



USAID | **KOSOVO**
NGA POPULLI AMERIKAN
OD AMERIČKOG NARODA

IMPROVING GOOD MANUFACTURING PRACTICES (GMP) WITHIN THE KOSOVO DAIRY INDUSTRY

KOSOVO CLUSTER AND BUSINESS SUPPORT PROJECT



September 15, 2005

This publication was produced for review by the United States Agency for International Development. It was prepared by the KCBS project team of Chemonics International Inc. based on a Final Report prepared by Short Term Technical Advisor, Arturo Inda Cunningham.

IMPROVING GOOD MANUFACTURING PRACTICES (GMP) WITHIN THE KOSOVO DAIRY INDUSTRY

FOOD SAFETY PRACTICES AND NEW PRODUCT DEVELOPMENT
FOR THE KOSOVO DAIRY INDUSTRY: CHALLENGES AND
OPPORTUNITIES

Kosovo Cluster and Business Support project Improving Good Manufacturing Practices (GMP) within the Kosovo Dairy Industry
Contract No. AFP-I-00-03-00030-00, TO #800

This report submitted by Chemonics International Inc. / September 14, 2005

The author's views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

CONTENTS

PURPOSE OF ASSIGNMENT.....	1
BACKGROUND	1
EXECUTIVE SUMMARY	3
FIELD ACTIVITIES TO ACHIEVE PURPOSES	4
TASK FINDINGS AND RECOMMENDATIONS	7
CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE ACTIVITY	9
ANNEXES.....	11

PURPOSE OF ASSIGNMENT

The purpose of the assignment was: to develop grades and standards regulations on all aspects of dairy products including chemical, physical, and microbiological criteria, as well as percentage of ingredients, consistency, storage time, etc. Any aspect of testing, handling and production that can affect the final dairy product should be written into the regulations, which will be entirely based on EU regulations, thus making the dairy products produced in Kosovo meet the same standards as imported products from the EU.

Increased Production of High Quality Dairy Products. Increase the production of high quality dairy products by introducing ISO 9000 certification or HACCP at the dairy plants to ensure proper milking and milk handling practices, storage and transportation of milk.

Quality Value-adding Processing. Training in better management of the milk processing plant to increase profitability for processors in the form of improved quality products commanding higher prices in the domestic and international market. This can be assisted by the implementation of an ISO 9000 plan to help the dairy processors to reduce costs, improve quality and ensure consistent quality.

BACKGROUND

The Kosovo dairy sector is poised to take a giant step forward in the increased production of high quality milk. This production must be accompanied by the manufacturing and marketing of high quality dairy products. The dairy sector is a prime example of how an industry must progress in terms of technology and management systems or be left behind in the world market. To launch the dairy industry in Kosovo to the next level of competitiveness, a focused approach that introduces technology and modern management techniques to the dairy processor is critical.

Kosovo and Slovenia are both major milk-producing countries with similar climate and geographic characteristics. However, Slovenia produced more than 500 million liters of milk in 2003, and all of this goes to dairy processors. They then export their high quality dairy products through out the region.

Kosovo is just the opposite. Most of the milk is sold directly from the farmer into the markets and Kosovo produces only about 10% of its dairy product needs. In addition, there is excess farm production of milk during the summer months. Dairy processors buy this extra milk at very low prices, and use it to produce more yogurt and cheese than the market can handle. This benefits the consumer with low priced dairy products; however, this ultimately reduces farm income.

The difference between the two national industries is a question of operational scale and level of technology. As much as 85 percent of Slovenia's raw milk production is processed by industrial dairy processing plants. In Kosovo, the proportion of raw milk flowing through industrial processors is about 9-12 percent. Normally in Kosovo the milk is sold at ambient temperatures, and much of this milk is processed by small-capacity dairy processing plants. This situation in Kosovo is not unlike Slovenia 30 years ago... or the US and the EU collection centers, developed financially strong and commercially viable farming units.

At this time, there is little or no local production of Grade "A" quality raw milk and Grade "A" quality processed dairy products. Production of raw milk at Grade "A" quality level is the most fundamental step needed to improve the Kosovo dairy industry, but without

corresponding improvements in the way dairy companies process the milk, the economic benefits of farm level improvement will be impaired. Stronger demand created by improved quality will be the foundation for the industry's sustainability and future growth. This can only be accomplished by the following:

- Specific recommendations for the regulations on each product and its characteristics, largely based on EU regulations.
- Specific recommendations for additional KCBS intervention at the dairy processor level that will help them produce a better product for the consumers and help them increase their profitability, thus increasing their own demand and profitability.
- Work with two dairy processors to determine their production capabilities and to design a strategy to implement an ISO 9000 and/or HAACP system.
- Make recommendations to the Kosovo Dairy Industry Association to improve dairy processing, purchasing of inputs and marketing thus making the industry more competitive in the world market through the use of ISO 9000 and HACCP systems.

EXECUTIVE SUMMARY

Work was done with **S&R** Products and **ABI** Food Industry to assess compliance with Good Manufacturing Practices (GMP), whereby it became clear that any work towards implementing HACCP or ISO was premature and counterproductive, since the required foundations were not in place. Consequently, the purpose of the assignment was modified, to place emphasis on improvement of GMP and on increased profitability through the manufacture of new products having high local demand.

To that effect, two products were made in both plants: Low-Moisture Part-Skim Mozzarella cheese from 2.7% fat milk, and Ricotta cheeses from mixtures of Mozzarella cheese whey and whole milk. Yields of Mozzarella and Ricotta cheeses were as expected, and the products were evaluated regarding sensory properties by the attendants to a Seminar on August 18, 2005, at KCBS. In addition, Ricotta whey lemonade was prepared at **S&R** Products Company.

Typical conditions regarding lack of compliance with GMP were: defective pasteurizers, absence of recording thermometers, food additives in unlabeled containers, use of wooden materials entering into contact with the food, lamps with no protective covers, hoses lying on the floor; personnel not wearing appropriate garments and footwear for working in a food processing plant, and not trained in GMP, and no enforcement of hygienic practices. In addition, production personnel have experience in cheese making, but lack scientific and technological training regarding the meaning of what they do.

The QAP Training Center in Pejë was visited in order to assess its facilities and capabilities. It has most of the equipment and laboratory instrumentation needed for training in fundamental dairy processing science and technology. Its shortcomings are that it does not have a well-equipped classroom, nor a well-suited library, and that it is practically unknown by its potential users. With improvements, the Center could be used for training trainers, operators, supervisors, laboratory technicians, dairy technologists, and plant managers, not only in dairy processing but in HACCP and ISO as well.

The main finding was that the two processing plants mentioned above are far from complying with GMP. However, they are licensed to operate by the Kosovo Veterinary and Food Agency, which points to the complex economic, social, and political issues underlying the interrelations between standards, food safety legislation, food security, milk production, employment, and competitiveness.

The most important recommendations for the dairy processing industry were: a) working with milk producers, to improve milk quality and quantity, together, in win-win relationships, b) improve compliance with GMP, c) train everyone in fundamentals of dairy processing science and technology, and d) when the proper time arrives, adopt HACCP and ISO. It is also recommended that the dairy processing industry receives training in novel cheese-making technologies.

Finally, it is recommended that the Kosovo Cluster and Business Support Project (KCBS) negotiates formal agreements with the dairy processing companies for implementing compliance with GMP within a reasonable time, whereby the companies commit themselves to make investments for improvement, and to train employees, including managers, while KCBS makes a commitment of providing support for training and follow-up. A reasonable time horizon for compliance with GMP is of the order of one to three years and, afterwards, work should begin to implement HACCP and ISO.

FIELD ACTIVITIES TO ACHIEVE PURPOSES

IV.1. S&R Products Company, Ferizaj (RONA[®] Brand Products)

Zijadin Gojnovci and myself visited this plant, which processes 6,000 – 8,000 liters of milk per day, on August 3, 4, 15, and 16, 2005. Inspection tours were made of the plant and its premises, to assess compliance with current Good Manufacturing Practices (GMP), and Zijadin Gojnovci took photographs. It became immediately clear that any work towards implementing HACCP (forming the HACCP team, making process flowcharts, describing the product and its end uses, etc.) or ISO 9001-2000 was premature and most likely counterproductive as well, since the required foundations are not in place. Consequently, the purpose of the assignment was modified, to place emphasis on improvement of Good Manufacturing Practices and on increased profitability through the manufacture of new products having high local demand.

To that effect, Low-Moisture Part-Skim Mozzarella cheese was made on August 04, 2005, and, on August 16, the following products were made: Low-Moisture Part-Skim Mozzarella cheese from 200 liters of 2.7% fat milk (using Chr. Hansen's TCC4 thermophilic culture), Ricotta cheese (from a mixture of 160 liters of Mozzarella cheese whey and 40 liters of whole milk), and Ricotta whey lemonade (10 liters, as a demonstration). Yields of Mozzarella and Ricotta cheeses were as expected (Annexes II and III), and they were evaluated regarding sensory properties by the attendants to a Seminar on August 18, 2005, at KCBS. Annex IV shows the forms used for the sensory evaluation of both cheeses. Ricotta whey lemonade was evaluated informally.

Comments on some conditions regarding Good Manufacturing Practices:

1. The “pasteurizer” has a holding time of about 5 seconds, and the heated milk (72°C) is then pumped to a holding tank, from which it is later pumped through a heat exchanger, to be cooled to the cheese-making temperature (35°C, for example). Hence, this is not a true HTST Pasteurizer, in which thermal treatment is 72°C/16 s. Here, milk can be either under-pasteurized, or over-pasteurized; in the first case this would be a food safety concern and, in the second, it would be a cheese quality concern, due to unwarranted variation in both texture and composition.
2. The calcium chloride container had no label, and thus no one at the plant knew the brand, the manufacturer, or the concentration.
3. The rennet used, “TOPLICANKA” Brand, had a declared strength on the label of 1:5,000 (1 liter per 5,000 liters of milk). However, its true strength was of the order of 1:400.
4. The plant does not have a moisture balance, to determine the moisture content of the cheeses it produces.
5. There is extensive use of wooden utensils, which enter into contact with the milk, after pasteurization.
6. The lamps in the ceiling have no protective covers.
7. There are very frequent electric power outages, and the plant does not have an electricity generator.

8. Production personnel do not wear appropriate garments and footwear for working in a food processing plant, they are not trained in GMP, and there is no enforcement or supervision of basic hygienic practices.
9. Hoses and various other materials are usually lying on the floor.
10. Production personnel have much experience in making the cheeses they make, but lack basic scientific and technological training regarding the meaning of what they do, from measuring titratable acidity to predicting cheese yield based on milk composition.
11. The plant does not comply with GMP, but a 4-hour meeting was held with the Director, to discuss the fundamentals of HACCP and ISO9001-2000 in some detail, including the reasoning behind the requisite that GMP are in full compliance before working on implementing HACCP, actions to be taken, expected time horizons, and the benefits of eventually having HACCP and ISO in place. The main purpose of this meeting was to increase awareness.

IV.2. ABI & ELIF19 Food Industry, Prizren

Zijadin Gojnovci and myself visited this plant, which processes ~30,000 liters of milk per day, on August 5, 8, 11, 12, and 13, 2005. Inspection tours were made of the plant and its premises, to assess compliance with current Good Manufacturing Practices (GMP), and Zijadin Gojnovci took photographs. It became immediately clear that any work towards implementing HACCP (forming the HACCP team, making process flowcharts, describing the product and its end uses, etc.) or ISO 9001-2000 was premature and most likely counterproductive as well, since the required foundations are not in place. Consequently, the purpose of the assignment was modified, to place emphasis on improvement of Good Manufacturing Practices and on increased profitability through the manufacture of new products having high local demand.

To that effect, on August 12, the following products were made: Low-Moisture Part-Skim Mozzarella cheese from 500 liters of 2.7% fat milk (using Chr. Hansen's TCC4 thermophilic culture), and Ricotta cheese (from a mixture of 160 liters of Mozzarella cheese whey and 20 liters of whole milk). Yields of Mozzarella and Ricotta cheeses were as expected (Annexes II and III), and the products were evaluated regarding sensory properties by the attendants to a Seminar on August 18, 2005, at KCBS. This plant's range of products can be seen in www.abimilk.com.

It is very important to take notice that ABI produces a fermented whey drink, called **K U M Ě S H T Ě**, **Pije freskuese prej qumështit të pasterizuar** (Refreshing, pasteurized, dairy drink), which is sold in supermarkets at 0.77 euros per 2-liter bottle. This is an excellent example for other dairy foods processors to follow, in devising innovative ways to use whey as the main ingredient for value-added foods and beverages.

Comments on some conditions regarding Good Manufacturing Practices:

1. The pasteurizer's gaskets are worn out, and milk spills on the floor from the free spaces between adjacent plates. Furthermore, temperature cannot be controlled, and the recording thermometer is out of order.
2. The pH meter in the laboratory is not calibrated as often as it should, there are no calibrating solutions in the laboratory, and the operating and calibration manual is missing.

3. The plant does not have a moisture balance, to determine the moisture content of the cheeses it produces.
4. There is extensive use of wooden utensils, which enter into contact with the milk, after pasteurization.
5. The lamps in the ceiling have no protective covers.
6. Hoses and various other materials are usually lying on the floor.
7. Production personnel do not wear appropriate garments and footwear for working in a food processing plant, they are not trained on GMP, and there is no enforcement or supervision of basic hygienic practices.
8. Production personnel have much experience in making the cheeses they make, but lack basic scientific and technological training regarding the meaning of what they do, from measuring titratable acidity to predicting cheese yield based on milk composition.
9. The plant does not comply with GMP, but a 2-hour meeting was held with the Manager, on August 13, to discuss the fundamentals of HACCP and ISO9001-2000 in some detail, including the reasoning behind the requisite that GMP are in full compliance before working on implementing HACCP, actions to be taken, expected time horizons, and the benefits of eventually having HACCP and ISO in place. The main purpose of this meeting was to increase awareness.

IV.3. QENDRA E AFTËSIMIT PROFESIONAL (QAP) Training Center, Pejë

The QENDRA E AFTËSIMIT PROFESIONAL (QAP) Dairy, Fruits, and Vegetables Processing Training Center, in Pejë, was visited on August 19, 2005, following a meeting at the KCBS office in Pristina on August 18, with Richard O'Sullivan, Senior Competitiveness & Association Advisor, and Ms. Sevdije Muhaxheri, the Center Director, among others. The KCBS party visiting the Center consisted of Zijadin Gojnovci, Mentor Thaqi, and Arturo Inda.

The Center is housed - temporarily - in a building that was not designed as a training facility; some rooms have been adapted to serve various functions (laboratories, classroom, processing room, etc.). In this regard, it is worth noting that, in the dairy foods processing area, the ceilings are wooden, the floor is not sloped, and it has no central drain. On the other hand, the laboratories, for both physical-chemical and microbiological analyses, are quite well equipped.

For cheese-making, the Center has a stainless steel batch pasteurizer-vat (capacity 200 liters, circular shape, milk heated through a water jacket, water heated using a gas burner), cheese knives, various types of hoops, stainless steel work tables, refrigerated storage, aging/ripening room, incubator, etc. The pasteurizer-vat can also be used for the manufacture of yoghurt, ayran, and other fermented milk products. They can currently make 10 different kinds of cheese.

Altogether, the Training Center has nearly all the equipment and laboratory instrumentation needed for training (groups of up to 20 persons) people in the fundamentals of dairy processing science and technology. The equipment and instrumentation for this center were donated by a Brescia (Italy) organization.

I believe the training center has some shortcomings: there are no appropriate facilities for attending lectures and conferences, watching videos or DVD, etc. (a well-equipped classroom), and there are no books, journals, or manuals for the trainees (a reasonably well suited library and reading room, including one or two computers, a printer, and a photocopying machine). Also, according to the Center Director, the Center seems to be practically unknown outside Pejë.

With a better classroom, a basic library, and basic public relations and promotion activities, the Center could be used successfully for training trainers and for training operators, production supervisors, laboratory technicians, dairy technologists, and plant managers, from all dairy-processing companies in Kosovo, not only in dairy processing science and technology but in HACCP and ISO as well.

TASK FINDINGS AND RECOMMENDATIONS

The main finding was that the two processing plants mentioned above are far from complying in full with current Good Manufacturing Practices (GMP), the group of criteria and operational definitions that are used to determine whether a food is adulterated, whether it has been manufactured under such conditions that it is unfit for human consumption, or whether it has been prepared, packed, or held under unsanitary conditions so it may have become contaminated, or otherwise rendered injurious to health.

In one form or another, nearly every country has the equivalent of Good Manufacturing Practices in its public health regulations. This is pointed out here only to underline the fact that complying with basic GMP is a legal obligation. Nevertheless, these plants are licensed to operate by the Kosovo Veterinary and Food Agency (Ministry of Agriculture, Forestry and Rural Development), which points to the complex economic, social, and political issues underlying the interrelations between standards, food safety legislation, food security, milk production, employment, and competitiveness. As a direct consequence of lack of compliance with GMP, working now with these plants on HACCP and ISO is premature, and, most likely, counterproductive as well, since the required foundations are not in place.

For illustration purposes, below is a partial list of the most important GMP which **were not** observed to be practiced, according to standard, in one or both plants, during the work with the two dairy foods processing companies. For purposes of clarity, GMP have been divided here, as they usually are, into several categories: Personnel, Buildings and Facilities, Equipment, and Production and Process Controls.

PERSONNEL

(a) Cleanliness, including hygienic practices, proper outer garments, proper footwear, and personal cleanliness.

(b) Education and training. Everyone should have the level of competency necessary for production of clean and safe food.

(c) Supervision. Responsibility for the production of food should be given to competent supervisory personnel.

BUILDINGS AND FACILITIES

(a) Plant and grounds, including plant construction and design, equipment storage, waste disposal, and pest control, should enhance food safety.

(b) Sanitary operations should be the routine order of the day, including proper handling and use of cleaning and sanitizing chemicals.

(c) Sanitary facilities and controls, including water supply, toilet facilities, hand washing facilities, plumbing, floor drainage, sanitary traps, and sewer disposal, should be such that opportunities for producing unsafe food are minimized.

EQUIPMENT

(a) Equipment and utensils should be designed and of such materials and workmanship as to be adequately cleanable, and properly maintained.

(b) Instruments for measuring and recording acidity, temperature, pH, etc. should be accurate (calibration), precise, and well maintained.

(c) Holding, conveying, and manufacturing systems should be of such design and construction that enables them to be maintained in an appropriate sanitary condition.

PRODUCTION AND PROCESS CONTROLS

(a) Processes and controls. All operations (receiving, inspecting, transporting, preparing, manufacturing, packaging, and storing of food) should be conducted according to adequate sanitation principles. This includes inspection and storage of raw materials.

(b) Equipment, utensils and food containers should be maintained in an acceptable condition, through appropriate cleaning and sanitizing procedures.

(c) Storage and transportation of food should be done under conditions that will protect the food against physical, chemical, and microbial contamination as well as against deterioration of the food and the container.

The main recommendation, regarding dairy processing plants, is for KCBS to negotiate a *formal* agreement with the owners of both factories, S&R and ABI, and perhaps with those of some other milk processing factories as well (AMPCO members such as Devolli, Frutti, Bylmeti, Ajka, Diti, Kabi, and Pet Plus), in case one or more of those other plants are operating under similar conditions, for implementing compliance with current GMP within a reasonable time horizon, whereby the owners commit themselves to make the necessary investments for improvement, and to train all employees, *including plant managers*, while KCBS makes a commitment of providing reasonable support for training and follow-up activities.

Such agreement could be bilateral, between KCBS and each selected company, or between KCBS and AMPCO. A reasonable time horizon is of the order of one to three years (depending on the findings of a formal audit on compliance with GMP, the size and complexity of the facilities, and the financial situation of the companies).

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE ACTIVITY

At the Seminar “*Food Safety Practices and New Product Development for the Kosovo Dairy Industry: Challenges and Opportunities*”, on August 18, 2005, in the KCBS Conference Room, a summary of the work was presented, and the following conclusions and recommendations were discussed with members of the audience:

To assure the production and sale of safe dairy foods, to obtain better cheese yields, at less cost and with more consistent product quality (less variation), all of which lead to better competitive position, the most important conclusions and recommendations are:

1. Work with milk producers, to improve milk quality and quantity, together, engaging always in win-win relationships. If there is a will, there are many ways, such as designing and implementing together milk-payment schemes based on quality, providing milk producers with feed bought at wholesale prices, granting soft loans for investment in milk receiving and cooling stations, to be paid back from deductions in milk payment over reasonable time periods, etc. Although the current predominant relationship seems to be one between adversaries, as it is commonly found in most other countries, there are examples everywhere of mutual substantial benefits when barriers against working in cooperation towards shared ends are demolished.

2. Improve compliance with GMP, steadily, continuously. Both S&R Products Company and ABI & ELIF19 Food Industry are far from compliance.

3. Train everyone, in fundamentals of dairy processing science and technology. No evidence of formal training was observed. People have experience in cheese-making, but little knowledge of the scientific and technological aspects of the business. To this end, design and implement a cooperation agreement with the QAP Training Center in Pejë.

4. Adopt a preventative food safety system (HACCP). Since the Hazard Analysis and Critical Control Points system builds on full compliance with GMP, initiating HACCP activities is some years into the future. When the proper time arrives, train everyone.

5. Adopt a quality management system (ISO). ISO can be implemented before, after, or simultaneously with HACCP. As an example of the latter case, the **SQF** system (**Safe and Quality Food**, a methodology owned by the Food Marketing Institute, Chicago, IL) could be considered as an alternative. However, it is crucial that the plants comply with GMP before beginning work towards this end, and thus ISO certification is also some years into the future. Again, when the proper time arrives, everyone should be trained.

Reasonable time horizons for these stages are the following:

- **Good Manufacturing Practices**. One to three years, and 80% - 90% of the total monetary investment in food safety and quality systems.
- **Hazard Analysis and Critical Control Points**. One to two years, and moderate amounts of investment. HACCP builds on GMP, necessarily.
- **ISO certification**. One to two years, and moderate money investment. Implementing a quality management system can be done before, after or simultaneously with implementing HACCP, but it is perhaps better to do it afterwards.

The road to HACCP and ISO will lead to great business success in time, but it takes *constancy of purpose, commitment, working with milk producers to improve milk quality and quantity, clear goals, constant learning, and patience*. Progress is measured in years.

6. Train the dairy foods processing industry in novel cheese-making technologies, such as special milk thermal treatments and cheese-making procedures, based on controlled whey protein thermal denaturation, for the manufacture of high-yield, high-moisture, reduced-syneresis cheeses. This technology can be used in the manufacture of the typical white cheeses of the region.

ANNEXES

- Annex I – List of Contacts and Site Visits Made
- Annex II -Monograph on Manufacture of Low-Moisture Part-Skim Mozzarella Cheese, for Use in Pizzas
- Annex III - Monograph on Manufacture of Ricotta Cheese from Mozzarella Cheese Whey and Milk, and Drinks from Ricotta Residual Whey and Fruit Juices
- Annex IV – Sensory Evaluation Form for Cheese and Pizza

ANNEX I: List of Contacts and Site Visits Made

1. **Ajvazi, Skifter.** Director. S&R Products Company, RONA[®] Brand. Ferizaj.
2. **Bytyqi, Kasim.** Agriculture Land Use Officer. Kosovo Trust Agency. Pristina.
3. **Fusha, Irfan.** Manager, ABI & ELIF19 Food Industry, Prizren.
4. **Kokarev, Vladimir.** Fruit and Vegetables Specialist. Macedonia Agribusiness Marketing Activity. Land O'Lakes, Inc., Skopje, Macedonia.
5. **Members,** Kosovo Association of Milk Producers (**KAMP**). Pristina.
6. **Muhaxheri, Sevdije.** Director. QENDRA E AFTËSIMIT PROFESIONAL (QAP) Training Center in Fruits, Vegetables, and Dairy Foods Processing. Pejë.
7. **Oldham, Peter.** Policy Advisor. Kosovo Ministry of Agriculture, Forestry and Rural Development. Pristina.
8. **Purrini, Ardian.** Chief, Food Hygiene Sector. Kosovo Veterinary and Food Agency (Ministry of Agriculture, Forestry and Rural Development). Pristina.
9. **Rozanaj, Fari.** Technologist. ABI & ELIF19 Food Industry, Prizren.
10. **Shahini, Remzi.** Co-owner, S&R Products Company, RONA[®] Brand, Ferizaj.
11. **Uka, Kutjim.** Chief, Veterinary Drugs and Residue Section. Kosovo Veterinary and Food Agency (Ministry of Agriculture, Forestry and Rural Development). Pristina.

ANNEX II: Monograph on Manufacture of Low-Moisture Part-Skim Mozzarella Cheese, for Use in Pizzas

Improved version of the handout given to attendants to the August 18 presentation at KCBS.

MANUFACTURE OF LOW-MOISTURE PART-SKIM MOZZARELLA CHEESE FOR USE IN PIZZAS

I. INTRODUCTION

Mozzarella cheese is one of several types of *pasta filata* cheeses of Italian origin in which the curd is heated to a molten state and stretched before being molded into the desired shape. Kaçkavall (*Cacciocavallo* in the original Italian) and Provolone are cheeses of the same family. Although originally done by hand, stretching the molten cheese is now done in industry by single-screw or twin-screw stretcher-cookers.

Low moisture (49%), part-skim Mozzarella cheese for use in pizzas is made from standardized cow's milk containing 2.6–2.7% fat, which corresponds to the optimal value of casein/fat ratio, 0.9, for this type of cheese. The expected yield is ~10-11 kg of cheese, with ~1.5% salt, per 100 kg of milk containing ~2.7% fat. The most important functional characteristics of low-moisture part-skim Mozzarella cheese are: a) "*shreddability*", b) unmelted cheese "*string*" formation (called "*chicken breast*" texture in the industry), "*meltability*", "*stretchability*", "*oiling-off*", non-enzymatic browning during pizza baking, and post-baking appearance and "*chewiness*". Flavor should be clean and relatively bland.

II. MANUFACTURING PROCEDURE

II.1. Pretreatment of milk.

Cheese-milk must first be clarified (centrifuged, to eliminate foreign solid matter, or at least strained through a fine cheese-cloth), separated and standardized. These operations must be followed by proper pasteurization, either **HTST** (High Temperature Short Time), 72°C for 16 seconds, in continuous equipment or vat pasteurization (65°C for 30 minutes), in batches. The pasteurized milk is then immediately (as soon as possible) cooled to 36 - 38°C, and pumped to the cheese-making vat.

Calcium chloride solution is then added to replace some calcium lost during pasteurization. This salt assists in coagulation, providing proper curd firmness, and reducing the amount of rennet otherwise required. It is normally added to milk at a rate of 0.02% (20 g per 100 kg of milk), *on the basis of pure calcium chloride*. The amount of calcium chloride *solution* to be added depends on the concentration of the commercial solution. Before addition to the cheese-milk, the calcium chloride solution should be diluted, ten times or so, in potable water.

II.2. Lactic acid culture ("Starter").

Mozzarella cheese-making relies on the fermentation of milk lactose by specific (designed for Mozzarella cheese) lactic acid bacteria (LAB) cultures, which lower pH, assist coagulation, promote syneresis, help prevent spoilage and pathogenic bacteria from growing, and contribute to cheese texture, flavor and shelf life. Mozzarella cheese is usually made with cultures containing *L. bulgaricus* (or *L. helveticus*) and *S. thermophilus*. After

inoculation with the starter culture, usually a freeze-dried, Direct-To-Vat culture, the milk is held for 30 to 45 min at 36 to 38°C to ensure bacteria are active and have developed acidity. This step is called “*ripening*” the milk and is done before adding the rennet. Proper culture activity can be verified either by a drop in pH of 0.1 – 0.2 units, or by an increase of 0.1 - 0.3% in titratable acidity.

II.3. Renneting (Milk coagulation).

Renneting is the formation of a gel, by destabilizing the casein micelles through the action of rennet (“*chymosin*”), causing them to aggregate and form a network (curd), which partially immobilizes water and traps the milk-fat globules in the matrix. Enough liquid rennet preparation is added to milk after “*ripening*” in order for coagulation to take place in about 30-40 minutes. Commercial liquid rennet preparations vary in “*strength*”, from 1:5,000 (one part in 5,000 parts of milk) to 1:60,000. They should be diluted, by a factor of 10 to 40, depending on strength, just before they are added to milk, in potable – *but chlorine-free* – water. The higher the strength of the rennet preparation is, the higher the degree of dilution. Commercial powder preparations must also be diluted in water, according to the instructions on the label. Milk must be stirred continuously while slowly adding the rennet preparation, and stirred further during 2–3 minutes after rennet addition, to assure uniform distribution of rennet in milk.

II.4. Curd treatment.

After the milk gel has been allowed to reach the desired firmness, it is carefully cut into small pieces (about 1.5 cm x 1.5 cm x 1.5 cm) with knife blades or wires. This increases geometrically the available area for whey release, and the curd particles immediately begin to expel whey and shrink.

The cut curd must be left quiescent (still, without stirring) during about 15 minutes, so that enough whey is expelled for the curd particles to acquire minimum mechanical strength so they can later be stirred gently without excessive breakage (breakage leads to the formation of “*cheese fines*”, a loss of yield). This waiting period is called “*curd healing*”. This syneresis process is further driven by a heating and stirring (“*cooking*”) stage.

Temperature is increased about 3°C (from 36-38°C to 39-41°C), at a rate *no faster* than 1°C per minute, while continuously stirring the mixture of whey and cut curd, very slowly at the beginning, and gradually at higher rate as the curd becomes firmer and firmer. Once the final temperature is achieved, the steam valve to the vat jacket is closed, and stirring continues until the curd achieves the desired texture (moisture content).

The increase in temperature causes the protein matrix to shrink, and also causes an increase in the rate of lactose fermentation. The increased acidity, in turn, contributes to shrinkage of the curd particles. The final moisture content of cheese depends to a significant extent on the time and temperature of the “*cooking*” stage.

II.5 Whey drawing and “Cheddaring”.

Whey is totally withdrawn (drained) from the vat when pH reaches 6.2 – 6.1. The cheese curd is then put together, in one pile against one side of the vat, where it will mat as further acidity develops. The matted mass of cheese curd is cut into “*loaves*” every 15 minutes or so, and these “*loaves*” turned upside down, with the purpose of keeping temperature (and thus bacterial growth and acid development) as uniform as possible throughout the curd mass. This process is called “*Cheddaring*”.

Acid production during “*Cheddaring*” allows the curd to reach a pH of 5.2, where proper curd demineralization, or calcium loss, for Mozzarella cheese occurs. In the vicinity of pH 5.2, calcium bridging in the casein matrix is reduced, thus allowing protein “*fibers*” to stretch. Besides pH, titratable acidity and the “*hot-water stretch test*” can be used successfully to

determine when the cheese has the proper texture and is ready to be processed in the stretching machine (finely cut and stretched in hot brine or hot water).

As soon as pH reaches 5.2, the rate of acid development must be reduced so that the pH of the final cheese is not below 5.1. Thus, controlling pH controls the level of residual calcium in the cheese; the lower the pH the lower the calcium content of the cheese, and vice versa.

II.6. Cutting, stretching, and salting.

At pH 5.2, the cheese is cut into small pieces by a rotating knife attached to the stretching machine and fed into the hot (68 to 72°C) brine or water in the machine. Stretching causes an alignment of the chains of casein micelles into long filaments ("*fibers*") that provide "*stringiness*" to the cheese.

Interactions between temperature and screw speed during stretching influence not only the formation of a "*stringy*" structure but also the state of dispersion of fat throughout the cheese structure. The latter is very important in the control of melting and "*oiling off*". If the fat is entrapped within the protein matrix as large size droplets, then too much free oil may be released during pizza baking.

When stretching, at cheese exit temperatures of 63 to 67°C, the speed of the screws needs to be rather fast, to avoid high fat loss. This helps keep the fat dispersed in smaller size droplets throughout the structure of the cheese, so that it will tend to "*oil-off*" less during pizza baking. The protein "*fibers*" of cheese stretched as described above will have the potential to be very "*stringy*". Since composition and temperature of the cheese entering the mixer vary, the residence time and final temperature of the cheese will vary, unless stretching conditions are adjusted to compensate. Hence, the more consistent the input cheese composition and temperature, the more consistent stretching will be.

Low-moisture part-skim Mozzarella cheese can be salted in various ways (dry salting, brine salting, and salting during stretching). Since Kosovo Kaçkavall cheese is salted during stretching, having brine rather than water in the stretching machine, this is the recommended method for salting low-moisture part-skim Mozzarella cheese as well, but using ~25% less salt in the brine than that used for salting Kaçkavall cheese. In the end, salt content should be adjusted to fit the preference of consumers.

II.7. Molding and cooling.

Low-moisture, part-skim Mozzarella cheese is best for pizza baking when it is very young (1 to 10 days old). Much of the change in functionality during the first 10 days of refrigerated storage is driven by residual rennet and starter culture activities, which are controlled by controlling the temperature of the cheese at the exit of the stretching, the residence time of the cheese in the stretching machine, and the rate of cooling of the cheese after it is molded and placed in cold water.

As soon as it is molded, Mozzarella cheese is placed in cold water (1 - 4°C), during 15 – 30 minutes, before being transferred to cold storage. The purpose of this rapid cooling is to reduce the activities of the residual rennet and of the starter culture. Once the cheese in the cold room is at 1 – 4°C, molds are removed, the cheese surface is allowed to dry, and the cheese is vacuum packaged.

III. THE MOST IMPORTANT VARIABLES FOR PROCESS CONTROL

The variables chosen for process control are those for which variation will have the largest influence on the important functional attributes of the cheese. The most important variables for low-moisture, part-skim Mozzarella cheese functionality are:

- Good quality milk supply (free of foreign matter, low somatic cell count, low bacterial count, and normal acidity or pH). Normal pH is 6.6-6.7, and corresponds to titratable acidity of 0.16-0.17% (when measured using 9 ml of milk and 0.1N sodium hydroxide solution).
- Control of protein to fat ratio in the milk, which is achieved by standardizing the milk to 2.6-2.7% milk-fat, from vat to vat and from day to day.
- Temperature of milk entering the vat
- Amount and activity of LAB culture
- Amount and activity of rennet
- Cutting and stirring times and rates
- Rate of temperature increase, and final temperature, during “*cooking*” the curd
- pH of whey at draw.
- Proper curd turning and temperature control during “*Cheddaring*”
- pH and temperature of curd when fed to the stretching machine
- Speed of screw(s) in the stretching machine
- Residence time in the stretching machine
- Temperature of curd exiting the stretcher
- Control of cooling rate and final core temperature of cheese after molding.

Differences in equipment design, manufacturing procedures, level of training, etc., may make some of these parameters more variable in some factories than in others. The design and operation conditions of the stretching machine may have a significant effect on the texture and functionality of the finished product.**

ANNEX III: Monograph on Manufacture of Ricotta Cheese from Mozzarella Cheese Whey and Milk, and Drinks from Ricotta Residual Whey and Fruit Juices.

Improved version of the handout given to attendants to the August 18 presentation at KCBS.

RICOTTA CHEESE FROM MOZZARELLA CHEESE WHEY AND MILK AND DRINKS FROM RICOTTA RESIDUAL WHEY AND FRUIT JUICES

I. INTRODUCTION

Ricotta cheese (the name means re-cooked, in Italian) is made industrially by high-heat (89°C), high-acid (pH 4.5 – 4.8) protein precipitation from whey, mixtures of whey and milk. When Ricotta is made properly, the “curd” floats to the top of the tank or vat, coalesces, and is then scooped off for further processing.

Ricotta is currently made in many countries, using various procedures, either from (“sweet”, pH>6.1, titratable acidity <0.14%) whey, from mixtures of “sweet” whey and milk (usually 80% whey and 20% milk), or from part-skim or whole milk. Ricotta cheese holds more water than regular cheeses and, unless pressed or dried, it contains about 67% moisture. It can also be molded, pressed, dried, and milled or grated, to give a product that resembles a grating cheese such as Parmesan. In Italian cuisine, it is used in a wide variety of pasta dishes such as Ravioli, Manicotti, Cannelloni, and Lasagna, and also in a wide variety of desserts. It can also be used as a base for manufacturing “dips”, by mixing it with cream, yoghurt, spices, herbs, etc.

Following the manufacturing procedure described below, the yield of Ricotta cheese from whey is about 4 kg/100 kg whey and the yield from whole milk is about 25 kg/100 kg milk. When made from a mixture of 80% whey and 20% whole milk, yield is about 7 kg/100 kg of mixture, and when made from a mixture of 90% whey and 10% whole milk, yield is about 6 kg/100 kg of mixture.

II. MANUFACTURING PROCEDURE

Figure 1 shows a flow diagram for the manufacture of Ricotta cheese from whey, from mixtures of whey and milk, or from milk alone. From the viewpoints of yield and nutritional value, the most important constituent present in whey (or in whey and milk mixtures) is the protein. Therefore, it is essential to follow the procedure described below in order to recover as much protein as possible. The lower the protein content in the whey, or in the milk and whey mixtures, the more fragile the “curd” will be. This fragile “curd” is, therefore, more vulnerable to losses during the latter stages of processing. The expected recovery rate of whey protein is approximately 50%, while that of casein (80% of the total protein in milk is casein) is close to 100%.

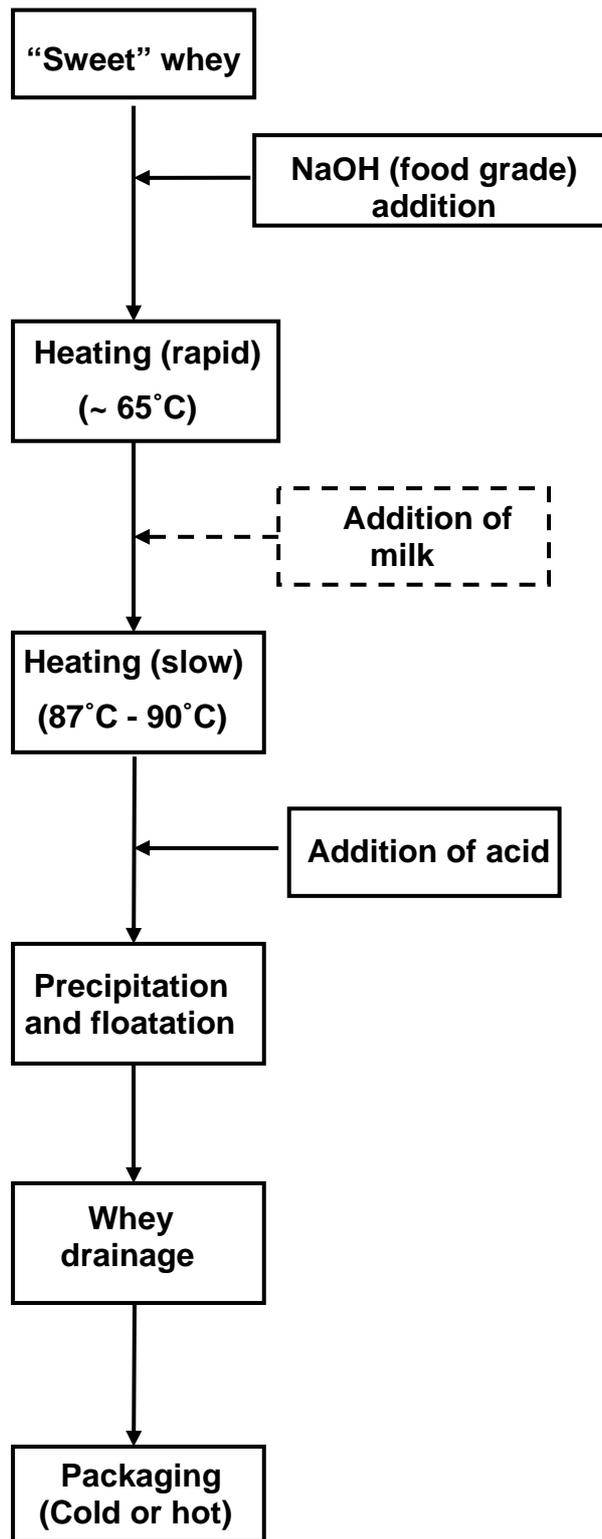


FIGURE 1. Flow-chart for the manufacture of Ricotta cheese

Cheese “fines” must first be eliminated from whey (by straining the whey through cheese cloth in small operations, or using a “fines saver” in large operations) and then the pH is raised to 6.8 – 7.0, by *slowly* adding 1N solution of food-grade sodium hydroxide (40 g of NaOH per liter of solution), while stirring the whey. Next, the whey is heated, as rapidly as possible, to 65°C, in order to inactivate the rennet remaining in it. Milk (raw, kept up to this stage in cold storage, at 2 - 6°C, to avoid acidification) is then added. Next, the mixture, now cooled at about 53°C because the milk was cold, is heated rapidly to 65°C. Afterwards, the mixture is heated *slowly* (at no more than 1°C per minute), until it reaches 89°C.

At this point, acid is added *all at once*, in the form of a ~30% aqueous solution of either lactic, citric, acetic, or phosphoric acid (food grade). Each of these acids will impart a different flavor to Ricotta cheese, and some are more economical or more readily available than others, but, from the viewpoint of flavor, the best is lactic acid. Lactic acid, food grade, is usually sold at a concentration of 80-84%. Before adding it to the whey (or whey-milk mixture), it should be diluted, with potable water, by adding two parts of water to one part of concentrated acid.

The exact amount of acid needed to achieve the desired pH (4.5 – 4.8) depends on the characteristics of the whey, on the characteristics and percentage of milk (which can vary from 0% to 100%) and on the type of acid, and thus it has to be found by experience for a given combination of the above. As an example, if lactic acid is used, the amount of concentrated (84%) acid needed for 100 liters of a mixture of whey and milk, 80/20, is 1.25 lt. In other words, the amount of acid solution added is 1.25 + 2.5 (water) = 3.75 liters. For maximum yield, the pH of Ricotta cheese should not be higher than 4.6.

Immediately upon the addition of acid, heating is maintained at low intensity or stopped, so that the temperature inside the kettle does not fall below 87°C. Protein (highly hydrated, and associated with milk-fat) will precipitate immediately and will float. The “curd” must be left quiescent (still, without any stirring whatsoever) during at least 10 minutes, so that enough whey is expelled for the “curd” to acquire minimum mechanical strength, and thus it can later be scooped off, *very gently*, without excessive breakage (breakage leads to the formation of “fines”, a loss of yield). Scooping the hot (87°C - 89°C) Ricotta is done using a perforated ladle or strainer, made of stainless steel or plastic.

Ricotta cheese is usually not salted, since it can be used both for preparing pasta-based dishes, some of which may require salt, and for preparing various types of desserts, which require adding confectionery sugar.

Precipitation at high temperatures offers important advantages. Not only a high yield results from the presence of whey and casein proteins in the cheese, but the “curd” is almost free of microorganisms as well. However, no guarantee exists that the same quality will be extended to the finished product and hence current GMP are essential from beginning to end.

If not properly handled, Ricotta spoils relatively quickly, usually within three to ten days after making, depending on the temperature at which it is held. Hence, the ultimate quality test for acceptability of Ricotta cheese is its shelf life, and one of the keys to long shelf life is low initial microbial count. Standard Plate Count, coliform count, and yeast and mold count are usually used to assess quality and shelf life. If possible, Ricotta cheese should be cooled rapidly to below 5°C after mechanical removal from kettles, and consumer packaged quickly in closed lines and filling systems. In some factories the cheese is packaged hot, at about 75°C and, as a result, the keeping quality can be extended considerably.

III. THE MOST IMPORTANT VARIABLES FOR PROCESS CONTROL

The variables chosen for process control are those for which variation will have the largest influence on the important functional attributes of the cheese. The most important variables for Ricotta cheese functionality are:

- Good quality whey supply (titratable acidity no higher than 0.13%, pH>6.0).
- Good quality milk supply (titratable acidity no higher than 0.18%, pH>6.5).
- Control of final pH of whey (or whey + milk mixture), during neutralization.
- Temperature of whey before adding the milk.
- Control of whey to milk ratio.
- Controlled rate of heating, from 65°C to 89°C.
- Amount and concentration of acid solution, so final pH is 4.5 - 4.6.
- Control of cooling rate and storage temperature of cheese after packaging.

Differences in whey and milk supply, equipment design, manufacturing procedures, level of training, etc., may make some of these parameters more variable in some factories than in others.

IV. DRINKS FROM RICOTTA WHEY

The residual, low-protein whey in the kettle should be a *clear*, slightly greenish yellow liquid (free of Ricotta cheese “fines”), and it can be used as a base for making drinks of various kinds. As an example, a good lemonade can be made by mixing 40 parts of *clear* Ricotta whey, 40 parts of potable water, 6.5 parts of sugar, and lemon juice at will, the latter two according to taste, in that order. In other words, the whey is diluted with potable water in a ratio of 1:1.

Lemon juice and sugar contents are adjustable according to consumer preferences, but the ideal pH for lemonade is 3.3 – 3.5. Juice or juice concentrate from any other acid fruit can also be used (orange, lime, mandarin, grapefruit, green apple varieties, passion fruit, mango, etc.), and it is important that the color is compatible with the color of the clear Ricotta whey. Green, yellow, and orange are all compatible colors. If desired, pH of the drink can be adjusted, after adding the fruit juice or juice concentrate to taste, by adding an aqueous solution (~10%) of citric acid until pH is 3.3 – 3.5. Cheese whey (rather than Ricotta whey) can also be used for making drinks, but it should be skimmed through a separator, to remove as much fat as possible, and then diluted with potable water in a proportion 1:2 (whey: water).

These beverages can have a shelf life of up to two months, without refrigeration, if they are heated to 75°C and hot-filled into previously washed and sanitized bottles (plastic or glass, but with screw caps, to assure hermetic sealing). Once opened, the drinks should be refrigerated. Otherwise, if they are not thermally treated, the drinks will have a shelf life of a few days, in refrigeration.

ANNEX IV: Sensory evaluation form for cheese and pizza.

Used to evaluate Ricotta cheeses, Mozzarella cheeses, and pizzas made with two Mozzarella cheeses, all products coded "A" and "B".

SENSORY EVALUATION FORMS FOR DAIRY PRODUCTS

PRODUCT: _____

Please write an "X" over the horizontal line, according to your evaluation of the corresponding sensory attribute. At the end, please make any additional comments. Thanks!

FLAVOR

I DISLIKE IT VERY MUCH	I DISLIKE IT	IT IS INDIFFERENT TO ME	I LIKE IT	I LIKE IT VERY MUCH
				

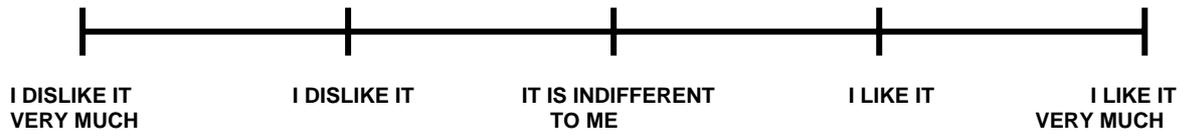
Comments: _____

TEXTURE

I DISLIKE IT VERY MUCH	I DISLIKE IT	IT IS INDIFFERENT TO ME	I LIKE IT	I LIKE IT VERY MUCH
				

Comments: _____

OVERALL GRADING



Comments:

Name (optional):

Organization:

Date:



USAID

NGA POPULLI AMERIKAN
OD AMERIČKOG NARODA

KOSOVO

FOOD SAFETY PRACTICES AND NEW PRODUCT DEVELOPMENT FOR THE KOSOVO DAIRY INDUSTRY: CHALLENGES AND OPPORTUNITIES

Dr. Arturo Inda
Kosovo Cluster and Business
Support Project

August 18, 2005



FOOD SAFETY, QUALITY MANAGEMENT, KNOWLEDGE BASE, AND PROFITABILITY

- Food safety practices (**GMP's**, **HACCP**), quality management (**ISO** certification), and successful new product development are closely interconnected.
- In the longer term, it is always *more profitable* to *comply with GMP's*, to *implement a preventative food safety system* such as HACCP, to have a recognized *quality improvement system* in practice, and to *continuously extend the knowledge base*.



USAID
NGA POPULLI AMERIKAN
OD AMERIČKOG NARODA

KOSOVO

GOOD MANUFACTURING PRACTICES (GMP's)

Criteria and definitions applied to determine whether a food is adulterated, whether it has been manufactured under such conditions that it is unfit for food, or whether it has been prepared, packed, or held under unsanitary conditions so it may have become contaminated, or rendered injurious to health.

- Personnel
- Buildings and Facilities
- Equipment
- Production and Process Controls



USAID
NGA POPULLI AMERIKAN
OD AMERIČKOG NARODA

KOSOVO

PERSONNEL

- (a) Disease control**, ill people excluded from operations.
- (b) Cleanliness**, including hygienic practices, outer garments, and personal cleanliness.
- (c) Education and training**. All with level of competency necessary for production of clean and safe food.
- (d) Supervision**. Responsibility given to competent supervisory personnel.



BUILDINGS AND FACILITIES

- (a)** Plant and Grounds, including plant construction and design, equipment storage, waste disposal, and pest control.

- (b)** Sanitary Operations, including proper handling and use of cleaning and sanitizing chemicals.

- (c)** Sanitary Facilities and Controls, including water supply, toilet facilities, hand washing facilities, plumbing, floor drainage, and sewer disposal.



EQUIPMENT

- (a) Equipment and utensils. ... designed and of such material and workmanship as to be adequately cleanable, and properly maintained.
- (b) Instruments for measuring and recording acidity, temperature, pH... accurate (*calibration*) and well maintained.
- (c) Holding, conveying, and manufacturing systems... of a design and construction that enables them to be maintained in an appropriate sanitary condition.



PRODUCTION AND PROCESS CONTROLS

- a) Processes and Controls. All operations ... receiving, inspecting, transporting, preparing, manufacturing, packaging, and storing of food ... conducted according to adequate sanitation principles. Includes **inspection and storage of raw materials.**
- b) Equipment, utensils and food containers... maintained in an acceptable condition through appropriate **cleaning and sanitizing.**
- c) **Storage and transportation of food**... under conditions that will protect it against physical, chemical, and microbial contamination as well as against deterioration of the food and the container.



USAID
NGA POPULLI AMERIKAN
OD AMERIČKOG NARODA

KOSOVO

LOW-MOISTURE PART-SKIM MOZZARELLA CHEESE FOR USE IN PIZZAS

A type of pasta *filata* cheese of Italian origin. Kačkavall is of the same family.

- Low-moisture (49%), part-skim Mozzarella cheese for use in pizzas is made from pasteurized cow's milk containing 2.6–2.7% fat. The expected yield is 11 kg of cheese, with 1.5% salt, per 100 kg of milk.
- Most important functionality: a) “*shreddability*”, b) unmelted cheese “*string*” formation, “*meltability*”, “*stretchability*”, “*oiling-off*”, browning, and post-baking appearance and chewiness. Flavor should be clean and relatively bland.



RICOTTA CHEESE FROM MOZZARELLA CHEESE WHEY AND MILK

- Ricotta cheese (re-cooked, in Italian) is made by high-heat (89 degrees C), high-acid (pH 4.6) protein precipitation from whey and/or milk. Unless pressed or dried, it contains about 67% moisture.
- In Italian cuisine, it is used in a wide variety of pasta dishes, and also in a wide variety of desserts.
- Yield: Ricotta cheese from whey, about 4 kg/100 kg whey; from whole milk, about 25 kg/100 kg milk; from a mixture of 90% whey and 10% milk, about 6 kg/100 kg of mixture, and from a mixture of 80% whey and 20% milk, about 7 kg/100 kg of mixture.



RICOTTA CHEESE





USAID | KOSOVO

NGA POPULLI AMERIKAN
OD AMERIČKOG NARODA

INGREDIENTS FOR LASAGNE





USAID
NGA POPULLI AMERIKAN
OD AMERIČKOG NARODA

KOSOVO

OPPORTUNITIES AND CHALLENGES

BETTER YIELDS, LESS COST, MORE CONSISTENT QUALITY,
BETTER COMPETITIVE POSITION...

- **Work** with milk producers, to improve milk quality, together... always win-win... there are many ways
- **Improve** GMP's, steadily, continuously...
- **Train everyone**, in fundamentals of dairy processing science and technology...
- **Adopt** a preventative food safety system (**HACCP**)
- **Adopt** a quality management system (**ISO**)



TIME SCALES

- **GPM's.** 1-3 years, 80% - 90% of total investment.
- **HACCP.** 1-2 years... moderate money investment. Builds on GMPs, necessarily.
- **ISO.** 1-2 years... moderate money investment. Can be done along with HACCP, but it is better to do it afterwards...

It will lead to great success, and it takes:

*constancy of purpose, commitment, clear goals,
constant learning, and patience...*