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Food contact surfaces and food handler's hygiene in one Serbian retail chain – estimation and trend

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Abstract. This research aimed to investigate the efficiency of sanitary procedures (cleaning, washing, disinfection) applied on food contact surfaces and food handlers' hands in one retail chain in Serbia. For that reason, a total of 364 swabs of food contact surfaces and 86 food handlers' hand swabs were investigated for microbiological parameters of process hygiene. The results showed that 15.66% (57 of 365) swabs of food contact surfaces, and 5.81% (5 of 86) swabs from the food handlers' hands, failed to meet the criteria laid down in the self-control plans of the food business operators. Therefore, continuous training of employees on the proper application of sanitation procedures is essential for efficient GHP and HACCP.

1. Introduction

Meat consumption is increasing worldwide due to the rapid growth of the population and urbanization. This has raised concerns and challenges regarding food and meat safety and hygiene because meat and meat preparations are routinely associated with food poisoning outbreaks [1]. Food safety is primarily achieved through a preventive approach, such as implementing a food safety management system based on Hazard Analysis and Critical Control Point (HACCP) principles and good hygiene practice (GHP). Good hygiene practices are prerequisites to implementing a HACCP system and are essential for producing safe food [2]. Furthermore, good hygienic practices at slaughterhouses and during distribution to and storage at retail shops, and during sales are critical points in ensuring the quality and safety of meat and meat preparations to safeguard public health [3]. Also, the implementations of the HACCP system and GHP are mandatory according to EU and Serbian Regulations, and every food business operator must have self-control plans with defined microbiological testing, such as type of examined microorganisms, dynamics, limits, etc.

To prevent contamination of meat, both during its processing and in retail, it is essential to regularly apply cleaning, washing, and disinfection of work surfaces, tools, equipment, and food handlers' hands [4]. Unfortunately, despite an increase in the number of food handlers receiving food hygiene training, many food poisoning outbreaks still occur due to improper food handling practices in the retail industry [5].

Food contact surfaces, such as food containers, utensils, plates, cooking kettle, cutting boards, slicers, knives, steel pallets and spatulas, stainless steel and plastic vessels for food distribution, are a significant concern for foodservice facilities in controlling the spread of food-borne pathogens because cross-contamination via food contact surfaces has been identified as an essential risk factor [6].



Food handlers' hands have been identified as pivotal vectors in the spread of food-borne disease due to poor personal hygiene or cross-contamination, resulting in the hands being contaminated with enteric pathogens [5]. The food handler and contact with contaminated surfaces are potential causes of cross-contamination and, consequently, outbreaks [7]. To prevent infection, people in the food production and food industries should be well trained and motivated to follow good personal hygiene practices, correct handwashing procedures, and follow these procedures while working [8].

Although handwashing may seem trivial to the food staff, failing to do it can have tragic consequences. It is generally acknowledged that a critical vehicle for cross-contamination of food is attributed to food handlers' hands. Accordingly, improved personal hygiene and meticulous hand washing would lead to the primary control of the feces-to-hand-to-mouth spread of potentially pathogenic transient microorganisms [8, 9].

This research aimed to assess microbiological parameters of process hygiene and investigate the efficiency of sanitary procedures applied on food contact surfaces and food handlers' hands in one retail chain in Serbia.

2. Materials and Methods

During four years (from January 2017 to December 2020), an assessment of the process hygiene was carried out in 18 retail shops in Serbia. Overall, a total of 364 swabs of food contact surfaces (FCS) and 86 food handlers' hand (FHH) swabs were investigated for microbiological parameters of process hygiene (Table 1).

Table 1. Number of sampled swabs in each year

Year	Food contact surfaces (FCS) swabs	Food handlers' hands (FHH) swabs
2017	109	/
2018	77	/
2019	101	48
2020	77	38
Total	364	86

2.1. Swab samples

Swab samples from the food contact surfaces and food handlers' hands were taken after cleaning, washing, and disinfection procedures. Sampling was conducted according to the standard method [10]. On the sampling day, swabs were transported to the laboratory in a cold chain and analyzed within 24h. All samples were analyzed in an accredited laboratory according to SRPS ISO/IEC 17025:2006.

2.2. Microbiological examinations

Swab samples from the food contact surfaces and food handlers' hands were tested for aerobic colony count (ACC) according to SRPS EN ISO 4833-1:2014 [11] and *Enterobacteriaceae* (ENT) in line with SRPS ISO 21528-2:2009 [12]. Results of the microbiological analyses were expressed as a number of bacteria per cm² (CFU/cm²) and number of bacteria per swab (CFU/swab) for swabs taken from the food contact surfaces and food handlers' hands, respectively.

2.3. Evaluation of microbiological results

The estimation of the obtained results of microbiological contamination was carried out following the limit values set by the self-control plans of the food business operators (Table 2).

Table 2. Microbiological criteria in the self-control plans of the food business operators

Microorganisms	Porcelain, glass, smooth metal food contact surfaces	Plastic, wood, stone food contact surfaces	Food handlers' hands (HS)
Aerobic colony count	≤ 10 CFU/cm ²	≤ 30 CFU/cm ²	≤ 2000 CFU/swab
<i>Enterobacteriaceae</i>	≤ 1 CFU/cm ²	≤ 1 CFU/cm ²	≤ 10 CFU/swab

3. Results and discussion

During the four years (from January 2017 to December 2020), in 18 retail shops, 364 swabs from food contact surfaces (cutting boards, slicing machines, knives, refrigerator doors, metalworking surfaces) were examined. During 2017, a total of 109 swabs were examined, followed by 77, 101, and 77 swabs in 2018, 2019, and 2020, respectively (Table 1).

The results showed that 15.66% (57 of 364) swabs of food contact surfaces failed to comply with the criteria laid down in the self-control plans of the food business operators. In 2017, 27.52% of swabs of food contact surfaces were non-compliant with the limits set in control plans, while in 2018, 2019, and 2020, rates of non-compliance were 14.29%, 9.90%, and 7.79% swab, respectively (Table 3). These findings are close to those conducted by Legnani *et al.* [13] in 2004 and Garayoa *et al.* [14] in 2014, while in the research undertaken by Vesković *et al.* [2], this percentage was significantly higher, up to 41.96%. Reduction of the percentage of non-compliant swabs in 2019 and 2020 compared to 2017 suggests that training of employees on the proper application of sanitation procedures proved to be essential for efficient GHP and HACCP.

The main reason for the non-compliant results of swabs of food contact surfaces in all four years was the high ACC (2017 – 93.33%, 2018 – 90.91%, 2019 – 70.00%, and 2020 – 83.33%).

Table 3. Microbiological status of the food contact surfaces

Year	Number of swabs	Non-compliant		Finding	Frequency		Finding	Frequency	
		N	%		n	%		n	%
2017	109	30	27.52	ACC	28	93.33	ACC + ENT	2	6.67
2018	77	11	14.29	ACC	10	90.91	ACC + ENT	1	9.09
2019	101	10	9.90	ACC	7	70.00	ACC + ENT	3	30.00
2020	77	6	7.79	ACC	5	83.33	ACC + ENT	1	16.67

During the two-year period (from January 2019 to December 2020), 86 swabs from food handlers' hands were examined in the same retail shops. In 2019, 48 swabs were tested, while in 2020, 38 swabs (Table 1).

The results of microbiological examinations of swabs from the food handlers' hands showed that 5.81% (5 of 86) swabs were not compliant with the criteria in the self-control plans of the food business operators. However, the results of food handlers' hand swabs showed a similar level of hygiene in both years (non-compliant in 2019 - 8.33%, and in 2020 - 2.63%) (Table 4). Again, in most findings, the reason for non-compliant results in both years was the high ACC (80.00%). These findings are similar to those reported by Ivanović *et al.* [15] in 2013, while in a study conducted by Rašeta *et al.* [4] in 2012, this percentage was significantly higher, 30.0%.

Table 4. Microbiological status of the food handlers' hands

Year	Number of swabs	Non-compliant		Finding	Frequency		Finding	Frequency	
		N	%		n	%		n	%

2019	48	4	8.33	ACC	3	75.00	ACC + ENT	1	25.00
2020	38	1	2.63	ACC	1	100.00	ACC + ENT	/	/

4. Conclusion

According to the results obtained in this study for the presence and enumeration of hygiene indicator microorganisms on food contact surfaces and food handlers' hands, the sanitary conditions in these retail shops were adequate. However, to maintain this level of process hygiene, it is necessary to constantly educate workers regarding the sanitary procedures of work surfaces, tools, equipment, and food handlers' hands. Also, it is obligatory to continue with regular swabs controls of food contact surfaces and food handlers' hands as defined in the self-control plan of the food business operators.

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