

Evaluation of Sanitation as a Preventive Measure of Foodborne Diseases in the Bakery Operation

Mária Vargová¹, Katarína Veszelits Laktičová², Nad'a Sasáková³ and František Zigo^{4*}

¹ Department of Public Veterinary Medicine and Animal Welfare,
University of Veterinary Medicine and Pharmacy, Košice, Slovakia
Email: Maria.Vargova [AT] uvlf.sk

² Department of Public Veterinary Medicine and Animal Welfare,
University of Veterinary Medicine and Pharmacy, Košice, Slovakia
Email: Katarina.VeszelsLakticova [AT] uvlf.sk

³ Department of Public Veterinary Medicine and Animal Welfare,
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— *Every step from production through consumption can influence the microbiology of food products. Unsanitary equipment and insufficient hygienic level in food industry lead to increased populations of microorganisms and can compromise quality and safety. Proper use of disinfectants can complement an effective sanitation program. Sanitation is an important part of the HACCP system, as its application significantly eliminates microorganisms in the production process. The system is an auxiliary control body for monitoring compliance with hygiene procedures. As a result of non-compliance with sanitation procedures, food products are contaminated and undesirable foodborne illnesses of the consumer occur. The epidemiology of foodborne diseases is rapidly changing as newly recognized pathogens emerge and well recognized pathogens increase in prevalence or become associated with new food vehicles. In this work, we focused on cleaning and disinfection of surfaces that significantly affect the hygienic safety of the resulting products. The purpose of sampling was to assess the effectiveness of disinfection in a bakery in order to prevent the occurrence of foodborne diseases. For disinfection, a 3% concentration of Savo disinfectant was used. Surface hygiene control was performed using microbiological swabs before the start of production, during production and after disinfection. Samples were taken from work surfaces floor, wall, table, tray and mixer. Disinfectant Savo was effective on floor, wall, tray and mixer where were detected significant decrease of colony forming units of total count of bacteria, coliform bacteria and moulds after disinfection. On these monitored surfaces no bacteria after disinfection was detected. On the table were detected 3 colony forming units of total count of bacteria after disinfection which represent decrease of microorganisms, in compare with numbers of microorganisms before production. The results from the microbiological swabs shows that disinfectant Savo was able to decrease the number of colonies forming units after disinfection.*

Keywords — Sanitation, HACCP, Disinfection, Foodborne Diseases.

ABBREVIATIONS: HACCP: Hazard Analysis Critical Control Point

1. INTRODUCTION

The basic requirement for food businesses is the production of safe food, which is influenced by the technological process at various stages, from agricultural production through the food industry to food processing [1]. HACCP is a management system in which food safety is addressed through the analysis and control of chemical, biological and physical hazards from raw material production, handling, to manufacturing and distribution of the finished product.

Sanitation as a part of HACCP, is a process to reduce the number of microorganisms to a safe level, from surfaces that have been properly cleaned [2]. In connection with food industry, sanitation is the process of providing conditions that will ensure safe and wholesome products for human consumption [3]. Appropriate sanitation and proper selection of

disinfectant is based on the knowledge of the resistance of microorganisms to the effect of the disinfectant, the efficacy of the disinfectants themselves and the potential negative impact on the environment [4]. The goal of disinfection is to destroy microorganisms, this does not automatically mean killing all microorganisms, but reducing the number to a level that is not normally harmful to health [5]. Disinfection is ineffective unless all surfaces have previously been thoroughly cleaned to remove interfering materials. Cleaning is therefore extremely important as part of a two-stage cleaning and disinfection program [6].

Despite the high level of food safety in Europe, we encounter foodborne illness or food poisoning on a daily basis [7]. Food-borne diseases represent very important health problem and an important cause of reduced economic growth. The contamination of the food products with the pathogens and its persistence, growth, multiplication has emerged as an important public health concern. In contrast with most chemical hazardous compounds, the concentration of food pathogens changes during the processing, storage, and meal preparation.

Microorganisms enter the production process from different sources and at different stages of the process. Worker's skin and clothing, water, air, contact areas and additives are the most common factors contributing to the introduction of microorganisms into the production environment [8]. Also, non-contact surfaces such as floors, walls, ceilings, ceiling beams and support devices are potential sources of microbial contamination. Packaging can also be a source of contamination. The hygienic standard of food products can be assessed by the analysis of the indicator microorganisms [9]. The fecal coliforms, as for example *Escherichia coli*, are used as an indicator of the sanitary conditions [10]. *Escherichia coli* is a component of the fecal microbiota, its detection may indicate the potential occurrence of other microorganisms which could be even more pathogenic to the man and both domestic and wild animals. It includes a broad variety of strains types, ranging from the highly pathogenic strains causing the worldwide outbreaks of severe disease to avirulent isolates which are part of the normal intestinal microbiota, or which are well characterized and safe laboratory strains [11, 12]. Several *E. coli* types have been implicated with the diarrhoeal illness, a major public health problem worldwide, with over two million deaths occurring each year [13]. The presence of coliforms on the surfaces and in the products demonstrates possible contamination and indicates poor manufacturing practices and inadequate factory hygiene standards [14]. The presence of coliform bacteria is generally an indication of fecal contamination of the water and food. Their quantification is therefore, an integral part of the quality assessment of food and water.

The purpose of sampling and subsequent laboratory analysis was to evaluate the effectiveness of disinfection in the bakery in order to prevent the occurrence of foodborne diseases. A properly designed and implemented Hazard Analysis Critical Control Point system and appropriately selected sanitation procedures are necessary to achieve the desired effect.

2. MATERIALS AND METHODS

2.1 Characteristics of bakery processing plant

The evaluated bakery processing plant produce a wide range of bakery products. The hygienic level of monitored surfaces - floor, wall, table, tray and mixer of pastry production (Figure 1, 2) in the bakery operation was examined and analyzed. The bakery was divided into several parts - Production hall with the bread making section and the pastry section; Packing hall including slicer and Dispatch hall. Swabs were taken from Production hall from the section of sweet pastry production. The bakery has a thoroughly developed and effective sanitation program, which is a part of HACCP system. All surfaces, machines and areas are cleaned and disinfected after the process of production.



Figure 1: Work table - pastry section



Figure 2: Mixer - pastry section

2.2 Microbiological control of effectiveness of disinfection

Samples were taken by microbiological swabs from work surfaces – floor, wall, table, tray and mixer. Swabs were taken from evaluated surfaces before the start of production, during production and after disinfection. ISO 18593 and ISO 21527 are standards for the method of sampling surfaces using prints and tampons [15, 16]. The swabs were taken from area of 10 x 10 cm. Each one microbiological swab was average value which was expressed of 5 swabs were taken from same place. The sampled areas were wiped with sterile cotton swabs and the swabs were then placed in a sterile tube containing 10ml of sterile saline solution. From this mixture 0.1 ml was applied to the different agar plates. Endo agar was used for coliform bacteria, Meat peptone agar was used for total count of bacteria and Sabouraud agar was used for yeasts and molds. The results from the Endo agar and Meat peptone agar were obtained after 24 hours incubation at 37 °C. The results from the Sabouraud agar were obtained after 5 days incubation at room temperature.

For disinfection of different surfaces was used disinfectant Savo in 3 % concentration with exposure time 30 minutes. Savo is liquid cleaning and disinfecting agent. Disinfectant was used in liquid form, applied by spraying, without heating. It contains active substance sodium hypochlorite $\geq 1\%$ - $< 5\%$; sodium hydroxide $\geq 0.5\%$ - $< 2\%$ and $< 5\%$ anionic surfactant, it is intended for cleaning any surfaces, including floors. The preparation has a broad-spectrum efficacy, is effectiveness against vegetative bacteria, fungi, poliovirus, adenoviruses, Bacillus subtilis, Mycobacterium.

Results were statistically processed using descriptive statistical analysis of data.

3. RESULTS

Effectiveness of evaluated disinfectant Savo before the start of production, during production and after disinfection is shown in Table 1. Disinfectant Savo was effective on floor, wall, tray and mixer where were detected significant decrease of CFU of TCB, CB and moulds after disinfection. On these monitored surfaces no bacteria after disinfection was detected. On the table were detected 3 CFU of TCB after disinfection which represent decrease of microorganisms, in compare with numbers of microorganisms before production, but this amount of CFU doesn't represent hygienic risk for production. Presence of 3 colonies forming units of total count of bacteria could be cause due to insufficient mechanical cleaning. Wood, as material which was used for table, is difficult to mechanical clean because wood is a porous material, and due to this fact usage of wood in the food industry is under debate and wood is getting discriminated in many sectors. The results from the microbiological swabs taken at the monitored bakery from section production of pastries shows that disinfectant Savo was able to decrease the number of colonies forming units after disinfection.

Table 1: Average values from microbiological swabs from section production of pastries

place of collection	before production			during production			after disinfection			
	TCB (CFU)	CB (CFU)	M (CFU)	TCB (CFU)	CB (CFU)	M (CFU)	TCB (CFU)	CB (CFU)	M (CFU)	
section production of pastries	Floor	3	1	1	15	0	2	0	0	0
	Wall	0	0	0	10	0	0	0	0	0
	Table	15	0	0	27	0	1	3	0	0
	Tray	0	0	13	111	0	0	0	0	0
	Mixer	0	0	0	8	0	0	0	0	0

Abbreviations: CFU - colony forming units, M – moulds, TCB – total count of bacteria, CB – coliform bacteria

4. DISCUSSION

Maintaining a clean work environment is critical in preventing foodborne illness. Bacteria can grow on unsanitary surfaces and then contaminate food. Sanitation is an applied science that incorporates the principles of design, development, implementation, maintenance, restoration, and/or improvement of hygienic practices and conditions. Sanitation applications refer to hygienic practices designed to maintain a clean and wholesome environment for food production, processing, preparation, and storage [17]. A sanitation plan is important in any food service preparation area. It ensures that all surfaces are cleaned on a regular basis and reduces the risks of transferring bacteria or other pathogens from an unclean surface to clean equipment such as cutting boards or tools [18]. An effective sanitation program can improve product quality and shelf life because the microbial population can be reduced. An effective sanitation program includes regular cleaning and sanitizing of all equipment in a facility including heating, air conditioning, and refrigeration equipment. Dirty, clogged coils harbor microorganisms and blowers and fans can spread flora throughout the facility [17].

Food-borne illness is a major international problem and an important cause of reduced economic growth. The contamination of the food supply with the pathogens and its persistence, growth, multiplication and/or toxin production has emerged as an important public health concern [19]. Most of these problems could be controlled with the efforts on the part of the food handlers, whether in a processing plant, a restaurant, and others [14]. Most outbreaks of foodborne disease are microbiological in origin and their investigation usually require a microbiology laboratory. Outbreaks caused by chemically contaminated food also occur, although they are much less common than microbiological events [20]. In contrast with most chemical hazardous compounds, the concentration of food pathogens changes during the processing, storage, and meal preparation, making it difficult to estimate the number of the microorganisms or the concentration of their toxins at the time of ingestion by the consumer [14]. Investigation of food establishments during a foodborne disease outbreak often require: interviewing managers; interviewing any employees who may have had a role in the processing or preparation of suspected foods; a review of employee records; a review of the overall operations and hygiene; food and environmental samples a review of food worker health and hygiene, including specimens for analysis; an assessment of the water system and supply; measurement of temperatures, pH and water activity with appropriate equipment [20].

5. CONCLUSION

Food can become contaminated at any stage in the food chain, including at the farm, during animal slaughter, during processing, in restaurants, or at home. Because bacteria are everywhere, sanitation is a major factor in preventing foodborne illness. By keeping everything hygienically clean that comes in contact with food, consumers can be assured they are helping to do their part to be food safe. According to obtained results in practical conditions of bakery operation we can conclude that the disinfectant Savo which was used in 3 % of concentration was effective on monitored surfaces – floor, wall, tray and mixer, but on the table were found 3 colonies forming units of total count of bacteria after disinfection. Disinfection as a part of sanitation is considered as one of the most important activities in food industry, because it provides the hygienic suitable environment for processing and all other activities, which is also confirmed by the results obtained in this work.

6. ACKNOWLEDGEMENT

This work was supported by Slovak grant KEGA no. 004UVLF-4/2020.

7. REFERENCES

- [1] Prousek J. Rizikové vlastnosti látok. Bratislava: Slovenská technická univerzita. 247 p. ISBN 80-227-1497-6, 2001.
- [2] Fraser A. Define "cleaning" and "sanitizing" and the differences between the two procedures. In: www.foodsafetysite.com. vol. 18, 2012.
- [3] Skaarup T. Slaughterhouse cleaning and sanitation. In: Rome: Food and Agriculture Organization of the United Nations, 1985, vol. 2018.
- [4] Vargová M., Veszelits Laktičová K., Hromada R., Cimboláková I., Uher I., Papajová I. Sanitation and the environment. Intechopen. 2020.
- [5] Wirtanen G, Salo S. Disinfection in food processing—efficacy testing of disinfectants. Environmental Science and Biotechnology, vol. 2: no 2, pp. 293-306, 2003.
- [6] Dvorak G. Disinfection 101. Center for Food Security and Public Health. Iowa State University, 2005.
- [7] Šalgotičová D. a kol. Stredisko pre vyhodnocovanie výskytu cudzorodých látok. In Bulletin potravinárskeho výskumu (Bulletin of Food Research). Vol. 39, no. 4, pp. 285-290, ISSN 0231-9950, 2000.
- [8] Kornacki J.L. Principles of Microbiological Troubleshooting in the Industrial Food Processing Environment. [online]. McFarland: Springer. ISBN 978-1-4419-5517-3, 2010.
<https://books.google.sk/books?id=p5Mr69ii008C&pg=PA4&hl=sk&source=gbs_toc_r&cad=4#v=onepage&q&f=false>

- [9] Forsythe S.J.; Hayes P.R. Food Hygiene, Microbiology and HACCP. A Chapman and Hall Food Science Book. Aspen Publishers, Gaithersburg. 1988.
- [10] Batt C., Batt C.A. Encyclopedia of Food Microbiology (Second Edition), Indicator organisms. pp. 358-363, ISBN: 9780123847331, 2014.
- [11] Sousa C.P. Pathogenicity mechanisms of prokaryotic cells: an evolutionary view. The Brazilian Journal of Infectious Diseases, vol. 7, pp. 23-31, 2003.
- [12] Sousa C.P. The strategies of *Escherichia coli* pathotypes and health surveillance. *Revisa*. **1**, pp. 65-70. 2005.
- [13] W.H.O. Emerging foodborne diseases. Fact Sheet. pp. 124, 2002. Available at: www.who.int/inffs/en/fact124.html.
- [14] Sousa C.P. The impact of food manufacturing practices on food borne diseases June 2008 Brazilian Archives of Biology and Technology
- [15] ISO 18593: Microbiology of food and animal feeding stuffs – Horizontal methods for sampling techniques from surfaces using contact plates and swabs. International Organization for Standardization, 2004.
- [16] ISO 21527: Microbiology of food and animal feeding stuffs -- Horizontal method for the enumeration of yeasts and moulds -- Part 1: Colony count technique in products with water activity greater than 0,95, 2008.
- [17] Marriott N.G., Gravani R.B. Principles of Food Sanitation, Fifth Edition. ISBN-10: 0-387-25025-5, pp. 15-30, 2006.
- [18] Victoria B.C. Food Safety, Sanitation, and Personal Hygiene. ISBN: 978-1-7753524-6-4, 2015.
- [19] Newell D.G., Koopmans M., Linda P.B., Duizer V.E. Food-borne diseases — The challenges of 20 years ago still persist while new ones continue to emerge. 2010.
- [20] WHO Library Cataloguing-in-Publication Data Foodborne disease outbreaks : guidelines for investigation and control. ISBN 978 92 4 154722 2, pp. 37, 2008