



## Bacterial contamination and associated factors among food handlers working in the cafeterias at Tripoli University

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### Abstract:

The research aims to assess the rate of bacterial contamination of surfaces, equipment, and hands that encounter food while being prepared in a university cafeteria. A cross-sectional study was conducted from May 2022 to July 2022 among food handlers working in the student cafeterias of Tripoli University's main campus. A total of 100 samples were collected over a two-month period and the isolates were identified using morphological appearance on both selective and differential media as well as biochemical tests before antibiotic sensitivity test was done. Out of the 100 samples, 92 (92%) were positive for different bacterial species and 8 (8%) samples showed no growth of any bacteria. Also, among the positive isolates, gram-negative bacteria prevalence was the highest with 61 (58%), while gram-positive bacteria were 35 (38%). The gram-negative bacteria identified were *E. coli* 22 (24%), *Klebsiella* 20 (21%), *P. aeruginosa* 15 (16%) and *Proteus* 1 (1%), while the gram-positive bacteria was *S. aureus* 35 (38%). *S. aureus* and *P. aeruginosa* showed resistance to colistin and ceftriaxone while the other bacteria were susceptible to the antibiotics tested. This study observed that the level of hygiene among the food handlers in restaurants at Tripoli University was unsatisfactory due to poor personal and environmental hygiene. Hence, efforts should be made to enhance regular cleaning and monitoring of the cafeteria by the staff and owners, especially on good personal hygiene practices and appropriate hand washing techniques.

**Keywords:** Food Handlers, Personal Hygiene, Foodborne Disease, Bacterial Contamination.

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## التلوث البكتيري والعوامل المرتبطة به بين متداولي الأغذية العاملين في المقاصف بجامعة طرابلس

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## الملخص

يهدف البحث إلى تقييم معدل التلوث الجرثومي للأسطح والمعدات والأيدي التي تصادف الطعام أثناء تجهيزه في كافتيريا الجامعة. تم إجراء دراسة مقطعية في الفترة من مايو 2022 إلى يوليو 2022 بين متداولي الطعام العاملين في المقاصف الطلابية بالحرم الجامعي الرئيسي لجامعة طرابلس. تم جمع 100 عينة خلال فترة شهرين وتم تشخيص العزلات باستخدام المظهر على كل من الأوساط الانتقائية والتفاضلية بالإضافة إلى الاختبارات الكيميائية الحيوية قبل إجراء اختبار الحساسية للمضادات الحيوية. من بين 100 عينة، 92 (92%) كانت إيجابية لأنواع بكتيرية مختلفة و 8 (8%) عينات لم تظهر أي نمو لأي بكتيريا. أيضا من بين العزلات الإيجابية كانت نسبة انتشار البكتيريا سالبة جرام هي الأعلى حيث بلغت 61 (58%) بينما كانت البكتيريا إيجابية جرام 35 (38%). وكانت البكتيريا سالبة الجرام التي تم تحديدها هي *E. coli* 22 (24%)، و *Klebsiella* 20 (21%)، و *P. aeruginosa* 15 (16%)، و *Proteus* 1 (1%)، بينما كانت البكتيريا إيجابية الجرام هي *S. aureus* 35 (38%). أظهرت *S. aureus* و *P. aeruginosa* مقاومة للكوليستين والسييفترياكسون بينما كانت البكتيريا الأخرى حساسة للمضادات الحيوية التي تم اختبارها. لاحظت هذه الدراسة أن مستوى النظافة بين متداولي الطعام في مطاعم جامعة طرابلس كان غير مرض بسبب سوء النظافة الشخصية والبيئية. ومن ثم، ينبغي بذل الجهود لتعزيز التنظيف والمراقبة المنتظمة للكافتيريا من قبل الموظفين والمالكين، وخاصة فيما يتعلق بممارسات النظافة الشخصية الجيدة وتقنيات غسل اليدين المناسبة.

**الكلمات المفتاحية:** متداولو الأغذية، النظافة الشخصية، الأمراض المنقولة بالأغذية، التلوث البكتيري.

## Introduction

Food borne illnesses refers to sickness caused by ingestion of contaminated food. Most cases are brought on by improper food handling, processing, and hygiene practices. Anyone who directly handles food, including both packaged and unpackaged items, kitchenware, and equipment, is considered a food handler (such as cutlery, plates, bowls, or chopping board). Unfortunately, food handlers have been shown to be the most significant source of food contamination with microbial pathogens, through handling of food with their hands, or transmission of contaminants from their hair, skin, or aerosol [1]. The last line of defense against pathogenic infection is the hand, which can be contaminated directly by touching the mouth, eyes, nose, or other parts of the skin, or indirectly by "handling" food. Therefore, if appropriate hand washing techniques and good personal hygiene are not practiced, these infected hands could spread intestinal bacteria to foods, tools, and other workers in the food storage and preparation area [2].

Community health has recently been burdened on a local and global scale. About one-third of the global population, including in developed and developing nations, is thought to contract a food-borne illness each year, with two million deaths being documented [3]. According to the Centers for Disease Control and Prevention, bacteria account for two-thirds of all outbreaks, and the microorganisms themselves or the toxins they release are what cause illnesses [1]. The major reason of concern is biological contamination, which includes bacteria, viruses, fungus, protozoa, and helminths and can cause anything from a minor sickness to a fatal illness or both. Most developing countries have recorded cases of illnesses like cholera, campylobacteriosis, *Escherichia coli* gastroenteritis, salmonellosis, shigellosis, typhoid fever, brucellosis, and amoebiasis because of unclean food preparation and storage practices [3].

Poor personal hygiene habits, improper storage temperatures, and dirty food contact surfaces all contribute to microbiological food contamination in catering operations [4]. *Salmonella* and *Shigella* are among the common causes of food-borne diseases throughout the world [5-6]. Furthermore, microbiological risks in kitchen environments have increased because of improperly cleaned surfaces and poor food handling procedures [7]. Opportunistic pathogenic bacteria like *Staphylococcus aureus* have been linked to improper food hygiene procedures and dirty surfaces [6]. Similarly, the World Health Organisations emphasizes that "outbreaks of foodborne disease can be minimized if effort is made to educate food handlers on the importance of good hygiene practice [1]. This will require them to avoid any practice or action that predispose the food to contamination such as smoking, sneezing and cough [2]. In addition, ensuring proper hand hygiene is one of the most important means of preventing foodborne contamination [8].

The preparation and sale of meals takes place in a cafeteria. Many individuals in both industrialized and developing countries rely on it as a source of income, however some of these cafeterias have low sanitary standards, which raise concerns about microbiological safety. One of the most frequently mentioned behaviors causing food-borne illness is food handlers' disregard for proper hygiene and awareness. Working surface hygiene and the cafeteria staff's soiled hands both contribute to the issue. The university cafeteria's lack of health management causes the workers to be careless with hygiene, which in turn causes the cafeteria to become contaminated and endangers to health of the students. Therefore, this research aims to assess the rate of bacterial contamination of surfaces, equipment, and hands that encounter food while being prepared at Tripoli university cafeteria. The study also seeks to understand the sensitivity or resistance of the bacterial isolates to generally recommended antibiotics in hospitals.

## Material and methods

### Ethical approval

This study was conducted in strict adherence to the principles and guidelines established in the Declaration of Helsinki by the World Medical Association. Ethical approval was duly obtained from the Institutional Review Board of Tripoli University, Libya (2022/UT-IRB/SN006).

### Study area

The research was done at Tripoli University's cafeteria in Libya. The study area was selected due to the university's cafeteria serving as a commercial food service for both students and staff. Various samples were taken from student cafeterias when they were open for business, and all swabs were taken once a week from people using the kitchen and serving areas.

### Sample collection

A sterile transport medium swab was used to aseptically collect 100 random samples from workers' hands, tools, and surfaces while food was being cooked. The swab was then put back into its sterile tube and labelled after collecting samples from the food handlers, tables, juicers, aprons, meat cutting boards, knives, fridge, food storage area, food preparation area, washing area, serving area, and eating area. To prevent wasting time or contaminating the samples, they were quickly transported from the collection site to the lab in ice container for the microbiological analysis.

### Microbiological test

**Culture of specimens:** Blood and MacConkey agar were inoculated with the obtained swabs. Following this, the inoculation plates were incubated for 24 to 48 hours at 37°C. Some strains were then isolated and sub-cultured on mannitol salt agar or CLED agar and were then incubated for 24 hours at 37°C. Gram staining of the bacterial colonies was then carried out.

**Biochemical test:** Bacterial identification and isolation were done by using conventional biochemical tests including (catalase, and coagulase,) for gram-positive bacteria, while the API20E system was done for gram-negative bacteria.

### Anti-microbial susceptibility testing

Anti-microbial resistance profile of the isolates was done using the Kirby Bauer disk diffusion method [9]. All identified bacteria were tested for general purpose (gram negative and gram positive) antibiotic susceptibility. Presumptive isolates were streaked on Muller-Hinton agar which was then embedded with antimicrobial resistance disc including amoxicillin/clavulanic (AMC), amikacin (AK), ceftriaxone (CRO), meropenem (MEM), ciprofloxacin (CPR), colistin (COL), cefatoxime (CTL), piperacillin /tazobactam antimicrobial agent. The susceptibility of tested isolates was detected depending on the diameter of growth inhibition zone formed by the bacterial isolates according to the clinical laboratories standard institute (CLSI) [10].

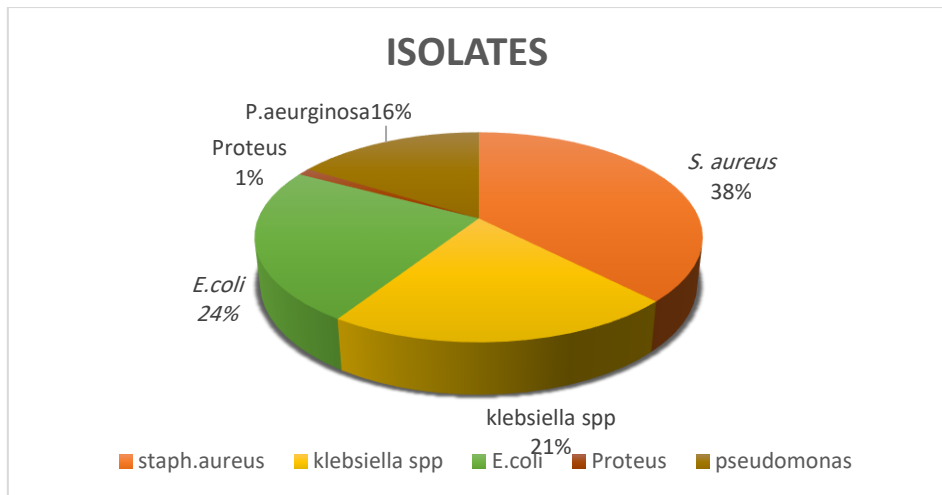
## Results

From a total of 100 samples, 92 were gram-positive while 8 were gram negative as shown in the graph above. The sample distribution and frequency of isolation across all sampling areas are shown in Table 1.

**Table 1.** Percentage distribution of isolates from the sample.

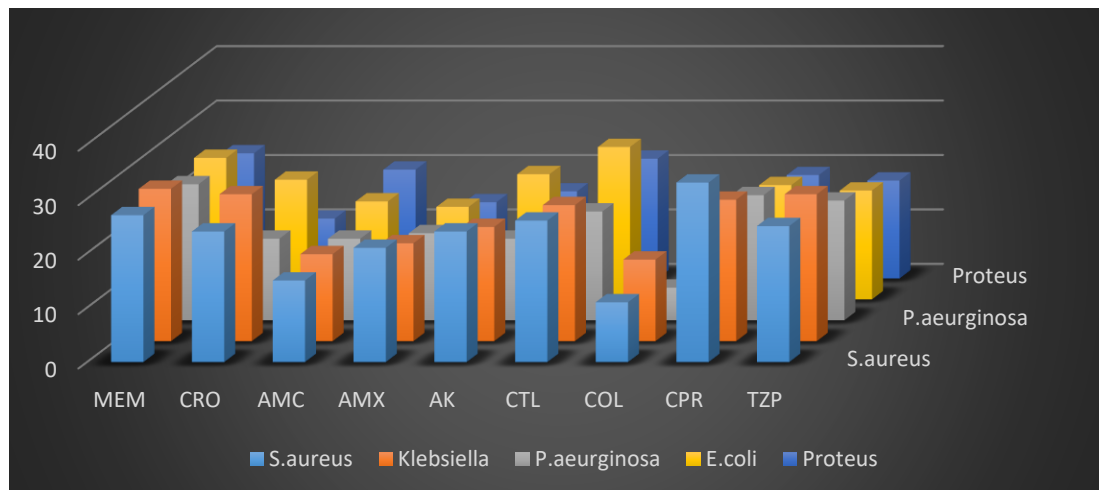
Sample	<i>S. aureus</i>	<i>Klebsiella spp.</i>	<i>E. coli</i>	<i>Proteus</i>	<i>P. aeruginosa</i>
Hand	7 (7.6%)	0	4 (4.3%)	1(1%)	0
Surfaces	6 (6.5%)	1 (1%)	3 (3.2%)	0	0
Juicer	2 (2.1%)	2 (2.1%)	3 (3.2%)	0	1 (1%)
Apron	3 (3.2%)	2 (2.1%)	2 (2.1%)	0	0
Utensils	2 (2.1%)	1 (1%)	1 (1%)	0	1 (1%)
Handles	6 (6.5%)	4 (4.3%)	0	0	3 (3.2%)
Money safe	1 (1%)	1 (1%)	1 (1%)	0	3 (3.2%)
Work equipment	7 (7.6%)	6 (6.5%)	5 (5.4%)	0	4 (4.3%)
Bowel	1 (1%)	3 (3.2%)	2 (2.1%)	0	3 (3.2%)
Total	35 (38%)	20 (21%)	22 (24%)	1 (1%)	15 (16%)

Similarly, *Klebsiella spp.*, *E. coli*, *Proteus*, and *P. aeruginosa* were the most frequently isolated gram-negative organisms (n=58, 63%), while *S. aureus* was the least frequently isolated gram-positive organism n=35 (38%) (Figure 1).



**Figure 1.** The distribution of isolates from sample swabs.

The antimicrobial resistance tests revealed that most of the isolates were susceptible to the antibiotics tested. The isolates however had varying sensitivity levels to ciprofloxacin, meropenem, and cefotaxime (Figure 2).



**Figure 2.** Susceptibility pattern of the isolates to conventional antibiotics. (KEY: MEM-meropenem, CRO-ceftriaxone, AMC-amoxicillin/ clavulanic acid, AMX-Amoxycillin, AK-amikacin, CTL-cefotaxime, COL-colistin, CPR-ciprofloxacin, TZP-piperacillin/tazobactam.

### Discussion

Diseases caused by foodborne pathogens have emerged to be one of the major public health challenges affecting the global population. Hence the urgent need to address this important health challenge especially as the pathogens are continuously exhibiting resistance to the most common drugs [11,12]. The highest number of microbial isolates were found in hand swabs in this investigation, and some of the isolates identified could cause health hazards if ingested in food, thereby putting students and other consumers at risk of infection. This outcome is consistent with other studies where food handlers were found to be a significant source of bacterial contamination in student cafeterias [13,14].

Five genera of bacteria were isolated and identified in the current investigation based on their morphological and biochemical characteristics, including *E. coli* (24%), *S. aureus* (38%), *Klebsiella sp* (21%), *Proteus* (1%), and *Pseudomonas sp* (16%). Multiple investigations has demonstrated that considerable rate of contamination in street vended foods is a common occurrence, and the identified foodborne bacteria are like reports in Nigeria, Egypt, and Ethiopia [1, 15, 16]. One or more bacterial strains were present on the hands of 12% of the individuals in this investigation, and the three most typical bacteria isolated from hand contamination samples are *S. aureus* 7.6%, *E. coli* 4%, and *Proteus* 1%. When people who have this bacterium in their noses, eyes, and skin lesions handle food, it can produce toxins that are the main cause of gastroenteritis [1]. In the present study, *Staphylococcus aureus* was isolated in 7.6% of the food handler's hands. This result is considerably less than the 17% reported in

Saudi Arabia, 31% in Egypt, and 23.5% reported in Ethiopia [16, 17, 1]. *S. aureus* is one of the most common pathogens incriminated in food poisoning and intoxication, leading to sudden start of nausea, vomiting, diarrhea and other gastrointestinal tract upsets [23]. The ability of *Staphylococcus aureus* to colonize and survive for long periods on bodies of food handlers, makes it very easy for transmission. Studies have shown that many foodborne outbreaks attributed to *S. aureus* is because of their ability to colonize personnel thereby serving as the source of food contamination [18,19].

*E. coli* are members of the intestinal microflora of humans and animals and most of them are harmless. However, they can some time cause illness including urinary tract infection, diarrhea, and other systemic infections. In this investigation, *E. coli* was isolated from hand swabs with 4.3% of the samples being positive. This is lower than the 10.9% reported in Ethiopia. Meanwhile, no isolation was recorded for the swab samples collected from work equipment [1].

The isolation of *Klebsiella spp* from food processing environments has been reported in our study with 21% of the isolates. The result of our study is higher than the 15.38% reported in South Africa [22]. Consequently, it can be relocated from surfaces to food and can harm food quality [20]. Food contact with equipment harboring pathogens contributed to the most significant factor during the processing of food. Microbes also frequently contaminate food during processing activities like cutting, especially from knives and cutting board [21]. Other notable concerns are sneezing, excessive talking while preparing the food and the habit of touching contaminated surfaces. Generally, the food handlers who lack the habit of wearing gloves usually escalate *Staphylococcus* bacteria to food [23].

In our research, *S. aureus* and *P. aeruginosa* were multi drug resistance to colistin and ceftriaxone, while *Klebsiella* was resistance just to ceftriaxone. Antibiotic resistance leads to higher medical costs, prolonged hospital stays, and increased mortality.

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## Conclusion

In summary, the isolation of bacterial organisms in the cafeteria indicates poor food handling and processing practice among the food handlers. The fact that some of the isolates were found to be resistant to some of the drugs also implies significant public health risks, especially to the students and staff who patronize these food joints. Therefore, efforts should be geared towards educating the food handlers on the importance of hygiene and the mode of transmission of infectious disease pathogens with a view to encouraging better practice such as personal hygiene and the use of appropriate clothing.

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