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FARM TO DAIRY HYGIENE MANAGEMENT IN THE DAIRY SECTOR IN MOROCCO: GUIDE TO BEST PRACTICES

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1. INTRODUCTION

1.1 CONTEXT

Green Morocco has identified milk production as a promising industry with definite potential for development. Currently, milk production in Morocco is on the order of two million tons. It is expected that production will increase to 3 million tons in 2014 and to 4.5 million tons in 2020. Milk is also among the most prevalent food items in every household; Moroccans currently consume 32 liters/year, and this figure is expected to triple, and even quadruple, in the short term. Therefore, the milk sector is expected to play a significant role in employment and to contribute significantly to rural development.

This development can only occur if primary production and the infrastructure for collection and processing undergo unprecedented development. The Morocco Plan assessed investments for achieving this goal of 12 Billion Dirhams. To ensure smooth growth in this sector, this quantitative leap must be accompanied by qualitative measures so that products placed on the market will meet regulatory requirements.

Milk is an excellent culture environment for rapid growth of microorganisms and the production of chemical reactions. The prevalence of bovine diseases—and the germs or the substances used to treat them that can pass into the milk—require rigorous surveillance at the farm, collection, and processing levels. Implementing a quality management program in these three links is a requirement.

In Morocco, the milk production chain is dichotomous. On the one hand, the upstream links of primary production and collection occur in hygienic conditions that are often unsanitary; on the other hand, people are working very hard to meet the required standards in the relatively modern processing link. The majority of dairies whose size exceeds a critical threshold have set up an HACCP quality assurance program, and some have even opted for ISO 22000 certification.

Planned development of the sector in the short term will only intensify this dichotomy. There will be an undeniable abundance of production farms having little mechanization that are called upon to comply with hygienic conditions, and, collection centers that will need to be doubly vigilant in only letting milk that meets quality standards move to the processing link. Meeting these requirements will necessitate upgrading these links with suitable equipment, properly trained human resources, and well thought out and carefully planned procedures. The diagnosis conducted in the regions of Oriental and Doukkala show the processing facilities' involvement in structuring and upgrading upstream links in the production chain, but so far efforts remain insufficient to ensure proper management of quality from production to processing.

There is an urgent need to implement an integrated policy to oversee quality management in the industry. Currently, services under the purview of dairies or the Ministry of Agriculture provide partial supervision. The following observations are unavoidable:

- The noticeable lack of a professional organization for technical supervision of quality management in the upstream links of the production chain.
- The inexistence of a guide for good hygiene practices that would serve as a reference for farmers and cooperatives providing milk collection.

The Moroccan Economic Competitiveness (MEC) Project, funded by USAID, has taken on the task of addressing these shortcomings. It will draft a guide for good hygiene practices, which is also the purpose of this mission. This guide will be made available to professionals and the organizations they represent. In addition, MEC will take the initiative to hold discussions with the professional organization representing the industry to find an appropriate structure that will take responsibility for supervising the management of quality and hygiene for all links in the chain. This structure, which will be managed by the professionals themselves with government support, will have the authority to review and enhance the guide and to develop a guide for each link or to develop all procedures for all operations where hygiene is critical.

We have set out to establish a summary of hygiene rules and best practices for production so that the milk transferred to dairies meets the standards in force. This current version of the guide is preliminary and will remain so until it is validated by the competent national authority. Meanwhile, it can be used by operators working in the milk sector and public officials as a basis for work, whether for supervision or inspection of the production chain.

The guide takes into account the Moroccan situation. Real conditions in the field were drawn upon to identify what measures to take. It is designed to be simple and recommends the most basic hygiene practices possible while remaining in compliance with the HACCP prerequisites.

1.2 OBJECTIVES

This guide aims to apply recommendations from the International Code of Practice on the general principles of food hygiene, specifically for milk. It also provides guidelines on how to meet the general requirements listed in the sections on hygiene in the Codex standards for dairy products.

2. BASIC PRINCIPLES OF THE GUIDE

2.1 SCOPE OF THE GUIDE

In addition to the national regulations, the guidelines set out in the international regulatory framework for food hygiene have developed a principle stating that each operator working in the production chain has an active responsibility in controlling the hygienic quality of dairy products. In each country, Guides to Good Hygiene Practices (Guides de Bonnes Pratiques d'Hygiène; GBPHs) are drafted to address the concerns and professional realities facing businesses and to help professionals comply with requirements for hygiene.

In order to have a solid consensus, the guides, organized by industry, must be recognized at the national level. For this to happen, professionals must first accept the guides before they are validated by a State official having the authority and jurisdiction to manage hygiene quality on a national scale. In some countries, the Higher Council of Public Health will play this role. In cases where no council of this type exists, an equivalent institution that has scientific and legal authority could play this role. In the case of Morocco, the Office National de Sécurité Sanitaire des Produits Alimentaires (ONSSA) is assigned this role.

Today, few guides for good hygiene practices are publically available. We recently conducted a survey on this; it showed that the only guides available to professionals are those related to the fishing sector. Moreover, these were not developed by associations working in the sector but by the department in charge of that sector.

This guide on good hygienic practices in the milk production chain in Morocco is a tool to raise awareness about the importance of good hygiene practices and their implementation among professionals in the industry depending on their degree of involvement. It suggests key points to understand about hygiene, called "Methods for Understanding," that provide know-how and the methods to achieve a good level of hygiene, for example on cleaning and disinfection or the hygiene of operators.

It should be noted that applying the Best Practices Guide for hygiene is voluntarily. Any professional who chooses to act otherwise must prove the hygienic validity of his or her practices by conducting his or her own risk analysis.

2.2 BASIC PRINCIPLE FOR DEVELOPMENT

Dairy product hygiene has been defined as all the necessary conditions and measures to ensure product safety and sanitation for all steps in the dairy industry. All measures that are recommended must comply with the Recommended International Code of Practice General Principles of Food Hygiene published by the Codex Alimentarius and validated by the competent authority in charge of hygiene in Morocco.

The General Principles of Food Hygiene provide a solid foundation that ensures hygiene for dairy products. They should be used in conjunction with best practices for manufacturing and agriculture.

These principles are applied to the four links in the production chain: primary production, door-to-door sales or peddling, collection, and processing.

Thus, the approach used in developing this guide is based on identifying and analyzing the hazards related to the four links cited above and what measures to implement to control these hazards. The HACCP program and its prerequisites have been used as the main reference. It is useful to recall that the following common principles should be applied to all links in the milk production chain:

- To ensure that dairy products covered by this guide are safe from any problems that might jeopardize public health, it is critical to plan a series of measures to control hazards that are implemented from the farm to the household. Therefore, good hygiene practices should be applied all along the production chain to ensure that the product placed on the market conforms to the required quality standards.
- The measures proposed in this guide are part of an integral system. No part of the guide should be used without taking into account the various steps applied before or after a specific measure.

In principle, hygiene requirements, commonly called "Precursory Programs" or "Prerequisite Programs" should be carried out before starting implementation of a quality program. The existing conditions in the production chain will be taken into account before implementing these preliminary programs.

2.3 REGULATORY AND LEGISLATIVE BASES

- Law no. 13-83 on fraud prevention for goods, promulgated by Dahir no. 1-83-108 of 9 moharrem 1405 (5 October 1984), specifically Article 16;
- Dahir on Law no. 1-75-291 of 24 chaoual 1397 (8 October 1977) enacting measures on sanitation and qualitative inspection of living animals, animal products, or foods of animal origin;
- Dahir no. 1-70-175 of 26 joumada I 1390 (30 July 1970) on industrial standardization aimed at maintaining quality and improving productivity;
- Decree no. 2-00-425 of 10 ramadan 1421 (7 December 2000) on controlling the production and marketing of milk and dairy products.
- Joint order of the Minister of Industry, Trade, and Handicrafts and the Minister of Agriculture, Rural Development, and Maritime Fishing no. 2301-98 of 2 ramadan 1419 (21 December 1998);
- Order of the Minister of Industry, Trade, and Handicrafts no. 359-91 of 23 rejeb 1411 (8 February 1991);
- Order of the Minister of Industry, Trade, and Handicrafts no. 1616-98 of 28 July 1998;
- Order of the Minister of Industry, Trade, and Handicrafts no. 1774-95 of 23 moharrem 1416 (22 June 1995); and
- NM 08 0 000 (2006) General Principles of Food Hygiene.

3. ANALYSIS OF VARIOUS HAZARDS

3.1 STANDARD MILK

3.1.1 Normal composition of milk

From a physical-chemical viewpoint, milk is a very complex product. An in-depth understanding of its structure is essential to better control the various industrial treatments it must undergo. This is the goal of this chapter.

Milk is a colloidal system made up of an aqueous solution of lactose, salt content, and several other components in a dissolved state, in which there are proteins in suspension and fats in an emulsion. On average, total dry extract is 13.1%, and the non-fat milk solids are 9.2%.

The overall composition of cow's milk is presented in Table 1, using quantitative approximations that vary depending on a range of factors: animal breed, diet, the animal's health status, period of lactation, and others. However, the exact composition of a milk sample can only be obtained through analysis.

Table 1: Overall composition of cow's milk

Component	Average Composition
Water	86.9%
Fat	3.9%
Proteins and non-protein nitrogen compounds	3.2%
Carbohydrates	5.1%
Salt content	0.9%

3.2 PHYSICAL-CHEMICAL PROPERTIES OF MILK

3.2.1 Quality criteria

Several definitions have been attributed to the quality of milk. As a product that alters rapidly and that is consumed on a large scale, nearly all definitions focus on the product's health aspects. There is no denying that the concepts of innocuousness and tampering remain central. The microbial and chemical aspects that place consumer's health in danger appear first and foremost when defining quality. The main industrial concerns are the presence of pathogenic microorganisms, antibiotic residues, or other chemical residues. Any other handling of the milk that changes its composition has a direct impact on its quality. Watering down or skimming the milk are forms of fraud that the industry is determined to eradicate at the source.

Depending on which production link is under question, milk quality has quite a specific resonance. The table below presents all the nuances related to the various facets presented in the different definitions.

Table 2: Various facets of milk quality

Physical aspects	Freezing point, density, color, fat separation, specific heat, viscosity, etc.
Chemical aspects	pH, buffering capacity (acidity), antibiotics, composition en proteins, fat, lactose, minerals, etc.
Microbiological aspects	Preservative properties, bacteria, somatic cells, viruses, microbial flora, enzymes, oxygen, etc.
Functional properties	Heat stability, rennet coagulation, emulsification, overrun, etc.
Biofunctional properties	Nutritive value (vitamins, minerals, CLA, Omega-3, pro biotics, etc.); fermentation and enzymatic hydrolysis (bioactive peptides, hydrolyzed lactose, etc.).

Quality assurance in the milk production chain must be ensured through concrete measures with boundaries defined in advance by national laws and the resulting standards. Basic minimum requirements are necessary to maintain an acceptable level of security. Adherence to a quality assurance program depends on the time of implementation, financial costs, confidence in the law, and services in charge, and lastly, the knowledge and understanding of health safety concepts.

The upstream links of the milk production chain exist in a complex environment that, in most cases, is marked by the lack of a cold chain and practices at the farm level that are still based on local traditions. Some farmers handle and transport milk in conditions that violate the most basic rules of hygiene. What can be expected when a sick cow is milked and in conditions where the cleanliness is lacking? How will milk, even if it starts out untainted, arrive in the collection center when it is transported in very dirty plastic drums at high temperatures? We must ensure that tools and procedures are in place at all times to avoid receiving contaminated milk in a collection center.

3.2.2 Quality standards

At collection centers, standards for receiving milk are defined by regulatory texts. The sections below detail aspects for quality that are regulated and the standards associated with them.

3.2.2.1 Bacteriological quality

This aspect is regulated by the provisions stipulated in the Joint Order of the Minister of Agriculture and Rural Development, the Minister of Health, and the Minister of Industry, Trade and Telecommunications no. 624-04 of 17 safar 1425 (8 April 2004) on microbial standards applied to animal products or foods of animal origin. Bacteriological standards for raw milk intended for consumption and showing a positive reaction for the phosphatase test are given in the table below:

Table 3: Bacteriological standards for raw milk

Raw milk for consumption showing a positive reaction for the phosphatase test (1)		
	m	**M**
Aerobic microorganisms (30°C) in 1 ml	300000	3000000 (n=5, c=2)
Coliforms at 30°C in 1 ml	-	-
Fecal coliforms at 44°C in 1 ml	100	10^3 (n=5, c=2)
Staphylococcus-aureus in 1 ml	-	-
Salmonella in 250 ml	None	None n=5,c=0
Beta-hemolytic streptococcus in 0.1 ml	None	None n=5, c=0
Listeria monocytogenes in 250 ml	-	-

With:
m = Satisfactory limit. Limit below which all results are considered satisfactory.
M = Acceptability limit, beyond which the results are considered unsatisfactory, without the product being regarded in any way as toxic.
n = number of units comprising a sample; and
c = number of sampling units giving counts of between m and M.

3.2.2.2 Other standards

Table 4: Physical-chemical criteria

Criteria	**Standard**
Somatic cells	< 500 000
Freezing point	- 0.52
Densimeter	1.027 – 1.030
Acidity (pH)	6.8

3.2.2.3 Comparing Moroccan standards with other countries

Table 5: Comparison of certain standards around the Mediterranean

Criteria	**Moroccan Standards**	**Tunisian Standards**	**European Standards**
Fat (g/l)	> 30	> 30	> 38
Proteins (g/l)	> 28	> 28	> 32
Freezing point (°C)	-0.52	-0.52	-0.52
Somatic cells/ml	< 500 000	< 500 000	< 400 000
Bacterial load/ml	< 500 000	< 500 000	< 500 000

3.3 MICROBIOLOGICAL HAZARDS

Microbial contamination is a major hazard in the milk production chain and must be controlled at all costs. As for all foods, microorganisms from several sources can contaminate milk and other dairy products. These infectious agents may come from the cow itself, the environment, equipment, staff that handle or collect the milk, and, lastly, visitors in contact with the product.

3.3.1 Microorganisms from cows

Any cow carrying a germ is likely to transmit it to the milk produced on the premises. Sick animals or ones that have tuberculosis or Brucellosis, Q fever, or mastitis produce milk contaminated by the infectious agents causing these diseases.

3.3.2 Microorganisms in the environment

Milk contains natural flora from the environment, and flora that is potentially harmful to human health will be addressed here. This category includes four naturally occurring microorganisms: *Escherichia coli*, *Listeria monocytogenes*, *Salmonella*, and *Staphylococcus aureus*. These microorganisms must not exceed the tolerable limits so that they do not pose a hazard to human health.

3.3.2.1 *Escherichia coli*

This family of bacteria is among the usual hosts in the intestine for both humans and animals. Some strains are pathogenic. The best prevention is very strict hygiene. At the dairy production level, these heat-sensitive germs are destroyed through pasteurization. Heat produced during pasteurization exceeds the thermo resistant limit for pathogenic bacteria and for those causing food spoilage. This thermo resistance depends on the environment in which pasteurization is performed. The more acidic the environment, the lower the heat resistance. Pasteurization significantly reduces the number of microorganisms in the pasteurized product, but some forms are resistant, such as spores.

3.3.2.2 *Listeria monocytogenes*

The *Listeria* comprise a family of bacteria of seven species, including one, *Listeria monocytogenes*, that can cause listeriosis, a serious illness among immuno-depressed people (pregnant women, infants, the elderly).

Pasteurization (heating to 72°C for 15 seconds) destroys *Listeria monocytogene*. However, if a food is contaminated by these bacteria after it has been pasteurized or sterilized, it is not protected by refrigeration. These bacteria can continue to survive in low temperatures. To avoid any contamination, measures that meet very strict procedures must be implemented in the dairy production chain.

3.3.2.3 *Salmonelles*

Salmonella are bacteria that have a high capacity to survive in the environment and rapidly develop in animal products. They are the cause of the disease salmonellosis.

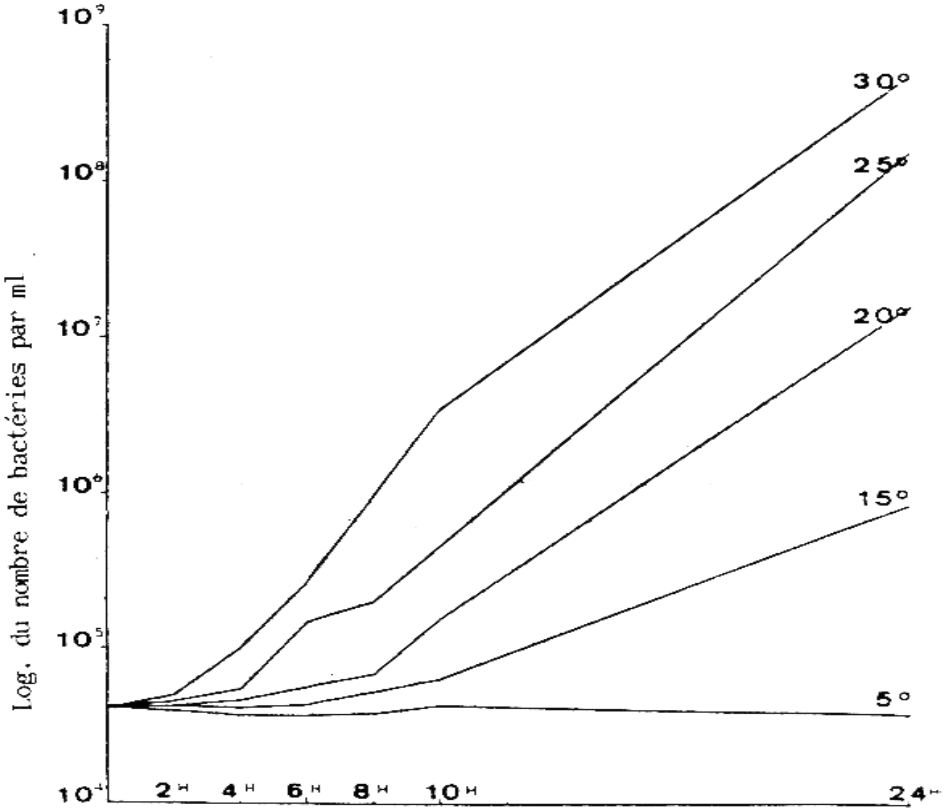
Pasteurization destroys them. In the dairy industry, the rule of zero salmonella in the finished product is required. Therefore, hygiene rules must be strictly observed during production, collection, and processing.

3.3.2.4 *Staphylococcus aureus*

Golden staphylococci are particular bacteria in the sense that their toxins cause poisoning. These bacteria are destroyed by heat (a few minutes at 70°C). Staphylococcus can cause infection of the udder, often with few of no signs, and is directly excreted in the milk. In this context, prevention of milk contamination begins at the farm. Staphylococci have a high capacity to spread to milking and other equipment. Therefore, ongoing prevention measures must be implemented along the entire chain.

3.3.3 Effects of refrigeration on microbial growth

It has been established that milking, transport, and collection—even when performed in satisfactory hygienic conditions—is always accompanied by contamination by various microorganisms. Several bacteria find the necessary nutrients for their growth in milk. Moreover, this development begins in the 3 to 4 hours following milking when the milk is kept at room temperature. As shown in the figure below, the intensity and rate that these bacteria multiply are affected by temperature.

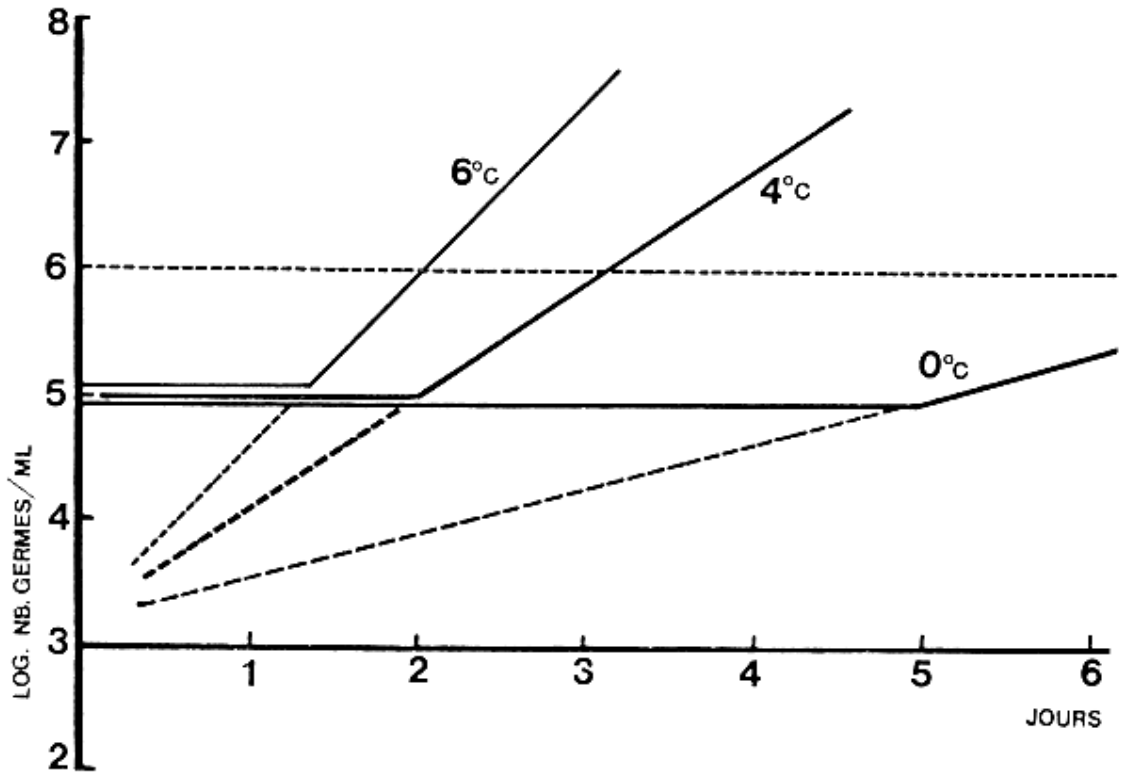


Source: FAO Guide

Figure 1: Effects of refrigeration on microbial growth

Refrigeration must be used to slow down the growth of bacteria in milk. To inhibit microbial growth, this operation is all the more effective when the initial bacterial count is low. In no cases can cold temperatures replace or compensate for poor hygiene during milking and/or lack of hygiene during transport and collection.

Once the temperature has dropped to around 10°C, the growth phase of certain microorganisms is significantly slowed down. As shown in the figure below, growth ceases for more than one day at a temperature of 4°C. This is the case for lactic acid bacteria, responsible for acidification.



Source: FAO Guide

Figure 2: Effect of low temperatures on the milk quality

3.4 CHEMICAL HAZARDS

Foreign chemical substances with long-term potential health hazards can exist in milk. Repeated ingestion of these substances poses problems, meaning that the chemical hazard has a cumulative effect. It should be noted that the presence of chemical products such as antibiotics has an impact on the technological aptitude of milk. These substances inhibit the growth of enzymes used to produce products derived from milk such as yoghurt and cheese.

3.4.1 Cleaning products

The products used to clean and disinfect equipment and spaces or substances used for rodent control on the premises can contaminate milk. It should be noted that some of these products are toxic and that appropriate measures must be taken so that they do not contaminate the milk.

Procedures for storing and using these products must be developed and followed at the farm and collection center as well as the plant where milk processing takes place. These procedures should specify that:

- A space, far from milk circuits, must be specifically dedicated to storing these products. A special labeling system must be used. This system must be understandable and easy to use even for users who have not had the opportunity to attend school.
- A specific method for using these products must be clearly defined in these procedures. As a simple security measure, all users must wear protective glasses and gloves before handling these products.
- Prescribed doses must be followed.

Cleaning and disinfecting will be done according to the procedures regulating this operation. Both the prescribed doses and the duration of the final rinse will be followed.

3.4.2 Antibiotic residues

Antibiotics are inhibitors found in the milk after these substances have been administered to cows for preventative or curative reasons. Their presence presents two risks:

- For milk product producers: The presence of inhibitors in the milk can block or slow down microbial fermentation and lead to poor or no coagulation of the milk in the cheese vat or yoghurt reactor.

- For the consumer: The presence of traces of antibiotics in milk is a major public health concern. Risks attributed to antibiotics in milk mainly concern allergies or antibiotic resistance caused by these substances over the long term.

The Maximum Residue Limit (MRL) is the maximum concentration of residues that can remain in milk, as determined by scientists and the appropriate authorities, regarded as the limit that poses no health risk to the consumer and with no negative impact on the manufacturing processes that milk undergoes. This MRL should not be exceeded in the milk received at the collection center. The table below lists the MRLs of some substances based on European Union standards.

Table 6: MRL for some administered substances

Antibiotique	LMR (µg/kg)
Benzylpénicilline (β-lactames)	4
Cloxacilline (β-lactames)	30
Oxytétracycline (tétracyclines)	100
Lincomycine (lincosamides)	150
Sulfaméthazine (sulfamides)	100
Spiramycine (macrolides)	200
Tylosine (macrolides)	50
Streptomycine (aminoglycosides)	200
Néomycine + framycétine (aminoglycosides)	1.500
Marbofloxacine (quinolones)	75
Nitrofuranes (furazolidon, …)	interdit
Nitro-imidazoles (ronidazol, metronidazol, ..)	interdit
Dapson	interdit
Chloramphénicol (phénicols)	interdit

The wait time before delivering milk to the collection center after an antibiotic treatment is defined for a very specific treatment protocol. It has been set for one dose, one route of administration, and one specific treatment period. The elimination kinetics of an antibiotic in milk is shown in the figure below.

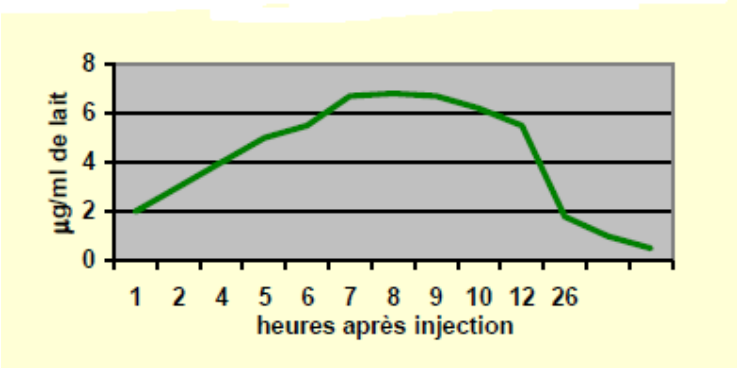


Figure 3: Elimination kinetics of an antibiotic in milk

If the dose is increased, the antibiotic remains in the milk longer. Each farmer must be aware that when one treatment variable is modified (whether dose or treatment duration), the wait time must be redefined before testing for residues. As shown in the figure below, changes in the treatment dose can substantially lengthen the wait time before milk can be delivered to the collection center.

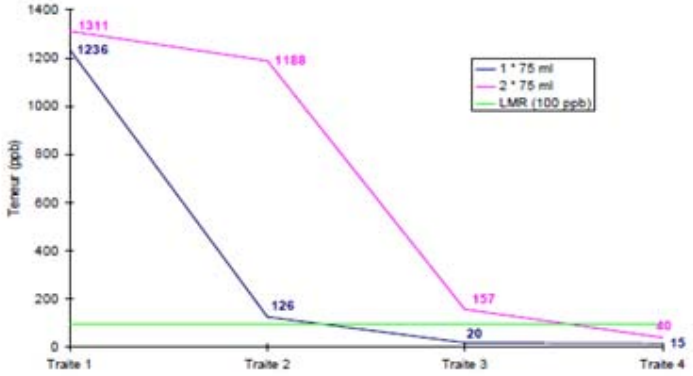


Figure 4: Elimination of antibiotics in milk: Sulphametazine dosage in milk following treatment

3.5 PHYSICAL DANGERS

Any foreign matter that is found in milk can be a physical danger. Therefore, the presence of insects, bristles of hair, pieces of wood, or grains of sand may cause a problem, whether technological or for the consumer.

4. MANAGING HAZARDS UPSTREAM OF THE PRODUCTION CHAIN

4.1 AT THE FARM LEVEL

The main objective of best practices in dairy production consist of producing healthy, high-quality milk from cows in good health by supporting measures for management that are sustainable for both the animal's well-being as well as from a social, economic, and environmental perspective. Hence, it would be impractical to want to produce milk that meets all regulatory requirements if shortcomings have been observed in infrastructure, animal health, or hygiene during milking. This guide emphasizes the importance of following covenants when designing infrastructure on the farm and advice for keeping cattle in good health before presenting best practices for milking, which is often the link that has a high probability of contamination.

4.1.1 Infrastructure on the farm

Premises used for milk production must be designed and maintained in a way that protects milk from any type of contamination. It has been proven that poorly designed or poorly maintained premises are among the causes of contamination. A few design tips are provided below.

Table 7: Recommendations for designing premises

Heading	Recommendation
Barn layout	• Depends on the number of cows • Only one row of cows • Two rows along the longitudinal axis • Number of cows > 16 cows; the two-row model is recommended
Space	Each cow must have a space with the following characteristics: • Surface area: minimum of 4.60 m^2, but with sufficient ventilation, this space may be less • A height of 2.40 m is recommended
Ventilation	• Air circulation is essential • Air exhaust systems must be placed above
Lighting	• In order to milk cows without risking contamination, the stables should have sufficient lighting. One 0.35 m^2 side window-opening per cow is recommended.

4.1.2 Animal health

Cows that produce milk must be in good health and receive rigorous health check-ups. The table below presents a series of good hygiene practices.

Table 8: Steps for keeping cows healthy

Good hygiene practices	Suggested measures	Objective of measures
Have disease-resistant cows	• Choose resistant breeds • Vaccinate the herd according to veterinary recommendations	Prevent contamination of milk by the cow
Use cleaning and disinfection products and medicines following directions or prescriptions	• Only use legally authorized products • Only use and apply the dosage and mode of application in accordance with the veterinarian's or manufacture's prescription • Store products in required conditions for safety	Prevent the presence of residue in milk
Prevent diseases from entering the farm	Set up a system to control entries at the farm level	Ensure biosecurity on the farm

4.1.2.1 Milking

Milking is a difficult operation in the milk production chain. Managing risks requires implementing the measures presented in the table below:

Table 9: Good hygiene practices during milking

Good hygiene practices	Proposed measures	Goal of measures
Prevent any injuries	• Attach milking equipment correctly • Handle the teats carefully	Protect animals
Minimize the probability of contamination	• Prepare the teats carefully before milking • Separate milk from sick cows • Only use drinking water for cleaning	Maintain milk quality
Observe good hygiene practices	• Observe prerequisites for the HACCP program by ensuring that: • Premises for both shelter and milking are well maintained and clean,	Prevent any contamination

	• Staff carrying out the milking are healthy and clean • Milking equipment are properly cleaned and disinfected after each use	
Handle milk correctly after milking	• Cool down the milk at the farm if it has the proper equipment • Transfer the milk to the collection center as quickly as possible • Use clean drums that are easy to clean	Maintain milk quality

A distinction must be made between traditional and mechanized milking. The following list summarizes the rules to follow when performing mechanized milking:

- Milkers, equipment, and the premises of the milking room are assumed to be clean before starting;
- Get animals from the paddocks, put them in the stalls, and milk them in a quiet setting;
- Regularly check the health of the udder when the cow enters the stall;
- It is essential to follow the correct milking order, milk the primiparas first, then fresh cows, then the rest of the herd;
- Perform pre-dipping to "get rid of microbes" accumulated in the teat sphincter;
- Check that there is no mastitis; never begin wiping off the teats before releasing the first squirts;
- Carefully clean the teats (one cloth per cow or two if necessary);
- Check the vacuum level before starting to milk (-42 KPa) and select the proper pulsation rate (ex: 60/40);
- Attach the clusters 60–70 seconds after cleaning the teats (5 cows by 5 cows);
- For automatic cluster rooms, choose a setting that prevents over-milking (setting > 1.4 l/min);
- Once the cow is milked, disinfect the teats with a post-dipping solution;
- Once milking is done, start the general cleaning (equipment, platform, exit corridor, etc.);
- Filter and cool down the milk before sending it to storage tanks (check the cool-down process);
- Regularly check the quality of milk, particularly when paid for quality;
- Ensure that cows do not sleep immediately after milking (sphincter still open) by feeding them; and
- None of the above rules should be skipped under any circumstances whatsoever.

All of the hygienic conditions described above also apply to manual milking. Preparing the udder is very important. Preparation begins with massaging the udder or rubbing it with a cloth moistened with water at 60°C to activate the secretion of oxytocin, which will reduce the milking time.

4.1.2.2 During pickup

The most widespread form of pickup is done by the farmers themselves. Since they do not live far from the collection centers, the farmers supply these facilities through their own means. The milk is put into drums made of various materials such as steel, aluminum, or plastic, with plastic being the predominant material in Morocco. The degree of cleanliness of these drums varies from one producer to another, but it is frequently noted that these containers are not cleaned carefully and do not meet the required standards for cleanliness.

Door-to-door milk sales also occur throughout the country. The vendor procures raw milk from the producer and delivers it directly to various users. The quality of this milk is often questionable. This practice is encouraged due to the lack of inspection and failure to observe regulations, affecting the milk quality and safety in all links of the production chain.

This part of the guide focuses on hygiene during the pickup and peddling of milk destined for collection centers. Peddling milk in good conditions requires observing certain practices, summarized in the table below:

Table 10: Good hygiene practices during pickup

Good hygiene practices	Proposed measures	Objective of measures
Transport milk in clean metal drums	• Help producers get metal drums • Provide collection centers with drum cleaning stations	Transport the milk in the required hygiene conditions
Deliver milk to collection centers in the shortest possible time	• Schedule rounds to coincide with milking • Optimize the collection circuit to minimize time spent on collection	Ensure product quality and prevent microbial growth
Deliver milk to collection centers at the lowest possible temperatures	• Put an end to the archaic door-to-door system used currently • Provide peddlers with mini doubled-walled, cooling tanks containing coolant that has been chilled at the collection center before starting the collection rounds	Ensure product quality
Only peddle milk that meets quality standards	• Train peddlers on basic hygiene measures • Also train them on conducting analysis tests • Provide peddlers with suitable instruments for monitoring milk	• Only deliver good-quality milk • Reduce milk losses and minimize red tape at the collection center

5. BEST PRACTICES IN COLLECTION CENTERS

Risks must be controlled during collection and transport as well as during the production process. This objective can only be achieved if good hygiene practices backed by a rigorous monitoring program are applied at the collection center level. All operations carried out in this center must be performed under optimal technical and hygienic conditions.

5.1 PRESENTATION OF COLLECTION CENTERS

Morocco has over 1000 collection centers. These collection centers are designed to provide a bridge between the upstream links of the production chain, comprising primary production, and its downstream, bringing together the processing and distribution links. They provide two main functions, namely receiving the milk and refrigerating it.

Needless to say, the primary interest in these centers is twofold. They provide early refrigeration of the milk while waiting to transfer it to the plant and, on the other hand, minimize transport costs for milk collection. In Morocco, developing a network of centers is justified because, firstly, nearly all producers are small operations lacking any means for refrigeration, and secondly, they are spread out in a vast area of dairy farming far from processing plants.

Providing a reliable outlet for producers encourages improvements in both the quality and daily quantity of their production. Collection centers are also satellites used to disseminate information and extend good production practices. Hopefully one day they will also play the role of supply stores for veterinary drugs and cleaning products.

Producers or collectors bring the milk to the center, which, in theory, should be brought within two hours after milking. The milk is measured by volume, or even better by weight, inspected through simple methods (physical appearance, odor, acidity, etc.), filtered, and immediately poured into and stored in the refrigerated tank. Each day or once every two days, it is shipped to the dairy, preferably in an isothermal tank. This facilitates transfers; milk kept in large volumes warms up less quickly; it also avoids cleaning and handling of the drums.

5.1.1 Layout of the premises

For hygienic and organizational reasons, a typical milk collection center must designate a specific space for each activity. Therefore, receiving, refrigeration, and drum cleaning must be performed in separate spaces.

In order to comply with the HACCP prerequisites, the interior walls and ceilings must be smooth and washable. They should be durable, non-slip surfaces that are easy to clean. They must slope enough to prevent any water stagnation and have one or several drainpipes to drain water outside of the facility. Good ventilation should prevent any condensation. Fine-mesh screens or other systems must often be installed to keep out flies or other animals.

The premise's dimensions vary depending on the daily flow of milk received each day. A design factor of 4 m^2 per 100 liters of received milk can be used. The center must be equipped with drinking water connected to a national grid and hooked up to a sanitation network. The openings for air vents or those providing ventilation for the condensers in the refrigeration unit to refrigerate the milk must be big enough and facing north.

In order to avoid any risk of milk contamination, all spaces must always be kept in the highest degree of cleanliness. It is recommended that the floor and 2-m-high white-tiled walls be cleaned after each milking is sent to the plant.

5.1.2 Risk analysis

The hygienic and sanitation quality of milk in the collection center depends on all the handling that the milk undergoes in the upstream of the production chain and handling occurring in the center. The various risks that may occur are:

- ***At receiving***: Risks related to the milk's history. They may be chemical if the milk received exceeds the tolerated limits for antibiotics, or they may be microbiological if the milk quality has begun to spoil. Generally, as shown in the figure below, milk spoilage causing excess acidity results from the growth of microbial flora. If it is handled poorly during receiving, the milk may be subjected to various contaminants. The source of these contaminants may be the container used to transport the milk, the staff handling milk during receiving, or the utensils and any equipment in contact with the milk.

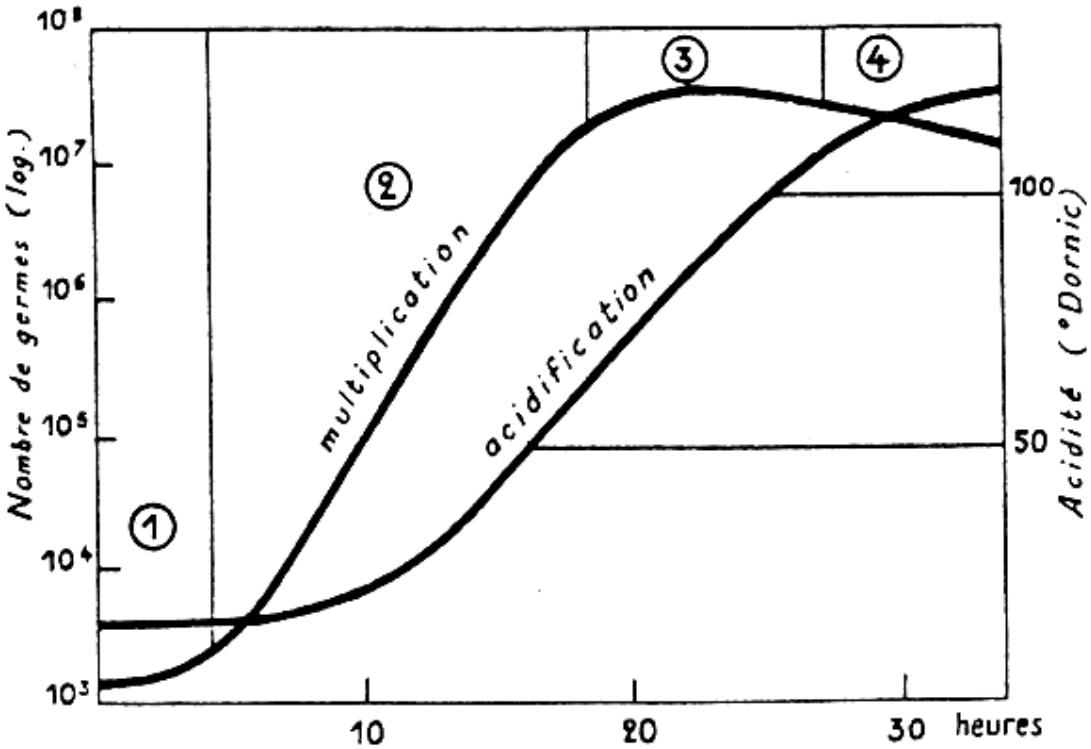


Figure 5: Relationship between acidity and microbial growth

- ***During refrigeration***: Contamination risks arise when transferring the milk to the cooling tanks and in the tank itself during cooling. The staff responsible for the operation and the tanks' cleanliness can be the source of all contamination that occurs in the center. It should be noted that cooling is never a way to prevent possible contamination in the tanks.

- ***During transfer into cisterns***: This microbiological risk is always present, especially if the milk transfer and/or sample collections are poorly conducted.

- ***During cleaning***: Improper cleaning using non-drinking water may cause contamination from a microbial risk.

5.1.3 Cleaning and disinfection

In order to send milk that meets the required standards to the plant, the collection center must observe several rules, including:

- Only accept good-quality milk
- Ensure good hygiene at the collection center and among staff who work there
- Follow operating procedures in the center, namely the cooling rate and cooling temperature setting. Milk must be cooled to a temperature of about 4°C in less than two hours.
- Properly clean and disinfect the tanks and all equipment in contact with the milk after each collection

A distinction is made in the collection centers between surfaces that come into direct contact with the milk, such as tanks and other items, and the other surfaces such as floors, ceilings, walls, etc. These other surfaces can cause cross contamination, and cleaning them should be a requirement.

A solid film forms on the tank surface as the milk passes through it during cool down. These deposits that build up over time could create an environment rich in nutrients that promotes the growth of microorganisms. Thus, it is essential to completely clean the tank immediately after the milk has been emptied out.

These built-up deposits are always difficult to eliminate without using active substances such as detergents with specific properties.

5.1.3.1 Classes of detergents

There are at least three categories of detergents, namely:

- Alkaline detergents (sodium hydroxide, sodium silicate, sodium carbonate, trisodium phosphate, polyphosphate, etc.). They specifically remove fats and proteins;
- Acid detergents (nitric acid, phosphoric acid, etc.), which dissolves minerals (tarter, milkstone); and
- Liquid or surfactant detergents (alkyl-sulfonate, alkyl-aryl-sulfonate, polyglycerol ethers, etc.). These are not used alone but added in small quantities to alkaline or acid detergents in order to facilitate spreading the cleaning solution over the entire surface and infiltrating the dirt.

Obviously, alkaline and acid detergents should never be mixed together. When used successively, they should be separated by thorough rinsing.

Detergents generally have only a weak disinfecting capacity. They act against bacteria by removing the soils that support them. This is why a thorough cleaning usually ensures sufficient and good microbiological cleanliness but not complete disinfection. In some cases—for example when water is polluted or mechanical control of bacteria is not completely satisfactory—it is good to use a disinfectant solution, whether alone after cleaning or mixed with detergents that are called bactericidal detergents. The most effective and commonly used disinfectant products are chlorine based (bleach, chlorine products) or iodine based (iodophors).

Avoiding the use of household products that are not adapted to cleaning tanks is recommended. Suppliers who specialize in this area and who are able to recommend appropriate products should be sought. These suppliers can often provide information on the instructions and conditions for use.

5.1.3.2 Factors affecting cleaning efficacy

Efficacy is attributed to a combination of several factors:

Drinking water safety

Use of water when cleaning is essential. Water used for any cleaning procedure must be of good quality and available in sufficient quantity. Current quality standards for water must be observed. In the event that water is not supplied by a Distribution Board or the National Drinking Water Agency (ONEP), this water must undergo chlorination. Whether preventive or curative, treatment consists of adding bleach to the water to obtain a free-chlorine concentration (or residual chlorine) ranging between 0.2–2.0 mg/l. Kits are available for measuring chlorine concentration. The advantage of using chlorine compounds to disinfect water is their residual effect, i.e. that their disinfectant action continues throughout the distribution network.

Conditions of use

Cleaning conditions also affect the operation's final efficacy.

- Temperature: High temperatures improve cleaning but must be limited for some detergents. Cleaning methods performed at room temperature are used in collection centers where it is difficult to get hot water.
- Concentration of the detergent solution: This varies depending on the product, but in general, the supplier prescribes it. However, exceeding the prescribed dosage improves nothing in terms of efficacy.
- Mechanical action: Scrubbing should be vigorous, and water should be sprayed at high pressure to wash away any type of contamination.
- Operation's duration: Each method has a prescribed duration for contact. It can be a few minutes up to half an hour, depending on the case. It is useless to exceed the prescribed duration because this only wastes time.

5.1.3.3 Carrying out the process

Tanks may be cleaned manually or automatically. Even though the two operations have the same result when carried out correctly, the second has an advantage. By leaving out the human factor, it cannot be simplified or botched. The automatic cleaning system is more widespread throughout the world. This guide only focuses on the manual system, widely used in the collection centers of Morocco.

5.1.3.4 Cleaning phase

- **Pre-cleaning**

The first step is pre-cleaning the tank with cold water immediately after removing the milk. The drain valve is open at the start of the process and then alternated between open and closed. This pre-cleaning is necessary for eliminating solids deposited on the tank surface.

- **Washing-scrubbing**

While observing the prescribed concentration and temperature, the alkaline detergent solution is prepared in a bucket. While keeping the drain valve closed, the inside of the tank is scrubbed vigorously, moving from top to bottom. Cleaning should also include the agitator, the tank rim, the cover, and various accessories. The detergent solution is then emptied out while the drain valve is scrubbed and washed.

- **Rinsing**

Rinsing is done with sufficient fresh water. Unsafe drinking water is treated with bleach. This process involves adding approximately 15 ml of bleach at 12 chlorometric degrees in a 10-liter bucket full of water.

- **Acid cleaning**

This suboperation using acid is a substitute in place of alkaline cleaning. The procedure should follow the supplier's directions. This process eliminates the film of minerals that accumulate on the surface and resist alkaline cleaning.

5.1.4 Analyses and tests to run at receiving

Raw milk delivered to the collection center must be of sound, fair, and marketable quality; free of antibiotics; antiseptics; and colostrum. It must comply with quality standards as established by current legislation and by interprofessional agreements. The contract between producers and the dairy may provide for compliance with particular specifications.

To ensure that the milk complies with specifications, samples taken from the received lots must undergo inspections. Some analyses related to these inspections are done on the receiving platform, while others are done in the dairy laboratory covering the collection center. The collection center can refuse milk that does not meet the required standards.

5.1.4.1 Inspections on the receiving platform

This involves the necessarily quick inspections to check whether the milk has been tampered with or is contaminated.

Determining acidity

Results from this analysis can provide information on the degree of milk spoilage and indirectly on the microbial load in the analyzed milk. The analysis consists of titrating a milk sample using a calibrated alkaline solution. The result is often expressed in percentage of lactic acid.

Alcohol test

This is a quick test. First, 2–3 ml of milk are placed in a test tube, and then an equal volume of 70% ethanol solution is added. The tube is inverted two times and then checked for particles on the sides. The test is positive if these particles are present. In this case, the lot from which the sample was taken should be rejected. However, one must be careful because some good-quality milk can present a positive result on the alcohol test if it is rich in minerals and albumin.

Tests to detect possible watering down

To ensure that milk has not been fraudulently watered down, milk density is measured using a lactometer. If the reading is abnormally low, the milk may be rejected. However, it is advisable to run a confirmation test by determining the freezing point of a sample from the same lot. Reliable and quick tools are available for this purpose.

Normal milk must have:

- A density between 1.026 and 1.030
- A freezing point of -0.52°C

There are various types of lactodensimeters on the market, designed with a stem thermometer for taking the temperature during the reading. These instruments, which are officially calibrated, have a reading ranging from 1.020 and 1.040.

Equipment currently on the market used to determine the freezing point of milk directly displays the sample's freezing curve. The plateau of the curve indicating the cryogenic point is easily detected. The output read on a screen during a time lapse not exceeding 50 s is presented below.

Figure 6: Level indicating freezing point

Tests capable of assessing microbial load

Microbial growth in milk is accompanied by decreased oxidation-reduction potential. This change in the environment can be indicated using an appropriate indicator. Resazurin and mthylene blue are two indicators used for milk that rely on the basic principle of two simple and quick methods that assess the milk's microbiological quality. These tests require few supplies and almost no technical skills to conduct them. Poor quality milk is noted quickly. Therefore, these tests are suitable for collection centers.

Resazurin test

Resazurin is a color indicator showing a range of colors depending on the redox potential in the environment. The resazurin test can estimate the microbial activity of milk, and therefore, its initial microbial load.
To conduct this test, place 10 ml of milk and 1 ml of 5 mg/ml resazurin in a test tube. The tube is hermetically sealed and inverted one or two times to completely mix the milk and color indicator and then placed in a water bath at 37°C for ten minutes. The color is compared to a standardized range and noted on a scale of 0 to 6. Milk that is good quality will fall on the high end of the scale between 5 and 6. Milk with slight contamination will fall between 3 and 4 on the scale. Contaminated milk falls at the low end between 0, 1, and 2.

Methylene blue test

The methylene blue reduction test is the most frequently used test upstream in the production chain for bacteriological testing of raw milk. Its advantages include simplicity, reproducibility, low cost, and capacity to quickly detect milk of poor quality. This test is based on the basic principle stating that microorganisms that are active at 37°C and undergo aerobic growth in milk consume dissolved oxygen in milk. The methylene blue fades when the environment is depleted of oxygen.
The test is conducted as follows:

- Sterilize the tube in boiling water for five minutes
- Stir the milk and take a 10-ml sample
- Add the 10 ml of milk sample and 1 ml of methylene blue to the tube
- Invert the tube twice to mix well. Avoid mixing by shaking.
- Place the tube in a water-bath set at 37°C
- Invert the tubes every hour
- Take a reading after 2 hours, then after 4 hours if possible

The test is positive if there is discoloration.

5.1.4.2 Testing done in the laboratory

Three types of analysis that cannot be conducted at the collection center are sent to the dairy laboratory or a specialized private laboratory. These analyses deal with:

- Checking for signs of mastitis.
- Microbial contaminants. Identifying total flora, pathogenic flora, and coliforms should be conducted regularly.
- Chemical contaminants that come directly from cows. Antibiotic residues are often the main focus. The frequency of conducting these analyses depends on farmers' behavoirs. As with

checking for watering down of milk, checking for these substances makes it possible to identify less reputable farmers who require closer supervision.

- Indentifying various components of milk, specifically fat and protein content. Results of these analyses are useful when calculating the premium paid for high-quality milk. According to Moroccan regulations, milk with a fat concentration less than 30 g/l should be rejected.

5.1.5 Best practices

Table 11: Good hygiene practice in the collection center

Good hygiene practices	Suggested measures	Goal of measures
Keep records on each producer	o Keep a database of all producers o Feed analysis results into this database o Keep a list of high-risk producers	Focus on high-risk producers more
Avoid mixing milk presenting microbiological risk with healthy milk	o Conduct rigorous analyses on received milk o Refuse contaminated milk o Report results in the database	Prevent unnecessary losses
Reduce milk contamination by farmers and the public to a minimum	o Provide a reception area that is the only space accessible to the public o Provide a system for transfering milk to tanks. This system includes a tank of at least 100 liters, a pump, and flexible pipes o Prohibit producers access to other areas in the collection center	Maintain milk quality

Refuse any milk that fails to meet quality standards	o Take a representative sample from each drum received
	o Conduct rigorous routine analyses on each sample
	o Only accept lots that meet the following standards
	  o A density between 1.026 and 1.030
	  o Acidity between 14 to 16 D, or 0.14% to 0.16% lactic acid. The milk must produce a negative alcohol test result.
		Send only good quality milk to the plant

Prevent any physical risk	o Remove any foreign matter capable of causing a physical danger. This can be achieved by filtering the milk o Equip each tank with a filter with mesh of at least 2 mm	Maintain product quality

Inhibit the growth of microorganisms	o Require producers to deliver their milk no longer than 2 hours after milking o Cool down the milk to a temperature of approximately 4°C within 2 hours of receiving	Prevent milk spoilage
Maintain milk quality during refrigeration	o Activate the agitator at high speed to prevent partial freezing of the milk o Keep the tank covering closed when cooling down milk to prevent any intrusion of insects	
Observe hygienic condition in the center in accordance with cleaning procedures	o Clean the tanks and other equipment after the tanker truck that collects milk passes through o Clean the floor and the wall up to at least 2 m after collection. o Do a major cleaning of the center once per week. It is recommended to clean all surfaces that do not come into contact with milk. Dust off all refrigeration equipment, upper walls, and ceiling. Light fixtures should also be cleaned.	Prevent any cross contamination
Encourage staff working in the center to comply with hygiene standards	o Ensure that staff are in good health o Also ensure that staff maintain personal hygiene and wear clean clothing in accordance with the prerequisites of the HACCP program o Wash hands before and after receiving milk whenever necessary	Prevent any cross contamination

6. BEST PRACTICES IN THE TRANSPORT LINK

Transporting milk from the collection center to the dairy is the final upstream link in the milk production chain. The processing plant takes on the responsibility for the overall quality of the milk after it has left the collection center. The tanker truck that will collect the milk from the various centers is specially equipped with a pumping mechanism, often operated under vacuum. This guide will only focus on safety and hygiene aspects during transport. All other aspects related to equipment and the technical characteristics of cisterns have been left out.

During the transport operation:

- Samples are taken in accordance with regulations, and routine tests are conducted in accordance with duly established procedures
- Appropriate measures are taken during transport so that the raw milk carried between the collection center and dairy are not subject to spoilage that degrades its quality
- Optimal technical and hygienic conditions are observed when raw milk is received at the plant
- Equipment and any surfaces in contact with the milk are cleaned effectively. As indicated above, cleaning must be done in accordance with well-established procedures. Information on the types of cleaning and disinfectant products to use and the time needed for precleaning, cleaning, and rinsing as well as the temperature conditions must all figure into these procedures. Water quality must meet current regulations.

6.1 STAFF IN CHARGE OF TRANSPORT

Transport involves a series of tasks that must be done correctly. Taking the sample, conducting tests, and filling out the delivery slips accompanying the cistern shall be entrusted to one sole person with recognized qualifications. Whether it is the pickup driver or the sampler (the job title currently used in the milk sector), these are people hold jobs that should be recognized. They must uphold certification granted by a body specializing in training in the milk sector. When transport is outsourced and the driver is an employee of the company providing the service, it is recommended that the sampler be a dairy employee.

6.2 INSPECTION AND TASKS

The collection system must be optimized so that milk quality is not compromised. Quality control of collection center output involves taking samples that will be analyzed later at the factory and running a series of tests detailed below:

6.2.1 Gauging the tanks

When the cistern arrives, it is taken for gauging to determine the volume of milk collected at the center.

6.2.2 Visual inspection

The pickup driver or the sampler does a visual check of the milk in the refrigerated tank. The color, odor, and the presence of foreign bodies are noted. In case the odor or appearance of the milk do not meet standards or if bodies that can react with the milk are present, the decision to reject it must be reported.

6.2.3 Measuring the temperature

One test to conduct before pumping is measuring the temperature. The controller must measure the temperature of the milk using a calibrated probe beforehand. This temperature must be between 4°C and 6°C. The value found must be compared to that indicated by the dial thermometer installed on the tank. Any discrepancy must be reported.

Milk at a temperature between 6°C and 10°C can become contaminated given that, in some cases, the time between milking and collection is too short to allow the milk to cool down below 6°C. Currently, the collection trucks may be equipped with a system that controls pumping through a temperature probe. The system is programmed to automatically stop the truck's pump when the milk's temperature exceeds 10°C. The pump can only be rebooted through manual intervention by the driver.

6.2.4 Alcohol test

A final sample is taken to conduct an immediate alcohol test. If the milk meets standards, the cistern of milk is connected to the tank and pumping begins.

6.3 BEST PRACTICES

Table 12: Best practices related to transport

Good Hygiene Practices	Proposed Measures	Objective of Measures
Follow an appropriate quality management program	• Follow pre-established procedures for taking and storing samples • Conduct analysis testing before pumping in accordance with existing hygiene rules • Clean the cisterns following cleaning procedures established by the dairy	Prevent any contamination
Prevent cross	• For transport, only use cisterns	Maintain milk quality

contamination during transport	specifically intended for transporting raw milk • Cisterns must be clearly labeled, indicating that they can only be used for transporting food products • Encourage staff in charge of collection to comply with personal hygiene standards and dress codes as prescribed in the prerequisites of the HACCP program. Prohibit staff from smoking, eating, and drinking when handling collection equipment and during transfer operations, unloading, and cleaning	
Ensure the safety of staff responsible for collection during handling and operations on top of cisterns, sampling milk in each compartment, external cleaning of cisterns, and checking cleanliness inside cisterns and of washing balls	• Equip cisterns with a passageway to access covers, equipped with a guardrail or a catwalk, accessible with a ladder	
Prevent any tampering with milk during transport	• Equip trailers and semi-trailers used for transporting raw milk with a system that shows the cistern from all angles • Prevent any unauthorized person from having access to raw milk • If a seal is used, it must be checked before unloading	
Maintain an uninterrupted cold chain	• Take the necessary precautions to ensure the temperature of the milk during transport stays below the limit set by legal standards	Maintain quality. When transporting over a longer distance in isolated cisterns, temperature measurements have shown that the temperature rises approximately 2°C over a distance of 250 km.