OPEN ACCESS
Global Journal of Research in Agriculture & Life Sciences
ISSN: 2583-4576 (Online)
Volume 05 | Issue 06 | Nov.-Dec. | 2025
Journal homepage: https://gjrpublication.com/gjrals/
Research Article

Evaluation of Herd Management Factors Associated with Bacterial Count in Small Dairy Farms in Red Sea State, Sudan

Sfa Sidig Mohamed Mohamed Ahmed [1], Awatif Mohamed Alhassan Hadad [2], Nadir Mohammed Ahmed Hassan Abdelrameem [3] and *Elniema A. Mustafa [4]

[1] General Directorate of Animal Resources, Ministry of Production and Economic Resources, Red Sea State
[2] Head of One Health Center, Red Sea University
[3] Head of the Department of Animal Production, Faculty of Agriculture, Red Sea University
[4] Safe Zone Consultancy, Khartoum, Sudan

DOI: 10.5281/zenodo.18021183 **Submission Date:** 29 Oct. 2025 | **Published Date:** 22 Dec. 2025

Corresponding author: Elniema A. Mustafa
Safe Zone Consultancy, Khartoum, Sudan

Abstract

This cross-sectional survey evaluated hygiene and management practices of 160 small dairy farms in the Albaraka complex, Port Sudan, between November 2023 and December 2025. The study aimed to assess the relationship between herd management and bacterial quality of raw milk. A structured checklist examined four categories: cow and milk hygiene, housing and facilities, feed and water management, and biosecurity. Each item was scored on a 0–100% scale, with <70% rated poor, 70–79% good, 80–89% very good, and ≥90% excellent. The mean scores for each category were calculated to provide an overall evaluation of farm performance. Laboratory analyses of 80 milk and 10 water samples were conducted to determine Standard Plate Count (SPC) and Total Coliform Count (TCC). Results showed all categories were rated "Poor." SPC in milk was uncountable, while mean TCC in milk was 430.63 cfu/ml ±450.19 and in water 700.00 cfu/ml ±235.70, far exceeding the acceptable limit of <100 cfu/ml. Correlation analysis revealed housing and facilities were positively associated with feed and water (r = 0.256; P<0.05), while cow hygiene, housing, and feed management strongly correlated with overall farm evaluation (P<0.001). TCC in milk was negatively correlated with biosecurity (r = -0.278; P<0.05). It could be concluded that the results revealed poor farm performance and alarming contamination levels of milk. Improved hygiene, sanitation, cooling, livestock health, and regulatory compliance are essential for safe milk production.

Keywords: *Dairy Cattle; Management Factors; Biosecurity; Milk Quality; SPC; TCC.*

Introduction

Sundos and El Zubeir (2024) identified key production and reproduction risks in Khartoum's camp-based dairy systems, particularly in Kuku and Saig. Nutritional deficiencies, heat stress, disease pressure, and inconsistent management practices were shown to reduce milk yield and heighten vulnerability to contamination during milking and handling. The camp environment further complicates hygiene control and proper documentation of treatments and withdrawal periods.

Similarly, Amna et al. (2022) emphasized persistent constraints among smallholder dairy producers, including chronic feed shortages, high input costs, limited veterinary services, weak cold-chain infrastructure, and financial barriers that restrict adoption of improved practices. These systemic limitations undermine milk yield, uniformity, and compliance with safety standards. Maintaining clean, dry, and comfortable housing for both lactating and dry cows remains essential for reducing environmental contamination and mastitis caused by environmental pathogens (Oliver, 2010).

El Mansouri et al. (2025) reported significant microbiological safety concerns in raw milk from Khartoum and Gezira States, driven by poor hygiene, inappropriate drug use, and unsafe disposal of antibiotic-contaminated materials.

These practices increase the risk of antimicrobial residues and resistant bacteria. Across studies, somatic cell count (SCC) and bacterial loads—particularly the standard plate count (SPC)—are critical indicators of raw milk quality, as elevated levels accelerate enzymatic degradation and contribute to defects in processed dairy products (Considine et al., 2004; Ismail and Nielsen, 2010).

Materials and Methods

Study area

The study was conducted at Albarka Complex Dairy Farms, located in the locality of Alqonb and Oleeb in Red Sea State, Sudan. Albarka complex contains 600 small-scale dairy farms with 15, 000 head of dairy cattle of various types. The complex supplies approximately 50 tons of milk daily to Port Sudan city.

Study Design

This cross-sectional survey evaluated hygiene and management practices of 160 small dairy farms comprising 27% of the total number of the farms in the complex, Port Sudan, between November 2023 and December 2025.

Data Source

A structured checklist examined four categories: cow and milk hygiene, housing and facilities, feed and water management, and biosecurity. Each item was scored on a 0–100% scale, with <70% rated poor, 70–79% good, 80–89% very good, and ≥90% excellent. The mean scores for each category were calculated to provide an overall evaluation of farm performance.

Milk and Water Sample Collection

A total of 80 raw milk samples and 10 water samples were aseptically collected from the selected farms. Milk samples were collected directly from milking buckets into sterile containers, stored on ice, and transported to the laboratory within 2 hours of collection. Water samples were collected from drinking troughs and water storage tanks under similar aseptic conditions.

Laboratory Analysis

Microbiological analyses included: Standard Plate Count (SPC) to estimate the total viable bacterial load and Total Coliform Count (TCC) in milk and water to assess fecal contamination levels. The analyses were performed using standard microbiological methods according to the American Public Health Association (APHA) guidelines (APHA, 2004& 2012). Results were compared against standard limits for milk and water quality (<100 cfu/ml for TCC). All tests were conducted in triplicate to ensure accuracy and reproducibility.

Laboratory Techniques

The determination of SPC

The reference method for bacteria counts as outlined in SMEDP, 17th ed. (Laird et al., 2004), is the SPC method, which was performed by plating the sample on standard methods agar (SMA) followed by aerobic incubation at 32°C for 48 h.

Determination of Total Coliform Count (TCC)

Milk samples were plated on Violet Red Bile agar or MacConkey's agar and incubated for 48 hours at 32°C (90°F), after which typical coliform colonies are counted. Coliform counts >100 cfu/mL suggest poor milking practices, dirty equipment, contaminated water, dirty milking facilities, and/or cows with subclinical or clinical coliform mastitis (Oliver, 2010).

Results

The results of the checklist used to assess different management and hygienic practices in Albarka complex dairy farms were rated as "Poor." Table (1) shows that the average score for cow and milk hygiene, housing and facilities, feeds stuff and water and biosecurity were 20.12%, 22.10%, 10.61 and 18.05, respectively. The assessment of housing and facilities showed the best score while the feedstuff and water scored the lowest score.

Table 1: Categories, average score and evaluation of Albarka complex dairy farms using field checklist

Category	Average score (%)	SD	Min	Max	Evaluation
Cow and Milk Hygiene	20.12	12.64	1.60	58.30	Poor
Housing and Facilities	22.10	9.96	4.00	50.00	Poor
Feedstuffs and Water	10.61	7.86	0.00	58.30	Poor
Biosecurity	18.05	9.07	0.00	70.00	Poor
Over all	17.32	7.87	4.60	46.50	Poor

Evaluation: < 70% = Poor, 70- 79%= Good, 80- 89% = Very good, ≥ 90% = Excellent

Table (2) represents the results of microbiological quality of milk and water in the investigated farms.

The results show that standard plate count (SPC) in milk was too high to count, while the mean total coliform count (TCC) was 430.63 ±450.19 and that mean TCC in water was700.00 ±235.70.

Table 2: The standards limits and laboratory test results of SPC, TCC in milk and TCC in water in the investigated farms.

Laboratory tests	Standards limits	Mean	SD	Standard error	Sig.
SPC in milk	10^5	Uncountable	Uncountable	Uncountable	Uncountable
TCC in milk	<100 cfu/ml	430.63	450.19	50.33	< 0.001
TCCin water	100cfu/ml	700.00	235.70	74.54	< 0.001

SPC: Standard Plate Count, TCC: Total Coliform Count. significant at $P < 0.05$ using One-Sample T test

A correlation table (3) presents the Pearson correlation between different management and hygienic practices of the investigated dairy farms and TCC in milk.

The housing and facilities positively correlated with feedstuffs and water ($r = 0.256$; $P< 0.05$). In addition, cow and milk hygiene, housing and facilities and feedstuffs and water were highly positively correlated with overall evaluation of the studied farms ($P< 0.001$). On the other hand, the TCC in milk was negatively correlated with biosecurity ($r = -0.278$; $P< 0.05$), while the TCC in water was correlated positively with housing and facilities ($r = +0.649$; $P< 0.05$).

Table 3: Correlation between different management and hygienic practices of dairy farms and TCC in milk

Categories	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1- Cow and Milk Hygiene	-						
2- Housing and Facilities	0.216	-					
3- Feedstuffs and Water	0.068	.256*	-				
4- Biosecurity	0.046	0.208	0.126	-			
5- Overall	0.601**	.382**	.495**	0.199	-		
6- TCC in milk	-0.14	0.202	0.012	-.278*	-0.032	-	
7- TCC in water	0.562	0.649*	0.513	-0.157	0.33	0.131	-
** Correlation is significant at the 0.01 level							
* Correlation is significant at the 0.05 level							

Discussion

This study investigated the association between herd management practices and the bacterial quality of raw milk in small dairy herds in Red Sea State. Field evaluations revealed poor overall farm performance (<70%), attributed to limited farmer awareness and insufficient governmental inspection, consistent with earlier findings in Sudan (Ibtisam & Muhammad, 2007a).

The poor score of cow and milk hygiene in this study may be attributed to absence of official veterinary inspection and control. Water use scored the lowest (1.31%), pointing to inadequate provision of clean water for both animals and milk handling. This is particularly concerning given that water quality directly influences microbial contamination in milk. The poor performance in chemical use (8.28%) also suggests weak control of sanitization practices, which may contribute to elevated microbial loads.

Feed and water management scored among the lowest categories, contributing to elevated microbial contamination. Biosecurity practices were largely absent (18.25%), and a negative correlation with TCC ($r = –0.278$; $P < 0.05$) underscored their role in reducing contamination.

The uncountable standard plate count (SPC) reported in this study highlights severely unsanitary milk production conditions. Such extremely high SPC levels may result from inadequate cleaning systems, milk residues on equipment, mastitic cows, and equipment failures such as ineffective water heating (Oliver, 2010). Multiple hygiene-related factors further contribute to this poor microbiological quality, including dirty udders, contaminated milkers' hands (Gleeson et al., 2022; Vissers and Driehuis, 2008; Magnusson et al., 2007), unclean milking equipment (Kelly et al., 2009), unsafe water sources, and contaminated storage containers. Additional risks arise from poor animal health, especially mastitis (Murphy and Boor, 2000), unhygienic farm environments with dust and manure (Aggad et al., 2020), and inadequate cooling or filtration under warm climatic conditions (Fagerberg, 2007; O'Connell et al., 2016). Weak regulatory oversight further exacerbates these issues.

Comparable findings were reported in Sudan. Ibtisam and Muhammad (2007a) documented high bacterial loads in 120 milk samples from Khartoum State, with counts ranging from 4.0×10^5 to 3.3×10^{11} cfu/mL across regions. Seasonal effects were also evident, with higher summer counts (Ibtisam et al., 2007b). Regionally, Mohamed et al. (2017) found 42–82% of milk in Djibouti to be microbiologically unacceptable. Internationally, Polish studies showed TBC values of 9.2×10^4–3.6×10^7 cfu/mL, with 98% exceeding acceptable limits (Pyz-Lukasik et al., 2015).

Coliforms are widely recognized as indicators of fecal contamination and may originate from contaminated equipment, utensils, and foods (Valero et al., 2016). In this study, coliform levels in milk (430.63 cfu/mL) and water (700 cfu/mL) exceeded international limits (EU, 2004; FDA, 2013), consistent with regional findings of high bacterial loads in raw milk (Ibtisam et al., 2007; Mohamed et al., 2017). Such elevated counts reflect poor hygiene, inadequate water quality, improper sanitation of storage containers, and weak biosecurity.

Additional contributing factors include uniform but inadequate hygiene practices across farms, limited awareness among workers, and cultural habits surrounding milking.

High coliform levels often arise from unclean udders and teats contaminated by manure, soil, feed, personnel, or water (Bille et al., 2009), as well as environmental conditions or contaminated milking equipment (Murphy and Boor, 2000). Water used in sanitation is also a critical contamination source (Fuquay et al., 2011; Kagkli et al., 2007).

Sporadic spikes may indicate undetected coliform mastitis, commonly caused by E. coli (Torkar and Teger, 2008). Reported values exceeded those of previous studies in Djibouti (Fekadu Beyene, 1994), Burkina Faso (Tankoano et al., 2016), and Ivory Coast (Kas et al., 2013), and aligned with ranges reported in Poland (Pyz-Łukasik et al., 2015). Modern dairy systems showed much lower counts (Pantoja et al., 2009).

Correlation analysis provided further insights into the relationships between farm management practices and microbial contamination. Positive correlations were observed between housing and facilities and feedstuffs and water ($r = 0.256$; $P < 0.05$), suggesting that weaknesses in infrastructure are linked to poor feed and water management. Cow and milk hygiene, housing and facilities, and feedstuffs and water were all strongly correlated with overall farm evaluation ($P < 0.001$), confirming that these categories collectively determine farm performance.

Importantly, biosecurity showed a negative correlation with TCC in milk, reinforcing its role in reducing contamination. Conversely, TCC in water was positively correlated with housing and facilities ($r = 0.649$; $P < 0.05$), indicating that poor infrastructure contributes to water contamination.

Conclusion

It could be concluded that the results of poor hygiene, inadequate infrastructure, and weak biosecurity standards collectively lead to high milk contamination.

Acknowledgement

The authors would like to thank the staff members of the College of Agriculture, Red Sea University, and the staff of Microbiology Dept. and the general administration of Animal resources, Albaraka complex respondents who participated in the study for their cooperation and support.

Competing Interest

The authors declare that they have no competing interests.

Ethical Standards:

The manuscript does not contain clinical studies or patient data.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for profit sectors.

Authors' contributions

Author (1) collected the research data, conducted laboratory analysis and contributed to drafting the initial manuscript. Author (2) acted as a co-supervisor over the research. Author (3) conducted statistical analysis. Author (4) conceptualized the initial idea, performed supervision over the research, drafted the initial manuscript, and carried out correspondence duties.

References

1. Aggad, H., Bridja, M., Aek, B., Benaouali, M., & Djebli, A. (2010). Some quality aspects of pasteurized milk in Algeria. *World Journal of Dairy & Food Sciences, 5*(1), 21–24.
2. American Public Health Association (APHA). (2004). *Standard methods for the examination of dairy products* (17th ed.). Washington, DC: American Public Health Association. ISBN 0-87553-002-8.
3. American Public Health Association (APHA). (2012). *Standard methods for the examination of water and wastewater* (22nd ed.). Washington, DC: APHA/AWWA/WEF. ISBN 978-0875530130.
4. Amna, Y. E., Dafalla, M. A., Tameem, A. A., & Ibrahim, N. A. (2022). The problems and constraints facing dairy farms producers in Gezira State, central Sudan. *Global Scientific Journal, 10*(10). https://www.globalscientificjournal.com
5. Considine, T., Healy, A., Kelly, A. L., & McSweeney, P. L. H. (2004). Hydrolysis of bovine caseins by cathepsin B, a cysteine proteinase indigenous to milk. *International Dairy Journal, 14*, 117–124.
6. El Mansouri, M. A., Salman, A. M. A., Mustafa, E. A., & Hamad, I. M. (2025). Microbiological and anti-microbial quality of raw milk produced in dairy farms in Khartoum and Gezira States, Sudan. *Acta Scientific Nutritional Health, 9.* https://doi.org/10.31080/ASNH.2025.09.1495
7. Fagerberg, A. (2007). *Milking machine use and maintenance.* In *Bulletin of the International Dairy Federation* (No. 418/2007, p. 33). Brussels, Belgium: International Dairy Federation. https://www.fil-idf.org/wp-content/uploads/woocommerce_uploads/2007/03/418-2007-Good-Dairy-Farming-Practices-related-to-Primary-2kr2uw.pdf#page=36
8. Gleeson, D., Paludetti, L., O'Brien, B., & Beresford, T. (2022). Effect of chlorine-free cleaning of milking equipment on the microbiological quality and chlorine-related residues in bulk tank milk. *International Journal of Dairy Technology, 75*, 262–269. https://doi.org/10.1111/1471-0307.12865
9. Ibtisam, E. M. E.-Z., & Muhammad, I. A. (2007a). The hygienic quality of raw milk produced by some dairy farms in Khartoum State, Sudan. *Research Journal of Microbiology, 2*(12), 988–991. https://www.researchgate.net/publication/26478373
10. Ibtisam, E. M. E.-Z., & Ahmed Mahboba, I. A. (2007b). The hygienic quality of raw milk produced by some dairy farms in Khartoum State, Sudan. *Research Journal of Microbiology, 2*, 988–991.
11. Ismail, B., & Nielsen, S. S. (2010). Invited review: Plasmin protease in milk: Current knowledge and relevance to the dairy industry. *Journal of Dairy Science, 93*, 4999–5009. https://doi.org/10.3168/jds.2010-3323
12. Kelly, P. T., O'Sullivan, K., Berry, D. P., More, S. J., Meaney, W. J., O'Callaghan, E. J., & O'Brien, B. (2009). Farm management factors associated with bulk tank total bacterial count in Irish dairy herds during 2006/07. *Irish Veterinary Journal, 62*, 1–7. https://doi.org/10.1186/2046-0481-62-1-7
13. Laird, D. T., Gambrel-Lenarz, S. A., Scher, F. M., Graham, T. E., & Reddy, R. (2004). Microbiological count methods. In H. M. Wehr & J. F. Frank (Eds.), *Standard methods for the examination of dairy products* (17th ed., pp. 153–186). Washington, DC: American Public Health Association.
14. Magnusson, M., Christiansson, A., & Svensson, B. (2007). *Bacillus cereus* spores during housing of dairy cows: Factors affecting contamination of raw milk. *Journal of Dairy Science, 90*, 2745–2754. https://doi.org/10.3168/jds.2006-584
15. Mohamed, A. F., Fourreh, A. E., Okieh, A. A., Said, C. N., & Mérito, A. (2017). Evaluation of microbiological quality of raw milk from farmers and dairy producers in six districts of Djibouti. *Journal of Food Microbiology, Safety and Hygiene, 2*, 124. https://doi.org/10.4172/2476-2059.1000124
16. Murphy, S. C., & Boor, K. J. (2000). Sources and causes of high bacteria counts in raw milk: An abbreviated review. *Dairy, Food and Environmental Sanitation, 20*(1), 1–4.
17. O'Connell, A., Ruegg, P. L., Jordan, K., O'Brien, B., & Gleeson, D. (2016). The effect of storage temperature and duration on the microbial quality of bulk tank milk. *Journal of Dairy Science, 99*, 3367–3374. https://doi.org/10.3168/jds.2015-10198
18. Oliver, S. P. (2010, December 21). How milk quality is assessed. *Dairy Extension.* https://articles.extension.org/pages/21197/how-milk-quality-is-assessed
19. Pyz-Łukasik, R., Paszkiewicz, W., Tatara, M. R., Brodzki, P., & Bełkot, Z. (2015). Microbiological quality of milk sold directly from producers to consumers. *Journal of Dairy Science, 98*(7), 4294–4301. https://doi.org/10.3168/jds.2014-9188
20. Sundos, Y., & El Zubeir, I. (2024). Risk factors associated with production and reproduction in dairy camps (Kuku and Saig) at Khartoum State, Sudan. *Farm Animal Health and Nutrition, 3*(1).
21. Tankoano, A., Kabore, D., Savadogo, A., Soma, A., Fanou-Fogny, N., et al. (2016). Evaluation of microbiological quality of raw milk, sour milk and artisanal yoghurt from Ouagadougou, Burkina Faso. *African Journal of Microbiology Research, 10*, 535–541.
22. Vissers, M. M. M., & Driehuis, F. (2008). On-farm hygienic milk production. In *Milk processing and quality management* (pp. 1–22). Oxford, UK: Blackwell Publishing Ltd.

CITATION
Sfa, S. M. M. A., Awatif, M. A. H., Nadir, M. A. H. A., & Elniema, A. M. (2025). Evaluation of Herd Management Factors Associated with Bacterial Count in Small Dairy Farms in Red Sea State, Sudan. In Global Journal of Research in Agriculture & Life Sciences (Vol. 5, Number 6, pp. 24–28). https://doi.org/10.5281/zenodo.18021183