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Biological analysis using a luminometer of surfaces intended for preparing meals

Anna Prędecka[1], Anna Bany[2], Krystyna Zużewicz[3]

[1]apredecka@sgsp.edu.pl

[1]https://orcid.org/0000-0002-7867-8319

[2]abany@sgsp.edu.pl

[3]zuzewicz.krystyna@gmail.com

[3]https://orcid.org/0000-0002-2116-9855

Department of Security Engineering and Civil Protection, the Main School of Fire Services, Słowackiego 52/54, 01-629 Warsaw, Poland

Abstract

The aim of the study was the microbiological analysis using a luminometer of surfaces intended for food preparation in mass catering establishments. Four production stations were selected for the research (cutting and portioning cold meats, processing vegetables, processing raw meat, and the serving line). In addition, samples were taken from the hands of the meal prep staff at those workstations. The biological contamination was measured using a 3MTM Clean-TraceTM NGi mobile Luminometer with a set of 3M reagents. The hygiene status (RLU) of working surfaces and hands at different kitchen stations was compared. The values of RLU measurements taken from the surface of the hands working on the cured meat cutting and portioning station differed significantly from the values obtained from the surface of the hands working on the food serving station ($p < 0.05$). A similar relationship was found when comparing the RLU values for the working area of both of these stations.

Keywords:

biological analysis, preparing meals, luminometer, food security

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Introduction

Both employees and customers risk exposure to harmful biological factors at mass catering establishments. The multidirectional technological processes and the variety of prepared meals are based on constant contact with raw materials of animal and plant origin, which may be the cause of primary and secondary sources of microbiological contamination.

Microclimatic conditions that occur in catering establishments (high temperature and air humidity) because of the presence of water at individual stages of the technological process and a large amount of organic matter (leftovers) are a breeding ground for microorganisms and food pests. As reported by Scott and Bloomfield (1990), in such conditions, the survival of microorganisms on work surfaces ranges from 4 to 24 hours, and even longer if the surface is wet and dirty.

Among the harmful microbiological factors that pose a threat to employees and customer of mass catering establishments are bacteria, viruses and mould fungi.

Bacteria can multiply and live at various temperatures, both low (psychrophiles) and high (thermophiles). They can thrive in both aerobic and anaerobic conditions. In unfavourable environmental conditions, they produce spores (spores) resistant to high temperature, salinity or drying. They contribute to many food poisonings and inflammation of the intestines and stomach. Bacteria can also produce toxins that are harmful to health (Zapór and Gołofit-Szymczak, 2009). Among the numerous bacteria, the botulinum toxin (*Clostridium botulinum*) is the most dangerous. The source of poisoning can be canned meat, vegetables, fruit or fish (Kołożyn-Krajewska, 2019, p. 345).

Viruses are transmitted from raw materials used for production at every stage of the technological process and in ready meals (Woźniak-Kosek, Kosek and Żukowska, 2010). Enteroviruses remain infectious even after thermal treatment, e.g. pasteurisation, salting or curing. They are also highly invasive in cold stores and freezers (they can survive in dry ice for several months). Viruses are resistant to most disinfectants, which makes it difficult to eliminate them from food or surfaces. The most frequently mentioned are the hepatitis A virus, the Norwalk virus and rotaviruses (Berthold and Żukowska, 2008).

Another group of threats are mould fungi of the Fusarium, Penicillium and Aspergillus genera, which, because of their toxicity and allergenic effects, contribute to many diseases of the respiratory system. Moulds produce mycotoxins, among which the most dangerous are aflatoxins from carcinogenic mould growing on food. They are found mainly in plant raw materials used in the production of meals and on the surface of meat. Like viruses, they are resistant to high temperatures (+250°C) during cooking, pasteurisation or sterilisation processes (Zapór and Gołofit-Szymczak, 2009).

Keeping surfaces on which meals are prepared clean is a basic activity of the services responsible for monitoring the hygiene of foodstuffs. Analysis of microbiological purity uses classical and modern methods. Classical methods are burdened with a long waiting time for the result (microbiological analysis in laboratories), while modern methods using the phenomenon of bioluminescence immediately identify contamination (Manju and Mishra, 2021; Mildenhall and Rankin, 2020).

The aim of the study was to assess the microbiological contamination level of 4 selected production stations and the hands of the personnel preparing meals, the measure of which was the determination of ATP concentration. These questions were asked: (1) Did the swabs collected from the analysed places and the swabs from the hands of employees allow

the degree of microbiological contamination to be assessed? (2) Did the ATP method used in the study allow for a quick and effective assessment of the degree of microbiological contamination of the surface?

The studies were limited by the inability to extend them to other mass catering facilities due to the COVID -19 pandemic. It should be noted that food security is one of the key issues related to fundamental needs of humans (Lizak, Zajączkowski and Kołodziejczak, 2021).

Materials and methods

The biological contamination was measured using a 3MTM Clean-TraceTM NGi mobile Luminometer with a set of 3M reagents. The study was conducted on two dates in December 2020 and in August 2021 in one of the mass catering establishments. Samples were taken from selected inanimate surfaces (4 production stations, including: cutting and portioning cold meats, vegetable processing, raw meat processing, serving line) and animated (staff hands). at a given position. The study consisted of four swabs from work surfaces and skin on the hands. The choice of research places was dictated by the duration of food processing, contact with water, and blood and serum present in the processing of meat, which are a medium for microorganisms.

The tests were carried out in accordance with the PN-ISO 18593:2005 standard "Microbiology of food and feed. Horizontal methods of sampling from surfaces using contact plates and swabs." Sterile swabs containing luciferase in the centre of the tubes were used to collect the samples. The tip of the swab was rubbed against the 25 cm^2 test surfaces. The swab from the hands covered the space between the fingers, the palm of the hand and the area around the nails. It was then placed back in the tube to initiate a reaction. After inserting the tube into the Luminometer and waiting for about 15 seconds, the RLU (Relative Light Units) value was read. The method uses the fact that the luciferase enzyme in the presence of ATP catalyses the oxidative decarboxylation of luciferin, which results in the emission of light with an intensity proportional to the ATP content (Griffith, 2016; Tomczyk *et al.*, 2014, p. 300). ATP is a substance found in all animal and plant organisms, as well as in most food debris, bacteria, fungi and other microorganisms.

The non-parametric Mann-Whitney U-test, which is the equivalent of the Student's t-test for unrelated samples, was used to compare the obtained results. The measure of the central tendency for this test is not the mean (standard deviation) as for parametric tests but the median (range). The test verifies the H0 hypothesis: the samples come from one population. An alternative hypothesis is H1: the samples come from different populations. The level of significance was $p < 0.01$.

Results and discussion

Based on the analyses, it was found that the RLU values for the tested working surfaces did not exceed the acceptable reference values (Worsfold and Griffith, 1996), except for the raw meat processing station. The RLU values for the surface of the hands of the person working at this position also exceeded the permissible limit of microbial contamination (unacceptable level) (Table 2).

Similar results of analyses in the research on the microbiological cleanliness of kitchen surfaces were presented by Worsfold and Griffith, indicating an acceptable level of hygiene for most kitchen worktops.

Table 1. Comparison of the hygiene status (RLU) of work surfaces and hands in different kitchen workstations.

Workstations	Analysed surface	Statistical indicators RLU value				Mann–Whitney U test p ≤
		Mean	Median	Range		
				x(min)	x(max)	
Cutting and portioning cold cuts	Working surface	55.8	54	38	78	0.01
	Hands	30.8	30	23	39	
Processing vegetables	Working surface	139.8	156	92	174	ns
	Hands	118.4	119	115	122	
Processing raw meat	Working surface	810	820	731	897	0.01
	Hands	392	351	318	510	
Serving line	Working surface	71.3	70	64	82	0.01
	Hands	35	36	29	38	

Note.: p – level of significance, ns – not significance.
Level of significance: 5% (P = 0.05).
Critical Values for the Mann-Whitney U-Test.
U (9, 9, 0.05) = 17.

Table 2. Reference values obtained during studies sponsored by the Ministry of Agriculture, Fisheries and Food in Great Britain (Worsfold and Griffith, 1996).

Surface evaluated	Accept RLU	Caution RLU	Reject RLU
Table top	<336	336–403	>403

Most bacteria grow on the surface of the tabletops for processing raw meat. This is caused by environmental conditions (temperature, air humidity) and the working surface, which remains dirty and wet for a long time (Scott and Bloomfield, 1990). The importance of caring for the hygiene of surfaces where food is prepared was also emphasised by Sogin *et al.* (2021).

The obtained RLU values for working surfaces and hands at four stations: cutting and portioning cold cuts, processing vegetables, processing raw meat and serving line are shown in Table 1.

The values of RLU measurements obtained from the surface of the hands working on the cured meat cutting and portioning station differed significantly from the values obtained from the surface of the hands working on the serving line station ($p < 0.05$). This was also true for the comparison of the RLU for the working surface of both of these stations.

Conclusion

1. The average RLU values for the tested workplace surfaces did not exceed acceptable hygienic standards, except for the tabletop for processing raw meat and the hands of the personnel performing these activities.

2. The RLU values from the surface of the tabletops and the hands of people working at the cured meat cutting and portioning station differed significantly from the RLU values obtained from the surface of the hands working on the serving line station ($p < 0.05$).

3. The use of the ATP method in the control of microbiological cleanliness of surfaces on which meals are prepared is an effective solution that is useful for quick assessment of the sanitary conditions.

4. Due to the importance of the problems of examining microbiologically contaminated surfaces, they will be extended to other mass catering facilities.

5. The results obtained from the research will be compared in future with other analyses of microbiological contamination of surfaces on which food is prepared. The results will help employers take appropriate technical and organisational action to eliminate or reduce biological hazards in food.

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Author contributions

Conceptualisation, A.P.; methodology, A.B.; software, A.P.; validation, K.Ż.; formal analysis, K.Ż.; investigation, A.B.; resources, A.B.: data curation, D.M.B.; writing – original draft preparation, A.P.; writing – review and editing, A.P.; visualisation, A.P. supervision, A.P.; project administration, A.P.

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Data availability statement

Not applicable.

Disclosure statement

No potential conflict of interest was reported by the authors.

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