

# Investigation of the Effects of Kitchen Hygiene Training on Reducing Personnel-Associated Microbial Contamination

Murat AY\*, Murat DOĞAN\*\*

## Abstract

**Aim:** In this study, it was aimed to determine the effect of kitchen hygiene training given to kitchen personnel in terms of reducing microbial contamination caused by personnel.

**Method:** Before and after kitchen hygiene training, a total of 70 swap samples from the kitchen personnel hands was taken and examined microbiologically (*S. aureus*, *E. coli* and coliforms as pathogen bacteria indicator).

**Results:** Before kitchen hygiene training, *Escherichia coli* (*E. coli*), coliforms and *Staphylococcus aureus* (*S. aureus*) strains developed on personnel hand surface samples. However, *E. coli* and coliforms did not develop on the samples after training and there was a 65% decrease in the count of *S. aureus* strains.

**Conclusion:** It has been concluded that kitchen hygiene training has a positive effect on reducing microbial contamination caused by personnel.

**Keywords:** Kitchen hygiene training, microbial contamination, personal hygiene, *E. coli*, coliforms, *S. aureus*.

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## Özgün Araştırma Makalesi (Original Research Article)

**Geliş / Received:** 21.04.2020 & **Kabul / Accepted:** 04.06.2020

**DOI:** <https://doi.org/10.38079/igusabder.724266>

\* Corresponding Author: Assist. Prof. Dr., Dogus University, Faculty of Arts and Design, Department of Gastronomy and Culinary Arts, Istanbul, Turkey, E-mail: [may@dogus.edu.tr](mailto:may@dogus.edu.tr)

**ORCID** <https://orcid.org/0000-0002-3872-3920>

\*\* Assist. Prof. Dr., Istanbul Gelisim University, Faculty of Fine Arts, Department of Gastronomy and Culinary Arts, Istanbul, Turkey, E-mail: [muratdogan72@gmail.com](mailto:muratdogan72@gmail.com)

**ORCID** <https://orcid.org/0000-0001-6391-4887>

## Mutfak Hijyen Eğitiminin Personel Kaynaklı Mikrobiyal Kontaminasyonun Azaltılmasına Etkisinin Araştırılması

### Öz

**Amaç:** Bu çalışmada mutfak personeline verilen mutfak hijyeni eğitiminin personel kaynaklı mikrobiyal kontaminasyonun azaltılması yönünde etkisinin belirlenmesi amaçlanmıştır.

**Yöntem:** Mutfak hijyen eğitimi öncesinde ve sonrasında; 70 mutfak personelinden el yüzeyi örnekleri alınmış ve mikrobiyolojik açıdan (patojen bakteri indikatörü olarak *S. aureus*, *E. coli* and coliforms) incelenmiştir.

**Bulgular:** Mutfak hijyeni eğitimi öncesi personel el yüzeyi örneklerinde *Escherichia coli* (*E. coli*), koliform bakteri ve *Staphylococcus aureus* suşları gelişmiştir. Ancak eğitim sonrası örneklerde *E. coli* ve Koliform bakterileri gelişmemiş ve *S. aureus* sayısında %65 azalma tespit edilmiştir.

**Sonuç:** Mutfak hijyeni eğitiminin personel kaynaklı mikrobiyal kontaminasyonun azaltılması yönünde pozitif etkisinin olduğu belirlenmiştir.

**Anahtar kelimeler:** Mutfak hijyen eğitimi, mikrobiyal kontaminasyon, personel hijyeni, *E. coli*, Koliform bakteriler, *S. aureus*.

### Introduction

Nutrition is the basic requirement of human beings and it has great importance that the food required to be met is safe. Because food-borne diseases caused by poor hygiene practices related to food safety have a significant impact on public health worldwide. The World Health Organization (WHO) reports that 600 million people get patient every year due to unsafe food consumption, and 420,000 of 600 million patients per year<sup>1-3</sup>.

In recent years, food services have gained significant attention due to technological developments, urbanization and the increase in the number of employees. Today, 70% of the populations in developed countries eat at least one meal a day, from food services. Food production by food services is among the most important sources of foodborne diseases<sup>4</sup>.

It is important that the person preparing the food in the kitchen follow the rules of personal hygiene. Because it is thought that 97% of foodborne diseases are caused by kitchen personnel<sup>5</sup>. There are many reasons that kitchen personnel do not obey the rules of personal hygiene. These reasons are listed such as that do not think that food can be

contaminated through pathogenic microorganisms by their hands, to not know which processes to wash their hands before or after, to not have access to items such as soap and disinfectant necessary for hand washing, and to think that wearing gloves can be sufficient to ensure hand hygiene. For these reasons, it is important that the kitchen personnel to know the personal hygiene rules adequately and apply them correctly. It can be considered that kitchen personnel can be given Good Manufacturing Practices (GMP) habits with a properly programmed training<sup>6</sup>.

As in food safety, hand hygiene is an important factor in controlling viral pandemics. It is reported that the most important procedure in the control of pandemics (Sars-CoV, Mers-CoV and COVID-19, etc.) threatening the world today is hand hygiene. The most important stage in the prevention of these diseases, which are spread by contact due to contaminated surfaces and hand contamination, is an effective hand washing in accordance with the rules<sup>7-9</sup>.

When foodborne diseases are examined, the most common foodborne disease is staphylococcal food poisoning caused by the *S.aureus* strain. In addition, *Enterobacteriaceae spp*, *E. coli*, *Salmonella*, *Listeria*, *Campylobacter*, *Cronobacter*, *Bacillus*, etc. species are other pathogenic microorganisms that cause foodborne diseases<sup>10-12</sup>.

It is reported that kitchen personnel is the most important factor in foodborne diseases by contaminating *S. aureus* into foods. Since toxins produced by *S.aureus* are very resistant to external factors, personal hygiene rules must be followed. There are many microorganisms in the nose, throat, skin and intestines of the kitchen personnel. While the nose, throat and skin lesions are the source of *Staphylococcus* species, the intestine is the main source of *E. coli*. Therefore, *E. coli* is an indicator bacteria known as fecal coliforms. The presence of *E. coli* on the hand surface of the kitchen personnel indicates the possibility of pathogenic bacterial contamination from feces, thereby a direct or indirect contact with feces<sup>13-15</sup>.

The most common way of transmission of pathogenic bacteria is contact. 25% of staphylococcal food poisoning occurs during cross-contamination from the hands of the kitchen personnel during the food preparation stage. For this reason, kitchen personnel should especially obey the rules of hand hygiene. Otherwise, infections caused by these factors cause deaths and significant labor losses<sup>6,16</sup>.

In order for the personal hygiene level of the kitchen personnel to be at a certain standard, they should be trained sufficient time. It is important to carry out microbiological controls of their hand surface samples to determine how hygienic trainings positively affect the behavior of the kitchen personnel. Analysis of indicator microorganisms such as coliforms, *E.coli* and *S.aureus* are important in determining the effectiveness of sanitation programs<sup>16,10</sup>.

Kitchen personnel are one of the most important causes of foodborne diseases as public health threats. For this reason, foodborne diseases should be prevented by personnel's kitchen hygiene training and compliance with personal hygiene rules.

In this study, it was aimed to determine the effect of hygiene training given to kitchen personnel on reducing microbial contamination caused by personnel.

### **Materials and Methods**

The study was carried out in two different catering companies in Istanbul in 2019. In the first stage of the study, hand surface samples of 70 kitchen personnel were taken, and in the second stage, kitchen personnel were given hygiene training (a total of 16 hours in a month- According to the Hygiene Education Regulation<sup>17</sup>), and then hand surface samples were taken and left for 48 hours incubation at 37°C for the detection of *S. aureus*, *E. coli* and coliforms strains. Baird Parker Agar (BPA; Condalab 1100-Spain) and *E. coli*-coliforms Chromogenic Medium (ECCM; 1340-Spain) were used for the microbiological examination of surface samples taken from personnel. After incubation, black colonies with white moire were identified as *S. aureus*, dark blue – purple colonies were *E. coli* and red colonies were coliforms<sup>18,19</sup>. These data then are analysed with descriptive statistics (tables, percentage, average, standard deviation, minimum and maximum values) and SPSS 22 (SPSS Inc., Chicago 2013) package program was used for statistical analysis.

### **Results**

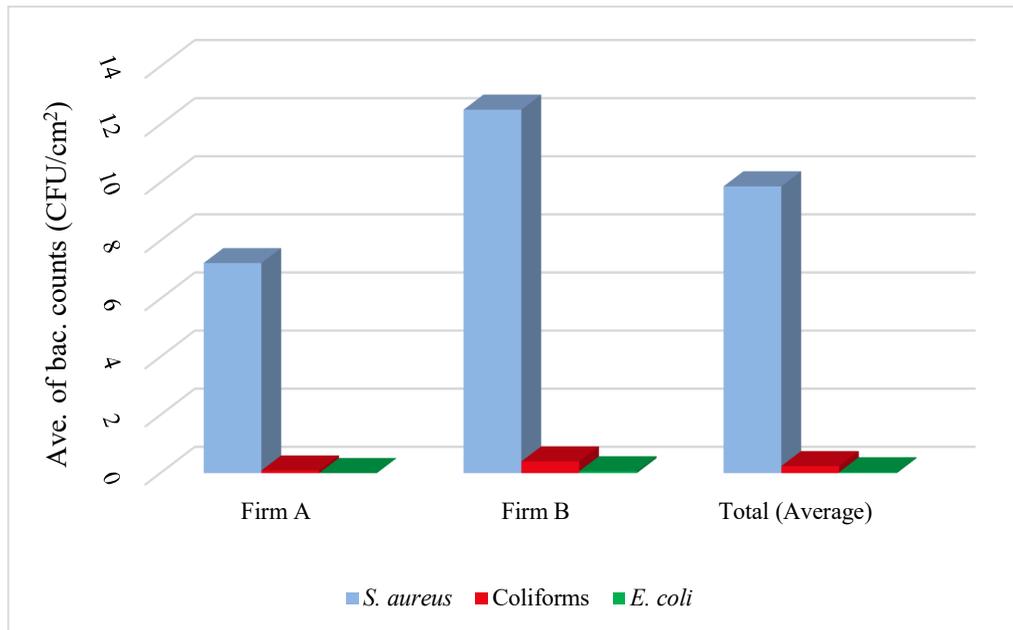
Microbiological results of the surface samples taken from the kitchen personnel of two different catering companies are given below (Table 1). Companies are classified as A and B, the samples were taken from the personnel before and after hygiene training, *S. aureus*, *E. coli* and coliforms counts (CFU/ cm<sup>2</sup>) were evaluated.

**Before hygiene training results****Table 1.** Microbiological results of kitchen personnel hand surface samples before hygiene training

Before Hygiene Training	Bacteria	Number of Samples	Number of Bacteria Contaminated Samples	Percent of Bacteria Contaminated Samples	Bacterial load (CFU/ cm <sup>2</sup> )		
					Minimum	Maximum	Average ±Sd
Food Service Firm A	<i>S. aureus</i>	35	25	71%	0	31	7,23±8,055
Food Service Firm B		35	28	80%	0	75	12,51±18,753
<b>Total</b>		70	53	76%	0	75	9,87±14,57
Food Service Firm A	Coliforms	35	1	3%	0	3	0,09±0,507
Food Service Firm B		35	6	17%	0	3	0,40±0,946
<b>Total</b>		70	7	10%	0	3	0,24±0,77
Food Service Firm A	<i>E. coli</i>	35	0	0%	0	0	0,00±0,000
Food Service Firm B		35	2	6%	0	1	0,06±0,236
<b>Total</b>		70	2	3%	0	1	0,03±0,17

As a result of microbiological examination; 35 hand surface samples taken before giving hygiene training to kitchen personnel of A Food Service Firm; *S. aureus* developed in 25 of them (71%), coliforms in 1 (3%) and *E.coli* not developed. On the other hand, 35 hand surface samples taken before giving hygiene training to kitchen personnel of B Food Service Firm; *S. aureus* developed in 28 of them (80%), coliforms in 6 (17%) and *E.coli* in 2 (6%). When the bacteria counts of the samples are evaluated; the average of hand surface samples of A Food Service Firm kitchen personnel were determined as 7,23 CFU/cm<sup>2</sup> for *S. aureus*, 0,09 CFU/cm<sup>2</sup> for coliforms, 0 CFU/cm<sup>2</sup> for *E. coli* and the average of hand surface samples of B Food Service Firm kitchen personnel were 12.51 CFU/cm<sup>2</sup> for *S. aureus*, 0,40 CFU/cm<sup>2</sup> for coliforms, 0,06 CFU/cm<sup>2</sup> *E. coli* (Table 1) (Figure 1).

**Figure 1.** Averages of bacterial counts of hand surface samples taken from A and B Food Service Firms kitchen personnel before hygiene training.



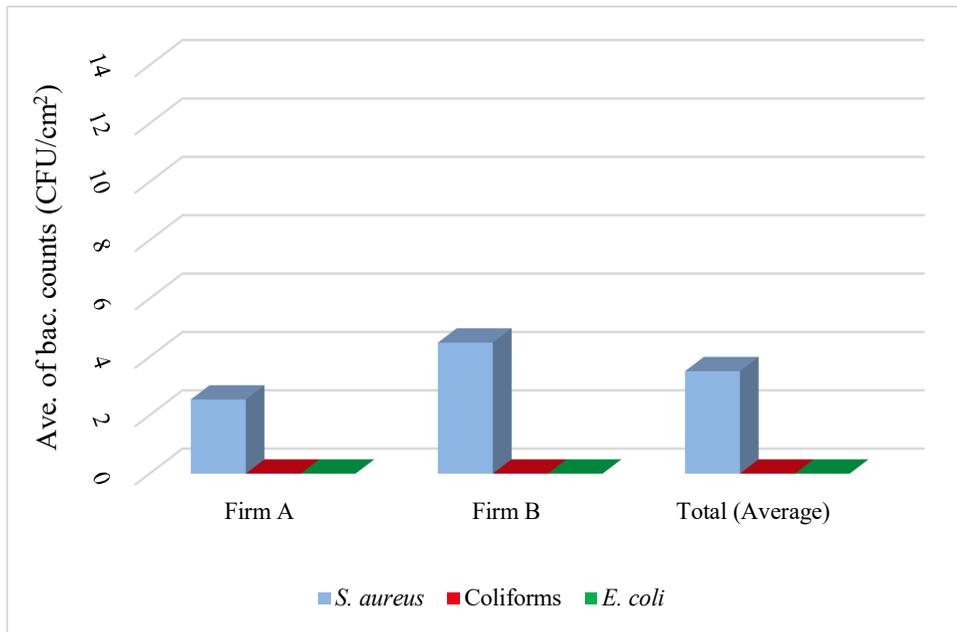
The most important factor leading to food poisoning caused by food service is the lack of hygiene knowledge of the kitchen personnel and their wrong practices<sup>1</sup>. Similar to the results of similar studies, the results obtained in the first stage of our research demonstrated that both companies have incomplete hygiene knowledge.

**After hygiene training results** before the second stage of our study, kitchen personnel were given hygiene training (16 hours in 1 month). After the hygiene training, hand surface samples of the kitchen personnel were examined microbiologically, and it was observed that *E. coli* and coliforms did not develop in the hand samples of both firms personnel. *S. aureus* developed in 19 (54%) and 12 (34%) hand surface samples of 35 kitchen personnel of A and B Firms, respectively, and these were found to be inappropriate. The average of *S. aureus* strain counts were 2.54 CFU/cm<sup>2</sup> in samples of A Firm and 4.49 CFU/cm<sup>2</sup> in samples of B Firm (Table 2) (Figure 2).

**Table 2.** Microbiological results of kitchen personnel hand surface samples after hygiene training

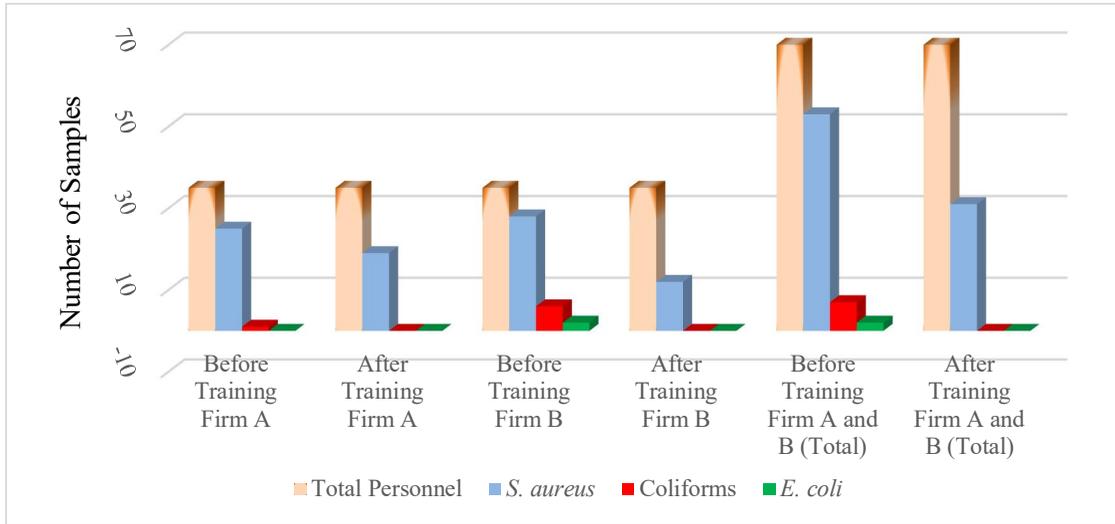
After Hygiene Training	Bacteria	Number of Samples	Number of Bacteria Contaminated Samples	Percent of Bacteria Contaminated Samples	Bacterial load (CFU/ cm <sup>2</sup> )		
					Minimum	Maximum	Average $\pm$ Sd
Food Service Firm A	<i>S. aureus</i>	35	19	54%	0	16	2,54 $\pm$ 3,898
Food Service Firm B		35	12	34%	0	27	4,49 $\pm$ 8,276
<b>Total</b>		70	31	44%	0	27	3,51 $\pm$ 6,50
Food Service Firm A	Coliforms	35	0	0%	0	0	0,00 $\pm$ 0,000
Food Service Firm B		35	0	0%	0	0	0,00 $\pm$ 0,000
<b>Total</b>		70	0	0%	0	0	0,00 $\pm$ 0,000
Food Service Firm A	<i>E. coli</i>	35	0	0%	0	0	0,00 $\pm$ 0,000
Food Service Firm B		35	0	0%	0	0	0,00 $\pm$ 0,000
<b>Total</b>		70	0	0%	0	0	0,00 $\pm$ 0,000

**Figure 2.** Averages of bacterial counts of hand surface samples taken from A and B Food Service Firms kitchen personnel after hygiene training.

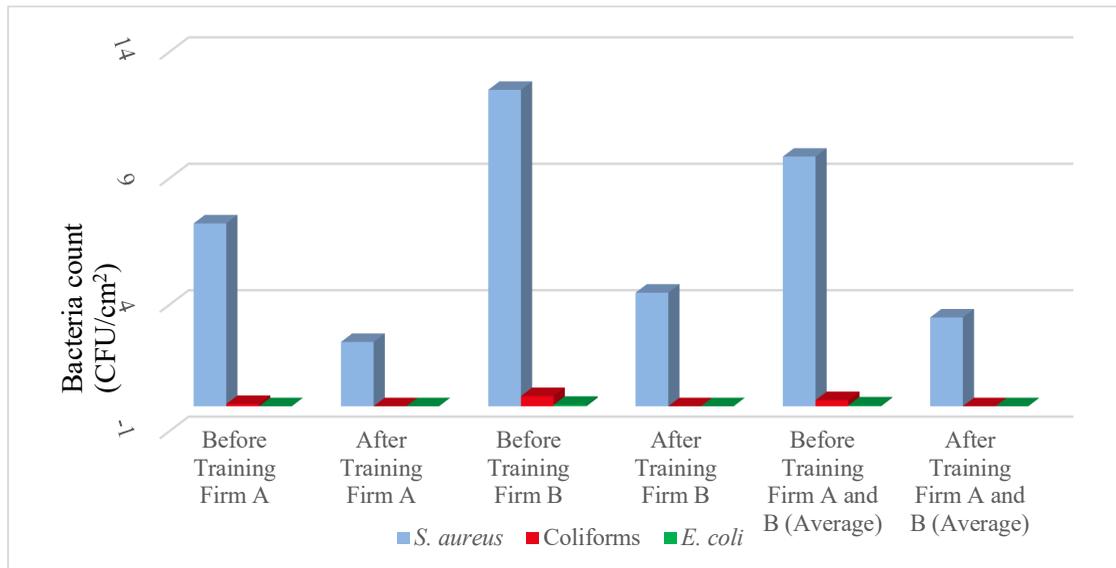


*S. aureus* growth of hand surface samples taken after the hygiene training of kitchen personnel of A and B companies were examined and In the samples of A and B Firms, *S. aureus* development decreased by 25%, 57% and average 42% (Figure 3), respectively. However, the count of *S. aureus* was 65% lower in Food Service Firm A, 64% in Food Service Firm B, and on average 65% (Figure 4) lower after training.

**Figure 3.** The number of samples detected microbial growth (*S. aureus*, coliforms and *E. coli*) in samples taken before and after hygiene training in Food Service Firm A and B and the sum of both.



**Figure 4.** Counts of *S. aureus*, coliforms and *E. coli* (CFU/cm<sup>2</sup>) developing on hand surface samples of personnel taken before and after the hygiene training at Food Service Firm A and B and the sum of both.



## Discussion

Similar to the results of other studies, the results obtained in the first stage of our study show that both Food Service Firms personnel have poor hygiene knowledge. In a study conducted to evaluate food hygiene knowledge levels and practices of kitchen personnel in India, 53,3% were determined to have insufficient hygiene knowledge and misapplied. It has been reported that inadequate food hygiene knowledge and practices of kitchen personnel are a major problem in terms of public health and this situation should be prevented<sup>20</sup>. In another study conducted to determine the food safety knowledge levels of the kitchen personnel, 67,9% stated that they were very interested in food safety, 28,6% were interested in them, 2,1% were less interested in them and 1,3% were not interested at all. On the other hand, almost all of the personnel stated that the food they prepared was safe. In addition, the kitchen personnel stated that the highest responsibility for food safety is in the cooks (%61,4)<sup>1</sup>.

Personal hygiene practices are extremely important to ensure that the produced food is safe for consumers<sup>21</sup>. The most important factor causing food poisoning is the hands of the kitchen personnel due to their poor personal hygiene. Hands and clothes of the personnel are contaminated with various microorganisms due to the things they touch. For this reason, the most effective and simple method that can be applied for the prevention of foodborne diseases is to control the hand hygiene of the kitchen personnel<sup>22</sup>. In a study; it has been reported that the habit of washing hands using soap and water was 77% after toilet, 57,4% after touching dirty things, 87,4% before touching foods, and others use only water in hand washing. This result demonstrated that the hygiene trainings of the kitchen personnel were not sufficient<sup>23</sup>.

When the kitchen personnel come to the firm, before and after using food, every time the process is interrupted, every time they touch potentially contaminated objects, after using the toilet... etc. should wash their hands carefully and disinfect when necessary<sup>24</sup>. In a study conducted to determine the hygiene information of veterinary students in Bulgaria, it was found that 91.1% of the participants thought that personal hygiene might prevent food contamination, and 94.4% of them washed their hands before and after cooking<sup>25</sup>. In another study, university students who participated in the study; stated that, 73% after touching the money, 74,8% after touching their work clothes, 73,8% after touching the counter, 85% before making a salad they washed their hands<sup>4</sup>.

In a study conducted to evaluate the knowledge levels of the students who are cooking cookery about food safety, 76,8% of the trainees participating in the research answered the question "In which cases should our hands be washed" correctly<sup>26</sup>. In the study conducted by Bayram (2011) received 72% "Agree" answer by the kitchen personnel to the question "must not touch the cooked foods after touch raw foods", while Başer et al. (2016) received 90% correct answer to the same question<sup>27,28</sup>.

Gloves are the most important source of cross-contamination if they are not frequently replaced by personnel in food service areas. Because pathogenic microorganisms adhere to the inner and outer surface of the gloves. According to hygiene rules, when gloves are worn without washing hands, their inner and outer surfaces become contaminated. It is also reported that personnel generally avoid hand washing when wearing gloves. For this reason, gloves can create a warm, moist environment and cause microbial development on the hands<sup>6</sup>. In a study to determine the food safety knowledge levels, attitudes and practices of the personnel of restaurants in a university in Saudi Arabia, an 82,8% positive response was reported to the question "I wash my hands before and after wearing gloves"<sup>21</sup>. These studies, which were conducted among kitchen personnel, cafeteria personnel or university students; demonstrated that the research groups' food hygiene knowledge was insufficient and they applied it incorrectly. It was determined that there was a lack of knowledge, especially in the use of gloves and hand hygiene.

According to the results of our research, incomplete hygiene knowledge of the personnel caused inadequate personal hygiene practices. Pamuk et al. (2018) in the study; it was reported that *S. aureus* was isolated from 57,7% and coliforms from 51,1% of the surface samples taken from 45 canteen personnel<sup>6</sup>.

In another study, *S. aureus* average 0,34 log CFU/cm<sup>2</sup> and coliforms average 1,08 log CFU/cm<sup>2</sup> were determined on the hand surface of the personnel<sup>29</sup>. In a study conducted to determine the count of bacteria on hand surfaces of a university campus cafeteria personnel, *S. aureus* from 23,5% of the hand surface samples and *Enterobacter* strains from 9,1% were isolated<sup>23</sup>. It can be claimed that the pathogen microorganisms that cause food-borne diseases increase on the hand surfaces of the personnel due to inadequate hygiene knowledge.

In researches, it is reported that the level of education is effective in hygiene awareness. In a study conducted among students with different education levels, to the statement of

'I always wash my hands with soap and hot water before preparing food / touching it with my hands', 96% of primary school graduates, 97,5% of high school graduates, and all university graduates answered yes. As a result of the answers given to the statements, it was reported that the general level of hygiene of the participants was quite high, but the highest level of knowledge was among university graduates<sup>30</sup>. In a study conducted in Austria, the hygienic score of the personnel who were given hygiene training was 78% and the hygiene score of the personnel who were not given hygiene training was 74%. With these results, it has been demonstrated that hygiene training causes differences in hygiene awareness among groups<sup>31</sup>. In the study conducted by Sormaz and Şanlıer (2017), it was reported that compulsory hygiene training increased the hygiene knowledge levels, habits and behaviors of the personnel in a positive way<sup>32</sup>.

In recent studies, it is reported that hygiene training given to kitchen personnel improves their food safety knowledge and personal hygiene practices<sup>33,34</sup>. Also in our study, hand surface samples of the kitchen personnel after hygiene trainings were examined microbiologically, and it was observed that *E. coli* and coliforms did not grow in the hand samples of both firm personnel. When the samples were examined in terms of *S. aureus* growth, it was determined that there was 64% less bacterial growth in the samples taken after hygiene training. The results show that hygiene training has a significant impact on the behavior of personnel, which is the most important factor in safe food production in maintaining public health. In a study to determine the importance of hygiene trainings; total count of bacteria of the food prepared by the personnel with hygienic training before and after the training was compared and as a result, it has been reported that the total bacteria count of the foods and salads produced after the training decreased by 99,5% and 99,9%<sup>35</sup>.

## **Conclusion**

Food service firms' personnel play a key role in the occurrence of foodborne diseases. For this reason, kitchen personnel should be provided with food safety training and hygiene training. They should know that the food safety risks that may occur during food production stages and the mistakes to be made at these stages will cause negative results. Thus, kitchen personnel who act in accordance with their trainings will significantly reduce the risk of foodborne diseases. In addition to protecting public health, it will help increase the quality of food service with hygiene training to be given to kitchen personnel.

Applying personal hygiene procedures correctly is the most important obstacle to bacterial food diseases as well as viral pandemics spread by contact with contaminated surfaces and hands. Therefore, trainings that will increase the knowledge and awareness of hygiene and ensure that it is reflected in practice will be an important step to prevent diseases and epidemics that start from the individual and spread to the society and even have global effects.

This study, which was carried out to determine the importance of hygiene training in terms of providing personal hygiene of kitchen personnel, also shows the necessity of hygiene training in terms of food safety. As a result, it is thought that the most important application to be done to reduce the microbial contamination caused by the personnel is to provide hygiene training to the personnel, to organize this training and to measure its effectiveness at regular intervals.

### **Conflict of interests**

The authors declare that there is no conflict of interest.

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