Original Article

Journal of Food Safety and Hygiene

Journal homepage: http://jfsh.tums.ac.ir

Knowledge of farmers in antibiotic usage and investigation of antibiotic residues in meats in Sunyani Municipality, Ghana

Richard Akansale[1], Frederick Adzitey[1,2]*, Gabriel Ayum Teye[1]

[1]University for Development Studies, Faculty of Agriculture, Department of Animal Science, Box TL 1882, Tamale, Ghana.

ARTICLE INFO

Article history:
Received 06 May. 2019
Received in revised form
28 Aug. 2019
Accepted 14 Sep. 2019

Keywords:
Animals;
Antibiotics;
Farmers;
Meat;
Residues;
Sunyani

ABSTRACT

The pervasiveness of antibiotic residues in animal foods undermines the safety and security of consumers. The consequences on human health through the development of antibiotic resistance is a growing disquiet to veterinary, health practitioners and stakeholders. This study evaluates the knowledge of farmers in antibiotic usage and the presence of antibiotic residues in chevon (lamb meat) and beef in Sunyani, Ghana. A total of 150 farmers were randomly selected and interviewed using a semi-structured questionnaire. In addition, 36 samples comprising 18 beef and 18 chevon samples were analyzed for antibiotic residues using a Liquid Chromatography Mass Spectrometry. Majority of the farmers kept only goats (30%), practiced the semi-intensive system (96%), had ever experienced infections on their farm (99.3%) and had ever used antibiotics (100%). The farmers used antibiotics mainly for therapeutic purposes (68%), encountered more diarrhea cases (65.3%), and used mostly tetracycline (56.7%) to treat their animals because of its effectiveness (84%). Most of the farmers confirmed they do not have in-depth knowledge in antibiotics (56%), received information about antibiotics mainly from veterinary officers (56%) and bought their antibiotics from veterinary shops/clinics (62.7%). The majority do not observe withdrawal periods (53.3%), were unaware misuse of antibiotics can promote pathogen resistance (76.5%), but knew consumption of antibiotic residues in meat will be harmful to humans (60%). The examination of the beef and chevon samples revealed the presence of amoxycilin, chlorotetracycline, ciprofloxacin, danofloxacin, doxycycline, norfloxacin, oxytetracycline, sulfadiazine and tylosine at varying concentrations. Chloramphenicol and metronidazole were not detected in the meat samples. This study revealed that the farmers had limited knowledge in antibiotic usage and some antibiotic residues were present in chevon and beef sold in Sunyani, Ghana.

Citation: Akansale R, Adzitey F, Ayum Teye G, **Knowledge of farmers in antibiotic usage and investigation of antibiotic residues in meats in Sunyani Municipality, Ghana.** J food safe & hyg 2019; 5(3):155-164

1. Introduction

Antibiotics are vital bioactive and chemotherapeutic antimicrobial substances that either exist naturally, semi-synthetically or synthetically manufactured, and have the potential to annihilate or hinder the survival of bacterial pathogens (1,2). They are either administered therapeutically or sub-therapeutical where they play imperative roles such as boosting immune-system of animals, improving feed conversion efficiencies and reducing morbidity and mortality in animals (3-5).

Due to the roles antibiotics play in animal production, they are often used by some farmers in Ghana without adhering to recommended dosages, application times and withdrawal periods (6); likely increasing the risk of antibiotic residues in animal products. Antibiotic residues are minute remnants of drugs that remain and contaminate the edible tissues or products from treated animals. These residues defile the safety and wholesomeness of products like muscle meat, milk and eggs derived from animals that have undergone treatment (7-9) and poses deleterious effects on the health of the consumer (3,5). Vishnuraj et al. (10) indicated that issues of drug residues top on the global

*Corresponding author. Tel.: +233249995310
E-mail address: adzitey@yahoo.co.uk

meat market on issues of high profile food trade disputes.

Antibiotic residues have been found in pork, beef, chevon, mutton, chicken, milk, liver, kidney among others of farm animals (9-11). Studies have also shown that farmers have exhibited limited knowledge in antibiotic usage and/or misused antibiotics in animal production (6, 14-16). The maximum permissible levels of veterinary drugs have been recommended (17,18). Therefore, it is important to analyse animal products to know their levels and the actions to take. Several studies in Ghana have shown that microbes isolated from beef and chevon exhibited multidrug resistance to antibiotics and harboured resistance genes (19-27). However, there is limited studies on the knowledge of farmers in antimicrobial usage and antimicrobial residues in meat and meat products in Ghana. Therefore, this work reports on the knowledge of farmers on antibiotic usage and the occurrence of antibiotic residues in chevon and beef obtained from Sunyani, Ghana.

2. Materials and Methods

2.1. Location of study

This study was carried out in Sunyani, Ghana, which is the capital of Bono Region. Sunyani covers a land area of 507 km^2 and located between longitude 7 degrees 5'N and latitudes 7 degrees 20'N, and longitude 2 degrees 10'W and latitudes 2 degrees 30'W (28). It shares borders with Asutifi District to the South and Sunyani West District to the North, Tano North District to the East, and Dormaa Municipality and Dormaa East District to the West.

2.2. Questionnaire administration

One hundred and fifty (150) respondents who were livestock farmers selected randomly and interviewed using a semi-structured questionnaire through face-to-face interview. The questionnaire was pre-tested and the necessary modifications were made before final administration. The questionnaire was made up of both close and open ended questions and covered the types of animals, reared, farming systems and their knowledge in antibiotics. A sample of the questionnaire used can be found in appendix 1.

2.3. Determination of antibiotic residues

Beef and chevon samples were purchased from three different locations (Sunyani Central Market, Sunyani Abattoir and Abisim Market) in the Sunyani Municipality between October and December 2018. In all there were 41 meat sellers in the markets examined, out of which 36 meat sellers were sampled. Pooled samples (six samples each from each market) were randomly collected from these locations. In all 18 beef and 18 chevon samples were examined. Beef and chevon samples were packaged into sterile plastic bags, labelled and sent to the Pesticide Residues Laboratory of the Ghana Standard Authority (PRL-GSA) on ice for antibiotic residues analysis. Analysis for antibiotic residues was done using a Liquid Chromatography Mass Spectrometry (Agilent 6460/6420 Triple Quad, USA) by following the manufacturers' procedures as used by the PRL-GSA.

The antibiotic residues analysed was based on what was done by the PRL-GSA, and was independent of the answers farmers provided for the antibiotics they use on their farmers.

2.4. Data analysis

Data obtained from antibiotic residues was analysed with One-way ANOVA of Genstat 12.2 Release 12.1 Copyright 2009 and means were separated using standard error of means at 5% significance level. The results were presented in tables.

3. Results

3.1. Demographic characteristics and husbandry systems practiced by livestock farmers in the Sunyani Municipality of Ghana

The demographic characteristics and husbandry systems practiced by the farmers is shown in Table 1. Most of the farmers were males (83.3%), age between 40-49 years (45.3%) and had non-formal education (39.3%). The farmers kept their animals by the semi-intensive (96.0%), intensive (2.7%) and extensive (1.3%) systems. Most of the farmers kept only goat (30.0%), followed by goat/sheep (28.0%). Those who kept cattle/goat (1.3%) and cattle/sheep (2.0%) were the minority. Majority of the farmers had 6-10 years (36.0%), 3-5 years (28.7%) and above 10 years (23.3%) experience in keeping livestock. The farmers have ever encountered infections on their farm (99.3%), were able to identify the kind of infection (64.0%) and used antibiotics before (100.0%).

Table 1. Demographic characteristics and husbandry systems practiced by farmers in the Sunyani Municipality of Ghana

Variable	Number of farmers	Percentage
Gender		
Male	125	83.3
Female	25	16.7
Age		
20-29	9	6.0
30-39	30	20.0
40-49	68	45.3
50-59	30	20.0
60 and above	13	8.7
Educational level		
Non-formal	59	39.3
Primary	29	19.3
Junior High School	26	17.3
Senior High School	11	7.3
Tertiary	14	9.3
Others	11	7.3
Animal ownership		
Sheep only	34	22.7
Goat only	45	30.0
Cattle only	5	3.3
Goat/Sheep	42	28.0
Cattle/Goat	2	1.3
Cattle/sheep	3	2.0
Cattle/Sheep/Goat	19	12.7
Experience		
1-2 years	14	9.3
3-5 years	43	28.7
6-10 years	54	36.0
Above 10 years	35	23.3
No response	4	2.7
Husbandry systems		
Intensive	4	2.7
Semi-intensive	144	96.0
Extensive	2	1.3
Have you ever encountered any infections on your farm?		
Yes	149	99.3
No	1	0.7
Were you able to identify the kind of infection based on your own experience?		
Yes	96	64.0
No	54	36.0
Have you or has antibiotics ever been used on your farm?		
Yes	150	100.0
No	0	0.0

3.2. Types and purposes for using antibiotics by farmers in the Sunyani Municipality of Ghana

The types and purposes for which the livestock farmers use antibiotics are presented in Table 2. Tetracycline (56.7%) was the most common antibiotic used by the farmers, followed by gentamicin, (18.7%), amoxycline/clavunic and penicillin (16.7%). The least used antibiotics were chloramphenicol (1.3%), tylosin (3.3%) and sulfamethoxazole (3.3%). Ciprofloxacin and ceftriaxone were not found to be used by farmers. Among the pressing reasons for using the afore-mentioned antibiotics are their effectiveness (84.0%), ease of accessibility (62.0%), easy usage (34.0%) among others.

The antibiotics were also used for therapeutic (68.0%) and prophylaxis (31.3%) purposes rather than for growth promotion (0.0%). Most of these antibiotics were prescribed by veterinary officers (78.7%) instead of self-medication (21.3%).

3.3. Knowledge of farmers in antibiotic usage in the Sunyani Municipality of Ghana

The knowledge of the livestock farmers with regards to antibiotic usage is indicated in Table 3. According to table 3, 56.0% did not have in-depth knowledge in the antibiotics used on their animals either by themselves or veterinary officers. Those preview to information about antibiotic usage received it mostly from veterinary officers (56.0%) and their colleagues (28.0%). They also buy antibiotics mainly from veterinary clinics/shops (62.7%), treat their animals with antibiotics whenever they are sick (52.0%) and the treatment is mostly done by veterinary officers (46.7%). Most of the farmers read safety and dosage instructions (64.7%) and knew that consumption of meat containing antibiotic residues can be harmful to humans (60.0%). However, they did not observe withdrawal periods (53.3%), did not know that non-adherence to withdrawal periods can lead to accumulation of antibiotic residues in animals (72.0%) and promote development of resistant pathogens (76.5%).

Table 2. Types and purposes for using antibiotics by farmers in the Sunyani Municipality of Ghana

Variable	Number of Farmers	percentage
Veterinary officer prescription		
Yes	118	78.7
No	32	21.3
Purpose of antibiotic use		
Therapeutic	102	68
Prophylaxis	47	31.3
Growth promotion	0	0.0
No response	1	0.7
Clinical Signs		
Mastitis	19	12.7
Diarrhea	98	65.3
Nasal discharge	54	36.0
Coughing	18	12.0
Lameness	31	20.7
Profuse Salivation	40	26.6
Type of antibiotic		
Tetracycline	85	56.7
Gentamycin	28	18.7
Amoxycline/clavanic	26	17.3
Sulfamethoxazole	5	3.3
Penicillin	24	16.7
Ciprofloxacin	0	0.0
Tylosin	5	3.3
Chloramphenicol	2	1.3
Ceftriaxone	0	0.0
Reasons for usage of a particular antibiotic		
Effectiveness	126	84.0
Easily accessible	93	62.0
Easy to use	51	34.0
Cost effective	23	15.3
Colleagues advice	26	17.3
No response	1	0.6

3.4. Occurrence of antibiotic residues in chevon and beef samples in Sunyani, Ghana

The occurrence of antibiotic residues in the chevon and beef samples can be seen in Tables 4 and 5, respectively. Averagely, amoxycilin (18.0 µg/kg), chlorotetracycline (5.96 µg/kg), ciprofloxacin (15.69 µg/kg), danofloxacin (9.72 µg/kg), doxycycline (8.73 µg/kg), norfloxacin (13.45 µg/kg), oxytetracycline (9.75 µg/kg), sulfadiazine (1.28 µg/kg) and tylosin (17.40 µg/kg) were found in the beef samples. Chlorampenicol and metronidazole were not detected in the beef samples. Significant differences ($p>0.05$) did not occur in antibiotic residues among the beef samples collected from the various selling points except for ciprofloxacin. Ciprofloxacin was significantly higher ($p<0.05$) in beef samples collected from the abattoir than those collected from Sunyani Central Market and Abisim Market. Similarly, for chevon an average of 22.03, 6.61, 16.15, 9.75, 9.62, 14.00, 8.91, 1.28, and 17.35 µg/kg were detected for amoxycilin, chlorotetracycline, ciprofloxacin, danofloxacin, doxycycline, norfloxacin, oxytetracycline, sulfadiazine and tylosin, respectively. Chlorampenicol and metronidazole were also not detected in the chevon samples. Significant differences did not ($p>0.05$) occur among the antibiotic residues obtained from chevon samples from the various selling points except for chlorotetracycline and norfloxacin. Chlorotetracycline and norfloxacin were significantly higher ($p<0.05$) in chevon samples collected from the Central Market than those collected from the Sunyani Abattoir and Abisim Market.

Table 3. Knowledge of farmers in antibiotic usage in the Sunyani Municipality of Ghana

Variables	No of farmers	Percentage
In-depth knowledge in antibiotics		
Yes	57	38.0
No	84	56.0
No response	9	6.0
Source of information		
Extension officers	9	6.0
NGOs	1	0.7
Colleagues	42	28.0
Veterinary officers	84	56.0
Others	2	1.3
No response	12	8.0
Source of antibiotic		
Veterinary shops/clinics	94	62.7
Friends	3	2.0
Veterinary drug hawkers	34	22.7
Drug stores	11	7.3
No response	8	5.3
Frequency of treatment		
1-3 months	39	26.0
4-6 months	15	10.0
7-9 months	3	2.0
Whenever animals are sick	78	52.0
No response	15	10.0
Antibiotic administration		
Self	57	38.0
Veterinary officers	70	46.7
Both	22	14.7
No response	1	0.7
Read safety and dosage instructions		
Yes	97	64.7
No	47	31.3
No response	6	4.0
Observance of withdrawal period		
Yes	52	34.7
No	80	53.3
No response	18	12.0
Knowledge that misuse of antibiotics can promote development of resistant pathogens		
Yes	32	21.3
No	115	76.5
No response	3	2.0
Knowledge that improper adherence to withdrawal period can lead to accumulation of residues in animals		
Yes	38	25.3
No	108	72.0
No response	4	2.7
Knowledge that consumption of residues of antibiotics in animal edible tissues can be harmful to humans		
Yes	90	60.0
No	55	36.7
No response	5	3.3

Table 4. Prevalence of antibiotic residues in beef obtained from Sunyani Municipal, Ghana

Antibiotics (µg/kg)	Abattoir	Abisim Market	Central Market	Sem	p- value
Amoxycilin	17.16	19.27	17.58	2.33	0.192
Chlorotetracycline	5.96	5.93	5.98	0.13	0.760
Ciprofloxacin	16.57[a]	15.18[b]	15.31[b]	0.97	0.022
Danofloxacin	9.74	9.70	9.73	0.05	0.193
Doxycycline	8.57	8.61	9.02	0.59	0.260
Norfloxacin	13.49	13.41	13.46	0.08	0.138
Oxytetracycline	8.36	10.74	10.16	4.62	0.572
Sulfadiazine	1.28	1.28	1.27	0.02	0.842
Tylosin	17.32	17.53	17.35	0.26	0.264
Chloramphenicol	ND	ND	ND	ND*	ND*
Metronidazole	ND	ND	ND	ND*	ND*

Sem, standard error of means; ND, not detected; ND*, not done; Means with the same superscript along the same columns are significant at $p<0.05$ and vice versa.

Table 5. Prevalence of antibiotic residues in chevon (lamb meat) obtained from Sunyani Municipal, Ghana

Antibiotics(µg/kg)	Abattoir	Abisim Market	Central Market	Sem	p-value
Amoxycilin	21.60	21.90	22.60	7.68	0.965
Chlorotetracycline	6.03[b]	6.27[b]	7.54[a]	0.83	0.005
Ciprofloxacin	15.72	16.46	16.26	1.21	0.474
Danofloxacin	9.72	9.75	9.77	0.06	0.331
Doxycycline	8.77	9.16	10.94	1.89	0.079
Norfloxacin	13.47[b]	13.67[b]	14.85[a]	0.73	0.004
Oxytetracycline	8.32	8.93	9.49	0.94	0.075
Sulfadiazine	1.27	1.28	1.30	0.02	0.174
Tylosin	17.35	17.33	17.37	0.05	0.368
Chloramphenicol	ND	ND	ND	ND*	ND*
Metronidazole	ND	ND	ND	ND*	ND*

Sem, standard error of means; ND, not detected; ND*, not done; Means with the same superscript along the same columns are significant at $p<0.05$ and vice versa

4. Discussion

Ruminant production is in Sunyani Municipality was dominated by males, the youth, and people with non-formal education. Similarly, to this work Pham-Duc et al. (29) found that males (70.9%) and 30-60 years' age group (82.1%) dominated in livestock and aquaculture production in Vietnam. However, they found that most of the farmers had secondary school education (53.8%). Ministry of Food and Agriculture (30) confirmed that the intensive, semi-intensive and extensive systems are the three main ruminant farming systems in Ghana. Ministry of Food and Agriculture (30) also indicated that ruminant production is changing progressively from extensive to semi-intensive system. In Ghana, Animal Production Directorate (31) reported that farmers adopted the semi-intensive or extensive systems of keeping animals and mostly kept more than one animal species under small farm size holdings. This study also found that, the farmers kept either single or combined ruminant species; sometimes under unhygienic conditions exposing animals to infections and subsequently the use of antibiotics. The factors which influenced the type of ruminants kept by farmers included financial capability, ease of management/experience, availability of rearing space, ease of marketability, selling price and the animals' ability to resist diseases. Goats and sheep in relative terms are cheaper to keep, require less space, easy to manage among others compared to cattle, causing farmers to keep more of these ruminants. Nwanta *et al.* (32) also found that 84% of farmers in Enugu State, South eastern Nigeria, engaged in livestock production especially goats and sheep due to their profitability and procreative potentials. In this study, it was observed that non-availability of grazing land largely hindered cattle production. Only farmers who lived at the outskirts and 'Zongos' of Sunyani managed to keep some cattle. Olafadehan and Adewumi (33) also observed that, lack of grazing land in urban centers was a major constraint to the rearing of cattle. Most of the farmers had many years of experience in raising ruminants and thus were able to identify some animal diseases by themselves. Their years of experience in animal production also contributed to the reason for using antibiotics by themselves.

In North Eastern Nigeria, Mamza et al. (34) indicated that 67% farmers had ≤ 5year experience in animal rearing and 75.0% of then used antibiotics to treat their animal.
Farmers used tetracycline most in this study due to its effectiveness. The use of tetracycline by farmers is consistent with other studies. In the United States of America, Katharine (35) indicated that tetracycline was one of the most common antibiotics used in cattle feedlot. Tetracycline (25.0%) and penicillin (19.5%) were the most common antibiotics used by livestock farmers in Nigeria (34). Alo and Ojo (36) also reported a high level of application of tylosin, neomycin, streptomycin, quinolones and gentamycin by poultry farmers in Nigeria. In the present study, farmers mostly used antibiotics for prophylactic and therapeutic purposes and not as growth enhancers, which is similar to that observed by Sasanya et al. (37)in Kampala, Uganda. The use of antibiotics for prophylactic purposes has contributed immensely to the increase in the development of antibiotic resistance and therefore, farmers should be discouraged from the over-reliance on antibiotics for prophylactics. The clinical signs which necessitated the use of antibiotics in order of magnitude were diarrhoea, nasal discharge, profuse salivation, lameness, mastitis, and coughing.The effectiveness of the antibiotics had an immense influence on their use and application by livestock farmers in the Municipality to control diseases and clinical signs observed. It is a good practise for most of the farmers to rely on veterinary officers for their prescription. Similarly, Kamini et al. (38) found that most (75.5%) poultry farmers in Cameroon depended on veterinary officers for the administration of antibiotics, while few (24.5%) administered antibiotics without prescription by veterinary officers. The years of experience farmers had in animal production enabled them to have knowledge in antibiotic usage and exposure to services that provided same. Non-formal educational background of most of the farmers could be major factor to farmers' not observing withdrawal periods. Although some educated farmers read safety instructions, they did not follow it because they did not know it will lead to accumulation of antibiotic residues.

In most communities in Ghana, farmers sell their animals when they are cash trap to solve immediate family needs or do so to prevent losing their sick animals to death, making them not to be concerned about withdrawal periods prior to selling their animals. The results of this study is comparable with other studies. In Nigeria, poultry farmer's acquired their antibiotics from pharmacy shops (91.4%) or drug hawkers (8.6%), and depended on veterinary officers' prescription (50.0%) or self-medication (43.0%) (39). Self-medication was very common among poultry farmers in Sudan, due to the acquisition of drugs sometimes without authorized prescription (40). In Ghana, Ekli *et al.* (6) found that most ruminant framers (73.2%) in the Wa municipality did not observe withdrawal periods. Ekli et al. (6) also observed that the farmers had knowledge on antibiotic administration (63%), acquired the knowledge through veterinary officers (51%), colleagues (29%) and extension officers (20%), and relied on veterinary officers for antibiotic administration (51%), self-administration (18%) or both (31%). In Mymensingh district of Bangladesh, Ferdous et al. (16) reported that farmers (94.16%) use antibiotics without following withdrawal periods. They also indicated that only 39.1% of farmers had knowledge on antibiotic residues. Knowledge on the use of antibiotics is essential to avoid its abuse. Antibiotic residues in meats will contribute to limiting the effectiveness of antibiotics in the treatment of humans. Furthermore, the toxicity and side effects of antibiotics in humans and animals is a threat to public health. It is therefore imperative to monitor residue levels in meats and meats products to help curb the situation. In this study, tetracycline, amoxycline/clavanic, penicillin, ciprofloxacin and tylosin residues were found in the beef and chevon samples, this could be associated with their utilization by farmers in this study. It was also evident that farmers used some antibiotics for example, sulfadiazine to control both bacteria and protozoa infections. Interestingly, chloramphenicol was used by farmers but was not found in the meat samples examined. Nonetheless this antibiotic residue could be present below detectable limit.

The mean oxytetracycline residues were 372.7 µg/kg (kidney), 1197.7 µg/kg (liver) and 51.8 µg/kg (muscle) in a study carried out in Akure, Nigeria (41). Ramatla *et al.* (42) indicated that high performance liquid chromatography (HPLC) detected antibiotic residue concentrations of 120.8 ± 3.3 µg/kg for streptomycin, 45.8 ± 35.1 µg/kg for sulphanilamide, 52.3 ± 22.2 µg/kg for tetracycline, and below detectable limit for ciprofloxacin. Furthermore, enzyme-linked immunosorbent assay (ELISA) detected concentrations of 110.3 ± 9.4 µg/kg for ciprofloxacin, 770.6 ± 325.6 µg/kg for streptomycin, 65.3 ± 0.00 µg/kg for sulphanilamide, and 48.6 ± 30.2 µg/kg for tetracycline in the raw beef muscles. Overall, ELISA detected ciprofloxacin (93.0%), streptomycin (33.3%), sulphanilamide (6.6%) and tetracycline (20.0%), HPLC detected ciprofloxacin (0.0%), streptomycin (0.0%), sulphanilamide (6.6%) and tetracycline (0.0%), and thin-layer chromatography (TLC) ciprofloxacin (0.0%), streptomycin (0.0%), sulphanilamide (6.6%) and tetracycline (0.0%) in beef samples (42). The antibiotic residue concentrations found in this study were generally lower than that of Olufemi and Agboola (41) and Ramatla et al. (42). The recommended maximum residues limits are 200 µg/kg for chlortetracycline, danofloxacin and oxytetracycline, 100 µg/kg for ciprofloxacin, doxycycline, sulfadiazine and tylosin, 50 µg/kg for amoxycilin, and 0 µg/kg or undetectable for norfloxacin and chloramphenicol (17,18). In this study the antibiotic residues ranged from 0-19.27 µg/kg for beef and 0 to 22.60 µg/kg for chevon, therefore, they all had safe level of residues.

5. Conclusion

Most of the ruminant farmers in the Sunyani Municipality, Ghana did not have in-depth knowledge in antibiotics. They used antibiotics for therapeutic purposes, and mainly use tetracycline due to its effectiveness. Majority also did not observe withdrawal periods but read safety instructions on antibiotic usage. Furthermore, most of the farmers kept only goats under the semi-intensive and had ever used antibiotics.

Amoxycilin, chlortetracycline, ciprofloxacin danofloxacin, doxycycline, norfloxacin oxytetracycline, sulfadiazine and tylosin except chloramphenicol and metronidazole were detected in chevon and beef samples. The concentration of antibiotic residues varied among the different selling points. Overall, the average antibiotic residues concentration was 9.09% µg/kg for beef and 9.61 µg/kg for chevon. Antibiotic residues in meat is a serious public health concern due to its detrimental effects on consumers wellbeing. However, the concentrations of the various antibiotics residues were below the maximum residue limit and can be considered safe for human consumption. Further research will look at other meat types and markets in the Sunyani Municipality.

Conflict of interests

The authors declare no conflict of interest.

Acknowledgment

The authors are grateful to the University for Development Studies and the Ghana Standard Authority for their assistance with the antibiotic residue analysis.

References

1.Barton MD. Antibacterial use in animal feed and its impact on human health. Nutr Res Rev 2000; 13: 279-299.

2. Macarov ACA, Tong BL, Martinez-Huélamo CM, *et al*. Multi residue determination of the penicillins regulated by the European Union, in bovine, porcine and chicken muscle, by LC–MS/MS. Food Chem 2012; 135: 2612-2621.

3.Hao H, Cheng G, Iqbal Z, *et al*. Benefits and risks of antimicrobial use in food-producing animals. Frontiers in Microbiol 2014; 5: 1-11.

4. Swatantra S, Shukla S, Tandia N, *et al*. Antibiotic residues: A global challenge. Pharma Sci Mon 2014; 5:184-197.

5. Baynes RE, Keith D, Lindsey K, *et al*. Health concerns and management of select veterinary drug residues. Food & Chem Toxicol 2016; 88: 112-122.

6. Ekli R, Adzitey F, Agbolosu, AA. Farmers' knowledge in antibiotic usage, antibiotic residues, and susceptibility of *Salmonella enterica* in beef samples from the Wa Municipality, Ghana. Bull. Anim Health Prod Afr 2020; 68: 89-101.

7. Manyi-Loh C, Mamphweli S, Meyer E, *et al*. Antibiotic use in agriculture and its consequential resistance in environmental sources: Potential Public Health Implications Molecules 2018; 23:1-48.

8. Ebner PD, Ghoryar MA, McNamara K, *et al*. Quality and safety assessment of raw bovine milk in Herat province, Afghanistan. J Food Safe & Hyg 2016; 2:15-20.

9. Mousavi S, Jahed-Khaniki G, Rezaie S, *et al*. Evaluation of some screening tests for detection of β-lactams residues in milk production chain. J Food Safe & Hyg 2015; 1:22-25.

10. Vishnuraj MR, Kandeepan G, Rao KH, *et al*. Occurrence, public health hazards and detection methods of antibiotic residues in foods of animal origin: a comprehensive review. Cogent Food & Agri 2016; 2:1235458.

11. Al-Ghamdi M, Al-Mustafa Z, El-Morsy F, *et al*. Residues of tetracycline compounds in poultry products in the eastern province of Saudi Arabia. Public Health 2000; 114: 300-304.

12. Alla, MBW, Mohamed, TE, Abdelgadir, AE. Detection of antibiotics residues in beef in Ghanawa Slaughterhouse, Khartoum State, Sudan. Afric J Food Sci 2011; 5: 574-580.

13. Jabbar A, Rehman SU. Microbiological evaluation of antibiotic residues in meat, milk and eggs. J Microbiol, Biotechnol & Food Sci 2013; 2: 2349-2354.

14. Ngom RRBV, Tomdieu T, Ziébé R, *et al*. Quality of veterinary pharmaceuticals and their use by pastoralists in the Far North Region of Cameroon. Pastoralism 2017; 7:1-6.

15. Majekodunmi AO, Dongkum C, Idehen C, *et al*. Participatory epidemiology of endemic diseases in West African cattle – Ethnoveterinary and bioveterinary knowledge in Fulani disease control. One Health 2018; 5:46-56.

16. Ferdous J, Sachi S, Noman ZA, *et al*. Assessing farmers' perspective on antibiotic usage and management practices in small-scale layer farms of Mymensingh district, Bangladesh. Vet World 2019; 12:1441-1447.

17. Codex Alimatarius. Maximum residue limits (MRLS) and risk management recommendations (RMRS) for residues of veterinary drugs in foods (CX/MRL2-2018). Available at: http://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FStandards%252FCXM%2B2%252FMRL2e.pdf; 2018. Cited: December, 17, 2019.

18. Anonymous. Standards of the Maximum Residue Limits and Prohibited Compounds in Livestock Products Available at: http://cexgan.magrama.es/Documentos/Standards ResidueLimitsCorea.pdf; 2019. Cited: December 17, 2019.

19. Adzitey F, Nsoah, JK, Teye G. Prevalence and antibiotic susceptibility of Salmonella species isolated from beef and its related samples in Techiman Municipality of Ghana. Turkish J Agri - Food Sci & Technol 2015; 3: 644-650.

20. Rasmussen MM, Opintan JA, Frimodt-Møller N, *et al*. Beta-lactamase producing *Escherichia coli* isolates in imported and locally produced chicken meat from Ghana. PloS One, 2015; 10: e0139706.

21. Adzitey F, Assoah-Peprah P, Teye GA. Whole genome sequencing of *Escherichia coli* isolated from contaminated meat samples collected from the Northern Region of Ghana revealed the presence of multidrug resistant genes. J Global Antimicrob Resist 2019a; 18: 179-182.

22. Adzitey F, Ekli R, Abu A. Prevalence and antibiotic susceptibility of *Staphylococcus aureus* isolated from raw and grilled beef in Nyankpala community

in the Northern Region of Ghana. Cogent Food & Agri 2019b: 5; 1-8.
23. Anning AS, Dugbatey AA, Kwakye-Nuako G, *et al*. Antibiotic susceptibility pattern of enterobacteriaceae isolated from raw meat and Ghanaian coin currencies at Cape Coast metropolis, Ghana: The public health implication. The Open Microbiol J 2019; 13:139-145.
24. Dekker D, Eibach D, Boahen KG, *et al*. Fluoroquinolone-Resistant *Salmonella enterica*, *Campylobacter spp*., and *Arcobacter butzleri* from local and imported poultry meat in Kumasi, Ghana. Foodborne Pathogen Dis 2019; 16: 352-358.
25. Tay MYF, Adzitey F, Sultan SA, *et al*. Whole-genome sequencing of nontyphoidal *Salmonella enterica* isolates obtained from various meat types in Ghana. Microb Res Announc 2019; 8: e00033-19.
26. Adzitey F, Ekli R, Aduah M. Incidence and antibiotic susceptibility of *Staphylococcus aureus* isolated from ready-to-eat meats in the environs of Bolgatanga Municipality of Ghana. Cogent Environ Sci 2020; 6:1791463.
27. Adzitey F, Teye GA, Amoako DG. Prevalence, phylogenomic insights, and phenotypic characterization of *Salmonella enterica* isolated from meats in the Tamale metropolis of Ghana. Food Sci & Nutr 2020; 00:1-9.
28. Ghana Statistical Service (2010). Population and housing census. Available at: http://www2.statsghana.gov.gh/docfiles/2010_District_Report/Brong%20Ahafo/Sunyani%20Municipal.pdf; 2012. Cited: December 17, 2019.
29. Pham-Duc P, Cook MA, Cong-Hong H, *et al*. Knowledge, attitudes and practices of livestock and aquaculture producers regarding antimicrobial use and resistance in Vietnam. PLoS ONE 2019; 14:1-21.
30. Ministry of Food and Agriculture. Ghana livestock development, policy, and strategy. Available at: http://agricinghana.com/wp-content/uploads/2017/07/ghana-livestock-development-policy-and-strategy.pdf; 2016. Cited: December 17, 2019.
31. Animal Production Directorate. State of Ghana's Animal Genetic Resources. Available at: http://www.fao.org/tempref/docrep/fao/011/a1250f/annexes/Country Reports/Ghana.pd; 2003. Cited: December 17, 2019.
32. Nwanta JA, Shoyinka SVO, Chah KF. Production characteristics, disease prevalence, and herd-health management of pigs in Southeast Nigeria. J Swine Health & Product 2011; 19: 331-339.
33. Olafadehan OA, Adewumi MK. Livestock management and production system of agropastoralists in the derived savanna of South-West Nigeria. Tropic & Subtropic Agroecosys 2010; 12: 685-691.
34. Mamza SA, Geidam YA, Mshelia GD, *et al*. Antimicrobial usage in livestock management in NorthEastern Nigeria: A survey of livestock farmers. Int J Sci & Res Methodol 2017; 8:149-172.
35. Katharine MB. Antimicrobial resistance surveillance in feedlot cattle. PhD Thesis submitted to Department of Clinical Sciences, Colorado State University, United States of America; 2011.
36. Alo OS, Ojo O. Use of antibiotics in food animals; a case of a major veterinary outlet in Ekiti State, Nigeria. Nigerian Vet J 2007; 28:80-82.
37. Sasanya JJ, Okeng JWO, Ejobi F, *et al*. Use of sulfonamides in layers in Kampala district, Uganda and sulfonamide residues in commercial eggs. Afric Health Sci 2005; 5: 33-39
38. Kamini MG, Keutchatang FT, Mafo HY, *et al*. Antimicrobial usage in the chicken farming in Yaoundé, Cameroon: a cross-sectional study. Int J Food Contamin 2016; 3:1-6.
39. Oluwasile BB, Agbaje M, Ojo OE, *et al*. Antibiotic usage pattern in selected poultry farms in Ogun state. Sokoto J Vet Sci 2014; 12: 45-50.
40. Eltayb A, Barakat S, Marrone G, *et al*. Antibiotic use and resistance in animal farming: a quantitative and qualitative study on knowledge and practices among farmers in Khartoum, Sudan. Zoonos Pub Health 2012; 59: 330-338.
41. Olufemi OI, Agboola EA. Oxytetracycline residues in edible tissues of cattle in Akure, Nigeria. Nigerian Vet J 2010; 31:93-102.
42. Ramatla T, Ngoma L, Adetunji M, *et al*. Evaluation of antibiotic residues in raw meat using different analytical methods. Antibiotic 2017; 6:1-17.