

Original article

Assessment of Bacterial Contamination in Locally Manufactured Cheese from Selected Factories in Tripoli City

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ABSTRACT

It is now a new tomorrow in the food industry, where food materials are available, but can be exposed to threats from microbial contamination that may affect its quality and safety. This study aimed to evaluate bacterial contamination in local honey from four different factories in Tripoli, Libya. Twelve samples of cheese were collected, three samples from each factory, and were analyzed for microbial contamination. The results showed microbial contamination of the cheese, as the production of the first factory and the third factory had a large bacterial record, especially with *Proteus spp.* and *Staphylococcus aureus* Two types of bacteria cause food poisoning,.. In contrast, the second factory showed new production, while the fourth factory showed the presence of bacteria in low levels. These results indicate the importance of adhering to good hygiene practices, pasteurization protocols, and optimal storage conditions in cheese making and food safety. The study also highlights the ongoing need for quality control in monitoring and preventing microbial spoilage. In addition, the standard study emphasizes the importance of Libya Specification 354 of 1992 regarding microbial limits in cheese making and consumer safety.

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INTRODUCTION

Food safety is a critical public health issue globally, particularly in developing countries where food contamination and foodborne diseases are widespread. Among the significant threats to food safety is *Salmonella*, a bacterial pathogen often associated with foodborne illnesses. Contamination with *Salmonella* in dairy products, particularly cheese, poses serious health risks, especially if production, handling, and storage are not conducted under proper sanitary conditions. Pressed cheese, a widely consumed dairy product in Libya and other Mediterranean regions, is particularly vulnerable to becoming a vehicle for *Salmonella* transmission [1].

Cheese manufacturing plays a pivotal role in the food industry by providing essential nutrients such as proteins, vitamins, and minerals. However, its safety and quality are often compromised due to microbial contamination, which can occur at various stages of production, from milk collection to processing and storage, particularly in environments lacking adequate hygiene and sanitation practices. Common pathogenic bacteria, such as *Salmonella*, *Proteus*, and *Staphylococcus aureus*, are frequently identified in dairy products, causing foodborne illnesses and posing significant risks to consumers [2].

Several studies have addressed the issue of microbial contamination in cheese, highlighting its implications for public health and safety. For instance, a 2022 study on artisan cheese production revealed significant contamination with common pathogens such as *Salmonella* and *Escherichia coli*, emphasizing the risks associated with traditional production methods. Similarly, research conducted in 2021 demonstrated that hygienic practices during production and

packaging play a crucial role in determining the microbial quality of cheese, with inadequate hygiene leading to higher contamination levels [2]. A 2022 study showcased the application of PCR and other methods to detect pathogens more accurately and efficiently [3]. In addition, a 2023 study focused on the dual role of lactic acid bacteria in ensuring cheese safety while noting the frequent presence of spoilage microorganisms such as yeast and mold. Furthermore, advancements in molecular techniques have proven valuable in identifying microbial contamination in dairy products [4]. Storage conditions, such as temperature and humidity, were also found to significantly influence microbial growth in pressed cheese, as discussed in a 2021 study [2]. The importance of packaging was further explored in 2022, where research demonstrated how appropriate packaging materials can help prevent microbial contamination, while substandard materials may exacerbate the issue [5]. Another study from 2023 provided a comprehensive analysis of pathogenic bacteria in both fresh and processed cheese, highlighting regional differences in contamination levels [4,6]. Additionally, market-sold traditional cheese was identified as a high-risk product in 2022, with street-vended cheese often exposed to environmental contaminants [7].

While fungal contamination in dairy products has been a concern, a 2021 study concluded that bacterial contamination, particularly by gram-negative bacteria, remains more prevalent. Finally, innovative approaches such as antimicrobial coatings were explored in 2023, showing promising results in reducing microbial contamination in cheese production and storage [8-11]. This study aims to investigate the level of bacterial contamination in locally produced pressed cheese from selected factories in Tripoli, Libya, to assess its safety, identify potential health risks, and provide recommendations for improving production standards.

METHODS

Sample collection

Twelve random samples of pressed cheese were collected from four different cheese factories in Tripoli, Libya. Three samples were taken from each factory, resulting in a total of 12 samples. Each sample was collected under sterile conditions, placed in sterile containers, and transported to the laboratory within two hours to maintain its integrity for accurate analysis.

Sample preparation

In the laboratory, all glassware used for analysis was thoroughly cleaned with tap water and then sterilized, each cheese sample was prepared under sterile conditions to prevent cross-contamination. 2 grams of cheese was homogenized in 10 ml of sterile water and incubated at 37°C for 24 hours to promote bacterial growth, if present.

Sample contamination detection

Prepared samples were cultured on specific microbiological media to detect and identify bacterial contamination. Media used included: Nutrient Agar: for general bacterial growth and counting. Blood agar: For isolation and differentiation of Gram-positive bacteria, such as *Staphylococcus spp.* MacConkey agar: For isolation and differentiation of Gram-negative enteric bacteria, such as *Escherichia coli* and *Klebsiella spp.*, and Salmonella-Shigella (SS) agar: For selective isolation and differentiation of *Salmonella* and *Shigella* species.

The inoculated plates were incubated at 37°C for 24–48 hours. After incubation, bacterial colonies were examined for their morphological characteristics and identified using biochemical tests to determine the presence of pathogenic bacteria. This step provided critical insights into the safety and quality of the cheese samples.

RESULTS

In this study, 12 cheese samples were collected from 4 different cheese factories in Tripoli, Libya, with 3 samples from each factory. The microbial contamination of these samples was analyzed, which showed the presence of Gram-negative and Gram-positive bacteria, including *Proteus spp.* and *Staphylococcus aureus*, in addition to other indicators of bacterial contamination.

The results from Factory 1 revealed a high contamination rate, with all three samples showing significant bacterial presence. *Proteus spp.* and *Staphylococcus aureus* were detected in all samples, with levels exceeding the permissible limits established by Libyan Standard 354 of the 1992 resolution, which sets the threshold at no more than 1 million harmful bacterial cells per gram of cheese. Both *Proteus spp.* and *Staphylococcus aureus* are known to produce intestinal toxins that can lead to foodborne illnesses, including severe poisoning when consumed in large quantities.

Factory 2 demonstrated no significant bacterial contamination. The samples exhibited minimal bacterial growth, with no detectable levels of *Proteus spp.* or *Staphylococcus aureus*. The contamination levels remained well within the

acceptable range specified by Libyan food safety regulations, indicating adherence to proper hygiene and safety standards during cheese production.

Moderate contamination was observed in all three samples from Factory 3. While *Proteus* spp. and *Staphylococcus aureus* were identified, their levels were slightly lower than those found in Factory 1. However, the contamination still exceeded the permissible limits, presenting a potential health risk if the cheese is consumed without further safety measures.

The samples from Factory 4 showed minimal contamination, with low bacterial growth. No significant presence of harmful bacteria was detected, indicating that the production and storage conditions at this factory are relatively well-managed compared to the other factories analyzed in this study.



Figure 1. Growth of *Proteus* spp. on MacConkey agar and Salmonella-Shigella agar.

DISCUSSION

The findings of this study highlight varying levels of bacterial contamination in locally produced cheese from four factories in Tripoli, Libya. Significant contamination was observed in Factories 1 and 3, while Factory 2 exhibited minimal contamination, and Factory 4 showed only slight bacterial presence. The detection of *Proteus* spp. and *Staphylococcus aureus* in contaminated samples raises significant public health concerns due to their association with foodborne illnesses. These results are consistent with previous studies that emphasize the critical role of hygiene and pasteurization in the dairy industry. For example, improper handling, inadequate pasteurization, and poor storage conditions have been repeatedly identified as major factors contributing to contamination in dairy products. A 2021 study demonstrated that poor hygiene practices during production and packaging significantly increase contamination levels, aligning with the high contamination observed in Factories 1 and 3. Additionally, research in 2022 confirmed that *Proteus* spp. and *Staphylococcus aureus* are common bacterial contaminants in cheese production, corroborating the findings of this study [4,5]. On the other hand, Factory 2's minimal contamination highlights the importance of strict adherence to health and safety standards, including proper pasteurization, efficient temperature control, and robust hygiene practices. This aligns with studies showing that implementing these measures significantly reduces microbial contamination, as evidenced by research conducted in 2022, which emphasized the role of hygienic practices and appropriate packaging materials in preventing bacterial growth [2].

Advancements in detection methods, such as PCR, have proven effective in accurately identifying pathogens, as demonstrated in a 2022 study [3]. This underscores the need for employing modern techniques in monitoring and controlling microbial contamination. Moreover, research from 2023 has emphasized the dual role of lactic acid bacteria in improving cheese safety while managing spoilage microorganisms, highlighting a potential avenue for improving production standards in Libyan factories [6].

Storage conditions also play a pivotal role in microbial growth. A 2021 study confirmed that temperature and humidity significantly affect contamination levels in pressed cheese, supporting the results observed in this study. Additionally, substandard packaging materials, as highlighted in 2022 research, can exacerbate contamination risks, underscoring the importance of investing in high-quality materials [3,5].

Lastly, while fungal contamination is a concern, a 2021 study reaffirmed that bacterial contamination, particularly by Gram-negative bacteria such as *Proteus* spp, remains more prevalent in dairy products. Innovative solutions, such as antimicrobial coatings explored in 2023, present promising strategies to mitigate microbial contamination during production and storage, offering a pathway for improving safety in Libyan cheese production [7,10].

These findings reinforce the importance of adopting strict hygiene practices, modern detection methods, and innovative technologies to minimize microbial risks in the dairy industry.

CONCLUSION

This study highlights the critical importance of maintaining strict hygiene standards and pasteurization protocols in cheese manufacturing to ensure the safety of the product for consumer consumption. The high contamination observed in Factory 1 and Factory 3 underscores the need for improvements in the production processes at these facilities. Factors such as proper pasteurization temperatures, hygienic handling, and adequate storage conditions must be enforced to minimize the risk of contamination. To ensure the quality and safety of cheese products, it is essential to adhere to Libyan Standard 354 of the 1992 resolution, which stipulates the maximum permissible levels of bacterial contamination. The results also stress the need for regular monitoring and quality control in dairy factories to detect and mitigate microbial contamination before products reach the market. Future research should focus on implementing and testing new methods of microbial control, such as antimicrobial coatings or advanced pasteurization techniques, to further reduce bacterial contamination in dairy products. Additionally, more extensive studies with a larger sample size from multiple regions of Libya could provide a broader understanding of the microbial contamination issues facing the country's dairy industry. Implementation of strict hygiene protocols and routine microbial testing to ensure cheese production safety is very important. Furthermore, training factory staff on food safety practices and enforce regulatory standards to minimize contamination and promoting the use of pasteurized milk and encourage further research on microbial contamination in Libyan dairy products are worth.

Conflict of interest. Nil

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تقييم التلوث البكتيري في الجبن المصنع محليا من مصانع مختارة في مدينة طرابلس

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المستخلص

لقد أصبح الغد جديداً في صناعة الأغذية حيث تتوفر المواد الغذائية ولكنها قد تتعرض لتهديدات التلوث الميكروبي الذي قد يؤثر على جودتها وسلامتها. هدفت هذه الدراسة إلى تقييم التلوث البكتيري في العسل المحلي من أربعة مصانع مختلفة في طرابلس ليبيا. تم جمع اثنتي عشرة عينة من الجبن، ثلاث عينات من كل مصنع، وتم تحليلها للتلوث الميكروبي. أظهرت النتائج تلوث الجبن بالميكروبات، حيث كان إنتاج المصنع الأول والمصنع الثالث سجلاً بكتيرياً كبيراً، خاصة بـ *Proteus spp.* و *Staphylococcus aureus*، وهما نوعان من البكتيريا تسبب التسمم الغذائي. في المقابل، أظهر المصنع الثاني إنتاجاً جديداً، بينما أظهر المصنع الرابع وجود البكتيريا بمستويات منخفضة. تشير هذه النتائج إلى أهمية الالتزام بممارسات النظافة الجيدة وبروتوكولات البسترة وظروف التخزين المثلى في صناعة الجبن وسلامة الغذاء. كما تسلط الدراسة الضوء على الحاجة المستمرة لمراقبة الجودة في مراقبة ومنع التلف الميكروبي. بالإضافة إلى ذلك، تؤكد الدراسة القياسية على أهمية المواصفة الليبية 354 لسنة 1992 بشأن الحدود الميكروبية في صناعة الجبن وسلامة المستهلك.

الكلمات المفتاحية: صنيع الجبن، التلوث الميكروبي، البسترة، سلامة الغذاء.