ABSTRACT

Popular dairy product yoghurt is fermented with the potential of health-promoting characteristics. It is considered a nutrient-dense foodstuff enriched with calcium, providing bioavailable form. The essential amino acids required for optimal health are present in Yoghurt. It may also be a probiotic carrier that may transfer large probiotic bacteria into the body, providing unique health benefits. Milk proteins in yoghurt are of higher biological value. Yoghurt is also said to help with lactose tolerance, immunological boosting, and the prevention of gastrointestinal problems. Consumer demand for Yoghurt and its products has surged due to these well-known health benefits, and it has become the fastest-growing dairy industry. Yoghurts are available in various styles, differing in fat content, flavor profile, and texture, making them suited for multiple meal settings. The current review covers yoghurt history, varieties, processing technology, and the nutritional profile of Yoghurt.

Keywords: Yoghurt, Probiotic, Functional food, Dairy industry
INTRODUCTION

Yoghurt is a widely consumed dairy product. Its health benefits promoting properties have been extensively documented for a period. Its origins can be traced back to 6000 B.C., when the Neolithic people of Central Asia transitioned from food gatherers to food producers, beginning to milking their animals (1). It is supposed that fermented milk products, such as Yoghurt, were accidentally discovered during storing milk in sheepskin bags. Commercial processing of Yoghurt evolved in years, paving the way for flavours, consistency, and textures commercially (2).

By culturing one or more dairy ingredients like cream, milk, skim, partially skimmed milk alone or combined with lactic acid-producing bacteria, *Lactobacillus bulgaricus* and *Streptococcus thermophilus* yoghurt is produced (3). According to the US FDA standards, before incorporating flavoring additives the yoghurt compositional requirement for milk fat and MSNF is adapted to the Yoghurt. Yoghurt is traditionally produced from cows' milk, water buffaloes, goats, and sheep. According to current studies, the health advantages of consuming Yoghurt have been widely documented for centuries (4).

The spontaneous acidification of milk obtains Yoghurt conducted employing scission-milk sugar, i.e., lactose into glucose and galactose, and the ensuing lactic acid production. The process of fermentation begins with microflora, including. Bacteria that ferment lactose into lactic acid are *Lactobacillus sp. Bulgaricussp. Streptococcus sp. and Thermophilus sp.* Yoghurt is defined as the food produced by culturing the milk or different types of milk in controlled conditions containing lactic acid-producing bacteria (*Lactobacillus bulgaricus, Streptococcus thermophilus*). Due to its health benefits and sensory attributes Yoghurt, have a significant effect on consumer acceptability (5). The standard parameters for the acceptability of dairy products are mouth feel as proper curd formation or smoothness. Different sorts of fermented milk products are available, and other lactic starter bacteria are used for various products (6).

Through the fermentation of lactic acid bacteria Yoghurt is obtained. In fermented foods lactic acid is the primary preservation agent since it lowers the pH and increases the acidity of the meal, restraining the growth of most other bacteria. The pH of Yoghurt ranges from 4.4 to 4.6. Low pH (4.4) or the use of poor-quality milk starting culture causes yoghurt to be overly sour. *Lactobacillus bulgaricus* strains can also give Yoghurt a bitter flavor (7).
Lactic acid bacteria, through fermentation, produce nutritional milk products. The presence of proteins in the hydrolyzed Yoghurt increases their availability in the human body. As compared to cheese, Yoghurt has more nutritional attributes with whey proteins as in the cheese-making process; whey proteins drain off. These factors enhance the nutritional value of yoghurt (5).

The fermentation process does not create any specific change in the energy value of milk. When lactic acid from lactose is produced, it decreases the energy content by a minimum (8). pH value increases in the stomach due to the consumption of fermented milk and reduces the potential risk of diseases by pathogens. Lactic acid bacteria produce antibiotic compounds that destroy pathogenic microorganisms. Sour milk product such as Yoghurt is more accessible to digest for lactose-intolerant than plain milk (9).

Yoghurt culture is responsible for the acidification and fermentation of milk. Commonly used Yoghurt cultures are lactobacillus bulgaricus and streptococcus thermophilus. The purpose of these bacteria is to produce lactic acid that maintains the acid value in the human body and prevents pathogenic microorganisms' growth. Breaking of lactose occurs due to Streptococcus thermophilus that helps digest lactose intolerant individuals more manageable (10). Yoghurt culture bacteria produce lactic acid, prevents the growth of harmful bacteria which helps maintain an acidic environment in the gut. In fermentation, both catabolism and anabolism processes are involved. Catabolism produces good flavor and quality Yoghurt, while anabolism provides such compounds with preservative and health-promoting attributes. This process also offers polysaccharides to modify the texture of Yoghurt (11).

In dairy products, Lactobacillus bulgaricus produces non-essential amino acids (glycine, alanine and lysine) from milk proteins used by S. thermophilus. Streptococcus thermophilus splays a vital role in improving the enzymes present in the liver involved in non-alcoholic fatty liver diseases. This bacterium helps prevent B.V. (Bacterial Vaginosis) and URI's (Upper Respiratory Infections). Both Yoghurt cultures must be present in the same ratio for good flavour development (12). Low acid development and improper culture growth occur due to different fermentation conditions and specific compounds current in milk. High numbers of somatic cells in milk reduce Yoghurt culture's 35% growth activity. These cells become inactivated after boiling or heating the milk for 2 minutes and 90°C for 20 minutes, respectively (13).
The growth of the Yoghurt culture depends on each other. Both (*Streptococcus thermophilus* and *lactobacillus bulgaricus*) support the development of each other. The concentration used of these bacteria is based on strains characteristics and is mostly in equal ratio like 1:1.(13)

By using lactic starter cultures lactic acid is produced from glucose. These starters have many other functions which include paying flavor, aroma and alcohol, proteolytic and lipolytic activities, and inhibition of undesirable organisms. These Yoghurt cultures are thermophilic grow at 40-45°C. Yoghurt must contain 3.25% milk fat, 8.25% milk solids, not fat and titratable acidity of not less than 0.9%, expressed as lactic acid (14).

Lactic acid bacteria are gram-positive, acid-tolerant, dominant in anaerobic conditions, and ferment food by hetero-fermentation or homo-fermentation. Without gas (CO2) production and flavour compounds in homo-fermentation lactic acid is the end product. Principal end product is the lactic acid in hetero-fermentation, (15). Still, specific amounts of one or more metabolites are produced, e.g., fatty acids of short chains such as acetic acid and propionic, CO2, and acetaldehyde (a significant Yoghurt flavor component) ethyl alcohol. As the consequence of the fermentation of carbohydrates, final product produced is lactic acid (16).

Freeze drying is an effective way to preserve starter cultures. Lyophilization is primarily used in freeze-drying to freeze the sample and extract the water in vapour using a high-pressure vacuum. Freeze drying does not change the basic chemical structure of both solids and liquids, maintains the product's physical system and preserves it for storage and transport. The natural size, composition and consistency of the sample are retained (17).

In Yoghurt, solid contents are improved by adding whey protein and stabilizers or sugar; it makes the textural characteristics better. Pectin is also used to give a specific curd shape to Yoghurt in different dairy industries. The exact time and incubation temperature are significant for texture development. Yoghurt quality depends on the incubation time, temperature and percentage of inoculation (13).

Due to these factors, the solid and smooth texture of Yoghurt is obtained. In Yoghurt production, large milk proteins convert into smaller milk protein molecules, and polypeptides are released with high biological activities during proteolysis. Microbial enzymes also play a role in the breakdown of proteins during fermentation, resulting in a loss in their biological properties (12).
Yoghurt general manufacturing procedure

Yoghurt production started thousands of years ago is an oldest method, from generation to generation the manufacturing information has been speeded. However, it developed into more logical during the last few years because of enhancing different areas, e.g., food engineering, microbiology and biochemistry. Now, it is a multifaceted process combined with science and art. (16).

The widespread methodology of manufacturing yoghurt consists of adjusting the initial composition of the milk, pasteurization of yoghurt mix, fermenting at thermophilic temps, such as 40-45 °C, cooling as well as adding flavors or fruits. Pakistan and India are the largest milk producers in Asia, while soy milk and dairy products are significant (18). The demand for ready-made or processed milk products intensifies day by day as the population increases, particularly for various varieties of milk, cheese and milk products containing low lactose levels, in enhancing due to rising level of lactose intolerance in people (19). Overall, Fermented milk products had turned into the central part of our meal. Yoghurt was one of the most popular products among dairy products.

General manufacturing steps of Yoghurt

- Selection of milk
- Standardization of milk
- Homogenization
- Heat treatment
- Inoculation and fermentation
- Cooling and Storage (18)

Selection of milk

Milk is a highly nutritious and essential part of the diet, but it is also a perfect medium for the growth of several pathogenic microorganisms. In yoghurt manufacturing selection of high-quality milk is very important and free from any diseases causing microorganism (20).

Standardization of milk

The solid content of Yoghurt must be 14-15% in commercial Yoghurt and 8.2-8.6% SNF. Yoghurt must contain 2.7% protein content and 15% fat content. Bovine milk is composed of lactose. Protein, fat and mineral content in a quantity of 4.5 %, 3.5% and 0.7%, respectively. Different types of yoghurts have different compositions depending on the product being
processed (6). Yoghurt should contain 2.7% protein. < 15% fat and titratable acidity that should be not less than 0.3% stated as lactic acid. Primarily, Skim milk and cream are used to obtain the desired level of solid contents. Yoghurt that is selling in the market should contain milk solids in 14 to 15 percent (21).

**Homogenization**

Homogenization decreases the size of fat globules to less than 1µ. The purpose of homogenization is the uniform distribution of fat in milk. Consequently, a separate creamy layer does not show on the top of the yoghurt layer and enhances the uniformity in Yoghurt. An equipment homogenizer or visualizer is used for homogenization (22). Milk is added into the homogenizer over a tiny hole or passage with pressure. Fat globules distribute into equally and uniform sizes. Milk is generally homogenized using pressure 20MPa at 55°C. Yoghurt firmness and water holding capacity increase by homogenization as compared with the ultra-high-pressure conventional homogenization processes. Fat globules size decreases to 1- 2µm by homogenization (6). Due to homogenization fat accumulation on the top layer of milk in the form of clusters does not occur. Fat globules increase surface area and enhance interactions between fat and casein protein (23).

**Heat treatment**

In the manufacturing process of Yoghurt, the heating of milk is an essential step that significantly affects Yoghurt's physio-chemical characteristics. Heating destroys the pathogenic microorganism present in milk and increases milk's shelf life. Heat treatment can be a continuous or batch process. The combinations of time-temperature for the batch process are 90-95 °C for 5 minutes (24). It is essential to destroy the heat resistant pathogen (Coxiella burnetii cause Q-fever in humans). Heat treatment of milk is also necessary to inactivate enzymes and other spoilage organisms present in milk (25). To destroy the disease-causing bacteria is the primary purpose of heat treatment (pasteurization). If the time-temperature combination (63 degrees for 30 mins or 72 degrees for 15 seconds) increases, then some nonpathogenic microorganisms are inactivated that change the physical properties of milk constituents. At 42 to 44 °C, Yoghurt is subjected to cooling immediately after heat treatment (18).
Fermentation and inoculation

After cooling, yoghurt culture is added to milk at the level of about 2 % v/v. Yoghurt culture (S.thermophilus and L. delbrueckii subsp. Bulgaricus) are equally added in milk. A container made up of stainless steel without any bacteria is used to inoculate media (26). Fermentation is done in individual containers to manufacture frozen Yoghurt, while large hygienic stainless-steel vats are used for stirred Yoghurt. Incubation temperature is maintained. The fermentation process is continued for 2-3 hours till the pH and acidity get their required levels. Further fermentation can be prevented by rapid cooling if lactose is converted into lactic acid during the fermentation process. Lactic acid bacteria coagulate milk proteins and produce certain volatile compounds to impart flavor and aroma. The best temperature for inoculation is 45 degrees for 4-6 hours (25).

Cooling and packaging

When the fermentation process stops and desired pH (4.5-4.6) of Yoghurt are achieved, cooling is done at refrigerated temperature (< 10 °C) to stop the fermentation process as well as more acid production. After this, set-type Yoghurt is sent to the cold storage in a straight line or by blast chilling from the cooling channels (27). While in stirred type yoghurt, firstly well shake to improve the consistency in an inoculation tank jacketed before filling in packaging material. Yoghurt must be kept at a cooling temperature of less than 7.2 °C after all steps of yoghurt manufacturing (20).

THE NUTRITIONAL PROFILE OF YOGHURT

Yoghurt contains more than ten vital nutrients, including vitamins and minerals is profoundly healthful and readily digested dairy product. depending on the starter culture strains, The nutritional composition of Yoghurt varies the type of milk used (whole, semi-skimmed, or skimmed milk), the breed of animal (bovine, goat, or sheep), the kind of milk solids, solid non-fat, sweeteners, and fruits added before fermentation, and the period of the fermentation process (28). Yoghurt has a pretty similar composition to that of milk. Yoghurt is enriched in milk proteins, carbohydrates, minerals like calcium and phosphorus, and vitamins like riboflavin (B2), thiamin (B1), cobalamin (B12), folate (B9), niacin (B3), and vitamin A (29). Because of their great biological value, milk proteins in Yoghurt are of excellent quality and contain practically all essential amino acids required for optimal health. Additionally, milk proteins found in Yoghurt have a greater concentration of proline- and glycine-containing amino acids than those
found in whole milk. They perform extra biological activities, including improving calcium absorption and stimulating the immune system (30).

Lactose, like other dairy products, is the primary carbohydrate in Yoghurt. Raw milk has lactose about 4.6%. The initial lactose content in milk is reduced by 20-30% throughout the fermentation process. However, due to lactic acid bacteria's metabolic activity, Lactose converts into its simple forms of glucose and galactose. The fat content of Yoghurt is strongly influenced by the fat level of the original yoghurt combination (27). Fat content fluctuates from 0.5-3.25 per cent. However, because certain varieties, such as Greek-style Yoghurt, have a high-fat level of up to 10%, the fat content of Yoghurt is very subjective.

Unlike milk, yoghurt manufacturing techniques such as homogenization and fermentation cause some fat to be broken down into easily digested and absorbable fatty acids (5). Vitamins and minerals in milk and dairy products are bio-available, meaning they can be absorbed and used by the body. Like other dairy products, Yoghurt is an excellent source of B vitamins, including riboflavin and thiamin. A 150g serving of whole milk plain yoghurt or low-fat plain Yoghurt offers 31% and 30% of an adult's daily riboflavin requirements, respectively (31).

HEALTH BENEFITS OF YOGHURT

Nutrient-dense food Yoghurt provides critical nutrients like protein, vitamins, and minerals required for growth and development. Dairy products, including Yoghurt, enhance the overall quality and acceptability of the diet boosting nutritional standards such as RDAs for each nutrient daily. A 50 g of Yoghurt serving provides 41 per cent of a 5-year-recommended old's daily calcium intake (32).

The nutritional benefits of fermented dairy products, like Yoghurt, appear to have been well-known for generations, referenced in the Bible and ancient Hindu texts. Yoghurt is said to provide several health advantages and a rich nutritional profile. The primary carbohydrate present in milk is lactose, a disaccharide composed of one glucose molecule and one galactose. (33).

Lactase is the enzyme that broke lactose into simple sugars inside the stomach. Inadequate secretion or interferences with lactase digestion can cause undigested lactose to flow into the large intestine, fermented by colonic bacteria, causing gastrointestinal symptoms such as flatulence, diarrhoea, and abdominal discomfort. Lactose intolerance is the term for this problem.
Lactose intolerance has been linked to reduced calcium intake and low bone mineral density, most likely due to the needless elimination of milk and dairy products from the diet (35). As a result, it can be concluded that Yoghurt is an efficient way for people with lactose intolerance to get all of the advantages of milk products without suffering the symptoms of hypolactasia. It is well acknowledged that a healthy gut microbiota balance is linked to optimal nutrition and health. The main microbial strains involved in this equilibrium are Lactobacilli and Bifido bacteria. According to available studies, frequent intake of bio-yoghurt results in a favorable microbial profile, which has several therapeutic effects (36).

The Russian scientist Metchnikoff proposed in 1908 that the Bulgarians’ longer lives were linked to their frequent use of fermented milk products containing lactic acid bacteria (32). Yoghurt is a probiotic carrier food that is simple to introduce microorganisms into, resulting in high probiotic viability. Excellent source of viable probiotic strains is Bio-yogurt such as Lactobacillus acidophilus and Bifido bacterium bifidum, which are the most often utilized probiotics in the dairy sector (37). Though, it has been noted that to achieve the probiotic effect, significant numbers of live probiotic cells must be consumed daily, which is known as the therapeutic minimum. Probiotics' medicinal and beneficial effects appear to assist preserve excellent health, restoring bodily strength, and treating intestinal problems (38).

Therapeutic effects of probiotics have been shown to have such as preventing urogenital infections, constipation, diarrhea, infant diarrhea, hypercholesterolemia, colon/bladder cancer, and osteoporosis. On the other hand, provide additional benefits of probiotics are such as maintaining normal gut flora, boosting the immune system, lowering lactose intolerance and serum cholesterol levels, and increasing anticarcinogenic action (39). Some have promoted for the use of fermented milk products to treat gastrointestinal diseases; for example, Tissier has promoted for Bifido bacteria to treat infant diarrhea (40).

CONCLUSION

Consumer demand for Yoghurt and its products has surged due to these well-known health benefits, and it has become the fastest-growing dairy industry. Nutrient-dense food Yoghurt provides critical nutrients like protein, vitamins, and minerals required for growth and development. Yoghurts are available in various styles, differing in fat content, flavor profile, and texture, making them suited for multiple meal settings.
Authors’ contributions

MAUR contributed to study concept; KI, FI, IK, and AA contributed to study design, data collection, data analysis and interpretation, literature review, write and critically review the manuscript. All the authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests

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