Praca oryginalna *Original paper*

Hygienic properties of food handlers and equipment in food production and sales units

ALI AYDIN, HARUN AKSU, OZGE OZGEN ARUN*

Department of Food Hygiene and Technology, Faculty of Veterinary Medicine Istanbul University 34320, Avcilar, Turkey
*TUBITAK Marmara Research Center, Food Science&Technology Research Institute, Gebze 41400, Kocaeli, Turkey

Aydin A., Aksu H., Arun O. O.

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Summary

In this study, hygienic properties of samples taken from hands of personnel working in food production (n: 266) and sales (n: 94) facilities and samples taken from various equipments used in these facilities are studied. In samples taken from 360 staff working in food production and sales departments aerobic plate count are determined to be in a level of 1 cfu/cm^2 in two samples (0.55%), 5 cfu/cm^2 in 119 samples (33.06%), 45 cfu/cm^2 in 195 samples (54.17%) and, 80 cfu/cm^2 in 44 samples (12.22%); the number of Enterobacteriaceae are determined to be 1 cfu/cm^2 in 189 samples (52.50%), 5 cfu/cm^2 in 128 samples (35.56%), 45 cfu/cm^2 in 43 samples (11.94%). In addition coagulase positive S. aureus is determined from 137 (32.70%) hand samples in total. Aerobic plate count of bacteria on the examined equipments (n: 70) is found to be 5 cfu/cm^2 in 25 samples (35.71%), 80 cfu/cm^2 in 45 samples (64.29%); and Enterobacteriaceae count found to be 1 cfu/cm^2 in 25 samples (35.71%), 45 cfu/cm^2 in 45 samples (64.29%). On the other hand S. aureus is found in a total of 18 (25.71%) samples. As a result, it is concluded that making personnel conscious of reduction of the bacteria found their hands at high levels, and controlling hygiene by carrying out up-to-date HACCP and GMP applications, also cleaning equipments under proper hygiene conditions contribute to the possibility of taking the problem under control to great extend.

Keywords: hand hygiene, equipment, food contact surface, dipslide

The aim of the microbiological hygiene which is applied during the food production is to protect the consumer against the pathogenic factors and to guarantee the high-quality of the foodstuffs (19). For the reliability of the food, especially for most of the foodstuffs that are ready-made to consumption, it is important to ensure the cleanliness of the surfaces with which these foodstuffs have contact and some simple methods relevant to the determination of the output of hygiene applications (16).

As the microorganisms on the food contact surfaces have a tendency to pass on the foods during the process of production, taking samples from surrounding surfaces carries a great significance (3). Microorganisms, existing on the surfaces that have contact with the food, have their roots in various sources: Hands of the personnel, raw material itself, insects, insufficient sanitation measures and uneven equipments all cause the contamination of microorganisms (10). In this respect, the control of the hand hygiene of the personnel, that has an important role in the emergence of the surface microflora, should be inspected together with the hygiene control of the food contact surface.

This study is planned with the objective of the determination of the hygienic condition of the hands of the personnel, who work at various food production and sale companies, and also the different kinds of equipments that are used during the process of production.

Material and methods

In the research, 430 of samples were obtained from personnel working in food production (n = 266) and sales facilities (n = 94) in some cities (Istanbul, Tekirdag, Edirne) of Turkey, additionally 70 of samples were collected from various equipments used in production processes after cleaning.

Collected dipslide (Hygicult, Orion Diagnostica, Finland) and swap samples were brought to laboratory in thermally-isolated bags at 5°C in two hours and placed in the incubators. Examination of the surfaces with the dip-slide technique was carried out under the guidance of Deutsche Institute für Normung (DIN) (4) 10113-3 instructions.

Through the process of determination of aerobic plate count, Hygicult® TPC (Orion Diagnostica) dipslides, surfaces of which were coated with Plate Count Agar, were used. In the process of determination of the *Enterobacteriaceae* spp., also Hygicult® E (Orion Diagnostica, Finland) dipslides, having surfaces coated with modified Violed Red Bile Glucose Agar (VRB Agar), were used. In the process of determination of number of bacteria on the surfaces, an area of 17 cm^2 with two sides of the surfaces coated with PCA and mVRBG Agar. Dipslides of type Hygicult TPC leaved to

incubation at 30°C for 48 hours (18) and of type Hygicult E leaved at 37°C for 24 hours (17). Incubated Hygicult dipslides were evaluated in five categories with the commercial evaluation schematics given together with testing kit used (13).

For the detection of *S. aureus* on the hands of personnel and equipments swab-rinse technique was used (14). The process of collected samples was carried out by applying swabs, which were humidified with physiological salt water, on the personnel hands and by applying to the equipment with a period of 20 seconds (dimensions 5 × 5 cm) (14). In determination of the number of *S. aureus* Baird Parker Agar (BPA, Oxoid CM 275) was used. From the swabs, which were brought to laboratory in thermally-isolated bags (5°C) in two hours, inoculation to the BPA was done and BPA Petri dishes were incubated at 37°C for 24-48 hours. After these processes coagulase test was applied to the suspected colonies.

Results and discussion

Evaluation results for the samples taken from hands of the personnel working in food production facilities are given in tab. 1. Evaluation results for the samples taken from hands of the personnel working in food serving units are noted on tab. 2. Results for the equipments used in production facilities are given in tab. 3.

Particularly many microorganisms can spread from a food to another food or to numerous equipments by means of hands, depending upon this, food reliability is endangered. The hands of food service employees can be vectors in the spread of foodborne disease because of poor personnel hygiene or cross-contamination. For example, an employee might contaminate his hands when using the toilet, or bacteria might be spread from raw meat to salad greens by food handler's hands (12).

For hygiene controls taking place in food production plants, total mesophilic aerobic count is important for determining contamination risk trough production process (7, 9, 13). In this study, total aerobic plate count was found to be at a level of 1 cfu/cm^2 on 2 out of 266 personnel (0.75%), of 5 cfu/cm^2 on 82 (30.82%), of 45 cfu/cm^2 on 149 (56.02%) and of 80 cfu/cm^2 on 33 (12.41%) of them. Additionally, aerobic plate count in the dipslide samples taken from hands of 94 employees, working sales departments, was detected to be at a level of 5 cfu/cm^2 in 37 (39.36%) samples, 45 cfu/cm^2 in 46 (48.94%) samples, and 80 cfu/cm^2 in 11 (11.70%) samples. Furthermore, aerobic plate count in the dipslide samples taken from a total of 70 equipments, which are used in food production processes, was determined to be; 5 cfu/cm^2 in 25 (35.71%) samples and 80 cfu/cm^2 in 45 (64.29%) samples. Legnani et al. (14) declared in the research, that they had carried out in 27 food production facilities, all of which applies HACCP system; that aerobic plate count was < 50 cfu/cm^2 on 71.4% and > 10^4 cfu/cm^2 on 18.6% of 140 food contact surface samples. Although

Tab. 1. Results of samples taken from hands of the staff working in food production units

Personnel Sampling	n	Microbiological parameters and contamination levels								
		Aerobic Plate Count				*Enterobacteriaceae* Count			Coagulase *positive S. aureus*	
		10^3 1 cfu/cm^2 (%)	10^4 5 cfu/cm^2 (%)	10^5 45 cfu/ cm^2 (%)	10^6 80 cfu/cm^2 (%)	10^3 1 cfu/cm^2 (%)	10^4 5 cfu/cm^2 (%)	10^5 45 cfu/cm^2 (%)	positive (%)	negative (%)
Head Cook	94	–	30 (31.91)	52 (55.32)	12 (12.77)	52 (55.32)	33 (35.11)	9 (9.57)	35 (37.23)	59 (62.77)
Cook	55	1 (1.82)	20 (36.36)	27 (49.09)	7 (12.73)	31 (56.36)	17 (30.91)	7 (12.73)	23 (41.82)	32 (58.18)
Baker	38	1 (2.63)	13 (34.21)	21 (55.26)	3 (7.90)	22 (57.89)	13 (34.21)	3 (7.90)	14 (36.84)	24 (63.16)
Dishwasher	10	–	2 (20.00)	6 (60.00)	2 (20.00)	8 (80.00)	–	2 (20.00)	2 (20.00)	8 (80.00)
Turkish pizza production staff	13	–	3 (23.08)	5 (38.46)	5 (38.46)	4 (30.77)	5 (38.46)	4 (30.77)	6 (46.15)	7 (53.85)
Cleanliningsstaff	6	–	2 (33.33)	2 (33.33)	2 (33.34)	3 (50.00)	1 (16.67)	2 (33.33)	3 (50.00)	3 (50.00)
Butcher	8	–	2 (25.00)	4 (50.00)	2 (25.00)	3 (37.50)	4 (50.00)	1 (12.50)	4 (50.00)	4 (50.00)
Doner kebab production staff	16	–	4 (25.00)	12 (75.00)	–	8 (50.00)	96 (37.50)	2 (12.50)	6 (37.50)	10 (62.50)
Dessert production staff	14	–	4 (28.57)	10 (71.43)	–	8 (57.14)	6 (42.86)	–	4 (28.57)	10 (71.43)
Sandwiches staff	12	–	2 (16.67)	10 (83.33)	–	2 (16.67)	8 (66.66)	2 (16.67)	6 (50.00)	6 (50.00)
Total (%)	266	2 (0.75)	82 (30.82)	149 (56.02)	33 (12.41)	141 (53.01)	93 (34.96)	32 (12.03)	103 (38.72)	163 (61.28)

Tab. 2. Results of samples taken from hands of the staff working in food serving units

Personnel sampling	n	Microbiological parameters and contamination levels								
		Aerobic Plate Count				*Enterobacteriaceae* Count			Coagulase *positive S. aureus*	
		10^3 1 cfu/cm^2 (%)	10^4 5 cfu/cm^2 (%)	10^5 45 cfu/cm^2 (%)	10^6 80 cfu/cm^2 (%)	10^3 1 cfu/cm^2 (%)	10^4 5 cfu/cm^2 (%)	10^5 45 cfu/cm^2 (%)	positive	negative
Heat meal serving staff	24	–	3 (12.50)	17 (70.83)	4 (16.67)	7 (29.17)	13 (54.17)	4 (16.66)	10 (41,67)	14 (58.33)
Snack food serving staff	15	–	7 (46.67)	7 (46.67)	1 (6.66)	10 (66.67)	4 (26.67)	1 (6.66)	10 (66.67)	5 (33.33)
Serving staff	8	–	4 (50.00)	4 (50.00)	–	8 (100.00)	–	–	–	8 (100.00)
Waiter/Waitres	27	–	15 (55.56)	12 (44.44)	–	15 (55.56)	12 (44.44)	–	6 (22.22)	21 (77.78)
Cold meal serving staff	8	–	–	2 (25.00)	6 (75.00)	–	2 (25.00)	6 (75.00)	8 (100.00)	–
Dessert serving staff	12	–	8 (66.67)	4 (33.33)	–	8 (66.67)	4 (33.33)	–	–	12 (100.00)
Total (%)	94	–	37 (39.36)	46 (48.94)	11 (11.70)	48 (51.07)	35 (37.23)	11 (11.70)	34 (36.17)	60 (63.83)

Tab. 3. Results of samples taken from equipments and food contact surfaces in food production units

Equipment	n	Aerobic Plate Count				*Enterobacteriaceae* Count			Coagulase *positive S. aureus*	
		10^3 1 cfu/cm^2 (%)	10^4 5 cfu/cm^2 (%)	10^5 45 cfu/cm^2 (%)	10^6 80 cfu/cm^2 (%)	10^3 1 cfu/cm^2 (%)	10^4 5 cfu/cm^2 (%)	10^5 45 cfu/cm^2 (%)	positive (%)	negative (%)
Meal kettle	8	–	–	–	8 (100.00)	–	–	8 (100.00)	–	8 (100.00)
Dough kettle	5	–	–	–	5 (100.00)	–	–	5 (100.00)	5 (100.00)	–
Saucepan	12	–	6 (50.00)	–	6 (50.00)	6 (50.00)	–	6 (50.00)	–	12 (100.00)
Meat hanger	20	–	10 (50.00)	–	10 (50.00)	10 (50.00)	–	10 (50.00)	10 (50.00)	10 (50.00)
Meat cutting board	15	–	9 (60.00)	–	6 (40.00)	9 (60.00)	–	6 (40.00)	3 (20.00)	12 (80.00)
Surfaces of working tables	10	–	–	–	10 (100.00)	–	–	10 (100.00)	–	10 (100.00)
Total (%)	70	–	25 (35.71)	–	45 (64.29)	25 (35.71)	–	45 (64.29)	18 (25.71)	52 (74.29)

the techniques used by researchers were different, the results are in accordance with each other. In the research carried out by Holmes (13) microbiological loads of butcher's hands, serving staff hands, production counters and equipments in 20 meat production companies were studied. Aerobic plate count in samples taken during production processes from butchers hands (dip-slide technique was also used) was found to be 70-80 cfu/cm^2, aerobic plate count detected from salesman hands was found to be 60-70 cfu/cm^2, aerobic plate count on metal or plastic food contact surfaces was found to be > 90 cfu/cm^2 and aerobic plate count on slicing machine was declared to be 60-70 cfu/cm^2.

The bacteria in the *Enterobacteriaceae* family are therefore suitable hygiene indicators; they can be cultivated quickly and easily, and they directly indicate the presence of faecal contaminations (17, 19). Nevertheless, the detection of indicator organisms, such as coliforms, is widely used as a means to measure the effectiveness of sanitation programmes (8), their presence indicating a substantially increased risk of the presence of pathogens (11). In the study that we have carried out *Enterobacteriaceae* counts were determined to be 1 cfu/cm^2 on 141 (53.01%) of 266 personnel working in food production, 5 cfu/cm^2 on 93 (34.96%) samples and 45 cfu/cm^2 on 32 (12.03%) samples. Furthermore, *Enterobacteriaceae* counts on 94 personnel working on food sales departments were determined to be 1 cfu/cm^2, 5 cfu/cm^2, and 45 cfu/cm^2 respectively on 48 (51.07%), 35 (37.23%) and 11 (11.70%) sam-

ples. In addition, in 25 (35.71%) of 70 samples from surfaces of equipments *Enterobacteriaceae* count was found to be 1 cfu/cm^2 and 45 cfu/cm^2 on 45 (64.29%) of them. Legnani et al. (14) detected the *E. coli* count as < 1 cfu/cm^2 for 92.2% of 51 equipment surfaces used in food sales points, in addition to this; they declared the *E. coli* counts < 1 cfu/cm^2 in 83.3% and > 1 cfu/cm^2 in 16.7% of 36 food contact surface samples. These results differ from findings of this study. This situation indicates insufficient cleaning for food contact surfaces and equipments from which the samples were obtained. Holmes (13), determined the *Enterobacteriaceae* count to be 70-80 cfu/cm^2 on butchers hands, 60-70 cfu/cm^2 on serving staff hands, > 90 cfu/cm^2 on the surfaces of plastic and metal equipments, and 60-70 cfu/cm^2 on slicing machine. In another study, Moore and Griffith (16), had taken samples with different methods from stainless steel surfaces, which they had contaminated experimentally (10^{-1} to 10^{-7} cfu/ml) with coliforms; they have declared that they had isolated *E. coli* at a level of 3.3×10^2 cfu/cm^2, *E. coli* at a level of 9.87×10^4 cfu/cm^2 and *Enterobacter cloacae* at a level of 2.2×10^3 cfu/ml from the samples which had been taken using dipslide method.

The only pathogen bacteria found in permanent microflora of personnel hands is *S. aureus* as well (15). From this point of view, personnel working in food production and sales facilities constitutes a potential risk for *Staphylococcus* based food contaminations. Together with the other microorganisms, isolation of S. *aureus* and coagulase negative *Staphylococci* to high extents is explained by this organisms being found in skins permanent flora (5). Therefore, presence of possible risky bacteria coagulase positive *S. aureus* was also searched on personnel and equipments in food production companies. On 103 out of 266 (38.72%) personnel working in food production, on 34 out of 94 (36.17%) personnel working in sales departments and on 18 equipments (25.71%) *S. aureus* was detected. In a similar study, Aycicek et al. (5) examined the microflora of naked hands and gloves of 180 personnel working at hospitals in food preparation departments and declared that they had isolated *S. aureus* from 126 (70.0%) of the samples. In another study, Aktan et al. (2) stated that those had isolated *S. aureus* from the personnel working in hospital kitchens. These results are quite higher than that of this study. This situation may result from hygienic conditions of the examined enterprises and different analysis methods. Acikel (1) declared that he had isolated *S. aureus* at ratio of 28% from the hands of the personnel during production process, Ayyıldız et al. (6) also declared that they had isolated at ratio of 23%. These results have similarities with finding of this study.

Conclusions

In conclusion, in the research that was carried out in some cities of Turkey, hygienic quality of hands of the personnel working in examined food production and sales enterprises, when the analyzed bacteria were taken into account, was found to be low and these bacteria were detected to be at high levels on the surfaces of the equipments, which have been studied in a similar way. Depending on these, in order for the personnel working in enterprises under consideration to pay attention to hand hygiene before and during work education, hygiene control etc. must be carried out and at the same time necessary measures must be taken to ensure suitable regulation of equipment cleanings and disinfections.

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Author's address: Dr. Ali Aydin, Department of Food Hygiene and Technology, Faculty of Veterinary Medicine, Istanbul University, 34320 Avcilar, Istanbul, Turkey; e-mail: aliaydin@istanbul.edu.tr