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On-site and one-year monitoring of food service business risks associated with poor hygiene quality in the catering establishments for consumer protection

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ABSTRACT

Hygiene is essential in foodservices to prevent food safety and public health issues. Implementation of food safety legislation represents a *sine qua non* obligation of the foodservice business. In this study, we aimed to monitor the foodservice business risks associated with poor hygiene quality in the catering establishments for consumer protection. To do this, a total of 504 samples (144 from food handlers' hands, 144 from tools and surfaces, 144 from prepared foods, and 72 from the water) was collected. Contamination frequencies between the sampling groups were statistically analyzed ($p < .01$). Microbiological results showed that 62.5% in food handlers' hands, 44% in tools and surfaces, 27% in foods, and 7% in the water were contaminated with mesophilic aerobic bacteria (64.6%), coliforms (47.2%), *Staphylococcus aureus* (34.7%), *Escherichia coli* (25.7%), *Citrobacter freundii* (1.4%), and *Listeria monocytogenes* (0.7%), whereas no *Salmonella* was detected. All the test prior powers among the sampling groups were strong ($=1.000$), the differences and effects' sizes were large enough, and statistically significant ($p < .01$). Overall, awareness about hygiene in the food services needs to be improved, and the uncertainties linked to poor hygiene quality should be identified for competitiveness and efficiency of the sector.

KEYWORDS

Food service business; hygiene; food safety; public health

Introduction

The demand for food is likely to grow by 70% until 2050. This accelerated food production for an additional 2.3 billion people by 2050 will cause some uncertainties of global food supply linked to unpredictable economic, political, climatic, and also biological (e.g. crop and animal diseases) challenges. Therefore, some policies and reforms should be implied for the global food security, and moreover the economy-wide effects of each policy need to be assessed for all sectors of the parties in the food manufacturing and service areas (FAO, 2020; EU Science Hub, 2018).

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Food services, also known as catering services, as the largest industry in the hospitality sector in today's world, prepare and serve meals on demand for out-of-home consumption, and play an important role in meeting the nutritional needs of consumers (Valero et al., 2016). Catering services provide food service at various locations, including private enterprises, government agencies, military facilities, schools, universities, hospitals, and nursing homes, etc. Therefore, the development of food services are undoubtedly related to socioeconomic changes such as consumer behavior, consumer protection, food safety, and public health (Doğan, 2018; Erdogan, 2018).

The catering service market value globally exceeded 130 USD billion in 2018 and projected to cross 205 USD billion by 2024. Asia-Pacific was the dominator of this global market in 2018, followed by North America and Europe. For instance, in the European Union, foodservices are the largest industry generating the largest part of added value and the majority of jobs in the hospitality sector. The United Kingdom and France are the two biggest actors in the foodservice industry, followed by Italy and Spain in 2014. According to the European Federation of Contract Catering Organizations (FERCO), 33% of the enterprises and organizations already have a contract with a catering company (EU, 2020; TechSci Research, 2019).

The Turkish catering sector, where over 5 thousand firms with 400 thousand employee work, recorded a turnover of 22 USD billion in 2017, and made 6 million meals a day according to Turkey's Catering Industrialists Federation (YESIDEF) (Anatolian Agency [AA], 2017).

Hygiene quality is essential in the foodservice sector to protect the consumers as well as preventing food safety and public health-related issues. Foods can be contaminated by microorganisms. Such contamination depends on the quality of the raw materials and on the application of Good Manufacturing Practices (GMPs) by the staff. For catering establishments, there are systems such as Hazard Analysis and Critical Control Points (HACCP) to effectively determine and reduce food contamination by microorganisms (Valero et al., 2016).

In catering services, foodborne infections and poisoning are still a concern and bacterial contamination are responsible for almost 90% of the risks that constitute foodborne infections and poisoning. One of the major factors contributing to the spread of foodborne diseases and the application of preventive measures in the catering sector is a complex of operations, in particular poor employee health and hygiene, and cross-contamination and contaminated equipment as identified by the World Health Organization (WHO). Developed countries regularly launch the initiatives to educate food handlers. However, limited efforts in developing countries are undertaken (Alqurashi et al., 2019; Minnesota Department of Health Food, Pools and Lodging Services & Minnesota Department of Agriculture Food and Feed Safety Division, 2019; Osimani & Clementi, 2016).

The European Food Safety Authority (EFSA) and European Center for Disease Prevention and Control (ECDC) have recently reported that catering establishments were identified as the most frequently reported setting for major foodborne outbreaks such as salmonellosis, listeriosis, and campylobacteriosis (Petruzzelli et al., 2018; Ulusoy & Çolakoğlu, 2018). The frequencies of food-borne (including waterborne) outbreak the caterers in the European Union (EU) were reported as 22.2% in 2013 and 26.6% in 2017, respectively. These facts reveal that there has been an increasing trend over several years in the public health risks associated with poor hygiene quality in the catering establishments as a causative factor (EFSA [European Food Safety Authority] & ECDC [European Centre for Disease Prevention and Control], 2018).

Foodservice business risks associated with poor hygiene quality are relevant to a broad range of the specialists in different areas such as hospitality, tourism, gastronomy, marketing, business research, consumer behavior, food sciences, and technology, sociology, sustainable development of economy, nutrition, food safety, public health, and production sector. In this study, we aimed to monitor the foodservice business risks associated with poor hygiene quality in the catering establishments in Istanbul, Turkey for consumer protection.

Methodology

Sampling

During a period of 12-months from 2018 to 2019, six catering establishments located in Istanbul, Turkey, which agreed to participate in the study, were selected by using a convenience sampling method “snowball technique.” The selected six catering establishments with a total number of 71 employees made 3720 meals a day.

Each catering establishment was inspected once a month. In each inspection, swap samples from food handlers’ hands (two employees in each establishment) before washing, and tools and surfaces during the operation were taken randomly, and along with two samples from prepared foods (soup, main dish, dessert, and salad), and one sample of water used for cleaning in each establishment were taken. This sampling plan was repeated during a period of 12-month. Finally, a total of 504 samples (144 from food handlers’hand, 144 from tool and surface, 144 from prepared foods, and 72 from the water) was collected.

All the samples were examined microbiologically according to the instructions by the International Organization for Standardization (ISO) 18593:2004 (International Organization for Standardization [ISO] 18593:2004, 2018).

Chemicals used

The chemicals used in the microbiological analysis were Baird Parker Agar (BPA) (Merck 1.05406, Darmstad, Germany), Chromocult[®] Coliform Agar (CCA) (Merck 1.10426, Darmstad, Germany), Mannitol-Egg-yolk-Polymyxine (MYP) Agar (Merck 1.05267, Darmstad, Germany), Oxford Listeria Selective Agar (OLSA) (Merck 1.07004, Darmstad, Germany), and Plate Count Agar (PCA) (Merck 1.05463, Darmstad, Germany). All the chemicals were prepared according to the instructions by ISO 11290-1, 2017 and APHA 1998 (International Organization for Standardization [ISO] 11290-1, 2017; American Public Health Association [APHA], 2017).

Microbiological evaluation

Swap samples from food handlers' hands were initially inoculated onto CCA and BPA media for determining *E. coli*-coliforms, and *S. aureus*, respectively. Subsequently, they were exposed to incubation at 37°C for 24 h. At the end of the incubation, blue-turquoise colonies were considered as *E. coli*, while pink-red ones as coliforms, and black colonies with transparent zones as *S. aureus* (Antunes et al., 2018; Mengual Lombar et al., 2016). Similarly, swap samples from tools and surfaces were inoculated onto PCA media for total aerobic mesophilic bacteria (TAMB), and onto CCA for *E. coli* and coliforms, respectively. After that, the plates were incubated at 37°C for 24 h. The colonies grown on PCA in different colors were evaluated as TAMB, whereas blue-turquoise *E. coli* and pink-red ones on CCA as coliforms (Nasopoulou et al., 2012). The samples of food and water were inoculated onto PCA, BPA, CCA, MYP, and OLSA media after making necessary dilutions and preparations. The inoculated media were allowed for incubation at an appropriate temperature and time. Different colors on PCA were evaluated as TAMB, black colonies with transparent zones as *S. aureus* on BPA, blue-turquoise colonies as *E. coli*, pink-red ones as coliforms, colorless ones as *Salmonella* on CCA, red ones as *Citrobacter (C.) freundii* on MYP, and blueish-brown to greenish-brown ones as *Listeria* on OLSA (Rai & Bai, 2017; Da Silva et al., 2018).

Statistical analysis

A two-sample proportion z-test was used to compare the unacceptable microbiological contamination frequencies between the sampling groups. Statistical analysis was performed using SPSS 19 (SPSS Inc., USA), and a *p*-value <0.01 was considered as significant.

Results

Microbiological results

Microbiological screening results revealed that contamination frequencies in food handlers' hands, tools, and surfaces, foods, and water samples were found as 62.5%, 44%, 27%, and 7%, respectively.

With regard to the bacterial species, food handler's hands harbored coliform (34.7%), *S. aureus* (30.6%), and *E. coli* (17.4%); tools and surfaces contained TMAB (38.2%), coliform (9.7%), and *E. coli* (3.5%); prepared foods included TAMB (20.8%), *E. coli* (4.9%), *S. aureus* (4.2%), *C. freundii* (1.4%), and *L. monocytogenes* (0.7%), whereas water samples were contaminated with TAMB (5.6%) and coliform (2.8%).

Overall, the frequencies of the bacterial species were found as 64.6% in TAMB, 47.2% in coliforms, 34.7% in *S. aureus*, 25.7% in *E. coli*, 1.4% in *C. freundii*, and 0.7% in *L. monocytogenes*, whereas no *Salmonella* was detected in any sample (Table 1).

Statistical results

Statistical analysis compared unacceptable contamination frequencies between sampling groups, i.e., food handlers' hands to tools and surfaces, food handlers' hands to prepared foods, and food handlers' hands to water samples. The results showed that all the test prior powers among sampling groups were strong and equal to 1.000, and the differences (p) and effects' sizes (h) were statistically significant ($p < .01$), enough large, and equal to $p = 2.50289 \times 10^{-11}$ and 0.83 in food handlers' hands to tools and surfaces, 2.22045×10^{-16} and 1.19 in food handlers' hands to prepared foods, and 0.00000 and 1.75 in food handlers' hands to water samples.

Table 1. Microbiological contamination frequencies in the analyzed samples.

Source of sample	No of sample (n)	Microbial contamination frequency											
		Coliforms		<i>E. coli</i>		<i>S. aureus</i>		TAMB		<i>L. monocytogenes</i>		<i>C. freundii</i>	
		n	%	n	%	n	%	n	%	n	%	n	%
Food handlers' hands	144	50	34.7%	25	17.4%	44	30.6%	0	0.0%	0	0.0%	0	0.0%
Tools and surfaces	144	14	9.7%	5	3.5%	0	0.0%	55	38.2%	0	0.0%	0	0.0%
Foods	144	0	0.0%	7	4.9%	6	4.2%	30	20.8%	1	0.7%	2	1.4%
Cleaning water	72	2	2.8%	0	0.0%	0	0.0%	4	5.6%	0	0.0%	0	0.0%
Total	504	66	47.2%	37	25.7%	50	34.7%	89	64.6%	1	0.7%	2	1.4%

Discussion

In this study, we performed on-site and one-year monitoring of foodservice business risks associated with poor hygiene quality in the catering establishments for consumer protection. The findings showed that all the sampling groups in the monitored catering-harbored bacteria, but among the sampling groups, food handlers potentially posed a risk higher than tools and surfaces, foods, and water.

The catering industry has gained significant importance in today's world. Therefore, poor hygiene quality should not act as a potential source of foodborne and waterborne safety and health risks for the consumers (Osimani & Clementi, 2016). Since the food services represent one of the fostering forces of the growth and development in the World, in particular, the EU region, the implementation of sanitary and food safety legislation specific to this sector is a "sine qua non" obligation of the establishments (Bondoc, 2016a). All relevant regulations are centered around the protection of consumer interests (Bondoc, 2016b), include conventional and contemporary directives (Bondoc, 2016c), and a systematic database regarding all the normative acts in the field of food safety (Bondoc, 2016d). The catering sector in Turkey harbors over 5 thousand firms with 400 thousand employees, and six-million meals a day are made (Anatolian Agency (AA), 2017). For instance, a report issued in Egypt indicates that 40% of the food safety requirements in the catering establishments are insufficient in food safety measures (Elsersy et al., 2018). In this study, we monitored six-establishment in Istanbul, Turkey for a period of twelve-month. At the end of the study, we revealed that the hygiene quality was somewhat poor although all the examined establishments were formally registered. On the contrary, it is a fact that there are many other food service establishments performing informal activities specific to this sector. Thus, awareness about hygiene in the foodservices needs to be monitored regularly.

The occurrence of microorganisms in the foods indicates deficiencies in the hygienic quality. Indeed, their presence does not always offer pose a risk to human health, but may potentially cause foodborne, and/or waterborne diseases under certain circumstances. According to International Commission on Microbiological Specifications for Foods (ICMSF) and the EU regulations, TAMB, coliforms, *S. aureus*, *E. coli*, and *L. monocytogenes* are the bacterial indicators, that need to be monitored as safety criteria in the foodservice business regularly (Valero et al., 2016). Due to this fact, many works has been conducted examining the hygiene quality of catering establishments, and many of them have confirmed the difficulties inherent to adequately apply the good hygiene practices (GHPs) (Garayoa et al., 2012). In Greece, a foodborne salmonella outbreak in 2015 was seen, and a strong indication showed that the individuals were cross-contaminated with *Salmonella enterica*

occurring from food preparing equipment (Tsakali et al., 2016). A study conducted in Italy showed that 10% of the samples from tool and work surfaces in 27 catering establishments were contaminated with regard to *E. coli* ranging from 5.4% to 10.8% (Legnani et al., 2004). Another work in Italy showed that the traditionally prepared foods in three catering establishments included *L. monocytogenes* (11.5%), *S. aureus* (2.2% to 34.6%), and *E. coli* (2.7% to 76.4%). In addition, the drinking and tap waters harbored *P. aeruginosa* ranging from 21.4% to 21.9% (Marzano & Balzaretto, 2011). A 7-month-survey in the United Kingdom indicated that 27% of the water samples, 32% of swabs, and 56% of the cloths in the catering establishments were poor in hygiene quality, and 20% of the food handlers' wristbands contained *Enterobacteriaceae*, *E. coli*, and/or coagulase-positive *staphylococci* (Willis et al., 2015). Similarly, in Ethiopia, the bacteria prevalent among the food-handlers were *E. coli* (3.1%) and *S. aureus* (16.5%), which is the third most important causative agent of food intoxication in the world (Andargie et al., 2008). In this work, the microbiological evaluation showed that the microbiological contamination frequencies in the food handlers' hands, tools, and surfaces, foods and water were found to be 62.5%, 44%, 27%, and 7%, respectively. The common types of bacteria detected were mesophilic aerobic bacteria (64.6%), coliforms (47.2%), *S. aureus* (34.7%), *E. coli* (25.7%), *C. freundii* (1.4%), and *L. monocytogenes* (0.7%). However, no *Salmonella* was detected in the screening. All the microbial findings indicate the occurrence of insufficient hygiene applications, fecal contamination, and improper disinfection in the catering operations as previously suggested by Chapman et al. (2010), Medeiros et al. (2011), and Valero et al. (2017).

A survey in the United States from 1998 to 2013 shows that 24% of the catering service-associated foodborne outbreaks are due to food handlers' failure to implement safe food handling practices, such as adequate handwashing. In addition, this study indicates that almost 60%–70% of the food staff work while ill (Young et al., 2018). Researching attitudes and practices of the food handlers in the foodservice business are very crucial because they may potentially disseminate microorganisms into foods and beverages during production, processing, distribution, and preparation processes. Therefore, the food handlers are expected to adapt their behavior through knowledge and attitude for operational safety and competitiveness (Kılıçhan et al., 2020). In the literature, there are many studies focusing on the role of the food handlers in enabling the food safety for the catering operations. In Portugal, the average score of correct answers on food hygiene was 56.5% among food handlers from 18 catering business units (Martins et al., 2012). In Egypt, 89.6% of the food handlers were insufficient in the application of food safety measures (Elsersy et al., 2018). In Saudi Arabia, 44.2% of the foodservice staff gave correct answer on the most common species causing foodborne diseases like *Salmonella* and *E. Coli*, whereas 62.6% of the respondents had poor knowledge

of how to recognize food contaminated with food poisoning bacteria (Alqurashi et al., 2019). Similarly, in Turkey, other works provided similar findings related to the hygiene quality attitude among the food handlers in the foodservice business. A study showed that the average score of the correct answers on “*Kitchen worker who is directly related to the food can touch the food with his bare hand*” by 400 food handlers from 22 catering services in Istanbul was only 29% (Ulusoy & Çolakoğlu, 2018). Similarly, the average scores of 317 food handlers from the catering firms in Ankara with regard to personal hygiene, food hygiene, and kitchen and equipment hygiene were found to be 10.7%, 19.8%, and 13.6%, respectively (Yardımcı et al., 2015). Another study in some Turkish catering establishments revealed that food handlers were contaminated with *E. coli* (7.8%) and *S. aureus* (70%) (Ayçiçek et al., 2004). In this study, we showed that the highest microbiological contamination frequency was detected in the food handlers’ hands (62.5%), followed by tools and surfaces, foods, and water. The common types of bacteria detected in the food handlers’ hands were coliforms (34.7%), *S. aureus* (30.67%), and *E. coli* (17.4%), respectively. On the other hand, no *C. freundii*, mesophilic aerobic bacteria, and *L. monocytogenes* were found. All the findings prove that the food handlers have potentially responsibility for the dissemination of foodborne outbreaks by numerous means. As Kılıçhan et al. (2020) suggest that food handlers must adapt their behavior through knowledge and attitude for hygiene and operational safety (Kılıçhan et al., 2020).

Our statistical findings pointed out that an improvement in the hygiene issues induced by food handlers in the catering services would have a positively large and specific outcome on lowering public health risks associated with poor hygiene quality of tools and surfaces, foods, and water.

Another important throughput of the hygiene quality in the foodservice business is the financial burden of food contamination with microorganisms, and this gap is poorly understood yet. Therefore, it should not be ignored, such as water quality monitoring of *E. coli* and coliforms. Their presence does not always point out a threat to health, but may indicate a problem with treatment operations. For instance, a failure in routine monitoring of indicator microorganisms leads to an average cost ranging from £575 in a customer tap failure to £4,775 in a water treatment work to finish the failure (Ellis et al., 2018).

Conclusion

The foodservice business is one of the largest economic sectors in the world, including Turkey. The national and international legal authorities regulate the sanitary and food safety legislation specific to this sector as a *sine qua non* obligation of the establishments to protect the consumers. Despite conventional and contemporary directives, and regular monitoring, the catering establishments may become a potential source of unsafe food endangering

the customers' health. In this regard, our study is important as it contributes to filling an important gap in the on-site and long-term monitoring of foodservice business risks associated with poor hygiene quality in the catering establishments for consumer protection. Overall, awareness about hygiene in the foodservice business needs to be improved, monitored regularly, and the uncertainties linked to poor hygiene quality should be identified for competitiveness and efficiency of the catering establishments, absolutely taking care of the human factor in the operations.

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