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Microbial Contamination of White Cheese during the Summer Season in Port Sudan, Red Sea State, Sudan

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Abstract

Introduction: Cheese, a versatile dairy product, is a safe and nutritious food for all ages. However, its rapid growth often lacks proper supervision and quality control. Factors influencing cheese quality include raw material composition, packaging, and preservatives. Improper personal hygiene and environmental hygiene are crucial for preventing foodborne diseases.

Objective and Justification: Food poisoning is a prevalent disease globally, particularly in Sudan, where cheese is a common culprit. Despite extensive research in Khartoum, there is limited research in the Red Sea state. This study surveys Port Sudan's administrative units and population density, providing a valuable scientific reference in this area. This study was designed to identify the major sources and types of microbial contamination in white cheese production and distribution in Port Sudan.

Methods: The study investigated Staphylococcus aureus and *E. coli* in Sudanese white cheese samples from Port Sudan, adhering to Sudanese Standard No. 310 for Milk and Dairy Products. Microbiological limits allowed were 5 cfu/g, with *E. coli*, Salmonella, and Listeria monocytogenes excluded.

Results: In a study conducted in three Port Sudan areas, *S. aureus* and *E. coli* were detected in cheese samples. In the East Port Sudan area, *S. aureus* was detected in 22 (96%) samples, while *E. coli* was detected in 1 (4%) sample. No statistically significant differences were observed between areas. In the Middle Port Sudan area, *S. aureus* was detected in 20 (80%) samples and *E. coli* in 5 (20%) samples. In the South Port Sudan area, *S. aureus* was detected in 22 (92%) samples and *E. coli* in 2 (8%) samples. In the three sample groups, *S. aureus* was detected in 64 (28%) samples and *E. coli* in 8 (4%) samples. The study highlights the importance of maintaining high environmental hygiene in cheese production and consumption.

Conclusion: Cheese consumption in Sudan is prone to bacterial contamination, with 40% of white cheese samples contaminated with *Staphylococcus aureus* and *E. coli* during the summer. The central Port Sudan unit showed the highest non-compliance. Raising awareness and implementing good hygiene practices at points of sale is crucial for cheese safety.

Keywords: Food-Borne Diseases; Food Poisoning; Food Hygiene; Portsudan; Red Sea State; Sudanese White Cheeses

Abbreviations

CDC: Centers for Disease Control and Prevention; IMVC: Indole, Methyl Red, Voges Proskauer, and Citrate; CFU: Colony-Forming Units; GHP: Good Hygiene Practices.

Introduction

Cheese is a significant dairy product that results from microbial fermentation, primarily derived from the casein component of milk, as reflected in the Latin term "caseus," which translates to cheese [1]. Generally regarded as a safe food, cheese benefits from the physicochemical properties and antagonistic effects of lactic acid bacteria [2]. It is a versatile food suitable for all age groups and can be enjoyed in various meal contexts [3]. As a ready-to-eat dairy product, cheese serves as a rich source of protein, vitamins, calcium, and phosphorus [4]. In recent years, the growth of the population has led to an expansion of the cheese industry, often without adequate supervision or quality control. Sudanese white cheese, in particular, is frequently delivered to the market immediately after processing, under suboptimal conditions, and subjected to poor handling techniques, inappropriate packaging materials, and insufficient storage facilities. It is crucial that essential dairy products like cheese are safe, acceptable, and meet consumer satisfaction [5-7]. Various factors influence the quality of white cheese and its nutritional value, including the composition of raw materials, the characteristics of the compounds used the type of packaging system, and any preservatives added. Proper packaging methods are essential for maintaining the chemical, physical, and microbial quality of white cheese [8]. Additionally, food handlers with inadequate personal hygiene can be significant sources of infection from various intestinal microorganisms. Notably, the area beneath fingernails is particularly challenging to clean and harbors microorganisms more than other parts of the hand. The transmission of diseases through food handlers remains a common and persistent problem worldwide [9].

Foodborne diseases, which encompass a wide range of illnesses in both developed and developing countries, represent a growing public health concern. They arise from the consumption of contaminated food products tainted by various pathogens, chemical hazards, or harmful toxins [10]. According to the Centers for Disease Control and Prevention (CDC), staphylococcal food poisoning is a gastrointestinal illness caused by ingesting foods contaminated with toxins produced by Staphylococcus aureus. The primary route of contamination is through contact with food workers who carry the bacteria [11]. Additionally, many foodborne outbreaks of *E. coli* have been linked to the consumption of foods contaminated with cattle feces [12]. Ensuring thorough environmental hygiene is vital for preventing the transmission of infectious diseases within healthcare settings. Environmental hygiene includes effective cleaning of surfaces with appropriate products, decontaminating medical equipment and devices used in patient care, safely handling sharps, managing blood and body fluid spills, and properly disposing of waste and linens.

Objectives

This study was conducted to assess the microbiological safety and quality of white cheese produced and sold in Port Sudan during the summer season, identifying key contamination sources and recommending strategies for improvement.

Methods

This study investigated the presence of *Staphylococcus aureus* and *E. coli* in Sudanese white cheese samples collected from three administrative units in Port Sudan. A stratified random sampling method was employed, collecting 225 samples categorized into three groups (A, B and C) within each unit, totaling 75 samples per group. Samples were collected in sterile bottles, transported in ice bags, and stored at recorded temperatures before laboratory analysis. Data collection spanned from April 2021 to January 2023 across five regions within the administrative units. Bacterial isolation and enumeration were conducted using the MPN technique. Staphylococcus aureus was isolated and cultured on Mannitol salt agar, followed by sub culturing on nutrient agar, while *E. coli* was isolated and cultured on nutrient agar, with presumptive *E. coli* confirmation through the Indole, Methyl Red, Voges Proskauer, and Citrate (IMViC) test, revealing positive or negative Indole, Methyl Red, Voges Proskauer, and Citrate (IMVC) patterns indicative of *E. coli* presence or absence. The study aimed to determine the prevalence of these bacteria in the collected cheese samples. This investigation adhered to the Sudanese Standard No. 310 for Milk and Dairy Products, specifically for hard and semi-hard cheese varieties. The study analyzed the microbiological limits for several bacterial species commonly found in these cheese types, including Sudanese white cheese, mudaffara cheese, and Romano cheese. These limits, expressed as the maximum permissible colony-forming units (CFU) per gram (cfu/g), indicate that total coliforms are permitted at a maximum of 5 cfu/g. However, the presence of *E. coli*, Salmonella, coagulase-positive Staphylococci, and Listeria monocytogenes is not allowed in these cheese types. The data was analyzed using a variety of statistical methods, including descriptive statistics, bivariate analysis, and multivariate regression analysis.

Results

East Port Sudan Area:

Total samples (75), 23 (31%) samples revealed bacteria isolate. *S. aureus* was detected in 22 (96%) samples and was found with an average count of 7.8×10^2, and *E. coli* was detected in 1 (4%) sample and was found with an average count of 0.01×10^2; no statistically significant differences were observed between areas (P.Value ≥ 05) (Figure 1).

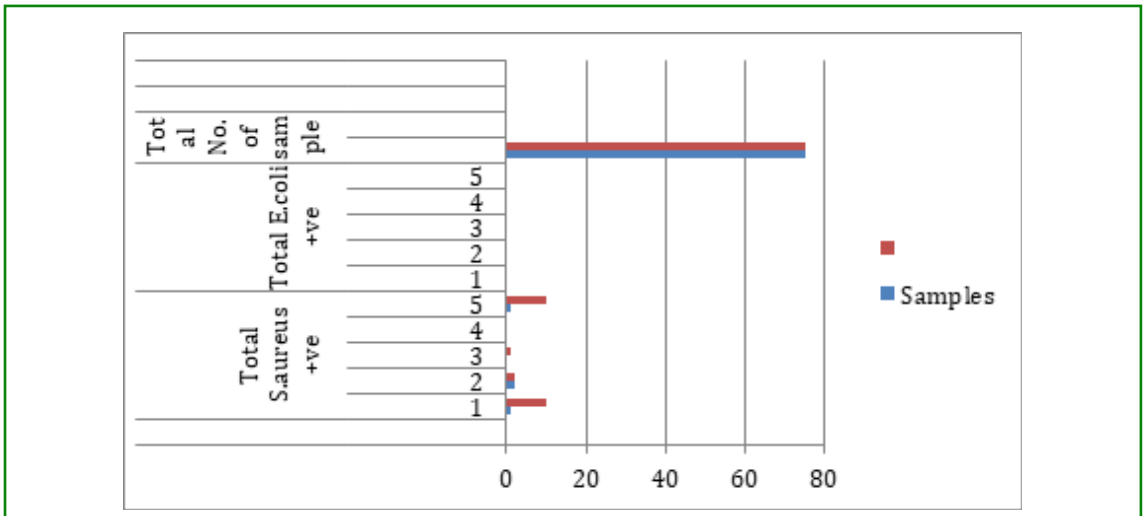

Figure 1: Frequency and percentage of bacteria's presence in different regions in Portsudan city.

Middle Port Sudan Area

Total samples (75), 25 (33%) samples revealed bacteria isolate. *S. aureus* was detected in 20 (80%) samples and was found with an average count of 10.6×10^2, and *E. coli* was detected in 5 (20%) samples and was found with an average count of 0.4×10^2. No statistically significant differences were observed between areas (P.Value ≥05).

South Port Sudan Area:

Total samples (75), 24 (32%) samples revealed bacteria isolate. *S. aureus* was detected in 22 (92%) samples and was found with an average count of 9.4×10^2, and *E. coli* was detected in 2 (8%) samples and was found with an average count of 0.04×10^2. No statistically significant differences were observed between areas (P.Value ≥ 05) (Table 1).

		Samples						Total	P value
		Sample A *S. aureus*	Sample A *E. coli*	Sample B *S. aureus*	Sample B *E. coli*	Sample C *S. aureus*	Sample C *E. coli*		
Al gadesya and Om alghora	+ve	1 (20%)	0%	2 (40%)	0%	3 (60%)	1(20%)	7/15	0.1
Hay Alsharef	+ve	0%	0%	1 (20%)	0%	4 (80%)	0%	5/15	
Abo hashesh and Salabona	+ve	0%	0%	2 (40%)	0%	2 (40%)	0%	4/15	
Dem alnour	+ve	0%	0%	1 (20%)	0%	2 (40%)	0%	3/15	
Al thaoura and Hadal	+ve	0%	0%	2 (40%)	0%	2 (40%)	0%	4/15	

Table 1: East Port Sudan area sample cross tabulation.

Total average count: *S. aureus* = 7.8×10^2 *E. coli* = 0.01×10^2

A= cans before using, B= big market, C=small market

		Samples						Total	P value
		Sample A *S. aureus*	Sample A *E. coli*	Sample B *S. aureus*	Sample B *E. coli*	Sample C *S. aureus*	Sample C *E. coli*		
West Salalab	+ve	0%	0%	3 (60%)	0%	3 (60%)	1 (20%)	7/15	0.08
East Salalab	+ve	0%	0%	1 (20%)	0%	3 (60%)	0%	4/15	
Alwehda and Aleskandrya	+ve	1 (20%)	0%	2 (40%)	0%	3 (60%)	2 (40%)	8/15	
Alsekahaded, wastalmadena, dabaywa, demalarab	+ve	0%	0%	1 (20%)	1 (20%)	0%	1 (20%)	3/15	
Altagadom, Alaman and Alferdous	+ve	0%	0%	1 (20%)	0%	2 (40%)	0%	3/15	

Table 2: Middle Port Sudan area samples cross tabulation.

Total average count: *S. aureus* = 10.6×10^2 *E. coli* = 0.4×10^2

A= cans before using, B= big market, C=small market

		Samples						Total	P value
		Sample A *S. aureus*	Sample A *E. coli*	Sample B *S. aureus*	Sample B *E. coli*	Sample C *S. aureus*	Sample C *E. coli*		
Dem swakin, Dem gaber, Alganayn, Alshaty	+ve	0%	1 (20%)	2 (40%)	0%	3 (60%)	0%	6/15	0.09
Dar Alnaeem and Dar Alsalam	+ve	0%	0%	2 (40%)	0%	2 (40%)	0%	4/15	
Almarghanya and Korea	+ve	1 (20%)	0%	1 (20%)	0%	3 (60%)	0%	5/15	
Hay Almatar and Transit	+ve	0%	0%	1 (20%)	0%	2 (40%)	0%	3/15	
Alsadaga and Alengaz	+ve	0%	0%	2 (40%)	0%	3 (60%)	1 (20%)	6/15	

Table 3: South Port Sudan area Port Sudan area Samples cross tabulation.

Total average count: *S. aureus* = 9.4×10^2 *E. coli* = 0.04×10^2

A= cans before using, B= big market, C=small market

Results of three Samples Groups (A, B, and C)

Out of (225) samples *S. aureus* detected in 64 (28%) samples and were found with average count (11.8×10^2), no statistical significant differences were detected between the three groups (P.Value = 0.484), and *E. coli* was detected in 8 (4%) sample and was found with average count (0.2×10^2), no statistical significant differences were detected between the three groups (P.Value = 0.343) in summer season (Tables 2 & 3).

Group (A) Samples

Was Cheese in cans or tins before they were opened or used. (75) Samples were collected from different areas in three main administrative units in Port Sudan city, *S. aureus* detected in 4 (4%) samples and were found with average count (0.5×10^2), and *E. coli* was detected in 1 (1%) sample and was found with average count (0.05×10^2), no statistical significant differences were observed between areas (P.Value ≥05).

Group (B) Samples

Was Cheese samples collected from Big and clean main selling points with high environmental hygiene. (75) Samples were collected from different areas in three main administrative units in Port Sudan city, *S. aureus* detected in 23 (32%) samples and were found with average count (6.8×10^2), and *E. coli* was detected in 1 (1%) sample and was found with average count (0.05×10^2), no statistical significant differences were observed between areas (P.Value ≥ 05).

Group (C) Samples

Were Cheese samples collected from Small and retail selling points and restaurant with low environmental hygiene (Figure 2). (75) Samples were collected from different areas in three main administrative units in Port Sudan city, *S. aureus* detected in 37 (49%) samples and were found with average count (28×10^2), and *E. coli* was detected in 6 (8%) samples and was found with average count (0.4×10^2), no statistical significant differences were observed between areas (P.Value ≥05) (Tables 4 & 5).

Groups	TOTAL SMPLE	+ve Bacteria		Count 10^{-2}	
				Average	
		S. aureus	*E. coli*	*S. aureus*	*E. coli*
A	75	4 (4%)	1 (1%)	0.5	0.05
B	75	23 (32%)	1 (1%)	6.8	0.05
C	75	37 (49%)	6 (8%)	28	0.4
TOTAL	225	64 (28%)	8 (4%)	11.8	0.2

Table 4: The results of samples that were collected from different samples groups (A, B, and C) in summer season.
A= cans before using B= big market C=small market +ve = existence %= percentage of existence

		Samples			
		Sample A	Sample B	Sample C	P value
Total *S. aureus* +ve	1	1	10	10	0.484
	2	2	2	2	
	3	0	1	11	
	4	0	0	13	
	5	1	10	1	
Total *E. coli* +ve	1	0	0	5	0.343
	2	0	0	1	
	3	0	0	0	
	4	0	0	2	
	5	0	0	0	
Total No. of sample		75	75	75	225

Table 5: Total +Ve Bacterial * Samples cross tabulation (summer season).
A= cans before using, B= big market, C=small market

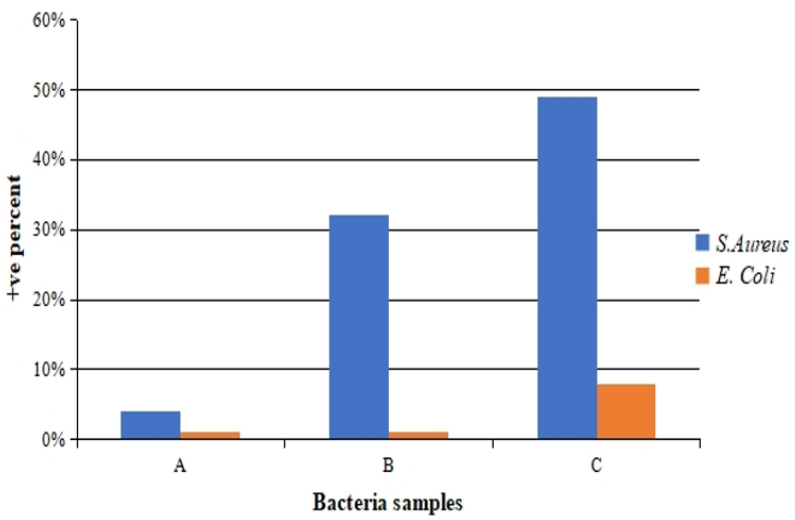

Figure 2: Detection of *S. aureus* and *E. coli* in different samples groups (A, B, and C) in summer season.

Discussion

The East Port Sudan area has a high contamination rate of 23.3% in Al gadesya and Om alghora neighborhoods, while Dem alnour and Abo hashesh, Salabona, Al thaoura, and Hadal neighborhoods have lower contamination rates at 13.3%, emphasizing the need for clean environments. This was in agreement with study done by Abdalla [13] in North Kurdufan, and with the study by Yousif [14] in Bahri locality, and with the study by Haddad, et al. [15] in Jordan, and this result was lower than the results that found in Sudan by Salih, et al. [16] and higher than the results that found in Egypt by Heikal, et al. [17].

The Central District of Port Sudan has the highest contamination percentage of bacteria isolates, with Alwehda and Aleskandrya neighborhoods showing the highest contamination, while other neighborhoods have shown commendable environmental preservation efforts [18].

In south Port Sudan, 32% of samples revealed bacteria, with areas like Dem swakin, Dem gaber, Alganayn, Alshaty, and Alsadaga recording pollution levels at 20%. Hay Almatar and Transite districts showed a commitment to cleanliness, with pollution rates at 10%. Out of 75 samples, 93% were compliant with Sudanese Standards No 310, while 7% did not. *S. aureus* was detected in 44% of samples and *E. coli* in 1%. *E. coli* was detected in various cheese samples, including those in Khartoum, Egypt, and Turkey, with higher results than previous studies, indicating potential contamination [19,20].

The study found that *S. aureus* and *E .coli* were detected in different sample groups in Port Sudan, with *S. aureus* detected in 4 samples and *E .coli* in 1 sample. The study revealed that samples from factories before packaging were the least contaminated, while samples from grocery stores had the highest contamination. The study highlights the complex interplay between industrial activities, retail settings, and public places in spreading harmful pathogens. The analysis of these samples deepened understanding of contamination patterns and prompted further research into the effectiveness of sanitation protocols and public health awareness campaigns [21].

The Middle Port Sudan area showed a higher prevalence of *S. aureus* compared to other pathogens, particularly in small shops and restaurants. Contamination levels from factories and large grocery stores were lower, but S. aureus surpassed *E. coli* in presence. In the southern region, *S. aureus* was most pronounced in small shops and restaurants, with the highest proportion of samples testing positive for bacteria surpassing *E. coli* [16].

The study compared *S. aureus* and *E. coli* bacterial strains, finding *S. aureus* more widespread across five regions and *E. coli* confined to two. This suggests a positive correlation between the bacteria's spatial distribution and the microbial ecology in the environment. The varying distribution patterns highlight their diverse ecological niches and their impact on ecosystem health and stability [22].

Conclusion

Cheese consumption is widespread in Sudan, but improper handling and marketing practices can lead to bacterial contamination and spoilage. Approximately 40% of white

cheese samples were found to be contaminated with *Staphylococcus aureus* and *E. coli* during summer seasons. The study revealed significant variations among the three administrative units in Port Sudan, with the central Port Sudan unit showing the highest non-compliance. The average bacterial count for *S. aureus* was 12.4×10^2, while *E. coli* averaged 0.3×10^2. To enhance cheese safety, efforts should focus on raising awareness about hygiene practices and ensuring proper sanitation of handling equipment. Implementing Good Hygiene Practices (GHP) at points of sale is essential to ensure the production and distribution of safe cheese.

References

1. Alcamo EI (1993) Fundamental of Microbiology. In: 4th Edition (Edn.), University of New York, USA.

2. Choi KH, Lee H, Lee S, Kim S, Yoon Y (2016) Cheese microbial risk assessments - A review. Asian-Australasian journal of animal sciences 29(3): 307-314.

3. Najafi MN, Koocheki A, Zadeh M (2008) Studies on the effectof Starter culture concentration and Renneting pH on the Iranian Brine cheese Yield. American-Eurasian Journal Agriculture and Environment Science 3(3): 325-332.

4. Pal M, Mulu S, Tekle M, Pintoo SV, Prajapati J (2016) Bacterial contamination of dairy products. Beverage and Food World 43: 40- 43.

5. Khalifa E (1989) The effect of salt concentration on the yield and chemical composition of Sudanese white cheese.

6. Ibrahim A (2003) Studies on some characteristics of Sudanese white cheese. Sudan J Vet Sci Anim Husbandry 12: 31-39.

7. El Owni AOO, Omer IAH (2008) Effect of Storage Period on Weight Loss, Chemical Composition, Microbiological and Sensory Characteristics of Sudanese White Cheese (GibnaBayda) Pakistan J Nutr 7(1): 75-80.

8. Dueruet A, Carter B, Hamid D (2001) Effect of processing conditions on yield, chemical composition and sensory characteristics of white cheese. J Trop Med Hyg 25(1): 122-136.

9. Zaglool DA, Khodari YA, Othman RAM, Farooq MU (2011) Prevalence of intestinal parasites and bacteria among food handlers in a tertiary care hospital. Nigerian medical journal 52(4): 266-270.

10. Kibret M, Abera B (2012) The Sanitary Conditions of Food Service Establishments and Food Safety Knowledge and Practices of Food Handlers in Bahir Dar Town. Ethiop J Health Sci 22(1): 27-35.

11. Centers for Disease Control and Prevention (CDC) (2004) Staphylococcus aureus food poisoning. Epidemiology report, pp: 8-12.

12. Pacheco FP, Galindo AB (2010) Microbial safety of raw milk cheeses traditionally made at a pH below 4.7 and with other hurdles limiting pathogens growth. Agricultural and Food Sciences pp: 789-1620.

13. Ahmed FE (2020) Isolation, Identification and Counting of Salmonella spp. from Poultry Products, Wad Medani City, Gezira State, Sudan (2016).

14. Yousif SY (2018) A study Occurrence of Staphylococcus aureus in white cheese in Bahri locality.

15. Haddad M, Yamani M (2017) Microbiological quality of soft white cheese produced traditionally in Jordan. Journal of Food Processing and Technology 8(12).

16. Salih ZA, Sulieman AME, Elkhalifa EA, Ali AO (2012) Chemical and microbiological characteristics of white cheese (Jibnabeida) produced in Sudan. Food and Public Health 2(6): 259-264.

17. Heikal G, Khater D, Al-Wakeel S (2014) Bacteriological hazard of white cheese processed in some small primitive plants (dairy shops) In Tanta City. Benha Veterinary Medical Journal 1: 185-194.

18. Saad AE (2004) Asurvey of Diseases Prevalent In Dairy Cows In The White Nile And Gezira States-Sudan. pp: 1-133.

19. Hammad THA (2013) Detection of White Soft Cheese Contamination by Bacteria Escherichia Coli (*E. coli*).

20. Elsamani MO, Habbani SS, Babiker EE, Ahmed IA (2014) Biochemical, microbial and sensory evaluation of white soft cheese made from cow and lupin milk. LWT-Food Science and Technology 59(1): 553-559.

21. Ahmed RAA, Barakat TM (2019) Identification of *E. coli*. In Sudanese White Soft Cheese. University of Khartoum Engineering Journal (UofKEJ) 9(2): 18-23.

22. Mustafa WA, Sulieman AM, Abdelgadir WS, Elkhalifa EA (2013) Chemical composition of the white cheese produced at household level in Dueim area, White Nile State, Sudan. Journal of Food Nutrition Disorder 2(2): 2-5.