Review Article

MILK AND MILK PRODUCTS

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Abstract:

In this review article, we are going to discuss about what is milk, its chemical composition and its products. The usage of milk across different countries of the world varies due to availability and total production world vide and the cost to produce milk from farm animals especially cows whose milk is used for commercial purposes to make different products like yogurt, cheese, butter, ice cream, margarine and several others including medical uses. Milk contains different minerals like Calcium, Potassium, Magnesium and Vitamins like A, C, D, B complex. In addition to that milk also contains Proteins and different enzymes. Due to chemical reactivity of different compounds in milk and also bacteria from surroundings milk is prone to spoilage hence it needs processing and treatment for long time storage and commercial uses. Different kinds of standardized equipment are used across the world to process and maintain the healthier state of milk.

Introduction

Milk includes “A white liquid secreted by mammary glands of female, containing both macro and micro nutrients such as fats, proteins, sugars, calcium, magnesium, phosphate, and variety of vitamins along with bioactive ingredients” (Goldman and Blanc, 1981).

Human milk is only used to feed their child but milk for animals like cow, goat, sheep, and camels is use to feed their child, also completing the nutrition. Milk is a liquid that is secreted by mammary glands of female mammals (H.D. Belitz, 2004). From the beginning of world (6000-8000 BC) milk has been used for drinking purpose to complete the nutritional demands and energy of the mammalian family from man to whales. Human beings only consume the milk comes from halal source specially Muslims, such as from cattle’s including cow, goat, sheep, camels, and milk from their females. Milk is always secreted after the birth of offspring for the period of 2 years, with variation according to specie. For getting whole and nutritious milk the mammals needed the diet that is healthy and nutritious which is the main factor for good quality of milk (Lichtenstein AH. Russell RM, 2005).

There are many definitions of milk due to wide profile of nutrients. Most of the Milk from animal sources used to make nutraceuticals. As the milk is used for such purposes, therefore it is necessary to maintain its original state for the sake of getting such nutrients. Nowadays the word "milk" is identical with cow's milk. The milk of other animals is not considered as commercial due to most of the reasons (H.D. Belitz et al, 2004). Hence for proper care and maintenance of the perishable commodity there are different methods of milking the animal, such as for household hand milking, and for dairy and commercial purpose, equipment’s are used according to availability. Then it is sent to industries for further processing to get desirable products.

The yield of milk worldwide is different due to animal varieties. As in Pakistan buffalo milk yield is 16456 while in other countries like Egypt 2050, Nepal 744, Iran 176, Iran 549, UK 15023, and Myanmar 109. And cow yield is as Spain 6300, Japan 8480, China 7138, and Canada 8340etc. due to advancement of technology various artificial injections like Bovine somatropin (BST) is used for getting higher yield (H.-D. Belitz et al, 2004).

The consumption of milk also varies within the countries according to availability for instance World-wide average per person consumption is 107kg, from which Europe has 380kg, Oceania

and North America 280kg, 70kg in Asia. Also the percentage of infant feeding varies because mostly babies can't feed due to allergies (Jane Ellenton, 1999).

As milk is a perishable commodity, it provides favorable conditions to microorganisms at certain temperatures which results in spoilage of milk and milk products. Therefore milk and milk products needs to be stored at specific temperatures both in form of raw or processed .With the advancement of technology, processing and storage conditions are much improved. Milk products are now developing day by day to meet consumer demands.

The processing of milk and milk products require management and quality control because heat treatments of milk changes its organoleptic properties, cause denaturation, and oxidation reactions, the impact on milk compounds, the processing equipment's needed to be cleaned , and watched out properly for safety concerns.

Milk Composition

Milk is consumed due its rich nutrient profile including fats, protein such as casein and whey , sugars such as lactose ,vitamins A, C, D ,B complex, gases such as oxygen and nitrogen, Enzymes such as lipase, catalase, phosphatase etc. Acids including acetate, formatate, citrate etc. Minerals as K, Ca, Mg, K, etc. (Blanc and Ruegg, 1982)

A. Fats

Milk fat is in the form of globules or droplets, having a membrane around it and emulsion of milk serum. The cream is separated after centrifugation and prolonged storage. The cream floats on the skim milk. The process of homogenization finely divides and emulsifies the fat particles then cream cannot be separated even after log time. Homogenization increases the surface area and decrease the diameter. After disruption of fat particles the surface tension increases. Some of the layer that is adsorbed consists of casein and serum protein (Jane Ellenton, 1999).

Milk fat plays important role in flavor, appearance, satiability and texture of dairy foods. Dairy fat is a source of fat-soluble vitamins, essential fatty acids, energy and several other components, such as sphingolipid, conjugated linoleic acid (CLA). Fat is also present in the form of monounsaturated, polyunsaturated, and minor fatty acids. Stearic, palmitic and meristic acid are important saturated acids (Miller GD, Jarvis JK & McBean LD, 2007).

Different varieties of milk have varied percentage of fat as skimmed, semi-skimmed, and whole. But mostly people think that milk is fattening and cause of obesity for consumers. Whether it's true that fat deposit in the adipose tissues and result in human diseases but it's not verified yet that the cause is milk fat. With the advancement of technology, various fat reduced products are available for weight seekers in the market.

Various fat concentrations in milk are as follows:

Whole milk: 3.5% fat (3.5g/100g), semi skimmed milk 1.7% fat (1.6g/100g or 1.7g/100ml), skimmed milk 0.1% fat (0.1g/100g or 0.1g/100ml. For processing of products, arrangement of chemistry needed to be changed according to desired product as fat destabilization is important for manufacturing of ice cream, butter and whipping cream. Destabilization is actually clumping of fat particles for fat matrix (Jane Ellenton, 1999). Fats are source of lubrication and gives mouth feel to the product. Short chain fatty acids impart flavor to the butter. Butterfat also a reservoir of imparting flavors to other products as cheese.

B. Protein

A good source of high quality protein is milk (Miller GD, Jarvis JK & McBean LD, 2007). Protein in the milk is present in the form of miscelles and microsomes. Miscelles are calcium salts of casein and present in milk in different sizes while milk microsomes are lipoprotein particles which have residues of microvilli, cell membranes etc. as well as somatic cells, which are mainly leucocytes.

Milk of cow contains 3.5% protein from which casein is 80% and whey is 20%. The function of casein is to carry large amount of insoluble calcium phosphate to the child for efficient nutrition. In many processing operations such as in manufacturing of cheese whey and casein are separated. The proteins that appear in the supernatant of milk after precipitation at pH 4.6 are collectively called whey proteins. The whey protein is soluble in water than caseins.

While the primary structure of proteins consists of a polypeptide chain of amino acids residues joined together by peptide linkages, which may also be cross-linked by disulphide bridges. There is three dimensional configuration of protein including secondary, tertiary and quaternary structures. The secondary structure consists of the spatial arrangement of amino acid residues

that are near to one another in linear form. The examples of secondary structures are ß -pleated sheath and alpha-helix.

Whereas, the tertiary structure have spatial arrangements of amino acids that are far apart in the linear sequence giving rise to folding and coiling. If protein is tightly folded and coiled into spherical shape then it is called globular protein. And if the protein has long polypeptide chains that are intermolecular linked, they are called fibrous proteins. When proteins containing two or more polypeptide chain subunits which are associated then it is called quaternary structure (Jane Ellenton, 1999).

C. Sugars

Milk sugar is lactose. Lactose is made up of glucose and galactose but is a disaccharide itself. It consists of 4.8 to 5.2% of milk, 52% of milk solid not fat and 70% of whey solids. It is not sweet like table sugar or sucrose. Lactose is hydrolyzed by enzyme lactase, which splits these monosaccharaides, the result in depressed freezing point and increased sweetness. The mild taste is due to this sweetness. It is used as a fermentation substrate. Bacteria produce lactic acid from lactose, used in fermented dairy products.

There is milk allergy in many people due to lactose that is called lactose intolerance, this is due to lack of lactase enzyme, and hence lactose cannot be digested by them and products which have lactose. Mostly the allergic reaction varies within the individual, some people have mild reaction and others have severe. Lactose is insoluble in many dairy products, sweetened condensed milk, ice cream (Jane Ellenton, 1999).

D. Vitamins

These are organic substances essential for carrying out life process. Milk includes fat soluble vitamins A, D, E, and K. milk is a rich source of Vitamin A and is derived from ß –carotene and retinol. During heat treatments mostly the vitamins denatures therefore in processed milk these vitamins needed to be fortified such as vitamin A and D. There are also water soluble vitamins in milk including riboflavin, thiamin, pantothenic acid, pyridoxine, niacin, cobalamin, vitamin C, and folate (Jane Ellenton, 1999).

E. Minerals

All the essential minerals are present in milk which are 22 in number. Na, K, Cl, Ca, Mg, Phosphorus, Iron, Zinc, Copper, Manganese, Iodine, Cobalt, Chromium, Vanadium, Tin, Nickel, Fluoride, Arsenic (Jane Ellenton, 1999).

F. Enzymes

There are many enzymes present in milk and perform wide variety of functions. These are considered as expansive number of catalysts in milk. Lipases are catalysts that debase fats. The significant lipase in milk is lipoprotein lipase. It is related with the casein micelle. Proteases are catalysts that debase proteins. The real protease in milk is plasmin. A few proteases are inactivated by warmth and some are most certainly not. Proteins can be unwanted and result in severe off-flavors, proteases is vital in cheddar produce. Alkaline phosphatase is a protein in milk that is utilized as pointer of purification.in purified milk, soluble phosphatase is inactivated. Lacto peroxidase is a standout between the most heat stable compounds found in milk. Lacto peroxidase, when linked with thiocyanate, hydrogen peroxide and has antibacterial properties.it is useful in the deactivation of microorganisms in milk. Lysozyme is another catalyst that has some antibacterial properties, in spite of the fact that the measure of lysozyme present in milk is little (Gerard Meurant, 1995).

Effects of Heat Treatments & Light Exposure on the Vitamin & Mineral Content in Milk

The heat treatments used for preservation and processing of milk and milk products have a great impact on nutritional profile of milk. Such as ultra-high temperature (UHT) cause loss of some water-soluble vitamins, vitamin C is reduced from 2.0 to 1.8 mg/L, Thiamin is reduced from 0.45 to 0.42 mg/L (Potter et al., 1984).

Calcium phosphate will be shifted from casein micelle with changes in temperature. This process can attain its actual stage at moderate temperatures. This cannot affect the nutritional properties of milk minerals. But at very high temperatures the calcium phosphate may precipitate out of solution which causes irreversible changes in the casein micelle structure. Exposure to light will

decrease the vitamin A, riboflavin content in milk. Milk must be stored under control conditions to retain vitamin profile (Gerard Meurant, 1995).

A. Changes in milk during storage

During storage of milk various changes occur due to variations in the control environment such as oxidation of protein and fat. Oxidation of fat is due to the presence of copper and iron salts which accelerates the development of off-flavor. Also the oxygen in the milk and light exposure can cause oxidation. It reduces shelf life of milk and milk products.

Fat oxidation can be checked by microorganisms in milk, for instance lactic acid bacteria consume oxygen subsequently lessening oxidation. Likewise, purification decreases oxidation since lessening mixes, for example, sulfhydryl bunches are framed when milk is warmed. When exposed to light, the amino acid methionine is degraded to methional by vitamin C and riboflavin. This compound causes the “sunlight flavor” in milk. Factors that are major cause of sunlight flavor development are: Intensity of the light, duration of exposure, especially light from fluorescent tubes, homogenized milk is more sensitive than non-homogenized milk, nature of the package - opaque packages such as paper plastic give good protection.

Lipase is an enzyme that catalyzes the hydrolysis of lipid’s ester bonds. Milk is rich in lipase but it has no effect on fat particles most of the time. During pasteurization protein lipase is deactivated. Fat is broken down into free fatty acids and glycerol, the resulting reaction is lipolysis.it has a damaging effect on the flavor profile of milk. Lipolysis is triggered by high storage temperatures and lipases.

During processing acidification is desirable for yoghurt and other dairy products. Acid casein can be purified and used in foods for its water binding and emulsifying properties. Milk is chemically stable at neutral pH. The stability decreases when milk is heated, concentrated and added to alcohol. Proteolysis is due to sensitivity of the casein micelles to calcium, so a firm gel and the two coagulate are formed. These reactions are the basis of cheese production (Michael J. Lewis , 2017).

Milk processing

Milk is a perishable commodity and prone to spoilage in a very short period of time. Therefore, number of preservation and processing techniques are used to keep the milk safe, healthy and nutritious. The yield of stored milk and milk products varies within the countries due to availability of equipment's and skilled persons. It includes methods to produce foods that have different textures and flavors, which can enhance the market value of the milk. The processing of Pasteurized milk, ghee and Butter, yoghurt and Soured milk, dairy confectionery and Cheese making and Ice cream production can be carried out on small scale.

Methods for processing of, sterilized milk and bottled sterilized milk, such as making dried milk powder, canned (evaporated or condensed) milk, or milk by-products such as casein, are not possible to carry out at small scale because equipment required is of very high costs of and brief technical knowledge of specialists is required.

Spoilage, food poisoning and preservation

Milk is a perishable commodity, it give rise to bacterial growth. Milk is a low-acid food, bacteria can grow and contaminate all products prepared from it. This contamination includes, change in flavor, color or texture of milk products, to make the products unmarketable. Bacteria are also cause of food poisoning. Diseases such as typhoid fever, brucellosis, tuberculosis, salmonellosis, shigella, which is due to poor milk quality. All the processing conditions needed to be controlled for good quality of milk and milk products.

Equipment

The designed and construction of dairy equipment's should be made to ensure safe cleaning and dismantling. Boiling pans, mixing bowl, must have smooth internal surface that has no corners. Stainless steel is best option for making dairy equipment. Others include aluminum, and food grade plastic for equipment and containers. Mild steel is cause of contaminate products and brass, copper, iron cannot be used because they cause rancidity in milk fats.

Cleaning and sanitation

Good sanitation is important in processing of dairy products. Equipment must be completed cleaned after day's production, using a cleaning routine that shows which equipment is to be cleaned, who is responsible for checking that cleaning has been done properly, who is responsible for cleaning it, how frequently it is done, how it should be cleaned. Hot water is used for cleaning that is chlorinated water. Cloth wiping is the cause of re-contamination.

Methods of processing

The methods to process the milk at small scale includes heating, cooling, making milk acidic and reducing the moisture content of milk.

Heating

There are specific rules and laws in every country that specify the temperature and time for heating and pasteurization. Most specifications include heating of milk to 63^{o}C for 30 minutes. Higher temperatures and shorter time are used in bigger business activities however the equipment expected to do this is more costly.

Cooling

Cooling is not only meant to deactivate bacterial growth or enzymes proliferation but also suppress their activity. Cooled raw milk is suitable for a few days before processing. Milk products such as cheese, butter, yoghurt and pasteurized milk are chilled to ensure shelf life for distribution to retail storage and shops. Refrigerator set at 4-5 ^{o}C can be used to cool milk. Final product must be stored in a separate dispatch store at 4^{o}C +/- 2^{o}C, or and ice cream, for frozen milk, frozen in a freezer operating at below -18^{o}C.

Acidifying

Corrosiveness is created in milk by the development of specific kinds of innocuous microorganisms called 'lactic corrosive microbes'. They are typically present in milk and are additionally utilized as starter cultures in the creation of yogurt. Lactase converts milk sugar (lactose) into lactic acid, which raises the acridity of the milk and keeps the development of unsafe microbes. The corrosive additionally makes the trademark curd of yogurt. The timeframe

of realistic usability is stretched out by a few days and the adjustments in flavor and surface make this a famous item in many areas.

Reducing moisture content

Isolating milk fat from the watery piece of milk produces cream. This can be made as an item available to be purchased, yet care is required in light of the fact that there is a more serious danger of cream causing nutritional issues. Elucidated margarine (ghee) likewise has a timeframe of realistic usability of a while. Both are high-esteem items and have a decent market in many countries. In making of cheddar a curd is created and the water of milk is isolated as 'whey'. 'Cabin' cheddar or basic curd cheeses are moderately simple to make at a little scale, however hard cheeses require more noteworthy levels of venture, and more ability and skill. Another procedure is bubbling milk to dissipate water and create a caramel gel that is eaten as a nibble nourishment or sweet. The item has a time span of usability of fourteen days and may have fixings, for example, flavors, sugar, shading, natural products or nuts changed it up of item (Axtell, B., 1993).

MILK PRODUCTS

Yoghurt

Yogurt is a semi-solid fermented milk product which was developed centuries ago in Bulgaria. Milk fermentation is the oldest method to preserve milk with suitable shelf life (W.A.D.V. Weerathilake, 2014).

General Manufacturing Procedure of Yogurt

Standardization of milk, homogenization 55-65 ºC and 15-20/5 MPa, pasteurization 80-85 ºC for 30 min or 90-95 ºC for 5 min, Cooling to incubation temperature (43-45 ºC), Inoculation of starter culture (2% v/v), Packing into individual containers, fermentation/Incubation (42-45 ºC) (Until pH reached to 4.6), Cooling and cold storage (< 4 ºC).

Varieties and Types of Yogurt

Yogurt can be categorized into two categories, bio- or probiotic yogurt and standard culture yogurt. Standard yogurt are made with S. Thermophilus and L. Bulgaricus On the other hand, bio

yogurts are manufactured by culturing beneficial microorganisms that have health benefits once consumed, including the probiotic strains of L. acidophilus and Bifidobacteria. These probiotic strains have more specific health benefits and represent those types of microflora that are beneficial for gut. Plain/Natural Yogurt, Flavored Yogurt and Yogurt related products including, Frozen Yogurt, Dried Yogurt/Yogurt Powder, Herbal Yogurt are some varieties of yoghurt.

Types of yogurt

Balkan-style Yogurt: Balkan-style yogurt is called set-style yogurt which has individual thick texture and made in small and individual batches after pouring the heated cultured mix into containers following via nurture without any thrilling for over 12 hours or more until the desired creaminess and wideness is achieved.

Greek-style Yogurt: This is called Mediterranean-style yogurt made from partially condensed milk or by tint whey from plain yogurt to make it creamier and thicker. Due to its thick texture, it tends to hold up better upon heat than regular yogurt and thus utilizes as a main ingredient in making thick dips such as tzatziki.

European-style Yogurt/Stirred Curd Yogurt: European-style yogurt is a type of stirred yogurt with a distinctive creamy and smooth texture and is made by incubating the yogurt mixture in a large vat in its place of individual cups, followed by cooling and then stirring in order to obtain a creamy texture most often with added fruits (blueberries, strawberries, mango, and peach) and flavors.

French-style Yogurt: This style of yogurt is also known as custard-style yogurt made by direct culturing in the pot according to a French culture and process which characterized with a pudding-like texture (D.M. Dilan Rasika, 2014).

Advantages of Yoghurt

Yoghurt helps to improve metabolism, prevents infections and allergies, helps to lower hypertension and prevents cardiovascular diseases, promotes healthy skin and reproductive system, beneficial in lowering level of gingivitis and removing plaque, provides relief to those suffering from colon cancer, relieves constipation diarrhea and inflammatory bowel disease. (Absulbasat et al., 2017).

Dairy Confectionery:

They can be grouped into five categories: dried milk-based products, heat/acid coagulated products, cultured/fermented products, fat-rich products and cereal-based puddings/desserts. Gulab jamun: Gulab jamun is prepared by a mixture comprising basically of milk solids from khoa and wheat flour (sometime including twofold cream) in sugar syrup enriched with cardamom seeds and rosewater, saffron or nectar. It is formed into round, tube shaped or circular shapes and fricasseed to deliver a brilliant to dim dark colored shading, with a somewhat fresh external surface and delicate to firm, cream/white, permeable smooth surface inside.

Different Products:

Burfi: Khoa is warmed and blended with 25–35% sugar to frame a smooth mixture. Nuts and flavorings might be added amid warming to deliver distinctive kinds of burfi. The blend is filled a lubed plate, spread consistently and allowed to cool. It sets into a tough item that is cut into desired sizes and shapes might be beautified with thwart to expand the interest. It is pressed in paperboard containers with material or greaseproof paper.

Chhanna-Murki: This sweet is set up from Chhanna in ≈ 1 cm 3D squares covered with sugar. The blocks are cooked in bubbling sugar syrup until firm, and in the wake of cooling they are covered with sugar, here and there enhanced and shaded.

ChumChum: A sweet arranged from chhanna, covered with sugar or khoa. Chhanna is waged to a uniform mixture and moved into balls. The balls are cooked in bubbling half sugar syrup until the point that a firm body and close surface are framed. The balls are expelled from the syrup and cut into half. The surface is covered with sugar or ground khoa and enriched with consumable silver thwart.

Kalajamun or Kalajam: Khoa is blended with 5-6% wheat flour and 0.5% preparing powder and massaged to a smooth batter. It is moved into balls and rotisserie in ghee until the point that the surface is roasted to relatively dark, yet within stays white. The balls are then absorbed 60% sugar syrup for a couple of hours and put away or devoured.

Kalakand: This is produced using danedar (granular) khoa. Citrus extract is added amid warmed to shape all around characterized grains. At the point when a semi-strong stage is achieved, sugar

is blended in and flavorings and additionally nuts may be included. After 5 min the blend is exchanged to a lubed plate to cool and set and is then sliced to the required shape and size. The sweet has a light caramel shading, a firm body and granular surface (Dr. Peter, 2008).

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