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NEW CHEESE MANUFACTURING PROCESSES FOR DAIRIES IN KOSOVO

KOSOVO CLUSTER AND BUSINESS SUPPORT PROJECT

06 December 2005

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NEW CHEESE MANUFACTURING PROCESSES FOR DAIRIES IN KOSOVO

PREVIOUS RECOMMENDATIONS FROM KCBS SHORT TERM TECHNICAL ADVISORS HAVE BEEN MADE TO A LIMITED SELECTION OF KOSOVO FARMERS. THIS REPORT OUTLINES A PROGRAM TO BE FOLLOWED IN IMPARTING THESE RECOMMENDATIONS TO A WIDER SELECTION OF FARMERS AND THE MEASURES TO BE TAKEN TO ENSURE THE CHANGES ARE MADE ON A SUSTAINABLE BASIS.

Kosovo Cluster and Business Support project "New Cheese Manufacturing Processes for Dairies in Kosovo"
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PURPOSE OF ASSIGNMENT

The purpose of this assignment is to help two dairy processors make an excellent quality "Feta" type of cheese during the high production time of the year in order to take more milk off the market at a higher price. The cheese processing specialist will work with the livestock cluster dairy processing specialist.

BACKGROUND

USAID/Kosovo has embarked on a series of programs in an effort to put Kosovo back on track after the civil war. One of the sectors selected for attention is the dairy industry. Milk production is fairly widespread throughout Kosovo and improvements in the production, collection, distribution, and processing of milk will lead to added income throughout the rural sector.

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 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 to the dairy processor is critical. Furthermore, the processing and distribution of high quality cheese products combined with aggressive marketing and promotion of their nutritional benefits is needed to stimulate demand for dairy products made from locally produced milk. The ability for the sector to grow and prosper must be based on improvements in cost efficiency and quality control at each level of the dairy sector from the farm through the processor to the consumer. It is only through the introduction of technologies at each of these levels that the Kosovo dairy industry will increase the internal demand for dairy products.

There are only five commercial dairy processing firms currently in operation in the Albanian section of Kosovo and one in the Serb area. These firms are located in Gjakova, Pristina, Gjilane, Prizren, Peja and Zvecan with a total production capacity in excess of 60,000 liters of milk a day with existing equipment and up to 100,000 liters a day with minor upgrades to existing equipment. The factories are currently processing an average of 30,000, 25,000, 5,000, 2,500, 2,000 and 1,000 liters of milk a day. These companies supply a limited range of dairy products to the domestic market. Since the market is substantially served by imports, their immediate goal is to compete effectively with the imported products. The quality of their products range from poor to excellent. All the processors demonstrated the ability to produce high quality milk products, however, quality control is a problem.

These firms produce a mix of packaged fluid milk, soft and firm yogurts, cheese and cream. All the processors indicated that the greatest profit margin is with fluid milk. The processors are buying the milk at between .22 and .30 per liter, selling it delivered to the retail stores in Pristina for .45 per liter, and the store is selling it for .50 to .60 per liter. The factory takes back all returns of milk that spoil before they are sold. In the winter, this is less than 1% of sales, however, in the hot summer months, this can run up to 25% and sometimes more when the electricity is off for more than 24 hours. Their biggest competition is imported UHT milk from Hungary that is selling for between .60 and .80 a liter.

The processors indicated that yogurt was also a profitable item. The factories usually produce twice as much yogurt as all other products combined. The biggest cost of production for the yogurt besides the milk is the cost of the packaging. They claim that they are paying an import tax on some of the packaging material that is causing them to be

uncompetitive with imports. A large problem the factories are now having is with the lack of electricity. The cost of running the refrigeration units with a power generator is very costly for the factories. A couple of the factories here attempted to get the yogurt to the market on the day it is made, and in doing so, incur additional expense.

Cheese is a loss leader item made during the surplus time for milk (July to September). All the factories claimed to be “losing” money on the manufacturing of cheese. However, they buy the milk at a discount during the surplus time of year so it is likely they make a profit based on the discount cost of the raw milk. On “White” cheese they nearly broke even because they had about 8 liters to 1 kilo conversion rate from milk into cheese. With the “Yellow” cheese, they said they lost money because they had about an 11 liters to 1 kilogram of cheese conversion rate. Currently, they do not receive any price differential between the two cheeses. They made the yellow cheese on a per order basis only in order to keep their other products in the distribution channel. One factory was making a fresh “mozzarella” once a week and had an excellent market for the product even though the cost of production was higher than any of their other products. They are receiving a premium price for the product because the consumer knows it is fresher than the imports and is willing to pay extra for the freshness.

Feta cheese is currently being imported from Hungary and Bulgaria. These are excellent quality cheeses, however, they are being “dumped” into the Kosovo market at a low price because the EU limits the amount of cheese these two countries can sell. Kosovo can produce during the high milk production season Feta cheese that is cost competitive with the imported Feta.

EXECUTIVE SUMMARY

This final report is a compilation of interim reports, reports on the activities of meetings and visits to various organizations and the presentation made during my 26-day consultancy in Kosovo from October 30 to November 27 2005.

The report contains documentation on visits to

- nine milk processing factories,
- three dairy processors and making of an excellent quality "Feta" type[1] of cheese.
- one milk producer
- one milk collection centre
- information on EU legislation pertaining to milk production, processing and marketing
- suggested tasks; action plans for improving and consolidating the dairy sub-sector project of KCBS.
- recommendations on use of the new starter cultures for improvement of consistency and taste of dairy products (yoghurt, set yoghurt, "Feta" cheese, "Kashkaval" cheese, ayran, sour-cream, ricotta).
- explanation of the following items:

  Making of business plan and technological project for a new factory; making calculations of cost price of dairy products; calculations for purchasing of new machines which are necessary in manufacture or for equipping of a new factory.

This consultant believes that the Kosovo dairy processing industry can, and must, make several important changes in order to improve its position in the dairy marketplace of Kosovo. The dairy processing industry requires an improvement in the quality of raw milk that the processors purchase from the milk producers. A milk quality payment scheme is suggested and this should be discussed among the milk producers and dairy processors in order that producers of high quality milk will be rewarded for their improved raw material, while giving an incentive to other producers to improve their raw milk quality.

The dairy processing industry in Kosovo will also need to implement an integrated quality management system. The international food market now requires that dairy processing plants have a Good Manufacturing Practices (GMP) program along with a Hazard Analysis Critical Control Points (HACCP) programs in order to minimize the presence of a hazard (microbiological, chemical, or physical) in the food items processed. A GMP checklist is included in the Annexes.

Findings include poor to very bad conditions at farm level militating against the production of good quality milk. Processing facilities should be improved to cater for the existing products as well as new and/or modified products, which may result from consumer demands.

Opportunities should be provided at the University of Prishtina to study Food Science and Technology at certificate, diploma and degree levels. The existing Institute of Public Health Laboratory has the potential to be the principal laboratory in Kosovo and to cater for the analytical requirements of the Food Industry.

It is strongly recommended that a milk quality payment scheme is introduced and implemented at the Dairy Plants and that formal training courses are conducted in clean milk production.

FIELD ACTIVITIES TO ACHIEVE PURPOSES

Oct 31.

I prepared updated service agreement for laboratory testing experts for improved lab testing of milk at milk collection centers and small dairy farms. The instructions on wash and disinfection of cooling tanks and "Good Hygiene Practice" at the farm with the following sub topics: hygiene at the stables (cleaning, disinfection and ventilation); hygiene of the milkers, hygiene of the milking (preparation of the udder, control of the vacuum and pulsations in the milking system, control of the rubber parts of the milking machine); cooling of the milk; hygiene of the milking equipment and storage of the milk (choose of cleaning chemicals and disinfectants for cleaning the milk equipment, choose of cleaning equipment, procedure for cleaning of the milking equipment and other equipment and utensils); testing dairy cows for sub clinical mastitis and proper therapy treatment of the sick cows

As a cheese processing expert I introduced project and prepared action plan. Together with, KCBS (Ziyadin Gojnovci) visited Bylmeti dairy plant in Miradi e Eperme, Fushe Kosove.
The needs for improvement at Bylmeti dairy plant are:

- Microbiological laboratory testing in milk collection centers and in dairy plant,
- Good Manufacturing Practices training,
- Bio filter for water cleaning is required
- A new arrangement of technological lines in order to escape crossings of technological lines.
- Improvement of hygiene at the dairy factory

The importance of arbitrage physical-chemical laboratory for testing of dairy products was discussed with Bylmeti.

Nov.01.

KCBS met with Mr.Bardh Begolli, from Agriculture Institute in Peja and discussed the proposal of Devolli on improvement of testing methods at milk collection centers. Mr.Begolli was asked by Devolli to implement testing improvement program at dairy farm. KCBS will prepare service agreement for laboratory testing expert.

Together with KCBS (Ziyadin Gojnovci) I visited milk collection center in Lugbunar Bec, Gjakove. KCBS organized direct training and recommended installation of automatic cleaning system at milk collection center, disinfections, lab analysis equipment and methods of milk collection, milk cooling recommendations and storage. We were presented dairy cheese processing line not installed and not in use. I recommended them to use the above mentioned line in processing of “Feta” and “Gouda” types of cheese, yoghurt, set yoghurt.

Together with Mr.Ziyadin we visited Ajka dairy plant in Lutogllave, Prizren. I recommended to develop new processing line for cream cheese [around 25,000 Euro]. KCBS worked for two more days at Ajka dairy plant in order to improve the quality of set yoghurt.

Nov.02.

Together with Mr.Ziyadin visited dairy training center in Lypjan for trade school needs. The purpose of the visit was the study of installation of dairy processing lines. The installation of dairy processing equipments was in process. The processing equipment was not properly synchronized, and installation was technically wrong. I recommended technical re-installation of dairy equipment. The equipment had no passport, background certificate and quality certificate. Lab testing equipment was not available. The training center will be included on KCBS training program.

Zijadin Gojnovci and myself visited this plant, which processes 6,000 – 8,000 liters of milk per day, on Nov.2, 5,8,14 and15 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. 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. There was potential for moving ahead in processing "Feta" cheese and production would start next week. A further four products could be produced [two improved yellow cheeses, one white and butter]. A plan for their introduction will be developed next week.

I organized training course, introduced General Hygienic Instructions which included wash and disinfection of the equipment. I prepared technical starter cultures for "Feta" cheese, demonstrated GMP for cheese processing from raw milk up to final product.

The level of hygiene was very low.

There is no microbiological control at milk reception centers, no control over the quality of ready product.

Their laboratory is able to control only the main physical and chemical parameters of milk reception.

Before KCBS intervention the lacks at Rona on not proper processing technology were up to 20%, on not proper processing equipments 15%.

The whey that comes from "Feta" and "Kashkaval" types of cheese is dumped into waste water though it could be used in the processing of albumin cottage cheese, and if it is separated after processing of Kashkaval cheese it is possible to get butter.

Daily dump of whey into the waste waters leads to the loss of 50 kg of albumin cottage cheese (from 1 ton) and 20 kg of butter (fat content 72 %). The price of 1 kg of butter is 2 Euro, 1 kg of albumin cottage cheese is from 1.3 up to 1.5 Euro -560 Euro per dey ,butter-120 Euro per day.

As there is no standardization of processed milk (fat\casein content) the dairy factory loses 80 kg of butter (72 %) per day. The price of 1 kg of butter (fat 72 %) is 2.6 Euro – 208 Euro per dey.

Rona has plans to increase milk-processing volume (20 tons per day) by 2006.

Rona required assisting on their technological project for the new factory with processing facility of 20,000 lit/day and on calculation of the processed products and on assistance in consultancy of purchasing of the equipment they need and help them in installation and start of the factory.

3 tons of raw cow milk was processed for "Feta" cheese. The fat content of the milk was 3,68%, density 1,027, dry materials 7,8 %, proteins 3,5 %, lactose 4,1 %, added water 6 %, pH 6,68, acidity 7,2 º, SH.

"Feta" cheese was processed from this milk and the whole technological process was introduced step by step up to the final product.

The new product was made (butter) from pasteurized sour-cream. The product was appreciated by the processor.

We got 1 kg of cheese from 6 liters of milk. The cheese was appreciated by the processor and sold in the market.

Comments on some conditions regarding Good Manufacturing Practices .

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.

The calcium chloride container had no label, and thus no one at the plant knew the brand, the manufacturer, or the concentration.

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. That is the reason why I used rennet “Chy max” Christian Hanson (2 gr per\100 liters).

The plant does not have a moisture balance, to determine the moisture content of the cheeses it produces.

There is extensive use of wooden utensils, which enter into contact with the milk, after pasteurization.

The lamps in the ceiling have no protective covers.

Production personnel do not wear appropriate garments for working in a food processing plant, they are not trained in GMP, and there is no enforcement or supervision of basic hygienic practices.

Hoses and various other materials are usually lying on the floor.

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.

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.

Nov. 7.

We visited Kabi dairy plant in Gjilane to study opportunity of processing of new products such as “Feta” and cream cheeses. Kabi are constructing a new processing plant which will be started up in February.

They required technical assistance for the installation and start up of machines for the new factory which meet the requirements of KCBS’s STTA.

There is no microbiological control at milk reception centers, no control over the quality of ready product.

Nov. 9, 17 & 18.

Together with Mr.Ziyadin I visited Shala dairy factory in Mitrovice. Although small [it produces only 1000 liters/day], KCBS negotiated with them to purchase an extra 500 liters/day from both Serbian producers and from Albanian producers. With this additional

supply, KCBS and the STTA is developing a plan for three more products production – two cheeses and one cream.

I organized training course, introduced General Hygienic Instructions which included wash and desinfection of the equipment. I prepared technical starter cultures for “Feta” cheese, demonstrated GMP for cheese processing from raw milk up to final product.

The level of hygiene was very low.

There is no microbiological control at milk reception centers, no control over the quality of ready product.

Their laboratory is able to control only the main physical and chemical parameters of milk reception.

Daily dump of whey into the waste waters leads to the loss of 50 kg of albumin cottage cheese (from 1 ton) 1 kg of albumin cottage cheese is from 1.3 up to 1.5 Euro – 70 Euros per deys.Butter – 20 kg per dey – 2,6 Euro/52 Euro/

700 liters of raw cow milk was processed for “Feta” cheese. pH 6,7.

“Feta” cheese was processed from this milk and the whole technological process was introduced step by step up to the final product.

“Feta” cheese was the new product for Shala factory. The white cheese processed by them was made from the non-pasteurized milk.

KCBS will support Shala on application to banks for financial credit support in value 60,000 Euro to increase processing capacities.

Shala agreed to collect 500 lit of raw milk from Kosovar Serbs farmers in Leposaviq.

KCBS met Kosovo Veterinary Food Agency on coordination activities and needs in future for inspection and licensing process, pasteurization and processing standards to be improved in dairy plants.

Nov. 10.

Mazreku Dairy at Malashiva. This is a new dairy by the Mazreku family, Sedri – Father - and sons Osmon and Azrem. By their own admission, they are not cattle people. They invested over 500,000 Euros from their petroleum business. They have about 120 cows, 20 Brown Swiss and 100 Simmental. 110 were lactating when we first saw them .

The level of hygiene in some parts of the farm wasn’t on a high level (cooling tanks).

The problem of milk storage comes from the level of hygiene of the cooling tanks.

The number of the cooling tanks is not enough for them (only for 2 tons of milk).

We negotiated that they would purchase a tank (4 tons) which would be connected with CIP.

I presented them a scheme of connection of lacto freezer with washing solution 2%NaOH and 1,5% HNO_3.

I gave them the recommendation of milk cooling; it included the following details:

Cooling milk

In the first two hours after milking, the milk should be cooled down under 8 ºC.

If the milk is delivered in the collecting centre immediately after milking, the cooling is not necessary. The best way for cooling the milk is with lacto freezers.

If the farmers don't have lacto freezers, the cooling of the milk can be done by tab water, ice or freezers for deep freezing. If the milk is cooled by using tab water or ice, the vessels with milk are put in bigger vessel filled with water. In any case, it is necessary to mix the milk in the vessel with water in order to balance the temperature.

Ajka Dairy Factory. I gave them new technological instructions for processing of a new product (Ayran) and confirmed it was now producing 100 lit/day of Ajran [soft yoghurt with salt]. Owner is very satisfied, though he is looking to improve his product packaging. General practices were discussed and a program for implementing GMPs was developed.

I organized training course, introduced General Hygienic Instructions which included wash and desinfection of the equipment. I prepared technical starter cultures for "set-yoghurt" , demonstrated GMP for set-yoghurt processing from raw milk up to final product. The product was appreciated by the processor.

As there is no standardization of processed milk (fat\casein content) the dairy factory loses 60 kg of butter (72 %) per day. The price of 1 kg of butter (fat 72 %) is 2.6 Euro -156 Euros.

The new product was made (sour-cream) from standardization of milk.

The next day, the set yoghurt was examined at Ajka, and then KCBS went to Abi.

We (Ziyadin Gojnovci, M. Petrova) were met by Mr. Ifram Fusha, Manager and Mr. Fari Rizanaj. ABI is located about 78km SW of Prishtina in the city of Prizren.

It was established in 1985 as an SOE. Mr. Fusha took over as owner in 1996.

They have 33 employees including 20 involved in processing.

They manufacture 20 different products, which include different cheese varieties, yoghurt, Kos, and pasteurised milk. Yoghurt and cheese (white and Sharri) are the largest volume products.

Zijadin Gojnovci and myself visited this plant, which processes ~30,000 liters of milk per day on Nov. 10,11,2005 . 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.

The absence of the lab control at the raw - milk reception centers, the quality control over milk processing is absent as well. The control over the ready products and microbiological lab are also absent. There are no specialists who can work at the microbiological lab. I organized training on testing of effectiveness of the starter cultures.

I organized training course, introduced General Hygienic Instructions which included wash and desinfection of the equipment. I prepared technical starter cultures for "Feta" cheese, demonstrated GMP for cheese processing from raw milk up to final product

Here they talked again about GMPs relating to feta cheese production. Abi has already produced feta cheese without ultra filtration – this improvement will not take place until next year, after privatization. KCBS also talked about opportunities new new products development at Abi.

Comments on some conditions regarding Good Manufacturing Practices.

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.

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. That is the reason why I used rennet "Chy max" Christian Hanson (2 gr per\100 liters)

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.

The plant does not have a moisture balance, to determine the moisture content of the cheeses it produces.

There is extensive use of wooden utensils, which enter into contact with the milk, after pasteurization.

The lamps in the ceiling have no protective covers.

Hoses and various other materials are usually lying on the floor.

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.

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.

The plant does not comply with GMP, but a 3-hour meeting was held with the Manager, on Nov 10, 2005, 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.

Daily dump of whey into the waste waters leads to the loss of 50 kg of albumin cottage cheese (from 1 ton) and 20 kg of butter (fat content 72 %). The price of 1 kg of butter is 2 Euro, 1 kg of albumin cottage cheese is from 1.3 up to 1.5 Euro. Albumin cottage cheese – 1400 Euros per dey.Butter – 400 Euros per dey.

As there is no standardization of processed milk (fat\casein content) the dairy factory loses 80 kg of butter (72 %) per day. The price of 1 kg of butter (fat 72 %) is 2.6 Euro / 520 Euro per dey/.

Nov. 14.

KCBS met NGO AgroDolli from Village Kushavec Gjakova, the association has new processing line capacities up to 3,000 lit per day. The association is interested to build new processing line, from KCBS they need technical assistance about machinery installation and necessary steps to be taken. KCBS will arrange the visit and provide technical assistance with STTA.

Together with Mr.Ziyadin I visited Devoli factory in Paja

Visit to Devoli dairy plant

Devolli Company is located in Peja about 85 km West of Prishtina.

It is privately owned. It has about 62 employees.

It began production of Vita UHT milk in November 2003. According to Devolli Vita milk is a result of successful cooperation between Devolli and Tetra Pak multinational company. We met with Mr. Ismet Bojku, General manager and Mr. Ernest Jusufi, Production manager.

In addition to producing UHT milk of 3 different fat contents (3.2%, 1.6%, 0.5%) Devolli also package coffee and 8 different juices in a standard and premium grade.

Processing capacity for UHT milk is 12,000 litres per hour. All UHT milk is produced from fresh cows milk. Seventy farmers supply about 17,000 to 24,000 litres of milk per day. Supplies range from 100 litres to 2,000 litres per farmer per day. About 55% of farmers deliver their milk to the Factory and Devolli collects the milk from the remaining farmers.

Payment for milk is based on fat content and hygienic condition. Payment is 7 cent per unit of fat and there is a bonus for milk of superior hygienic quality based on the Methylene Blue test.

At reception the milk is tested for acidity, pH and alcohol (75%) test. An additional sample, which is taken 3-4 times per month, is tested for antibiotics, total bacterial count and somatic cell counts. Details of the quality payment scheme were not available.

The main problems for Devolli are the unreliability of electricity supplies, the high price paid to the farmer for his milk, the high cost of milk assembly, the high price of fuel oil, high taxes on imports of consumables such as detergents and cleaning materials. The quality of milk from farmers can cause problems but this situation is improving. Imports of dairy products are disrupting the market especially as it is alleged that goods are invoiced at prices below the cost the importer is actually paying for the milk. Mr. Ismet stated that the total cost of milk, milk assembly, processing and distribution is 50 cent per litre of UHT milk. The invoiced value of imports is 30 cent per litre.

The cost of 3.2% fat Vita in a supermarket in Prishtina was 60 cent per litre.

There is no discernable difference between the quality of imported and locally produced UHT milk according to Mr. Ismet.

Devolli are aware of the need for integrated quality management systems and are working towards achieving HACCP and ISO standards. We suggested that a good starting point would be an audit of Good Manufacturing Practice (GMP) and a checklist was provided. Processors should be mindful that GMP includes activities within the plant and conditions of buildings and the surrounding compound.

Farmers are given advice on clean milk production and financial assistance is provided to enable farmers to improve milking conditions, milk cooling and storage.

Devolli have recently started exporting semi-skimmed UHT milk to Albania and Macedonia. Before they could export to Macedonia the Devolli plant was subjected to a sanitary inspection by Macedonian authorities.

Location of their factoru does not comply with HACCAP requirements, they plan to construct a new factory by the 2006 and they asked for my technological assistance which include technological project, calculations of the products they plan to produce: white cheese, Gouda, Kashkaval, fruit yoghurt, set yoghurt and butter, albumine cottage cheese, equipment recommendations, calculation of necessary space for storage of these products.

During our visit to Devoli dairy plant in Pech, we had a meeting with Mr.Driton who is manager of the raw milk sector. We informed him on planned activities of the project and the main goal that is upgrading the knowledge and improving the skills of the farmers on farm management for producing quality milk. We agreed to determine one model farm on their choice where we can have training and workshop for 10- 20 farmers.

The representative form Devoli dairy plant gave us the following data:

The dairy processes UHT milk; they have around 300 cooperants; daily quantity of the collected milk is around 30.000 litres; the payment system is according to the microbiological quality since they have their own laboratory capable for this type of tests; they permanently have problems with milk quality from most of the of farmers; most of the farmers are not enough educated for production of quality raw milk that affects the price they are paid off per litre.

Nov. 16.

KCBS with STTA visited Lahor dairy plant in Shtrpce, the plant is operating with 500 lit raw milk per day, process sharr cheese, yogurt, set yogurt and cream cheese. Raw milk potential to collect is up to 2,000 lit/day. Lahor dairy plant has need to improve and to process dairy

products with new technology, they would like to process “Feta” cheese. KCBS will assist lahor dairy plant to find new market to sell dairy products. Lahor dairy plant agreed to process feta cheese on this week at his plant, but we could not process it there due to circumstances.

Nov. 18.

KCBS with STTA prepared the schedule of visits in Bulgaria for dairy processors needs. KCBS prepared material for dairy processing technology based on request from dairy processors.

The intervention plan was arranged in Lahor dairy plant in Shtrpce kosovar Serb owner, for security reasons KCBS cancelled intervention and post pounded for new event.

In last two weeks based on KCBS and STTA intervention from 4 dairy plants launched in the market 4 new products Ajran product from Ajka dairy plant, feta cheese first time made in Kosovo from Abi dairy plant in Prizren, Rona Feta cheese plant in Ferizaj and Shala dairy plant in Bare Mitrovice. The yield on cheese was increased for 25-35-50%, processing expenses has been reduced for 20% in each KCBS intervention. The detailed report of intervention STTA will prepare next week.

KCBS organized and held with STTA 7 training program on developing new dairy products, 4 feta cheese development new dairy products, 4 training on hygiene and GMP standard improvement.

We (Ziyadin Gojnovci, M. Petrova) and Ajka(Mr. Ramadan) dairy plant from Prizren organized visit report in Bulgaria from 21-25 Nov.05. In order to complete the training in developing new dairy products KCBS organized the trip.

21 Nov. 05.

KCBS visited Lactina Company in Sofia, general Manager Georgi Georgiev. The company is for production starter cultures for fermentation dairy products like yogurt, set yogurt, flavour yogurt, cheese, yellow cheese and special products like cream cheese. Lactina presented to KCBS the whole range of products (starter cultures) and detailed specifications and technological process of starter culture production. Lactina Company is able to produce specific aroma product with specific viscosity based on client needs. If it is needed Lactina Company can provide its technical assistance.

KCBS visited Dairy-processing association of Bulgaria in Sofia with 230 dairy processors licensed members. Executive director Mr. Mihail Velkov presented activities of association for last 15 years. Mainly the association is active on:

- Preparation certification of dairy plants based on EU standards,
- Preparation pre qualification for EU standards implementation,
- Organizing seminars for laboratory testing training,
- Organizing seminars on improvement processing technology

Before licensing of dairy plant Bulgaria there were 825 dairy plants, after the number was reduced to 360 dairy processors.

Bulgaria processed and produces 1,500,000,000 ton of milk annually, with average milk production per cow per lactation 3,600 lit. Up to the present day 33 dairy processors have license for export and currently are exporting dairy products mainly cheese. Each dairy processor has to pay annually 360 USD for being the member of the association.

The association in Bulgaria is able to provide KCBS and KDPA with any services if it is required. The profound study of experience of Bulgarian Association by KDPA is possible by visiting it.

22 Nov. 05.

KCBS visited market in Haskovo and got price list of dairy products and bought a special filter for Feta cheese for “Rona”, “Shala”, “Ayka” and “ABI” factories.

KCBS visited “ Marvel “ company in Plovdiv.

We explored lab equipment and made up a list of equipment necessary for us for making analyses at dairy factories. They have to send price – list, installation and work instructions to KCBS by e-mail.

KCBS visited “PIM” company in Haskovo which manufactures dairy equipment. KCBS collected detailed information about cost and service offered with additional spare parts available. Most of the spare parts required by KCBS clients were not available.

“PIM” requires the information concerning technological project and full list of equipment according to the technological project while making order. If there is no the required information it is not possible for them to fulfill the order.

We bought special knives for Feta cheese (2 sets); one for training in KCBS the other for Rona Company.

KCBS visited “Donido” company which is the producer of dairy equipment in Haskovo.

The company is certified by ISO 9001:2000 and UKAS Quality Management 005. Mr. Krasimir Angelov ,general manager, has presented the factory and the process of equipment production. Donido Company is licensed for machine manufacturing according to British standards. KCBS required the information concerning technological project and full list of equipment according to the technological project while making order . Every client must indicate the processing line he needs, its technical and technological details.

KCBS visited “ENKO”PVC Company in Plovdiv, producer of the packaging material for dairy production. The company is offering the packaging material with half price which is available in Kosovo market. KCBs collected the samples with offered price list.

“Ayka” Company has bought packaging material for storage yoghurt.

KCBS visited “Tonus” Dairy Factory. This factory processes 50 tons of milk per day. It produces storage yoghurt – 30 tons per day, ayran – 5 tons per day, pasteurized milk 5 tons per day and yoghurt 10 tons per day. This factory corresponds to EU standards.

23 Nov. 05.

KCBS visited “Milko Miloshev” in Haskovo, packaging equipment producer for yogurt ,set yogurt, pasteurized milk and sour-cream and cream cheese. The company presented and demonstrated the way of use of offered packaging equipments. The packaging equipment is available with manual system, half automatic and full automatic system.

KCBS visited “Chimtex” Ltd. Service Company for purchasing laboratory testing equipments in Dimitrovgrad. KCBS collected the price list physic-chemical analyses, microbiological analyses and chemicals for dairy industry. We purchased thermometer, humidity meter, phenolphthalein, thermometer for butch pasteurizer for “Ayka” Company, two thermometers for office, pH meter, bureto, phenolphthalein for office, refractor meter, measuring pipette, alcoholmeter, saltmeter.

KCBS visited “ Lactoskan “ company which produces lab testing equipment for analyzing of dairy products in Nova Zagora. The lab testing equipment demonstration of work and technical instruction of use have been presented to KCBS. Lactockan equipment is testing parameters:fat, density, dry materials, lactose, proteins, added water, freezing point, mineral salt content, temperature, pH in raw milk, UHT milk, yogurt, whey and sour-cream . We purchased a Lactoskan for use in the office.

24 Nov. 05.

KCBS visited " Hraninvest," company in Chirpan which produces all types of valves, pipes, stainless parts for dairy industry. This company manufactures rubber compressions for all types of valves and pipes used in dairy industry.

We were given offers covering all their manufacture, because the most of dairy factories in Kosovo were interested in purchase of spare parts.

"Ayka " Company purchased 45 compressions for valves and stainless material for making thermo rings for yoghurt packing equipment and material for making devices for homogenizing of sour-cream.

I contacted "Tempra Pack" company which produces packaging equipment in Gorna Orjahovica. We purchased spare parts for yoghurt packaging equipment for "Ayka" Company.

On the way back KCBS visited "Lactina" Company and "Enko" Company for second time purchased additional starter cultures discussed during the first meeting.

During this visit KCBS created good source of information for client's need in future. KCBS also prepared detailed information for organizing study of visit of dairy industry if it is required by KDPA

TASK FINDINGS AND RECOMMENDATIONS

The main finding was that the processing plant 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 insanitary 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 GMPs which ***were not*** observed to be practiced, according to standard, in the plant, during the work with the dairy foods processing company. Selected photographs are included in Annexes A and B. 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 Control.

1. Personnel

1.1 Cleanliness, including hygienic practices, proper outer garments, proper footwear, and personal cleanliness.

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

1.3 Supervision. Responsibility for the production of food should be given to competent supervisory personnel.

2. Buildings and Facilities

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

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

2.3 Sanitary facilities and controls, incuding 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.

3. Equipment

3.1 Equipment and utensils should be designed and of such materials and workmanship as to be adequately cleanable, and properly maintained**.**

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

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

4. Production and Process Controls

4.1 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.

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

4.3 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.

Recommendations on construction of Independent Milk Testing Laboratory

Milk that is delivered to Dairy Plants in Kosovo is mainly paid for on the basis of fat content. In some cases the microbiological content of the milk is used as an additional basis for payment, i.e., where the bacterial content of the milk is deemed excessive by the Dairy Plant then a penalty is imposed on the milk producer. One can understand that if a farmer is receiving a low price for his milk supplies then he may feel that poor sampling and inaccurate testing may be a contributory factor in this low price. The farmer may also feel that any errors that may be made will always disadvantage the milk producer and some farmers may feel strongly that they may be cheated by the chemical and microbiological analysis. From work in several countries this consultant's experience has been that a significant number of farmers are not happy with the test results of Dairy Plants in so far as they impinge upon and affect the final payment made to the milk producer.

Some farmers spoken to during this assignment were happy with the test results of the Dairy Plant while others wished they had an opportunity to have an independent check on the results of the Dairy Plant. There are two approaches to this situation. One is that an independent laboratory is set up and run by the Association of Milk Producers (KAMP) and the second approach is to utilize the facilities of an existing laboratory, e.g. the Institute of Public Health Laboratory, to carry out spot checks on split samples that are taken by the Dairy Plant.

It is this writers opinion that the establishment of an Independent Laboratory by milk producers, at this stage in the development of the dairy industry in Kosovo, would be excessive and that the use of an existing laboratory on a fee per sample or test basis would be the most cost effective.

EU Rules and Regulations pertaining to the Dairy Industry

As Kosovo aspires to membership of the EU then it is essential that Kosovo adopts the laws of the EU relating to Food Production, Processing and Standards.

The following are examples of EU Regulations that are relevant to the Food, including Dairying, Industries.

852/2004 – Hygiene of Foodstuffs

92/46 – Milk and Milk based products

89/362 – Hygiene in Milk Production Holdings

213/2001 – Methods of analysis and quality evaluation of milk and milk products

2160/2003 – Control of Salmonella

The main recommendation, regarding dairy processing plants, is for KCBS to negotiate a *formal* agreement with the owners of both factories, ABI, and perhaps with those of some other milk processing factories as well (members such as Devolli, Rona, Bylmeti, Ajka, Kabi, and Shala), 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.

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE ACTIVITY

Some farmers appear to have little appreciation of the need for good animal husbandry and hygienic milk production practices. They do not appear to realize that cows need proper care and attention including proper nutrition and clean healthy housing.

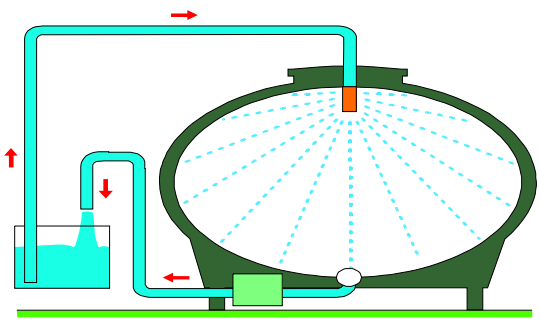
It is strongly recommended that a comprehensive milk quality payment scheme is introduced and implemented. This must be done by discussions and cooperation between the Milk Producers Association and the Dairy Processors Association.

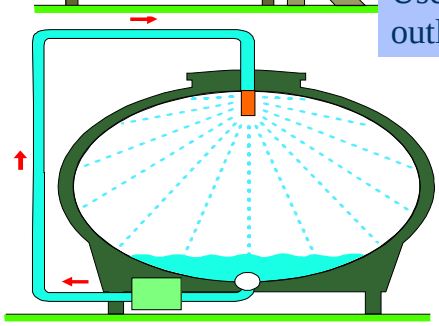
It is accepted that good quality milk is required to produce a good quality wholesome dairy product. As it was found that milking techniques and conditions were substandard it is recommended that formal training courses be held to assist the farmer to produce milk of the required hygienic and compositional standard. Clear milking guidelines and procedures must be provided. The economic benefits of producing good quality milk must be explained to the farmer.

Conditions at Milk Processing Plants need improvement and it is recommended that Good Manufacturing (GMP) techniques be introduced to all Dairy Plants followed by the introduction of Hazard Analysis and Critical Control Points (HACCP) and ISO quality standards. Considerable improvements in Good Manufacturing Practices can be brought about at minimum cost. For example the removal of grass and weeds adjacent to the milk reception and processing area is neither time consuming or costly. Staff at the dairy plant should be advised to dispose of cigarette ends and spent matches in a proper container and the removal of broken pallets, paper wrapping and cardboard boxes to an appropriate area would greatly improve the appearance of the plant. Discarded papers, cardboard boxes and other materials attract flies and vermin who may gain access to the processing area. Windows of the plant should be adequately screened to prevent the ingress of flies and rodent control measures should be put in place. Within the Plant the careful use of water hoses is important from a safety and water conservation point of view. A rack should be provided where a water hose is placed when not in use. Each water hose should have an automatic cut off tap, which will safe water and water costs. See diagram below. The above are a few examples of where improvements can be made at minimum or no additional cost to the Dairy Plant.

Pay extra attention to cleaning of the tank outlet and under the propeller

Use the tank outlet brush





Laboratory facilities at plant level should be upgraded to carry out a greater range of tests and this presupposes the availability of trained laboratory technicians.

An examination of the formal training of technical personnel for the Food Industry showed a lack of appropriate courses. It is recommended that training courses, at certificate, diploma and degree levels should be established at the University of Prishtina. Assistance and guidance with regard to detailed curricula, syllabus and pilot plant facilities should be provided as well as providing opportunities for graduates to pursue postgraduate courses overseas.

Constraints to the Further Development of the Dairy industry.

These may be summarized as follows and are already referred to above.

- Substandard on-farm facilities
- Poor quality milk supplies from farmers
- Bad management at farm level
- Substandard processing facilities
- Product modification and product diversification limitations due to poor quality raw milk and moderate processing facilities
- Insufficient advisory inputs particularly at farm level
- Lack of technically trained personnel at all levels of the dairy industry
- The threat of cheap dairy product imports

Frequent electricity breakdowns in the national grid supply and the high cost of borrowing money for expansion or improvement in equipment at either Farm or Plant level were often cited as problems faced by the Dairy industry. Unless and until these constraints are seriously and systematically addressed then the Dairy Industry will not reach it full potential with knock on adverse affects for the economy of Kosovo.

Recommendations for Further Action

These can be summarized as follows.

- A series of formal training courses on clean milk production should be organized through KAMP.
- A comprehensive milk quality payment scheme should be drawn up and implemented through discussions and collaboration between the Milk Producers Association and the Milk Processors Association.

ANNEX I

Feta Cheese

Standards: Moisture 55%; Fat 22%

Traditional Procedure (Structured Feta)

1. Standardize milk to P/F = 0.90 and pasteurize (72C, 16 S or 62C, 30 min.). The Bulgarian's prefer a perfectly white smooth product made from sheep's milk. Goat's milk also produces a white cheese. If desired, a smoother cows' milk product can be made by selecting milk with higher fat contents in the range of 5.5 to 6.0%. The undesirable cream color of cows' milk can be removed by treating the milk with 0.03 - 0.04% titanium dioxide. Titanium dioxide is diluted with 10x its weight of warm water and added to the milk before renneting. Whiter cheese can also be produced from cows' milk by homogenizing the milk.

2. Adjust temperature to 30C. Add 3% of *S. lactis* and/or *S. cremoris* starter. And 3 g lipase per 1,000 kg milk. Ripen for about an hour until TA increases by at least 0.05% and pH is 6.6 - 6.5.

3. Measure 120 ml rennet per 1,000 kg milk. Dilute the rennet with 10 volumes of water and add the mixture to the milk. Agitate for 3 minutes and then allow milk to set. Setting time should be 45 - 60 min.

4. Cut the curd using Omega" (12.8 mm knives) knives.

5. Stir gently for 20 min.

6. Dip curd and whey into rectangular forms on a drain table.

7. Drain for two hours at 30C, and then place the curd in a room at 18C and 85% RH. In the absence of such a room, cover the cheese with a clean cloth and store overnight at room temperature and humidity.

8. When the pH is 4.7, 20 - 24 hrs. After adding culture, take the cheese out of the hoops, weigh to the nearest 0.1 kg, and cut into 10 cm. cubes.

9. The required salt is 50 g of salt per kg of cheese. Weigh all the salt for all the cheese at once and distribute it uniformly by rubbing salt on all sides of the cheese surfaces. Place the cheese in 1 l plastic tubs with the lids partially open to allow some drying off of the cheese, and store at room temperature for 24 h. An alternative process is to dry off for 1 day under a damp cloth and then store in barrels or canisters for up to 30-45 days at 10 to 16C. After this ripening period, the cheese may be consumed as is or stored in 8% brine.

10. Add sufficient 8% brine to cover the cheese, and ripen at 10-16C for up to 30 -45 days. Subsequently store at 2-4C until consumed. The brine solution should contain 0.06% calcium chloride and sufficient acetic acid (vinegar) to adjust the pH to 4.6.

Distribution

Typically, Feta cheese is packaged and distributed to retailers and restaurants in one of four forms: (1) Cubes and brine in small tubs; (2) Crumbled product in a gas flushed package (nitrogen) ready for addition to salads; (3) Vacuum packed blocks; (4) Bulk shipments of cubes in large containers.

Process and Quality Control Notes

- At least 0.05 increases in TA before renneting
- pH 4.7 before surface salting
- Yeast and mould counts are the best indicators of hygienic problems. The low pH keeps bacterial spoilage to a minimum.
- a comfortable best before date is 6 months after manufacture. Good manufacturing practice and storage can achieve 12 months shelf life.

UF Procedure (Cast Feta)

1. Standardize milk to P/F = 0.80.

2. Ultra filter until retentive is 40% solids.

3. Add 3% *S. lactis* culture and 250 ml rennet/1,000 kg of precheese.

4. Quickly pour into 1 l plastic containers (3/4 full). Cover and allow to ripen to pH 4.8 (18 - 24 hrs.).

5. Add salt (3% of weight of cheese) to surface.

6. Store at 18C for at least 1 week before consumption.

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ANNEX II:

Yoghurt

Yogurt (also spelled yoghurt or yoghurt) is a semi-solid fermented milk product which originated centuries ago in Bulgaria. It's popularity has grown and is now consumed in most parts of the world. Although the consistency, flavors and aroma may vary from one region to another, the basic ingredients and manufacturing are essentially consistent:

- Ingredients
- Starter Culture
- Manufacturing Methods
- Yogurt Products and Others

Ingredients
Although milk of various animals has been used for yogurt production in various parts of the world, most of the industrialized yogurt production uses cow's milk. Whole milk, partially skimmed milk, skim milk or cream may be used. In order to ensure the development of the yogurt culture the following criteria for the raw milk must be met:

- low bacteria count
- free from antibiotics, sanitizing chemicals, mastitis milk, colostrums, and rancid milk
- no contamination by bacteriophages

Other yogurt ingredients may include some or all of the following:
Other Dairy Products: concentrated skim milk, nonfat dry milk, whey, lactose. These products are often used to increase the nonfat solids content
Sweeteners: glucose or sucrose, high-intensity sweeteners (e.g. aspartame)
Stabilizers: gelatin, carboxymethyl cellulose, locust bean Guar, alginates, carrageen, whey protein concentrate
Flavors
Fruit Preparations: including natural and artificial flavoring, color

Starter Culture
The starter culture for most yogurt production in North America is a symbiotic blend of *Streptococcus salivarius* subsp. *thermophilus* (ST) and *Lactobacillus delbrueckii* subsp. *bulgaricus* (LB). Although they can grow independantly, the rate of acid production is much higher when used together than either of the two organisms grown individually. ST grows faster and produces both acid and carbon dioxide. The formate and carbon dioxide produced stimulates LB growth. On the other hand, the proteolytic activity of LB produces stimulatory peptides and amino acids for use by ST. These microorganisms are ultimately responsible for the formation of typical yogurt flavour and texture. The yogurt mixture coagulates during fermentation due to the drop in pH. The streptococci are responsible for the initial pH drop of the yogurt mix to approximately 5.0. The

lactobacilli are responsible for a further decrease to pH 4.0. The following fermentation products contibute to flavour:

- lactic acid
- acetaldehyde
- acetic acid
- diacetyl

Starter cultures are those microorganisms that are used in the production of cultured dairy products such as yogurt and cheese. The natural microflora of the milk is either inefficient, uncontrollable, and unpredictable, or is destroyed altogether by the heat treatments given to the milk. A starter culture can provide particular characteristics in a more controlled and predictable fermentation. The primary function of lactic starters is the production of lactic acid from lactose. Other functions of starter cultures may include the following:

- flavour, aroma, and alcohol production
- proteolytic and lipolytic activities
- inhibition of undesirable organisms

There are two groups of lactic starter cultures:

1. simple or defined: single strain, or more than one in which the number is known
2. mixed or compound: more than one strain each providing its own specific characteristics

Starter cultures may be categorized as mesophilic or thermophilic:

Mesophilic

- *Lactococcus lactis* subsp. *cremoris*
- *L. delbrueckii* subsp. *lactis*
- *L. lactis* subsp. *lactis* biovar *diacetylactis*
- *Leuconostoc mesenteroides* subsp. *cremoris*

Thermophilic

- *Streptococcus salivarius* subsp. *thermophilus* (*S.thermophilus*)
- *Lactobacillus delbrueckii* subsp. *bulgaricus*
- *L. delbrueckii* subsp. *lactis*
- *L. casei*
- *L. helveticus*
- *L. plantarum*

Mixtures of mesophilic and thermophilic microorganisms can also be used as in the production of some cheeses.

Bacteriophage
Bacteriophages are viruses that require bacteria host cells for growth and reproduction. Initially, the bacteriophage attaches itself to the bacteria cell wall and injects nuclear substance into the cell. Inside the cell, the nuclear substance produces shells, or phage coats, for the new bacteriophage which are quickly filled with nucleic acid. The bacterial cell ruptures and dies as the new bacteriophage are released.
Bacteriophages are ubiquitous but generally enter the milk processing plant with the farm milk. They can be inactivated heat treatments of 30 min at 63 to 88° C, or by the use of chemical disinfectants.
Bacteriophages are of most concern in cheese making. They attack and destroy most of the lactic acid bacteria which prevents normal ripening known as slow or dead vat.

Starter Culture Preparation
Commercial manufacturers provide starter cultures in lyophilized (freeze-dryed), frozen or spray-dried forms. The dairy product manufacturers need to inoculate the culture into milk or other suitable substrate. There are a number of steps necessary for the propagation of starter culture ready for production:

1. Commercial culture
2. Mother culture - first inoculation; all cultures will originate from this preparation
3. Intermediate culture - in preparation of larger volumes of prepared starter
4. Bulk starter culture - this stage is used in dairy product production

Manufacturing Method
The milk is **clarified** and **separated** into cream and skim milk, then **standardized** to acheive the desired fat content. The various ingredients are then blended together in a mix tank equipped with a powder funnel and an agitation system. The mixture is then **pasteurized** using a continuous plate heat exchanger for 30 min at 85° C or 10 min at 95° C. These heat treatments, which are much more severe than fluid milk pasteurization, are necessary to acheive the following:

- produce a relatively sterile and condusive environment for the starter culture
- denature and coagulate whey proteins to enhance the viscosity and texture

The mix is then **homogenized** using high pressures of 2000-2500 psi. Besides thoroughly mixing the stabilizers and other ingredients, homogenization also prevents creaming and wheying off during incubation and storage. Stability, consistency and body are enhanced by homogenization. Once the homogenized mix has cooled to an optimum growth temperature, the yogurt starter culture is added.

A ratio of 1:1, ST to LB, inoculation is added to the jacketed fermentation tank. A temperature of 43° C is maintained for 4-6 h under quiescent (no agitation) conditions.

This temperature is a compromise between the optimums for the two micoorganisms (ST 39° C; LB 45° C). The titratable acidity is carefully monitored until the TA is 0.85 to 0.90%. At this time the jacket is replaced with cool water and agitation begins, both of which stop the fermentation. The coagulated product is cooled to 5-22° C, depending on the product. Fruit and flavour may be incorporated at this time, then packaged. The product is now cooled and stored at refrigeration temperatures (5° C) to slow down the physical, chemical and microbiological degradation.

Yogurt Products
There are two types of plain yogurt:

- Stirred style yogurt
- Set style yogurt

The above description is essentially the manufacturing proceedures for stirred style. In set style, the yogurt is packaged immediately after inoculation with the starter and is incubated in the packages. Other yogurt products include:
Fruit-on-the-bottom style:
fruit mixture is layered at the bottom followed by inoculated yogurt, incubation occurs in the sealed cups
Soft-serve and Hard Pack frozen yogurt
Continental, French, and Swiss:
stirred style yogurt with fruit preparation

Yogurt Beverages

Drinking yogurt is essentially stirred yogurt which has a total solids content not exceeding 11% and which has undergone homogenization to further reduce the viscosity, Flavoring and coloring are invariably added. Heat treatment may be applied to extend the storage life. HTST pasteurization with aseptic processing will give a shelf life of several weeks at 2-4°C, which UHT processes with aseptic packaging will give a shelf life of several weeks at room temperature.

Other Fermented Milk Beverages
Cultured Buttermilk

This product was originally the fermented byproduct of butter manufacture, but today it is more common to produce cultured buttermilks from skim or whole milk. The culture most frequently used in S. lactis, perhaps also spp. cremoris. Milk is usually heated to 95°C and cooled to 20-25°C before the addition of the starter culture. Starter is added at 1-2% and the fermentation is allowed to proceed for 16-20 hours, to an acidity of 0.9% lactic acid. This product is frequently used as an ingredient in the baking industry, in addition to being packaged for sale in the retail trade.

Acidophilus milk

Acidophilus milk is traditional milk fermented with Lactobacillus acidophilus (LA), which has been thought to have therapeutic benefits in the gastrointestinal tract. Skim or

whole milk may be used. The milk is heated to high temperature, e.g., 95°C for 1 hour, to reduce the microbial load and favor the slow growing LA culture. Milk is inoculated at a level of 2-5% and incubated at 37°C until coagulated. Some acidophilus milk has acidity as high as 1% lactic acid, but for therapeutic purposes 0.6-0.7% is more common.

Another variation has been the introduction of a sweet acidophilus milk, one in which the LA culture has been added but there has been no incubation. It is thought that the culture will reach the GI tract where its therapeutic effects will be realized, but the milk has no fermented qualities, thus delivering the benefits without the high acidity and flavor, considered undesirable by some people.

Sour Cream

Cultured cream usually has a fat content between 12-30%, depending on the required properties. The starter is similar to that used for cultured buttermilk. The cream after standardization is usually heated to 75-80°C and is homogenized at >13 MPa to improve the texture. Inoculation and fermentation conditions are also similar to those for cultured buttermilk, but the fermentation is stopped at an acidity of 0.6%.

Others

There are a great many other fermented dairy products, including kefir, koumiss, beverages based on bulgaricus or bifidus strains, labneh, and a host of others. Many of these have developed in regional areas and, depending on the starter organisms used, have various flavors, textures, and components from the fermentation process, such as gas or ethanol.

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ANNEX III :

Production of cheese

Definition and chemical composition of milk

Milk is a product of the mammary gland produced by regular milking of healthy and properly fed milking animals. During the process nothing is either added or taken from it. Milk has a very complex chemical composition, made from hundreds of elements and compounds which determine the physical characteristics of milk. The composition of milk varies widely; therefore it is difficult to define it. During the process of determining the composition of milk, middle values and variations apply. Milk is composed of dry matter, in average about 12.5%. The dry matter of milk is composed of those elements which, during the heating process of milk do not evaporate. The other component of milk is water, which makes up to 87.5%. During the heating process, other gasses such as CO_2, NH_3, H_2S, O_2, N_2 and H_2 evaporate along with water, as well as some easily evaporative elements such as alcohol, fatty acids, amines, ketons, esters, aromatic compounds etc.

Water

The largest amount of sheep's milk, about 87.5% consists of water. The largest amount of water is free water, and a smaller amount, about 4% is bound to protein, fat and lactose. The free water is not bound to milk components and that is the water which evaporates at 100C. The other components of milk are dispersed through it.

Protein

Protein is the main nitrogen – based component of milk and it makes up about 95% of the total nitrogen – based components of milk. The average amount of protein in milk is 3.55% or, 28% of the total dry matter. Milk protein is divided into casein and protein of milk serum. (Whey protein). Another division, based on origin divides protein on mammary gland synthesized protein and blood derived protein. Casein, lactoalbumine, and lactoglobuline derive from The mammary gland. Serumalbumines and immunoglobulines derive from the blood.

Casein is the most important milk protein. Its amount in milk varies from 2.8 – 3.4 or 78 – 85% the amount of total milk protein. Casein is a complex protein, a phosphoprotein, which is synthesized in the glandular epithelium of the udder. Casein is composed of 18 amino acids out of which 40% are essential amino acids. Besides amino acids, casein contains phosphorus, calcium, galactose, N – acetylneuraminic acid and some other acids. All of this gives us the right to classify casein in the group of phosphoglucoprotein.

Main fractions of casein are: αs - casein, β – casein, γ - casein and K- casein. αscasein makes up the largest amount of the casein molecule. Main fraction is the αs1casein. The second fraction in size is the β - casein, whilst γ - casein is the least present fraction. K - casein is the most complex fraction, because besides amino acids, it also contains phosphorus, sugar and elements derived from sugar. The main sugar is galactose, and, N - acetyl galactozamine and N – acetyl galactozaminic acid as elements that derive from sugar. Since the k – casein molecule is found on the surface of the casein molecule, it is thought that all of these components provide the lyophilic character of k - casein.

The casein of milk is in the form of mycelia and each micelle is composed of 50 – 100 submicellia. The casein micelle is composed of protein and minerals which are in form of salts. The protein components make up 94% of the casein molecule, and the rest is made up from elements such as Ca, P, Na, K, Mg, and citrates. The monomer units of casein micelle are connected trough calcium – phosphoric bind. The COO- group from one side of the molecule connects to the Ca^{2+} ion, and the inorganic phosphorus connects the other side of the molecule through calcium. Thus, the so formed, calcium – phosphate – casein ate complex has the following structure:

…R_1 – COO – Ca – HPO4 – Ca – OOC – R_2…

The molecules of the casein in milk are in a stabile colloid solution. The stability of this solution depends on the electric charge and the degree of hydration of casein molecule.

How does the coagulation of casein take place?

Coagulation caused by acids

Mycelia of casein have negative electric charge in fresh milk. This electric charge derives from the -COOH group which dominates over positive $–NH_2$ group. This situation does not allow the -COOH group to connect during contact. This phenomenon provides the stability of casein molecules.

If the negative charge would be neutralized by adding H+ ions from acids it would lead to neutralization of the rejection forces and creation of agglomerates of mycelia and their sedimentation. The casein mycelia will be completely sedimented on pH 4.6. On this pH value the number of - COOH will be the same with the H+ from the organic or inorganic acid. The electricity of the casein on this pH will be zero. This way of destabilization of the casein complex, or the coagulation of casein does have a practical use in acid milk products production (yogurt and acid milk) as well as ricotta.

Coagulation caused by enzymes

Regarding technology, enzymes (hymosine, trypsine, pepsin, or their mixtures in various ratios) have the widest use in the coagulation of casein from milk. Hymosine plays the biggest role of all enzymes in casein mycelia destabilization. Its function is based on hydrolysis of k – casein. Hymosine tears the peptide band between the 105 and the 106 amino acid in the k - casein chain. The numbers 105 and 106 are the amino acids phenin and methionine. This process results in the creation of two new molecules: paracapa casein and glycomacropropeptide. The first molecule contains 105 amino acids, and the second one contains 64. Paracapa casein is insoluble in water and in the absence of Ca^{2+} does not form gel. A very important factor of gellation is the presence of Calcium phosphate in the native casein mycelia, which results in creation of Ca – parakapa – casein.

The gellation process has two stages:

Transformation of casein into paracasein, which is a purely chemical process, and coagulation of the paracasein under the influence of the Ca ions, which is a chemical process. The first stage results in creation of Ca – paracaseinate and soluble protease which become components of the gel. The second stage results in creation of Ca – diparacaseinate after Ca – ions interact with Ca – caseinate. Ca – dicaseinate is insoluble and sediments in a form of porcelain – white soft, and variable in firmness curd.

The higher the concentrations of Ca ions in milk the higher the aggregation of the paracasein particles, and the other way round. That is why it is not possible to form a gel from fresh milk which has a small quantity of Ca ions, unless some $CaCl_2$ is not added.

Milk serum Protein is protein that stays in milk serum after casein is removed from it. Milk serum protein can be: α - lactoalmubine, β – lactoglobuline, and blood serum albumin. Compared to casein, milk serum protein is richer in amino acids that contain sulfur, which is an additional factor for its higher biological value. Coagulation starts at temperatures above 70C and it is most intensive at temperatures above 80C. The coagulated milk serum protein sediment and stick on the bottom of the heated surface, which is visible when milk is boiled. Milk serum protein has globular structure, because its peptide bands are spirally curved and are interconnected with hydrogen or other bands. According to this there is α and β structure. If this protein is treated with high temperatures, the band break which causes the process of denaturation of milk serum protein. Denaturation results with relocation of the - S – S – groups on the surface of protein. During this H_2S is released, and that is how boiled milk gets its taste and aroma.

Milk fat

The most variable component of sheep's milk is milk fat. The average content is 3.8%. Milk fat can be simple or complex. The biggest amount of simple fat consists of glycerides (98.5%), out of which, 96% are triglycerides). Complex milk fat is also known as polar lipids. Simple milk fat has mainly energetic value, whilst complex milk fat has mainly biological value.

Simple fats are in fact esters of trihydroxil alcohol Glycerol and fatty acids. Triglycerides make up 96% of all simple fat; the diglycerides make up about 2-3%, and the monoglycerides 0.1%. Biosynthesis of fat occurs in mammary gland cells. Glycerol needed for synthesis derives from blood glucose, through the process of hydration of dioksiacetone phosphate, and a smaller part derives from triglyceride or from blood glycerol. The low fatty acids ($C_4 – C_{10}$) are produced in the mammary gland but they can also be produced from acetic acid and beta – hydroksibutyric acid. The higher fatty acids (over C_{18}) are not synthesized in the mammary gland, but derive from blood, from hylomicrones and beta – lipoprotein, whilst the $C_{12} – C_{16}$ fatty acids derive from both sources. Fat is characterized with the presence of low fatty acids which are not found in other types of fat both from vegetable or animal origin, or they are present but in them, but, in minute quantities. The content and the interratio of fatty acids influence the consistence of fat. The higher the contents of low fatty acids, the softer the fat. This is because the melting point of milk fat is lower. Volatile fatty acids are essential because milk fat is especially important in human nutrition. The average number is 20 – 60 fatty acids which are composed of 4 to 22 C volatile and non - volatile C atoms. The most prevalent from the unsaturated free fatty acids are myristic (With 14 C atoms), palmitic (C_{16}) and sthearic (C_{18}). Besides these, there is some butyric (C_4), caproic (C_6), caprylic (C_{10}) and lauric (C_{12}) acid. The most prevalent of the saturated free fatty acids is the oleic acid. There is some linoleic, linolenic and arachidonic acid.

Milk fat is neutral. The taste and flavor of the particular fatty acids are not accentuated. Exception from this statement is tributrin which has a particular unpleasant taste. The volatile fatty acids (butyric and caproic) have very unpleasant taste and flavor. If they are found as such unbound in milk or milk products they could cause serious disruptions of taste and flavor (typical example being goats milk). Milk fat is dispersed in milk either as suspension or as emulsion. Immediately after milking, fat is found in the form of emulsion, after cooling it gets in the form of suspension. Fat in milk is found in the form of fat droplets. Their size depends on type, breed and lactation phase of the animal from which milk derives. Fat droplets can be separated on the surface of milk with time, and they are the least dispersed from all milk components.

Complex fat is in fact phosphatidesin which besides fatty acids contains phosphoric acid and an amino acid. The total amount of phospholipids in milk is 0.0337%. Lecithin, kefaline and sphingomyelin are some of the phosphatides that are found in milk. The most prevalent is lecithin with 65% of the total phosphatides of milk.

Lecithin (glycerophospatidilicholine) consists of glycerin, two fatty acids and choline. Lecithin has free acid and alkali group and could be bound with acids and alkali as well as with protein. After binding with protein it creates a lecithin – protein complex which is found on the surface of the fat droplet. Lecithin has combined features, because it has a part of the molecule that is similar to fat and is soluble in fat. It also has a part which by features and characteristics is similar to protein. These characteristics enable lecithin to be a connecting point between fat and the water phase. Lecithin is a surface - active substance which enables it to concentrate on the area between the two phases thus creating a stabile emulsion of fat.

Kefalin consists of glycerin, phosphoric acid and ethanolamine or serine. Kefalin is also a surface - active substance and is concentrated mainly in the area between the two phases, which enables it to be found in the adsorptive layer of the fat droplet.

Sphingomyelin is a complex fat consisting of aminoalcohol sphingosine, a fatty acid and choline.

Changes in milk fat

When subdued to physical, chemical or biological factors, milk fat is prone to hydrolysis, oxidation or polymerization. From the physical factors Light has the highest influence. Light accelerates oxidation and hydrolysis. Light influences volatile fatty acids, causing oxidation. These changes can be noticed by the change of taste and flavor to smell of fish, tar, metals, etc. Oxidation can result in many different products which could be sensed through change of taste and flavor of milk or milk product. On 50C oxidation takes place on the volatile bound of the fatty acid. This results in creation of peroxides and hydroperoxides. Since they are not stabile they dissolve and as a result oxygen is created. The oxygen molecule can oxidize another volatile fatty acid, which along with water produces H_2O_2 and ozone. The new peroxides further react with other volatile fatty acids, which results in two other free radicals. So, the chain reaction, known as autooxidation continues. Since peroxides are not stabile, there is a further dissolution of fatty acids to aldehides, ketones, new acids etc. Changes in appearance which accompany this process result in bitter and sharp taste of fat (rancidity). Hydrolytic changes are caused by the action of an enzyme known as lipase on the glycerides, which results in creation of fatty acids, amongst which, volatile fatty acids, which have very particular taste and flavor. As a result, the taste and flavor of milk changes also. This is defined as hydrolytic lipolysis of milk fat. Hydrolysis of milk fat is caused by lipase which arrives from microorganisms present in the mammary gland. Hydrolysis of milk fat could never end totally because the released fatty acids (butyric acid) inhibits the further hydrolysis. Lipolysis is caused by different factors. One of them is mechanical damage of fat droplets. Mechanical milking, especially if the machines have pipes with curves, causes enhanced lipolysis. This is explained with the fact that during flow through the pipes milk hits the walls of the pipes, which causes enhancement of lipolysis. During this there is some damage on the layer of the fat droplet and free fatty acids are formed. They then come into direct contact with lipase.

Lactose

Specific product of the mammary gland, and it can be found only in milk. Lactose is a disaccharide composed of glucose and galactose. The glucose needed for lactose synthesis comes directly from the blood into the mammary gland cells. Galactose is created from glucose through glucoso – 6 phosphate, with the help of the glucoso – 6 – phosphatase

enzyme. When glucose and galactose are bound they form lactose. Lactose is the least prone to variation in size from all milk components. The amount of lactose in milk depends on the animal kind and the health condition of the mammary gland. A low amount of lactose in milk of particular animals could be a signal for mastitis. The concentration of lactose in milk varies from 4.7 – 4.9%. When heated to 150 – 160C, lactose gets a yellowish shade, and when the temperature is raised to 175C it turns brown. This temperature causes caramelisaton of lactose which is accompanied by particular smell. Higher temperatures change milk color, not because of caramelisation, but because of reaction between free amino groups from the protein and the aldehide groups of the sugar. This degradation processes results in creation of melanoids, aldehides, acids, $C0_2$, H_20 etc.

Lactose can be hydrolyzed by enzymes of microbial origin. According to the products of lactose fermentation, there are several types of fermentation: acid milk fermentation, acid fat fermentation, propionic and butyric fermentation. Pure homfermentative milk acid bacteria cause acid milk fermentation which results in creation of lactic acid. Besides lactic acid, there is some $C0_2$, H_2, CH_4, $CH_3 – COOH$, CH_3CH_2COOH as well etc.

Propionic fermentation is important in production of certain types of cheese. (Swiss cheese). Propionic acid can be a direct product of glucose transformation, but, during the cheese production process, this is only secondary, and is only a continuation of the milk acid fermentation. Milk acid bacteria dissolve glucose to lactic acid which immediately converts into propionic acid.

Butyric fermentation is a secondary process from glucose transformation products: lactic acid, pyruvic acid and glycerin. Butyric fermentation is an unwanted process in milk and milk products, because it results in creation of butyric acid which changes the taste and flavor to the extent that the products could not be consumed.

Alcohol fermentation is done by direct transformation of milk sugar into alcohol and CO_2. This fermentation has found a wide use in the production of fermented acid milk products.

Chemical reactions of some types of fermentation of milk sugar:

Milk acid fermentation

$C_6H_{12}O_6$ ----------$2CH_3CHOHCOOH$

glucose lactic acid

Propionic fermentation

$3C_6H_{12}O_6$ ---------- $6CH_3CHOHCOOH$

glucose lactic acid

$3CH_3CHOHCOOH$ ---------- $2CH_3CH_2COOH + CH_3COOH + CO_2 + H_2O$

lactic acid propionic acid acetic acid

Citric fermentation

$CH_2COOH – HOOCCOOH – CH_2COOH$ ---------- $2CH_3COCOOH$ --------- $CH_3COCHOHCH_3$ +

citric acid pyruvic acid acetylmethylcarbinole

$2CO_2$

$CH_3COCHOHCH_3$ ---------- $CH_3COCOCH_3$

acetylmethylcarbinole oxidation –2H diacetyl

$CH_3COCHOHCH_3$ ---------- $CH_3CHOHCHOHCH_3$

acetylmethilcarbinole reduction +2H 2,3butlengycol

Alcohol fermentation

$C_6H_{12}O_6$ ---------- $2C_2H_5OH + 2\ CO_2$

glucose ethanol

Butyric fermentation

$C_6H_{12}O_6$ ---------- $CH_3COOH + CH_3CH_2CH_2COOH + CH_3CH_2OH + CH_3CH_2CH_2CH_2OH +$

glucose acetic acid byturic acid ethanol butanol

$CH_3COCH_3 + CO_2 + H_2$

acetone

Coliform gas fermentation

$2C_6H_{12}O_6 + H_2O$ ---------- $2CH_3CHOHCOOH + CH_3COOH + C_2H_5OH + 2CO_2 + 2H_2$

glucose lactic acid acetic acid ethanol

Minerals

Minerals comprise 0.65% of milk and 5% of total dry matter. Even though the amount of minerals in milk is very small they are very significant for nutrition and for the physical balance of milk. Around 40 different minerals are determined in milk. They are divided into macro and microminerals. Minerals (ash) contain elements which originate from both organic and inorganic compounds of milk.

Microelements in milk are in various forms. There is K, Ca, Na, Cl, citrates, Mg, P, etc.

Ca and P are most important, because without their presence it is unimaginable to transform milk into cheese.

Citrates are in the form of citric acid in milk. It is synthesized in the cells of the mammary gland from pyruvic acid. Ca and Mg form a complex which is important for milk stability and prevention of milk coagulation during heating and freezing.

Microelements are components of some enzymes and vitamins. Iron is a component of some enzymes, and Cobalt is a component of vitamin B_{12}.

Enzymes in milk

There are 60 different enzymes in milk. They originate from the mammary gland, blood plasma, leukocytes and microorganisms. Some enzymes are inactivated during heat treatment of milk. This is used in the process of processing analysis. The most important enzymes in this matter are hydrolases and oxido – reductases. The most important oxido - reductases are: Peroxidase, catalase, xantin – oxidase, and super - dismutase. The most important hydrolases are: phosphatase, prothease, lipase, amylase, beta – galactosidase etc.

Peroxidase

Peroxidase consists of a protein carrier which has characteristics of an albumin. The prosthetic group of the peroxidase consists of chemine. Peroxidase produced in the mammary gland varies from the other types because it has two atoms of iron and it is called lactoperoxidase. Peroxidase catalyses dissolution of hydrogen peroxide in the presence of

oxygen as an acceptor. Peroxidase is inactivated on 80C, which is used in controlling high pasteurization of milk. When pasteurized milk is kept on a temperature of 30C for a longer period peroxidase becomes active again. Along with thyocianate and H_2O_2 lactoperoxidase limits the growth of microorganisms in milk. Lactoperoxidase has two enzymes which oxidize thyocianate (SCN -) in the presence of H_2O_2 to intermediary products of oxidation, which have antimicrobial effect. (OSCN – O_2SCN -; O_3SCN -). The final products of oxidation (SO_4, NH_4, and CO_2) are inactive. The oxidation products cause damage of the bacterial membranes.

Catalase

It enhances dissolution of H_2O_2 into water and oxygen. Catalase originates from the mammary gland and microorganisms. The amount of catalase in milk is proportionate with the presence of leykocytes in milk. This feature is used for indirect count of the somatic cell number in milk, therefore for diagnosis of mastitis.

Phosphatase

Phosphatase enhances hydrolysis of phosphoric acid esters. It is present in all living organisms. In milk it originates from the mammary gland and microorganisms. The alkaline phosphatase is important because the conditions for its destruction are close to the conditions necessary for the temperature and time needed for destruction of the Mycobactherium tuberculosis. This feature is used to analyze if heat treatment of milk was done on low pasteurization temperature (65C for 30 minutes) or high pasteurization (72C for 15 seconds) temperature.

Proteinase

Enzymes which enhance dissolution of protein to peptides and amino acids. Their origin is from milk and microorganisms. Dissolution of milk protein is caused from the proteinases of microbial origin.

Lipase

It enhances milk fat hydrolysis to fatty acids and glycerol. Milk contains three types of lipase: natural, lipase that originates from leukocytes and lipase of microbial origin. They are thermolabile and are inactivated on a temperature of 85C for 10 seconds. Lipolysis is higher in milk cooled on 2C than on 4C.

Vitamins

Vitamins are biologically active substances necessary for all biochemical processes in the organism. Their amount in milk varies and depends on the nutrition and the way on which the animals are raised. It also depends on the lactation stage and the health condition of the animal. Based on their solubility, vitamins could be divided on vitamins soluble in water and vitamins soluble in fat. Fat - soluble vitamins are: A, D, E, and K. water - soluble vitamins are: B_1 (thiamin), B_2 (Riboflavin), B_6 (pyridoxine), B_{12} (cobalamine), B group (niacin, biotin, folic acid, pantothenic acid) and vitamin C (ascorbic acid). Milk contains vitamin A and its precursor β-carotene. B – Carotene splits into two molecules of vitamin A in the liver, which then, through the blood comes in milk. Both vitamin A and β – carotene are fat - soluble and connect to the layer of the fat droplets. The amount of vitamin A in milk depends on the amount of carotene in the feed of the animal. When the animal is fed with more green food, its milk is richer in vitamin A, than when it is fed with dry feed. Carotene has orange color, thus the yellowish color of milk. 20% of vitamin A is lost during the pasteurization process. Its amount is also decreased for 25 – 50% when milk is left to stay. There are disturbances in eyesight when there is not a sufficient amount of milk.

Milk contains D – group vitamins as well. It contains D_2, D_3, D_4, and D_5. Most important are D_2 (ergostherol) and D_3 (calciferol). Vitamin D takes part in the transportation of Calcium and Phosphorus in blood and it is essential in the proper growth of the young. The amount of Vitamin D depends on the nutrition and the way the animals are raised. Milk from animals fed on pastures is richer in vitamin D. This vitamin is thermoresistant. The amount of this vitamin is not sufficient for human consumption, therefore it is added to milk.

Vitamin E is found in the adsorptive layer of fat droplets. The amount of vitamin E in milk depends on the nutrition of animals and its amount averages 0.2 – 2.5 mg/kg. When animals are fed with green feed, their milk is richer in vitamin E. During pasteurization, the amount of milk decreases for 20 – 30%. Vitamin E has anti – oxidation effect and it influences the stability of the fat droplets, and therefore stops rancidity of fat.

Vitamin K is found in traces. It takes part in creation of pro – trombine.

Vitamin B_1 (thiamin) is a part of the coenzyme carboxylase which enhances the decarboxylation of pyruvic acid in the process of carbohydrathe transformation in the body. Lack of this vitamin causes storing of large amount of pyruvic acid, which has a negative influence on the nervous system. The amount of thiamin in milk is averages 0.5 mg/kg.

Vitamin B_2 is more known as riboflavin or lactoflavin. This vitamin is an essential part of the enzymes NAD and FAD which take part in the oxidation of glucose, fatty acids and amino acids. The amount of this vitamin in milk is 1 – 2 mg/kg. Its color is yellow – green, which determines the color of the whey.

The amount of vitamin B_6 (pyridoxine) in milk is 2.3mg/kg.

Vitamin B_{12} (cobalamine) is mostly bound to protein, for whey protein in particular. This vitamin is the least stabile of all vitamins in milk. It is present in traces from 0.003 – 0.005 mg/kg. People suffer various disorders if they lack vitamin B_{12} it their nutrition. Anemia being the most common example.

The amount of vitamin PP (niacin) in milk is 1 – 2 mg/kg. Avitaminosis causes pellagra. The average amount of vitamin PP in milk covers only 9 – 12 % of the daily need of humans.

The amount of vitamin H (biotin) in milk is 0.05% mg/kg which covers 15% of the daily needs of humans. During pasteurization the amount of biotin decreases for 16%. Avitaminosis causes pain in the muscles, weakness and dermatitis.

The amount of folic acid in milk is 0.06 mg/kg which covers 14% of the total daily needs of humans. Avitaminosis or hypovitaminosis cause slow growth, anemia, leucopenia etc.

Vitamin C (ascorbic acid) is biologically active in the forms of L – ascorbic acid and dehydro L – ascorbic acid. Avitaminosis of vitamin C causes scurvy. The amount of vitamin C in milk is 20mg/kg, which is far from enough to satisfy the daily needs. Vitamin C is prone to oxidation, so after milking or heat treatment its amount decreases. Vitamin C decreases fat oxidation and has a role of anti – oxidant.

Composition of milk in different mammals

	Dry matter	Fat	Protein	Casein	Lactose	Ash
Cow	12.5	3.8	3.5	2.8	4.8	0.65
Sheep	19	7.5	5.7	4.5	4.3	0.9

Goat	13.5	4.4	4.1	3.3	4.4	0.8
Buffalo	17.6	7.7	4.1	3.5	4.8	0.72
Woman	12.5	3.7	2.1	0.9	6.4	0.3

Sheep's milk has twice the amount of dry matter than cow's milk. The double amount of dry matter is due to larger amount of fat and protein, because of which this milk is especially good for production of various types of cheese. Milk composition varies during lactation. The smallest percent of dry matter is at the beginning of lactation with 16%, whilst the largest per cent is at the end of lactation with 24.5%. Sheep's milk contains much more volatile fatty acids than cow's milk, which causes big differences in the physical characteristics of milk fat and the appearance of milk. The melting point of sheep's milk fat is 29C which is significantly lower than the same of cow's milk. Because of this, sheep's milk is not a good raw material for making butter. The size of fat droplets of sheep's milk is 5 – 6 μm which is larger than the same in cow's milk. Even though, the size of fat droplets in sheep's milk is larger than the size of fat droplets in cow's milk. Due to the higher viscosity of sheep's milk, fat is appears on milk surface more slowly than in cow's milk. Sheep's milk contains double the amount of whey protein which makes it a better raw material for production of ricotta as a by – product. Sheep's milk has 35% more minerals, higher amount of calcium and nearly 10 times more iron than cow's milk. The color of sheep's milk is white because most of beta – carotene is already converted into vitamin A, which is not the case in cow's milk. This is also why milk products from sheep's milk are white in color. Because of the higher amount of protein, sheep's milk has a higher value for titration acidity which varies from 7 to 9.5 SH, or a pH of 6.5 – 6.6.

Physical and chemical characteristics of milk

Milk is an intransparent white liquid with various yellowish shades. Due to the presence of lactose it has a sweetly taste. The smell of fresh milk varies by the origin of milk and is similar to the smell of the animal from which it originates. Milk is semi dispersed systems, whose components are various and are variably dispersed. Some of the components of this system are dispersed in water, e.g. lactose and salts. Their solution in water is then a solution for the protein, and the entire milk plasma is a solution for fat. If milk would not contain protein, then the entire structure would be divided into fat and water. If milk would not contain minerals, then the structure would be deprived of protein.

Acidity: Fresh milk has a slight acidity with pH from 6.5 - 6.7 depending from the type of the animal it originates from. This acidity is called natural acidity and it comes from protein, primary and secondary phosphates, citrates and CO_2. The activity of microorganisms on lactose results in creation of lactic acid. This type of acidity is called acquired acidity. The acidity of milk is presented either as a total acidity or as a active acidity. Total acidity of milk is defined as the number of ml of alkali needed to neutralize 100 ml of milk in the presence of phenolphthalein as an indicator. The usual choice for an alkali is NaOH. Active acidity is defined as degrees of acidity of Soxhlet – Henkel (SH), which is number of ml. Of 0.25mol/l NaOh needed for neutralization of acidity groups in 100 ml of milk in the presence of phenolphthalein as an indicator. Thorner (T) is defined as number of ml. Of –0.1 mol/l NaOH used for neutralization of acidity groups 100 ml of milk in presence of phenolphthalein as an indicator. Dornic (D) is defined number of ml. Of 1.9mol/l spent for neutralization of acidity groups in 100 ml milk in the presence of phenolphthalein as an indicator. Some countries use % of lactic acid which is degrees of Dornic divided by 100.

% m. acid = D/100

Our legal regulations require acidity by SH. The different types of acidity degrees could be transformed on the following way:

1SH = 2.5T; 1SH = 2.25D

The total acidity of milk varies from 6.4 – 7.2 SH.

The active acidity or pH is a negative decade logarithm f the hydrogen ions concentration and is as previously mentioned 6.5 – 6.7.

Density: physical characteristic which is defined s a ratio between the weight and volume on an apposite temperature and pressure. The measure is in kg/m3. Milk density depends on the composition of milk. Average density of cow's and goat's milk on 20C is 1.028 and 1.030 kg/m3. The density of sheep's milk on the same temperature is 1.033 – 1.035 kg/m3. Protein, lactose and minerals have in average higher density than milk as a whole, therefore, if the concentration of these components in milk is higher, the density of milk as a whole would be higher as well. Fat and water have lower density than milk, so by increasing their amount in milk, the density if milk as a whole decreases.

(With the removal of fat, the density of milk increases.) This shows that normal values for milk density could be achieved by removal of fat which is used in falsifying. There are several methods which are used in determining milk density. The simplest and most practical method is by lactodenismether on 20C. When the density is measured on temperatures higher than 20c, 0.0002 is added for each degree above 20C. The same goes for temperatures bellow 20C. 0.0002 is taken for each degree bellow 20C.

Freezing point: This value is directly depends from the osmotic pressure. During secretion of milk, its osmotic pressure is mainly the one of the blood, which is regulated by the ratio between the lactose and chlorides in milk. Thus, the freezing point of milk depends from the content of lactose and minerals in it. The freezing point of cow's milk is – 0.55C, and could vary between

–0. 525 to –0. 565C. If we determine the freezing point of milk we could easily determine the water added. The oxido - reduction potential of milk varies from + 0.2 to +0.3V, the average viscosity is $1.8x10^{-3}$ Pa on temperature of 20C, the osmotic pressure is 0.67kPa, ant the value of ++++ (refraction) is 1.3470 – 1.3615 on 20C.

The refraction of milk is usually measured by refractomether by Abbe. Refraction of milk measured in this way is 39 but, it could vary from 38 – 42 on 17.5C. Refraction is used to determine the amount of water added in milk. By adding water in milk, the degree of refraction decreases. The per cent of water added in milk is calculated by the following formula:

% Of added water = (39 – R) x100/24

39 – average value of refractometric number of milk which is constant on 17.5C.

R – refractometric number of milk

24 – difference between the refractometric number of milk with constant composition and distilled water (39-15).

Heat treatment of milk

The basic principle of heat treatment of milk is to heat it and hold it on a certain temperature for a period of time. The aim of this procedure is to destroy the pathogenic and to minimize the saprophytic microorganisms, whilst at the same time to withhold the nutritional value and the appearance of milk. Coliform microorganisms are destroyed on a temperature of 70C for

1 second or 65 C for 10 seconds. M tuberculosis is more thermoresistant than coliform bacteria; therefore milk should be treated on a different time/temperature regime. M. Tuberculosis is destroyed on a temperature of 63C for 30min. or on 72C for 15 seconds. These parameters are in fact pasteurization parameters and are used in production of all milk products, except the acid fermented products which have different time/temperature regime for pasteurization. The M.Tuberculosis pasteurization time/temperature regime is the regime where phosphatase is also inactivated; thus its presence in milk is a proof of an inappropriate pasteurization. Heat treatment of milk does not only destroy the pathogens, but it also changes the appearance of milk (taste and flavor). However, if the time/temperature regime for destruction of M. tuberculosis is used, it does not change the taste and flavor of milk and its nutritional value stays the same. The following regimes are used for heat treatment of milk: thermisation, pasteurization, and sterilization. The most important regime in the cheese production process is pasteurization.

Pasteurization

Pasteurized milk is often used in the cheese production process. Pure bacterial strains are added to milk in order to produce cheese. Bacteria added to milk is called starter, because it starts the cheese production process. Bacteria from the starter invert the lactose into lactic acid which givers milk an acid taste. The starter also plays part in the gellation, in the separation of whey and it also take part in the maturation process, which influences the taste of cheese. The use of pasteurized milk and starter enables more control over the cheese production process.

What is pasteurization?

The main purpose of pasteurization is to destroy all pathogens and to limit the total number of other microorganisms in milk. Pasteurization also eliminates bacteria which could cause problems in cheese production process and could limit the quality of the final product. The pasteurization itself could not enhance the quality of milk. Its primary purpose is to make milk proper for consumption.

There are three approved ways of milk pasteurization:

Low or permanent pasteurization on 63 – 65C on 30 minutes.

Short pasteurization on 72C during 15 seconds.

High pasteurization above 87 C on few minutes.

Sanitation and maintenance of equipment

It is of paramount importance to keep the equipment clean and sanitized. More problems in cheese production occur exactly because equipment is not properly cleaned and sanitized. Equipment should always be rinsed immediately after use.

The following procedure is used:

Rinse the utensils with warm water (40C) in order to remove the remains of milk and coagulum. Do not use hot water for rinsing because it will only cause the remaining milk and coagulum to stick to the surface of the utensil.

Wash the utensils with an alkali detergent (solution of sodium hydroxide 0.5 – 1%) heated to 55 – 60C in order to dissolve milk fat.

Rinse the utensils with warm water

Clean the hard remains (milk stone) with acid detergent (nitric acid or another acid solution with a pH 2.5 – 3) heated to 55 – 60C.

Rinse the utensils with warm water

Before use, disinfect the equipment with hot water (80 degrees Celsius or higher) or with a sodium solution.

Always check the equipment for apertures or abrasions. Do not use any damaged equipment because this is a fertile ground for development of bacteria, which lather disrupts the cheese production process.

Bacteria common for milk and milk products

The most important members of this group are the bacteria of acid milk fermentation. They comprise the normal microflora of milk and are almost always present in milk and milk products.

The first study of milk microorganisms was done by Orla - Jensen. According to this study, bacteria are classified to typical and atypical.

During lactose fermentation typical bacteria produce mostly lactic acid, they are facultatively anaerobic, do not reduce nitrates and contain catalase. Atypical bacteria primarily produce larger amounts of fermentation, contain catalase, they reduce nitrates and are aerobic. They produce only small amount of lactic acid. Another classification is the classification of Berger. The bacteria common in milk are divided into the following families: Pseudomonadaceae, Achromobacteriaceae, Micrococcaceae, Entherobacteriaceae, Brevibacteriaceae, Lactyobacillaceae, Propionbacteriaceae, and Bacillaceae. Each family has genera and species which take part in the fermentative processes in milk and milk products.

Certain microorganisms have synonyms as well. Some author use different names for the same microorganisms, which might be confusing.

Typical bacteria of acid milk fermentation

(Streptococci and Lactobacilli)

Streptococci have a round shape, they are smaller than $2x10^{-6}$m they either form pairs or chains, are Gram + and are facultatively anaerobic.

Lactobacilli are rods, either long or thin or short and round with width of 1 and length of 6-$7x10^{-6}$ m. They could be single, or they form chains. Gram+ and facultatively anaerobic whilst some species are strictly anaerobic (lactobacillus Lactis, Lactobacillus leichmanii).

These bacteria convert lactose into lactic acid. Cocci create less lactic acid and they could survive in 1.2%, whilst rods 3 – 4 % of lactic acid. Lactose is first converted into monosacharides (glucose and galactose). Afterwards, two molecules of lactic acid are created form the monosacharides.

$C_{12}H_{22}O_{11} + H_2O$ ---------- $2C_6H_{12}O_6$

$C_6H_{12}O_6$ ---------- $2C_3H_6O_3$

Some species produce primarily lactic acid; others produce by products as well (acetic acid, alcohol, CO_2 etc). Almost all bacteria in this group could cause creation of mucus under certain conditions. Many are resistant to high temperatures. They require microelements and vitamins for growth, especially panthothenic acid, lactoflavine etc. During the fermentation process the amount of lactic acid increases. The acidity of normal cow's milk is 0.14 – 0.19%, or 6.0 – 7.5 SH, or pH 6.4 – 6.7. The increase of the amount of lactic acid to 0.50 –

0.65% or 4.60 (isoelectric point) causes gellation of casein. Lactic acid then reacts with the salts of calcium and Sodium which results in creation of salts of lactic acid – lactates.

Bacterial activity causes increase of the amount of lactic acid to the point when the amount of the acid itself inhibits the bacterial growth.

Creation of lactic acid in milk and milk products is important because, lactic acid has protective properties. Lactic acid inhibits growth of many bacteria, especially bacteria that cause rotting, which could not survive in acidic surroundings.

However, after a certain amount of time, milk undergoes undesirable changes, caused by microbial and chemical factors, therefore the use of milk products with lactic acid is limited.

Genus Streptococcus

Bacteria from this genus grow on temperatures of 10 – 45C, and can not develop in surroundings with amounts of salt over 6.5%, neither on pH over 9.6. The following species are important in milk industry:

Streptococcus lactis. It can be found either as single or in pairs, or in short chains, it grows well in milk and milk products. It could convert almost 95% of lactose into lactic acid. It survives on pH of 4.0 – 9.2. Some strains produce antibiotics - NISIN which inhibits growth of Streptococcus cremoris and some pathogenic microorganisms. (M. Tuberculosis). Optimum temperature for growth is 30 – 35C. It is used in combination with other species of the genus in production of acid cream and butter, many types of cheese and fermented milk. The curd is firm, gelatinous, does not contain bubbles or gas and does not release whey. Streptococcus lactis comes in milk from the environment, not from the udder.

Streptococcus cremoris. It produces significant amount of lactic acid. It grows on temperatures of 10 – 40C. Optimum temperature for growth is above 30C. It produces aroma during maturation of acid cream> it comes in long chains. It produces an antibiotic called Diplokokcin which is active against Streptococcus lactis. When milk in held on low temperatures for a longer period of time it creates mucus. This is used in production of some products. Sometimes it can cause unpleasant smell.

Streptococcus thermofilus. Optimum temperature for growth is 40 – 45C, but it also grows well on 50C. It can be found in pasteurized milk, because it survives 65C in 30 minutes. It can survive pH of 4.0 – 4.5, but can not survive in surrounding with more than 2% salt. This species is used in products which during the processing require higher temperatures (joghurt. Emmental cheese, kashkaval, mozzarella).

Streptococcus lactis subsp. Diacetilactis. This species has almost the same characteristics as Streptococcus lactis, except the fact that S. Diacetilcatis could convert citrates into CO2, acetone and diacetyl.

Leuconostoc citrovorum has the size of $0.6 – 1.0X10^{-6}$m. It grows on a temperature of 10 – 30C, and the optimum temperature for its development is 18 – 25C. It is facultatively anaerobic. It belongs in the group of heterofermentative streptococci. Besides lactic acid, it also creates other by-products, but only when the pH get bellow 5.0. Besides the conversion of lactose to lactic acid, it also converts citric acid (0.1% - 0.2% in milk) to acetoin and aromatic, 100 – 250 mg of acetoin and 1 – 4 mg diacetyl on 1kg of culture. It also creates acetic and propionic acid, HCl, alcohol, and CO_2. It gives the cheese, acid cream, butter and other products a specific aroma.

Genus Lactobacillus

Genus with many varieties. Homofermentative rods with size of $6 – 7x10^{-6}$m. They primarily produce lactic acid form glucose, and they also produce some other products in traces. They

grow on a temperature of 5 – 53C, the optimum being 30 – 40. Resistant to acid, optimal pH is 5.5 – 5.8 and they tolerate up to 4% of lactic acid. Anaerobic or facultatively anaerobic. They get in milk from the environment.

Lactobacillus caucasicus. Grows on 25 – 45C. Optimum growth on 40 – 44C. It can be found in the kefir pieces and takes part n the fermentation of milk during kefir production.

Lactobacillus lactis. Optimum growth on 40 – 43C but it could grow on temperatures between 16- 50C. Takes part in the maturation of semi hard and hard cheeses.

Lactobacillus helveticus. Grows on 15 0 35C. optimum growth on 40 – 42C. Takes part in the maturation of Emmental and other types of cheeses.

Lactobacillus acidophilus optimum growth on 35- 38C, does not grow bellow 20C, nor above 48C. It is used in the production of acidofillic milk. The products with acidofilic microorganisms that contain vitamins (folic acid) are especially appreciated.

Lactobacillus bifidus. Anaerobic and a constant inhabitant of the digestive system in sucklings and young children. Optimum growth on 37C, it is eliminated on a temperature of 60C in 15 minutes. It is used in production of bifdogenic fermented milk.

Lactobacillus bulgaricus. Optimum growth on 45 – 50C, minimal on 22C. It is used in production of joghurt.

Lactobacillus thermophilus. Very resistant to high temperatures. It is destroyed on 71C in 30 min, or on 82.5 in 2.5 minutes. Optimum growth on 50 – 62.8C, minimal on 30C. It is present in pasteurized milk and hard cheeses.

Lactobacillus casei. Grows in chains. Optimum temperature for growth is 30C, but it grows on temperatures between 10 – 40.C. Takes part in maturation of cheeses. It is microaerofillic.

Lactobacillus Leichmanii. Optimal growth is 35 – 40C, but it can grow between 15 – 45C. It is microaerofillic, and can be found in milk and milk products.

Atypical bacteria of milk fermentation

Colliformorganisms which take part in fermentation of lactose (group Escherichia – Aerobacther)

Short, flat rods, single or in pairs 2 – $6x10^{-6}$m in length and $1.5x10^{-6}$m in width. The members of this group ferment lactose into pyruvic acid, which lather converts into small amount of lactic acid and significant amount of acetic acid as well as alcohol. These bacteria are either aerobic or facultatively anaerobic optimum growth is 37C. Milk coagulates fast, the curd is with precipitates, and it contains a lot of gas and easily releases the whey. These bacteria produce diacetyl – reductase which reduces diacetyl. E. Coli is found in human and animal intestines. A. Aerogenes is found on the surface of plants and in water. Some members of this group cause intestinal and stomach disease. These bacteria are often present in milk and milk products. If a correct handling of milk during milking and storing is used it is possible to avoid a large-scale infestation with these bacteria. These bacteria damage both milk and milk products. They can cause creation of mucus and blowing of cheese with large amount of gasses with unpleasant taste and flavor. Blowing can become visible very fast, often when cheese is pressed and in the first few days of fermentation. (Early blowing). If milk is heated to 65C for 30 min, most of these bacteria are destroyed, but, unsanitary handling of the processing equipment contributes to further contamination.

There are two main species in this group:

Escherichia Coli, which has an optimum growth on a temperature of 10 – 45C, with optimum growth on 30 – 37C. This species has many varieties, which differ in their ability to ferment

sugar, to produce a yellow pigment; they also vary in shape, and in the ability to produce indole. Other varieties are E. coli communis, and E. Coli var. acidilactici.

Aerobacther aerogenes, optimum growth on 30C. The other characteristics are the ones of E. Coli.

Indole test is used in distinguishing E. Coli and A. Aerogenes (E. Coli produces indole).

Bacteria that dissolve protein (protheolytic bacteria)

Protheolysis is a process during which protein is dissolved into smaller particles which are water-soluble. They could be dissolved to different particles such as peptones, amino acids, ammonia, and free oxygen. Protheolysis is caused by different microorganisms. Some of them are capable of enzyme synthesis which could then cause the so-called sweet gellation of milk. Milk will turn into gel even though it is not acid, and the acidity will increase after gellation. Sweet gellation of milk often occurs in warm summer months when milk is kept on higher temperatures. Protheolysis causes creation of some products (peptones) which give a bitter taste to milk. The bitterness can occur again when milk is kept on low temperatures (under 10C for a longer period of time). In this case this process could be caused by Streptococcus Liquefaciens. Many protheolytic bacteria take part in protheolysis. They are divided into two groups: protheolytic bacteria which do not sporulate and protheolytic bacteria that sporulate.

Protheolytic bacteria which do not sporulate (asporogenc bacteria)

The bacteria from this group are short rods which mainly cause moderate protheolysis whose final result are peptones. (Peptonisation). They could also produce some acids. The optimum pH for their growth is 7.0 – 7.2. They can grow on temperatures between 5 – 45C. They dissolve protein with the help of the enzymes hyosin, tripsine, erepsine, etc. They are widely found in the environment especially in places where decay occurs (water, soil, wound with puss, wastewater, see water etc.)

Genus Protheus

Protheus Vulgaris is an aerobic microorganism and has an optimum growth on 37C. It is rod - shaped with a width of $0.5 – 1x10^{-6}$ m. and width of $1 – 3x10^{-6}$m. They can be found single in pairs or in chains. They produce indole and H_2 S. It is often found in water, dust and garbage. It is destroyed by pasteurization. Cheese infested with this microorganism contains toxins.

Genus Pseudomonas

Single, flat or curved rods, width $0.6x10^{-6}$m and length of $2 – 3x10^{-6}$m. Many bacteria of this genus create yellow, blue violet and other fluorescent pigments. They are aerobic and re found in water and soil. Optimum temperature for growth is 20 – 25C. It can also grow on 5C; therefore it can be found both in fresh as well as cooled milk. It produces lipase which dissolves fat in milk, butter and cheese. It is sensitive to acidity and salt and the maximum level of tolerance is 3%. It dissolves protein very fast.

Pseudomonas aerugonosa optimum growth on 37C. Produces blue pigment called pyocianine.

Pseudomonas synxantha, optimum growth on 20C. It does not produce indole. Aerobic produces yellow – orange pigment in the fatty layer of milk and acid cream.

Pseudomonas syncyanea, optimum growth on 25C. Facultatively anaerobic. It produces dark blue pigment. It does not produce indole.

Pseudomonas fluorescens. Optimum growth on 25 - 30C. It is also active on 4C. Aerobic. It does not produce indole. It produces fluorescent yellow pigment.

Genus Sserratia

The size of these varieties is 0.5 – $1x10^{-6}$m. They dissolve protein and fat. Optimum growth is between 25 – 30C; they do not grow on 37C. Aerobic and facultatively aerobic. It produces acetyl methylcarbinol and trymethylamine (smell). It is characteristic because it creates pink – red colonies in milk, cream, and in cheese rind.

Genus Alkaligenes

The members of this genus are rods, round or cocci, with width of 0.5 and length of 1.2 – $2.6x10^{-6}$m. They are single bacteria. They are motile, Gram- and produce alkali. They do not use carbohydrates. The Variety A. Viscolactis alkalizes milk and causes yellow color. They also cause viscosity. During this carbohydrates are not dissolved, and there is no creation of acid. Aerobic, optimum temperature of growth 20 – 37C, but, it can grow between 10 – 20C, even on 0C. All varieties grow fast on pH 7. It gives milk strong bitter taste.

Genus Brevibactherium

Both long and short rods with width of 0.5 and length of 2.5 – $4x10^{-6}$m. They can dissolve carbohydrates. Aerobic and facultatively aerobic. They create yellow, red and brown pigments. They are found in soil and water.

Brevibactherium linens – dissolves protein and creates red – orange coloring. It alkalizes the surrounding. Optimum growth between 20 – 30C grows on 8C as well, but not on 45C. Some varieties could survive with 15% of salt. It grows on pH of 6.0 – 9.8, and it stops growing on 5.0. Aerobic. Along with the other varieties of this genus takes part in maturation of the limbourg types of cheeses.

Protheolytic bacteria that sporulate (sporogenic bacteria)

This group consists of bacteria whose spores are resistant to high temperatures; therefore they could survive the pasteurization process. That is why they are found in pasteurized milk and products made from it. They can be aerobic or anaerobic. A typical representative of the aerobic group is the genus Bacillus, and of the anaerobic groups the genus Clostridium.

Genus Bacillus

The representatives of this genus are short rods with width of 0.3 – 2.2 and length of 1.3 – $7.0x10^{-6}$m. Most of them are motile, single or in chains, and are able to create endospores. They dissolve protein intensively, and create ammonia. They convert sugars into acid, and some produce gas. They are mainly saprophytic and are found in water and soil. Main representatives are:

Bacillus cereus. It creates colonies similar to wax. It has egg shape spores with size of 1.0 – $1.5x10^{-6}$m. Optimum growth on 30C, and the maximum on 48C. It peptonises milk very fast. It produces acid, but not gas. It is aerobic, and is widely found in the soil, water and plants.

Bacillus cereus var. anycoides. Similar to Bacillus cereus, it is only different by the motility ad the appearance of the colonies. It produces acetoine.

Bacillus megatherium has the form of long and motile rods. The optimum growth is on 28 – 35C, and the maximum temperature is 40 – 45C. Aerobic. It peptonises milk, and is found in soil and water.

Bacillus anthracis. Causes anthrax in humans and animals. It is lethal (like B. cereus). Optimum growth is on 35C, maximum temperature is 43C. It coagulates milk which is acidified, but peptonised. It is found in humans and animals that have contracted anthrax.

Bacillus subtilis. Some strains produce antibiotics (subtuiline, baciline, bacilomicine etc). Optimum temperature for growth is 25 - 5C. It can survive 50C. Aerobic and grows on pH 5.5 or higher. It produces acid but not gas. It is widely found in the environment, in the dust and rotting grass.

Bacillus coagulans Optimum growth on 33 – 45C and the highest tolerable temperature is 60C. Aerobic and facultatively aerobic. It grows on pH bellow 5.2. It is found in spoiled food, cream, cheese and silage.

Bacillus sthearothermophillus. Optimum growth on 50 – 65C, and it tolerates 70C with pH of 4.5 – 4.6. It is found in soil and rotten food. Its spores are very resistant.

Bacillus mesenthericus. It is called potato bacillus. It does not coagulate milk, but it alkalizes it and it peptonises it. Its optimum growth is on 30C. It does not grow in sour milk product sine it does not tolerate such environment. It is similar to B. suptilis.

Bacillus subtilis var. attherrimus. Similar to B. subtilis. It produces a dark pigment only on culture with carbohydrates.

Genus Clostridium (anaerobic sporogenic protheolytic bacteria)

Bacteria of this genus are rod - shaped bacteria 1.1x10-6m wide and 3.5 – 7.0x10^{-6}m long with round ends. They are single, in pairs or in long chains. They produce spores with particular pear – like shape – clostridium. They ferment lactose in anaerobic environment and produce fatty and acetic acids, CO_2, H_2, and sometimes CH_4, alcohol and acetone. Some varieties dissolve protein. They coagulate milk slowly; the curd is filled with bubbles of gas. They are undesired in milk industry because they cause the so-called lathe blowing.

They grow on a neutral pH of 7.0. Pasteurization does not destroy the spores. Some of these bacteria originate form the intestinal tract of cows. The way to protect milk from these bacteria is to apply sanitation during milk production and processing and to feed animals with healthy and not infested feed. Main representatives are:

Clostridium butyricum. Optimum growth on 25 – 37C. Found in soil.

Clostridium butylicum. Causes intensive fermentation of milk. Optimum growth on 30C.

Clostridium botulinum. Slowly acidifies milk without coagulation and creation of gas. There are several strains that create toxins. Optimal growth is on 20 – 30C. It is strictly anaerobic. Spores are very resistant and can survive in cans and cream cheese. It causes botulism. It has antagonistic reaction with the bacteria of milk acid fermentation. It is found in the soil and intestines of sick animals.

Clostridium perfringens. Optimum growth on 45C, and it grows between 20 – 50C. It ferments milk intensively and produces acids, gas, and toxins. It is very sahcharolytic. During strong fermentation and creation of gas, the curd hastens.

Clostridium letoputrscens. Optimum growth on 37C. It is found in the intestinal tract of animals and in the soil. It is anaerobic. It dissolves protein and creates strong smell. Creates rotten spots in cheese.

Clostridium putrefaciens. Optimum growth between 20 – 25C. and it can grow between 0 – 30C. It causes spoilage of milk products.

Bacteria of propionic fermentation

Genus Propioni – bactherium (Propionic bacteria)

Rods nonmotile, or cocci length of 0.5 –0.6x10^{-6}m. They appear single or in pairs in the shape of the letters V or Y. Gram +. This group embodies all bacteria that produce propionic acid. Mainly anaerobic, or aerobic, they ferment lactic acid, carbohydrates and alcohol with final product propionic acid. Optimum growth on 30C. Besides propionic acid they also create small amounts of acetic acid, As well as CO_2. They produce vitamin B_{12} thus enriching the product in which they are found.

Propionbactherium shermanii. These bacteria are important introduction of hard cheeses. They do not grow in cheese at the beginning of fermentation, but when pH riches 7.0. Presence of CO_2 and some hydrogen causes the typical holes in the emmental cheeses. At the same time calcium – propionate is created which gives cheese a sweet – bitter taste. Optimum temperature for growth is 30 – 37C. They are wide spread and thermoresistant, but proper pasteurization procedure destroys them.

Bacteria of acetic fermentation

Genus acetobacther (acetic bacteria)

Bacteria from this genus are egg - like in shape, flat or slightly curved and are 0.6 – 0.8x10^{-6}m wide and 1.0 – 3.0x10^{-6}m in length. They are strictly anaerobic. Optimum growth is on temperature of 30C, but they can grow between 10 – 42C. Low pasteurization on 63C in 30 minutes destroys them. Common representatives are A. Aceti and A Xylinum.

Recipes

White brined cheese " Feta "

Depending on the type of the raw material, white brined cheese can be cow's, sheep's, goat's, or mixed white brined cheese from two or three types of milk.

Procedure:

Milk pasteurization

Two regimes of milk pasteurization are used:

Low temperature and long time (65c in 30 minutes) and

High temperature and short time (72C in 15 seconds)

The first regime is used when there are duplicators for pasteurization, whilst the second is used in Plate, board pastheuraser.

Cooling of milk to appropriate temperature for adding of starter (32C).

Adding of starter. Starter is added on 32C. Industrial starters can be used or pre made cultures from rennet. Widely used starters are white brined cheese are R – 703, R – 704, R – 708 and FRC – 60 (producer Chr Hansen). The first three are mesofillic and require temperature of 32C, whilst the latter requires 35C. A pre – made rennet culture could be acid milk in amount of 120 – 18-g on 100 l of milk in summer and 200 – 300g on 100 liters of milk in winter. The industrial starter is left 45 minutes, whilst pre – made is left 20 – 30 minutes.

Adding of Calcium chloride $CaCl_2$

It is added immediately after starter or at least 15 – 20 minutes before.

Adding of rennet.

Ch Hansen rennet is recommended. The dose is written in the instruction of use. It is important that milk should be left with the rennet for 60 minutes on a temperature of 32C.

Cutting of the curd.

It is cut horizontally and vertically. Dimensions of the pieces are 3cm.

Resting of the curd for 10 minutes.

Molding and straining of the curd

After the resting period, the curd is transferred in the mold and covered by cloth. In the curd is strained 3 – 4 hrs, depending on the weather conditions 9 summer or winter). The pressure used during straining is 0.5 – 1 kg on 1 kg of cheese. The initial pressure used is small and it is gradually increased towards the end of the straining.

Cutting into blocks

Strained curd is cut into blocks with dimensions 11x11x6-8 cm and is transferred into already prepared brine and it stays there for 18 – 24 hours.

Putting the cheese into cans One can could hold 4 rows of 4 blocks of cheese. Between the rows dry salt is put, and the cans with cheese in them are left open for few hours and are then filled with already made brine.

Maturation of cheese

Cans are closed and the cheese ripens on 15 – 18C for 45 days.

After that period the cans are put on a temperature of 4C until they are sold.

Brine

The brine is made of salt, water, $CaCl_2$ and acid.

The concentration of the brine is 18%. The amount of salt is 0.02% (20 grams on 100lithers of brine) $CaCl_2$ and it is set on pH 4.7 This is made by using lactic, acetic, citric acid or HCl.

Brine for maturation

The brine is made of salt, water, $CaCl_2$ and acid.

The concentration of the brine is 12%. The amount of salt is 0.02% (20 grams on 100lithers of brine) $CaCl_2$ and it is set on pH 4.7 This is made by using lactic, acetic, citric acid or HCl.

Basic features

A basic feature of this type of cheese is that it has very simple technology of production and a short maturation period. They do not require any special production conditions. They are salted with brine, and are matured in brine. They stay in the brine during storage as well. The curd, depending on the quality and the type of the raw material has white, to dark white color. The consistency is homogeneous, they are fragile, and the crud has many holes, it has moderate salty – acid taste and slightly acidic smell. The most usual shape is square.

Appearance: white to dark white color in the ripened cheese, pleasant salty – acidic taste and pleasant acidic smell.

Structure and consistency of the curd: fragile and homogenous, the curd is without holes or small number of holes, and layer structure.

Rind: none

Ripening: at least 1.5 months

Shape and packaging: 11x11x6 – 6cm, it may be packed into small or large barrels with its own brine, or separate pieces in vacuum.

Chemical composition: White brined cheese has the following average chemical composition:

Water 55 – 58%

Dry matter: 42 – 45%

Fat: 20 – 24%

Fat in dry matter: 47 – 53%

Salt: 4 – 6%

pH: 4.4 – 4.7

Kashkaval

The raw material for production of kashkaval is cow's, sheep's or goat's milk, or blend of these types of milk in appropriate proportion. It is common to use non pasteurized milk, but in some cases pasteurized milk is also used. Production of kashkaval is common in this region. If pasteurized milk is used to produce kashkaval then the procedure is the following:

Milk is pasteurized on 65C n 30 min. or 72C in 15 seconds

Milk is cooled on 35C and the starter is added (type R – 704; Str. Lactis and Str. Cremoris) as well as TCC – 3 or TCC – 4 (Str. Thermofulus and L. bulgaricus)

Calcium chloride is added

Milk is kept on that temperature for 45minuthes,so the starter could create a certain amount of lactic acid, so the rennet could be added.

Up to this point the procedure of production of kashkaval from pasteurized milk is different from the processing of kashkaval production from unpastheurized milk. After adding the rennet, the procedure is the same in the further steps. If unpastheurized milk is used and then the rennet is added immediately after milking.

Milk with the rennet stays for about 30 minutes, and then it is cut into pieces of $1cm^3$.

The curd rest for the next 10 minutes.

The mixture of curd and whey is mixed on temperature of 35C for 20 minutes.

The mixture is cooked with simultaneous mixing. The heating is done on 41C for 30 minutes (1C on 5 minutes).

The mixture is mixed on this temperature until the pH reaches 6.25 (about 30 – 40 minutes)

The curd is left to cool and the whey is removed. After that, the curd stays at the bottom of the pen.

The curd is transferred into a cloth it is dispersed and it is pressed in the cloth in order to gain a form. After 30 minutes, the curd is unfolded from the cloth, it is dispersed again and it is pressed in the cloth again. The pressure this time is 2kg of weight on 1kg. of curd. This pressure is applied for two hours, after which the weight is removed and the formed piece is left to mature up to pH of 5.20 which is a good pH to extend the curd and knead it. The curd in this stage is called baskija.

When the curd is ready for kneading and treatment with vapor it is cut into small bands. The vapor treatment is done with2 – 4% solution of salt and water heated to 72C.

The vapor treatment requires special skills and experience. There are two techniques for kneading the curd, out of which more accepted is the technique when the curd is kneaded to form a mushroom cap. The formed curd in this manner is then out into moulds and the "mushroom cap" is removed on the top of the mould. Afterwards holes are made with a needle in the curd in orbed to remove the air.

The molds are turned over several times during the day and 15 – 18 hours lather, when the curd has become firm, it is removed form the moulds.

The curd is then left on 16 – 18C and relative air humidity of 80 – 85% for 3 – 4 days so it could get yellowish color. After that the salting procedure begins and it lasts about 20 days.

There are 7 saltings;

Salt is put on the top and the bottom of the shelves on which the curd is placed and the curds are left there until they do not absorb the alt.

The curds are wiped with cloth and salted again.

The same procedure again, this time the curds are placed on the top of another.

The same procedure, this time 3, 4 or 5 curds are put one over another.

If the curds have moulds or fungi they are wiped with cloth soaked in salt solution.

After the last salting, the curd is cleaned with salty water slightly warmed and it is left to dry for 7 days.

The curds are put one over another (in pairs) and are ripened on 16 – 18C with relative air humidity of 80% for 40 – 50 days, and then they are cleaned, wiped and packed. After this they can be marketed, or in order to achieve better taste they are ripened further.

Basic characteristics

The heating temperature of the curd is 41C. The curd, before it is molded, it is cheddarised (segmented to intensive fermentation processes) in order to increase the acidity. After the cheddarisation, the curd is cooked in order to stop the biochemical processes and to create the necessary conditions for the physical and structural characteristics of the curd. These characteristics are: elasticity, pliable, laminar ver close with visible layers and occasional slits, but no gas holes. It as a long shelf life.

Appearance:

The curd is yellowish, it has a slightly darker shade on the surface, and it has salty – piquant taste and specific aroma.

Structure of the curd: hard, elastic, compact without holes, with visible layers, significantly fatty.

Rind: smooth, elastic, medium hard and fatty.

Ripening: at least three months.

Shape and packaging: round in the shape of pie with diameter of 30cm and height of 10cm. The shape can be cylindrical, square, circular, or pear – like. It can be packed in vacuum or in plastic covering.

Chemical composition of kashkaval produced from sheep’s milk

Water: 40 – 42%

Dry matter: 58 – 60%

Milk fat: 25 – 28%

Fat in dry matter: 43 – 46%

Salt: 2- 3%

pH: 5.2 – 5.6

Bieno sirenje

Raw materials for production of bieno sirenje is unpastheurized cow's sheep's, or goat's milk, or a blend of these types of milk in appropriate ratio. The rennet is added in milk, immediately after milking.

This procedure is done on 35C for 30 minutes, which means that a larger amount of rennet is needed compared to the brined cheese.

The curd is cut.

After milk is acidified, the curd is cut into slices of 1cm3.

The curd rest for the next 10 minutes.

The whey and the curd are mixed on 35C for 20 minutes.

The mixture is heated on 41C.

The heating could be done in two ways: heating with simultaneous mixing up to 41C for 30 minutes. (1C in 5minuthes). In the duplicator, and the heating material is hot water which circulates between the walls of the duplicator, or,

Heating to the same temperature so that 1/3 of the whey is replaced with the same amount of water heated to 65C. This way the mixture is heated to 41C.

Mixing the mixture.

The working temperature is 41C. The mixture is mixed for 10 – 15 minutes and is left to sediment for 20 minutes.

The whey is removed.

The curd is transferred into moulds.

The mould is covered with cloth and the curd is put on the top of the mould. It is then shredded and is covered with the mould so it could be strained. The cloth is pressed until it is possible and it is pressed that way for 18 hours (3 – 4 hors after the beginning of the pressing the cloth is tightened some more)

The curd is unfolded from the cloth.

18 hours later the curd is unfolded from the cloth and is put on shelves with the rough side of the bottom. They are left that way on a temperature of 15 – 18C for 2 – 3 days and during this time the holes in the curd form.

Cutting the curd on pieces

The curd is cut on pieces 3 – 4 cm thick.

Salting

The salting is dry. The curds are salted on both sides for two days.

Storing into barrels and adding of brine

The slices are placed in barrels and brine is added. The brine is prepared in the following manner:

Brine:

25 gr. $CaCl_2$ is added in 10 liters of boiled water and a 22% salt solution is made. The pH is 4.7.

Bieno sirenje can be consumed immediately after finishing if milk used is both microbiologically and chemically correct.

Basic characteristics:

Bieno sirenje is a characteristic product from Macedonia

Appearance: Waxy yellow color, characteristic smell and milky – acidic taste, and very salty.

Structure of the curd: Firm curd, with many holes different in size, which gives it a spongioform appearance.

Rind: none

Maturation: in brine

Shape and size: curd has the form of home – made bread.

Chemical composition:

Water: 39% (35 – 43%)

Dry matter: 61% (57 – 65%)

Fat: 22.5% (15 – 30%)

Fat in dry matter: 37% (24.5 – 49%)

Salt: 7.5% (6 – 9%)

pH: 5.50 (5.25 – 5.70)

Defects of cheese

Often the cheese does not have the typical appearance, the chemical composition, and the curd structure. It can be with unpleasant or untypical smell and taste, untypical color, bitter taste. Too salty or in addition, acid, the firmness is low or the cheese id fragile, swollen etc. These untypical characteristics of cheese are called defects.

They can be classified in the following manner:

defect of taste and flavor

defects of the curd

defect of the rind and

Defects caused by parasites or insects.

Defects of taste and flavor are the most common defects in cheese. The cause of this might be a low quality raw material, and often the incorrect procedure of fermentation during ripening, which results in creation of chemicals with untypical and unpleasant smell and taste. Further it can be caused by the use of salt with low quality, and the bad sanitary conditions of the room where the maturation process of the cheese takes place. The most common defects in this group are: bitterness, acidity, rancid smell of rotten smell etc.

Bitter taste is a quality defect that appears not only in unripe cheese but in ripened as well. Usually the quality defect appears because the raw material

(Milk has been kept on a very low temperature for a long period of time, thus enabling the development of rotting microflora instead of milk acidification microorganisms. The raw material from animals fed with bitter feed could result in such defects as well. If the unripe cheese id not acid enough and is left to mature on low temperatures bitterness occurs. Cheese can develop bitter taste also when inpure salt which contains excessive amounts of magnesium is used. When excessive amount of pepsin is added in the rennet it could also result in bitter taste. Sometimes bitter taste occurs during the ripening. In this case, the bitter taste is due to the presence of peptides which are created in the early stage of proteolysis

under the influence of milk acidification bacteria. This defect is but temporary because further the peptides dissolve into amino acids and this defect disappears.

Acidic taste occurs mostly in soft and semi hard cheeses, as well as in cheeses in which the entire amount of lactose in fermented into lactic and other kinds of acids. The acidic taste, which is usually manifested at the beginning of ripening, appears in cases when too much starter has been added, and the cheese is then left to ripen on a higher temperature. Often this defect disappears at the beginning of ripening.

In order to avoid this defect, it is recommended tat the rennet is added on a lower temperature and for shorter period of time. In cheese that goes through cheddarisation in order to avoid this defect it is recommended that part of the whey should be replaced with boiled and then cooled water.

If during ripening fat undergoes through saponification process, cheese has a taste of soap.

Rancid taste is a defect which often appears in kashaval. This defect often occurs under the influence of lipolytic enzymes on fat. During this process chemicals such as glycerin and fatty acids are created, which get in the inside of the kashkaval thus creating rancidity. Prevention against such appearance is regular cleaning of the kashkkavals' surface and storage on lower temperatures.

Rotten smell is a quality defect which usually appears in unripe cheese produced from pasteurized milk, which is massively infested with bacteria from the geni Escherichia – Aerobacther. These cheeses lack lactic acid. In overripe cheese these bacteria have a fertile ground for growth. They dissolve protein and create chemicals with bad taste and flavor. Prevention against this defect is use of quality raw material and pure starter.

Often large amount of ammonia is created which causes strong smell of ammonia in cheese.

Cheese that ripens with mucus on the rind also has the ammonia smell and that is not considered as a defect. Hard cheese on the other side that has hard rind, and smell on ammonia is considered defective. That appears in cases when salting and ripening do not do under normal conditions.

Defects of the curd

Defects of the curd are: blowing, softening and appearance of layers.

Blowing is the most frequent defect in cheese. It is caused by microorganisms in cheese like Escherichia – Aerobacther which cause early blowing and anaerobic sprogenic bacteria (bacteria that cause oxidation of fat). Seldom this defect can be caused by yeast which can grow in unpasteurized milk. This defect is manifested by a large number of holes which are in different size and shape and are formed in the curd itself. Often the entire curd has a spongioform appearance. This is usually followed by an unpleasant smell and taste. Depending when this defect appears there is early and late blowing.

Early blowing usually occurs in the first few days after the cheese is made. However, if milk which is used for the cheese production is contaminated with a large number of microorganisms from the Escherichia – aerobacther to begin with and the technological stages are inadequate, then the blowing could appear during the pressing of the curd. The above mentioned bacteria convert lactose into lactic acid and acetic acid, many gasses and other chemicals. The prevention against this is sanitation during milk processing, pasteurization of milk and use of pure starter as well as use of KNO3 in milk before rennet is added. Lathe blowing in cheese occurs either in the middle or at the end of the ripening. It is due mainly to the presence of bacteria from the Genus Clostridium. In the middle or at the end of the ripening when the semi hard and the hard cheeses change their pH to a higher

values, the spores grow and cause the lathe blowing in the cheeses. The lathe blowing is characterized with larger and more holes than the early blowing. The bacteria transform lactose into fatty and acetic acid, CO_2, and H_2, or transform protein into CO_2 and other products which have unpleasant smell. In this case besides the already created holes cheeses also have unpleasant smell and taste. Prevention against blowing in cheeses is strict sanitation during processing, and heat treatment of milk. Milk should be pasteurized, starter should be pure, proper and sufficient salting etc.

Softening of the curd is a defect which occurs in soft cheese and rarely in hard cheese. It occurs because the room temperature where cheese is produced is too low, and also when cheese during maturation is left in rooms with low temperatures (up to 9C). Low acidity and temperature cause development of rotting, which makes the cheese soft. This defect is usually followed by defects in taste and flavor. It appears because during heat treatment curd is not salted enough and not pressed and ripened enough during processing.

==== occurs always in cheeses produced from milk with high acidity. This causes the curd to be too acid, thus the final product is acid as well. It also may because by a very large amount of $CaCl_2$ added in milk.

Defect of the rind

Rind is formed after the ripening of cheese and is characteristic for hard and semi hard cheeses. Besides giving protection to cheese from external influences, it also enables the biochemical and microbiological processes in the inside of the cheese. If defects occur on the rind, it is possible that they influence the ripening process as well.

Thick rind is typical for hard cheeses which ripen on low temperatures, which are not salted enough, and the curd is not acid enough. If the cheese is pressed for too long, and the filter is used all the time, and it is rinsed with hot water during ripening and is kept in dry room (relative humidity under 80%), in this case the cheese will always have thick rind. Since the thick rind is removed before consumption the useful mass of the cheese is smaller.

Soft rind is the most common defect of the rind in the cheeses which have not been pressed enough, and which have not sufficient rind. If this cheese after salting is left in rooms with too high humidity, the rind will become unusually soft.

“Cancer” of the rind. It is caused by rotting bacteria which grow over the rind if it has low acidity. This defect usually occurs in cheeses which produce mucus during ripening. With rinsing the acidity of the rind is lowered. During the “cancer” small spots appear first, then they spread and form larger spots. In this case the rind becomes soft and separates from the cheese. If the rind breaks mould could develop.

Mould is unwanted defect in many cheeses. It is developed because of the presence of molds which grow on the surface of cheeses or in holes (geni Aspergillus, Penicillium, Mucor, Monilia, Cladosporium etc).

Molds also influence the appearance of the cheese, and with cleaning of the rind, the volume of the cheese decreases.

Prevention against this is constant care of cheese and regular sanitation of the rooms where the cheese ripens and is stored.

Defect caused by parasites and other insects

The most common are worms and scab of cheese/

Worms/ One of the most common defects in the kashkaval. It is caused by the fly Phiophila casei. It is present in the ripening chambers and the processing facilities from April to

September when it lays eggs over the cheese. After 3 – 4 weeks later small worms develop which then get in the inside of the cheese. They undergo the transformation to flies later, and this cycle repeats 3 – 4 times during the season.

Prevention against worms is permanent painting of the walls, nets on the windows and permanent sanitation of wooden shelves. Once a year they should be cleaned with a brush and hot water and then they should be disinfected with 3% solution of NAOH.

Scab. It is caused by insects which grow only on the rind of the cheeses. They cause the transformation of the rind into dusty rind, which causes further drying. To prevent this it is necessary that the cheese is often cleaned with ethanol and vinegar, as well as proper sanitation of the rooms with compounds based on sulfur, which could also be replaced with compounds based on ammonia.

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