

ANALYSIS OF THE STATE OF THE HACCP SYSTEM IN THE DAIRY INDUSTRY IN RNM¹

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ABSTRACT

The HACCP food safety system is a preventive approach to the analysis and control of hazards at all stages of food production, which is a legal obligation for all food operators, including the dairy industry. The purpose of this paper is to analyze the state of the HACCP system in the Macedonian dairies and to identify the factors that affect its functioning. The survey covered 16 dairies with different structure and capacity. The obtained data shows that all dairies without exception have implemented and apply the HACCP system, of which only 62.5% have certified it. As one of the benefits of the application of the HACCP system, 87.5% of the dairies point out the product safety improvement and the increased trust of the consumers, for which all the dairies answered in the affirmative. Food premises requirements, financial resources and insufficient staff education are some of the problems in implementing the HACCP system that most dairies have faced.

Key words: food safety, HACCP system, dairy industry

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INTRODUCTION

Food safety and quality undoubtedly have the greatest impact on human health, so today, more than ever, consumers are looking for safe, healthy and quality food. Food safety is a state in which all people, at all times, have physical, social and economic access to a sufficient amount of safe food, which meets their nutritional needs, necessary for a healthy and active life (Bilska & Kowalski., 2014). In the last decade, after numerous incidents caused by contaminated food, consumer awareness of food quality and safety is increasing.

Milk and dairy products are extremely important foods, with high nutritional value in the human diet, due to their composition which includes proteins, fats, carbohydrates, vitamins, minerals and essential amino acids. Due to its composition and properties, neutral pH value and high water activity, milk is a perishable food, which is a favorable medium for growth and multiplication of microorganisms (Grandos et al., 2018). Milk and dairy products, due to their nutritional and therapeutic properties, are potentially dangerous products, if processed in conditions that do not comply with the rules for the production of safe food or due to the possibility of contamination that makes them unsuitable and unsafe for consumption. Therefore, they are identified as high-risk food products. The concept of food safety as a scientific concept deals with the handling, production, distribution and storage of food, to avoid potential dangers and to prevent diseases transmitted through food (Farooq et al., 2021). The safety of dairy products in dairies can only be ensured by taking care of potential hazards throughout the production process, starting with the raw milk. To this end, it is necessary at each stage of milk processing to identify the causes of any potential hazards and to determine the measures to be taken to limit their impact. Sources of danger in milk can be: biological, chemical or physical (Bilska & Kowalski. 2014). The incidence of contamination of raw milk and dairy products with biological and chemical hazards is a major problem worldwide. Systematic risk control is required at every stage of the process to minimize or eliminate failures in the production process. Contamination with pathogenic microorganisms can occur at any time and at any stage of the production, processing, packaging and distribution of milk and dairy products (Samaržija & Antunac, 2002). Pathogens that may be present in milk include: *Listeria monocytogenes*, *Salmonella*, *Campylobacter*, *S. aureus*, *B. cereus* and *Clostridium botulinum*, *E. coli* O157: H7. Their presence in the milk increases the risk of disease. Of the reported epidemics in developed countries caused by bacterial foodborne infections, milk has been identified as the carrier of approximately 1-5% of the total infections. *Salmonella* spp. and *Campylobacter* spp. are the most common hazards that

cause dairy-related epidemics (Tomašević et al., 2016). The large number of incidents and epidemics have made the food safety system necessary for the dairy industry. Milk is a potential carrier of many chemical contaminants, which even in the form of residues can adversely affect the health of consumers (Peristeropoulou et al., 2015). Typical chemical hazards most common in milk are veterinary drug residues, especially antibiotics, feed mycotoxins (aflatoxin M, zearalenone), polychlorinated biphenyls and cleaning agent and disinfectant residues (Jeličić et al., 2009). Small amounts of chemical hazards such as mycotoxins can contribute to chronic disease over time. Therefore, feed control is of great importance. In addition to the mentioned hazards, raw milk can be contaminated with physical agents such as: animal hair, straw, insects, glass pieces, pebbles, etc. which may reach the milk as a result of improper hygiene of the animals, the farm, the staff, the milking equipment, the environment, etc. (Grădinaru et al., 2020). The concept of food safety is a scientific concept that deals with the handling, production, distribution and storage of food, to avoid potential hazards and to prevent diseases transmitted through food (Farooq et al., 2021). An important aspect for improving the safety of dairy products is the application of prerequisite programs at the farm level and the HACCP system in dairies, as a basis for the production of safe dairy products. Industrial milk control has long exceeded the limits of occasional testing of only basic physico-chemical parameters. New plans and strategies are found in the specific food safety system. The risk associated with the production of dairy products can be reduced to an acceptable level or eliminated through the application of HACCP methodology, which will guarantee the safety of products. The implementation of the HACCP system from production to consumption of dairy products promotes their safety and prevents diseases caused by consuming unsafe products (Peristeropoulou et al., 2015).

Many government authorities around the world, including RN Macedonia, have adopted food safety controls based on the HACCP principles. With the enactment of the Law on Food Safety (Official Gazette of RM no. 157/2010), the HACCP system for assessment of the hazards at critical checkpoints becomes a mandatory legal obligation in food production and trade, in order to ensure food safety. HACCP principles are mainly oriented towards the identification, assessment and control of hazards at critical control points, which will increase the level of quality and safety of products, as well as the protection and trust of consumers (Birhanu et al., 2017). The HACCP system provides manufacturers with a scientific methodology that allows them to control the quality of production, rather than inspecting finished products (Liu et.al., 2021).

MATERIAL AND METHODS

In order to analyze the condition of the HACCP system in Macedonian dairies, a survey was conducted in which 16 dairies with different structure and production capacity participated voluntarily. The survey method was used in the research, which is one of the most applied methods in scientific research work. For the research, a detailed structured survey questionnaire with 38 questions was prepared, which was sent via e-mail to all dairies involved in the survey. The survey questionnaire contained mostly closed-ended questions to which the respondents could choose from the previously offered answers (some questions were multiple choice) and several open-ended questions. The survey questionnaire used in the research contained questions that would provide general information about the dairies and thematic questions related to the research and related to the implementation and functioning of the food safety system, as well as the difficulties and benefits faced by the dairies in the implementation and application of the HACCP system. The answers to some of the questions from the survey will be presented later in the paper.

RESULTS AND DISCUSSION

The survey included 16 dairies, of which, according to the structure and number of employees, 43.75% belong to micro dairies with up to 10 employees, 37.5% to small dairies up to 50 employees and 18.75% to medium dairies up to 250 employees. The analysis of the results showed that all 16 dairies that participated in the survey implemented and are applying the HACCP system which is a mandatory legal obligation in RN Macedonia, according to the Law on Food Safety (Official Gazette of RM no. 157/2010), and only 10 of them or 62.50% certified the HACCP system. The implementation of the HACCP system in 37.5% of the dairies was carried out by the employees, and in the majority of the dairies (62.5%) external consultants were hired for the implementation of the system, which indicates insufficient competence and necessary knowledge by the dairy employees to establish the HACCP system. The main motivating factor for the implementation of the HACCP system and the benefit for most of the dairies (87.5%) is the improvement of the safety of the products.

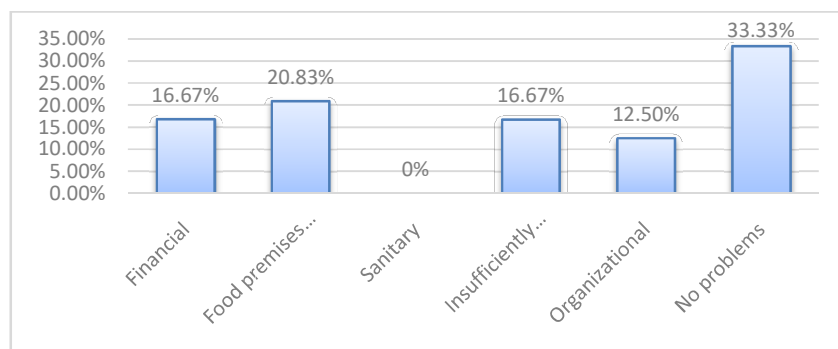


Chart 1 - Problems during the implementation of the HACCP system

The implementation of the HACCP system is accompanied by certain problems and barriers that complicate and hinder the process. During the survey, the dairies were asked to list the problems they faced in the implementation of the HACCP system. The obtained results show that the biggest problem in the implementation of the HACCP system that the dairies point out are the food premises requirements (20.83%), financial problems (16.67%), insufficiently educated staff (16.67%) and organizational problems (12.5%), while 33.35% of the dairies did not have any implementation problems at all (Chart 1). Similar studies (Karaman et al., 2012) cite financial resources and uneducated staff as the main problems in the implementation of the HACCP system. The implementation and maintenance processes of the HACCP system increase the operating costs of dairies, which was confirmed in this research. The data show that 31.25% of the dairies had a significant increase in costs in the initial phase of the implementation of the HACCP system, 43.75% of the dairies had increased costs in the later phase for maintenance and management of the HACCP system, 6.25% of the dairies had increased costs for the additional education of the employees and 18.75% of the dairies stated that they had other additional costs for the implementation of the HACCP system other than those listed (Chart 2). In the maintenance phase of the HACCP system, the costs are mainly related to engagement of employees and the time spent monitoring the critical control points and corrective activities, as well as record keeping procedures (Cusato et al., 2012).

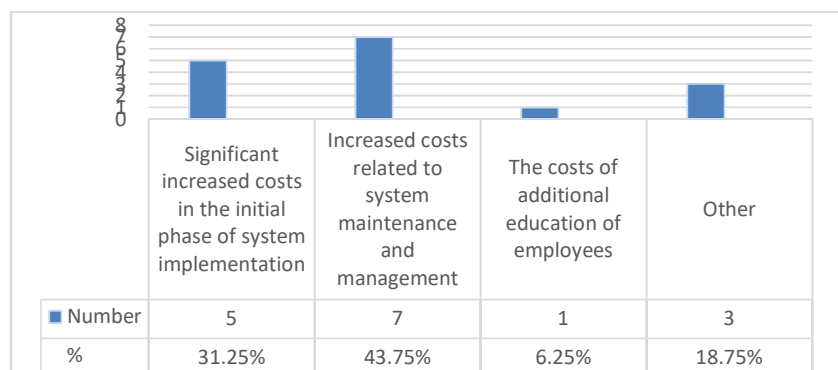


Chart 2 - The costs of implementing and applying na HACCP system

Identifying the critical control points of the technological process of milk processing, potential risks and preventive measures, is one of the most important conditions that dairies must meet to obtain compliant dairy products. (Grădinaru et al., 2020). Critical control points can be identified at all stages (steps) of the process, where potential hazards are likely to occur. The number of critical control points is different for each process and may vary depending on the type and complexity. In the survey, dairies were asked to indicate the stages of the technological process where they have identified critical control points. The analysis of the results shows that critical control points were identified at the intake of raw milk (27.5%) due to the possibility of antibiotics presence, in the milk heat treatment stage (30%), finished products storage stage (20%) and transport (distribution) of the finished products (15%). Antibiotics as residues in milk are a major problem for the dairy industry and consumer health. Antibiotic control is mandatory and is performed with rapid tests during milk intake. Another commonly identified critical control point in the technological process as seen in the results is the heat treatment of the milk.

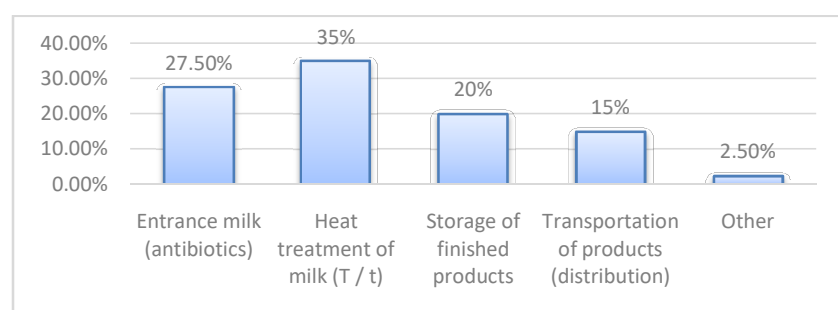


Chart 3 - Overview of identified critical control points in the process

Failure to comply with the parameters at this stage can lead to the survival of pathogenic bacteria, which can cause health problems for consumers. Therefore, in this stage, strict control of the time and temperature of the heat treatment is performed, which should undoubtedly provide a limit to the growth of a large number of specific bacteria, which will provide favourable conditions for the development of the necessary microflora for fermentation of the milk (Muresan et al., 2020). Literature data from similar studies (Suherman et al., 2020) indicate that in the largest percentage, critical control points were identified during heat treatment of the milk. The long period of storage of dairy products, non-compliance with the temperature range of 2 to 4 °C and without the possibility of air flow, expose the finished products to microbiological risk; for exponential growth of pathogenic microorganisms. The storage stage is usually considered a critical control point, where by applying the HACCP methodology, the risk is reduced to an acceptable level. For observing and measuring the control parameters of the critical control points, monitoring is one of the key procedures in the HACCP system that allows to warn the operators when there are deviations from the critical limits in the processes (Grădinaru et al., 2020). The data from the research showed that, without exception, all dairies (100%) that participated in the research, answered that they perform regular monitoring and verification of the critical control points, regular calibration on the equipment and measuring instruments, as well as regular testing of the products, in accordance with plans and regular legal obligations, which is a guarantee of compliance with the HACCP plan and production of safe dairy products. Calibration of the equipment and measuring instruments affirms their accuracy in controlling the critical constraints, which are established at the critical control points in the technological process. In order to check the effectiveness of the HACCP system, verification is a key element that is implemented in accordance with the verification plan (Osama, 2020). The verification procedures confirm that the system operates on the basis of the established HACCP plan and that the result is a safe dairy product. The results of the research showed that when asked if they perform regular verification of the HACCP system, all dairies (100%) that participated in the survey perform regular verification of the HACCP system. The majority of dairies (75%) complete the verification of the HACCP system once a year, and the remaining 25% of the dairies perform the verification as needed, if there are changes in the technological process, installation of new equipment etc. In almost 75% of the dairies, the HACCP system verification was performed by the employees who are members of the HACCP team, and in the other 25% of the dairies external consultants were in charge of the system verification. The implementation of the HACCP system, in addition to problems, brings numerous advantages and benefits for producers and consumers of dairy products. The survey asked dairies to highlight the

benefits of implementing and applying the HACCP system. Therefore, the data from the research show that the biggest advantages and benefits from the implementation of the HACCP system that the dairies emphasize are the increased safety of the dairy products (21.4%), the compliance with food safety legislation (up to 20%), improved product traceability (20%), increased consumer confidence (14.3%), reduction of consumer complaints (8.6%), increased company productivity (7.1%), increased product competitiveness (5.7%). The smallest benefit from the implementation of the HACCP, according to the assessments of the dairies, is a reduction of the production costs (2.9%) (Chart 4).

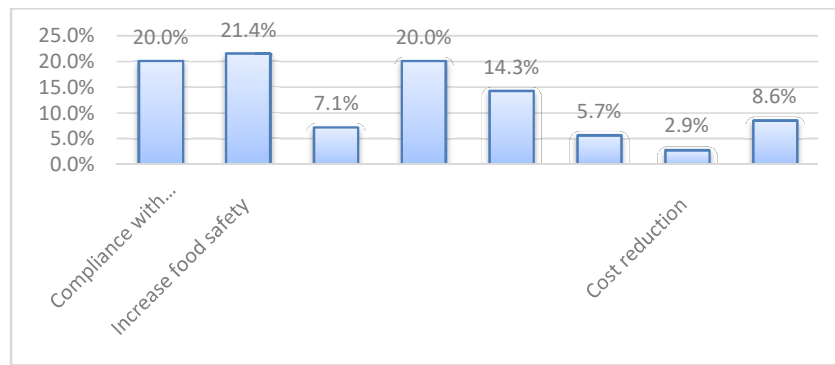


Chart 4 - Advantages of implementing the HACCP system

The data from the literature show that the economic benefits of the application of the HACCP system are related to better process control, reduction of loss of raw materials and finished products, which lead to benefits in the efficiency and productivity of companies and thus increased revenues, sales and company profits (Yussupova et al., 2020).

Asked if they had increased revenue, 31.25% of dairies surveyed said they had increased revenue, 25% of dairies had partially increased revenue, while 43.75% of dairies said they did not increase revenue with the implementation and application of the HACCP system. The application of the HACCP system as a preventive oriented approach provides food producers better control over operations, better production practices and greater efficiency that will strengthen the positions of companies and will contribute to improving their products' competitiveness. The majority of dairies (62.5%) in the research confirmed that with the implementation and application of the HACCP system they have increased the competitiveness of their products. In addition to the stated benefits, the implementation and application of the HACCP system opens new opportunities for products to access foreign markets (Yussupova et al., 2020).

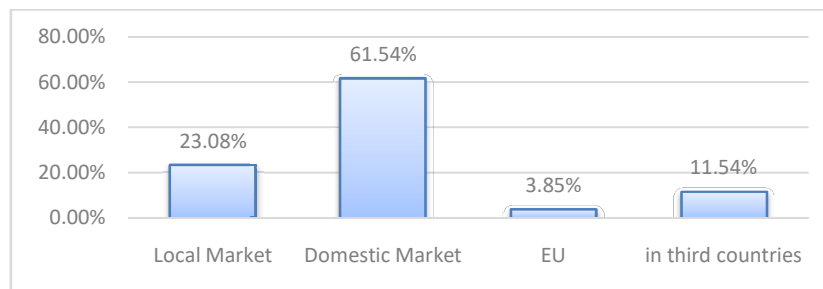


Chart 5. Ranking of dairy products

When asked where they sell their dairy products, the majority of dairies in the survey (61.54%) answered that they sell their dairy products in the domestic, 23.08% in the local market, and only a small part of dairies are oriented towards foreign markets; 11.54% of the dairies sell their products in third countries' markets and 3.85% in the European market. In addition to the HACCP system as a mandatory legal obligation, the results showed that of the total number of dairies included in the survey, only a small proportion have implemented optional or voluntary systems. Namely, 4 dairies claim to have implemented the ISO 22000 food safety management system, and 2 dairies claim to have implemented the ISO 9001 quality management system, which guarantee the safety of dairy products, quality management of the dairy production processes and sale of dairy products in foreign markets.

CONCLUSION

In this paper, the state of the implementation and functioning of the HACCP system in Macedonian dairies was analysed. The survey mostly included micro and small dairies, which actually expresses the real structure, in terms of the size of the companies in this sector in RN. Macedonia. All dairies which were included in the research, without exception, confirmed that they have implemented the HACCP food safety system, and only some of them have been certified. The implementation and application of the HACCP system in the dairy industry is accompanied by a variety of problems, of which the most prominent are the food premises requirements and financial ones. These problems, to a greater or lesser extent, cause an increase in costs in the initial phase of implementation or in the later stages of operation and maintenance of the HACCP system. As the biggest advantage and benefit from the implementation of the HACCP system, the dairies emphasize the increased safety of the products and the compliance with food safety legislation. In addition to the HACCP system as a mandatory legal obligation, a small number of dairies have implemented both optional and voluntary ISO 22000 safety management systems and the

ISO 9001 quality management system. Although these systems are formally voluntary, they are recently becoming mandatory as they are increasingly sought after by retail chains and are considered a condition for entering foreign markets. Therefore, in the coming period, dairies should focus on the establishment of higher voluntary food safety management systems, which will provide greater recognition and competitiveness of dairy products in foreign markets, in accordance with the requirements of modern consumers. For the realization of this process, especially for micro and small dairies, financial support from the competent public institutions is necessary, by creating an appropriate model for subsidizing part of the costs, as well as supporting activities that will be aimed at providing the necessary knowledge, through various educations and trainings for employees at all levels.

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