Available online at www.jobpcr.com

ISSN-2394:3076
CODEN(USA) : JBPCBK

Journal of Biological Pharmaceutical And Chemical Research, 2023, 10(3): 11-30

(*http://www.jobpcr.com/arhcive.php*)

INDUSTRIAL PRODUCTION AND BIOCHEMISTRY OF DAIRY PRODUCTS

Ajiduku Leyoa Abershi[1], Joseph Ikwebe[2], Ezeonu Chukwuma Stephen [2], Christopher Bando[3], Gideon Abugbum[4], Ephraim Haruna[2]

[1] Department of Biochemistry, Taraba state university, jalingo, Nigeria
[2] Department of Biochemistry, Federal University, Wukari, Taraba State, Nigeria
[3] National Biotechnology Development Agency, Jalingo, Taraba, Nigeria
[4] College Of Health Technology, Takum Taraba State
Corresponding author: ajilenny52@gmail.com

ABSTRACT

Dairy products have long been recognized as a source of healthy nourishment, a vital part of many people's diets because of the protein, vitamins, minerals, and fatty acids they contain. According to recent studies, consuming dairy products appears to help with muscle growth, lowering blood pressure and low density lipoprotein cholesterol, and preventing tooth decay, diabetes, cancer, and obesity. Organic milk and probiotic microorganisms that use milk products as a vehicle may also provide additional benefits. In addition to the previously mentioned advantages; research demonstrates that dairy products are essential for immune system function and gastrointestinal health. Yogurt, cheese, vinegar, butter, soy milk, lactic acid, and other dairy products are a few of them. Certain texts include in-depth information on the historical manufacturing of certain dairy products as well as the industrial production process, including the metabolic route that breaks down the protein, fat, and carbs.

Keywords: Dairy product, Cheese, Soya Milk, Yoghurt, Vinegar, Lactic Acid, Casein Plastic, LAB and Microorganisms.

INTRODUCTION

Around ten thousand years ago, when man transitioned from gathering to producing food, fermentation of milk was understood and was a regular process to prolong the shelf life of dairy products (Tamime and Robinson, 1991). The milk from which they are produced is said to be less value and less nutrient-dense than fermented dairy products (Younus *et al*., 2002). According to Campbell-Platt (1987), fermented foods are those that have been exposed to the action of microbes or enzymes in a way that results in desirable biochemical changes that considerably modify the food.

According to recent studies, dairy products offer benefits beyond the usual "growing strong bones" benefit. For instance, several elements in milk and dairy products are good for the gastrointestinal system and immune system (Ha et al., 2003). Milk can be fermented by bacteria, yeasts, and filamentous fungi to produce a variety of products such as cheese, butter, and yoghurt. Yogurt, which is native to the Balkan and Eastern Mediterranean regions, is the most extensively consumed fermented milk product globally (Staffe, 1998; Walstra *et al*., 1999). The flavor, sour taste, and aroma of yoghurt are attributed to the most prevalent mixed cultures of Streptococcus thermophilus and Lactobacillus bulgaricus, which remain active in the product during manufacture (Bille and Keya, 2002; Douglas, 2005).

Some people have lactose intolerance as a result of their digestive systems being deficient in the enzymes required to break down lactose into simpler carbohydrates. Lactose intolerant people can often tolerate cultured milk products that have had some of the lactose partially broken down (Vesa et al., 1996). Like lactose-free soy milk, which is an example?

Lactic acid is what gives the majority of these dairy products their tart flavors. This lactic acid is produced when lactic acid bacteria (LAB), such *as Lactococcus lactis, Lactobacillus species, Streptococcus thermophilus, Bifidobacterium species, and Leuconostoc species*, break down the sugars present inside dairy products.

In other instances, ethanol is created by yeast using glucose from the breakdown of lactose, and vinegar is created by acetic acid bacteria using the ethanol. When the evidence for the preceding hypotheses that dairy products are hazardous to human health is no longer available.

According to Muehlhoff *et al*. (2013), they are crucial for good human development and nutrition throughout life, but notably in childhood. These vital effects are mostly obtained from dairy products' proteins, minerals, vitamins, lipids, and carbs.

MATERIAL AND METHODS

CHEESE

It is believed that the habit of transporting milk in ruminant stomach-built bladders with their inherent rennet supply gave rise to the creation of cheese in ancient times. Whether cheese manufacture began in Europe, Central Asia, the Middle East, or the Sahara is the subject of conflicting evidence. According to Pliny the Elder, cheese-making had advanced to a sophisticated level by the time ancient Rome was founded, and priceless foreign cheeses had been imported to Rome to satisfy the tastes of the social elite. Making cheese has a long history in Europe, going back to the earliest Greek myths. According to Simoons *et al*. (1971), dairying may have been performed in the Saharan grasslands around 4,000 BCE.

The only way that milk can be preserved in a hot area is in hard salted cheese, which dates back to the earlier days of dairying. It is likely that the process of making cheese was discovered accidentally by storing milk in a container made from a ruminant's stomach, which resulted in the milk being turned to curd and whey and the rennet remaining in the stomach. Storage containers made from animal skins and inflated internal organs have been used for a variety of foods since ancient times. Even though cheese is believed in an Arab tradition to have been discovered by an Arab trader who used this method of milk storage (Reich *et al.,* 2012).

Cheese is a food product that is made from curd that is obtained from milk by coagulating the casein with the help of rennet or similar enzymes in the presence of lactic acid produced by additional microorganisms, from which part of the moisture has been removed by cutting, cooking, and/or pressing, which has been shaped in a mould, and which has then been kept to ripen by being allowed for a period of time at a prefer temperature and humidity. Cheese is composed out of milk, coagulants (which cause liquid to paste or change liquid into a soft semi-solid mass), bacterial cultures, and salt. The coagulant causes milk protein to clump, transforming fluid milk into a partial thick gel. The whey, which is primarily made up of water and lactose, starts to separate from the gel when it is broken into minute pieces, or curds. The final cheese's moisture, flavor, and texture are largely determined by the acid produced by bacterial cultures, which is necessary to help whey be expelled from the curd (Omotoso *et al*., 2011).

In cheese, which is formed based on the temperature, acidity, and calcium content of the milk among other factors, many of the nutrients found in milk are concentrated. Rich assemblage of bacteria present during cheese fermentation encourages starter culture robustness. Although lower temperatures are typically utilized in practice, the ideal temperature for rennet enzyme as a coagulant is in the range of 40°C. This is primarily done to prevent the coagulum from becoming overly hard. According to Akinloye *et al*. (2014), the type of coagulants used and the quality of the milk used are what affect the yield and quality of cheese. In 1815, Switzerland opened the first factory for the manufacturing of cheese on an industrial scale, but it wasn't until the United States that large-scale production was successfully shown before it developed alongside European culture. The majority of people credit Jesse Williams, a dairyman from Rome, New York, who started making cheese in large quantities in 1851 using milk from surrounding farms, hundreds of these dairy associations was established within decades. In comparison to Europe and North America, Africa produces a minuscule amount of cheese. Typically at the farm level, small-scale production accounts for the majority of cheese produced in Africa. There is virtually little available scientific knowledge on how to manufacture cheese at the farm level; instead, parents pass down the recipe or process to their children through observation and hands-on experience. The milk can be coagulated using a variety of methods, including the juice extracted from nearby plants that thrive, acid precipitation paired with heating, and rennet coagulation (FAO 1990). Domiati, Ayib, Karish, Wara, Gybna, and Mudaffara are just a few examples of African-native cheese kinds (O'Mahony 1988).

INDUSTRIAL PRODUCTION OF CHEESE

Weighing the required amount of milk, it is then boiled for 15–20 minutes at 80–90°C. After that, it is cooled to 45–48°C. Before being added, the milk is mixed with two to three percent of the yoghurt culture. The milk is kept in clean, hygienic containers for setting. The milk in the container is incubated at 45°C until the coagulation becomes more solid. The product is removed from the incubator and kept at 5°C until it is ready to be distributed to clients. The equipment is kept tidy and prepared for the next activities (Tamine and Robinson, 2004).

The manufacture of most varieties of cheese involves the following:

Milk treatment: Milk can be sterilised, for example, at 73oC for 15 seconds, to kill pathogens and subside microbial populations.

Starter: A high-quality starter is necessary. The cheese recipe will determine the kind and amount.

Coagulation: There are many coagulants utilized, including rennet and lemon juice. The coagulants cause the milk to coagulate into a solid, jelly-like substance under specific restrictions of temperature, quantity, and time.

Cutting coagulum: The coagulum can be ladled into containers or cheese molds, or it can be sliced with knives into curd particles of a specific size, such as 1-2 cm.

Sterilising or cooking the curd: The pace at which whey is ejected from the curd particles and the development of the starting microbes are both impacted by sterilizing (40–45ºC) the curds and whey. The curds and whey of some cheeses may be combined with hot water.

Milling curd: When the curd has reached the desired consistency, it is splice up into fragment to allow even salting. The curd can be milled manually or automatically.

Salt addition: The cheese curd can be salted, as was already said. Additionally, it can be incorporated into the finished cheese by soaking it in a brine solution. Use of salt slows the development of lactic organisms and lowers the production of acid. Salt also inhibits or delays the growth of microorganisms that can alter the flavor and other properties of the cheese.

Storage: The type of cheese will determine the amount of time and storage conditions.

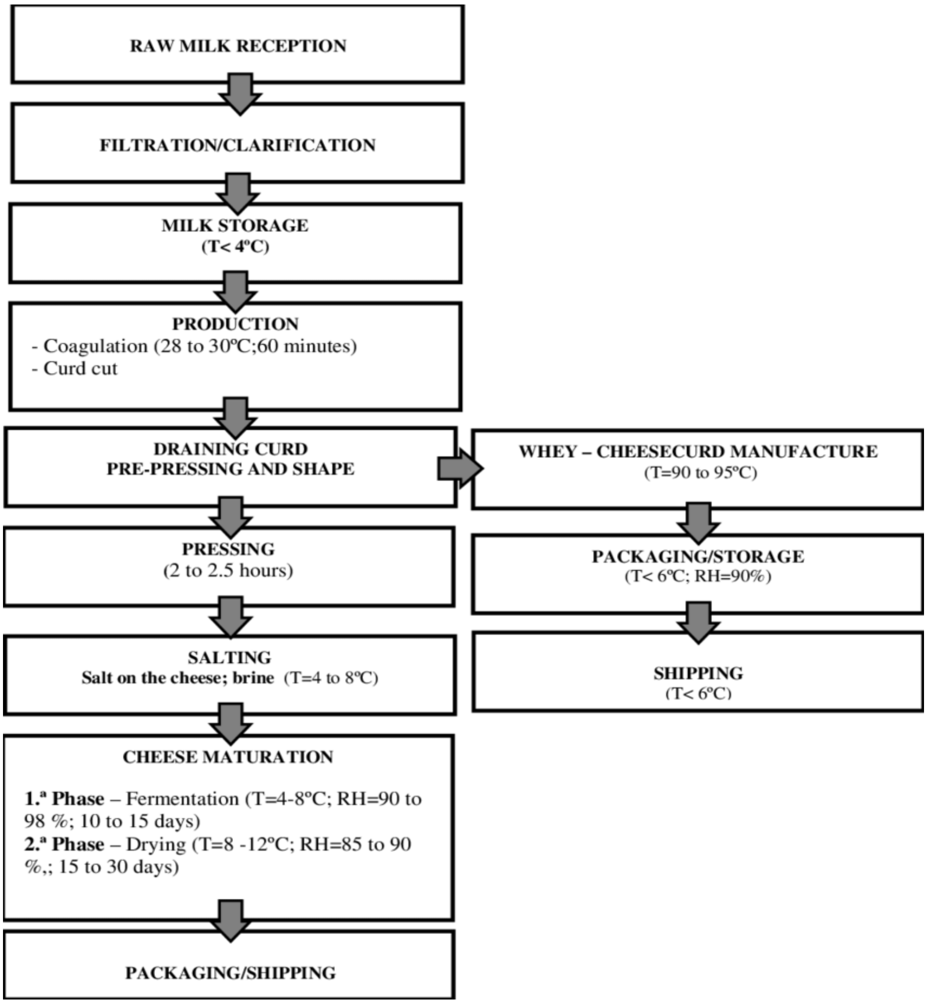


Figure 1: the Steps in the Industrial production of Cheese (Tassou *et al.*, 2010).

Yogurt

The fermentation of milk's lactic acid yields yogurt, a fermented dairy product. It can be produced both professionally and at home, making it one of the most well-known fermented milk products ever manufactured (Willey *et al*., 2008). When non-fat or low-fat milk is produced commercially, it is pasteurized, cooled to 43°C, and injected with known starter cultures of microbes. The starter cultures may consist of a pure strain of a certain Lactobacillus species or a 1:1 mixture of Streptococcus thermophilus and Lactobacillus bulgaricus. Streptococcus thermophilus, the coccus, grows more quickly than Lactobacillus bulgaricus, the rod, and is primarily in charge of producing acid while the rod provides flavor and scent. At least as early as 1908, when Metchnikoff hypothesized that ingesting fermented milk with lactobacilli by man would lengthen life (Hughes and Hoover, 1991; O'Sullivan et al., 1992), there has been interest in the role of probiotics for human health.

According to most regulatory bodies throughout the world, yogurt (sometimes written "yoghurt" or "yoghourt") is a fermented milk product that contains digested lactose and specifically identified, live bacterial strains, often *Streptococcus thermophilus* and *Lactobacillus bulgaricus*. It acts as a vehicle for fortification and is a source of various critical nutrients, such as protein, calcium, potassium, phosphorus, and vitamins B_2 and B_{12} (Bodot *et al*., 2014).

A food produced by culturing one or more optional dairy ingredients, such as cream, milk, partially skimmed milk, and skim milk, either alone or in combination with a distinctive bacterial culture made up of lactic acid-producing bacteria, Lactobacillus bulgaricus and Streptococcus thermophilus, is referred to as yogurt in the Code of Federal Regulations of the United States Food & Drug Administration (FDA. 2013a).

Yogurt is a very old meal that has been around since 5000 BC, or more than 7,000 years ago! Middle Eastern herdsmen would salt the milk and hang it across the backs of their camels in goatskin sacks (Ezeonu *et al*., 2016). The milk was transformed into the tart custard after it had journeyed under the scorching July sun. Bacteria detected in digestive secretions in the goatskin bag and the warmth and stimulation supplied by the camel's movements were used to effectively make the first batch of yogurt. Over the centuries, yogurt has been known by many different names, including katyk in Armenia, dahi in India, zabadi in Egypt, mast in Iran, leben raib in Saudi Arabia, laban in Iraq and Lebanon, roba in Sudan, iogurte in Brazil, cuajada in Spain, coalhada in Portugal, dovga in Azerbaijan, and matsoni in Georgia, Russia, and Japan (Moreno *et al*.,2013).

Today's yogurt is typically milk that has been fermented and acidified by bacteria that are still detectable and well-defined, creating a thicker, frequently flavored product with a long shelf life. In addition to providing fortification (additional probiotics, fibre, vitamins, and minerals), it provides a source of essential nutrients. Its consistency and aroma can also be readily changed by adding sweeteners, fruits, and flavors. To produce yogurt, you can also use rice, soy, or almonds. To make yogurt, two bacterial strains—*S. thermophiles* and *L. bulgaricus*—conduct a symbiotic relationship at a very low temperature (360°C–420°C) for 3–8 hours. Both bacterial strains must be active and present in the final product.

INDUSTRIAL PRODUCTION OF YOGURT

The art of making yogurt has been practiced for thousands of years, and generations have passed along their knowledge of the process. However, due to developments in a number of fields, such as microbiology, biochemistry, and food engineering, it has recently become more plausible. Changing the milk's original composition, pasteurizing the yogurt mixture, allowing it to ferment at thermophilic temperatures (40–45oC), cooling it, and then adding fruit and flavorings are the fundamental processes in making yogurt. The production steps in manufacture of yogurt are illustrated in the steps and diagram below:

1. Adjust Milk Composition & Blend Ingredients

Milk composition can be altered to get the desired fat and solids level. Dry milk is frequently used to increase the amount of whey protein for an appropriate texture. The addition of stabilizers and other substances (Hui et al., 2007).

2. Pasteurize Milk

The milk mixture is pasteurized at 185°F (85°C) for 30 minutes or at 203°F (95°C) for 10 minutes. A high heat treatment is used to denature the whey (serum) proteins. In order to prevent the separation of the water during storage, the proteins might produce a gel that is more stable. Less milk-spoiling organisms are present as a result of the high heat treatment, which enhances the environment for the survival of the beginning cultures (Serra et al., 2009).

3. Homogenize

To fully combine all of the essential ingredients and enhance the yogurt, the mixture is homogenized at 2000 to 2500 psi (Serra et al., 2009).

4. Cool Milk The milk is chilled to 108°F (42°C) to get the yogurt to the right growing temperature for the starter culture (Lee and Lucey, 2010)

5. Inoculate with Starter Cultures: The cooled milk is combined with the starting cultures (Hui et al., 2007).

6. Hold

The milk is kept at 108°F (42°C) until the pH level reaches 4.5. This enables the fermentation process to continue, producing a soft gel and the distinctive yogurt flavor. This procedure could require several hours (Hui et al., 2007).

7. Cool: In order to stop the fermentation process, the yogurt is chilled to 7°C (Tamime, and Robinson 1998).

8. Package: After being pumped out of the fermentation tank, the yogurt is packaged as needed. (Serra et al., 2009)

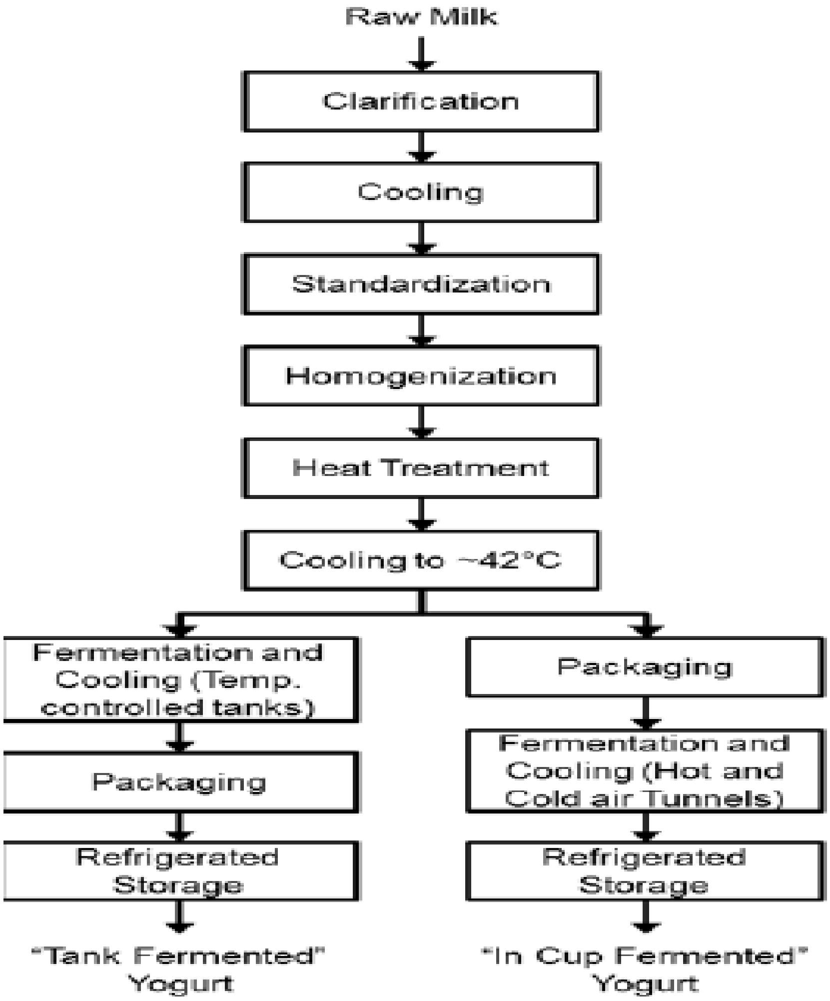


Figure 2: The steps in yogurt production (Hui *et al.,* 2007).

LACTIC ACID

In 1780, the Swedish chemist Carl Wilhelm Scheele made the discovery that lactic acid might be used for fermentation. In impure black syrup, he isolated the acid from sour milk, and he gave it a name based on its lineage. After nine years, in 1789, Lavoisier gave this milk component the name "acide lactique"; this went on to serve as the foundation for the nomenclature still in use today for lactic acid.

Up until 1857, lactic acid was regarded to be a component of milk for a very long time. Later on in the same year, Pasteur discovered a different phenomenon and hypothesized that lactic acid was a fermentation metabolite created as a result of the interaction of particular bacteria. In order to validate Pasteur's theories, a French scientist by the name of Fre'my created lactic acid by fermentation. As a result, the first industrial production of lactic acid in the United States utilizing a microbiological method occurred in 1881 (Randhawa *et al*., 2012).

Lactic acid is incredibly significant since it is used in the food, pharmaceutical, and textile industries, as well as a raw material in the fermentation-based manufacturing of many various things (Young-Jung *et al*., 2006). It is a popular flavoring ingredient, acidulant, and bacterial inhibitor, in addition to its usage in the pharmaceutical, chemical, and food preservation sectors. It can be utilized as a moisturizer in cosmetic formulations because to its propensity to retain water. Because it contains hydroxyl and carboxyl groups, it may be converted into useful compounds such as esters and organic solvents (Gao *et al*., 2011). The action of microbes in starter cultures produces the vast majority of the flavor components found in yogurt. Lactic acid bacteria (LAB) are the most common species in these starting cultures, for example, *Lactococcus lactis*, *Lactobacillus* species, *Streptococcus thermophilus, Bifidobacterium* species*, and Leuconostoc* species (Steele *et al*., 2013). These bacteria perform three major biochemical conversions of milk components during fermentation: (i) glycolysis, which is the breakdown of carbohydrates into lactic acid or other metabolites; (ii) proteolysis, which is the hydrolysis of caseins into peptides and free amino acids; and (iii) lipolysis, which is the breakdown of milk fat into free fatty acids. The synthesis of Poly Lactic Acid (PLA) has become a current trend in the use of lactic acid. PLA might potentially replace polymers made from fossil fuels, but to do so, its production costs must be halved from what they are at the moment (Lopes *et al*. 2012; Abdel-Rahman *et al*., 2013)

INDUSTRIAL PRODUCTION OF LACTIC ACID

Lactic acid can be synthesized chemically or by microbial fermentation. Lactonitrile is produced chemically by reacting acetaldehyde with hydrogen cyanide in the presence of a base under high pressure. This crude lactonitrile is purified by distillation. Lactic acid is then produced by hydrolyzing pure lactonitrile with sulfuric acid. Ammonium salt is also generated as a byproduct (Wee *et al*., 2006). The sugars obtained can then be fermented with the appropriate microbe to yield optically pure L (+) or D (-) lactic acid (Hofvendahl *et al*., 2000).

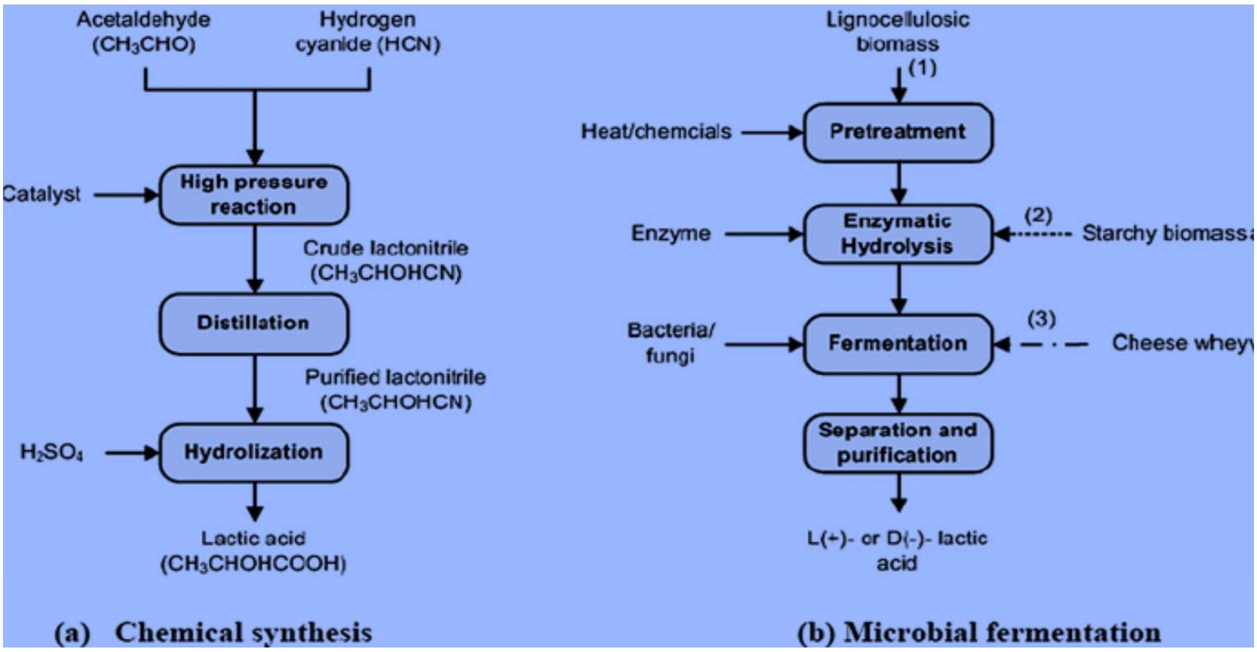


Figure3: The Industrial Processes in the Lactic Acid (Wee *et al.* 2006).

VINEGAR

Vinegars are liquid products created as a result of the alcoholic and subsequent acetous fermentation of carbohydrate sources (Ordoudi *et al*., 2014). Vinegar is a common dietary ingredient that is easily available on the market. The two types are cider vinegar and ordinary vinegar. Cider vinegar is produced from fruit juices, as opposed to normal vinegar, which is generated from unprocessed plant materials like wheat, apples, grapes, or sugarcane (Madrera *et al*., 2010, Junior *et al*., 2014). Apart from to being consumed directly, vinegar is a key ingredient in the production of culinary items since it is added to many products such sauces, ketchups, and mayonnaise. Cider vinegar is a very beneficial beverage for consumers since it not only has anti-diabetic qualities but also lowers blood cholesterol levels by reducing the oxidation of low density lipoproteins (Salbe *et al*., 2009). The French word "vinaigre" (which means "sour wine") is where the word "vinegar" originally came from. Wine was undoubtedly discovered as a result of the evolution of vinegar. When wine is exposed to air, it quickly turns acidic and becomes "sour wine." This beverage has a lengthy history and may be identified by its flavor and scent. Around 3000 B.C., the Babylonians used date palm fruit and sap as a raw material to create alcoholic beverages, which is when vinegar was first mentioned in literature. When they came into touch with air, they naturally turned into vinegar, which the Babylonians used as a food preservative and pickling agent. Hippocrates, the founder of modern medicine, recommended mixing honey and cider vinegar to cure colds and coughs in ancient Greece. (Budak *et al*., 2014).

Between 1347 and 1771, the plague struck many European towns. It's estimated that 50 million individuals died from this illness, which was transmitted to humans by flea-infested rats. When the plague ravaged France's cities in 1721, it was difficult to properly bury the dead. Prisoners were made to bury the sickening corpses of the victims as a solution to the problem. The folklore claims that although most captives perished, four convicts managed to survive by consuming massive amounts of vinegar macerated with garlic every day. The vinegar known as "the four thieves' vinegar" is still available today; it received its nickname because the four men were said to have looted the dead bodies they were burying.

INDUSTRIAL PRODUCTION OF VINEGAR

The bacteria of the *Acetobacter* genus transform ethyl alcohol into acetic acid to produce vinegar. As a result, vinegar may be made from any alcoholic substance, including different fruit wines and alcohol-water mixes (Peppler and Beaman 1967). The genus *Acetobacter* contains groups of bacteria known as vinegar bacteria, sometimes known as acetic acid bacteria (AAB), which are distinguished by their capacity to transform ethyl alcohol (C2H5OH) into acetic acid (CH3COOH) by oxidation as shown below:

Anaerobic	Aerobic
Glucose $\xrightarrow{\text{Yeast}}$ $2C_2H_5OH$ Ethanol	$\xrightarrow{\text{AAB}}$ $2CH_3COOH + 2H_2O$ Acetic acid (Vinegar)

Figure4: Acetous Fermentation in the presence of Acetic acid Bacteria (Maris *et al.*, 2006).

Acetic acid is dissolved in vinegar, which is created via a two-step bioprocess. Yeast causes fermentable sugars to be converted into ethanol in the first stage. In the subsequent phase, AAB use an aerobic reaction to convert the ethanol into acetic acid. Due to their capacity to generate significant amounts of acetic acid from ethanol and other components found in wine, AAB are widely known for their capacity to taint wine.

SOYA MILK

The milk from soy beans is extracted to create an aqueous liquid known as soy milk. It involves making slurry by pulverizing soaked soy beans with water, separating the milk from the chaff by combining the slurry with water, and separating the milk from the slurry (Gbabo *et al*., 2012). According to McGee (2004), beverages derived from cereals do not cause the same health problems as dairy milk, such as a higher risk of acquiring a cow milk allergy (Amusa *et al*., 2005).

Soya milk offers several benefits for its many customers, including social, economic, nutritional, and medical ones. The low cost of this milk in comparison to other non-alcoholic beverages such as soft drinks has also contributed to its popularity. The main issues with locally processed soya milk are contamination and limited shelf life; also, the production procedure is difficult and time consuming (Odu *et al*., 2012). The rusting of the processing equipment, which is commonly made of mild steel, might be the source of the milk contamination. Furthermore, because it includes a multitude of techniques and equipment, the manufacturing process is arduous, long, and prone to contamination. As reported by (Adebayo-Tayo *et al*., 2009), the pH of the milk, which ranged from 7.0 to 7.5, and the activities of the various microorganisms present in the milk, as well as inadequate processing equipment and post-processing contamination, have all been proposed as potential causes of soy milk deterioration (Ikpeme-Emmanuel *et al*., 2009).

In Asian nations including China, Japan, and Thailand, soy milk is a well-liked beverage (Kanawjia and Singh, 2002). In 1910, Li Yu-ying, a Chinese resident of France, received a patent for the manufacturing of soymilk (Wang et al., 1978). Given that soymilk is nutritionally equal to both cow's and mother's milk, it has a great deal of potential to replace dairy milk. Beyond being cholesterol-free and low in saturated fat, soymilk also offers several benefits over animal proteins in terms of nutritional value. Based on the nutritional and sensory qualities, soymilk and cow milk have nearly the same protein quantity and composition, and the amino acid composition is comparable. Soymilk is said to naturally include isoflavones, plant compounds that help regulate low density lipoprotein cholesterol (LDL), which may help lessen the risk of heart problems (Rolfes *et al*., 2011).

INDUSTRIAL PRODUCTION OF SOYA MILK

Cleaning soybeans is the first stage in the traditional soymilk production process. The beans are then soaked in water at room temperature for 12 to 24 hours (the water will be 3 - 4 times the dry soybean weight).The cotyledon is removed, and the beans are blended into a fine pulp. The slurry is continuously stirred while it is heated to froth for about an hour.

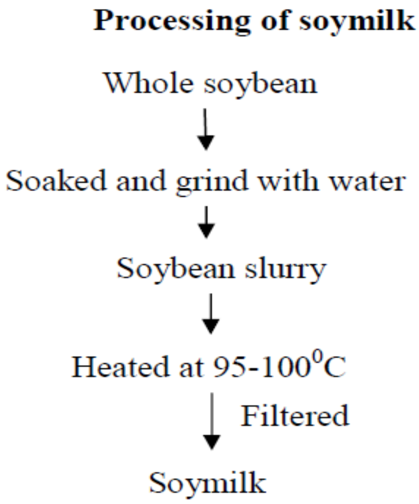


Figure 5: Industrial flow diagram for processing soy milk. FAO, 2002.

In overall, a new method of processing and storing soy milk has been created; this technology reduces the risk of contamination owing to the manual manufacturing process, which causes stomach discomfort. As a result, the design of the soy milk production and pasteurization facilities would aid in extending the shelf life of the milk.

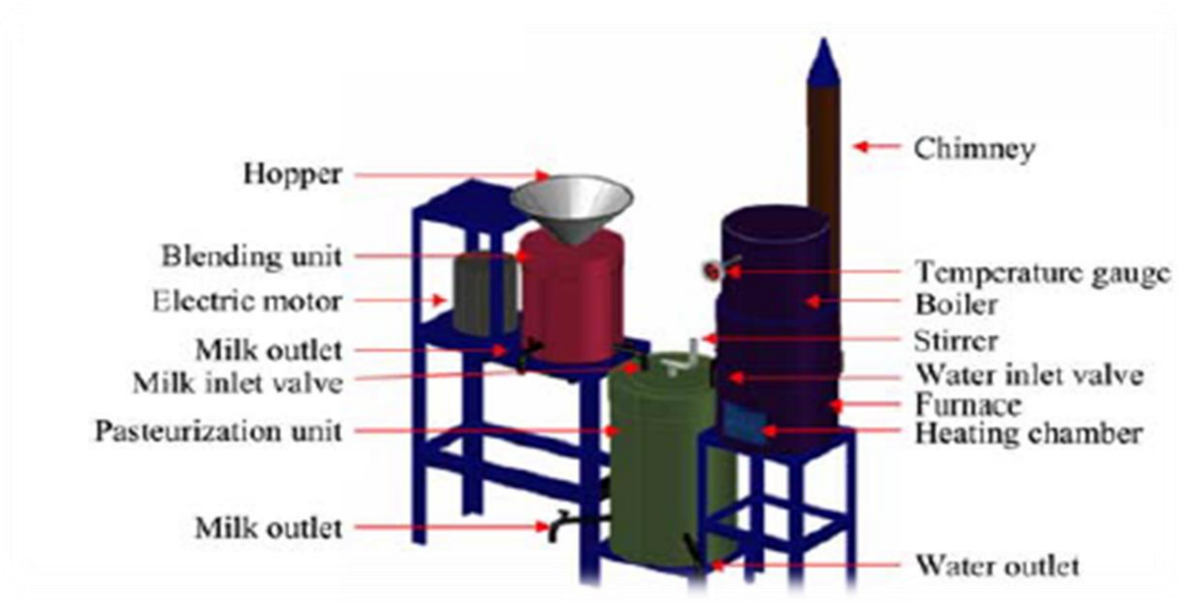


Figure 6: mini soya milk plant (Gana, 2011).

Machine components

The mini plant was made utilising stainless steel items and which include the following components: Blending unit, Pasteurization unit, Hot water generating unit.

PLASTIC FROM MILK AND LACTIC ACID

In reality, milk plastic was relatively prevalent from the early 1900s until around 1945. Casein plastic, also known as Galalith and Erinoid, was used to make buttons, ornamental buckles, beads, and other jewelry, as well as fountain pens, hand-held mirrors, and beautiful comb-and-brush sets (Ellias 2011). Tampere, Finland's first plastic plant, opened in 1921. This facility made plastic out of milk. Button-making was done using the plastic. Although it had low fire sensitivity, its low moisture resistance was a problem. Synthetic thermoplastics that were introduced to the market in the 1950s and 1960s eventually took the place of casein plastic (Golding *et al*., 2001).

Milk includes two forms of protein: casein (approximately 80%) and whey (20%). Proteins are long chains of amino acids that can have 100 to 100 000 amino acids connected to each other. We know there are 20 different types of amino acids. αS1 -casein, αS2 -casein, β-casein, and κ -casein are the four kinds of casein protein. Like αS1 -caseins, αS2 -caseins, and β-caseins, caseins are arranged into micelles with the interior sections of the micelle being primarily hydrophobic (lipophilic). The hydrophilic (water soluble) κ -caseins are found on the micelle's outer surface. The micelle retains its shape due to calcium phosphate clusters in the center.

The casein molecules in milk expand and rearrange into a long chain when heated and treated with an acid (such as lactic acid or vinegar). Each casein molecule is a monomer, and the polymer you create is composed of a lot of those monomers connected in a pattern that repeats (porta *et al*., 2011).

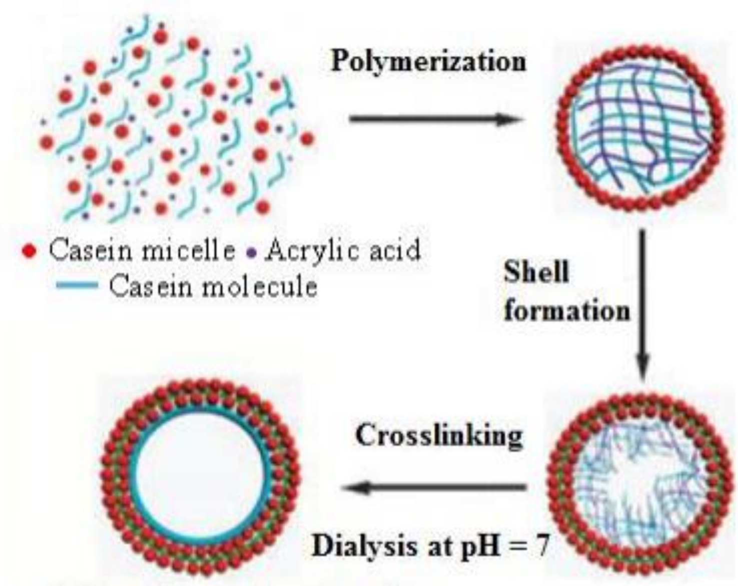


Figure 7: The synthesis of hollow casein spheres in aqueous solution (Liu *et al*., 2010)

MICROORGSNISM AND ENZYME ASSSOCIATED WIH DAIRY PRODUCTS PRODUCTION.

Since Metchnikoff suggested that people should consume milk fermented with lactobacilli to lengthen their lives (Hughes and Hoover, 1991; O'Sullivan *et al*., 1992), probiotics have been crucial for human health. Due to a number of advantageous characteristics, lactic acid bacteria (LAB) have been employed in food production historically and now. Consuming products prepared from fermented milk has been associated with several health benefits. Most of these microorganisms include:

Lactobacillus bulgaricus, Streptococcus thermophiles, Lactobacillus acidophilus, bifidobacterium Lactobacillus johnsonii, and *Lactobacillus gasseri.*

BIOCHEMICAL PATHWAY ASSOCIATED WITH PRODUCTION OF DAIRY PRODUCTS

A significant quantity of lactose is naturally found in milk, and it also serves as the main source of energy and carbon for the growth of LAB. Lactose is changed by LAB into lactic acid, which gives yogurt its distinctive sour flavor. Variations in the metabolic byproducts of lactose metabolism have led to the two main kinds of fermentation, homo-fermentation and hetero-fermentation, depending on the LAB species, the substrate, and the environmental variables (Aleksandrzak-Piekarczyk *et al*., 2014).

Lactic acid is the primary byproduct of homo-fermentative pathways, whereas acetic acid, ethanol, and carbon dioxide are among additional metabolites produced by hetero-fermentative metabolism. Several fragrance molecules or scent precursors, such as acetaldehyde, ethanol, and diacetyl, are among these metabolic byproducts. These four-carbon molecules, sometimes referred to as C_4 compounds, are what give fermented dairy products their characteristic scent and buttery flavor. Examples of C_4 compounds in yogurt include diacetyl, acetoin, and 2, 3-butanediol.

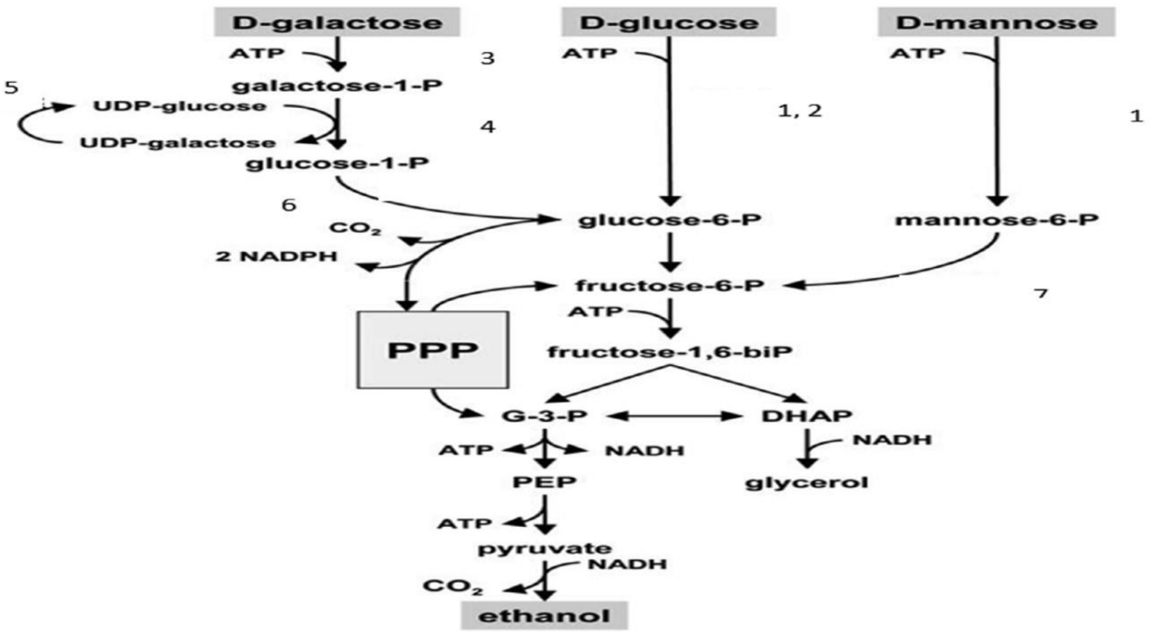


Figure 8: Alcoholic fermentation by yeast under anaerobic condition (Maris et al. 2006).

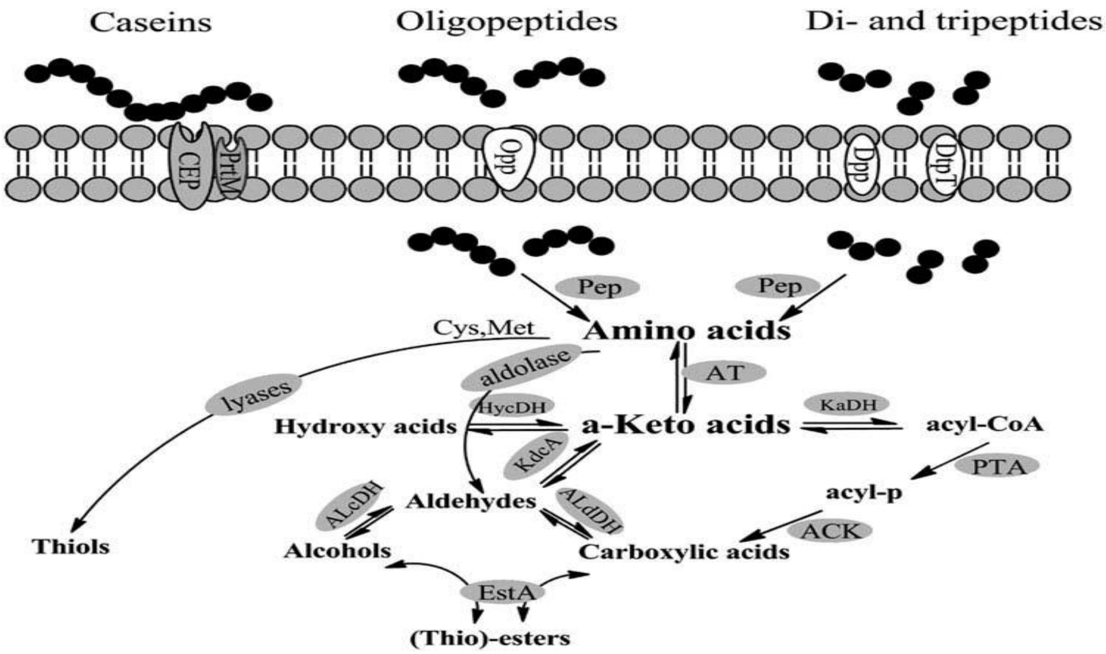


Figure 9: General Conversion pathways of proteins relevant for flavour formation by LAB (Aleksandrzak-Piekarczyk *et al.,* 2015, Bustos *et al.*,2011).

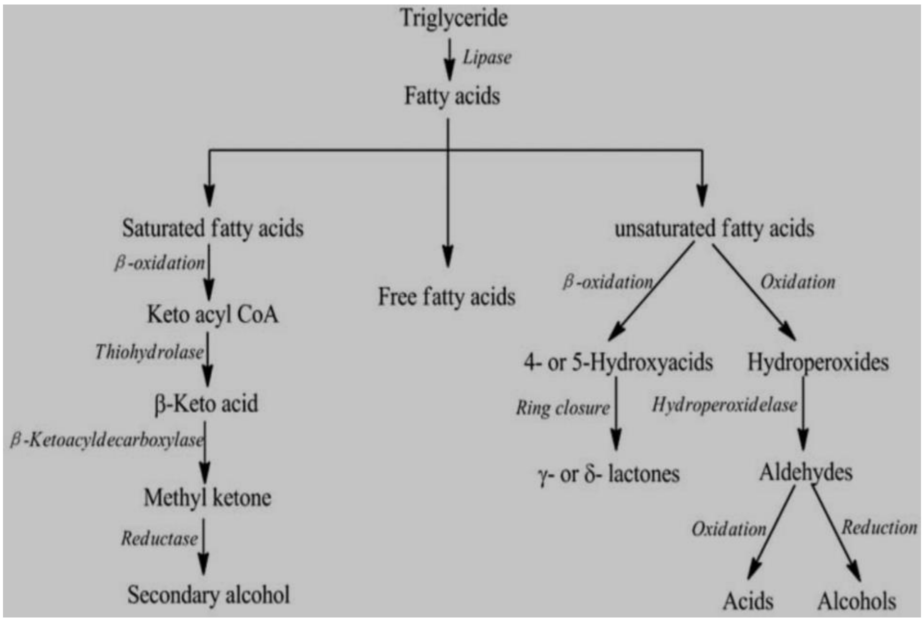
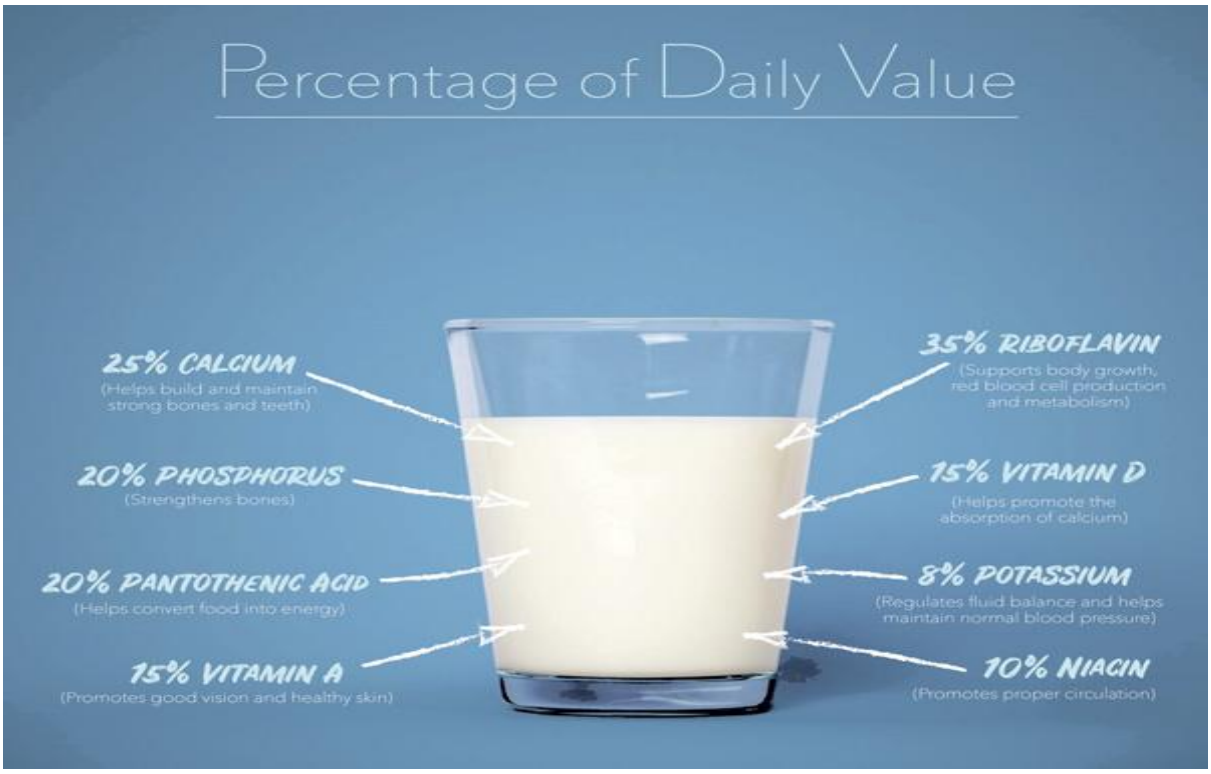


Figure 10: General degradation pathways of lipids during milk fermentation by LAB (Cheng *et al*., 2010 and Mcsweeney *et al*., 2005)**.**

HEALTH BENEFIT OF DAIRY PRODUCTS



Dairy products' nutritional worth has long been stressed, and new researchers have discovered benefits that go beyond the usual "growing strong bones" assertion. Some of the components in milk and milk products served roles that are now recognized to be advantageous to the immune system and the gastrointestinal tract one or two generations ago.(Ha *et al*., 2003).

CONCLUSION

Dairy products, in general, provide a solid nutritional base for weight loss. Dietary minerals may be important because they influence adipocyte metabolism via calcitrophic hormone and lower the amount of energy available from fat in food items by producing indigestible complexes. Functional dairy components have an important role in the prevention of numerous diseases, including diabetes, cancer, obesity, hypertension, and several communicable diseases.

On the contrary hand, there are several applications for these bioactive diary components. For instance, phosphopeptides are now used as nutritional and medical supplements. For those who don't consume dairy or who may be lactose intolerant, a number of milk ingredients can be isolated and utilized in certain applications. Numerous milk components may function as a preventative measure against the onset of diseases brought on by obesity. Be aware of how businesses have enhanced the processes used to produce dairy goods, easing the burden placed on workers in earlier times.

In conclusion, more milk and dairy products should be included in the daily meals of both adults and children, because dairy products are not restricted to strong bones, as many people believe. It is also preferable to provide breast milk to a baby rather than synthetic created baby milk since breast milk has eight sugars and eight amino acids, whereas the other comprises eight carbohydrates and one amino acid.

REFERENCE

[1] Adebayo-Tayo, B. C., Adegoke, A. A., & Akinjogunla, O. J. (**2009**). Microbial and physico-chemical quality of powdered soymilk samples in Akwa Ibom, South Southern Nigeria. *African Journal of Biotechnology*, *8*-13.

[2] Akinloye, A. M., & Adewumi, O. O. (**2014**). Effects of local coagulants on the yield of cheese using cow and sheep milk. *International Journal of Development and Sustainability*, *3*(1), 150-161.

[3] Aleksandrzak-Piekarczyk, T.; Mayo, B.; Fernandez, M.; Kowalczyk, M.; Alvarez-Martin, P.; Bardowski, J. (**2015**). Updates in the Metabolism of Lactic Acid Bacteria In Biotechnology of Lactic Acid Bacteria: Novel Applications; Mozzi, F.; Raya, R.R.; Vignolo, G.M.; Eds.; Wiley-Blackwell: West Sussex, UK, 3–33.

[4] Amusa, N. A., O. A. Ashaye, A. A. Aiyegbayo, M. O. Oladapo, M. O. Oni, and O. O. Ajolabi. (**2005**). Microbiological and nutritional quality of hawked sorrel drinks (soborodo) (the Nigerian locally brewed soft drinks) widely consumed and notable drinks in Nigeria. *Journal of Food Agriculture and Environment*, 3(3-4): 47–50.

[5] Aworanti, O. A., S. E. Agarry, and A. O. Ajani. (**2013**). Statistical optimization of process variables for biodiesel production from waste cooking oil using heterogeneous base catalyst.

British Biotechnology Journal, 3(2): 116–132.

[6] Aworth O.C. and Muller H.G. (**1987**). Cheese-making properties of vegetable rennet from sodom apple (*Calotropis procera*), *Food Chemistry, 26(1)*, 71-79.

[7] Barling, P.M. **(2012)** Lactose tolerance and intolerance in Malaysians (Suppl. 1), S12–S23.

"Barfly Retro Fridge History". Retrieved 26 September 2013

[8] Chowdhury, R., Warnakula, S., Kunutsor, S., Crowe, F., Ward, H. A.; Johnson, L., Franco, O. H.; Butterworth, A. S., Forouhi, N. G., Thompson, S. G., Khaw, K.-T., Mozaffarian, D., Danesh, J., Di Angelantonio, E.(**2014**). Association of dietary, circulating, and supplement fatty acids with coronary risk: a systematic review and meta-analysis. *Ann. Int. Med*., 160, 398−406.

[9] Dairy Consultant, (**2013**). *Dairy Science Information*. [online] Available at: <http://www.dairyconsultant.co.uk/si-yoghurt.php#> [Accessed 5 December 2013).

[10] Dairy Council of California. (**2015**). Yogurt Nutrition. Dairy Council of California

[11] Daliri, E.B.-M., Lee, B.H. (**2015**). New perspectives on probiotics in health and disease. Food Sci. Hum. Wellness, 4, 56–65.

[12] De Bok, F.A.; Janssen, P.W.; Bayjanov, J.R.; Sieuwerts, S.; Lommen, A.; Van Hylckama Vlieg, J.E.; Molenaar, D.(**2011**) .Volatile Compound Fingerprinting of Mixed-Culture Fermentations. *Applied and Environmental Microbiology,* 77, 6233–6239.

[13] Ezeonu, C. S., Tatah, V. S., Nwokwu, C. D, Jackson SM (**2016**). Quantification of Physicochemical Components in Yoghurts from Coconut, Tiger Nut and Fresh Cow Milk. *Advanced Biotechnology & Microbiology*. 1 (5): 555573. DOI: 10.19080/AIBM.2016.01.555573.

[14] FAO (Food and Agriculture Organization of the United Nations). (**1990**). *The technology of*

traditional milk products in developing countries. FAO Animal Production and Health Paper 85. FAO, Rome, Italy. 333 pp.

[15] Foxx-Orenstein, A.E.; Chey, W.D. (**2012**). Manipulation of the gut microbiota as a novel treatment strategy for gastrointestinal disorders. *Am. J. Gastroenterol*., 1 (Suppl. 1), 41.

[16] Freiburghaus, C.; Lindmark-Månsson, H.; Paulsson, M.; Oredsson, S. (**2012**) Reduction of ultraviolet light-induced DNA damage in human colon cancer cells treated with a lactoferrin-derived peptide. J. Dairy 95, 5552−5560.

[17] Gao C, Ma C, Xu P (**2011**). Biotechnological routes based on lactic acid production from biomass. Biotechnology Advances.

[18] Gana, I. M. (**2011**). Development and performance evaluation of grain drinks processing machine. M.S. thesis. Minna, Nigeria: Federal University of Technology.

[19] Gbabo A., I. M. Gana and A. I. Peter. (**2016**). Interactive study of some mechanical parameters of an automated grain drinks processing machine with respect to its blending efficiency. *International Journal of Engineering Research and Technology*, 5(10): 514–518.

[20] Gbabo, A., I. M. Gana, and S. M. Dauda. (**2012**). Effect of blade types on the blending efficiency and milk consistency of a grains drink processing machine. *Academic Research International*, 2(3): 41–49.

[21] Gilbert, M. (**2017**). Plastics materials: Introduction and historical development. In *Brydson's plastics materials* (pp. 1-18). Butterworth-Heinemann.

[22] Goh, Y.J. and Klaenhammer, T.R. **(2013)**.A functional glycogen biosynthesis pathway in Lactobacillus acidophilus: Expression and analysis of the glg operon. Mol. Microbiol., 89, 1187–1200.

[23] Guo, T.; Kong, J.; Zhang, L.; Zhang, C.; Hu, S. (**2012**). Fine Tuning of the Lactate and Diacetyl Production through Promoter Engineering in *Lactococcus lactis*. PLOS One 7, e36296.

[24] Gyawali, R.; Oyeniran, A.; Zimmerman, T.; Aljaloud, S.O.; Krastanov, A.; Ibrahim, S.A. (**2020**),A comparative study of extraction techniques for maximum recovery of _-galactosidase from the yogurt bacterium Lactobacillus delbrueckii ssp. bulgaricus. J. Dairy Res., 87, 123–126.

[25] Ha, E.; Zemel, M. B. (**2003**). Functional properties of whey, whey components, and essential amino acids: mechanisms underlying health benefits for active people (review). J. Nutr. Biochem., 14, 251−258.

[26] Hati, S.; Mandal, S. and Prajapat, J.B. (**2013).** Novel Starters for Value Added Fermented Dairy Products. Curr. Res. Nutr. Food Sci. J., 1, 83–91.

[27] History of Cheese. [1] (http://www.gol27.com/HistoryCheese.html) accessed 2007/06/10

[28] Moreno Aznar LA, Cervera Ral P, Ortega Anta RM, (**2013**). [Scientific evidence about the role of yogurt and other fermented milks in the healthy diet for the Spanish population (Spanish)]. Nutr Hosp., 28:2039–2089

[29] Oliveira, R.P.D.S., Perego, P. and Oliveira, M.N.D. (2012). Convert i, A. Growth, Organic Acids Profile and Sugar Metabolism of *Bifidobacterium lactis* in Co-Culture with *Streptococcus*

Thermophilus: The Inulin Effect. Food Research International, 48, 21–27.

[30] Omotoso O.E. Oboh G. and E.E.J. Iweala, (**2011**). Comparative effects of local coagulants on the nutritional value, *in vitro* multi enzyme protein digestibility and sensory properties of *wara* cheese, *International Journal of Dairy Sciences, 6(1),* 58-65.

[31] O'Mahony F. (**1988**). *Rural dairy technology.* ILCA Manual 4. ILCA (International Livestock Centre for Africa), AddisAbaba, Ethiopia. 64 pp.

[32] Pan, D.D.; Wu, Z.; Peng, T.; Zeng, X.Q. and Li, H. (**2002**). Volatile Organic Compounds Profile during Milk Fermentation by Lactobacillus Pentosus and Correlations between Volatiles Flavor and Carbohydrate Metabolism. *Journal of Dairy Science* 2014, 97, 624–631. Reich, Vicky "Cheese". *Moscow Food Co-op*. Retrieved December 11, 2012.

[33] Pan, D.D.; Wu, Z.; Peng, T.; Zeng, X.Q.; Li, H. (**2014**) Volatile Organic Compounds Profile during Milk Fermentation by Lactobacillus Pentosus and Correlations between Volatiles Flavor and Carbohydrate Metabolism. *Journal of Dairy Science* 97, 624–631.

[34] Ramzi A. Abd Alsaheb, Azzam Aladdin, Nor Zalina Othman, Roslinda Abd Malek, Ong Mei

Leng, Ramlan Aziz and Hesham A. El Enshasy (**2015**). Lactic acid applications in pharmaceutical and cosmeceutical industries.

[35] Ridgwell, Jenny and Ridgway, Judy (**1968**). *Food Around the World*. Oxford University Press. ISBN 0-19-832728-5.

[36] Routray, W. and Mishra, H.N. Scientific and Technical Aspects of Yogurt Aroma and Taste: A Review.Comprehensive Reviews in Food Science and Food Safety **2011**, 10, 208–220.

[37] Rodrigues, L.P.S. Vandenberghe, A.L. Woiciechowski, J.de Oliveira, L.A.J. Letti, C.R. Soccol

(**2017**), Production and Application of Lactic Acid.

[38] Sadeghi, M.; Khosravi-Boroujeni, H.; Sarrafzadegan, N.; Asgary, S.; Roohafza, H.; Gharipour, M.; Sajjadi, F.; Khalesi, S.; Rafieian- Kopaei, M. (2014). Cheese consumption in relation to cardiovascular risk factors among Iranian adults- IHHP study. Nutr. Res. Prac., 8, 336−341.

[39] Sadishkumar, V. and Jeevaratnam, K. (**2017**). In vitro probiotic evaluation of potential antioxidant lactic acid bacteria isolated from Idli batter fermented with Piper betle leaves. *Int. J. Food Sci. Technol.,* 52, 329–340.

[40] Salque M, Bogucki PI, Pyzel J, Sobkowiak-Tabaka I, Grygiel R, et al. (**2012**). "Earliest evidence for cheese making in the sixth millennium bc in northern Europe". *Nature*. Nature Publishing Group. doi:10.1038/nature11698. Retrieved 13 December 2012.

[41] Samara, A.; Herbeth, B.; Ndiaye, N. C.; Fumeron, F.; Billod, S.; Siest, G. and Visvikis-Siest, S. (**2013**). Dairy product consumption, calcium intakes, and metabolic syndrome-related factors over 5 years in the STANISLAS study. Nutrition, 29, 519−524.

[42] Sanchez, M.; Darimont, C.; Drapeau, V.; Emady-Azar, S.; Lepage, M.; Rezzonico, E.; Ngom-Bru, C.; Berger, B.; Philippe, L.; Ammon-Zu_rey, C. (**2013**). Effect of Lactobacillus rhamnosus CGMCC1.3724 supplementation on weight loss and maintenance in obese men and women. Br. J. Nutr., 111, 1507–1519.

[43] Serra, M., Trujillo, A. J., Guamis, B., & Ferragut, V. (**2009**). Evaluation of physical properties during storage of set and stirred yogurts made from ultra-high pressure homogenization-treated milk. *Food Hydrocolloids*, *23*(1), 82-91.

[44] Settachaimongkon, S.; Nout, M.J.; Antunes Fernandes, E.C.; Hettinga, K.A.; Vervoort, J.M.; Van Hooijdonk, T. C.; Zwietering, M.H.; Smid, E.J.; Van Valenberg, H.J.(2014). Influence of Different Proteolytic Strains of *Streptococcus thermophilus* in Co-Culture with *Lactobacillus delbrueckii Subsp. Bulgaricus* on the Metabolite Profile of Set- Yoghurt. International Journal of Food Microbiology 177, 29–36.

[45] Simoons and Frederick J. (July **1971**). "The antiquity of dairying in Asia and Africa". *Geographical Review*. American Geographical Society. **61** (3). JSTOR 213437.

[46] Smid, E.J. and Kleerebezem, M. (**2014**). Production of Aroma Compounds in Lactic Fermentations. Annual Review of Food Science and Technology 5, 313–326.

[47] Smit, G., Smit, B.A. and Engels, W.J. (**2005**). Flavour Formation by Lactic Acid Bacteria and Biochemical Flavour Profiling of Cheese Products. FEMS Microbiology Review, 29, 591–610.

[48] Smith, J.S. and Hui, Y.H. (**2015**). Dairy: Yogurt InFood Processing: Principles and Applications; Smith, J.S.; Hui, Y.H.; Eds.; Wiley-Blackwell: West Sussex, UK, 297–318.

[49] Smit, B.A.; Engels, W.J.; Alewijn, M.; Lommerse, G.T.; Kippersluijs, E.A.; Wouters, J.T.; Smit, G. (**2004**). Chemical Conversion of Alpha-Keto Acids in Relation to Flavor Formation in Fermented Foods. Journal of Agricultural and Food Chemistry, 52, 1263–1268.

[50] Steele, J., Broadbent, J. and Kok, J. (**2013**). Perspectives on the Contribution of Lactic Acid Bacteria to Cheese Flavor Development. Current Opinion in Biotechnology, 24, 135–141.

[51] Subbaraman and Nidhi (12 December **2012**). "Art of cheese-making is 7,500 years old". Nature. Retrieved13 December 2012.

[52] Tamime, A.Y. and Robinson, R.K. (**1999**). Chapter 7: Biochemistry of Fermentation. In Yoghurt: Science and Technology; Tamime, A.Y.; Robinson, R.K.; Eds.; CRC Press: Boca Raton, USA.

[53] The archaic myth of the culture-hero Aristaeus, who introduced bee-keeping and cheese-making before wine was known in Greece.

[54] The History Of Cheese: From An Ancient Nomad's Horseback To Today's Luxury Cheese Cart". *The Nibble*. Lifestyle Direct, Inc. Retrieved **2009**-10-15.

[55] "The Linear B word tu-ro". *Palaeolexicon. Word study tool for ancient languages*.

Thierry, A.; Pogacic, T.; Weber, M.; Lortal, S.(2015). Production of Flavor Compounds by Lactic Acid Bacteria in Fermented Foods In Biotechnology of Lactic Acid Bacteria: Novel Applications; Mozzi, F.; Raya, R.R.; Vignolo, G. M.; Eds.; Wiley-Blackwell: West Sussex, UK, 314:340

[56] Toussaint-Samat (**2009**):103

τυρός (http://www.perseus.tufts.edu/hopper/text?doc=Perseus:text:1999.04.0057:entry=turo/s).

Liddell, Henry George; Scott, Robert; *A Greek–English Lexicon* at the Perseus Project.

[57] Vazquez-Landaverde, P.A.; Velazquez, G.; Torres, J.A.; Qian, M.C. Quantitative Determination

of Thermally Derived Off-Flavor Compounds in Milk Using Solid-Phase Microextraction and Gas Chromatography. Journal of Dairy Science **2005**, 88, 3764–3772.

[58] Vonk, R.J.; Reckman, G.A.R.; Harmsen, H.J.M.; Priebe, M.G. (**2012**).Probiotics and Lactose Intolerance. IntechChapter 7, 149–160.

[59] Walstra, P., Wouters, J.T.M. & Geurts, T.J.(**2006**). Dairy Science and Technology, Second Edition.

[60] Wang H, Troy L.M. and Rogers G.T. (**2014**). Longitudinal association between dairy consumption and changes of body weight and waist circumference: the Framingham Heart Study. Int J Obes.; 38:299–305.

[61] Ward, L. (**2013**) Increasing awareness of the health benefits of dairy products. Food Manuf., 2 (9), 38.

[62] Wee YJ, Kim JN, Ryu HW. (**2006**). Biotechnological production of lactic acid and its recent applications. Food Technology and Biotechnology **44**(2):163–172.

[63] Yamada Y, Yukphan P. (**2008**). General and species in Acetic Bacteria. International Journal of Food Microbiology, 125: 15-24.

[64] Yukphan P, Malimas T, Lundaa T, Muramatsu Y, Takahashi M, Kaneyasu M, Tanasupawat S, Nakagawa Y, Suzuki K, Tanticharoen M, Yamada Y. (**2010a**). Gluconobacter Wancherniae Sp. Nov., An Acetic Acid Bacterium From Thai Isolates In The Proteobacteria, The Journal Of General And Applied Microbiology, 56: 67-73.

[65] Yukphan P, Malimas T, Muramatsu Y, Takahashi M, Kaneyasu M, Tanasupawat S, Nakagawa Y, Suzuki K, Potacharoenw, Yamada Y. (**2010b**). Tanticharoenia Sakaeratensis Gen. Nov., Sp. Nov., A New Osmotolerant Acetic Acid Bacterium In The Proteobacteria, Bioscience. Biotechnology and Biochemistry, 72: 672-676.