

Monitoring process hygiene in Serbian retail establishments

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Abstract. The present study was conducted to estimate the effectiveness of sanitary procedures on food contact surfaces and food handlers' hands in Serbian retail establishments. For that purpose, a total of 970 samples from food contact surfaces and 525 samples from workers' hands were microbiologically analyzed. Results of total aerobic plate count and total *Enterobacteriaceae* count showed that the implemented washing and disinfection procedures, as a part of HACCP plans, were not effective enough in most retail facilities. Constant and intensive education of employees on proper implementation of sanitation procedures are needed in order to ensure food safety in the retail market.

1. Introduction

Food safety is primarily achieved through a preventive approach such as the implementation of a food safety management system based on the principles of Hazard Analysis and Critical Control Point (HACCP) and good hygiene practice (GHP). Good cleaning practices are prerequisites to the implementation of an HACCP system and are essential for the production of safe food. Food contact surfaces are considered a major concern for food service facilities in controlling the spread of food-borne pathogens because cross contamination via food contact surfaces has been identified as a significant risk factor [1]. Likewise, improvement of the hand hygiene of workers who come into direct contact with food during retail sale of food is of great importance in prevention of food-borne diseases [2]. Food contact surfaces include food containers, utensils, plates, cooking kettle, cutting boards, slicers, knives, steel pallets and spatulas, stainless steel gastronorms and plastic vessels for food distribution [3].

Pathogens are often found attached to the food contact surfaces of processing equipment, such as knives, cutting boards and the conveyor belts of slicing machines and these are typically made of stainless steel, plastic and polyester urethane (PSU), respectively. As microbiological indicators of surface hygiene, the aerobic plate count and total *Enterobacteriaceae* count are the most frequently examined microbiological parameters [4]. In the past two decades, serious outbreaks of food-borne disease were caused by *Listeria monocytogenes*, a pathogen frequently found in retail delicatessens [5]. In addition, *L. monocytogenes* can form biofilms, and thus, successfully persist in retail and/or food processing establishments, which makes this pathogen a significant concern for the food industry and a serious threat to public health. Especially on porous surfaces (such as damaged or old plastic conveyor belts) or in the niches where it is difficult to access, the bacteria can persist and form biofilms [6], after which, routine cleaning may not eliminate them. Thus, it is of great importance to implement sanitary procedures to ensure thorough removal of impurities and minimizing the number of microorganisms on the surfaces to a minimum acceptable level. Therefore, to ensure the safety of



the finished food product, it is necessary to control the cleanliness of the environmental surfaces in processing and retail levels, as well as of the hands of workers who manipulate food.

The aim of this study was to estimate the effectiveness of sanitary procedures on food contact surfaces and food handlers' hands in Serbian retail establishments.

2. Materials and Methods

During a one year period (from July 1, 2016 to June 30, 2017), an assessment of the process hygiene was carried out in retail facilities in Serbia. A total of 524 retail facilities were included in this study, where 970 food contact surfaces and 525 food handlers' hands were investigated for microbiological parameters of process hygiene. Depending on size and capacities, retail facilities were classified into categories (A, B and C), where facilities of A category were the largest. The number of samples in each facility was adjusted according to those criteria (Table 1).

Table 1. Number of swabs sampled for the estimation of process hygiene in different categories of retail facilities

| Category of retail facilities | Number of facilities | Number and type of swab samples | |
|-------------------------------|----------------------|---------------------------------|----------------------|
| | | Food contact surfaces | Food handlers' hands |
| A | 128 | 384 | 128 |
| B | 191 | 382 | 191 |
| C | 205 | 204 | 206 |
| Total | 524 | 970 | 525 |

2.1. Swab samples

Swab samples from the food contact surfaces or food handlers' hands were taken after cleaning, washing and disinfection procedures. Sampling was conducted according to the standard method [7]. On the sampling day, swabs were transported to the laboratory in a hand-held refrigerator and analyzed within 24 h.

2.2. Microbiological examinations

Depending on the surface from which the swab was taken, microbiological analyses were performed. Namely, aerobic plate count, total *Enterobacteriaceae* count and the presence of *L. monocytogenes* were analyzed in samples from the surface of the equipment and tools, such as slicing machines, cutting boards, knives or hatchets. The surfaces of food handlers' hands were tested for aerobic plate count and total *Enterobacteriaceae* count. The microbiological examinations were performed following standard SRPS ISO methods: aerobic plate count [8]; total *Enterobacteriaceae* count [9] and detection of *L. monocytogenes* [10]. Results of the microbiological analyses were expressed as 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 (data not shown).

2.3. Evaluation of microbiological results

The assessment of the obtained results of microbiological contamination was carried out in accordance with the limit values set by the self-control plans of each retail food business operator (Table 2). These compliance criteria were selected because they were practical, achievable and verifiable for the evaluation of hygiene and sanitation program in the food industry.

Table 2. Microbiological criteria–limit values contained in the self-control plans of the food business operators

| Microorganisms | Surfaces | |
|---------------------------|--------------------------------|----------------------|
| | Equipment and tools | Food handlers' hands |
| Aerobic plate count | ≤ 10 CFU/cm ² | ≤ 1000 CFU/swab |
| <i>Enterobacteriaceae</i> | ≤ 1 CFU/cm ² | ≤ 10 CFU/swab |
| <i>L. monocytogenes</i> | Absence in 100 cm ² | |

3. Results and Discussion

Serbia, within its process of legal harmonization with the EU, recently reorganized its food safety system to comply with European Union (EU) regulations according to *acquis communautaire* [11]. Among the legislative changes, a new Food Safety Law was introduced in 2009 [12] and a Veterinary Law in 2005 [13]. This mandatory law requires implementation of a food safety system based on HACCP principles for all subjects in the food chain, except primary production [14].

As hygiene indicator organisms, aerobic plate count and *Enterobacteriaceae* count in samples from the surfaces were investigated. The limit that distinguishes dirty (or unsatisfactory) from clean (or satisfactory) food contact surface is not defined by current Serbian or EU regulations. Therefore, food business operators engaged in the production, processing, and distribution of food are obliged to define the limit values for their own process hygiene parameters [15].

During the one year period, in 524 retail facilities (128 – A category, 191 – B category, and 205 – C category), 1495 swabs were examined: 970 from food contact surfaces (slicing machines, cutting boards and knives or hatchets) and 525 swabs from food handlers' hands (Table 1). A high standard of hygiene in the working environment, in particular on food contact surfaces, equipment and facilities, is a fundamental requisite for the prevention of microbial contamination of food [16]. Traditional microbiological analyses (aerobic plate count and *Enterobacteriaceae*) are generally used to evaluate the effectiveness of sanitation operating procedures. Results of analyzed data for aerobic plate count and total *Enterobacteriaceae*, in samples from the food contact surfaces, are presented in Table 3.

Table 3. Results of the process hygiene estimation in different categories of retail facilities

| Category of retail facility | No ^a | Non-compliant | | No. of swabs | Non-compliant | | Finding/Frequency (%) | | | | | |
|-----------------------------|-----------------|----------------|-------|--------------|----------------|-------|-----------------------|-------|------------------|------|------------------------|-------|
| | | n ^b | % | | n ^c | % | APC ^d | % | ENT ^e | % | TBC + ENT _f | |
| | | | | | | | | | | | | % |
| A | 128 | 91 | 71.09 | 384 | 177 | 46.09 | 127 | 71.75 | 9 | 5.08 | 41 | 23.17 |
| B | 191 | 109 | 57.07 | 382 | 146 | 38.22 | 118 | 80.82 | 1 | 0.7 | 27 | 18.48 |
| C | 205 | 108 | 52.68 | 204 | 84 | 41.18 | 69 | 82.14 | 1 | 1.19 | 14 | 16.67 |

^aNumber of retail facilities

^bNumber of all non-compliant retail facilities

^cNumber of non-compliant swabs

^dAerobic plate count

^e*Enterobacteriaceae*

^fAerobic plate count + *Enterobacteriaceae*

The results showed that 41.96% of the total swabs tested did not fulfill the process hygiene criteria, whereby increased aerobic plate counts were, for the most part, the reason for the non-compliant

results in all facility categories (A – 71.75%, B – 80.82%, and C – 82.14%). These findings should alert food business operators and trigger them to properly apply effective sanitary procedures. During the examinations, *L. monocytogenes* was detected in only one sample from the surface of a plastic cutting board (data not shown). Lakićević and Nastasijević [5] stated that risk mitigation strategies for *L. monocytogenes* should be based on integrated control along the food chain continuum, from farm to retail establishment, in order to ensure food safety, especially safety of ready-to-eat foods. Inadequate cleaning and disinfection of food contact surfaces can result not only in the reduction of the shelf-life of food, but also in the possible presence of pathogens, particularly problematic for those with a low minimum infective dose [17].

Table 4. Microbiological status of the food handlers' hands

| Category of retail facility | No of swabs | Non-compliant | | Finding/Frequency (%) | | | | | |
|-----------------------------|-------------|----------------|-------|-----------------------|-------|------------------|---|-----------------------------------|-------|
| | | N ^a | % | APC ^b | % | ENT ^c | % | APC ⁺ ENT ^d | % |
| A | 128 | 45 | 35.15 | 30 | 66.67 | - | | 15 | 33.33 |
| B | 191 | 51 | 26.70 | 32 | 62.74 | - | | 19 | 37.25 |
| C | 206 | 69 | 33.49 | 59 | 85.50 | - | | 10 | 14.49 |

^a Number of non-compliant swabs

^b Aerobic plate count

^c *Enterobacteriaceae*

^d Aerobic plate count + *Enterobacteriaceae*

The results of microbiological examinations of swabs from the food handlers' hands (presented in Table 4) are worrying. Of 524 swabs, 169 (31%) were non-compliant in relation to the set limits (A – 35.15%, B – 26.70%, and C – 33.49%). These findings are very close to those in 2012 conducted by Rašeta *et al.* [2]. Workers who manipulate food must be trained, informed and competent in food handling. Constant attention and compliance with the norms of GHP within HACCP are of great importance, since it is apparent that when workers become less attentive, it reflects immediately on hygiene results. Green and Selman [16] found that non-compliant results were obtained in cases when workers did not pay enough attention to the execution of work procedures/operations for hand washing. Results of the present study confirm a similar situation in Serbian retail establishments. Protection of hands with gloves is considered an effective way of preventing the transmission of bacteria to food [17,18].

4. Conclusion

The results show that the washing and disinfection procedures are not effective enough in most retail facilities. This relatively large study has shown that in all facilities where food is manipulated, even if HACCP has been introduced, constant and intensive education of employees on the proper implementation of sanitation procedures must be employed. Definitely, only proper sanitation will help to reduce the presence of microorganisms, some potentially pathogenic, which can negatively affect the microbiological status of the foodstuffs.

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References

- [1] Cosby C M, Costello C A, Morris W C, Haughton B, Devereaux M J, Harte F and Davidson P M 2008 *Appl. Environ. Microb.* **74** 6918

- [2] Rašeta M, Sverak Matekalo V, Đorđević V, Vranić V, Branković Lazić I, Grbić Z, Grubić M and Lončina J 2012 *Proc. Int. Conf. Biological Food Safety and Quality BFSQ*, 4-5 Oct. 2012, Belgrade, ed S Bunčić (Novi Sad: Faculty of Agriculture, University of Novi Sad) 171
- [3] Lahou E, Jacxsens L, Verbunt E and Uyttendaele M 2015 *Food Control* **49** 75
- [4] Aarnisalo K, Tallavaara K, Wirtanen G, Maijala R and Raaska L 2006 *Food Control* **17** 1001
- [5] Lakićević B and Nastasijević I 2017 *Food Rev. Int.* **33** 247
- [6] Poulsen L V 1999 *Lebensm. Wiss. Technol.* **32** 321
- [7] SRPS ISO 18593: 2010 Microbiology of food and animal feeding stuffs-Horizontal methods for sampling techniques from surfaces using contact plates and swabs
- [8] SRPS ISO 4833-1:2014 Microbiology of the food chain-Horizontal method for the enumeration of microorganisms Colony count at 30 degrees C by the pour plate technique
- [9] SRPS ISO 21528-2:2004 Microbiology of food and animal feeding stuffs-Horizontal methods for the detection and enumeration of Enterobacteriaceae-Part 2: Colony-count method
- [10] SRPS EN ISO 11290-1:2010 Microbiology of food and animal feeding stuffs-Horizontal method for the detection and enumeration of *Listeria monocytogenes*-Part 1: Detection method
- [11] Smigic N, Rajkovic A, Djekic I and Tomic A 2015 *Brit. Food J.* **117** 1 94
- [12] Food safety law 2009 Official Gazette of the Republic of Serbia No. 41/2009
- [13] Veterinary Law 2005 Official Gazette of the Republic of Serbia No. 91/2005
- [14] Tomasevic I, Kuzmanović J, Anđelković A, Saračević M, Stojanović M and Djekic I 2016 *Meat Sci.* **114** 54
- [15] Commission Regulation (EC) No. 2073/2005 of 15 November 2005 on microbiological criteria for foodstuffs *O. J. L* 338/1
- [16] Green L and Selman C 2005 *Food Prot. Trends* **25** 981
- [17] Michaels B, Keller C, Blevins M, Paoli G, Ruthman T, Todd E and Griffith C 2004 *Food Serv. Tech.* **4** 31
- [18] Montville R, Chen Y and Schaffner D 2002 *Int. J. Food Microbiol.* **73** 305