

Assessment of the Hygiene Level in the Dairy Processing Plant

Katarína Veszelits Lakticova¹, Mária Vargova², Nad'a Sasáková³, František Zigo⁴

¹ Department of the Environment, Veterinary Legislation and Economy, University of Veterinary medicine and pharmacy, Košice, Slovakia

Email: Katarina.VeszelitsLakticova [AT] uvlf.sk

² Department of the Environment, Veterinary Legislation and Economy, University of Veterinary medicine and pharmacy, Košice, Slovakia

Email: Maria.Vargova [AT] uvlf.sk

³ Department of the Environment, Veterinary Legislation and Economy, University of Veterinary medicine and pharmacy, Košice, Slovakia

Email: Nada.Sasakova [AT] uvlf.sk

⁴ Department of Nutrition and Animal Husbandry, University of Veterinary medicine and pharmacy, Košice, Slovakia

*Corresponding author's email: Frantisek.Zigo [AT] uvlf.sk

ABSTRACT— *Hygiene and sanitation has decisive position in dairy industry, because their level greatly affects food quality and safety. The food industry in the territory of the Slovak Republic applies the HACCP system, which is mandatory for all producers and persons who handle food or place food on the market. HACCP is generally an organizational system that ensures the production of health-friendly food through the analysis and subsequent control of chemical, biological and physical hazards that are able to endanger the health safety of food throughout the production process. In addition, requirements for cleaning and disinfection of the plant are an important part of it Milk, as the main raw material in the dairy plant in the production of drinking milk and dairy products, is an excellent substrate for the growth and multiplication of a wide range of microorganisms. Multiplied microorganisms often cause food contamination and the development of foodborne illness in the consumer. The effectiveness of disinfection affects not only the resistance of microorganisms but also the choice and method of use of disinfectant as well as the external environment in which the disinfection process takes place. The correct choice of disinfectant application play a key role in achieving the desired goal. In this work we focused on the hygienic level and efficiency of sanitation, using microbiological swabs taken from various surfaces and technological equipment in the monitored parts of the dairy operation and personal hygiene in selected employees. We also used the fingerprint method to monitor the level of personal hygiene, which is an important element in the production of safe food. The results obtained indicate a satisfactory level of hygiene in the various stages of production, sufficiently efficient sanitation of premises and technological equipment, with the exception of the working table in section of cottage cheese production, where we detected 40 CFU of total count of microorganisms and 2 CFU of coliform bacteria. The assessment of the personal hygiene of the employees' hands in dairy processing plant was satisfactory, except for one employee who was working in section of cottage cheese production. On his right hand we detected 50 CFU of total count of microorganisms and 1 CFU of coliform bacteria after disinfection. In case non-respect of hygienic principles of surfaces in production sections, and of employee's hands in dairy processing plant, food contamination can occur and consequently endanger the health of the consumer.*

Keywords— Hygiene, Dairy, Disinfection, Disinfectant, Microorganisms, Employees

ABBREVIATIONS: CFU: Colony Forming Units, HACCP: Hazard Analysis Critical Control Point

1. INTRODUCTION

Milk extraction and processing in Slovakia has a long tradition and is one of the major manufacturing industries. The Slovak dairy industry is characterized by a high pace of development, has optimally built capacities, opportunities to increase the production and processing of milk, qualified professionals and especially the high quality of its products [1]. The main goal of food production today is the health safety of food, which is influenced by many factors during production. Safe food can be considered only those that are free of pathogens or opportunistic pathogens, foreign, noxious and toxic substances [2]. In the environment, microorganisms are ubiquitously distributed and often contaminate

raw materials or food products. Some of the microorganisms can also survive protective technological operations. Contamination of food during production, processing, distribution and preparation can be caused by man himself. That is why every food, whether raw or processed, poses a certain risk for foodborne illness [3]. The food or equipment may be contaminated without visible dirt with microorganisms or chemicals that may cause foodborne infections or degrade intermediates, finished products, or finished foods [4]. In the food industry, the process of cleaning and disinfection is an important part of sanitation. The main task of cleaning and disinfection is to ensure that all food contact surfaces are clean, uncontaminated, thus preventing microbial contamination and producing quality and safe food products [5]. The cleaning process can remove more than 90% of surface-associated microorganisms, but cannot be relied upon to kill them. Bacteria can be re-deposited in other places and, due to the presence of water and nutrients, can form a bio film. Therefore, disinfection must always be performed [6]. The disinfection efficiency of preparations is ensured by chemical active substances [7]. It is essential to respect the prescribed standard of personal hygiene. Employees who come into contact and handle raw materials and foodstuffs must wash their hands constantly and thoroughly with a suitable disinfectant under running lukewarm water. They can enter the operation only in still clean work clothes with a head covering [8]. This study is focused on the assessment of hygienic level of different surfaces, technological equipments and personal hygiene of the employee's hands in dairy processing plant from the point of view of safe production of dairy products.

2. MATERIALS AND METHODS

2.1 Characteristics of dairy processing plant

The monitored dairy processing plant belongs to a group of large plants, with the production of a wide range of dairy products. The hygienic level of surfaces, technological equipment and personal hygiene in the areas of cheese production (Figure 1), yoghurt production (Figure 2) and cottage cheese production (Figure 3) in the dairy operation was examined and analyzed. The dairy has a thoroughly developed sanitation program, which is an integral part of their HACCP system. All areas and machinery are always cleaned and disinfected after the production process. The exchange of alkaline and acidic preparations in dairy is important. The monitored operation in the cleaning and disinfection process uses a CIP system (Clean-in-Place System) with the following program.



Figure 1: Cheese production (Cheese bath)

After each production, a rinse is performed with water heated to 50 ° C, then NaOH is injected through the piping system, which stands in it until the following day. In the morning, this is acidified using HNO₃ with an exposure time of 10-15 minutes and a thorough rinsing with water at a temperature of at least 50 ° C. All demountable parts are immersed in PedoxPAA / 50 for 15-30 minutes after mechanical washing with lukewarm water. Walls and floors are mechanically cleaned and disinfected daily using Nové Savo. Prosavon hygienic soap with antibacterial effect is used to clean and disinfect hands.

Sodium hydroxide (active substance content is 98% NaOH) is used in 1% concentration with exposure time 15 minutes to disinfect pipes, tanks, machinery in all parts after production. NaOH is produced in the Czech Republic and is distributed by company Mikrochem, s.r.o., Slovakia.

Nitric acid (active substance content 53-55% HNO₃) is used in a concentration of 0.5% with an exposure time 10 minutes for disinfection of pipes, tanks, machinery in all parts after production. Nitric acid is produced by company Centralchem, s.r.o., Slovakia.

Pedox PAA / 50 (content of active substances is 10-40% Peracetic acid, 5-15% Hydrogen peroxide, 1-5% Acetic acid). It is used to disinfect the screw, removable parts of the machinery in all parts at a concentration of 0.1% with a time exposure of 15 minutes. The manufacturer is Polychem, s.r.o., Slovakia

Nové Savo contains 10% of Sodium hypochlorite. It is used in 10% concentration, with a exposure time 30 minutes, for disinfection of floors, walls in all parts of the dairy operation. The manufacturer is Biochemie, a.s., Czech Republic.

Prosavon contains active substances such as Chlorhexidine, O-phenylphenol, Digluconate, surfactants, used for washing and disinfecting hands as undiluted, for 30 seconds. The manufacturer is Schulke CZ, s.r.o., Czech Republic.



Figure 2: Yogurt production of (filling machine)



Figure 3: Cottage cheese production (cottage cheese bath)

2.1 Control of the disinfection effectiveness of surfaces and technological equipment using the microbiological method

In the monitored individual parts of the dairy processing plant, microbiological swabs were taken from individual surfaces and technological equipment and were evaluated by the classical microbiological method, always before and after disinfection. Samples for analysis were taken with a microbiological swab using sterile templates from various surfaces using sterile swabs in sterile saline tubes. The purpose of monitoring was to determine the total count of microorganisms (TCM), coliform bacteria (CB) and fungi using the nutrient medium according to applicable standards. The classical microbiological method guarantees the most objective expression of the effect of disinfectants. Samples were taken from the investigated area 10 cm² with sterile template, using a sterile swab into 10 ml of sterile saline. It is recommended to moisten the end of the swab before taking the swab, especially if the sample is taken from dry surfaces.

From the mixture obtained 0.1 ml was applied to Meat peptone agar (MPA), Endo agar (EA) and Sabouradov agar (SA). After required incubation time and temperature, the results were obtained and evaluated. The results obtained are the arithmetic mean of the 5 swabs taken and are expressed in CFU (colony forming units) units.

2.2 Control of the hand disinfection effectiveness by using fingerprint method

To assess the level of personal hygiene and analysis of microbial contamination of workers' hands, the imprint method was used on nutrient media in Petri dishes, namely Meat peptone agar and Endo agar. This is a method of fingerprinting performed before and immediately after disinfecting the hands. The fingerprint was taken by the monitored staff and performed before and after hand disinfection. Subsequently, the plates were incubated at the desired temperature and incubation time. After cultivation, the overgrown colonies are read and, based on this, the level of personal hygiene as well as the effect of the preparation used for disinfection in the monitored operation is evaluated.

3. RESULTS AND DISCUSSION

Food and subjects of daily use must be regularly microbiologically examined to check good manufacturing practices, durability and good hygiene practices [9]. In connection with the requirements for the quality and hygienic safety of products, there is more and more talk not only about the detection of microbiological contamination, but especially about a comprehensive quality assurance system, including hygiene monitoring [10]. The evaluated results of microbiological swabs cultivation from individual surfaces and technological equipment in the section of cheese production point to the fact that the numbers of monitored species of microorganisms decreased after disinfection and meet hygienic requirements. The disinfection process in this section of the operation was effective (Table 1).

Table 1: Average values of evaluated microorganisms from different surfaces in section of cheese production

Place of collection	Number of swabs	Before disinfection			After disinfection		
		TCM Ø	CB Ø	Molds Ø	TCM Ø	CB Ø	Molds Ø
Wall	5	150	22	0	0	0	0
Floor	5	>300	0	0	2	0	0
Table	5	20	0	0	0	0	0
Door	5	25	5	0	0	0	0
Cheese bath	5	70	0	4	0	0	0
Auxiliary cart	5	110	10	0	0	0	0

It is only possible to produce safe food under strictly controlled and controlled production conditions [11]. These requirements are met by an organized HACCP system. The HACCP plan should cover all microbiological, chemical and physical hazards [12]. The level of hygiene in the food industry is influenced by many factors (suitability of technological production procedures, personal hygiene of employees, order, sanitation procedures). All these factors are defined by good manufacturing and hygiene practices. Observance of all modified production procedures and requirements, application of technical, technological and hygienic rules is essential for the production of safe products. In the production of safe food, in addition to a thorough control of the input raw material, it is necessary to ensure the required hygiene in the production and handling of food [13]. Table 2 shows the results of microbiological swabs from the monitored surfaces in the yoghurt production section. Reduced numbers of monitored types of microorganisms from evaluated surfaces and technological equipment after disinfection indicate correct and effective disinfection.

Table 2: Average values of evaluated microorganisms from different surfaces in section of yogurt production

Place of collection	Number of swabs	Before disinfection			After disinfection		
		TCM Ø	CB Ø	Molds Ø	TCM Ø	CB Ø	Molds Ø
Wall	5	70	16	0	0	0	0
Floor	5	256	5	0	6	0	0
Table	5	10	0	0	0	0	0
Door	5	5	1	0	0	0	0
Conveyor belt	5	65	4	0	0	0	0
Yogurt fillers injections	5	25	0	4	0	0	0
Jam fillers injections	5	14	1	0	0	0	0

Microorganisms found in production facilities form part of the microbial contamination of the finished product. The cause of their presence can be insufficient cleaning and disinfection of surfaces, the formation of a biofilm and the

persistence of microorganisms that are difficult to clean and disinfect. The authors further add that in case of insufficient sanitation, the biofilm will form a protective layer around the microorganisms resistant to sanitizing and disinfecting agents [14]. The ideal disinfectant must have a wide spectrum of action, fast, time-saving use and solubility in water. The disinfectant should also be stable, environmentally friendly, non-toxic, non-corrosive, economical and safe to use for a sufficient period of time. However, such a disinfectant does not exist in real practice and therefore it is important to choose a suitable combination of the use of disinfectants [15]. The monitoring of the level of hygiene must provide information at such a time that, in the event of unfavorable findings, immediate remedial action can be taken to prevent deterioration of the product or adversely affect the health of the consumer [10]. In the part of the cottage cheese production, even after disinfection, we found 40 CFU of total count of microorganisms and 2 CFU of coliform bacteria on the work table (Table 3). The microbiological load of other monitored surfaces in this part of the operation indicates sufficiently disinfected surfaces.

Table 3: Average values of evaluated microorganisms from different surfaces in section of cottage cheese production

Place of collection	Number of swabs	Before disinfection			After disinfection		
		TCM Ø	CB Ø	Molds Ø	TCM Ø	CB Ø	Molds Ø
wall	5	70	2	0	0	0	0
floor	5	256	1	0	4	0	0
working table	5	100	5	0	40	2	0
door	5	5	1	0	0	0	0
cottage cheese bath	5	65	2	0	0	0	0
creamer cottage	5	25	0	4	0	0	0
cream tank	5	14	1	0	0	0	0
stirrer in the bath	5	46	0	0	0	0	0

Ordinary (detergent) soaps together with water mechanically remove a certain amount of microorganisms, but disinfectants are necessary to kill or inhibit their growth [16]. The Center for Disease Control and Prevention guidelines state that, unless otherwise stated, ordinary soaps should be used for hand washing. There is still no clinical controlled study to assess the benefit of disinfectant soaps over conventional soaps. Unless clinical studies are performed, parameters for the use of disinfectants in hand hygiene should be established. When selecting antimicrobial products, their type, spectrum of efficacy and method of application should be taken into account [17]. Soap and water do not effectively reduce microorganisms on the hands [18]. On the other hand, the application of 70% ethanol on contaminated hands reduced 99.7% of their amount. When an antiseptic was applied to the skin, the maximum level of bacterial count reduction was achieved, regardless of the frequency and intensity of hand washing [19]. The skin is inhabited by various types of microorganisms, which are divided into resident and transient. Permanent, fixed, skin-like or resident microflora is found in the deeper layers of the epidermis, in the outlets of the sebaceous glands and sweat glands and around the nails. Its composition is constant, but the influence of external physical and chemical factors can upset its balance. Transient or transient microflora causes contamination of the skin surface of the hands. It is a mirror of environmental contamination as well as the hygienic habits of staff [20]. Table 4 provides information about the results of the samples taken by the imprint method. When comparing the microbial load of employees' hands before and after disinfection, we can state the following, the state after washing with antibacterial soap reduces the original contamination of employees' hands to almost zero numbers of coliform bacteria and reduced numbers of total microorganisms. The results of hand hygiene testing of employees working in the dairy plant show that the personal hygiene of the monitored employees is at a good level, except for the person working in the cottage cheese production section, where 50 CFU of total microorganisms and 1 CFU of coliform bacteria were detected on the right hand after disinfection. Such contamination of the employee's hands becomes a potential secondary source of contamination of the raw material, intermediate or final product.

Table 4: Comparison of Prosavon efficacy before and after hand disinfection at employees

Personnel	Sampling site	Microbial load on the hands			
		TCM		CB	
		right hand	left hand	right hand	left hand
employee working in the cheese production	before disinfection	80	55	0	0
	after disinfection	1	0	0	0
employee working in the yogurt production	before disinfection	55	50	0	0
	after disinfection	0	0	0	0
employee working in the cottage cheese production	before disinfection	110	45	4	1
	after disinfection	50	0	1	0

Insufficiently cleaned working table in the cottage cheese production section and poor hand hygiene of the employee working in this section points to a certain connection, possible secondary contamination of table by the employee. If cleaning and disinfection are not effective enough, attention must be paid to the suitability of the agent used for this activity, but also to the procedure of the actual performance of this activity [21].

4. CONCLUSION

From the point of view of health and hygienic food safety, pathogenic and technologically undesirable microorganisms have become the subject of interest of food microbiologists. Such an approach not only reduces the risk of harm to the health of consumers, but also helps business profitability by reducing losses. At present, sanitation plays an important role in the food industry. Without proper cleaning and subsequent disinfection, the production of safe food would not be possible. Hygiene and sanitation are essential measures in dairy industry. Hygiene level of food establishments is monitored through the application of the HACCP system which, based on the legal requirements of each operation, must be developed and observed by the respective team. Proper cleaning and disinfection of areas and materials with the right choice of effective products is very important. Based on our results obtained in practical conditions it can be presented following, that provision of preventive and regular cleaning and disinfection in premises of dairy plant has importance. The high level of hygiene is ensured by regular dairy hygiene control at every stage of the production process, including personal hygiene. However, the hands of people working in food businesses are an important work tool, but they can also be a threat. On the surface of the hands, various microorganisms have ideal conditions for their existence and multiplication, where they can survive for several hours. If the hands are not kept clean, they are involved in the transmission of many diseases and can thus contribute to the development of foodborne diseases. Regular monitoring of the level of personal hygiene in the dairy plant leads to the production of healthy food and prevents the spread of foodborne diseases.

5. ACKNOWLEDGEMENT

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6. REFERENCES

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