

## Teacher Notes

# Milk – Keep refrigerated

## Background



The term 'milk', as a basic food, without any adjective added, applies usually to *cow milk* that is fresh, full-fat, it has not undergone any dehydration or condensation, and does not contain any additional material. For any other type of milk that is available on the market, its difference(s) from the previous 'milk' should be properly labeled; for instance:

- Sheep milk, or goat milk, or mixed sheep and goat milk;
- Pasteurised, sterilised, frozen when it is not fresh.
- Skimmed, semi-skimmed, partially skimmed, indicating on the label its fat content when it is not full-fat.
- Evaporated, condensed, dry (in powder or tablets), when it has undergone the named processing.
- Sugared milk and cocoa/choco milk when it has sugar or sugar and cocoa added.

In recent years, new types of milk are available in the market, that contain additional ingredients, such as vitamins, calcium, omega-3 fats, phytosterols, various fruit tastes, etc.

Sold milk must come from one animal only (cow, sheep, goat). Only sheep and goat milk are allowed to be mixed in equal proportions. Table 1 provides the values of some parameters for various kinds of milk.

**Table 1.** Values of basic parameters for various kinds of milk.

| Origin           | Density (at 15°C) | Fat (%) | Solid residue* (%) |
|------------------|-------------------|---------|--------------------|
| Cow              | 1.030             | 3.5     | 8.46               |
| Sheep            | 1.032             | 4.0     | 9.00               |
| Goat             | 1.035             | 6.0     | 10.20              |
| Mixed sheep/goat | 1.033             | 5.0     | 9.60               |

\* Solid residue, excluding fat (SREF).

As fresh is considered the milk that has not undergone any other processing, except filtering, cooling, and homogenisation. This milk must satisfy the following conditions:

- It should contain colostrum, and should not precipitate/thicken when it is boiled.
- It should not be coloured with any kind of food colouring or its natural colour is changed by the presence of microbes.
- It should not come from animals suspect of illness, OR that have been treated with drugs, OR have been fed with nutrients that can be dangerous for man's health or can change its characteristic features.
- It should not have any kind of suspended material.
- It should not have high microbe load or contain any preservatives.
- It is not allowed that milk is prepared from milk powder or milk tablets or from condensed or evaporated milk.
- It should not contain added sugar or have undergone skimming or watering (addition of water).

Pasteurised is termed the milk that has undergone *pasteurisation* with any standard method, and should be contained in tightly closed cartons or glass or plastic bottles, that show on their

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package the expiration (and possibly the preparation date). **Pasteurisation**<sup>1</sup> is the process of heating milk at 62.8 – 65.6°C for half an hour OR at 71.7°C for 15 seconds. After this, milk must be immediately cooled down to at least 10°C. Pasteurisation kills 95 –99% of bacteria. Pasteurised milk must fulfil the conditions listed above for fresh milk, and it must be kept refrigerated until its consumption. Its characteristic parameters and properties are the same as those of fresh milk.

**Sterilised** is the milk that is heated at 100°C at least, so that all micro-organisms are killed, without condensation to occur.

**Frozen** is fresh milk that undergoes quick freezing and is maintained at temperatures under – 15°C. This milk should be consumed after complete thawing.

**Skimmed** is the milk that is taken from fresh milk after removal of fat with a mechanical process (e.g. centrifugation), without nothing added. Any fat left should not exceed 0.2%, and the solid residue excluding fat (SREF) must be under 1.036% at 15°C.

**Semi-skimmed** milk is similar to skimmed milk, but its fat content is between 1.5 – 1.8%, and should be clearly marked on the product label.

## Composition

Milk consists mainly from three basic components, water, fat, and SREF. The organic part consists mainly of proteins (casein, albumin, and globulin), lactose, galactic acid, and citric acid. Casein is found only in milk and makes 78.5% of its protein content. Lactose (a dextrose-galactose disaccharite) is also a characteristic component of milk. Potassium and calcium are metals that are present in milk in considerable concentrations.

Milk contains also vitamins, mainly vitamin A (in fact,  $\beta$ -carotene / pro-vitamin A). It is heat resistant, but sensitive to oxidation. Milk also contains vitamin D that is stable to heating for pasteurisation or sterilisation. Pro-vitamin D (mainly cholesterol) is transformed by summer sunlight into vitamin D, of which the excess is deposited in liver to be used during winter. Finally milk contains also a number of enzymes. Both vitamins A and D are fat-dissolving, so their

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<sup>1</sup> The term pasteurisation derives after Luis Pasteur (1822-1895), a French chemist and bacteriologist who discovered that the fermentation of milk and of alcohol is caused by microorganisms.

content is considerably reduced in skimmed and semi-skimmed milk.

- *It is useful to discuss with the students in class the usefulness of skimmed and semiskimmed milk (for medical reasons), but also their drawbacks.*

## Acidity and pH

Cow milk is slightly acidic, with a pH value ranging from 6.4 to 6.6. Total acidity in fresh milk is usually about 0.14% (calculated as galactic acid). Acidity is due to acid phosphoric salts and to galactic acid. The acidity can be measured with titration of a certain amount of milk with NaOH solution (e.g. 0.10 M), with phenolphthalein as indicator.

During storing, acidity increases because of the action of micro-organisms. Bacterial action has as a result the fermentation of lactose into galactic acid, and when it reaches about 0.3%, the sour milk taste becomes sensible. At 0.4% acidity, milk is clearly sour, and at 0.6% it precipitates at normal temperature. At acidity over 0.9%, it moulds. Finally, at 2 – 2.5% it decomposes, when its acidity is *reduced*.

Milk precipitation is due to the precipitation of casein, which occurs at pH = 4.6. Casein precipitation occurs also with addition to milk of enzymes (a process that is applied for the preparation of yogurt from milk) or with addition of neutral salts.

## Yogurt

**Yogurt** is the product of galactic fermentation of fresh milk under the effect of a suitable culture. The culture contains in equal proportions *Streptococcus Thermophilus*, and *Lactobacillus bulgaricus*. The latter produces the largest amount of galactic acid. Full-fat yogurt is produced usually from fresh milk. In this activity, students will prepare yogurt by using as culture a small amount of commercially obtainable yogurt.

## References

Tzouwara-Karayanni, S. (2000). *Composition, chemical analysis, and specifications of basic foods* (in Greek). Ioannina, Greece: University of Ioannina.