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Research Article

Determination of the Hygiene Quality of Food Workers, Surface Areas and Ambient Air in Mass Catering Places

Toplu Beslenme Yerlerinde Gıda Çalışanları, Yüzey Alanları ve Ortam Havası Hijyen Kalitesinin Belirlenmesi

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Abstract

Aim: The aim of this study is to microbiologically evaluate the hygienic conditions of a mass catering business in Burdur, focusing on personnel, food contact surfaces, and ambient air. **Materials and Methods:** In the research, various microbiological analyses were performed on samples taken from red, green, and yellow cutting boards, the hands of food preparation personnel, and the ambient air. **Results:** *Staphylococcus/Micrococcus* was detected at a 3.33x10² CFU/cm² level on the red cutting board. At the same time, total aerobic mesophilic bacteria (TAMB) and yeast-mold were found at levels of 4.07x10³ CFU/cm² and 3.67x10² CFU/cm², respectively, on the yellow cutting board. Additionally, as a result of the study, the counts of total mesophilic aerobic bacteria, yeast-mold, coliforms, and *Staphylococcus/Micrococcus* on the hands of the kitchen staff were determined as 3.37x10³ CFU/cm², 5.67x10³ CFU/cm², 4.77x10³ CFU/cm², and 1.3x10³ CFU/cm², respectively. Furthermore, a high level of yeast-mold contamination was identified in the ambient air. These findings indicate significant deficiencies in the hygienic conditions of both the cutting boards and the personnel. **Conclusion:** In conclusion, the results from this research demonstrate that the presence of microorganisms that should not be found on utensils and other samples from the mass catering business suggests a failure to fully adhere to proper hygienic standards, reflecting poor personnel hygiene. Given that a lack of hygiene poses a potential risk to consumer health, improving hygienic practices and ensuring traceability in mass catering establishments is critical.

Öz

Amaç: Bu çalışmanın amacı, Burdur ilinde faaliyet gösteren bir toplu beslenme hizmeti sağlayan işletmenin hijyenik niteliklerini, personel, gıda temas yüzeyleri ve ortam havası açısından mikrobiyolojik olarak değerlendirmektir. **Gereç ve Yöntem:** Araştırmada, kırmızı, yeşil ve sarı kesme tahtalarından ve yemek hazırlama personelinin ellerinden alınan örnekler ile ortam havası üzerinde çeşitli mikrobiyolojik analizler gerçekleştirilmiştir. **Bulgular:** Kırmızı kesme tahtasında 3,33x10² KOB/cm² düzeyinde *Staphylococcus/Micrococcus*, sarı kesme tahtasında toplam aerob mezofil bakteri (TAMB) 4,07x10³ KOB/cm² ve maya-küf 3,67x10² KOB/cm² olarak tespit edilmiştir. Ayrıca, çalışma sonucunda bu yemekhanede çalışan personelin el örneklerinde toplam mezofil aerob bakteri, maya-küf, koliform ve *Staphylococcus/Micrococcus* sayıları sırasıyla 3,37x10³ KOB/cm²; 5,67x10³ KOB/cm²; 4,77x10³ KOB/cm²; 1,3x10³ KOB/cm² tespit edilirken; ortam havasında ise yüksek bir maya-küf kontaminasyonu belirlenmiştir. Bu bulgular, kesme tahtalarının ve personelin hijyenik durumlarında ciddi eksiklikler bulunduğunu göstermektedir. **Sonuç:** Sonuç olarak, araştırmadan elde edilen bulgular, çalışmanın yapıldığı yemekhanede kullanılan araç-gereç ve diğer örneklerde bulunmaması gereken mikroorganizmaların tespit edilmesiyle, yemekhanede genel hijyenik koşullara tam anlamıyla uyulmadığını ve personel hijyeninde eksiklikler olduğunu göstermektedir. Hijyen eksikliği, tüketici sağlığı için potansiyel bir risk oluşturduğundan, toplu beslenme hizmeti veren işletmelerde hijyenik uygulamaların iyileştirilmesi ve izlenebilirliğin sağlanması kritik öneme sahiptir.

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INTRODUCTION

One of the key principles of a sustainable society is encouraging individuals to adopt more sustainable dietary habits. In this context, mass catering services play a particularly crucial role. In addition to the food services provided in public institutions such as nurseries, schools, and universities, the meals offered in workplaces and healthcare facilities are also integral to this process (1). Urbanization, industrialization, and socio-economic shifts**,** the demand for mass catering services has been increasing rapidly. It is estimated that over half of the population in developed countries, and around one-tenth in countries like Turkiye, consume at least one meal per day from mass catering systems, further underscoring the importance of these services in public health (2).

Food is a fundamental element of human life, providing the essential nutrients for physical development. However, it also serves as an ideal medium for microorganisms. As a result, food safety has become a critical concern within mass catering systems. One of the primary responsibilities of food processing units and their personnel is to ensure a safe and hygienic production environment. Comprehensive official controls must be conducted at every stage of the food chain, and adherence to hygiene standards should be consistently monitored (3).

Inadequate storage conditions and environmental factors within food preparation areas can present significant hygiene risks. Any disruptions during the stages of mass catering service can lead to serious consequences, including foodborne illnesses, fatalities, economic losses, and customer dissatisfaction (4,5). The emergence of foodborne diseases poses a direct threat to public health, and the transmission of microorganisms is often linked to improper hygiene practices among personnel. Thus, the connection between staff hygiene and microbial load in food is critical (6). Employing personnel who are highly aware of hygiene standards in food production areas can substantially lower the risk of foodborne illnesses and poisoning (7). Failure to follow proper hygiene protocols by food handlers can accelerate the spread of foodborne pathogens. To mitigate these risks, it is essential that personnel strictly maintain personal hygiene, particularly through regular handwashing (8). Hand contact is a common route for pathogen transmission during food preparation, which makes hand hygiene a more critical preventive measure than the cleanliness of environmental surfaces. Hand hygiene plays a vital role in controlling pathogens (9). In light of this, ensuring that personnel working in mass catering systems follow hygiene protocols, including basic measures such as hand hygiene, can significantly reduce the incidence of foodborne illnesses. Achieving food safety requires adherence to personal hygiene practices and maintaining hygiene at every stage of the production process.

This study aims to microbiologically assess the overall hygienic conditions of mass catering, focusing on personnel, food contact surfaces, and the ambient air within the food processing area.

MATERIALS AND METHODS

Samples were collected on three separate occasions, spaced 15 days apart, from various areas of a mass catering establishment in Burdur, including ambient air, three distinct surfaces in the food preparation areas (red, yellow, and green cutting boards), and three different personnel responsible for food preparation. The samples were then subjected to the microbiological analyses detailed below.

Determination of Hand and Surface Hygiene

In the study, samples were collected with swabs from the palms of the personnel responsible for food preparation and approximately a 10 x 10 cm² area of green, red, and yellow cutting boards used for fruits and vegetables, red meat, and white meat, respectively. The collected samples were analyzed for coliform, *Staphylococcus aureus*, total aerobic mesophilic bacteria (TAMB), and yeast-mold counts as described below:

- **TAMB:** The samples were inoculated into Plate Count Agar and incubated at 37±1ºC for 48-72 hours (10).
- **Coliform:** The samples were inoculated into Violet Red Bile Agar and incubated at 37±1ºC for 24-48 hours (11).
- **Yeast-Mold:** The samples were inoculated into Potato Dextrose Agar (PDA), and the plates were incubated at 22±1ºC for 5 days, after which the formed colonies were counted (12).
- ***Staphylococcus/Micrococcus:*** The samples were inoculated into Baird Parker Agar enriched with Egg Yolk Tellurite and incubated at 36±1ºC for 30 hours (13).

Determination of Ambient Air Hygiene

To determine the yeast and mold quality of the ambient air, petri dishes containing PDA were placed on the ground in the areas where green, yellow, and red cutting boards were located, as well as in the cooking area, with the lids opened for approximately two hours. At the end of this period, the petri dishes were incubated at 22±1ºC for 5 days (14).

Statistical Evaluation of Data

Samples collected from a mass catering in the Burdur region at three different time points with 15-day intervals, including ambient air from the kitchen, three different surfaces in food preparation areas, and the hands of three personnel responsible for food preparation were examined for microbial contamination and results were expressed as mean ± standard deviation.

RESULTS

The results of microorganism counts are presented in Table 1. *Staphylococcus/Micrococcus* was detected on the red cutting board (RCB) at a level of 2.52±1.73 $\log_{10}$ CFU/cm² (3.33 x 10^2 CFU/cm²), while no total aerobic mesophilic bacteria (TAMB), yeast-mold, or coliforms were found on this surface.

Table 1. Detected microorganism counts in kitchen samples ($\log_{10}$ CFU/cm²)

	TAMB	Yeast-mold	Coliform	*Staphylococcus/ Micrococcus*
RCB	nd	nd	nd	2.52±1.73
GCB	nd	nd	nd	nd
YCB	3.61±2.36	2.56±1.53	nd	nd
P	3.53±0.97	3.75±2.26	3.68+2.40	3.12±1.88
A	*	2.42±0.40	*	*

A: Ambient; GCB: Green Cutting Board; P: Personnel; RCB: Red Cutting Board; YCB: Yellow Cutting Board
nd: Not detected
**: Not analyzed*

The green cutting board (GCB) showed no detectable microorganisms. In contrast, the yellow cutting board (YCB) exhibited counts of 3.61±2.36 $\log_{10}$ CFU/cm² (4.07x 10^3 CFU/cm²) for TAMB and 2.56±1.53 $\log_{10}$ CFU/cm² (3.67x10^2 CFU/cm²**)** for yeast-mold, with no detectable *Staphylococcus/ Micrococcus* or coliforms.

Personnel hand samples demonstrated higher levels of contamination across all categories, with TAMB, yeast-mold, coliforms, and *Staphylococcus/ Micrococcus* detected at levels of 3.53±0.97, 3.75 ±2.26, 3.68±2.40, and 3.12±1.88 log10 CFU/cm², respectively. The number of microorganisms in the ambient air samples analyzed for yeast and mold was determined at the level of 2.42±0.40 $\log_{10}$ CFU/cm².

Table 2. Percentage distribution of microorganisms in the samples

	TAMB (%)	Yeast-mold (%)	Coliform (%)	*Staphylococcus /Micrococcus* (%)
Cutting Board	11.1	22.2	nd	11.1
Personne Hands	100	66.7	33.3	66.7
Ambient Air	*	100	*	*

*nd: Not detected; *: Not analyzed*

The percentage distribution of the detected microorganisms is presented in Table 2. In the samples taken from the surfaces of the cutting boards, TAMB was detected in 11.1%, yeast-mold in 22.2%, and *Staphylococcus/Micrococcus* in 11.1% of the samples, while no coliform bacteria were detected.

DISCUSSION

Cutting boards used in many restaurants are frequently subject to bacterial contamination, which poses significant risks for foodborne illnesses. Such contamination typically results from improper cleaning practices and cross-contamination during food preparation. The gravity of this issue is further underscored by research investigating microbial contamination on food preparation surfaces in various professional settings. In this context, Çetin and Doğan conducted a comprehensive microbiological assessment of cutting and chopping boards in the kitchens of 20 local restaurants in Istanbul (15). They found *S. aureus*, total mesophilic aerobic bacteria, and yeast-mold counts to be 0.74 x 10^2 CFU/cm², 1.53 x 10^2 CFU/cm², and 1.21 x 10^2 CFU/cm², respectively.

These findings indicate that the values obtained in our study are significantly lower. The absence of evidence in Çetin and Doğan's study regarding the source of contamination from specific food groups increases the significance of their results. In a study conducted in Istanbul by Tabak and Ergün, coliform bacteria were found in 58 (28%) of the 200 cutting boards sampled, and total aerobic mesophilic bacteria were detected in 51 (25.5%) of them (16). Considering that the coliform and total aerobic mesophilic bacteria values in this study were higher, it suggests that there may be deficiencies in the hygienic measures implemented.

Another study by Elverir and Gönülalan reported an average total aerobic mesophilic bacterium count of 2.4 x 10^3 CFU/cm² and a yeast-mold count of <1.0 x 10^2 CFU/cm² from samples taken from vegetable chopping counters (17). When compared to our study, it is observed that the aerobic mesophilic bacteria and yeast-mold counts in this study were higher. Since yeast and mold counts are indicators of hygienic conditions during food production, the study conducted in Malatya suggests hygiene deficiencies. A study investigated the microbial contamination of cutting boards used in long-hour restaurants in the Klang Valley, Malaysia. The results indicated that the aerobic bacteria count on the cutting boards ranged from 3.95 to 7.07 $\log_{10}$ CFU/cm², with coliform bacteria present at levels of <1.00 to 5.58 $\log_{10}$ CFU/cm², *Escherichia coli* at <1.00 $\log_{10}$ CFU/cm², and *Staphylococcus aureus* at <1.00 to 2.90 $\log_{10}$ CFU/cm²; *Salmonella spp.* contamination was detected in 12% of the samples (n = 4/33). Furthermore, the cleanliness levels of the restaurants were assessed, revealing that only 3% (n = 1/33) met level A and 48.5% (n = 16/33) met levels B and C. These findings suggest that the bacterial contamination of cutting boards was not influenced by the cleanliness levels of the restaurants (18).

In a study on meat chopping boards by Ünal and Toğay, no *S. aureus* or fecal coliforms were isolated, and the total aerobic mesophilic bacteria load was found to be 0.46 log CFU/cm², coliform bacteria 0.22 log CFU/cm², and mold-yeast load 0.02 log CFU/cm² (19). The absence of *S. aureus* indicates a favorable hygiene status for the meat chopping boards, while the lack of coliform bacteria suggests that hygiene practices are effectively implemented. In another study conducted by Tiryaki, *S. aureus* isolation was not observed on the cutting boards (20). The lower *S. aureus* values on equipment samples in this study compared to other studies suggest that the food safety management system was effectively applied. However, the lack of evidence regarding the source of contamination on the cutting boards from specific food groups requires a broader perspective when evaluating the research findings.

Aksu et al. conducted a study where 132 (47%) out of 279 surface samples collected from different sections of 10 supermarkets tested positive for total aerobic mesophilic bacteria, and 40 (14.3%) of them for coliforms (21). When compared to our study, the surface samples in their study had higher proportions of TMAB and coliforms, indicating that food hygiene and good manufacturing practices in supermarkets may not be sufficiently followed. In their study in six campus cafeterias, Pamuk et al. detected coliform bacteria in 11 (55%) of the 27 cutting board surface samples, *S. aureus* in 4 (14.8%), and aerobic mesophilic bacteria in 22 (55%) of them (22). However, this study also did not provide information regarding which food group was the source of contamination on the surfaces, suggesting the need for further research on kitchen hygiene.

Fidan and Ağaoğlu evaluated the hygiene conditions of restaurants in the city center of Ağrı and found total aerobic mesophilic bacteria, coliform, coagulase-positive staphylococci, and yeast-mold counts in cutting board samples to be 6.1 x 10^4 CFU/cm², 4.1 x 10^3 MPN/25cm², 9.1 x 10^1 CFU/cm², and 6.0 x 10^2 CFU/cm², respectively (23). While the total aerobic mesophilic bacteria, coliform, and yeast-mold counts in their study were higher than those in this research, the coagulase-positive staphylococci count was lower. However, once again, no evidence was provided regarding the food material group from which the microorganisms originated on the cutting boards. In a study conducted in Italy by Legnani et al., *S. aureus* and *E. coli* were detected in 0.7% and 16.7% of the 140 surface samples taken from 27 mass catering establishments, respectively.

Legnani et al. indicated that the most critical surfaces for *E. coli* were tables and chopping boards (24). The absence of this microorganism in equipment samples suggests that hygienic practices were effective, yet the lack of information on the food material group from which the microorganisms originated on the chopping boards represents one of the study's limitations. The total counts of mesophilic aerobic bacteria, yeasts-mold, and *Staphylococcus/Micrococcus* on cutting boards were found to be significantly higher when compared to studies conducted by Çetin and Doğan (15) and Elverir and Gönülalan (17). These results suggest that the cutting boards are inadequately cleaned and pose a serious risk of contamination during food processing. On the other hand, although high levels of coliform bacteria were reported in Tabak and Ergün's (16) study, no coliform bacteria were detected on the cutting boards in this study. This could indicate that hygiene standards are better implemented in certain regions.

In a study conducted by Mohammed et al. assessing food-contact surfaces in university restaurants for the presence of *E. coli* and *S. aureus*, it was reported that 26% of the 50 samples analyzed were positive for *E. coli*, with 23% of these positive results coming from

cutting boards (25). Similarly, Tenna et al. found that the microbiological quality of utensils in hotels and restaurants in Addis Ababa was insufficient, particularly on trays and ladles, where high levels of coliforms, *E. coli*, and *Staphylococcus aureus* contamination were detected. The total coliform counts on trays reached 5.93 $\log_{10}$ CFU/100 cm² in hotels and 5.00 $\log_{10}$ CFU/100 cm² in restaurants. Additionally, fecal coliforms were found on 14.37% of utensils, and *E. coli* on 3.12% (26). These findings highlight the urgent need for significant improvements in hygiene practices and cleaning services for food-contact surfaces in these establishments.

Fahim et al. examined the hygiene status of food contact surfaces and food handlers' hands using samples collected from four restaurants in Cairo. High levels of aerobic mesophilic bacteria (7.32 $\log_{10}$ CFU/cm²) and coliform bacteria (6.89 MPN/cm²) were detected on food contact surfaces. Positive results for *S. aureus* were found on food handlers' hands (6.15 $\log_{10}$ CFU/cm²) (27). These findings indicate that food contact surfaces and food handlers' hands play a critical role in the microbial contamination of ready-to-eat foods. In a study, surface swabs were collected from food handlers' hands and food contact surfaces in restaurants in northern Thailand to evaluate the prevalence of *S. aureus*. Out of 650 samples, 200 *S. aureus* isolates were obtained, with the highest contamination found on food handlers' hands (78%), followed by cutting boards (26%) and plates (23%). The study highlighted that *S. aureus* strains capable of forming biofilms and producing enterotoxins were present, indicating a significant risk of food contamination from these sources. Proper handwashing for food handlers and thorough cleaning of all food preparation equipment are essential to prevent cross-contamination (28).

Personnel hand hygiene is a crucial aspect of food safety that directly impacts the risk of foodborne illnesses. In many food service establishments, improper handwashing practices can lead to the transfer of pathogens from hands to food, utensils, and surfaces. Studies have shown that food handlers often neglect proper hand hygiene, especially after handling raw foods or using the restroom. This negligence highlights the lack of compliance with hand washing protocols and shows that more attention should be paid to hand hygiene. It is important to regularly train and monitor staff in this regard. By implementing effective hand hygiene practices, food service operations can significantly reduce the likelihood of cross-contamination and enhance the overall safety of the food served to consumers.

In this study, the total mesophilic aerobic bacteria count on personnel hand samples was found to be 3.37 x 10^3 CFU/cm² on average, with yeast-mold counts averaging 5.67x10^3 CFU/cm², coliform counts averaging 4.77x10^3 CFU/cm², and *Staphylococcus/Micrococcus* counts averaging 1.33x10^3 CFU/cm². In terms of percentage, total mesophilic aerobic bacteria were found in 100% of hand samples, yeast-mold in 66.7%, coliforms in 33.7%, and *Staphylococcus/Micrococcus* in 66.7% of the samples. Another study conducted in a mass catering facility in Malatya by Elverir and Gönülalan reported an average of 2.5 x 10^6 CFU/ml of aerobic mesophilic bacteria and 1x10^2 CFU/ml of yeasts-molds on personnel hand samples (17). The high yeast-mold counts obtained from personnel hand samples in this study suggest inadequate hygiene conditions during food production. In a study conducted by Tabak and Ergün, coliform bacteria were detected in 17.7% and *S. aureus* in 22.5% of hand samples from 800 personnel (16). The contamination in this study was attributed to a lack of adequate hygiene knowledge among staff and insufficient cleaning plans. Fidan and Ağaoğlu emphasized that chefs' hands were the most significant source of contamination, with aerobic mesophilic bacteria, coagulase-positive staphylococci, and coliforms detected at levels of 1.5 x 10^5 CFU/ml, 1.9 x 10^2 CFU/ml, and 3.0 x 10^4 CFU/ml, respectively (23). These data show that the microbial load on personnel hand samples was higher than in other studies. In a study conducted by Ünal and Toğay in the kitchens of three private hospitals, the average bacteria load on personnel hand samples was determined as follows: *S. aureus*, 0.34 log CFU/cm²; total aerobic mesophilic bacteria, 0.34 log CFU/cm²; yeasts-mold, 4.35 log CFU/cm²; and coliform bacteria, 1 log CFU/cm² (19). A study by Çatar and Yıldırım in the canteens of Erciyes University found *S. aureus* in 82.6% and total coliforms in 73.91% of hand samples from personnel who had contact with food, indicating inadequate hand hygiene among personnel (29). In contrast, a study conducted by Aksu et al. found that only 0.8% of the hand samples collected from 251 personnel tested positive for *S. aureus*, a relatively lower rate compared to other studies (21). Tiryaki found that 2.1% of hand samples from 190 personnel working in food preparation areas were contaminated with *S. aureus* (20). This finding suggests that an effective food safety management system may have been implemented.

In a study by Pamuk et al. which evaluated the hygiene of personnel hand samples in six campus canteens, coliforms were isolated in 51.1% and *S. aureus* in 57.7% of the hand samples from 45 personnel (22).

The quality of air in the food service ambient plays a vital role in maintaining food safety and preventing foodborne illnesses. Contaminated air can introduce pathogens and allergens into food preparation areas, thereby increasing the risk of cross-contamination. Studies have indicated that airborne microorganisms, such as bacteria and molds, can thrive in poorly ventilated kitchens, highlighting the importance of proper air circulation and filtration systems. Ensuring clean and well-maintained ambient air not only protects food from microbial contamination but also contributes to the overall health and safety of food service staff and consumers. Regular monitoring of air quality and adherence to ventilation standards are essential steps in safeguarding food safety in any food service establishment. In Fidan and Ağaoğlu's study, ambient air samples collected to assess the hygiene status of restaurants reported an average yeast-mold count of 2.6 x 10 CFU/plate (23).

This value indicates the presence of microbiological contamination in the restaurant ambient, potentially reflecting insufficient hygiene practices. The presence of yeast and mold in the ambient, which is an indication of poor hygiene conditions in the kitchen, can threaten food safety. On the other hand, Elverir and Gönülalan reported an average yeast-mold count of 4.25 CFU/m³ in kitchen air samples from a mass catering facility in Malatya (17). This result points to a higher level of yeast-mold contamination than that found by Fidan and Ağaoğlu (23). The higher levels found in Elverir and Gönülalan's study likely result from inadequate hygiene practices (17). Elevated levels of yeast and mold increase the risk of contamination for both workers and food products, underscoring the need for improved hygiene measures. Implementing good hygiene practices is critical not only for ensuring food safety but also for preventing foodborne illnesses. The yeast-mold levels detected in the air in this study are consistent with the values reported by Elverir and Gönülalan, suggesting that air contamination levels may vary based on regional hygiene practices and climate conditions (17). However, the higher yeast-mold values reported in Fidan and Ağaoğlu's study suggest that the air quality in the ambient of this study was relatively better (23).

CONCLUSION AND RECOMMENDATIONS

In conclusion, the data from this study indicate serious deficiencies in the hygiene of cutting boards and personnel hands, which pose a risk to food safety. Strict implementation and monitoring of hygiene protocols are essential for preventing contamination.

It is crucial for personnel working in mass catering to receive hygiene training to reduce the risk of microbial contamination. Training programs should include hand hygiene, surface cleaning, and food safety practices.

Additionally, effective cleaning and disinfection plans should be developed and implemented to reduce microbial loads. The efficacy of cleaning products should also be regularly reviewed. Regular microbiological analyses of air and surface samples are necessary to monitor hygiene conditions. These analyses will help evaluate the adequacy of hygiene practices and guide necessary improvements.

Frequent hygiene inspections in food businesses will improve personnel compliance with hygiene regulations. These inspections could serve as an incentive mechanism to ensure adherence to hygiene standards. Effectively implementing food safety management systems can improve hygiene conditions in mass catering settings. Such systems should include risk analysis and the identification of critical control points. Identifying contamination sources and eliminating contamination sources will reduce the microbial load. In this context, it is important to regularly monitor food-contact surfaces and equipment.

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