

Influence of Disease Control Practices on Occurrence of Antibiotic-Resistant Bacteria and Antibiotic Residues in Milk from Kilosa and Morogoro Municipality

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How to cite this paper: Paul, M. and Sanka, P.M. (2026) Influence of Disease Control Practices on Occurrence of Antibiotic-Resistant Bacteria and Antibiotic Residues in Milk from Kilosa and Morogoro Municipality. *Open Journal of Animal Sciences*, 16, 76-88.

<https://doi.org/10.4236/ojas.2026.161006>

Received: November 21, 2025

Accepted: December 26, 2025

Published: December 29, 2025

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Abstract

The overuse of antibiotics in humans and animals has become a major global concern due to its contribution to antimicrobial resistance. This study investigated the influence of disease control practices on antibiotic resistance and drug residues in cow milk from intensive and semi-intensive cattle farming systems in Tanzania. A cross-sectional survey was conducted among 216 livestock keepers in Kilosa District (semi-intensive system) and Morogoro Municipality (intensive system). Data on disease control practices were obtained using structured questionnaires, while milk samples were analyzed for bacterial resistance and antibiotic residues. Results showed universal antibiotic use among livestock keepers in both districts. However, self-administration of drugs was more common in Kilosa (66%) compared to Morogoro (5.6%). Knowledge of withdrawal periods also varied significantly, with only 14.8% of farmers in Kilosa reporting awareness, versus 89.8% in Morogoro. Microbiological analysis revealed that 25% of milk samples from Kilosa were contaminated with *Staphylococcus aureus* compared to 13% from Morogoro. Although the occurrence of resistant isolates did not differ significantly between the two sites, resistance levels were slightly higher in Morogoro. In terms of drug residues, 18.5% of milk samples in Morogoro tested positive, compared to 5.6% in Kilosa. These findings indicate that antibiotic use in livestock management contributes to the persistence of residues and resistant bacteria in milk, posing potential risks to consumer health and the environment. The study underscores the need for enhanced farmer education, stricter regulation of antibiotic use, and adoption of best practices to safeguard public health.

Keywords

Antibiotic Residues, Antimicrobial Resistant Bacteria, Disease Control

1. Introduction

Antibiotic resistance poses a major threat to global health, food security, and development, and can impact anyone, regardless of age or location [1]. Resistant microorganisms can survive the effects of antibiotics, rendering standard treatments ineffective and increasing the risk of infection spread to others. Misuse of antibiotics, such as excessive dependence, arbitrary drug combinations, incorrect dosage, and failure to observe withdrawal periods, have contributed to the development of organisms that are resistant to commonly used antibiotics [2]. For instance, inappropriate use of antibacterial drugs in treating food-producing animals has been associated with the emergence of bacteria species that can withstand attack by these antibiotics to the extent that standard treatments become ineffective and infections persist [3]. The emergence of antibiotic resistance is a gradual process that results from repeated exposure of bacteria in humans and animals to different types, strengths, and frequencies of antimicrobial drugs. As a result, certain bacterial strains with unique resistance patterns are favored due to selective pressure [4]. Moreover, resistance traits can be transferred from one bacterium to another through horizontal gene transfer [5]. Recent cases of multidrug-resistant tuberculosis (MDR-TB) have been identified in 100 countries; these cases lead to treatment courses that are much longer and less effective than those for non-resistant TB [6]. A high percentage (over 90%) of *S. aureus* are resistant to penicillin and oxacillin, leading to the common prescription of Vancomycin to treat infections caused by multiply-resistant *S. aureus* [6]. Studies in Tanzania have reported several bacteria resistant to commonly used antibiotics in livestock production [7]. The presence of antibiotic-resistant pathogens has an important public health implication, especially in developing countries like Tanzania where there is a widespread and uncontrolled use of antibiotics among livestock keepers [8]. Excessive use of antibiotics can lead to the buildup of antibiotic residues in animal food sources [1]. This occurs when an animal ingests tainted grasses, water, or any food contaminated with antibiotics from the feces of another animal that had been previously treated with antibiotics [9]. Their presence in human foods is associated with several adverse public health effects, including hypersensitivity, gastrointestinal disturbance, and neurological disorders [10]. It is important to acknowledge that the presence of antibiotic residues in milk can hinder the fermentation process involved in the production of some essential food items like yogurt and cheese [1]. The use of antibiotics that may result in the deposition of residues in meat, milk, and eggs should not be allowed in food meant for human consumption unless it is necessary for the prevention and treatment of animal diseases. In that case, a withholding period must be observed until the residues are negligible or no longer detected [11]. The present study is aimed at investigating the influ-

ence of disease control practices on the development of antibiotic-resistant bacteria and antibiotic residues in milk collected from the two farming systems (intensive and semi-intensive).

2. Methodology

The present study involved the selection of two districts in the Morogoro region, namely Morogoro Municipal and Kilosa District. The choice of Morogoro Municipal was based on its high concentration of livestock keepers. Specifically, it was observed that roughly 33% of the region's population is engaged in subsistence farming and livestock keeping [12].

2.1. Experimental Design

A cross-sectional study was conducted using a random selection of 8 Wards from each district as sampling areas. The study aimed to compare sociological data obtained from questionnaires and laboratory results to find any scientific correlation. The chi-squared test was used to compare questionnaire responses, proportion of isolates, prevalence rates, and antibiotic resistance patterns of *S. aureus* isolates between the two groups. The sample size for the study was calculated using a confidence level ($Z\alpha$) of 95%, a prevalence rate of 7.6%, and a maximum error (e) of 5%. The formula used to calculate the sample size was [13]

$$n = Z\alpha^2 P(-) e^2$$

$$n = 1.962 \times 0.076 (1 - 0.05^2)$$

$$n = 107.909$$

2.2. Questionnaire Survey

The questionnaire included questions in both open and closed-ended formats to allow respondents to express themselves freely. This approach ensured that a range of information was obtained, including knowledge on key topics such as the withdrawal period, availability of veterinary services, drug administration, and consumption of milk from an animal under treatment without observing the withdrawal period.

2.3. Sampling

To gather data, questionnaires were completed by willing livestock keepers and milk samples were obtained. From the pooling containers used by households, 25 ml of milk was directly collected. The samples were then transferred into sterile screw-capped falcon tubes and kept cool before being frozen within 8 hours. Each district provided 108 milk samples, with an average of 12 samples per ward.

2.4. Laboratory Analysis

The milk samples were transferred to the laboratory for identification and isolation of *S. aureus*, determination of antibiotic drug resistance and antibiotic residues.

2.5. Isolation and Identification of *S. Aureus*

The fresh milk samples collected from the households in Kilosa and Morogoro Municipality were immediately cultured on blood agar and MacConkey agar according to the standard methods of the examination. Bacterial culturing was performed by streaking three loopfuls from each milk sample onto labeled media plates. The plates were then incubated at 37°C for 24 hours before readings were taken and recorded.

2.6. Gram Staining

Two drops of normal saline were added to a sterilized slide using a sterilized wooden stick. A small sample of test colony was transferred to the slide and a form smear, which was dried by gently heating on a gas burner. A few drops of crystal violet were then added and left for about one minute. The slides were washed in a gentle and indirect stream of tap water for 2 seconds and then flooded with mordant iodine and were left to dry for one minute. Thereafter, the slides were washed again in a gentle and indirect stream of tap water for two seconds, followed by washing the slides by using a decolorizing agent (Acetone-alcohol decolorizer) and left for 15 seconds. Finally, slides were washed in a gentle and indirect stream of tap water until no color appeared and then was dried with absorbent paper ready for observation using microscope.

2.7. Catalase Test (Slide Test)

A small amount of bacterial colony was grown on nutrient agar and incubated at 37°C for 18 - 24 hours, and then transferred to a surface of a clean, dry glass slide using a loop or sterile wooden stick. This was followed by transferring 3 to 4 drops of 3% hydrogen peroxide on the slide and mixed. A positive reaction was indicated by the formation of bubbles from the culture.

2.8. Coagulase Test

Rabbit plasma was diluted in saline (0.85% NaCl) at a ratio of 1:6; 1 ml of the resulting dilution was transferred into small tubes. Several isolated colonies of test organisms were then transferred into the small tubes to give a milky suspension. The suspension containing tubes were incubated at 35°C in for 4 hours. Examination for clot formation was done by tilting the tube through 90°; negative tubes were left at room temperature overnight and re-examined.

2.9. Determination of Antibiotic Resistance

Antibiotic resistance test was done by using the agar disk diffusion standard method with Mueller-Hinton agar. The plates were incubated at 37°C for 24 hours in the incubator. The antibiotics tested included oxacillin (1 mg) (30 mg), cefoxitin (30 mg), amoxicillin (30 mg), Vancomycin (30 mg), ampicillin (10 mg), tetracycline (30 mg) and kanamycin (30 mg). Susceptibility categorization was carried out according to National Committee of Clinical Laboratory Standards (NCCLS)

recommendations (Hindler, 2010).

Procedure

Appropriate drug discs were impregnated on the surface of the agar plate using sterile forceps or a needle tip. To ensure complete contact with the agar surface the forceps or needle tip was gently pressed down on each disc. The discs were distributed evenly so that they were no closer than 15 mm from the edge of the plate and no two discs were closer than 24 mm from center to center. The plates were then inverted and placed in a 35°C - 37°C incubator for 20 hours. After 20 to 24 hours of incubation each plate was examined, and the diameters of complete inhibition zones were measured using sliding calipers.

Interpretation

Sizes of zones of inhibition were then interpreted by referring to National Committee of Clinical Laboratory Standards (NCCLS) recommendations. A categorization of “s” susceptible implies that an infection due to the strain tested may be expected to respond to the recommended dosage of antibiotic for that type of infection and infecting species. Resistant strains “R” on the other hand are not completely inhibited by concentrations within the therapeutic range. The intermediate “I” is a category including strains which may respond to concentrations attainable by unusually high dosage or in areas. The intermediate category also comprises a “buffer zone,” which should prevent major interpretative discrepancies from small, uncontrolled technical factors.

2.10. Detection of Antibiotic Residues in Milk Samples

Detection of antibiotic residues in milk samples was done by using Delvotest kit (FAO 2014). Delvotest is a broad-spectrum microbial inhibition test used specifically to detect the presence of antibiotic residues in dairy products, especially milk, to enable producers to adhere to MRL as required by FAO. A kit for 100 samples is composed of 100 ampoules each containing *Bacillus stearothermophilus* var. *calidolactis*, nutrients for growth and bromocresol purple.

Briefly, 0.1 ml of a well-homogenized milk sample was added to each ampoule and covered by adhesive foil before being incubated for at least three hours. Color changes were examined/observed from the underneath of a slantly held ampoule and were interpreted as follows:

- Yellow color indicated negative test/results, meaning that the milk does not contain any antibiotics, or the antibiotic concentration is below the detection sensitivity of the test.
- Purple color indicated positive test/results, meaning that the milk sample contains antibiotics equal and above the detection limit.

3. Results

3.1. Questionnaire Survey

Results showed that all livestock keepers use drugs (antibiotics) to treat animals in case of sickness in both study areas (Kilosa and Morogoro Municipality). 27%

of the livestock keepers in Kilosa required veterinary personnel to administer drugs, whereas 83% of the farmers in Morogoro Municipality relied on veterinary personnel in administering drugs. Assessment of farmers' knowledge about withdrawal periods showed that only 14.8% of farmers in Kilosa were aware, compared to 89.8% in Morogoro. Milking practices during and after treatment varied markedly between the two areas. In Kilosa, 44% of respondents reported using the milk for household consumption, 38.9% fed it to calves, 2.8% sold it, 13% discarded it, and 1.9% refrained from milking altogether. In Morogoro, 43.3% of respondents fed the milk to calves, 1.9% sold it, and 63.9% discarded it. Importantly, none of the respondents in Morogoro Municipality reported consuming milk from animals undergoing or immediately after treatment. Availability of veterinary services was low in Kilosa compared to Morogoro Municipality; it was 17% and 77% for Kilosa and Morogoro, respectively, as indicated in **Table 1**.

Table 1. Questionnaire results from the study area.

Category	Code	Morogoro Municipality		Kilosa	
		Number of respondents	Percent (%)	Number of respondents	Percent (%)
Drugs administration	Vet personnel	90	83.3	29	26.9
	Livestock keepers	6	5.6	71	65.7
	Animal attendants	12	11.1	8	7.4
Knowledge about the withdrawal period	Yes	97	89.8	16	14.8
	No	11	10.2	96	85.2
Milk during and after treatment	Do not milk	0	0	1	1.9
	Sell the milk	2	1.9	3	2.8
	Milk and discard	69	63.9	14	13
	Consume in family	0	0	48	44.4
	Used by calves	37	43.3	42	38.9
Availability of veterinary services	No	25	23.1	90	83.3
	Yes	83	76.9	18	16.7
Education Level	No school	2	1.9	62	57.4
	Primary education	29	26.9	38	35.2
	Secondary education	49	45.4	6	5.6
	High education	28	25.9	2	1.9

3.2. Prevalence of *Staphylococcus aureus*

About 25% of all milk samples collected from Kilosa were contaminated by *Staphylococcus aureus* isolates, compared to only 13% of the milk samples collected in Morogoro (**Table 2**).

Antibiotic resistance profile of Staphylococcus aureus

Determination of the Antibiotic resistance profile was conducted as shown in

Figure 1.

All *Staphylococcus aureus* isolated from both study areas were entirely resistant to ampicillin, amoxicillin and oxacillin. Furthermore, 82% of *Staphylococcus aureus* isolates from Kilosa were resistant to ceftiofur, 56% were resistant to vancomycin, and only 26% resistant to Kanamycin. Likewise, in Morogoro Municipality 86% of *Staphylococcus aureus* isolates were resistant to ceftiofur, followed by vancomycin (57.1%) and 21.4% were resistant to kanamycin (**Table 3**). Multi-drug resistance (MDR) isolates of *Staphylococcus aureus* were observed in milk from Kilosa whereby (75.2%) of *Staphylococcus aureus* were resistant to more than two antibiotics, where samples from Morogoro had (79.1%) which were resistant to more than two drugs as indicated in **Table 4**.

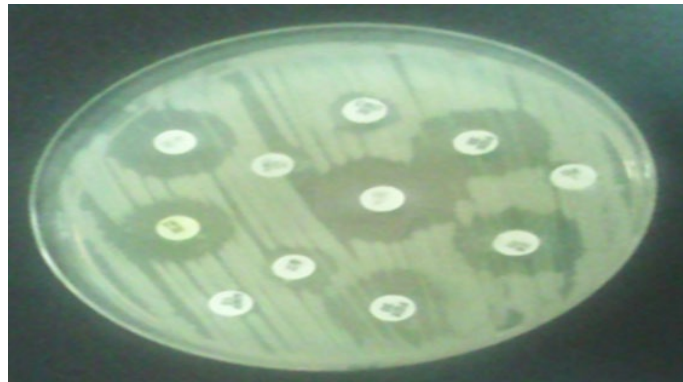


Figure 1. Inhibition zones of *S. aureus* around different antibiotic discs.

Table 2. *S. aureus* isolates from milk samples.

Morogoro Municipality			Kilosa		
Location	Number of samples	Number of isolates (%)	Location	Number of samples	Number of isolates (%)
Kihonda	13	1 (0.93)	Dumila	13	5 (4.6)
Kihonda mag	13	2 (1.85)	Magubike	14	2(1.85)
Bigwa	15	2 (1.85)	Magole	14	3 (2.77)
Kilakala	13	1 (0.93)	Mabwerebwere	14	2 (1.85)
Kichangani	13	3 (2.77)	Kimamba A	13	4 (3.7)
Msamvu	13	2 (1.85)	Kimamba B	14	2 (1.85)
Mazimbu	15	1 (0.93)	Berega	13	4 (3.7)
Chamwino	13	2 (1.85)	Maguha	13	5 (4.6)
Total	108	14 (13)		108	27 (25)

Table 3. Antibiotic resistance patterns of *S. aureus* isolates.

Drugs	Isolates (%)	
	Morogoro Municipality	Kilosa
K	3 (21)	7 (26)
OX	14 (100)	27 (100)

Continued

FOX	12 (85.7)	22 (81.5)
AML	14 (100)	27 (100)
VA	8 (57)	15 (55.5)
AMP	14 (100)	27 (100)
TET	11 (78.5)	18 (66.7)

Key: K: Kanamycin, OX: Oxacillin, FOX: Cefoxitin, AML: Amoxicillin, VA: Vancomycin, AMP: Ampicillin, TET: Tetracycline.

Table 4. Multi-Drug resistance patterns of isolates.

<i>Drugs</i>	<i>Isolates (%)</i>	
	<i>Morogoro Municipality</i>	<i>Kilosa</i>
AMP/AML	14 (100)	27 (100)
TET/AMP/AML	11 (78.6)	18 (66.7)
K/AMP/AML	9 (64)	7 (26)
FOX/AMP/AML	13 (92.8)	22 (81.5)
TET/K/AMP/AML	7 (50)	4 (14.8)
K/FOX/AMP/AML	3 (21.4)	7 (26)
TET/OX/FOX/AMP/AML	3 (21.4)	19 (59)
TET/VA/K/FOX/AMP/AML	6 (42.8)	4 (14.8)
TET/VAK/FOX/AMP/AML	1 (7.1)	4 (14.8)

Key: TET: K: Kanamycin, OX: Oxacillin, FOX: Cefoxitin, AML: Amoxicillin, VA: Vancomycin, AMP: Ampicillin, TET: Tetracycline.

3.3. Antibiotic Residues in Milk Samples

About 6% of milk samples from Kilosa contained antibiotic residues, whereas the figure was high up in samples from Morogoro Municipality, as 19% were positive for antibiotic residues, as indicated in **Table 5** and **Figure 2**.

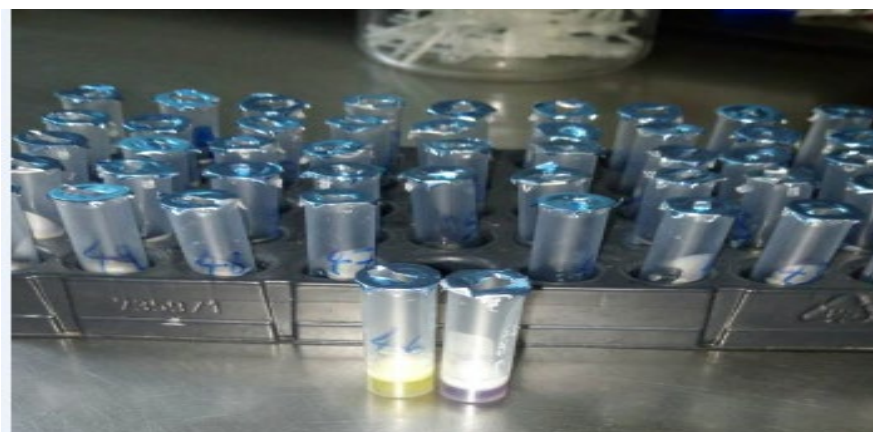


Figure 2. Positive and negative results for antibiotics.

Table 5. Milk samples containing antibiotic residues in each ward.

Morogoro Municipality			Kilosa		
Location	Number of sample	Number (%) of samples with antibiotic residues	Location	Number (%) of sample	Number (%) of samples with antibiotic residues
Kihonda	13	3 (2.77)	Dumila	13	1 (0.92)
Kihonda mag	13	1 (0.92)	Magubike	14	0 (0)
Bigwa	15	4 (3.7)	Magole	14	0 (0)
Kilakala	13	6 (5.6)	Mabwerekwere	14	2 (1.85)
Kichangani	13	0 (0)	Kimamba A	13	1 (0.92)
Msamvu	13	1 (0.92)	Kimamba B	14	0 (0)
Mazimbu	15	3 (2.77)	Berega	13	0 (0)
Chamwino	13	2 (1.85)	Maguha	13	2 (1.85)
Total	108	20 (18.5)		108	(5.54)

4. Discussion

The current study has revealed more disease control malpractices, such as the administration of veterinary drugs by unprofessional personnel, including animal attendants, in Kilosa than in Morogoro Municipality. The major reason behind the observed trend is that there are limited and/or expensive veterinary services in most rural areas [14]; this is further compounded by our second finding that livestock keepers in Kilosa had lower levels of formal education than those in Morogoro Municipality. Similar findings were reported by Karimuribo *et al.* (2020), who also associated disease control malpractices with the poor availability of veterinary services together with the uncontrolled selling of veterinary drugs in livestock markets by unscrupulous businessmen in rural areas. Similarly, the knowledge of the milk withdrawal period and failure to observe the period by livestock keepers in Kilosa is a direct effect of the lack of vet extension services in the area in comparison to the case in Morogoro. Municipality.

Milk collected from Kilosa showed higher percentage of *S. aureus* compared to that from Morogoro Municipality. The reasons for this disparity in prevalence of *S. aureus* between the two study areas may be accounted by the differences in milking practices including poor hygiene of the milkers, unhygienic milking equipments, storage containers/utensils, unsuitable storage condition, unclean udder and/or teats, poor quality of water used for cleaning udder [15]. Poor hygiene in rural areas is mainly caused by lack of veterinary services including health workers to educate livestock keepers on maintaining cleanliness [16]. Similar results have showed that 55% of milk samples collected from Hamdallaye village in Nigeria were contaminated with *Staphylococcus aureus* [17]. Various studies have been conducted in Tanzania including one done by (Mohammed, 2015), which recorded a prevalence of *S. aureus* in cow's milk as high as 64%.

Occurrence and spread of bacteria with resistance to one or more antibiotics poses significant public health threat worldwide [18]. In respect to this study,

Staphylococcus aureus isolates in both study areas were resistant to ampicillin, amoxicillin and oxacillin; other isolates had multi-drugs (MDR) [19]. High prevalence of antibiotic-resistant *S. aureus* in the study areas was probably due indiscriminate use of antibiotics by farmers. For instance, penicillin is predominantly used for treatment of mastitis this can lead to development of resistance involving other members of penicillin family such as oxacillin, dicloxacillin, ampicillin, amoxicillin, carbenicillin, ticarcillin, and piperacillin [20]. Indiscriminate use of antibiotics could be linked with lack of knowledge, limited extension services and uncontrolled selling of antibiotics in livestock markets. A study by [21] showed that ampicillin, amoxicillin, oxacillin and tetracycline were among the frequently used antibiotics by majority of farmers. Comparable results have been reported in various countries. A study to investigate antibiotic resistance of *S. aureus* in Northern Ethiopia, showed resistance of 82%, and 59% to clindamycin and ampicillin, respectively [22]. In Tanzania, a study conducted in Morogoro, showed high resistance of *S. aureus* to penicillin 72% which was found to be among the most used drug by livestock keepers [12].

Presence of antibiotic residues in food is a serious public health concern because of the harmful effects of these residues on consumer's health. Antibiotic residues find their way into food chain due to their extensive use and failure in observing withdraw period of these drugs [23]. Results of this study showed that high number of milk samples collected from Morogoro Municipality contained antibiotic residues compared to milk samples from Kilosa. This finding was contrary to questionnaire results, which indicated that livestock keepers in Morogoro had more knowledge on milk withdraw periods suggesting that information gathered from questionnaires is not always a true reflection of the real situation.

5. Conclusion

This study demonstrated that disease control malpractices were more common in Kilosa than in Morogoro Municipality, largely due to limited veterinary services, high costs of professional care, and lower education levels among livestock keepers. Poor milking hygiene and lack of extension services in Kilosa contributed to a higher prevalence of *Staphylococcus aureus* in milk, while indiscriminate antibiotic use in both areas resulted in the emergence of resistant strains and multi-drug resistance. Furthermore, the presence of antibiotic residues in milk, particularly in Morogoro, underscores the risk of drug misuse and the failure to observe withdrawal periods. These findings highlight the urgent need to improve disease control practices in Kilosa and Morogoro. To address the challenges, veterinary services should be strengthened by increasing the number of qualified professionals and making services affordable to livestock keepers. Farmer education and training are equally important to raise awareness on proper drug use, hygiene, and the risks of antibiotic residues. Extension services must be expanded to provide regular guidance, supervision, and monitoring of livestock health. In addition, stricter regulation of veterinary drug sales and use should be enforced to curb in-

discriminate antibiotic use. Finally, public health campaigns are necessary to inform communities about the dangers of consuming contaminated milk, thereby promoting safer practices.

Acknowledgements

The authors would like to sincerely thank the Water Institute, Dar es Salaam, for providing logistical and technical support during this study. We are also grateful to the livestock keepers and veterinary personnel in Kilosa and Morogoro Municipalities for their cooperation and valuable information. Special thanks to our colleagues in the Department of Water Resources Management for their assistance and guidance throughout the research process.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Tóth, A.G., Csabai, I., Krikó, E., Tózsér, D., Maróti, G., Patai, Á.V., *et al.* (2020) Antimicrobial Resistance Genes in Raw Milk for Human Consumption. *Scientific Reports*, **10**, Article No. 7464. <https://doi.org/10.1038/s41598-020-63675-4>
- [2] Menon, K.V. (2021) Chemical Contaminants in Milk and Milk Products. Shahaji Phand, Sathian, CT Radha.
- [3] Bayou, K. and Haile, N. (2017) Review on Antibiotic Residues in Food of Animal Origin: Economic and Public Health Impacts. *Applied Journal of Hygiene*, **6**, 1-8.
- [4] Amábile-Cuevas, C.F. (2016) Antibiotics and Antibiotic Resistance in the Environment. CRC Press/Balkema.
- [5] Burmańczuk, A., Tomasz, G., Gbylik-Sikorska, M., Gajda, A. and Kowalski, C. (2017) Withdrawal of Amoxicillin and Penicillin G Procaine from Milk after Intramammary Administration in Dairy Cows with Mastitis. *Journal of Veterinary Research*, **61**, 37-43. <https://doi.org/10.1515/jvetres-2017-0005>
- [6] Urban-Chmiel, R., Marek, A., Stepień-Pyśniak, D., Wieczorek, K., Dec, M., Nowaczek, A., *et al.* (2022) Antibiotic Resistance in Bacteria—A Review. *Antibiotics*, **11**, Article 1079. <https://doi.org/10.3390/antibiotics11081079>
- [7] Sonola, V.S., Katakweba, A.S., Misinzo, G. and Matee, M.I.N. (2021) Occurrence of Multi-Drug-Resistant Escherichia Coli in Chickens, Humans, Rodents and Household Soil in Karatu, Northern Tanzania. *Antibiotics*, **10**, Article 1137. <https://doi.org/10.3390/antibiotics10091137>
- [8] Kimera, Z.I., Frumence, G., Mboera, L.E.G., Rweyemamu, M., Mshana, S.E. and Matee, M.I.N. (2020) Assessment of Drivers of Antimicrobial Use and Resistance in Poultry and Domestic Pig Farming in the Msimbazi River Basin in Tanzania. *Antibiotics*, **9**, Article 838. <https://doi.org/10.3390/antibiotics9120838>
- [9] Ferroni, L., Lovito, C., Scoccia, E., Dalmonte, G., Sargenti, M., Pezzotti, G., *et al.* (2020) Antibiotic Consumption on Dairy and Beef Cattle Farms of Central Italy Based on Paper Registers. *Antibiotics*, **9**, Article 273. <https://doi.org/10.3390/antibiotics9050273>
- [10] Patangia, D.V., Anthony Ryan, C., Dempsey, E., Paul Ross, R. and Stanton, C. (2022) Impact of Antibiotics on the Human Microbiome and Consequences for Host Health.

- MicrobiologyOpen*, **11**, e1260. <https://doi.org/10.1002/mbo3.1260>
- [11] Jamali, H., Paydar, M., Radmehr, B., Ismail, S. and Dadrasnia, A. (2015) Prevalence and Antimicrobial Resistance of *Staphylococcus Aureus* Isolated from Raw Milk and Dairy Products. *Food Control*, **54**, 383-388. <https://doi.org/10.1016/j.foodcont.2015.02.013>
- [12] Kalee, N.E., Gahamanyi, N. and Hoza, A.S. (2021) Prevalence and Antimicrobial Susceptibility Profiles of *Staphylococcus Aureus* from Raw Bovine Milk in Dairy and Pastoral Farms in Morogoro Region, Tanzania. *German Journal of Veterinary Research*, **1**, 1-7. <https://doi.org/10.51585/gjvr.2021.2.0007>
- [13] Ndanu, M.C. and Syombua, M.J. (2015) Mixed Methods Research: The Hidden Cracks of the Triangulation. *General Education Journal*, **4**.
- [14] Afakye, K., Kiambi, S., Koka, E., Kabali, E., Dorado-Garcia, A., Amoah, A., *et al.* (2020) The Impacts of Animal Health Service Providers on Antimicrobial Use Attitudes and Practices: An Examination of Poultry Layer Farmers in Ghana and Kenya. *Antibiotics*, **9**, Article 554. <https://doi.org/10.3390/antibiotics9090554>
- [15] Deddefo, A., Mamo, G., Asfaw, M. and Amenu, K. (2023) Factors Affecting the Microbiological Quality and Contamination of Farm Bulk Milk by *Staphylococcus Aureus* in Dairy Farms in Asella, Ethiopia. *BMC Microbiology*, **23**, Article No. 65. <https://doi.org/10.1186/s12866-022-02746-0>
- [16] Grace, D., Wu, F. and Havelaar, A.H. (2020) MILK Symposium Review: Foodborne Diseases from Milk and Milk Products in Developing Countries—Review of Causes and Health and Economic Implications. *Journal of Dairy Science*, **103**, 9715-9729. <https://doi.org/10.3168/jds.2020-18323>
- [17] Harouna Hamidou, Z., Morsli, M., Mamadou, S., Drancourt, M. and Saad, J. (2022) Emergence of Multi-Drug-Resistant Mycobacterium Tuberculosis in Niger: A Snapshot Based on Whole-Genome Sequencing. *PLOS Neglected Tropical Diseases*, **16**, e0010443. <https://doi.org/10.1371/journal.pntd.0010443>
- [18] Amian, A.K., Solange, K., Kouadio, F.K., Edwige, A., Audrey, A., David, C.N., *et al.* (2020) Occurrence of Multidrug-Resistant Bacteria in Aquaculture Farms in Cte Divoire (West Africa). *African Journal of Microbiology Research*, **14**, 182-188. <https://doi.org/10.5897/ajmr2019.9277>
- [19] Hernandez, L., Bottini, E., Cadona, J., Cacciato, C., Monteavaro, C., Bustamante, A., *et al.* (2021) Multidrug Resistance and Molecular Characterization of Streptococcus Agalactiae Isolates from Dairy Cattle with Mastitis. *Frontiers in Cellular and Infection Microbiology*, **11**, Article ID: 647324. <https://doi.org/10.3389/fcimb.2021.647324>
- [20] Balemi, A., Gumi, B., Amenu, K., Girma, S., Gebru, M., Tekle, M., *et al.* (2021) Prevalence of Mastitis and Antibiotic Resistance of Bacterial Isolates from CMT Positive Milk Samples Obtained from Dairy Cows, Camels, and Goats in Two Pastoral Districts in Southern Ethiopia. *Animals*, **11**, Article 1530. <https://doi.org/10.3390/ani11061530>
- [21] Mupfunya, C.R., Qekwana, D.N. and Naidoo, V. (2021) Antimicrobial Use Practices and Resistance in Indicator Bacteria in Communal Cattle in the Mnisi Community, Mpumalanga, South Africa. *Veterinary Medicine and Science*, **7**, 112-121. <https://doi.org/10.1002/vms3.334>
- [22] Ferroni, L., Albini, E., Lovito, C., Blasi, F., Maresca, C., Massacci, F.R., *et al.* (2022) Antibiotic Consumption Is a Major Driver of Antibiotic Resistance in Calves Raised on Italian Cow-Calf Beef Farms. *Research in Veterinary Science*, **145**, 71-81. <https://doi.org/10.1016/j.rvsc.2022.01.010>
- [23] Arsène, M.M.J., Davares, A.K.L., Viktorovna, P.I., Andreevna, S.L., Sarra, S., Khelifi,

I., *et al.* (2022) The Public Health Issue of Antibiotic Residues in Food and Feed: Causes, Consequences, and Potential Solutions. *Veterinary World*, **15**, 662-671.
<https://doi.org/10.14202/vetworld.2022.662-671>