increasing the range of raw materials that can be used to produce fermented food products and removing anti-nutritional factors to make food safe to eat and to prolong their shelf-life. Fermentation is a cheap and energy-efficient means of preserving perishable raw materials (Hasan et al., 2014).

4.8. Vitamins Metabolism

Milk contains a lot of water or fat-soluble vitamins when starter cultures are growing in milk, some vitamins may be utilized by them. On the other side, some vitamins might also be synthesized, leading to expanded content material in fermented milk. This increase or reduce relies upon appreciably on the strain of starter. However, commonly it is stated that yoghurt microorganism synthesizes folic acid, niacin and vitamin B6. Propionic bacteria are recognized to produce nutrition B12 (Rakib et al., 2017).

CONCLUSION AND RECOMMENDATIONS

Fermented dairy products are crucial to the human diet due to the increasing demand for safe and functional food consumption of new and enriched foods has shown growth to higher rates. The use of any probiotic substance for the enrichment of fermented products provides its delivery into human GIT and hence, a stimulation of beneficial health effects Importance of some LAB strains belong to the normal microflora of GIT is completely well-known. Lactic acid bacteria display numerous antimicrobial activities in fermented foods. This is mainly due to the production of organic acids, but also other compounds, such as ethanol, H2O2, diacetyl, reuterin, nisin, and bacteriocins. Bacteriocins, that inhibit not only closely related species but also effective against foodborne pathogens and many other gram-positive spoilage microorganisms, have attracted considerable interest for use as natural food preservatives in recent years. Thus, the lactic acid bacteria play an important role in dairy food fermentation as starter cultures to improve food quality and safety. However, careful selection of specific strains will be necessary to ensure that desired benefits are provided to consumers and studies in different parts of the world can be carried out to explore the diversity of the fermenting bacteria.

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