LFS 250

BC Dairy System Course Notes

FROM COW TO CONSUMER AND BEYOND

A. Overview of Milk Processing and Distribution

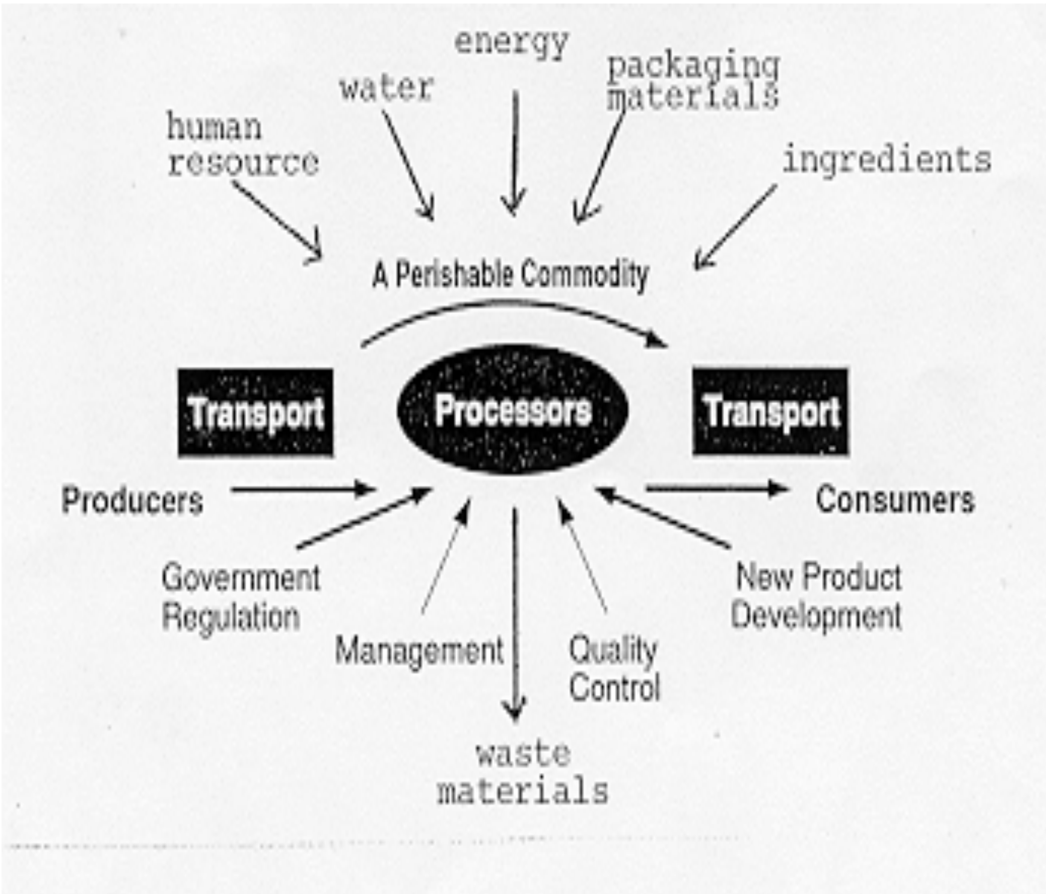
To analyze this system, we need to ask the same questions as we did for the dairy farm system. These are: What is the goal? Where is the boundary? What are the components and the interactions?

Within the boundary of the processing subsystem there are only a few processing companies, compared to approximately 680 dairy farms in the production subsystem. Within each milk processing plant there are a number of processing operations used to produce a variety of products. Another important component of the system is transportation, both of raw milk to the plants from the dairy farms and of products out to wholesale or foodservice and retail outlets. Dairy products valued at approximately $364 million dollars were produced in 2001 in British Columbia and represent the second highest dollar value category within B.C. agricultural commodities in 2001.

Just as the farmer interacts with agencies outside the farm, so does the processor. Government departments are involved in many aspects ranging from provincial regulations pertaining to public health, to the regulations of federal departments such as the Canadian Food Inspection Agency concerning packaging and labeling, good manufacturing practices and adherence to the British Columbia Milk Industry Act and the Food and Drugs Act and Regulations of Canada. There are numerous suppliers of inputs such as human resources, processing equipment, packaging materials, ingredients, cleaning and sanitation supplies, water and energy. While the overall manager of a given dairy farm is often the owner/operator, management of a processing plant is frequently much different — consisting of a board of directors, a general plant manager and a hierarchy of managers of the various departments. The nature of the management structure depends on the type of processing plant in question. Three types can be identified in the B.C. dairy system:

- Large multinational dairy processors such as Saputo Inc. which purchased Dairyworld Foods, which was owned and controlled by farmers in B.C., Alberta and Saskatchewan, who were members of Agrifoods International Cooperative Limited, the second largest dairy processing company in Canada and was a cooperative with 1750 dairy farmer members.
- A second type is the “independent” dairy which is not controlled by milk producers but which is associated with a major retail food outlet. An example is Safeway’s Lucerne Dairies.
- The third type tends to be smaller-scale private operations, of which Avalon Dairy in Vancouver and D-Dutchman Dairy in Sicamous are examples.

- The fourth type are farmer owned co-operatives, such as Island Farms Dairies Co-op Association which is located on Vancouver Island but also markets dairy products throughout the Lower Mainland.



The milk processor, or the processor of any agricultural product, acts as a vital link between the producer and the consumer (Fig. 2.6). The processor plays a particularly important role in agricultural systems because all food products are perishable — some more than others — with milk being an example of a highly perishable product

B. Functions of Milk Processing

There are four main reasons to process milk: preservation, reduction of health hazard, protection and added value.

1. **Preservation**
   Since milk is highly perishable, a primary function of processing is to prevent

spoilage by microorganisms, enzymes and chemical reactions, to extend shelf life, and to maintain nutritional value as well as sensory properties.

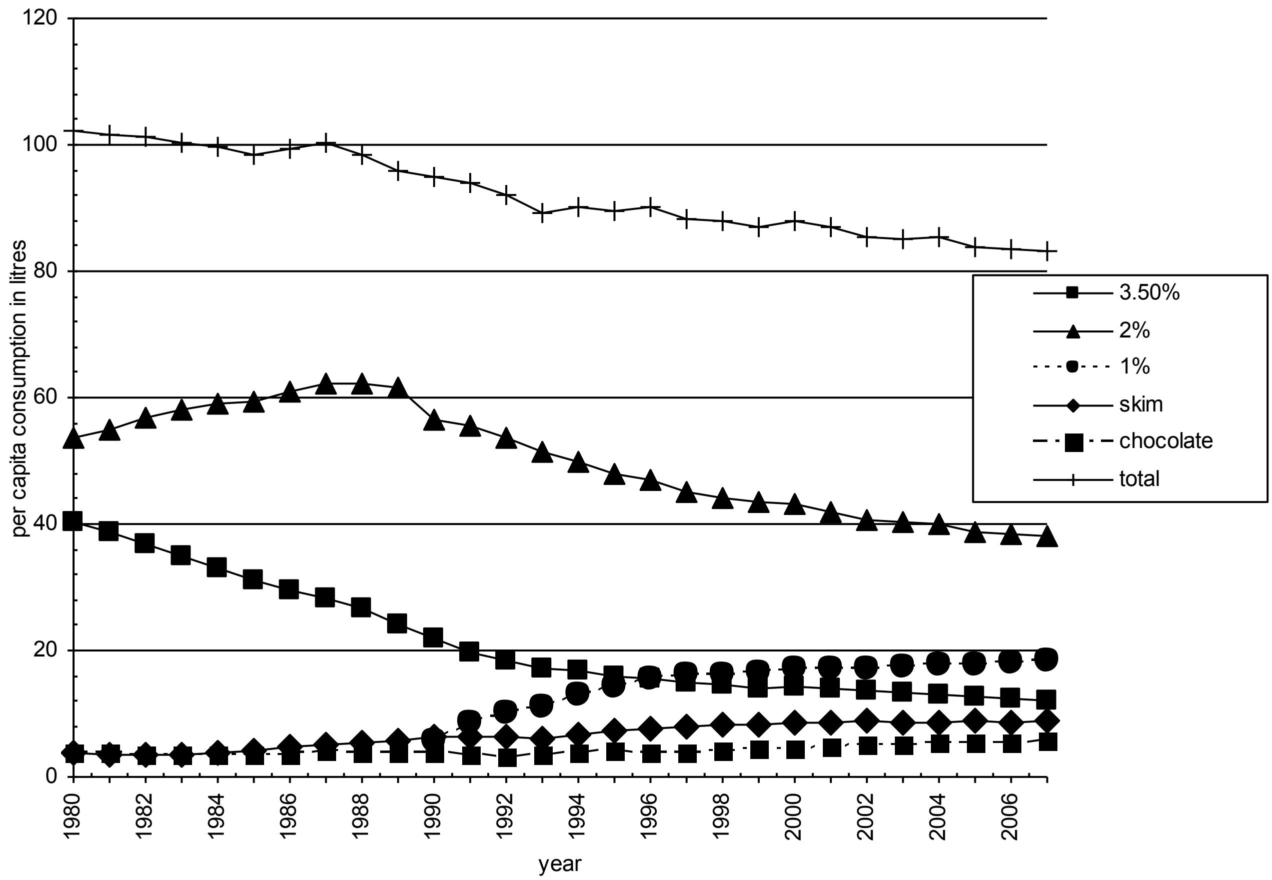
2. **Reduction of health hazard**
   Milk is an ideal "culture medium" for microorganisms and in the past has been a means of transmitting diseases such as tuberculosis and brucellosis to the human population. Although this problem has been virtually eliminated in Canada, it is still a concern in many parts of the world. Processing is one of the factors responsible for reducing the health hazards than can be associated with the consumption of raw, unprocessed milk. Under the B.C. Milk Industry Act the sale of unpasteurized milk is illegal.
3. **Protection**
   Packaging of milk ensures that it is protected from contamination after processing and facilitates transportation, distribution and handling by the consumer. Labeling acts as a source of consumer information, advertising and performs a merchandising function. Two dairies may produce the same product of equal quality but the packaging and labeling of one may be more appealing to the consumer than the other — an example of the role of psychology.

4. **Added value** Milk enters the dairy as liquid in virtually the same state it left the cow; however, it leaves in a wide variety of products. Processing can add value, converting standard milk, which is a dietary staple, as well as a variety of ingredients into the category of luxury foods such as fancy ice creams.

C. Changes in the Processing Industry

Consumption of dairy products in Canada has undergone many changes over the past several decades. In the past, fluid milk was available as pasteurized, homogenized milk (3.5% butterfat, b.f.), skim milk and as canned evaporated milk. Development of improved processing technologies combined with consumer demands for lower fat products lead to the introduction of 2% bf milk about 30 years ago followed by the introduction of 1% mf milk in 1990 with 0.5% mf milk being introduced in 1999. These product introductions have reflected consumer demands for products with lower energy and fat contents, which reflects recommendations by nutritionists that Canadians should decrease their total intake of energy and fat. Overall consumption of fluid milk has decreased from 102 litres in 1980 to 83 litres per capita in 2007. If one looks at consumption of the various types of fluid milk, there have been dramatic changes in consumption of the various types of fluid milk products. Consumption of 3.5% mf milk has decreased from 40 litres in 1980 to 12 litres in 2007 while consumption of 2% mf milk increased from 54 litres in 1980 to 61 litres in 1989 after which consumption began to decline to 38 litres in 2007 as a result of introduction of 1% mf milk in 1990. One per cent mf milk consumption increased from 6 litres in 1990 to 18 litres in 2007. It will be interesting to determine the impact of the introduction of 0.5% mf milk on the consumption pattern for 1% mf milk. Consumption of skim milk, which has less than 0.1% mf, increased from 4 litres per capita in 1980 to 8.8 litres in 2007. One would think that with demand for low fat milk the consumption of skim milk would have rapidly increased but issues of mouthfeel, flavour and colour (all of which are affected by milk fat) have been contributors to the success of 1% milk and to the slow increase in consumption of skim milk. More recently, microfiltered milk (milk pasteurized by a combination of microfiltration and heat pasteurization), calcium-fortified milk and omega-3 oil enriched milks have been introduced into the retail market. It will be interesting to observe the consumption patterns for those products as well as to observe how introduction of those products will influence the consumption patterns for the more traditional types of fluid milk available in the marketplace.

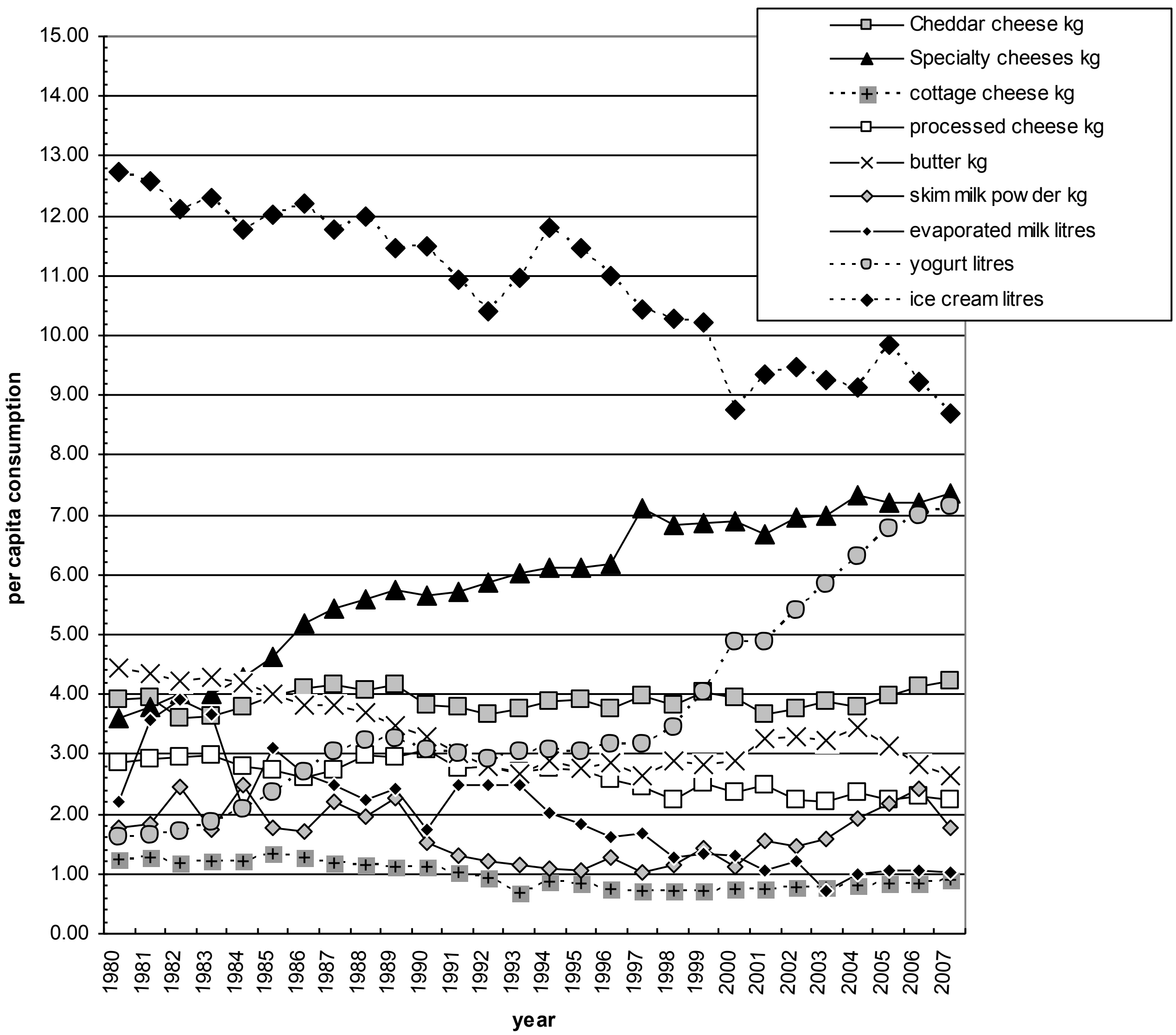
Figure 2.7: Fluid milk consumption trends in Canada



(From: Canadian Dairy Information Centre)

Cheese increased between 1980 and 2007 with the greatest increase occurring within the specialty cheeses (cheese varieties other than Cheddar). Yogurt consumption increased from 1.6 litres in 1980 to 7.1 litres per capita in 2007. Ice cream consumption decreased during the period of 1980 to 2007.

Figure 2.8: Per capita consumption, in Canada, of dairy products processed from industrial milk.



(From: Canadian Dairy Information Centre)

In addition to these long-term trends the processor must anticipate and cope with seasonal changes in demand, such as ice cream in the summer and whipping cream at Christmas. Such changes can present problems such as a surplus of butterfat (cream) at one time or a surplus of skim milk at another. Competition from substitute products such as margarine, "coffee whiteners", "non-dairy ice-cream" and milk alternatives such as soy beverages is another factor with which both the milk producers and milk processor have to contend. For example, Dairyworld Foods has a joint venture with Sunrise Soya Foods, of

Vancouver, in the form of Soyaworld Inc. which is a major processor of soy and rice based non-dairy beverages that are marketed as alternatives to cows milk for people who choose not to consume cows milk or milk from animals because they are vegetarians or because they have sensitivities or allergies to components of cows milk.

Just as dairy farms have evolved, so has the processing industry. A large number of small plants have been replaced by a smaller number of large, automated plants, which are more efficient in the use of several resources, including energy. Most processes involve a considerable amount of energy in the form of heating and refrigeration. Some examples of reductions in energy use by the processing plants are as follows:

- Refrigerated bulk tankers do transport of milk from farm to plant. This has replaced the old method of transporting milk in 10 gallon (45 litre) cans. Now, a single truck can transport a much larger load and there is no need to deliver milk from the farm to the processing plant every day.
- Milk is pasteurized by the HTST (high temperature-short time) method, which is a continuous process that uses less energy than the old vat process, which involved heating large tanks of milk for longer time periods. In addition, the HTST processing operation enables heat recovery by capturing heat from the hot pasteurized milk to warm the cold raw milk entering the pasteurizer. In effect the raw milk is warmed and the hot pasteurized milk is cooled thus saving heating and refrigeration costs all the while ensuring that the pasteurized milk does not come in direct contact with the raw unpasteurized milk in order to maintain the safety of the pasteurized milk.

Changes in packaging from bottles to cartons, pouch packs, and plastic jugs have reduced energy input. This has been combined with changes in the distribution system (e.g., reduced home delivery) to effect further energy savings

D. Milk Processing

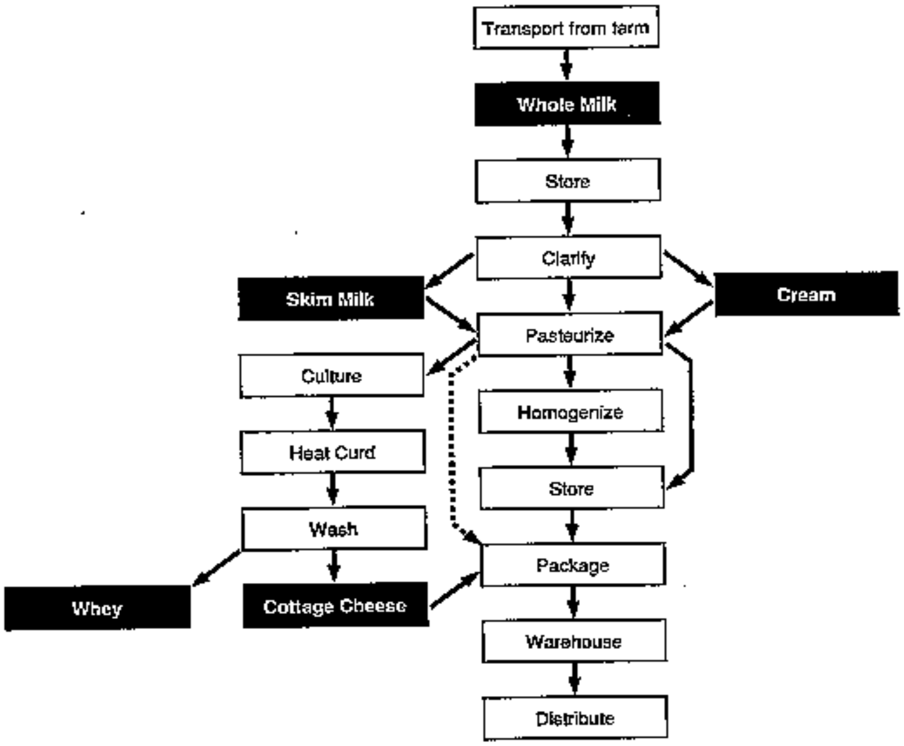


Figure 2.9 illustrates the major steps involved in processing fluid milk. High quality milk products begin with sound production practices and herd management techniques on the farm. The goal is to obtain milk that has a low microbial content and is free from antibiotics and other undesirable factors.

Most dairy farms employ milking machines to milk the cows and the milk from each cow is conveyed within a closed system to a bulk tank where the milk is rapidly cooled to await transport to the processing plant. Rapid cooling of the milk in the bulk tank is important to minimize growth of bacteria in the milk. Although milk as it exits a healthy udder is almost sterile, bacteria are picked up from equipment and the environment in which the milk is handled. Milking equipment is thoroughly cleaned with detergents and sanitized with agents such as chlorinated water between milkings, but that does not sterilize the equipment. Milk is normally held less than two days before being picked up by a tanker truck for transport to the milk processing plant.

It is important that the same level of care and cleanliness applied to on-farm milking equipment and the bulk tank be applied to the fittings, transfer hoses and the tank on the tanker truck. Milk, once it has been delivered by bulk tanker to the dairy processing plant, is tested to ensure it is of satisfactory quality and then placed in refrigerated storage (raw milk silo).

Quality attributes tested include the amount of sediment (dirt), microbiological numbers and presence of antibiotics (inhibitory substances), and freezing point (a test to determine whether milk contains added water, a form of economic fraud).

E. Standards for Milk

Milk has a standard (description) of identity within the Food Regulations of the Food and Drugs Act of Canada, administered by the Health Protection Branch of Health Canada and enforced by the Canadian Food Inspection Agency. A standardized food is designated by the symbol [S] before it in the Regulations. The following are exerpts, pertaining to milk, from the Regulations (Foods, Division 8 [Dairy Products] of Part B of the Regulations of the Food and Drugs Act of Canada):(http://www.hc-sc.gc.ca/fn-an/alt_formats/hpfb-dgpsa/pdf/legislation/e_b-text-1.pdf) see Division 8; Dairy products (pages 95 and 96)

"[S] Milk or Whole Milk

a. Shall be the normal lacteal secretion, free from colostrum, obtained from the mammary gland of the cow, genus *Bo*s, and
b. Shall contain added vitamin D in such an amount that a reasonable daily intake of the milk contains not less than 300 IU and not more than 400 IU of vitamin D.

[S] Skim milk

a. Shall be milk that contains not more than 0.3% milk fat.
b. Shall, notwithstanding section D01.009 and D01.010, contain added vitamin A in such an amount that a reasonable daily intake of the milk contains not less than 1200 IU and not more than 2500 IU of vitamin A, and
c. Shall contain added vitamin D in such an amount that a reasonable daily intake of the milk contains not less than 300 IU and not more than 400 IU of vitamin D.

[S] Partly skimmed Milk or Partially Skimmed Milk

a. Shall be derived from milk that has had its fat content reduced by mechanical separation or adjusted by the addition of cream, milk, partially skimmed milk or skim milk either singly, or in combination;
b. Shall, notwithstanding section D01.009 and D01.010, contain added vitamin A in such an amount that a reasonable daily intake of the milk contains not less than 1200 IU and not more than 2500 IU of vitamin A, and

c. Shall contain added vitamin D in such an amount that a reasonable daily intake of the milk contains not less than 300 IU and not more than 400 IU of vitamin D."

The only substances that can be added to milk are vitamins A and D. It is mandatory, in Canada, to add vitamin D to milk and vitamins A and D to skimmed and partially skimmed milk products, because milk has traditionally been an important source of those two fat soluble vitamins. The Food Regulations are very specific about the amount of vitamins A and D that can be added since excess of either to those two vitamins can be toxic. In the Regulations, reference to a "reasonable daily intake, RDI" is a regulatory mechanism and for fluid milk the RDI is 832 ml.

Milk Composition

Cows milk is a fluid product that is composed of water, proteins, fat, carbohydrate, minerals and vitamins. The composition of cows milk is approximately 87% water, 3.9% fat, 3.3% protein, 5.0% lactose (milk sugar) and 0.7% minerals (calcium, phosphorus, potassium, sodium, zinc) with vitamins (vitamin A, pantothenic acid, riboflavin, thiamin, vitamin B_6, vitamin B_{12}) making a minuscule fraction by weight but a very important fraction from a nutritional point of view. The exact composition of milk will vary with breed of cow and may vary somewhat with age of the cow, stage of lactation, season, feed composition and physiological condition of the cow. The components of milk play very important roles:

- in the nutritional value of the milk in the diet of consumers;
- in the role that milk and milk ingredients play in the processing of milk;
- in conversion of milk into other dairy products (cheese, yogurt, ice cream and ice cream based products, butter, skim milk powder);
- in the separation of milk into components (milk caseins, cheese whey powder, whey proteins, lactose) for use as ingredients in other food products (processed meats, bakery products, confectionary items, beverages, etc).

F. Steps in Fluid Milk Processing

For homogenized (standard milk), 2% fat, 1% fat and 0.5% fat (partly skimmed), light cream (10% fat) and whipping cream (35% fat) the steps are as follows. The flow chart (Fig. 7.2) shows milk drawn from storage at which point the fat content will be about 3.7%. The **clarifier** is a separator, which removes cream, and the amount can be standardized to produce standard milk (3.5% fat) or partly skimmed (2%, 1%, 0.5%), skim milk, or fat can be added to produce different types of cream (heavy cream which is 40% butterfat; all-purpose cream, 30% butterfat; light cream, 20% butterfat and "half and half ", 10% butterfat). The cream separator operates on the principle that fat is less dense than the water phase of milk and will rise when subjected to centrifugal forces in a high-speed centrifuge.

The next step is **pasteurization** that kills all pathogenic (disease-causing) organisms and most organisms, which cause spoilage as well as inactivating enzymes that, can cause milk spoilage. Pasteurization is achieved by heating the milk to a specific temperature for a specified period of time that has been pre-determined to kill disease-causing microorganisms (bacteria and viruses) thus rendering the milk safe for human consumption. Raw milk can be contaminated with disease-causing bacteria and viruses and should never be consumed. The modern pasteurization process is a continuous process whereby the milk flows through heating and cooling equipment during the pasteurization process. During pasteurization the milk is heated to 71.7°C and held at that temperature for 15 seconds prior to cooling. This heating process creates very little flavour change in the milk and virtually no change in milk colour and causes minimal loss of nutrients. Since pasteurization does not sterilize the milk, pasteurized milk must be kept cool (ideally at 4°C or lower) to maintain the shelf life of the product.

Homogenization is the process by which the fat globules are reduced in size so the cream does not separate from the "milk". Milk fat is less dense than the water based portion (skim milk portion) of milk and the large fat globules normally present in cow milk gradually rise to the top of the milk creating two distinct layers (cream at the top and skim milk under the cream layer). In this processing operation, pasteurized milk is forced under very high pressure through a very small orifice in the homogenizer to break the fat globules into smaller sizes. Even though the specific gravity (density) of the smaller fat globules is the same as the larger globules in unhomogenized milk, the fat does not separate as easily because of the smaller globule size and the milk maintains its uniform property during refrigerated storage.

The milk or cream can then be **packaged** in a variety of package types, such as cartons, jugs, pouches, or glass bottles, and in different sizes. Packaging must be performed in a clean environment using clean containers and packaging equipment. Plant employees do not touch the milk during the transition from raw milk to packaged pasteurized milk. It is a closed process — the milk, once it enters the processing system, is not exposed to employee or environmental contact. The containers are usually sealed in a manner that is tamper proof. This means that the containers have features that clearly demonstrate to the consumer whether someone else previously opened the container.

G. Packaging for Fluid Milk Products

Drink boxes (ultrahigh temperature sterilized milk): The cartons are a laminate of (from the inside toward the outside of the carton): polyethylene, aluminum foil, polyethylene, paper, polyethylene. The packaging material is delivered to the milk processing plant as roll stock and the packaging material is fed into the packaging machine where it is sterilized with hydrogen peroxide, ultra violet light and hot air prior to being formed. The carton, while it is being formed is also being filled, with commercially sterile milk, and then sealed inside the sterile packaging machine. The cartons are packed in a cardboard master carton which is over-wrapped with plastic. Master cartons are stacked on pallets, which in turn are over-wrapped with plastic to keep the cartons from shifting during distribution.

Glass bottle: The glass bottle is reusable and returnable. A deposit is paid on the bottle at the time of purchase and the bottle is cleaned with a hot caustic wash, rinsed with potable water, and sanitized with chlorinated water (usually 200 parts per million chlorine) or by subjecting the bottle to a hot water rinse for a time period long enough to kill disease causing bacteria and viruses. The bottle is then filled, capped with a paper based lid and the mouth of the bottle is covered with an aluminum foil based cover. The filled jugs are sealed, labeled and shipped to the marketplace in plastic, returnable crates that are stacked on pallets which are then over-wrapped with plastic film to keep the crates from shifting or falling from the pallet during distribution..

Gable top carton: The carton is made from paper that is coated on both sides with a plastic film to make the carton water proof. The cartons are delivered to the processing plant as flat cartons shipped in large paperboard cartons. The packaging machine folds the carton into its correct configuration, folds and seals the bottom of the carton, fills the carton and seals the top of the carton. The filled jugs are sealed, labeled and shipped to the marketplace in plastic, returnable crates that are stacked on pallets which are then over-wrapped with plastic film to keep the crates from shifting or falling from the pallet during distribution. Gable top cartons are now available with a resealable spout that facilitates opening and pouring from the carton. Although made of the same materials as gable top cartons for juice, that can be recycled, gable top cartons from dairy products are not accepted in municipal recycling systems. This is most likely because of the smells that would emanate from improperly cleaned cartons and the public health dangers that would be posed by microbial growth in milk residues remaining in improperly cleaned cartons placed in recycling systems.

High density polyethylene jug: The empty jugs are blow molded at a packaging manufacturing plant, loaded onto pallets, which are over-wrapped with plastic film to prevent dust and dirt from getting into the empty jugs. The jugs are transported to the milk processing plant, loaded onto the filling line and filled with the pasteurized milk. The filled jugs are sealed, labeled and shipped to the marketplace in plastic, returnable crates that are stacked on pallets which are then over-wrapped with plastic film to keep the crates from shifting or falling from the pallet during distribution.. High density polyethylene jugs are accepted in municipal recycling systems.

H. Storage of Milk Products

Although the pasteurization of milk products kills most spoilage organisms, they are not completely destroyed and pasteurized products need to be stored under refrigeration in the plant, during distribution, and until the time of consumption. Cold storage must be maintained continuously between pasteurization and the consumers' table to maintain quality and safety of the pasteurized milk. Pasteurized milk will eventually spoil in the refrigerator due to growth of cold tolerant bacteria that survive the pasteurization process.

Sealed containers of pasteurized milk are labeled with a “durable life” or “best before” date. The date signifies a date after which the milk should not be sold. “Durable life,” as defined in Section B01.001 of the Food Regulations of the Food and Drugs Act of Canada, is “the period, commencing on the day on which a prepackaged product is packaged for retail sale, during which the product, when it is stored under conditions appropriate to that product, will retain without appreciable deterioration, its normal wholesomeness, palatability, nutritional value and any other qualities claimed for it by the manufacturer”(for more information on these regulations, see

The appropriate temperature for storage of pasteurized milk products is 4°C. The milk should maintain its desirable properties for about 7 days after the best before date, if it has been stored under proper conditions.

I. Ultra High Temperature (UHT) Processing of Milk

This example is used to illustrate new product development using a teamwork process in identifying and solving problems. It also identifies the need for a sound understanding of scientific principles and the need for teamwork among scientists from several disciplines. The main actors in this example are food scientists, engineers and economists.

The older vat method of pasteurization which involved heating milk to 60°C and holding it at that temperature for 30 minutes has been replaced by the High Temperature Short Time (HTST) process in which milk is heated to 77°C for 15 seconds. As mentioned earlier, this is a quicker and more energetically efficient process. The Ultra High Temperature (UHT) process goes one step further with operating conditions of 140°C for less than 8 seconds.

As previously stated, pasteurization kills most, but not all, spoilage organisms. Pasteurized milk has a shelf life of 14 days only if it is maintained in a refrigerated state from the time of packaging to its use in the home.

The UHT process has the advantage of destroying all spoilage organisms and effectively sterilizing the milk. When packaged in sterilized containers it has a shelf life of several months (rather than days) and does not require refrigeration in the warehouse, during transport, at the retail level or at home. This, together with less frequent deliveries, results in considerable saving in energy.

The idea of sterilized milk has been around for a long time. Why is it not a standard product? There have been a few problems to be solved, including:

- The equipment and the environment in which the process occurs must be aseptic and therefore is more expensive than transitional pasteurization.
- The initial milk must be of an exceptionally high quality in terms of a low bacterial count. This situation requires a link between the producer and the processor.
- A major deterrent has been the fact that when milk is heated to a temperature high enough to sterilize it, the resultant product has sensory problems, that is, an undesirable odour and/or flavour — it has a burnt milk odour and has a "cardboard" flavour.

The food scientist can explain this as being due to the Maillard browning reaction, which leads to the production of brown colours and uncharacteristic flavour in the milk. The chemical reaction is between the milk sugar, lactose and lysine which is an amino acid contained in the milk protein.

The problem of "off flavour" is the main one that has had to be solved. Chemical reactions tend to be temperature- and time-dependent so a partial solution has been to develop the process so that a high temperature is reached quickly and a short holding time is used, hence 140°C for three to eight seconds. This reduces the amount of reaction that occurs. The temperature and time conditions should be the minimum necessary to achieve sterilization.

The food scientist has identified the problem, the cause, and a possible solution; it is now up to the engineer to design equipment that will produce the desired operating conditions. Early equipment passed thin films of milk between heated plates to achieve rapid heating of the milk, but coagulation of milk protein on the metal plates caused problems. The latest engineering technology involves injecting steam into the milk and the removal of the steam by vacuum. This resolves the protein coagulation problem.

Having produced sterile milk, the next step is to ensure that the packages into which it is placed are sterile. Again the food scientist and the engineer have had to work together. Special foil lined packages have been developed and these are sterilized by the addition of hydrogen peroxide (H_2O_2) prior to filling. This procedure could produce problems because H_2O_2 is a powerful oxidant and small traces could lead to rancidity of the milk fat. This is prevented by exposing the packages to ultraviolet light which also helps to sterilize, but its main effect is the conversion of H_2O_2 to $H_2O + O_2$. This step is carried out immediately prior to filling the packages.

The production and packaging problems have largely been resolved and the product is now being produced, but the market demand has been disappointing. Why?

This is where the economist comes in, although economists would argue that an economic analysis should have been done prior to, not after, developing the product. The economist could have determined whether the cost savings would outweigh the development costs, and market surveys could indicate if there were enough advantages to the consumer to make the product an attractive alternative. Such analyses might have indicated that the potential market was small and producing the product would not be worthwhile. Some possible reasons for a low demand might be:

- The price is higher than regular milk and the convenience does not compensate for this.
- The problem of flavour has not been completely solved.
- The technology of the process limits the container size to a maximum of 1 litre — inconveniently small for many consumers.
- UHT milk does not require refrigeration (its main advantage), therefore it is not placed with the regular dairy products in the refrigerated display cases in retail stores. This may be a problem of merchandising psychology — it is not where people expect to find it. Another factor is that not all stores sell UHT milk.
- UHT milk is popular in Europe and parts of Asia but as indicated above it has not met with much success in North America. Part of the reason for that phenomenon is that milk of very high quality is produced in North America and as a result the North American consumer is much more sensitive to slight off-flavours in milk compared to consumers in other countries.

The small containers of coffee cream used by restaurants are UHT processed and packaged, but at lower temperatures. These have been very successful — there is no problem of flavour. The reasons are the lower processing temperature and the somewhat lower levels of lactose and protein which react to create the problem and slower reaction rates due to the lower processing temperature. The creamers, however, do have to be stored at refrigeration temperatures because of the survival of some spoilage-causing organisms during the lower temperatures used in heat treatment of the cream used in the creamers. The cream is filled into polystyrene cups that are then sealed with a plastic/aluminum foil laminated lid.

The same reason applies to the successful processing of fruit juice by UHT. Juice contains sugar but very little protein so the browning reactions are not a problem.

The question of consumer acceptance of the UHT product raises another interesting possibility. If one assumes that a prior economic analysis was not done, it is possible that the decision to produce UHT milk for the B.C. market was based on the observation that this product was selling well in several countries in Europe. Making the assumption that what works in one system will work in another can be a mistake if all the factors have not been considered. Sociological and cultural differences may exist — for example, refrigerators may be less common in European households than in B.C., and therefore UHT milk would be more attractive there. Another possible difference might be a government policy to encourage acceptance of the product by means of a subsidy, making UHT milk less expensive to the consumer. [These examples are hypothetical and used for illustration only].

The composition of the milk that the processor receives is dependent on the production sector of the industry (e.g., the breed of cows, types of feed, level of production, and effects of climate). All these factors influence the fat, protein and lactose content of the milk. Also, the quality of the milk in terms of bacterial content depends on the level of hygiene on the farms. There are many interactions in the dairy system from the producer to the consumer.

J. Nutritional contributions of dairy products

Canada's Food Guide recommends that each person should consume 6 – 8 servings of grain products, 7– 10 servings of vegetables and fruit, 2 servings of milk products and alternatives and 2 servings of meat and alternatives per day. Canada's Guidelines for Healthy Eating are based on the following principles:

1. You should eat a variety of foods.
2. You should emphasize cereals, breads, other grain products, vegetables and fruit.
3. You should choose lower-fat dairy products, leaner meats as well as food prepared with little or no fat.
4. You should strive to achieve and maintain a healthy body weight by enjoying regular physical activity and healthy eating
5. You should limit consumption of salt, alcohol and caffeine.

More information about Canada's Food Guide can be found at the following website (http://www.hc-sc.gc.ca/fn-an/food-guide-aliment/basics-base/index-eng.php)

The contribution made by dairy products to the dietary intake of the average Canadian is shown in Table 3. That information clearly shows that dairy products make a substantial contribution to the dietary intake of Canadians for a substantial number of nutrients.

Dairy products have had a prominent role in the diet of North Americans for many decades. Milk and dairy products are the most important source of calcium in the diet of Canadians. Milk, as produced by the cow, does not contain vitamin D but all fluid milk sold in Canada must be fortified with vitamin D such that milk will be an excellent source of vitamin D. You will note from Table 1, that cheese, butter, yogurt and frozen desserts are not a source of vitamin D since the industrial milk used to make those products is not fortified with vitamin D. Milk is also a good source of vitamins A, B_{12} and riboflavin as well as a source of magnesium, phosphorus and potassium. Vitamin D, protein, calcium, phosphorus, and magnesium are all important nutritional factors in bone formation in infants and children and for maintenance of bone health in adults and the elderly,

Unlike calcium from other food sources, especially calcium from some plant products, the calcium in milk and milk products has a high bioavailability with about 25 to 40% of the calcium in dairy products being absorbed from the intestinal tract into the blood stream. Bioavailability of calcium from plant products is variable. In some cases, it is similar to or even greater than bioavailability from milk and dairy products. For example, the percentage of calcium absorbed from broccoli is about 50%. In other cases, it can be much lower. Only about 5% of the calcium in spinach is absorbed, and only about 17% of the calcium in red, white or pinto beans is absorbed. However, even when the percentage absorption is high, the contribution of plant foods to calcium intake is generally low because the absolute amounts of calcium per serving are low. For example, one would need to eat 2.5 cups of broccoli to absorb the same amount of calcium as from one cup of fluid milk

Calcium and vitamin D intakes have received considerable research attention recently because of their influence on bone density and therefore on the risk of osteoporosis. Osteoporosis affects one in four Canadian women over the age of 50, and one in eight men. It's associated with fractures of the hip, wrist, ribs and spine. Although calcium and vitamin D intakes are only one of many factors affecting the risk of osteoporosis (others include family history, age, sex, physical activity, body size, ethnicity, smoking, alcohol use, use of certain drugs, etc.), they are important because they can be modified. Studies conducted in growing children, for example, have shown that higher calcium intakes are associated with greater gains in bone mineral content during growth. In this regard, there is concern because increased soft drink consumption and decreased dairy product in growing children is leading to lower calcium intakes. Calcium and vitamin D intakes are also important to older adults. When intakes are increased to the levels recommended, studies have shown that bone loss is reduced and that the risk of fractures is decreased.

There has been a dramatic increase in the number and types of milk alternatives available on the market for individuals who cannot consume milk due to an allergic response to milk proteins or who do not want to consume cows milk (strict vegetarians) or who do not want to consume cows milk for other reasons (concern about genetically modified foods or use of genetically modified crops as animal feed). And although BST has not been approved for use in Canada, publicity surrounding its use in the United States has led some consumers to avoid milk for this reason.

Alternatives to cows milk include milk from other milk-producing animals (goats milk, sheep milk), which are available as pasteurized, homogenized products or as UHT fluid products. Plant based milk alternatives included soy beverages (available in a range of flavours ranging from unflavoured to vanilla, strawberry or chocolate) as pasteurized, homogenized products or as sterilized, shelf stable product in UHT drink boxes. Rice beverage is also available as a milk alternative in the packaging formats described for soy beverages. These products are available from local processors or as imported products. The nutritional value of these milk alternatives is quite variable, and depends to a great extent on whether or not they have been fortified. Unfortified soy and rice beverages, for example, provide miniscule amounts of calcium – one would need to drink about 30 cups to absorb the same amount of calcium as is absorbed from a glass of cows' milk. They also do not contain any vitamin D or B_{12}, or appreciable amounts of vitamin A or riboflavin. However, fortified versions of these plant beverages are also available in the marketplace. They have nutrients added to them so that their content of major vitamins and minerals is similar to that of fluid cows' milk.

>From the information presented above it becomes readily apparent the conversion of cows milk to fluid milk products in an involved process that ultimately delivers a nutritious and safe product to the consumer with a variety of choices in terms of fat content and packaging formats.

Table 2.2. Contribution of dairy products to the average Canadian diet in 2001 (values in the table are in percentages)

Dairy Products	Fluid Milk[a]	Cheese (all varieties	Yogurt	Frozen Desserts[b]	Other	Total
Energy	4.8	3.9	0.5	2.2	1.5	12.9
Total fats	4.1	7.3	0.5	2.7	3.2	17.8
SFA[c]	7.6	13.8	0.9	5.0	6.0	33.3
MUFA[d]	2.5	5.1	0.3	1.9	2.2	12.0
PUFA[e]	0.8	1.3	0.1	0.6	0.7	3.4
Cholesterol	5.9	8.4	0.6	3.8	3.5	22.3
Protein	9.6	6.9	1.0	1.1	0.9	19.5
Calcium	28.3	15.8	2.7	3.1	2.8	52.6
Phosphorus	15.3	9.0	1.6	1.8	1.6	29.2
Potassium	12.0	1.0	1.3	1.4	1.1	16.8
Sodium	3.3	5.7	0.3	0.5	0.3	10.1
Magnesium	9.8	1.8	0.8	1.1	0.8	14.4
Zinc	8.3	5.9	1.2	1.5	1.0	18.0
Vitamin A	11.5	6.2	0.3	2.3	2.7	23.0
Vitamin D	58.3	0.7	0.0	0.0	1.4	60.3
Riboflavin	18.6	4.3	1.9	2.9	1.9	29.7
Niacin	5.3	3.6	0.2	0.6	0.6	10.4
Vitamin B_6	6.1	1.1	0.6	0.7	0.4	8.9
Vitamin B_{12}	20.0	5.0	2.3	2.2	1.4	30.9

a. Fluid milk includes whole (3.5% mf,), 2% mf, 1% mf and skim milk)
b. Frozen desserts includes ice cream and frozen yogurt
c. SFA: saturated fatty acids
d. MUFA monounsaturated fatty acids
e. PUFA polyunsaturated fatty acids

From: Agriculture and Agri-Food Canada. 2008. Statistics of the Canadian Dairy Industry, 2007. http://www.dairyinfo.gc.ca/pdf/Publication_2007.pdf (accessed September 25, 2008) Page 136.