ORIGINAL ARTICLE

Bacteriological safety of smears of surfacesio in catering facilities and food industry in Zenica-Doboj Canton in the period 2005-2007

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ABSTRACT

Aim To research bacteriological (hygienic) safety of surfaces (hands smear of staff involved in the process of work, smear of furniture used for work, smear from walls in offices) in the facilities for production of meat and meat products (8), for production of milk and milk products (3), products of cakes (14), bakery and bakery products (4) sugar refinery and biscuits (1) and in objects of social sustenance in the territory of Zenica-Doboj Canton (Bosnia and Herzegovina B&H) in period 2005-2007 and to point out the importance of this analysis in providing food safety for consumers.

Methods: Data from the protocol of the Laboratory for Clinical and Sanitary Microbiology,of the Cantonal Institute for Public Health Zenica were used. Samples of smears were inoculated on MacConkey and blood agar. Results were interpreted in accordance with applicable law in B&H.

Results From 5051 analyzed smears, 190 (3,/%) were not satisfactory. The largest number of unsatisfactory smears was noted in Zenica, 75 (39; 47%), Visoko 49 (25.8%) and Tešanj 37 (19.5%). From 190 unsatisfactory smears, 57 (30%) were smears from dishes, 43 (22.6%) from furniture and work surfaces 42 (22,1%) and 41 (21.6%) smears from hands. The most frequently isolated was *Escherichia coli*, in 25 (22.6%) smears from machines, and 34 (17.2%) smears from dishes. Unsatisfactory smears were mostly found in objects of public maintenance, 96 (50.5%) and in objects for production of meat, 82 (43.2%).

Conclusion Regular control (monitoring), hygienic sutabilityquality of smears in objects and education of employees to improve hygienic measures for the purpose of the prevention of food contamination.

Key words: smears, bacteriologic cleanliness, objects, food industry, food poisoning.

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INTRODUCTION

According to the World Health Organization (WHO) illnesses caused by contaminated food are a big public health problem worldwide. (1,2). Because of circumstances in which food is ideal for keeping microorganisms alive and their reproduction due to nutritious ingredients, spreading of infectious diseases with food is a big problem in the whole world (2,3). Some food-borne pathogens are considered emerging because the role of food in their transmission has been recognized recently or become more common (1).

Moreover, some food-borne pathogens developed new virulent strains by transfer of mobile virulence factors, the others developed the ability of adaptation and better survival in adverse environmental conditions during food production, processing and preservation. New pathogens became emerging because of changing ecology and changing technology that connects a potential pathogen with the food chain (4). Important reasons for emerging microbial food-borne pathogens and diseases are changes in modern lifestyle and human demographics affecting nutritious behavior of the population. People eating pre-prepared meals in restaurants, canteens or even street vendors, are exposed to risk factors for food-borne diseases, because of insufficient food safety education of food suppliers and consumers (5-7). On the other hand, larger migrations of people, animals, food and other commodities in globalized form of food production and distribution bring pathogens to new geographic areas (8,9). Nevertheless, emergence of new food-borne pathogens is a function of changes in host susceptibility (3). The population of highly susceptible persons is expanding worldwide because of ageing, malnutrition, increasing number of immunocompromised patients and other underlying medical conditions (1). Besides the changing spectrum of microbial food-borne pathogens and illnesses they cause, other characteristics can be recognized, such as global dissemination of some food-borne pathogens in pandemic form, their increasing antimicrobial resistance, identification of opportunistic pathogens and a new type of large and highly dispersed food-borne outbreaks, which may only be detected when microbial strains are collected, subtyped and compared in well-developed infectious disease surveillance systems (4,10).

Different vehicles for transmission of human infections have been identified, but it is estimated that around 80% of them are transmitted by food (11). Undercooked or cross-contaminated poultry meat, untreated drinking water, and raw milk have been sources of outbreaks (12). The most consistent risk factor in a number of case-controls studies worldwide has been consumption of, cross-contamination from or contact with raw or undercooked poultry, accounting for approximately 10% to 50% of cases. The risky poultry was specifically that eaten outside of the home, chicken livers and other organ meats and consumption of barbecued meat (12). Slaughter and particularly further processing provide the opportunity for reducing bacteria on poultry carcasses. However, in crucial steps, such as the evisceration, bacterial counts increase due to fecal recontamination, but decline again during subsequent chilling (13,14). Chickens from *Campylobacter*/*Salmonella* - free flocks are frequently contaminated during transport, slaughtering and/or processing (14). It is obvious, that only a general strategy including attempts "from farm to table" can ensure safety of food products (15). We can find Salmonella in many food items, especially in eggs and meat, but also in milk products as well as unwashed vegetables. Today there are over 2,000 discovered stereotypes of salmonella, of which several hundred are pathogenic for humans (3). *Campylobacter* spp. are zoonotic bacteria with the natural habitat in gastrointestinal tract of warm-blooded mammals and birds. They have become the leading cause of food-borne infections in many countries (13,14). Biosecurity measures such as improved hygiene barriers, pest and rodent control, staff education, chlorinated water or even more specialized procedures as the treatment of chicken with commensal bacteria or immunization of birds reduce *Campylobacter* spp. colonization in poultry flocks (11).-Active surveillance for detecting nasal carriage in a person without clinical symptoms of infection is a very important step in the infection control strategies, because undetected carriers may serve as a source of transmission (16,17). It is well documented that an environment has been identified as a source of MRSA, and/or a vehicle of transmission (16-18). Accordingly, cleaning of all surfaces by which workers may transmit bacteria with their hands is of great importance (19). Therefore, nasal and hand carriage in food

handlers are important sources of food contamination (17, 20-22).
As far as kitchen tools and equipment are concerned, the most risk lies in ice cream spoons in ice-cream shops, and meat boards in restaurants and hotels.
These are the main ways of transferring bacteria during cross-contamination (23).
The goal of this paper was to determine hygienic safety of smears on surfaces in objects in the territory of Zenica-Doboj Canton in the period 2005 – 2007.

MATERIAL AND METHODS

Laboratory for the Clinical and Sanitary Microbiology of the Cantonal Institute for Public Health Zenica analyzed samples of smears to assess hygienic safety at territory of 10 municipalities of Zenica-Doboj Canton (Zenica, Žepče, Zavidovići, Olovo, Maglaj, Tešanj, Doboj-Jug, Kakanj, Visoko, Breza) (population of Zenica-Doboj Canton is 350,000).
Using data from a protocol for analysis of samples of smears for hygienic safety, retrospective analysis was performed for all samples that were received for bacteriological analysis in the period between 2005–2007.
Samples were received from the facilities for the production of meat and meat products (8), milk and milk products, ice-cream and cakes (14) bakery and bakery products (4) sugar refinery and production of biscuits (1) and facilities for public maintenance (restaurants, kitchens, coffee bars, fast food) (47).
Hygienic safety was determined from five standard smears: employees' hands during the work process, clothes at work, furniture at work, dishes or cutlery, and walls. In facilities for food production smears from machines and other tools were taken if required.
Samples of smears were inoculated at the Mac Conkey oxoid agar and blood agar in order to identify gram negative or gram positive bacteria. Final identification was performed with standard microbiological methods and some of the commercial tests of aglutination at a plate according to the producer's instruction in case of gram positive bacteria or biochemical tests and aglutination in case of gram negative bacteria (24). Presence of *Enterobacteriaceae* family members and gr (+) bacteria *Staphylococcus aures, Enterococcus* spp., *Streptococcus pyogenes* are not allowed to be found in a smear analysed for bacteriological safety (24).

Table 1. Distribution of smears analyzed for hygienic safety in the territory of Zenica-Doboj Canton in the period 2005 – 2007

Period	City	Number (%) swabs	
		Analyzed	Unsatisfactory
2005	Zenica	876 (64.2)	22 (2.5)
	Žepče	10 (0.7)	0
	Zavidovići	132 (9.7)	0
	Maglaj	50 (3.7)	1 (2)
	Tešanj	8 (0.6)	0
	Visoko	109 (8)	9 (8.3)
	Kakanj	150 (11)	0
	Breza	29 (2.1)	0
	Total	**1364 (100)**	**32 (2.4)**
2006	Zenica	1080 (60.9)	24 (2.2)
	Žepče	10 (0.6)	0
	Zavidovići	114 (6.4)	0
	Maglaj	98 (5.5)	0
	Tešanj	88 (4.9)	19 (21.6)
	Visoko	182 (10.3)	38 (20.9)
	Kakanj	151 (8.5)	1 (0.7)
	Olovo	50 (2.8)	11 (22)
	Total	**1773 (100)**	**93 (5.3)**
2007	Zenica	913 (47.7)	29 (3.2)
	Žepče	9 (0.5)	1 (11.1)
	Zavidovići	189 (9.9)	1 (0.5)
	Maglaj	120 (6.3)	0
	Tešanj	349 (18.2)	18 (5.2)
	Doboj - jug	56 (2.9)	10 (17.9)
	Visoko	156 (8.1)	2 (1.3)
	Kakanj	122 (6.4)	4 (3.3)
	Total	**1914 (100)**	**65 (3.4)**
2005-2007	Zenica	2869 (56.8)	75 (39.5)
	Žepče	29 (0.6)	1 (0.5)
	Zavidovići	435 (8.6)	1 (0.5)
	Maglaj	268 (5.3)	1 (0.5)
	Tešanj	445 (8.8)	37 (19.5)
	Doboj - jug	56 (1.1)	10 (5.3)
	Visoko	447 (8.8)	49 (25.8)
	Kakanj	423 (8.4)	5 (2.6)
	Breza	29 (0.6)	0
	Olovo	50 (1)	11 (5.8)
	Total	**5051(100)**	**190 (100)**

RESULTS

During 2005 the total of 1364 smears of surfaces were analyzed for hygienic safety, of which 32 (2.4%) did not meet the requirements of the regulations for hygienic safety (Table 1).
The highest number of unsatisfactory smears was found in the municipality of Visoko, 9 (out of 109, 8.3%) and Zenica, 22 (of 876, 2.5%).
During 2006 the total of 1773 smears were analyzed for hygienic safety, of which 93 (5.3%) smears did not meet the requirement

Table 2. Distribution of unsatisfied smears

Period	Type of smears	Number (%) of unsatisfactory smears
2005	Smear of hands	6 (1.9)
	Smear of clothes	0 (0)
	Smear of furniture	11 (3.5)
	Smear of dishes	15 (4.8)
	Smear of walls	0 (0)
	Total	**32**
2006	Smear of hands	20 (18.6)
	Smear of clothes	2 (1.86)
	Smear of furniture	17 (15.8)
	Smear of dishes	22 (23.7)
	Smear of walls	0 (0)
	Smear of working surfaces	32 (34.4)
	Total	**93**
2007	Smear of hands	15 (9.7)
	Smear of clothes	1 (0.7)
	Smear of furniture	15 (9.8)
	Smear of dishes	20 (13)
	Smear of walls	4 (2.6)
	Smear of working surfaces	10 (15.4)
	Total	**65**
2005-2007	Smear of hands	41 (21.6)
	Smear of clothes	3 (1.6)
	Smear of furniture	43 (22.6)
	Smear of dishes	57 (30)
	Smear of walls	4 (2.1)
	Smear of working surfaces	42 (22.1)
	Total	**190**

of hygienic safety regulations (Table 1).
The highest number of unsatisfactory smears was found in the municipalities of Olovo, 11 (of 50, 22%), Tešanj, 19 (of 88, 21.6%) and Visoko, 38 (of 182, 20%).
During 2007 the total number of analyzed smears of surfaces was 1914, of which 65 (3.4%) smears were not satisfactory according to the hygienic safety regulations. (Table 1).
The highest number of unsatisfactory smears was found in the municipality of Doboj-Jug, 10 (of 56, 17.9 %).
In the period 2005 – 2007 the highest number of unsatisfactory samples was found in the municipalities of Zenica 75 (39.5%), Visoko 49 (25.8%), Tešanj 37 (19.5%) (Table 1).
Out of the total of 190 unsatisfactory smears there were 57 (30%) smears of dishes, 43 (22.6%) smears of furniture, 42 (22.1%) smears of machines and 41 (21.6%) smears of hands. (Table 2).
In the period 2005 – 2007 the most common cause isolated from smears was *Escherichia coli* found in 21 (22.6%) smears of machines for food processing and 16 (17.2 %) of dishes smears (Table 3).
During the period 2005 – 2007 out of the total of 190 unsatisfactory smears most were found in social sustenance facilities for preparation of ready-to-eat meals 96 (50.5 %), meat production facilities 82 (43.2 %), bakeshops (ice cream and cakes production) 5 (2.6 %). (Table 4).

DISCUSISSION

The results of this study have shown that 190 (3.7%) of the total of 5053 analyzed smears did not meet the requirements. Unsatisfactory smears mostly contained *Escherichia coli* (41.5%) and *Klebsiella pneumonia* (26.3 %).
During 1990/91 in students' restaurants in Zagreb the presence of a relatively pathogenic bacteria *Enterococcus* was found in 5.9% of samples of surfaces for food preparation; in 1.2% of samples *Escherichia coli* and coagulase-positive staphylococci and *Enterococcus* bacteria from surfaces for food serving were found in 1.8% on forks and 0.9% on plates, i.e. on 0.8% of samples (25). Of the total of 40 samples of employees palms over 20% of samples were not satisfactory because of an increased number of aerobic mesophilic bacteria. Also, 4.7% did not meet the requirements of microbiological cleanliness (26).
In our study microbiological cleanliness was found mostly in social sustenance facilities 96 (50.5%) and 82 (43.2 %) in the facilities for meat production. In the period 2005-2007 41 (21.6%) hands smears were not satisfactory in Zenica–Doboj Canton, which indicates that we have a higher rate of unsatisfactory smears .
The American Administration has developed and implemented several main steps towards the modernization of food safety regulations and control - the Food Safety and Inspection Service (FSIS) and the Food and Drug Administration (FDA) encourage the regulation of requirements that the production of red meat, poultry meat and sea food must comply with the HACCP procedure. According to this regulation, HACCP requires the food industry to introduce preventive measures designed at their own discretion in order to produce safe food thus increasing responsibilities towards the consumers (13). In early 1994 the Centre for Disease Control and Prevention (CDC) started the strategic program for the control and prevention of alarming infectious diseases

Table 3. Distribution of unsatisfactory smears according to type and causative agents during 2005-2007

	Type of smear and causes	Number (%) of smears			
		2005	2006	2007	Total
Smear of hands	*Escherichia coli*	4 (12.5)	7 (7.5)	6 (9.2)	17 (8.9)
	Proteus spp.	1 (3.1)	-	-	1 (0.5)
	Staphylococcus aureus	1 (3.1)	2 (2.2)	-	3 (1.6)
	Klebsiella spp.	-	11 (11.8)	4 (6.2)	15 (7.9)
	Streptococcus freacalis	-	-	5 (7.7)	5 (2.6)
Smear of clothes	*Escherichia coli*	-	-	1 (1.5)	1 (0.5)
	Proteus spp.	-	1 (1.1)	-	1 (0.5)
	Klebsiella pneumoniae	-	1 (1.1)	-	1 (0.5)
Smear of furniture	*Escherichia coli*	7 (21.9)	8 (8.6)	4 (6.2)	19 (10)
	Streptococcus spp.	2 (6.2)	2 (2.2)	3 (4.6)	7 (3.7)
	Klebsiella spp.	2 (6.2)	7 (7.5)	8 (12.3)	17 (8.9)
Smear of dishes	*Escherichia coli*	11 (34.4)	16 (17.2)	7 (10.8)	34 (17.9)
	Staphylococcus aureus	1 (3.1)	-	2 (3.1)	3 (1.6)
	Klebsiella spp.	3 (9.4)	4 (4.3)	10 (15.4)	17 (8.9)
	Citrobacter spp.	-	1 (1.1)	1 (1.5)	2 (1)
	Proteus spp.	-	1 (1.1)	-	1 (0.5)
Smear of walls	*Escherichia coli*	-	-	4 (6.2)	4 (2.1)
Smear of machines used for food processing	*Escherichia coli*	-	21 (22.6)	4 (6.2)	25 (13.1)
	Klebsiella spp.	-	6 (6.4)	2 (3.1)	8 (4.2)
Smear of work surfaces	*Escherichia coli*	-	3 (3.2)	2 (3.1)	5 (2.6)
	Staptococcus spp.	-	2 (2.2)	1 (1.5)	3 (1.6)
	Klebsiella pneumoniae	-	-	1 (1.5)	1 (0.5)
	Total	**32**	**93**	**65**	**190**

and food processing and they have made a significant progress in the achievement of such goals (13).

Although sophisticated laboratory studies may reveal causes of diseases and show the link among bacteria, they are not sufficient – researchers who collect necessary epidemiological data need to be involved in order to identify sources of contamination (13). Epidemiological services, jointly with health care departments, monitor infectious and non-infectious diseases by collecting data from doctors, laboratories and local medical and other institutions (13). Sanitary inspection is tasked with scientific, professional, fast and efficient identification and removal of sources of facilities' contamination in line with regulations, thus preventing food poisoning, and longitudinal research aimed at monitoring of crucial parameters for the assessment of health safety and microbiological cleanliness on a representative number of samples is a public health interest (24). It is known that microbiological cleanliness of surfaces, tools and equipment for processing of food items and cleanliness of hands of the personnel working with food items directly affects food safety. Every contamination with pathogenic bacteria due to cross-contamination may cause poisoning (24). Facilities with unsatisfactory microbiological cleanliness are those which have a huge turnover (shops, coffee bars) and facilities where only minimum hygienic requirements are met having in mind the number of employees, size of the facility and quantity of tools and equipment and hygiene maintenance (restaurants) (24).

Table 4. Distribution of unsatisfactory samples according to types of objects in the period 2005 – 2007

Type of object	Number (%) of unsatisfied smears
Production of meat	82 (43.2)
Production of milk	2 (1)
Production of cakes	5 (2.6)
Bakeries and products of brad	4 (2.1)
Sugar refinery and products	1 (0.5)
Social sustenance facilities	96 (50.5)
Total	**190**

Hygiene of the working environment, equipment, tools and employees' hands plays

an important role in ensuring microbiological safety of food and it certainly needs to be controlled and improved and people should be continuously trained (24). Good hygienic practice should be a principle complied with by all caterers and their staff and it is the main precondition for the introduction of the HACCP system. However, it needs to be pointed out that the manner of handling ready-to-eat food is still more crucial for safety of food served to consumers (24).

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Bakteriološka ispravnost briseva površina u ugostiteljskim objektima i objektima za proizvodnju hrane na području Zeničko-dobojskog kantona u periodu od 2005. do 2007. godine

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SAŽETAK

Cilj Istražiti bakteriološku (higijensku) ispravnost briseva površina (bris ruku zaposlenog osoblja u procesu rada, bris radne odjeće osoblja, bris radnog namještaja, bris s posuđa ili escajga, te bris zidova prostorija) u objektima za proizvodnju mesa i mesnih proizvoda (8), za proizvodnju mlijeka i mliječnih proizvoda (3), slastičarni (sladoled i proizvodnja kolača) (14), pekara i proizvodnje peciva (4), šećerana i proizvodnje keksa (1), te u objektima za društvenu prehranu na području Zeničko-dobojskog kantona (Bosna i Hercegovina, BiH) u periodu od 2005. do 2007. godine.

Metode Korišteni su podaci protokola Laboratorija za kliničku i sanitarnu mikrobiologiju Kantonalnog zavoda za javno zdravstvo Zenica. Uzorci briseva su inokulirani na McConkey i krvni agar. Rezultati su interpretirani u skladu sa zakonskom regulativom BiH.

Rezultati Od ukupno 5051 analiziranog brisa, 190 (3,7%) briseva nije zadovoljavalo odgovarajuće standarde. Najveći broj nezadovoljavajućih briseva zabilježen je u općinama Zenica, 75 (39,47%), Visoko, 49 (25,8%), i Tešanj, 37 (19,5%). Od 190 nezadovoljavajućih briseva, 57 (30%) ih je bilo iz briseva posuđa, 43 (22,6%) iz briseva namještaja, 42 (22,1%) iz briseva radnih mašina i 41 (21,6%) iz briseva ruku. Najčešće je izolirana *Escherichia coli,* iz 25 (22,6%) briseva mašina u procesu rada, te iz 34 (17,2 %) brisa posuđa. U periodu od 2005. do 2007. godine, od ukupno 190 nezadovoljavajućih briseva, najviše ih je zabilježeno u objektima za društvenu prehranu za spravljenje gotovih jela, 96 (50,5 %), te u objektima za proizvodnju mesa, 82 (43,2 %), i u slastičarnama (sladoled i proizvodnja kolača), pet (2,6 %).

Zaključak Redovnom kontrolom (nadzorom) higijenske ispravnosti briseva u ugostiteljskim objektima, kao i odgovarajućom edukacijom zaposlenika, moguće je poboljšati sprovođenje higijenskih mjera s ciljem sprečavanja kontaminacije hrane.

Ključne riječi: brisevi, bakteriološka čistoća, ugostiteljski objekti, industrija hrane, trovanje hranom