MANUAL ON THE PRODUCTION OF TRADITIONAL BUFFALO MOZZARELLA CHEESE

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Chapter 1

MILK

Milk is a valuable source of nutritional substances: it is considered as the most complete of food. Through the centuries, man has wisely learnt how to use this food source in two ways:

- as a foodstuff: for direct consumption (milk as a drink);
- transformed: as an element from which it is possible to obtain dairy products (cheese, butter, yoghurt, etc.)

Buffalo cow

Buffalo cows start producing milk after giving birth. The first liquid secreted by the udder is the ***colostrum***, which is only used for the feeding of the calf; it is not collected as it cannot be used for the production of dairy products. The colostrum is much richer than normal milk in vitamins and immunoglobins, a class of proteins with an immune, defensive function. After about 6 days from calving, the colostrum changes into milk.

Buffalo cows are milked twice a day for 10 months; this period is known as the ***lactation period***. When the buffaloes stop producing milk, it means they have entered the "dry period".

The chemical composition of milk depends on various factors: species, breed, age of the animal, feeding, health condition, environmental factors and lactation period. Water, proteins, fat, sugars, mineral salts, vitamins and enzymes are the substances we usually find in milk.

Table 1- *Average chemical composition of milk of different species (for 100 g of fresh milk)*

SPECIES	WATER %	PROTEINS %	FAT %	LACTOSE %	MINERAL SALTS %
BUFFALO	***82.2***	***4.8***	***7.5***	***4.7***	***0.8***
GOAT	86.5	3.9	4.3	5.8	0.8
EWE	80.9	6	7.5	5.4	1.1
COW	87.5	3.2	3.7	4.6	1

Immediately after milking, the milk can be contaminated by both intrinsic and extrinsic factors. The health condition of the animal itself is the most important intrinsic factor; for example udder infections contaminate the milk at the moment self of milking. Whereas man is responsible for the extrinsic factors; in particular, the utensils used, the milkers' cleanness (clothes, hands, boots), the work environment, the milking plant, etc., must always be kept under control to avoid direct or indirect contamination of the milk. With a "dirty" milk, we will certainly have coagulation problems and the final product, namely cheese, would show more or less evident defects relative to the degree of the contamination.

1.1 BUFFALO MILK

If we compare buffalo milk with cow's milk, we can draw the following conclusions:

- buffalo milk is richer in fat than cow's milk
- the buffalo, compared to the cow, produces a milk with a higher percentage of proteins

Buffalo milk is the raw material from which buffalo Mozzarella cheese is traditionally produced.

1.2 MICROBIOLOGY

It is possible to find micro-organisms everywhere in nature. We classify them as viruses, bacteria, yeasts and moulds.

Beware! Not all micro-organisms are harmful.

First of all, it is necessary to make an important specification: in nature there are pathogenic micro-organisms and useful micro-organisms (in the dairy language, the latter are called "dairy micro-organisms").

The ***pathogenic micro-organisms*** are responsible for diseases caused by the ingestion of contaminated food; this leads to diarrhoea, vomit, sense of nausea, high temperature and dehydration.

Table 2- *Some pathogenic micro-organisms*

Micro-organism	**Where it is possible to find it**
Salmonella	Products of animal origin Water Man (intestines and faeces)
Staphilococcus Aureus	Man
Clostridium botulinum	Products of animal origin Vegetable preserves
Coliforms of faecal origin	Intestines and faeces

The ***useful micro-organisms*** are not harmful for man. This category comprises all the micro-organisms that are used in the agro-industrial sector (dairy products, yoghurt, bread, alcoholic drinks, etc.).

In general, all micro-organisms need favourable conditions to grow and develop.

The factors that mainly influence their development are the following:

1) the presence of food substances;
2) temperature: if a micro-organism reaches its maximum growth only with a temperature lower than 10°C (°C are degrees centigrade) it is classified as *psychrophilic*; if it grows between 20°C and 30°C it belongs to the category of *mesofilic* (the greater part of micro-organisms is included in this group); if it grows at its best between 20°C and 45°C it is classified as *thermophilic*;
3) acidity: very high or very low pH values usually block microbial growth;
4) humidity: bacteria can grow even in a very humid substrate; moulds and yeasts can develop in an environment with a low degree of humidity;
5) oxygen: some micro-organisms can only grow if there is oxygen, they are called "strictly aerobic" (moulds, some bacteria); micro-organisms that only grow in environments with no oxygen are classified as "strictly anaerobic" (*clostridium*); finally there are also micro-organisms that grow independently of the presence or less of oxygen (salmonella, coliforms, *staphylococcus*).

Let us now go on to a specific example: **the micro-organisms of milk.**
The micro-organisms that are found in milk come from:
- the animal
- the feedstuffs
- milking
- storing (period of time between milking and cheese-making)
- the environment
- man

In the specific case of milk destined to the production of cheese it is possible to distinguish *dairy* (useful, necessary, essential) and *anti-dairy* micro-organisms (that disturb the cheese-making process).

Dairy micro-organisms

The leading factors in the cheese-making process are the **lactic bacteria**. They are necessary for the lactic fermentation: they transform lactose (the milk sugar) into lactic acid; this acidification process helps the rennet's work, the draining of the whey after the curd has been broken and the cheese maturation. Lactic bacteria are indispensable for the production of buffalo Mozzarella cheese; in fact, the importance of milk and curd acidity will be discussed in every detail in the chapter relative to technology (chapter 4). This acidity is "created" by the lactic bacteria in the milk of origin. If the milk or the curd do not have the right degree of acidity the liquid mass will not string and it would be impossible to produce buffalo Mozzarella cheese. We can say, without any doubt, that acidity is the most important parameter in the production of buffalo Mozzarella cheese.

Anti-dairy micro-organisms

Coliform and butyric bacteria are the most harmful ones we can find in milk. If the former is present, it means little attention has been given to hygiene during the process (even during the milking phase). The latter, on the other hand, come from the feedstuffs, the soil or the water and cause cheese to blow.

Generally, to prevent the development of anti-dairy micro-organisms, it is necessary to pay attention to the following:

- workers, animals, tools and buildings must always be carefully kept in a condition of good hygiene
- a scrupulous respect of production parameters (temperature, acidity, draining, salting)

It is possible to control the microbiological quality of the milk by the use of a very simple method which does not need any particular equipment and can even be carried out in the farm dairy; it is called ***lacto-fermentation***. Practically, 10 ml of milk are introduced in a test tube, trying to keep everything as sterile as possible; the tube is then closed with a metallic cap or with some cotton. Next, the tube is put in an environment of about 30-37°C (hot room, stove, "bain-marie") for 24 hours, if it is cow's, buffalo or goat's milk; for 48 hours, if it is ewe's milk. After this period of time, the reading is possible.

Lacto-fermentation reading

Very good milk

Good milk

Bad milk

Very bad milk

When the curd has a homogeneous aspect and some bubbles or cracks are present only in the upper part of the tube, the microbiologic quality of the milk is **very good**. Instead, when the curdle is partly homogeneous and some cracks that originate from the bubbles are observed, it means that the milk is **good** from a microbiologic point of view. Instead, if we see that the curdle in the tube is fragmented and there are considerably big bubbles, the milk is **bad**. Last possibility: if the curdle is very fragmented with strong undesirable smells, it means that the milk is **very bad** with a high microbial contamination.

Chapter 2

HOW IS CHEESE PRODUCED: GENERAL OUTLINE

Cheese is the fresh or ripened product obtained from the acid, rennet or mixed coagulation of whole or partially skimmed milk. The process that transforms milk into cheese is called **a technological process**. Each cheese, and more in general, each dairy product is produced following a specific technological process. The following outline represents a standard process of production; the specific technological phases have been explained in order to show the most important dairy typologies.

Diagram 1- *Standard process for cheese making*

MILK	*The raw material, milk, can be from different species: cow (for cow cheese), buffalo (for buffalo cheese), sheep (for sheep cheese), goat (for goat cheese), or it can be a mixture of milks from more than one species (in this case we speak of mixed milk cheese).*
MILK PREPARATION	*Not all technologies include this phase. The milk is treated as to render it suitable for specific transformations (heating, pasteurisation, skimming, milk enzyme addition)*
COAGULATION	*In this phase milk is transformed in curd,* i.e. *from a liquid it becomes gel-like. There are three distinct types of coagulation: by rennet (rennet is added to the curd – it is called renneting), by acid (the milk is left to become sour until it reaches pH = 4.6; at these conditions the caseins and milk proteins precipitate) or mixed (acid with the addition of a small quantity of rennet). The initial milk acidity, the temperature, the quantity of rennet used, the enzymatic composition of the rennet and the protein contents of the milk are usually the main factors that influence the coagulation process. A closer examination will follow in the chapter relative to the production technology of buffalo Mozzarella cheese.*
CUTTING	*With the cutting, the curd (a whole mass) is transformed in granules of different sizes depending on the kind of cheese that one wants to obtain: large granules (nut, hazelnut size) = high percentage of water = soft, fresh cheeses; small granules (rice, corn size) = low percentage of water = hard, ripe cheeses. There is a vast range of tools used for the cutting process: knife, metal curd-knife, etc.*
SCALDING	*Some technologies want the curd to be partially cooked (about 45°C) or fully cooked (about 55°C); the names that are given to these cheeses are respectively, partially cooked (boiled) or cooked (boiled) cheeses.*
CURD MATURATION (OR ACIDIFICATION)	*This phase is carried out only during the production of stretched curd* ("pasta filata") *cheeses (buffalo Mozzarella, Scamorza, Caciocavallo): cheeses characterised by an "elastic" string curd. Further explanations are given in chapter 4 (paragraph 4.4)*
STRETCHING	

SHAPING OR "MOZZATURA"	*Shaping is the word used when one speaks of* "pasta filata" *cheeses: the mass is worked into the desired shape (spherical, spherical with small head, braids, small knots, etc.). Instead, for all the other types of cheeses, after the breaking and scalding (when necessary), the curd is put into appropriate moulds where it obtains its final size and shape.*
SALTING	*The cheese can be salted when already dry (the salt is sprinkled directly on the cheeses) or brined (the cheeses are kept in a salty solution for a period of time that depends on their weight; usually 12 hours per kilo).*
SALE	*Only fresh cheeses (buffalo Mozzarella cheese) are sold at this stage.*
RIPENING OR MATURATION	*During this phase the fresh curd becomes matured cheese. The ripening needs an environment with a specific temperature and humidity. Throughout this resting period, the proteins and the fats in the curd follow chemical transformations that are responsible for the aromatic characteristics of the final product. The ripening phase can last several months or even years.*

Chapter 3

THE WORLD OF STRETCHED CHEESES: NOT ONLY BUFFALO MOZZARELLA CHEESE

Buffalo Mozzarella cheese belongs to the category of **stretched curd**, or **"pasta filata"** cheeses. By "pasta filata" is intended a dairy technique characterised by a double process:

- the cheese-making in itself, that implies the various phases of coagulation, cutting, draining, shaping, salting and ripening (when necessary);
- the curd stretching, a treatment that renders the curd elastic.

The category of "pasta filata" cheeses includes different dairy types that differ one from another because of the raw material, technology, size, etc. Here are some examples.

"Scamorza" cheese

This cheese has a very short ripening period; it has a sweet taste, a smooth and thin rind, a white, close and buttery texture; it is pear-shaped with a small "head". What makes this cheese type different from buffalo Mozzarella cheese is mainly the degree of whey loss; the curd used for the production of "Scamorza" cheese undergoes more whey loss than for making buffalo Mozzarella cheese, consequently the latter will be more humid. The cheeses are cooled down under running water and then salted in cold brine (18-20% NaCl) for one or more hours, according to their size. Furthermore, the "Scamorza" cheese's technological process also allows an initial ripening period. They are normally marketed and eaten within 15 days. "Scamorza" cheese can also be smoked. "Scamorza" cheese can be used in various ways: it can be eaten as fresh cheese, it can be grilled or used as an ingredient in many dishes and recipes.

"Provola" cheese

From a technological point of view, its production process is very similar to that of "Scamorza" cheese: they are different in shape ("Provola" cheese appears as a truncated-cone, "Scamorza"

cheese is pear shaped with a little “head”) and weight (a “Provola” cheese weighs 700 g at most, "Scamorza" cheese 500 g at most).

“Provola” cheese can be smoked as well; when it is smoked the external part darkens, acquiring a dark yellow colour and the cheese acquires a typical smoked flavour.

Provolone cheese

It is thought that the name “Provolone” derives from the Italian word “prova”, which in the past referred to the sample of ”pasta filata” cheese that was taken from the vat to check its stretching degree.

Technically, the curd is pulled out manually and left on tables to dry and mature for about 24 hours at room temperature. It is then cut into strips for the stretching phase: it can be stretched manually or with the use of special spinners. The shading of “Provolone” cheese can be of various shapes: pear shaped with a truncated cone as a head, melon-shaped or of cylindrical shape. After cooling down, the fresh cheeses are salted in brine at a concentration of 22-25%. For ripening the cheeses are tied together in pairs and then hung over a beam for a period of time that can vary from one month to a year.

“Caciocavallo” cheese

Caciocavallo Palermitano

Caciocavallo Silano

Depending on the area of production and on the raw material used, “Caciocavallo” cheeses have different names. There is the “Caciocavallo Palermitano”: its curd maturation takes place in whey - the liquid that remains after the production of Ricotta cheese - at 80°C for 4 hours; the obtained “pasta filata” cheese is then placed on a special table where it is tossed over a few times with wooden boards resulting in the typical parallelepiped geometric shape. Another type is the “Caciocavallo Silano”: cow’s milk cheese of medium hard texture; the maturation phase takes 4 to 10 hours; when the curd is ready to be stretched, the cord-form is prepared and manually handled to obtain an oval or truncated cone shape with or without a head.

Chapter 4

BUFFALO MOZZARELLA CHEESE: THE TECHNOLOGY

Where does the term *Mozzarella* come from? It derives from the Italian word “mozza”, which refers to the final phase of the dairy process when the curd is cut into shapes of established size (“mozzatura”).

4.1 THE RAW MATERIAL AND ITS ACIDITY

Buffalo milk is the raw material used to prepare buffalo Mozzarella cheese.

The first technological phase is the ***straining*** of the milk through filters or sheets. This eliminates any big particles that could be present in the milk.

At this point it is possible to:

1) ***start the dairy process as soon as the milking is finished***: this is what usually happens in smaller dairies that do not have structures and systems for the preservation of milk; this way many problems due to microbial contamination can be avoided;

2) ***refrigerate*** the milk at 4°C and start the dairy process later; semi-industrial dairies use this procedure. Be careful though when using the refrigerator it is important to pay great attention to the information given by the manufacturing company.

Acidity

A very important parameter for the production of buffalo Mozzarella cheese is the milk’s acidity: the quality of the cheese depends on its evolution. The acidity must be kept under control during all phases, from the milking to the stretching. If the milk has the right degree of acidity it coagulates well: the acidity and the temperature of the milk are the factors affecting the renneting in its coagulation effect. Should the curd not reach the right degree of acidity during the maturation phase, it may then not be possible to stretched it; the proper acidity allows the chemical-structural alterations that are necessary for the entire stretching process.

First of all: how do we measure acidity and how is it expressed?

Titration

Titration is a colorimetric measurement used to determine the quantity of NaOH (soda = basic solution) needed to neutralise all the acids present in the milk.

Necessary chemical glassware:

1) a graduated pipette with a tap
2) a glass
3) a syringe
4) a glass stirring stick
5) a dropper

Necessary reagents:

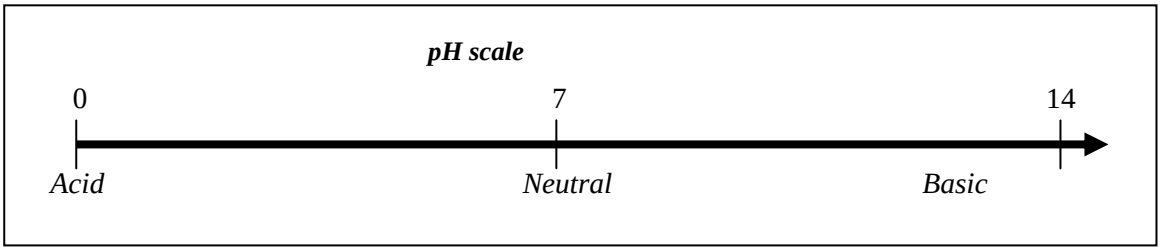
1) soda N/4 (NaOH)
2) phenolphthalein drops (indicator)

Procedure

Fill the pipette with soda. Use the syringe to put 10 ml of milk in the glass, add 3 drops of the indicator and stir well with the glass stick. Put the glass under the pipette so that the soda may very slowly drip into it; it is important to remember to keep stirring the milk. Continue until the milk gains a pinkish colour for at least 30 seconds (when this happens it means that the soda has neutralised all the acids in the milk sample). At this point immediately stop adding soda; thus notice on the graduated pipette how many ml of soda have been used. These ml are the Soxhlet-Henkel degrees or °SH; milk has usually an acidity of about 7 °SH.

pH-meter

The pH is the parameter that expresses the quantity of acid in a product.

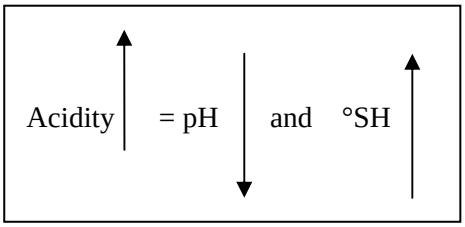


The compounds with a pH value between 0 and 7 are called **acid** (lactic acid, hydrochloric acid, citric acid, etc.), if the pH value is around 7 the compounds are called **neutral** (clear water), if the pH value is higher than 7 the compounds are called **basic** or **alkaline** (soda, potassium, etc.).

It is possible to calculate the pH value with a pH-meter, a measuring instrument that works thanks to the sensitivity of an electrode. The average values for milk are:

	pH
Cow	6,6-6,8
Ewe	6,4-6,6
Goat	6,5-6,7
Buffalo	6,5-6,7

Beware! Don’t get confused! A higher acidity value means a lower pH and a higher °SH degree!



Memorise this diagram

Empirical measurement

Should it not be possible to determine the degree of acidity by titration nor by using a pH-meter, it is always possible to measure it empirically. Do not expect very precise values, though. To calculate the acidity of milk empirically, it is first of all necessary to know its "history": the animal's health, how much time has passed since the milking, what kind of treatments it has undergone, at what temperature has the milk been kept, etc. When the milk arrives at the dairy it is possible to determine if it has acidity problems even from its smell, but this occurs when the milk has a big acidity default, thus when it is very acid.

Different pH or acidity values mean that there is an anomaly. For example, a pH value higher than 6.7 could indicate ***mastitis***, a microbial infection of the udder that causes changes in the composition and technologic characteristics of the milk. Many bacteria can cause mastitis, but the specific agent that causes it is *Streptococcus agalactiae*. Mastitis can easily be treated with antibiotics: these are though cause of big inconvenients for the dairy industry; in fact, even a low quantity of antibiotics per litre can render the milk not fit for dairy processing because the antibiotics modify the milk's microbial flora.

The first thing to do is to determine the acidity of the milk that will be used to produce the buffalo Mozzarella cheese, thus decide how to act next. It is important to remember that before the coagulation process starts the milk must be rendered acid to permit a normal maturation of the curd, which will then be fit to be stretched. To produce buffalo Mozzarella cheese we must also enrich the milk to produce a cheese with suitable sensory characteristics (taste, flavour, structure, etc.).

How do we proceed? There are various possibilities. After having measured the acidity of the milk it is possible to add:

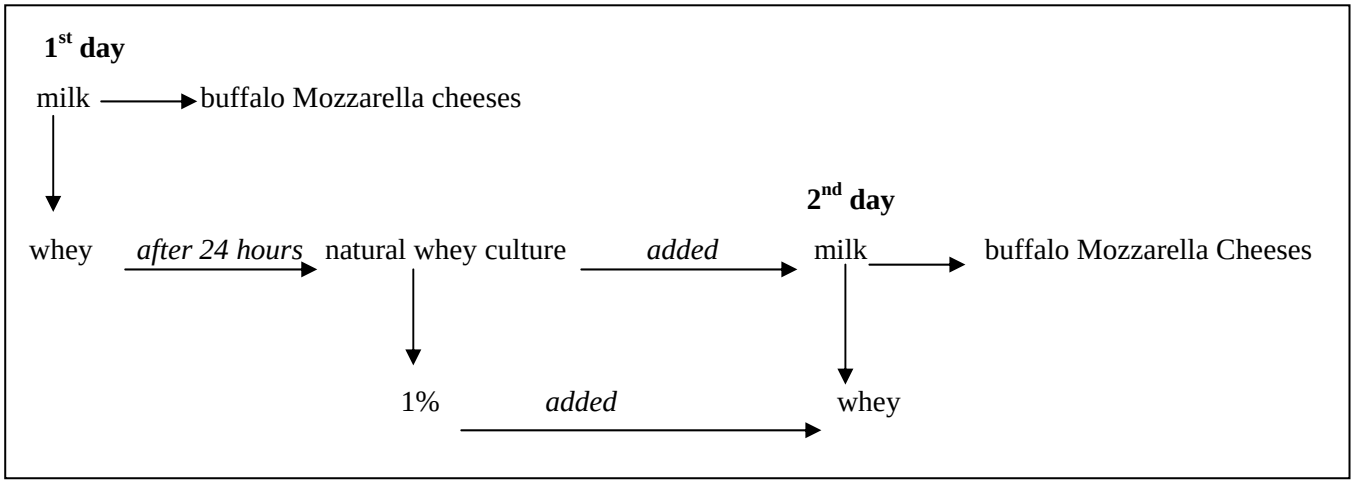
1) natural whey culture
2) industrial lactic acid bacteria
3) citric acid, lactic acid or acetic acid

Added natural whey culture

The natural whey culture that is used is the whey from the dairy process of the day before, left to acidify at 30-40°C for 24 hours. To be more precise, the whey collected at the end of the ripening of the batch produced the preceding day is left to acidify. If 100 litres of milk are used each day, at the end of the day it is possible to obtain 10 litres of whey; it is also used to clean the dairy tools and to prepare the "water" used to preserve the buffalo Mozzarella cheese. The whey is put into a plastic or steel container covered by a sheet or film as to avoid contaminations (by flies, dust, etc.). The container is transferred in a room at 30-40°C. It

is very important to keep the temperature constant during the 24 hours; a thermometer in the room will help check this.

Furthermore, there should not be any drafts in the room; these could cause a drop of the temperature or carry dust. After 24 hours the acidity of the natural whey culture should be around 15-20°SH (about 4.5 pH). It is possible to measure this by titration, with the pH-meter, or by tasting the natural whey culture (you should have a sour taste in your mouth, as if tasting drops of lemon juice). If it difficult to obtain the required temperature, the natural whey culture will not be acid enough after 24 hours. A procedure to increase the degree of acidity is the following:



With this work-plan, on the second day the whey will already be slightly acid.

Nevertheless, if the added natural whey culture still presents a low degree of acidity, it is possible to add more than the normal quantity to the milk.

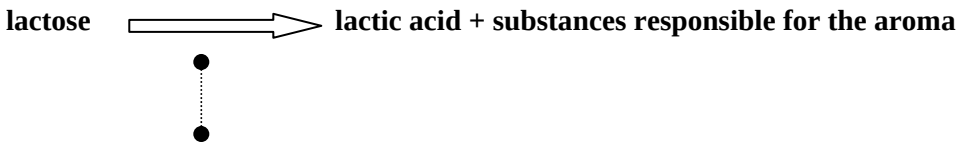
Before adding the natural whey culture it is necessary to determine the acidity of the milk and heat it up to 35°C. If the milk has the proper degree of acidity (7°SH) it takes about 3 litres of natural whey culture per hundred kilograms of milk; the amount will of course vary according to the higher or lower acidity of the milk. Here are some numerical examples:

Milk acidity	**Added natural whey culture**
7 °SH	3 litre/100 kg of milk
7,5 °SH	2,5 litre/100 kg of milk
6,5°SH	3,5 litre/100 kg of milk

Why is the added natural whey culture acid?

Let's take a step back in time. We have already seen that the milk's useful micro-organisms, called lactic acid bacteria, can be found in all *dairy products*: curd, whey and cheese. The acidity of natural whey culture is thus due to the action of these lactic acid bacteria that induce lactose to ferment (technically, one would

say that lactose is the lactic acid bacteria's substrate). The result of this process is the lactic acid, thus acidity with all the related substances that will give the buffalo Mozzarella cheese its characteristic aroma. The action of the lactic acid bacteria is called **lactic acid fermentation.** Let's summarise it all in a diagram:



action of the lactic acid bacteria (lactic acid fermentation)

Industrial lactic acid bacteria

The industrial lactic acid bacteria contains a mixture of different lactic acid bacteria. It is sold as a powder (lyophilised) in metallic-plastic packets and dissolves very easily. To produce buffalo Mozzarella cheese it is necessary to use thermophil enzymes that can withstand the high temperatures of dairy production; in this case must be present contain *Streptococcus thermophilus*, *Lactobacillus helveticus* and *Lactobacillus bulgaricus*. As for the quantities to be used and the procedure, it is best to carefully follow the instructions on the label of the package.

Acids

If one decides to use citric acid, lactic acid or acetic acid, these will be added to obtain milk with an acidity of pH= 5.6. In this case the stretching immediately follows the cutting of the curd: the ripening phase is skipped; it is called *immediate stretching.*

Specific example with citric acid (milk used: 100 kilograms)

Weigh 120g of citric acid and add 5 litres of water, add this solution to the milk that will reach a pH value of 5.6

Depending on the acidifying agent, the buffalo Mozzarella cheese will have a different structure and aroma.

In detail:

	CARACTERISTICS
Mozzarella produced with added natural whey culture	Very aromatic Dense and spongy texture The outer and the inner part separate distinctly
Mozzarella produced with industrial lactic acid bacteria	Slightly aromatic Dense and spongy texture The outer and the inner part separate distinctly
Mozzarella produced with acids	Not very aromatic Humid Dense and soft texture

4.2 COAGULATION

The milk is heated up to 36-38°C (this temperature favours the coagulating effect of the enzymes that are in the rennet) and the rennet is added.

The rennet

The rennet is a mixture of various enzymes, each of which has a specific function on the milk's chemical elements (especially on its fats and proteins). The rennet can be of animal or plant origin.

Animal rennet

It is extracted from the *abomasum* (stomach) of ruminants, specifically from calves, kids and lambs (the rennet is never extracted from adult animals because theirs has a different composition which renders it less active for dairy processing). Animal rennet can be *industrial* or *farm-produced*. The first one is usually liquid and mainly from calves; it is possible to buy this type in specialised shops. The *farm-produced rennet* is instead a paste; it is produced at the farm with the traditional methods [*e.g.*, the *abomasum* of young animals – usually 20-30 days old - are extracted and dried in open air for 10 days. After this period, they are layered

with salt layers in containers perforated at the bottom; this allows the liquid to drain. They will remain in these containers for 15 days. The *abomasums* are then taken out of the salt and hung in a room at a temperature of about 15°C for 60 days. After this period the rennets are cleaned and then ground to obtain a homogeneous paste to which salt is added (15%). This paste is kept in opaque jars (light damages the enzymes contained in the rennet). The quantity of rennet used each time will vary depending on the technology. Practically one has to dissolve the suitable amount of rennet in hot water, filter it with a strainer and add the filtrate to the milk].

Plant rennet

Many plants produce enzymes that can cause milk coagulation. Two plants have traditionally been used for this purpose: the thistle (*Cynara Cardunculus*) and the fig (*Ficus carica*).

Thistle

Fig

The coagulating enzyme of the thistle is located in its stamenswhich are first left to desiccate for 24 hours in a dry, hot (25-30°C) and dark room, then put in pure water for another 24 hours and finally filtered; when the filtrate is added to the milk it produces a very soft curd. The curdling element of the fig is its lattice; to prepare it, it is necessary to get small branches from the fig tree when it is vegetating, cut them in small pieces, incise them and leave them in a container filled with lukewarm water to macerate for about 1 hour. After having strained this liquid, the filtrate is the rennet ready to be used. Plant rennet is traditionally used in Spain and Portugal to produce certain cheeses.

A diagram will help memorise:

<table>
<tr><th colspan="5">RENNET</th></tr>
<tr><td colspan="3">Animal</td><td colspan="2">Plant</td></tr>
<tr><td>Calf</td><td>Kid</td><td>Lamb</td><td>Thistle</td><td>Fig</td></tr>
<tr><td colspan="3"></td><td colspan="2" rowspan="2"></td></tr>
<tr><td colspan="3">farm-produced
- paste</td><td>industrial
- liquid</td></tr>
</table>

Liquid industrial calf rennet is used for the production of buffalo Mozzarella cheese.

How do we determine the correct amount of rennet to be added to the milk to obtain coagulation at the times required by the technology? There is a parameter that refers to the coagulating capacity of milk: rennet **title** or **strength**. The higher the title, the lower the amount of rennet necessary to coagulate the milk. The title of the rennet used in most dairy products is of 1:10000.

What does 1:10000 mean?

> The 1:10000 ratio is to be **read as follows:** 1 ml of rennet can coagulate 10 000 ml of milk at the temperature of 35°C in 40 minutes.

The label on the packages of industrial rennet must bear the title; it is also possible though to determine the title of the rennet at the dairy. Proceed as follows: heat one litre (1000 ml) of milk up to 38°C while always stirring; when the milk reaches this temperature, add 0.1 ml of rennet and at the same time start a timer while introducing a straw in the milk. When the straw manages to hold up by itself in the milk (it means that the milk has started coagulating) stop the timer. At this point we have all the data we need to insert in the following formula:

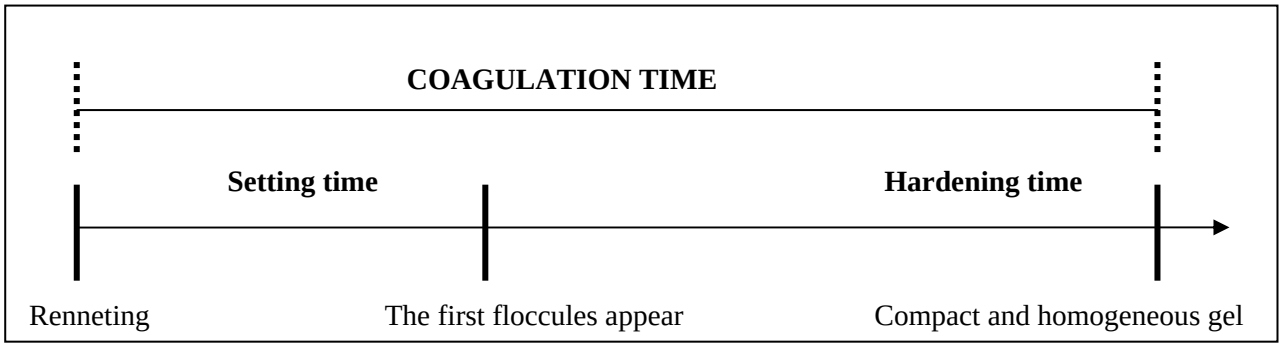
F=(2400x1000)/0.1xT

2 400 = constant factor (40 minutes expressed as seconds)
1 000 = ml of milk that have been used
0.1 = amount of added rennet
T = coagulation time (determined with the timer)

Liquid calf rennet with a title of 1:10 000 is used for making buffalo Mozzarella cheese; the amount of rennet to be added varies between 15 to 20 ml/100 kilograms of milk and the coagulation time is about 15 minutes. When the curd reaches the proper consistency, usually the hardening takes 30-40 minutes and the cutting process starts. Beware: do not wait more than 1 hour.

Let's shed some light on the terminology.

When speaking about coagulation time, we consider the whole process, including the setting and the hardening time. Let's see the diagram:



The hardening time is usually twice as long than the setting time. In the dairy it is possible to determine whether the hardening phase has finished by touching the surface of the mass with the back of the hand. If the hand remains dry, it means that the curd is dense and thus ready to be cut.

Tools used

Before starting to describe the tools, it is necessary to understand the heating systems. To heat milk it is possible to use:

- wood
- gas

Wood is mostly used in dairy farms, where there are not large amounts of milk to be heated. Gas, instead, allows direct heating with the production of steam.

Let's take a look at the tools.

Dairy farm	Semi-industrial dairy
Tin plated copper vat	*Stainless steel vat*

Tool features

Plated copper vat

Stainless steel vat

How to clean the tools

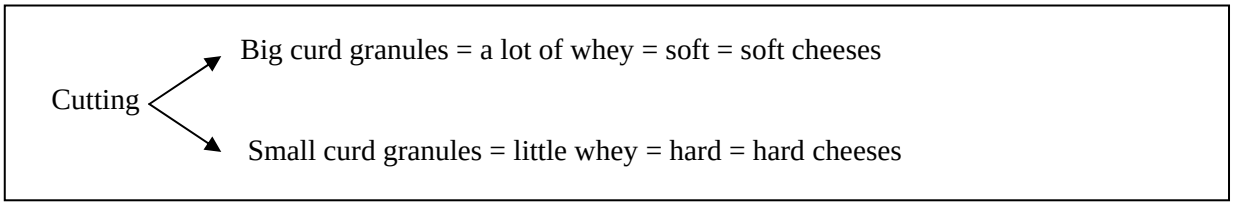
It is usually possible to use either acid serum or alkaline disinfectants to clean the tools.

Dairy farms also use *wooden vats*

Particularly, milk is heated in a tin plated copper vat, acidified with added natural whey culture or acid and then put into a wooden vat; the milk is then renneted.

4.3 THE CUTTING OF THE CURD. A CRITICAL STAGE!

The cutting expels the whey from the curd. Let's go step by step: the coagulation has transformed the milk (liquid state) into curd (gel state); more specifically, the curd contains whey - a liquid made up of water, lactose and proteins. Depending on the kind of cheese that we want to produce, the cutting can be of two different types. If we want to make soft cheese (like buffalo Mozzarella cheese) the cutting process must be divided in two phases separated by a more or less long lapse of time: in the first phase the curd is cut into big cubes using a knife; during the following pause can be noticed the separation between whey and curd. During the second cutting (with a curd knife) the cubes are reduced into nut-size granules, soft and very moist because of the whey, that will give birth to a soft cheese. Instead, only one cutting will be necessary (always with a curd knife) if we want to produce a hard cheese; in this case the cutting takes longer and finishes when the curd has been transformed in corn- or rice-sized granules: very small granules that do not contain much whey, therefore hard, permitting to give birth to a hard cheese.
Thus:



Beware! Soft cheeses are very rich in whey and must be eaten almost immediately, otherwise the fermentation process spoils the cheese. Instead hard cheeses can be matured (the ripening time depends on the cheese) and is eaten after this time spent in ripening rooms.

In the specific case of buffalo Mozzarella cheese, the curd is cut during two phases: with the *first cutting* the curd is cut in cubes with a knife; after about 5 minutes takes place the *second cutting*, that reduces the curd

into nut-size granules (3-6 cm) with a curd knife. This phase is very important for the buffalo Mozzarella cheese's composition and its final production yield. For example, during the cutting some fat is always lost into the whey (*i.e.*, part of the fat passes from the curd to the whey; there can be up to 1% of loss). A good cutting is thus fundamental to reduce these losses: it is best to always stir the curd gently.
Having finished the cutting, another very important phase takes place: curd maturation.

Tools used

Farm dairy and Semi-industrial dairy
Knife (first cutting) Metal curd-knife (second cutting)

Tools features

Metal curd-knife

Metal curd-knife

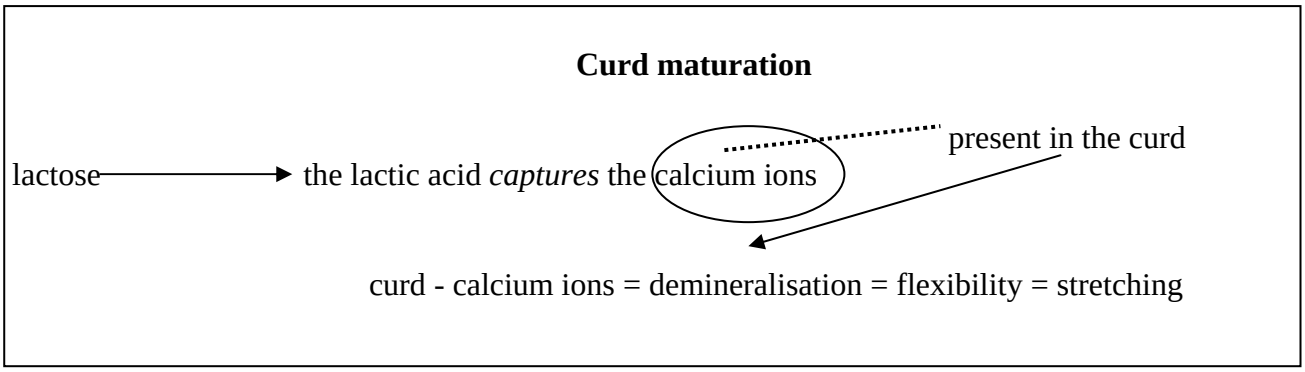
How to clean the tools

Acid serum and alkaline detergents are excellent "disinfectants" in this case as well.

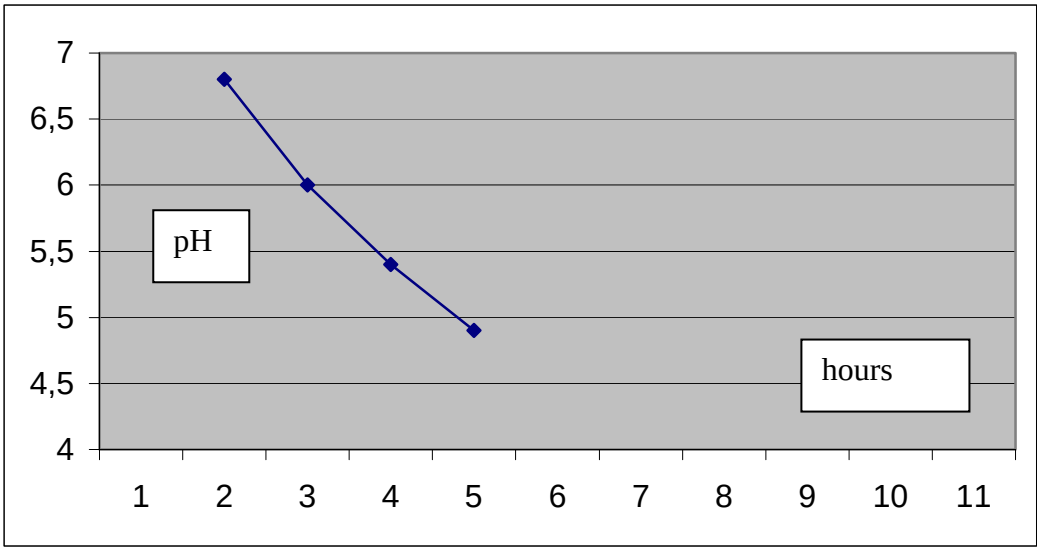
4.4 THE MATURATION OF THE CURD UNDER WHEY. A CRITICAL STAGE!

In the specific case of buffalo Mozzarella cheese, maturation takes place under whey. Once the cutting is finished 60% of the whey is withdrawn (the whey is extracted until the curd is almost visible); part of this whey is heated up to 46°C and then added again to the mass, this operation allows the curd to be kept at a temperature of about 36°C. Lactic acid starts being produced during this rest (the pH value goes down and the curd becomes more acid); the acid captures the calcium ions (the mineral that allows casein to aggregate and thus form curd) and causes curd demineralisation, which acquires flexibility. Practically, during the maturation takes place a reduction of the calcium in the curd with its increase in the whey.

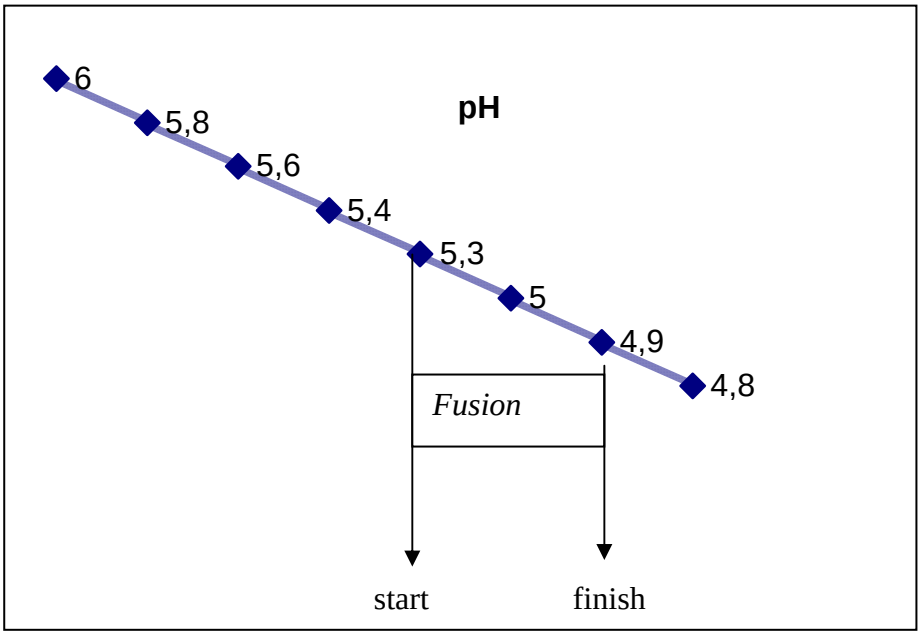
Let’s take a look at the diagram



Graph 1 - *pH variation of the curd in function of time*



Graph 2 - *pH trend of the curd during maturation*



On average it takes 3 hours (at a room temperature of 20°C). The optimal pH for the curd, at the end of the maturation stage, is of 4.9.

The ***maturation*** can also be ***natural***; in detail, the curd does not become acid under whey, but it is put on a table where it is left to ripen for a length of time that mainly depends on the room temperature. Usually, when we have a room temperature of 21°C the mass reaches its right acidity after 12-18 hours.

Beware! Should the curd be too matured or, on the contrary, not matured enough, the buffalo Mozzarella cheese will have consistency defects.

4.5 THE STRETCHING

How do we determine when to stop the maturation process? How do we know that the curd is matured enough and thus ready to be stretched? At an instrumental level, it is possible to follow the pH trend with a pH-metre and thus determine when the stretching value has been reached.


Stretching trial

A ***stretching trial*** is otherwise possible with the following procedure: 100 g of matured curd are cast in boiling water; the melted paste is then transferred on a stick and pulled by hand, if it stretches in unbroken threads that are more than one metre long, it can be considered ready for the stretching process.
At this point it is necessary to distinguish between the technology used on farm dairies and semi-industrial dairies.

Farm dairy	Semi-industrial dairy
curd ready for the stretching	curd ready for the stretching
it is put on a curd-draining table on which it is left for 10 minutes	
cut into thin strips with a knife	the curd is cut into small pieces by a machine with rotary blades
transfer into a wooden or iron curd vat	
boiling water (95°C) is added	
manual stretching done with the help of wooden sticks and a ladle	stretching done with mechanic equipment

The stretching is usually considered finished when the cheese becomes shiny and homogeneous.

The manual stretching is a very difficult stage and it is necessary to pay attention to many small, but extremely important, details. When the paste is in the vat it is necessary to add water in an amount that is double the quantity of paste and continuously stir the mixture with a stick. When the cheese starts to stretched, keep on stirring and with a ladle pour enough water out until the cheese is nearly dry (filter this water, you will surely find some granules to be put back into the vat). At this point, the cheese is gathered around the stick and stretched with the ladle; should some more whey come out during these movements, it

is eliminated. The cheese is now ready for the shaping or “mozzatura” (the cutting of the curd into pieces of established size).

Tools used

Before describing the equipment used for this technological phase, we must remember that it is necessary to have very hot water at one’s disposal; in particular the temperature of the water during the stretching phase is of 95°C. For this reason it is necessary to be able to “produce” hot water with a fire or gas heating system, or to have at one’s disposal specific iron implements, double-walled and steam fed. Let’s proceed to the tools.

Farm dairy	Semi-industrial dairy
Wooden or iron vat *Wooden stick* *Ladle*	*Stretching machines*

Tools features

On farms dairies, *wooden vats* are used; they have a truncated cone shape with an upper diameter of 90 cm, a lower diameter of 75 cm and are 25 cm in height. The diameter-height ratio is of fundamental importance. These size characteristics allow a high speed rotation of the stretched curd and a vaster area of thermal exchange with the air while the cheese is being dried and getting ready for shaping.

Wooden vat

Iron vat

Wooden stick

Ladle

Stretching machines

How to clean the tools

Acid whey and alkaline disinfectants are perfect “detergents”.

4.6 SHAPING OR “MOZZATURA”

Also in this phase the handcraft-technology differs from the semi-industrial one. On *farms dairies* the stretched cheese is handled with great care, performing characteristic movements that finish with the “mozzatura” to obtain buffalo Mozzarella cheese. In *semi-industrial dairies* instead, the whole operation is totally mechanized and when coming out of the dairy, the buffalo Mozzarella cheese has a pre-established size.

Manual shaping

Manual shaping

Mechanised shaping

Farm dairy	Semi-industrial dairy
Manual phase Two people carry out the shaping: one cheese-maker chops (“mozza”) the stretched curd with his thumb and index, while the other one holds the curd	Mechanised dairy

In addition to the characteristic spherical shape of buffalo Mozzarella cheese, other shapes can be “created”, for example bite-sized portions called *bocconcini* (little snacks), *perline* (little pearls), *ciliegine* (little cherries), as well as *trecce* (braids) and *nodini* (small knots). In the specific case of buffalo Mozzarella cheese, the weight can vary from 200 to 800 g.

Bocconcini (little snacks)

*Nodini (*small knots)

Ttrecce (braids)

Tools used

Farm dairy	Semi-industrial dairy
“Hands”	*Shaping machines*

Tools features

If we consider the fact that at the time of shaping the temperature of the cheese is about 70°C, we can easily realise that while using our hands it is possible to receive severe burns.

With the use of moulders, the whole phase is mechanised.

How to clean the tools

It is better to use the detergents that the supplying firm recommends to clean the moulders.

After the shaping, the produced buffalo Mozzarella cheese is allowed to fall into containers or tanks filled with cold water to allow the **cooling,** as to insure that the cheese maintains its shape. After being cooled, the product is salted.

4.7 THE SALTING

Nowadays there is a great trend towards the elimination of this phase.

There are various ways in which one can operate:

- *salting in brine*: to prepare the brine it is necessary to boil the water, add salt (usually about 200 g of salt per litre of water) and then cool the solution taking it down to 20°C. The produced brine can be used until a contamination phenomenon can be noticed (the brine becomes cloudy). After the cooling the buffalo Mozzarella cheese is soaked in the brine for a time that varies according to its size (*e.g.,* for a cheese that weighs 400-500 g, the time is of about 2 hours);
- *stretching the curd with salted water (1% of salt)*;
- *using a "sauce"*: the stretching water is used to prepare a solution (1 part) + water (1 part) + acid whey collected at the beginning of the maturation (just enough to take the acidity of the solution to pH 4; 8°SH) + salt (2%); the buffalo Mozzarella cheese is soaked in this solution up to when it is sold. Beware! The sauce will have a whitish colour because of the stretching water. Basically the sauce acts as a **conservation liquid;**
- *using a solution* made of water + citric acid (an amount sufficient to take the solution to a pH 4; 8°SH) +salt (2%); in this case the solution will be clear.

4.8 THE DAIRY YIELD

The usual yield (the productivity from milk into cheese) is about 20%. This means that if we transform 100 kg of milk we will produce, on average, 20 kg of buffalo Mozzarella cheese.

4.9 THE PACKAGING AND SALE

As briefly mentioned in the paragraph relating to salting, it is very usual to keep buffalo Mozzarella cheese in solutions that contain salt, amongst other ingredients. This allows to enclose in just one phase both the salting and the packaging; in particular, until it is consumed, the salt acts on the product. When instead traditional salting or stretching with salted water is chosen, the buffalo Mozzarella cheese is conserved in the liquid. This is usually composed of: water, salt and citric acid. The buffalo Mozzarella cheeses can be packed in small plastic bags or trays.

Trays

Bags

Buffalo Mozzarella cheese is then kept at 15°C. The product is usually eaten within 1 or 2 days.

Beware! To be able to appreciate all its flavours, buffalo Mozzarella cheese must be at room temperature when eaten.

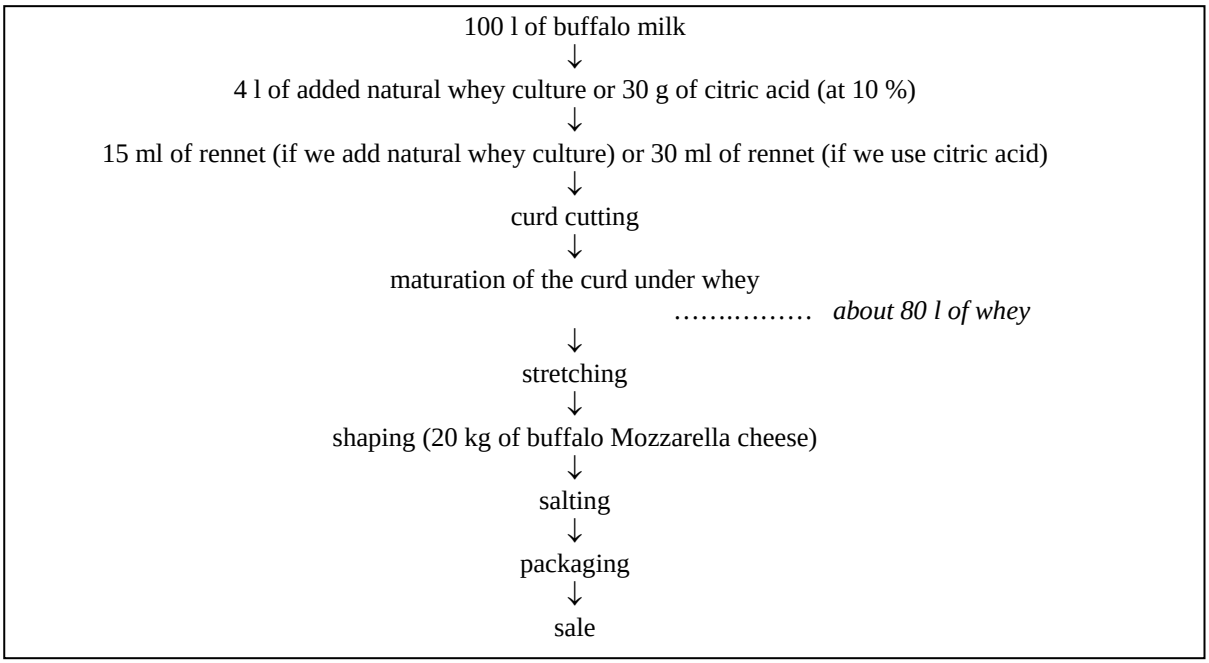
4.10 SMOKING

This phase is not always performed. When carried out, the buffalo Mozzarella cheese is exposed to the smoke made from the burning of wood chips and straw or is dipped into solutions of smoke essences (acrolein, pyrene, etc.). In this case one will talk about ***smoked buffalo Mozzarella cheese***. When the operation is finished the product is packaged.

4.11 A “NUMERIC” EXAMPLE

With the intention of making the whole producing process clearer, we will conclude the chapter with a recapitulatory diagram showing a practical production example.

Diagram 2- *Recapitulatory diagram of the entire buffalo Mozzarella cheese production process*



When reading this diagram it is possible to notice that if we start with 100 l of milk, besides obtaining 20 kg of buffalo Mozzarella cheese, we will have the production of 80 l of **whey**. What can we do with this sub-product? It is excellent to be fed to animals and represents as well the raw material for the production of Ricotta cheese (see the specific chapter 6).

Chapter 5

TECHNOLOGICAL PROBLEMS AND DEFECTS

5.1 TECHNOLOGICAL PROBLEMS

A slow acidification of the milk or of the curd and an excessive curd acidity are the main production problems that occur during the dairy technology of buffalo Mozzarella cheese.

If the ***acidification process*** *is* ***slow,*** then the buffalo Mozzarella cheese will be hard, while a curd that undergoes an ***excessive acidification process*** will show an elasticity defect that will disturb the shaping. The causes of these problems can derive from the adding of a non-suitable natural whey culture, curd and milk temperatures that can be too high or too low, the adding of too much natural whey culture or the use of milk with a too high a degree of acidity.

Let's observe the diagram:

Slow acidification = hard buffalo Mozzarella cheese
Excessive acidification = buffalo Mozzarella cheese with elasticity defects

5.2 DEFECTS

Cheeses are usually liable to defects that transform more or less deeply their physical, chemical and sensory characteristics, depreciating their commercial value.

In most cases the deterioration depends on:

- the use of milk charged with "anti-dairy" micro-organisms;
- milk contamination during various phases of the dairy production;
- technological mistakes during the various working phases;
- the use of rooms not fit for milk processing and/or for cheese storage.

As far as buffalo Mozzarella cheese is concerned the most common defects are:

bubbles or blowing
putrescence and whey-excess
development of moulds
peeling
too hard or too soft texture

When looking at the buffalo Mozzarella cheese, if we notice the presence of ***bubbles or blowing,*** it means that the milk or the cheese have been microbiologically contaminated (in particular by coliform germs). To avoid this defect, it is necessary to pay special attention to hygiene and to increase the acidity.

If the buffalo Mozzarella cheese presents signs of ***putrescence and whey-excess***, it means that the milk or the cheese have been contaminated by putrescent spore-forming bacteria.

If we notice the presence of ***moulds,*** it means that the buffalo Mozzarella cheese has undergone a superficial contamination. To avoid this defect it is necessary to pay attention to the environmental hygiene and to perform surface treatments on the cheese or on the conservation liquid.

If we notice some ***peeling*** of the buffalo Mozzarella cheese while it is in the conservation liquid, it means that there is an incorrect salt-acid balance between the product and liquid.

If the buffalo Mozzarella cheese's ***texture is too hard or too soft,*** it means that there have been some mistakes made during the phase of whey drainage that have determined a too high or too low level of humidity.

If while eating buffalo Mozzarella cheese we notice a ***bitter taste,*** it means that too much rennet has been added, or that the rennet had a high proteolytic activity, or that there is an excessive presence of proteolytic microflora (*lactococcus*).

Chapter 6

RICOTTA CHEESE

At the end of the dairy process, besides having obtained buffalo Mozzarella cheese, we will have at our disposal a certain quantity of ***whey***. It is possible to use the latter to feed animals or to produce Ricotta cheese.

But let's proceed in order.

What is whey?

After the coagulation phase, precisely after the curd has been cut, there is the separation of a jelly-like mass from a greenish liquid, the whey. We can thus consider without any doubt whey as a dairy sub-product. Its chemical composition is water, lactose, whey proteins and a small percentage of fat. Actually, its constituent characteristics vary according to the type of cheese that has been produced.

Where does the word Ricotta come from?

Etymologically, the word derives from the Latin term *recoctus* that stands for "re-cooking of the whey"; in fact, Ricotta cheese is the product of the thermo-acid coagulation of the whey. It is possible to start from sheep, goat, buffalo or mixed whey.

But let's have a look at the specific technology and especially reveal the secrets to obtain good quality Ricotta cheese.

The whey must be strained, put into a vat of adequate capacity and continuously stirred while heated till it reaches boiling point. When the temperature of about 85°C is reached, the whey proteins start to separate from the whey, surfacing as small flakes that gather on the surface forming a white layered stratum.

Beware!

To avoid the formation of granules in the final product it is necessary to stop stirring as soon as the flakes start to surface.

At this point it is necessary to wait until all the flakes have come up and then the mass is pulled out. The structural characteristics of the final product are affected to a great degree by the way the flakes are skimmed off. A perforated ladle is used.

By working very carefully the Ricotta cheese is put into moulds or in a cloth bundle for the draining phase, which usually takes about 3-4 hours.
This technology allows us to obtain ***fresh Ricotta cheese***.

fresh Ricotta cheese

The liquid left over after the production of Ricotta cheese is no longer called whey but *scotta*.

Beware!

During the heating phase it is possible to add an acid solution to promote the surfacing of the flakes, in particular acid whey, hydrochloric, citric or tartaric acid. It is furthermore possible to add a certain percentage of milk to the whey before the heating to increase the productive yield and produce more Ricotta cheese.
To render the Ricotta cheese tastier, it is possible to add 1% of salt to the whey during the heating phase.

If we want to produce ***salted Ricotta cheese*** we must dry-salt the product after the draining and then leave it to mature for 15-30 days. If the ripening lasts for months, then one will speak of ***mature Ricotta cheese*.**

salted Ricotta cheese

In general, the chemical composition of Ricotta cheese depends on the whey we start off with, which, as we have already said, depends on the cheese that has been produced.
Fresh Ricotta cheese can present microbiologic and structural defects. As far as the structure is concerned, big granules - due to heavy stirring during the surfacing, mistakes during the skimming or bad transfer into the moulds - can often be found; to avoid this defect the secret is to take out with the perforated ladle only

the exact quantity of Ricotta cheese that it can hold. Furthermore the curd may present some granules; this happens when the whey has been poorly or insufficiently filtered. When Ricotta cheese is kept at temperatures that are too high, there may be the formation of a surface micro-flora.

Mature Ricotta cheese instead can present structural defects such as friability and chalkiness (the cause of this is an excessive acidification) or superficial cracks (due to mistakes during the drying phase: too high temperatures and insufficient humidity).

Chapter 7

THE DAIRY

The word “dairy” indicates all structures that are appointed to host milk transformation activities. Once the most favourable site has been found, it is necessary to ***orientate the building*** as to avoid exposing the area in which milk is processed and transformed to the north, the south or the direction in which the wind blows. A good rule to follow is to position the corners of the building towards the cardinal points.

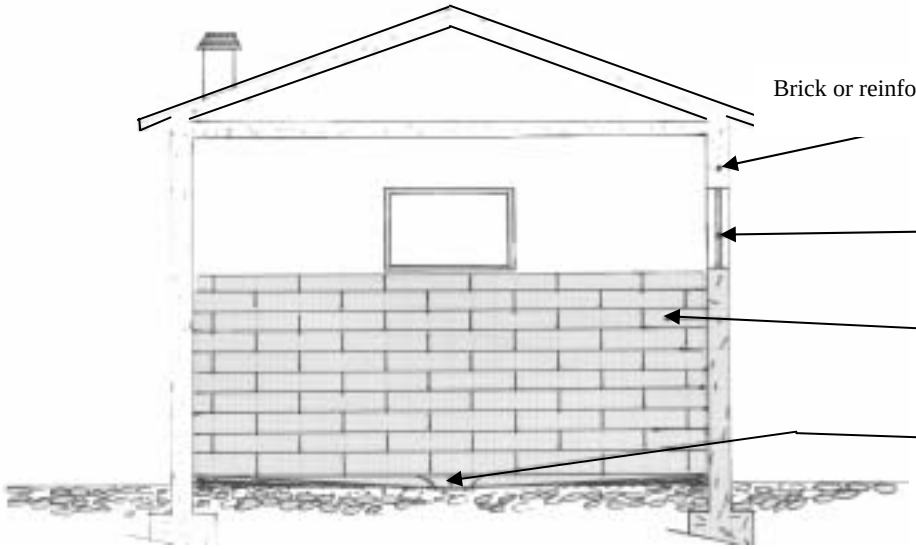
The ***nature of the building*** depends on numerous factors, such as: the dairy’s size, the dimensions of the machinery, etc. Furthermore, the choice of ***systems*** and of ***building materials*** is subordinated to the building’s typology, size, costs, etc. Usually, the materials are *reinforced concrete* (the concrete structure has a cumbersome and heavy appearance, but the execution time is short and it ensures a longer life and better resistance to atmospheric conditions), *precast reinforced concrete* (this is the most sought after structure nowadays because of the short execution times, reasonable costs and, least but not last, good resistance, life service and ease with which it is possible to adapt the structure to other activities), *traditional brickwork (*this type of structure is rarely used; it is less economically convenient because of the execution costs and duration, even though its resistance and life service are valuable).

The dairy must, in general, be very clean, with nets at the windows and curtains at the doors to prevent insects from entering the building.

The ***floor*** must preferably be covered, with non-slippery tiles and with a slope of at least 2% towards the door to allow the drainage of the dairy effluent. It would be better for the ***walls*** to be covered in washable tiles up to 1.50 m of height and the corners must be rounded off to ease cleaning.

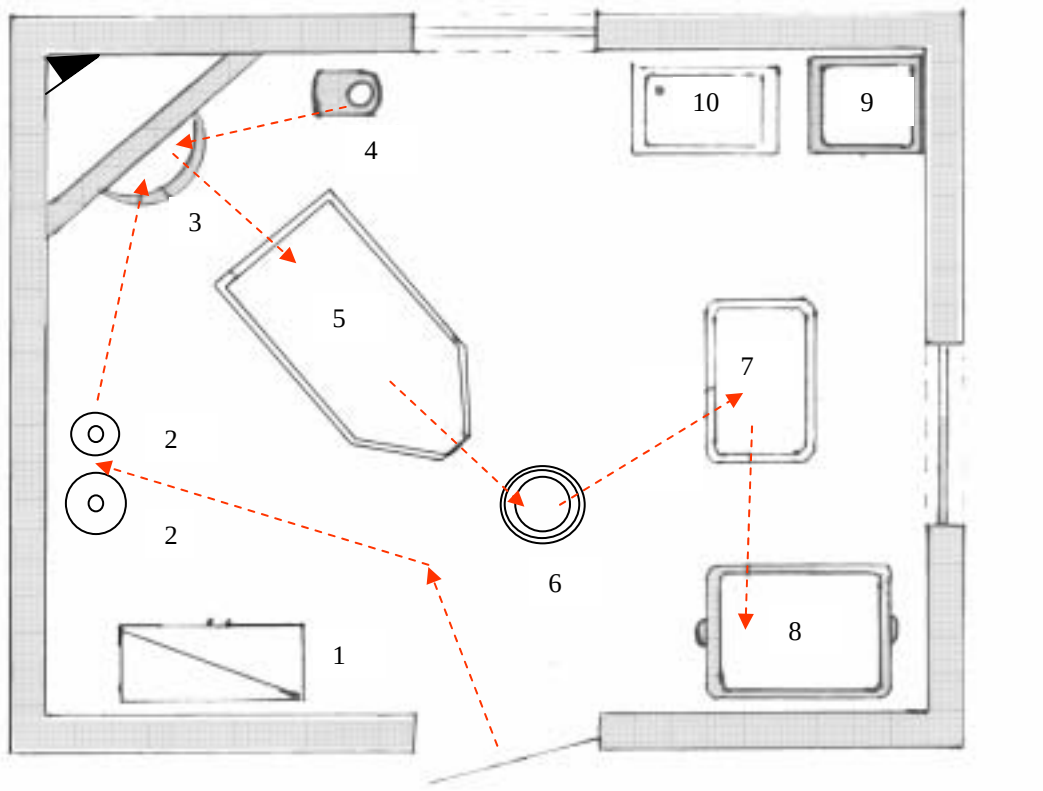
8.1 ORGANISATION OF A DAIRY WITH A WORKING CAPACITY OF 20 TO 200 L OF MILK

Drawing 1 **–** ***Exterior***



(*M. Pizzillo)*

Drawing 2 – *Interior*



(*M. Pizzillo)*

PRODUCTION COURSE

1. Cupboard
Place in the cupboard the small equipment and various ingredients (milk strain, curd cutting knife, stretching rod, rennet, etc.)

2. Area in which milk is received
Stainless steel thank of 20-50 litres are present. The milk must be processed within two hours of milking; if this is not possible it is necessary to cool the milk down to 8-10°C. This type of dairy does not usually buy a refrigerator, thus the milk can be cooled by putting the thanks under running cold water, remembering to shake the milk, or, where small quantities of milk are concerned, it may be put in a fridge, but always remembering to shake it now and then.

3. Coagulation area
There is a vat plated copper or a stainless steel vat

4. Natural whey culture container

5. Spreading table
It is used for the drainage of the matured curd. It can be in stainless steel or wood.

6. Vat for stretching
It can be in stainless steel or wood.

7. Cooling area
There is a plastic or stainless steel food basin.

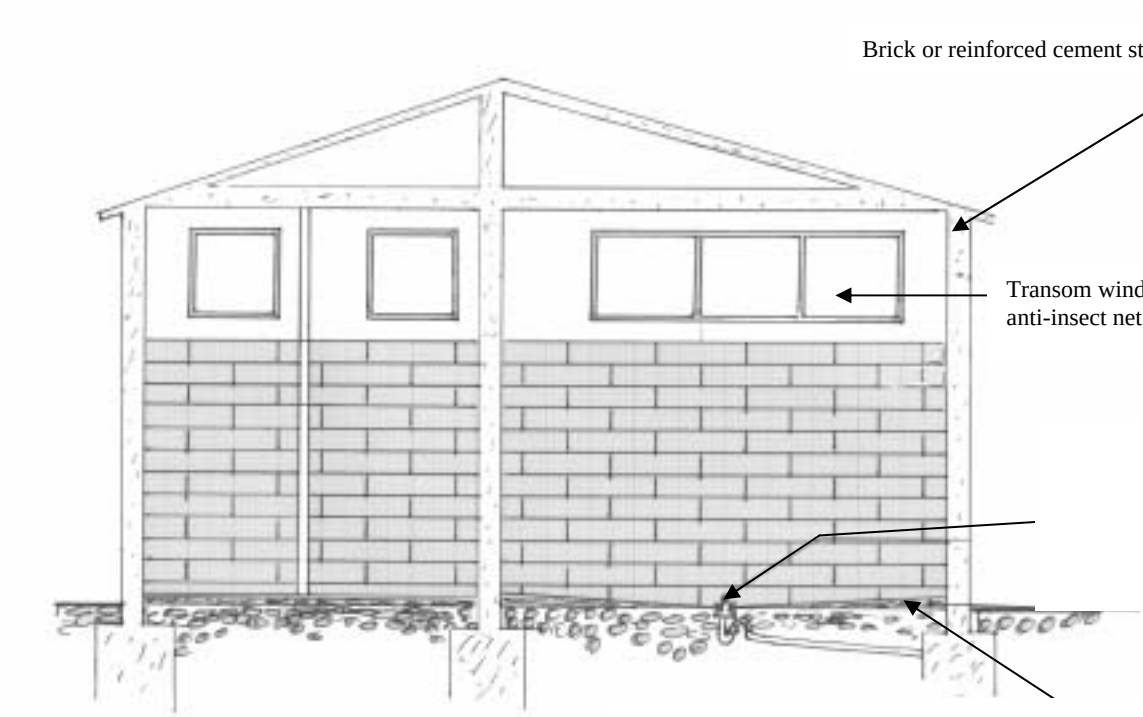
8. Brine container
The brine can be prepared in a stainless steel or plastic container.

9. Supply water container

10. Wash basin

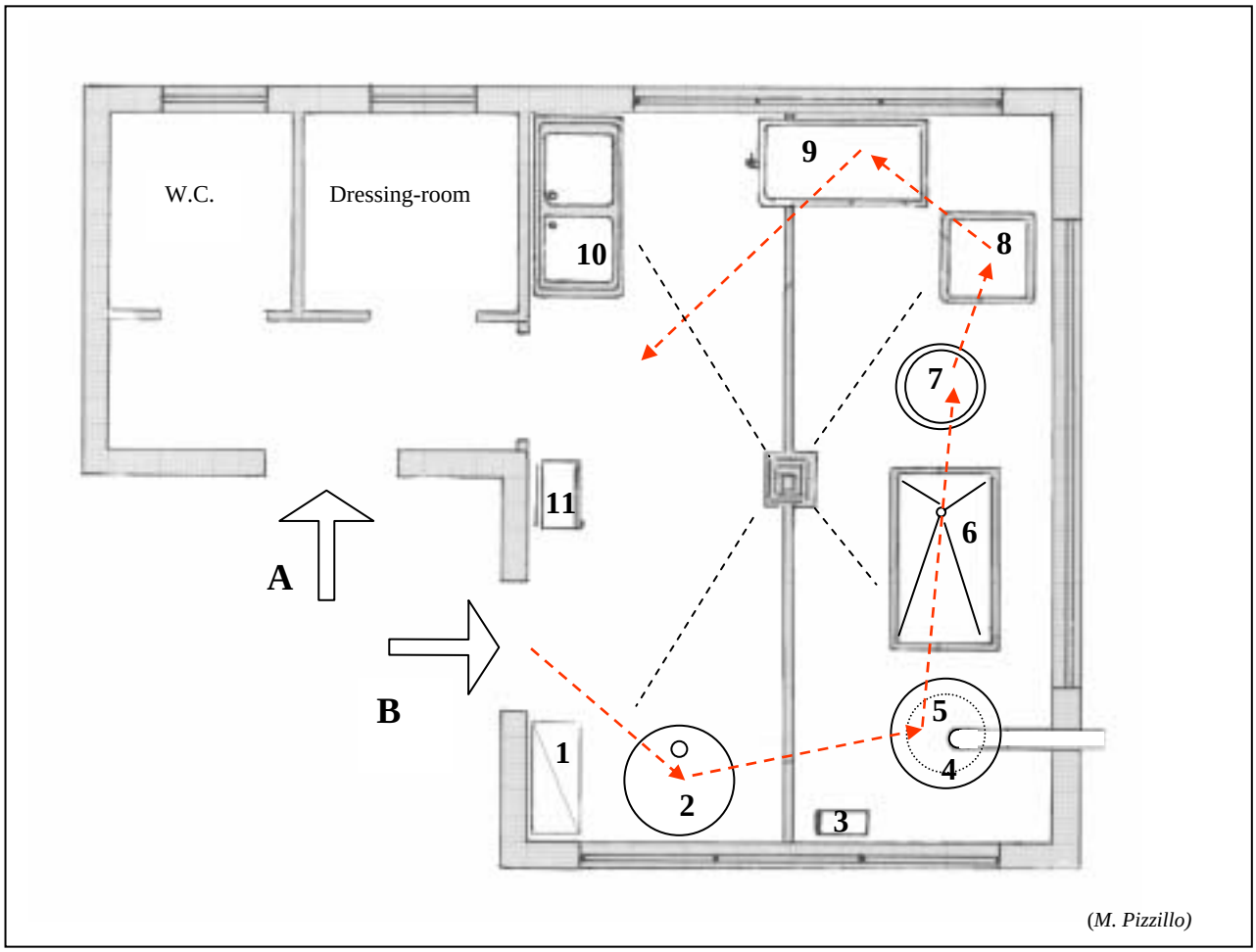
8.2 ORGANISATION OF A DAIRY WITH A WORKING CAPACITY OF 100 TO 600 LITRES OF MILK

Drawing 3- *Exterior*



(*M. Pizzillo)*

Drawing 4- *Interior*



(*M. Pizzillo)*

A ⟶ *staff entrance*

B ⟶ *milk reception*

PRODUCTION COURSE

1. **Cupboard**
   Place in the cupboard the small equipment and various ingredients (milk strain, curd cutting knife, stretching rod, rennet, etc.)
2. **Milk refrigerator**
3. **Natural whey culture container**
4. **Cowl for the aspiration of fumes and vapours**
5. **Stainless steel coagulating vat**
6. **Spreading table**
   It is used for the drainage of the matured curd. It can be in stainless steel or wood.
7. **Vat for stretching**
   It can be in stainless steel or wood.
8. **Cooling tank**
9. **Brine tank**
10. **Wash basin**
11. **Fridge**

8.4 GOOD BEHAVIOUR IN A DAIRY

To obtain a good quality cheese it is necessary to check on sources of contamination, keep everything thoroughly clean, check on the workers' and visitors' hygiene, pay attention to the quality of air and water, and not neglect waste and parasites.

Let's proceed in order.

-At the end of each dairy process it is necessary to *clean* the rooms and tools. By cleaning we intend eliminating all visible stains and leaving all surfaces clean. The tools can be cleaned either with drinking water or with the residues of the processed whey, which is a very good detergent; avoid using sponges that could be the receptacle of micro-organisms that contaminate the environment, it is better to use brushes. Floors, instead, must be cleaned with water and specific products; the best tools in this case are brooms.

-Man can transport various contaminations: hair, respiratory system, hands, clothes, shoes, etc., are the main sources of contamination. For this reason all the people that enter the dairy must follow very strict hygiene rules. For example, a mask must be used if one has an infection of the respiratory system, gloves if one has a skin infection. Furthermore the clothes and the boots used in the dairy must not be used elsewhere (in the cowshed or near the animals, for example). Finally, it is good custom to cover hair with a cap or a bonnet.

8.5 PHOTOS IN DAIRY

Plastic tanks

Stainless steel coagulating vat

Cowl

Cooling container

Spreading table

Milk refrigerator

Chapter 8

GLOSSARY

A

ACID

Compound which liberates in a water solution protons H+, giving a pH factor lower than 7; *e.g.* hydrochloric acid and lactic acid. See also “Lactic acid” and “Lactic acid bacteria”.

ACIDITY

pH values lower than 7. The acidity of fresh milk is between pH 6.65 and 6.67. The titrated acidity and the pH vary in opposing ways: the higher the acidity, the lower the pH value.

AEROBIC

Adjective indicating micro-organisms that can develop only in presence of air or free oxygen.

AMMINOACID

Base molecule of the complex protein structure (a protein is made up of hundreds of amino acids).

ANAEROBIC

A micro-organism that develops in air and oxygen free environments.

B

BACTERIA

Unicellular micro-organisms that represent an intermediate kingdom between plants and animals. Their size is between 0.3 and 10 μ. They can be of various shapes: *i.e.* small rods (*bacillus*) or spherical (*coccus*). They trigger various fermentations, *e.g.* lactic fermentation. See also “Lactic acid bacteria”.

BLOWING

Cheese defect due to gas fermentation caused by coliform or spore-forming bacteria.

C

CALCIUM

Metal associated to casein that contributes to curd formation.

CASEIN

Main protein in ruminant’s milk; it is present as micelle. Rennet acts on this specific protein, transforming milk into curd.

CHEESE

A fresh or aged product obtained from the coagulation of milk, cream, skimmed or semi-skimmed milk. Different cheeses present specific characteristics linked to the type of coagulation, drainage, microbial flora

that liberate the enzymes responsible of the flavour, texture and general appearance. The milk used as raw material can originate from various animal species (cow, buffalo, goat, ewe).

CHEESE MATURATION

A phase that concerns only hard mature cheeses. Period during which cheeses undergo, because of natural and microbial enzymes that exert their action on them, physical-chemical transformations that determine the characteristics of the final product (texture, flavour, aroma, appearance). The length of the ripening period depends on the type of cheese produced. See also “Maturation”.

COAGULATION

Process during which numerous factors (temperature, acidity, milk composition, rennet) cause casein precipitation with the formation of curd and whey. There are three types of coagulation: acid (the caseins precipitate because of acidification), rennet (rennet addition causes precipitation) and mixed (the coagulation takes place because of both the acidity action and effect).

COLIFORM

Bacteria normally present in mammal intestines; if found in water or milk, it indicates that there has been faecal contamination, thus bad hygiene control.

COLOSTRUM

The first liquid secreted by the mammary gland after giving birth. Its composition and appearance is very different from milk; it is very rich in protein and vitamins.

CURD

Protein network that derives from milk coagulation. It is obtained by adding rennet (rennet curd) or leaving the milk to acidify (acid curd).

CURD CUTTING

Operation in which the curd is fragmented into small pieces (from cubes into rice-sized granules – the size depends on the cheese that one wants to produce). Its purpose is to help whey drainage.

CURD GRANULES

Particles resulting from curd cutting.

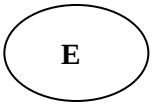
CUTTING

See “Curd cutting”.

D

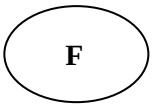
DRAINAGE

Physical phenomenon that consists in the separation of whey from the curd. Drainage allows the regulation of humidity in cheeses. It begins with the cutting of the curd and finishes with the ripening of the cheese.



ENZYME

Organic substance of protein origin produced by living organisms that act by promoting or accelerating biochemical reactions. Their names derive from the substrate on which they exert their action; we have, in fact, protease (acting on proteins), lipase (acting on lipids or fats), lactase (acting on lactose) and so on. Coagulation takes place thanks to enzymes that are present in the rennet. Cheese maturation occurs under the action of enzymes that come from the rennet, the milk and the environment.



FAT GLOBULES

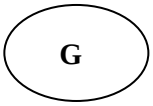
Microscopic drops (with a diameter from 2 to 5 μ): fat assumes this form in milk.

FERMENTATION

Transformation of certain substances triggered by micro-organisms called yeasts. For example, in lactic fermentation, lactic acid bacteria ferment lactose with the production of lactic acid.

FERMENTS

Fermentation agents: micro-organisms (yeasts, moulds, bacteria) that trigger fermentation thanks to the action of their specific enzymes. In the case of milk, we speak about milk enzymes.

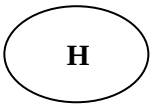


GLOBULES

See “Fat globules”.

GRANULES

See “Curd granules”.



HARDENING TIME

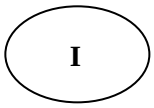
Time that runs between the formation of the curd and the start of cutting.

HUMIDITY

It indicates the water content in food. It is expressed as a percentage; in milk it can vary from 80 to 87% (depending on the species).

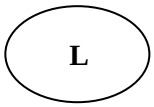
HYDROLYSIS

Chemical degradation of a substance, usually a big molecule split into a smaller one. Protein hydrolysis is called proteolysis, fat (lipid) hydrolysis is called lipolysis.



IMMUNOGLOBULINS

Whey proteins with an immunity role, *i.e.* the organism's defence.



LACTATION

Milk secretion and production related to the mammals' sexual phases of life. The length varies depending on the species (about 1 year for cows, buffaloes and goats; about 6 months for ewes). The lactation cycle includes: the delivery (the first days represent the *colostrum* phase), the lactation phase and the end of lactation in which the milk starts to assume some modifications in its composition that may cause coagulation problems.

LACTIC ACID

Product of lactose fermentation sustained by specific milk bacteria.

LACTIC ACID BACTERIA

Typical dairy micro-organisms; they multiply in milk and curd, allowing an increase in acidity and the production of specific aromas. They ferment lactose with the production of lactic acid. An important "origin" of milk lactic acid bacteria is natural whey culture. It is also possible to find lactic acid bacteria under a lyophilised form, in small packages. They are classified as homofermentative (if they only produce lactic acid) and heterofermentative (if they produce other substances as well as lactic acid).

LACTOSE

It is milk's sugar. The average content of lactose in milk is of 48-50 g/l.

LADLE

Wood utensil using for the manual stretching of curd; it specifically used to eliminate excess water.

LIPASE

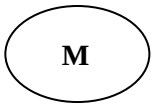
Enzyme that can degrade fats (or lipids).

LIPID

Fat component that can be liquid (oil) or solid (fat).

LIPOLYSIS

Splitting of fats made possible by a specific enzyme (lipase).



MASTITIS

Udder infection of bacterial origin.

MATURATION

Generic word that indicates the physical-chemical modifications that milk or dairy products undergo. There is to be made a distinction between: milk maturation (or acidification) and cheese maturation (see also).

MESOPHYLL

Group of bacteria that ideally develop between 25 and 30°C.

MICELLE

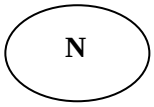
In milk, casein is present as micelle, *i.e.* big molecules in suspension. The individual casein molecules ”bind” together with mineral bridges. If the micelles degrade, the casein precipitates and milk curdles; it is the rennet that degrades the casein complex.

MINERALS

We can usually find sulphates, chlorides, phosphate, sodium, magnesium and potassium in milk.

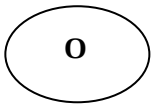
MOULDS

Microscopic mushrooms. If their presence is undesired, it is a defect. If instead they are desired, the cheeses are called blue cheeses (when the mould is inside the cheese) or cheeses with surface mould (when the mould develops on the surface).



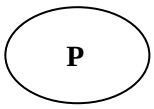
NATURAL WHEY CULTURE

Whey developed from a precedent manufacture, which added to milk allows the development of specific fermentations, *e.g.* lactic fermentation.



ORGANOLEPTIC CHARACTERISTICS

Flavours, smells and tastes perceived by our senses.



PASTEURISATION

Thermal process that destroys indifferently the harmful and useful micro-organisms in milk. After this treatment it is necessary to add lactic acid bacteria to at least partly re-establish the initial microbial flora. Pasteurisation usually takes place at 73-74°C and lasts for 15-20 seconds.

pH

It indicates a product's acidity degree. Values between 1 and 6 indicate an acid pH, 7 is neutral and from 8 to 14 indicates a basic or alkaline pH.

PRESERVATION

Phase that ensures the integrity of food products. Sterilisation, freezing, cooling, salting, etc., are some types of preservation.

PROTEIN

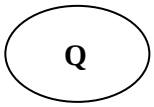
A chain with more than 100 amino acids. Milk proteins are caseins and whey proteins.

PROTEOLYSIS

Splitting of big protein molecules into simpler substances (peptides, amino acids).

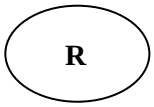
PSYCHOTROPHIC

Non-pathogenic germs that develop in refrigerated milk.



QUALITY

Food product properties and characteristics, in particular its nutritional, hygienic, sensory, technological and economical ones.



REFRIGERATION

Lowering of the temperature under 5°C.

RENNET

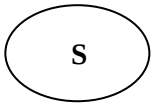
Enzymatic product extracted from the *abomasum* of ruminants containing the enzymes responsible for milk coagulation. Rennet can be of animal, plant or microbial origin.

RENNET TITLE (OR STRENGTH)

It indicates rennet coagulation activity; it is usually defined as the quantity of milk coagulated by 1 ml of rennet in 40 minutes at 37°C. The rennet title is usually of 1:10 000, *i.e.* 1 ml of rennet coagulates 10 000 ml of milk.

RICOTTA CHEESE

Dairy product obtained from heating the whey.



SALTING

Operation performed to favour whey elimination, limit the development of undesired micro-organisms, encourage rind formation (in the case of matured cheeses) and “add flavour” to the cheese.

SALMONELLA

Pathogenic bacteria responsible for toxic infections in the consumer.

“SCOTTA”

Remaining whey after Ricotta cheese has been produced.

SETTING TIME

Time that goes from the rennet addition in the milk to the appearance of the first flakes in the curd.

SKIMMING

Separation of the fat from the milk.

SMOKING

Exposure of food to the combined action of heat and smoke coming from the burning of specific types of wood (beech, chestnut tree, oak, etc.). Herbs can also be used (bay, juniper, rosemary, etc.).

SOLUTION

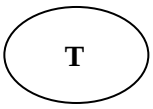
Homogeneous mixture between a substance that can dissolve (solvent) and one or more substances that are dissolved in it (solute).

SPORE

Some bacteria produce them to be able to resist when in difficult conditions.

STRENGTH

See also “Rennet title”.



TECHNOLOGICAL YIELD

Yield measurement of milk into cheese; it is expressed in percentage (amount of cheese in kg obtained from 100 kg of milk).

THERMIZATION

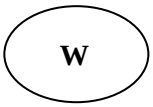
Moderate thermal milk treatment that takes place at 65°C and lasts only a few seconds. It implies a smaller loss of useful bacteria than pasteurisation.

THERMOPHILE

A bacteria group whose optimal development temperature is between 45 and 55°C.

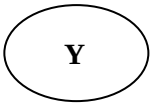
TITLE

See “Rennet title”.



WHEY

Liquid that starts to separate during the cutting. It is rich in water, lactose, proteins (whey proteins) and minerals. It is the raw material for the production of Ricotta cheese.



YEAST

Micro-organism of 2 to 9 μ of size that belongs to the plant kingdom. Yeast can be found in raw milk and in dairy products. It sometimes causes technological defects: undesired blowing and fermentation.