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Antibiotic residue in raw milk collected from dairy farms and markets in Benadir, Somalia

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Abstract

Introduction: *antimicrobial residue in milk, meat and their by-product posed a significant public health challenge. This cross-sectional study was designed to evaluate antibiotic residue from fresh milk samples collected from randomly selected dairy farms and markets.* ***Methods:*** *the study was conducted between July, 2019 and February, 2020. All milk samples were analyzed using Delvotest® screening test.* ***Results:*** *of the 100 milk samples analyzed, 24 samples (24%) had antibiotic residues. Comparison between sample source revealed that (30%) of milk samples from dairy farms contain antibiotics and (18%) from markets had residual antibiotics. The level of antibiotic residue from five farms ranged from 0% to 50 %. Similarly, 40%, 30% and 20% of milk samples collected from markets in Laiberia, Bakaro and Hamarweyne had antibiotic residues, while milk samples from Sebiyano and Suqa Weyn have not shown any antibiotic residue.* ***Conclusion:*** *the results of this study though preliminary, but still highlighted the problem of residual antibiotics from milk samples in Benadir, Somalia.*

Introduction

The use of antimicrobial agents in food animal production particularly in low income countries where the burden of disease is high has greatly threatened the gains of antimicrobial stewardship. This is because, there is little or no capacity for residue testing programs, lack of strict regulations with regards to the use of antimicrobial agents and enforcement of antibiotic withdrawal periods. Depending on the formulations of the drug, the withdrawal periods for oxytetracyclines and ampicillins in milk is 4 and 2 days respectively. Strict observance of these regulations is not economically feasible for most farmers in low income countries [1,2]. Antimicrobials still contribute to the health and well-being of animals and their administration is considered indispensable. Misuse, overuse or indiscriminate usage of antibiotics can lead to contamination of animal products [3,4]. When their concentrations in milk or any other food products exceed the maximum residue limit (MRL), it is a serious public health problem [5]. Possible public health implications of antimicrobial residues include allergic reactions, bone marrow toxicity, destruction of human intestinal microflora and development and sustenance of antibiotic-resistant bacteria and antibiotic resistance genes [6,7]. Over the years, Antimicrobial resistance has reduced the efficacy of last resort antibiotics, which in turn lead to prolonged hospital admission stay, increase in severity of infectious diseases and reductions in treatment options [8,9].

An array of antibiotics is used in dairy farms including beta-lactams (penicillins, cephalosporins), macrolides, tetracyclines, aminoglycosides, quinolones, and polymyxins, commonly to fight against mastitis [10]. Mastitis is a major welfare and economic problem in the dairy industry due reduction in quantity and quality of milk and milk products [11]. Additionally, antibiotic residues affect the qualities of raw milk processing by inhibiting the cultivation of starters used in cheese production and other fermented dairy products. It also decreases the production of desired acids and flavors [3,12].Residue control and monitoring guarantees more consumer safety and is thus applied in the European Union (EU), a condition set out in EU Directive 96/23/EC and Commission Decision 97/747/EC [13,14]. Despite the public health concern of antimicrobial resistance, no effective monitoring systems of antimicrobial residues have been applied in many developing countries. This study was designed to evaluate antimicrobial residue from raw milk samples in Benadir, Somalia

Methods

Study design: a cross-sectional study was conducted from July 2019 to February 2020 to determine the antibiotic residue in milk from ten dairy farms and ten markets in Benadir region.

Sample size: sample size was determined based on the reported 3.8% proportions of antibiotic residue in milk samples from Somalia by Abdiqani *et al*. [15], using the formula given for simple random sampling methods [16].

$$n = \frac{1.962[pexp(1 - pexp)]}{d^2}$$

Where: n = Required sample size, Pexp = Expected prevalence of antibiotic residue (3.8% by Abdiqani *et al*. [15], d = Desired absolute precision level at 95% confidence level (5%) 1.96 = The value of Z at 95% confidence level. Thus, the desired sample size for Pexp = 0.038 is n = 56, however, 100 samples has been tested.

Samples collection: a total of 100 milk samples 50 each from dairy farms and retail markets were collected and used in this study. Raw milk samples were collected in clean sterile bottles from dairy farms and markets in Benadir. All milk samples were transported under chilled conditions to the Veterinary Diagnostic Laboratory of Somali National University and immediately processed.

Questionnaire survey: a questionnaire survey was administered to the dairy farm owners whose lactating cows were included in the study. The farms were visited to conduct personal interviews with the dairy farm owners to assess their awareness about dairy farm management practices and antibiotic residues. Moreover, knowledge assessment and observations were made about the professional qualification of person who administers antibiotics to cows, record keeping and knowledge of withdrawal periods of antibiotics was also collected.

Screening test: screening test (Delvotest SP kit) was used per the manufacturer´s instruction (DSM, Netherlands). Delvotest is a broad-spectrum screening test for the detection of different antibiotic residues in milk. Briefly, 100 µL of milk sample was transferred to the ampoule containing nutrient agar embedded with Bacillus stearothermophilus spores and Bromocresol purple indicator and incubated at 64°C for 3 h. A clear color change from purple to yellow indicates that the antimicrobial compounds are below the detection limits (negative result). A purple color indicates the presence of antibiotics at or above the detection limits of the test (positive result) (Figure 1). The color changes of the agar in each tube were assessed by two people.

Data analysis: data obtained was coded and entered into Microsoft Excel spread sheet and analyzed using SPSS version 20. Descriptive statistics was employed to summarize the data and expressed in terms of frequency and percentage. Chi square analysis was used to determine the level of antibiotic residue in milk. For all analysis, a P≤0.05 was used as cut-off point for significance difference.

Results

The finding of this study showed that 90% of the farmers do not keep farm records and had no knowledge of antibiotic residue nor withdrawal period. Additionally, only 30% of the farmers seek for veterinary services. Screening for antibiotic residue revealed 24% of sampled milk contain antibiotic residue. Source wise comparison showed that 15 (30%) of milk sampled from dairy farms had antibiotic residue, while only 9 (18%) of milk from markets contain antibiotic residue (Table 1). At farm level, the level of antibiotic residue ranged from 0% to 50 % and the result is not statistically significant p ≥ 0.05. The rate of antibiotic residue in milk samples collected from market were as follows; 40% (Laiberia), 30% Bakaro, 20% (Hamarweyne) and 0% in both (SuqaWeyn) and (Seybiano) (Figure 2).

Discussion

Notwithstanding the therapeutic and prophylactic benefits of antimicrobial agents, their residues in milk, meat and their products can cause adverse effects to human health and negatively impact the

dairy industry. The rise in the development of antimicrobial resistance from food animal sources and the environment threatens the global gains in the fight against antimicrobial resistance [17,18]. This is partly so, because of the indiscriminate use of antimicrobials in food animal production and lack of observance of withdrawal periods prior to sale or slaughter of animals. The present study was undertaken to determine the presence of antibiotic residues in milk samples from dairy farms and Markets in Benadir region, Somalia. Of the 100 milk samples tested for antibiotic residues, 24% had antibiotic residues, this was higher than (3.8%) reported by Abdiqani *et al*. [15] in Togdheer region, Somalia. Antibiotic residue found in this study was also slightly above the 23% reported by Shata *et al*. [19] in Nigeria, 21 % in Kenya [20], 14% in Iran [21], 13% in Uganda [22]; 10% in Trinidad [23] and 3.1% in Ghana [24]. This variation in the level of contamination of milk with antibiotic residues could be explained by the type of legislation and regulations with regards to the use of antimicrobials in each region, differences in laboratory test methods and skills, variation in farm management system in different regions, sample size and cultural practices [25].

In this study, milk samples from dairy farms contain higher (30%) antibiotic residue than those from markets (18%). This is because those sold in markets might have been pre-treated or pasteurized before been sold to the consumers, as such the antimicrobial residue might have been destroyed by heat. Additionally, the animals might have been treated with antibiotics prior to collection of milk samples. Despite the difference in level of milk contamination with antibiotics, statistically, the difference is not significant. Comparison between farms showed that some farms had high contamination rate than others. This could be attributed to the difference in management practice, lack of knowledge on withdrawal periods and antibiotic residue, lack of absence of screening capabilities, lack of access to veterinary services and level of awareness and knowledge of the farmers. Similarly, the rate of antibiotic residue in the market was 40% (Laiberia), 30% Bakaro, 20% (Hamarweyne) and 0% in both (SuqaWeyn) and (Seybiano). The differences of antibiotic residue in the market chain suggests that the problem mainly originates at the farm and that combining milk in bulk tanks further up the market chain has no significant dilution effect on the concentration of the residues. Hence, milk sold in the markets might come from lactating animals during treatment period or before completing withdrawal period. Moreover, milk samples sold in the markets are supplied from near regions to Benadir which are nomadic herdsmen who have access to veterinary drugs and are known for indiscriminate administration of antimicrobial agents without prescription. This is also an indication of lack of adequate veterinary public health regulatory control in the country. However; there is no statistically significant difference in antibiotic residue in milk between Markets ($p \geq 0.05$.). This study revealed a potentially serious public health problem for consumers of locally produced milk in Somalia. It is likely that constant exposure over long periods may lead to an increase in antimicrobial resistance within communities, thus leading to the need to resort to more expensive drugs that a poor country such as Somalia cannot afford.

The questionnaire survey included questions that were helpful to gain insights into antibiotic usage in the dairy farms. Only (10 %) of the farms surveyed consider withdrawal period and kept records of antibiotic treatment. A survey of dairy producers in Michigan, USA revealed that inadequate record keeping and poor knowledge about drug withdrawal periods among producers were important factors leading to drug residues in milk [26]. All the respondents (100%) cited that they never heard about antibiotic residue and they do not perform antibiotic residue testing on farms before distribution which, may lead to multidrug resistance in human pathogens [27]. Moreover, it will cause problems in the production of fermented milk products, because such compounds inhibit the growth of the starter culture even with low

concentrations of antibiotics residues. Therefore, drug residues remain very significant from the prospective of international trade and consumer confidence because it results in international trade barrier. Most of the farm owners (70%) did not consult a veterinarian. These results underline an urgent need for education of farmers with respect to risks associated with the administration of antimicrobial drugs.

Conclusion

The findings of this study revealed that antibiotic residue in milk is a major public health issue in Benadir. Because majority of the farmers lack requisite knowledge on the impact of antimicrobial residue on human health and are not aware of withdrawal period.

What is known about this topic

- *Antimicrobial resistance from food animal sources is a major public problem worldwide;*
- *Antimicrobial resistant bacteria and genes can be transmitted to humans via food chain;*
- *Antibiotic residue is known to cause deleterious effect on human health and milk industry.*

What this study adds

- *Established a baseline data on antimicrobial residue in milk in Benadir;*
- *Established knowledge gaps on screening of antimicrobial residue and withdrawal periods among farmers in Benadir, Somalia;*
- *Established factors that facilitates occurrence of antibiotic residue in Benadir.*

Competing interests

The authors declare no competing interest.

Authors' contributions

MAM and AASE conceived the research idea and performed the experiment, ABD, YHSH and AAB collate, analyzed and interpret the data, AMO wrote the first draft of the manuscript, while AAB revised and edited the manuscript. All authors read and accepted the final draft of these manuscript.

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Table and figures

Table 1: proportion of milk samples containing antibiotic residue
Figure 1: A) negative, B) positive Result: a purple color indicates the presence of antibiotics at or above the detection limits of the test
Figure 2: antibiotic residue of raw milk from markets in Benadir

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Table 1: proportion of milk samples containing antibiotic residue

Result	**Farm**	**Market**	**p-value**
Positive	15 (30%)	9 (18%)	0.248
Negative	35 (70%)	41 (82%)	
Total	50	50	

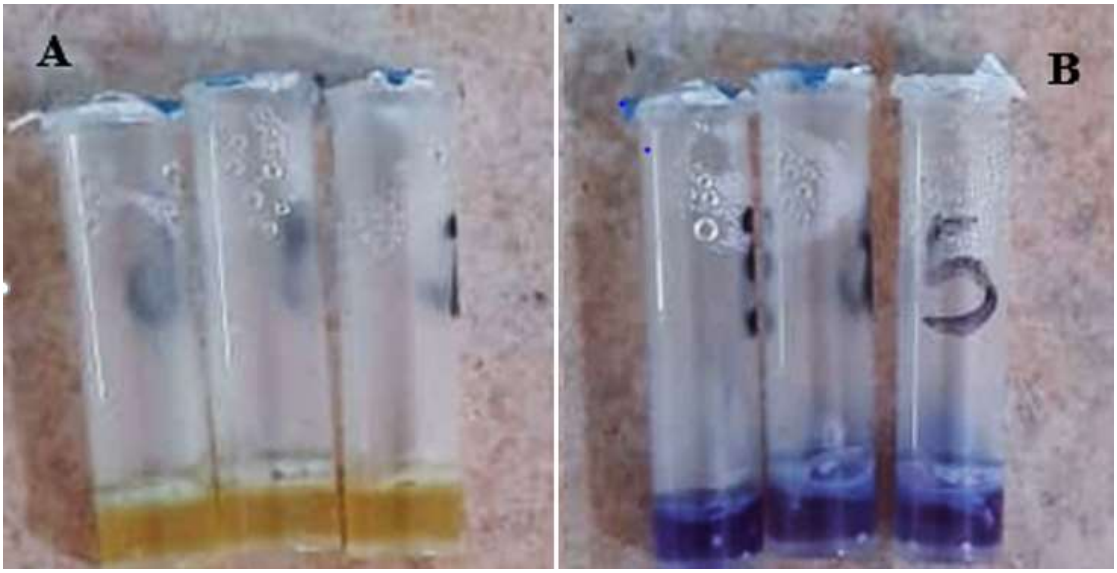

Figure 1: A) negative, B) positive Result: a purple color indicates the presence of antibiotics at or above the detection limits of the test

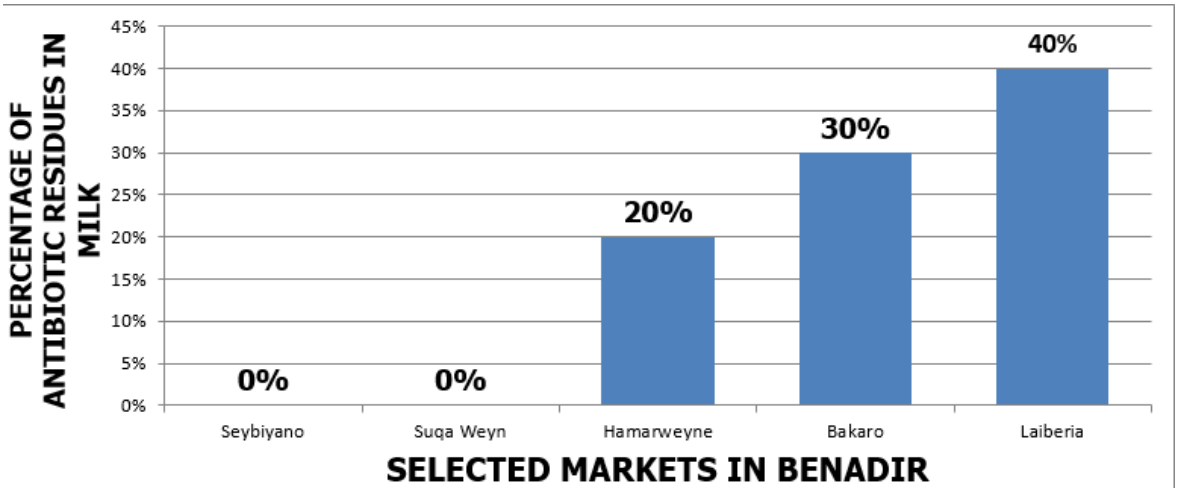

Figure 2: antibiotic residue of raw milk from markets in Benadir