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Bacteriological Assessment of Sudanese White Cheese in Port Sudan during Winter Season

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Abstract

Introduction: Sudanese white cheese is a traditional dairy food product made from raw milk, popular among rural and urban residents. The industry relies on non-pasteurized milk, which poses health risks due to the potential attachment of infectious bacteria. Cheese maker hygienic practices determine the milk quality, and there is limited information about its quality. Consuming Sudanese white cheese may increase public health risks due to lower storage temperatures and longer storage times in informal markets, especially during winter. The potential growth of pathogenic bacteria in the cheese could have adverse public health consequences, making it crucial to ensure public health through its production and consumption.

Methods: The study investigated the presence of *Staphylococcus aureus* and *E. coli* in Sudanese white cheese samples from Port Sudan. Bacterial isolation and enumeration were conducted using the MPN technique, adhering to Sudanese Standard No. 310 for Milk and Dairy Products. Total coliforms were allowed at a maximum of 5 cfu/g.

Results: The study analyzed the presence of bacteria in three different areas of Port Sudan. In East Port Sudan, *S. aureus* was detected in 84% of samples, with an average count of 13.8×10^2 In Middle Port Sudan, *S. aureus* was detected in 87% of samples, with an average count of 14.3×10^2 In South Port Sudan, *S. aureus* was detected in 80% of samples, with an average count of 11.5×10^2 However, no statistical significant differences were observed between areas. The results showed no significant differences in the average count between the three groups.

Conclusion: Improper hygiene practices in Port Sudan, particularly in handling and marketing cheese, can lead to bacterial contamination and spoilage. A study found that 40% of white cheese samples were contaminated with *Staphylococcus aureus* and *E. coli*. Raising awareness and implementing Good Hygiene Practices at points of sale is crucial for cheese safety.

Keywords: Contamination; *E coli*; Port Sudan; *Staphylococcus aureus*; Sudanese white Cheese; Winter Season

Introduction

Sudanese white cheese is a traditional dairy food commodity produced from raw milk. It gains high popularity among rural and urban inhabitants. Sudanese white cheese industry greatly depends on non-pasteurized milk supply, which is common in most cases. Milk borne disease represents a health hazard [1]. An important risk factor to public health

comes from the probable attachment of infectious bacteria. Cheese maker's hygienic practices are key in determining milk quality and thus prevalence of bacteria in the final product. There is no adequate information available about Sudanese white cheese quality [2]. The public health risk in consuming Sudanese white cheese may be increased by lower storage temperatures and longer storage times in informal markets, especially during the winter season. The potential growth of pathogenic bacteria in this food commodity could have adverse public health consequences and thus make it necessary to ensure public health [3].

Sudanese white cheese is a traditional dairy food commodity that is manufactured by a high number of traditional cheese makers. It is locally consumed and has great importance. Sudanese white cheese is considered one of the main dietary sources of calcium, with high nutritional value. Sudanese white cheese industry greatly depends on non-pasteurized milk supply which is common in most cases [4]. The fast fermentation by natural non-starter lactic acid bacteria limits the growth of pathogens in Sudanese white cheese. Moreover, the acidic environment of Sudanese white cheese may retard the growth of pathogens. Therefore, the products are generally safe. However, the growth of pathogenic bacteria during long period storage at moderate temperature or the use of contaminated milk may have adverse public health implications [5]. Since there is no adequate information available about Sudanese white cheese quality and public health risk which Sudanese community may obtain from consumption of the said cheese. The public health risk in consuming Sudanese white cheese would be increased by lower storage temperatures, longer storage times in informal markets especially during the winter season [6]. The potential growth of pathogenic bacteria in this food commodity could have adverse public health consequences. Thus, it is necessary to ensure public health through its production and consumption [7].

Methods

The study examined the presence of *Staphylococcus aureus* and *E. coli* in Sudanese white cheese samples from three administrative units in Port Sudan. The samples were collected using a stratified random sampling method, with 75 samples per group. Bacterial isolation and enumeration were conducted using the MPN technique. *Staphylococcus aureus* was cultured on Mannitol salt agar, followed by sub-culturing on nutrient agar. *E. coli* was isolated and cultured on nutrient agar, with presumptive *E. coli* confirmation through the IMVC test. The study adhered to Sudanese Standard No. 310 for Milk and Dairy Products, specifically for Hard and Semi-hard cheese varieties. The microbiological limits for several bacterial species were analyzed, indicating that total coliforms are permitted at a maximum of 5 cfu/g.

Results

East Port Sudan Area

Total samples (75), 31(41%) samples revealed bacteria isolate. *S. aureus* detected in 26(84%) samples and were found with average count (13.8×10^2), and *E. coli* was detected in 5(16%) sample and was found with average count (0.4×10^2), no statistical significant differences were observed between areas (P.Value≥05) (Table 1,2).

Geographical location in Port Sudan		+Ve Frequency	Percent
East Port Sudan area	Al gadesya and Om alghora	8	26.7
	Dem alnour	5	16.7
	Abo hashesh and Salabona	6	20
	Al thaoura and Hadal	6	20
	Hay Alsharef	6	20
	West Salalab	9	30
	East Salalab	8	26.7
Middle Port Sudan area	Altagadom, Alaman and Alferdous	7	23.3
	Alsekahaded, wastalmadena, dabaywa, demalarab	5	16.7
	Alwehda and Aleskandrya	9	30
	Almarghanya and Korea	8	26.7
South Port Sudan area	Dar Alnaeem and Dar Alsalam	8	26.7
	Hay Almatar and Transit	4	13.3
	Alsadaga and Alengaz	9	30
	Dem swakin, Dem gaber, Alganayn, Alshaty	6	20

Table 1: Frequency and percentage of bacteria's presence in different regions in portsudan city (winter season).

		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 (0%)	2 (40%)	0 (0%)	4 (80%)	1 (20%)	8/15	0.241
Hay Alsharef	**+ve**	1 (20%)	0 (0%)	1 (20%)	1 (20%)	2 (40%)	1 (20%)	6/15	
Abo hashesh and Salabona	**+ve**	0 (0%)	0 (0%)	3 (60%)	0 (0%)	3 (60%)	0 (0%)	6/15	
Dem alnour	**+ve**	1 (20%)	0 (0%)	2 (40%)	1 (20%)	1(20%)	0 (0%)	5/15	
Al thaoura and Hadal	**+ve**	0 (0%)	0 (0%)	2 (40%)	0 (0%)	3 (60%)	1 (20%)	/615	

Total average count: *S. aureus* = 13.8×10^2, *E. coli* = 0.4×10^2.
Table 2: East Port Sudan area sample cross tabulation (winter season).

Middle Port Sudan Area

Total samples (75), 38(51%) samples revealed bacteria isolate. *S. aureus* detected in 33(87%) samples and were found with average count (14.3×10^2), and *E. coli* was detected in 5(13%) sample and was found with average count (0.5×10^2), statistical significant differences were observed between areas (P. Value≤05). (Table 1,3).

		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 area	**+ve**	0 (0%)	0 (0%)	3 (60%)	0 (0%)	4 (80%)	2 (40%)	9/15	**0.033**
East Salalab	**+ve**	1 (20%)	0 (0%)	3 (60%)	0 (0%)	3 (60%)	1 (20%)	8/15	
Alwehda and Aleskandrya	**+ve**	1 (20%)	0 (0%)	3 (60%)	0 (0%)	4 (80%)	1 (20%)	9/15	
Alsekahaded, wastalmadena, dabaywa, demalarab	**+ve**	0 (0%)	0 (0%)	2 (40%)	0 (0%)	3 (60%)	0 (0%)	5/15	
Altagadom, Alaman and Alferdous	**+ve**	0 (0%)	0 (0%)	2 (40%)	0 (0%)	4 (80%)	1 (20%)	7/15	

Total average count: *S. aureus* = 14.3×10^2, *E. coli* = 0.5×10^2.
Table 3: Middle Port Sudan area sample cross tabulation (winter season).

		Samples						Total	P value
		Sample A *S. aureus*	Sample B *E. coli*	Sample B *S. aureus*	Sample C *E. coli*	Sample C *S. aureus*	Sample C *E. coli*		
Dem swakin, Dem gaber, Alganayn, Alshaty	**+ve**	0 (0%)	0 (0%)	2 (40%)	0 (0%)	3 (60%)	1 (20%)	6/15	0.052
Dar Alnaeem and Dar Alsalam	**+ve**	1 (20%)	0 (0%)	3 (60%)	0 (0%)	3 (60%)	1 (20%)	8/15	
Almarghanya and Korea	**+ve**	0 (0%)	0 (0%)	2 (40%)	0 (0%)	4 (80%)	2 (40%)	8/15	
Hay Almatar and Transit	**+ve**	0 (0%)	0 (0%)	1 (20%)	0 (0%)	3 (60%)	0%	4/15	
Alsadaga and Alengaz	**+ve**	0 (0%)	0 (0%)	4 (80%)	1 (20%)	2 (40%)	2 (40%)	9/15	

Table 4: South Port Sudan area sample cross tabulation (winter season).

South Port Sudan Area

Total samples (75), 35 (47%) samples revealed bacteria isolate. *S. aureus* detected in 28(80%) samples and were found with average count (11.5×10^2), and *E. coli* was detected in 7(20%) sample and was found with average count (0.4×10^2), no statistical significant differences were observed between areas (P.Value ≥05). (Tables 1,4).

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

S. aureus was detected in 39% of 225 samples, with an average count of 13×10^2, and *E. coli* in 8% of samples, showing significant differences in winter season (P.Value = 0.004) (Table 5,6).

Group(A)samples: Cheese samples from Port Sudan city showed *S. aureus* in 6 (8%) samples, with an average count of 0.8×10^2, and no significant differences between areas (P.Value ≥05) (Table 6).

Group (B)samples: Cheese samples from Port Sudan city's main selling points showed *S. aureus* in 47% of samples and *E. coli* in 4%, with no significant differences observed between areas (Table 6).

Group(C) samples: Cheese samples from small and retail selling points and restaurants in Port Sudan city showed *S. aureus* in 61% of samples and *E. coli* in 19%, with no significant differences observed between areas. (P.Value ≥05) (Table 6) (Figure-1).

Groups	Total Sample	+ve Bacteria		Count 10^{-2} Average	
		S. aureus	*E. coli*	*S. aureus*	*E. coli*
A	75	6 (8%)	0	0.8	-
B	75	35 (47%)	3 (4%)	10.5	0.1
C	75	46 (61%)	14 (19%)	27.8	1
Total	225	87 (39%)	17 (8%)	13	0.4

A= cans before using, B= big market, C=small market, +ve = existence %= percentage of existence

Table 5: The results of samples that were collected from different samples groups (A, B, and C) in winter season.

		Samples			P value
		Sample A	Sample B	Sample C	
Total *S. aureus* +ve	**1**	3	2	4	0.04
	2	0	18	8	
	3	0	5	12	
	4	3	0	22	
	5	0	10	0	
Total *E. coli* +ve	**1**	0	1	3	0.004
	2	0	0	1	
	3	0	1	0	
	4	0	1	10	
	5	0	0	0	
Total No. of sample		75	75	75	225

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

Table 6: Total +Ve Bacterial Samples cross tabulation

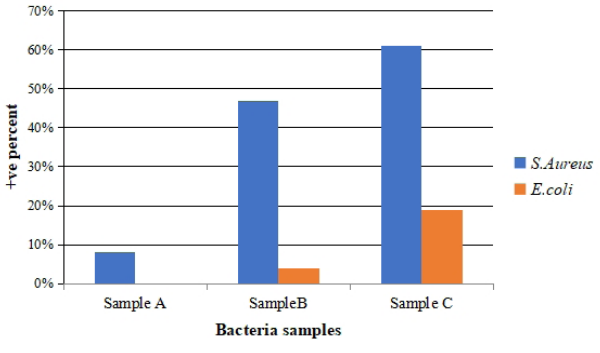

Figure 1: Detection of *S. aureus* and *E. coli* in different samples groups (A, B, and C) in winter season.

Discussion

During the winter season in Port Sudan, samples revealed high pollution rates in certain neighborhoods, with West Slalab, Alwehda, Aleskandrya, and Alsadaga and Alengaz showing the highest contamination rates. Hay Almatar and Transit neighborhoods had the least pollution at 13.3%. In the east, 31(41%)[8]. Samples showed bacteria isolate, while small and retail selling points and restaurants showed heightened contamination presence. Al gadesya and Om alghora districts had the highest contamination levels (26.7%). Dem alnour had minimal contamination (16.7%) [9]. In the middle area, 51% of samples showed bacteria isolate, with small groceries and popular restaurants being

the most heavily contaminated. In the south, 47% of samples showed bacteria isolate, with *S. aureus* being the most prevalent. These findings highlight the need for targeted intervention efforts to combat contamination challenges in affected areas [10].

The study analyzed samples from three Sudanese Standards groups (A, B, and C) and found significant differences in the detection of *S. aureus* and *E. coli*. *S. aureus* was detected in 6 (8%), 47% in group A, and 61% in group B. *E. coli* was detected in 0%, 4% in group B, and 19% in group C [11]. The prevalence of *S. aureus* and *E. coli* in milk or processed products was lower in Nigeria than in the present study. These findings highlight the need for improved standards and monitoring practices [11]. A study comparing the prevalence of *S. aureus* and *E. coli* in three sample sets in Port Sudan city revealed nearly identical proportions of these bacteria in grocery and restaurant environments. The study also found a moderate correlation between the prevalence of *S. aureus* and *E. coli* in the samples [12]. The study also found no significant differences in the detection of *S. aureus* and *E. coli* between summer and winter seasons. However, the winter season showed higher pollution levels than summer, suggesting that external factors beyond seasonal influence might be influencing the pollution landscape [13]. This highlights the need for further research to understand the underlying complexities of pollution trends in Port Sudan and develop more effective pollution mitigation strategies. The findings suggest the importance of monitoring bacterial presence in public spaces and the need for more targeted pollution mitigation strategies [12,14,15].

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.

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