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Assessment of the presence of antibiotic residues in meat from small-scale broiler farms in the Pwani region of Tanzania

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Abstract

The unregulated use of veterinary drugs, particularly antibiotics, on Tanzanian broiler farms is widespread. Still, little attention has been paid to the factors that promote the presence of antibiotic residues in broiler meat. This study aimed to identify rearing practices likely to favour the presence of antibiotic residues and to determine the presence of residues of commonly used antibiotics in broiler meat. The length of the rearing period, poultry pathologies and the type of veterinary medicines used were studied on 78 farms in the Pwani region (Tanzania). The results showed that infectious coryza, coccidiosis, chronic respiratory diseases, salmonellosis and omphalitis were the most common diseases. Of the veterinary medicines used to treat these diseases, antibiotics were the most widely used (69 %), mainly enrofloxacin (ENO), limoxin (LX), oxytetracycline (OTC), tylosin (TS) and tylodox (TDX). Eight farms were selected to take broiler meat samples for laboratory analysis of residues of these five antibiotics. These analyses revealed that all but one of the samples were negative. Samples taken from four-week-old birds tested positive for another antibiotic, sulfamethazine (SF), which was not initially one of the five antibiotics selected for this study. This study highlighted the significant use of veterinary drugs in response to various diseases. The absence of antibiotic residues can be attributed to the age of the animals sampled, as at over 5 weeks they would have had time to eliminate the drugs. A rearing period of four weeks is insufficient and would be a factor favouring the presence of drug residues in broiler meat.

Keywords: Antibiotics, avian diseases, LC-MS/MS, poultry meat, rearing length

1 Introduction

Animal health involves the use of either naturally produced or synthesised antibiotics to prevent (prophylaxis), treat (antibiotic therapy) or control diseases (metaphylaxis) (Taylor & Walker, 1956; Kantati, 2011; Oufella & Smail, 2012; Buket *et al*., 2013; Mensah *et al*., 2014; Mohamed Said, 2015; Okombe *et al*., 2016; Prajapati *et al*., 2018; Zamouma *et al*., 2020; Moga *et al*., 2021; Azabo *et al*., 2022). They are also used as growth stimulants in poultry farming to increase productivity while reducing the stress associated with farming (zootechnical activities, vaccination) and the impact of disease (Zerbo, 2014; Agbodossindji *et al*., 2018; Ahmed et Ben Hamida, 2019).

Although there are several families of antibiotics, the most commonly used in poultry farming are tetracyclines, B-lactams, macrolides, quinolones and sulphonamides (Messaï, 2006; Chafer-Pericas *et al*., 2010; Oufella & Smail, 2012; Renaud, 2012; Mohamed Said, 2015; Ramatla *et al*., 2017; Ahmed & Ben Hamida, 2019; Kumar *et al*., 2020; Moga *et al*., 2021).

Antibiotics offer many advantages, but their inappropriate and uncontrolled use has harmful consequences (antibiotic resistance, presence of antibiotic residues in animal products, environmental contamination, etc.) (Hinton, 1988; Parent, 2009; Zerbo, 2014; Bagré *et al*., 2015; FAO, 2015; Gaudin, 2016; Okombe *et al*., 2016; Ramatla *et al*., 2017; Agbodossindji *et al*., 2018; Vana *et al*., 2020; Mdegela *et al*., 2021; Sangeda *et al*., 2021).

Furthermore, uncontrolled use of these veterinary products has been observed in Tanzanian poultry farming, particularly commercial poultry (broilers and layers), despite the existence of regulations on the use of antibiotics. This

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is primarily due to easy access to antibiotics, inappropriate use, incorrect dosage, and non-compliance with withdrawal periods, which is the minimum period between the administration of a drug to poultry and its slaughter (Mdegela *et al*., 2021; Sangeda *et al*., 2021). Antibiotic residues in poultry products have already been reported in several African countries (Egypt, Ethiopia, Ghana, Kenya, South Africa, Sudan, and Tanzania). This increased and uncontrolled use of antibiotics exposes consumers of poultry products to health risks (hypersensitivity reactions, cancer, bacterial resistance in humans, toxicity, allergies, changes in the intestinal flora, etc.) (Wouembe, 2013; Zerbo, 2014; Mohamed Said, 2015; Gaudin, 2016; Vana *et al*., 2020). In addition, in developing countries such as Cameroon, Ghana and Kenya, the absence, inefficiency or lack of regulations governing the circulation and use of veterinary products contributes to the growing and uncontrolled use of antibiotics (Oufella & Smail, 2012; FAO, 2015; Ahmed & Ben Hamida, 2019; Kimera *et al*, 2020; Vana *et al*., 2020; Mdegela *et al*., 2021; Mshana *et al*., 2021; Sangeda *et al*., 2021; Mouiche *et al*., 2022; Mudenda *et al*., 2022). To protect public health, sanitary control of animal products (microbiological contaminants, antibiotic residues, etc.) is essential. Similar considerations apply to the development and effective implementation of legislation and policies aimed at controlling the circulation, quality and use of antibiotics (Mensah *et al*., 2014; Kimera *et al*., 2020; Zamouma *et al*., 2020; Oyedeji *et al*., 2021).

Many studies, including those carried out in Tanzania, have focused on the detection of antibiotic residues in poultry meat and their possible contribution to the development of microbial resistance (Nonga *et al*., 2009; Nonga *et al*., 2010; Vana *et al*., 2020; Mdegela *et al*., 2021; Sangeda *et al*., 2021; Ulomi *et al*., 2022; Getahun *et al*., 2023; Mohammed *et al*., 2023; Nouri and Salehi, 2023; Hedges *et al*., 2024; Marsini *et al*., 2024; Tek *et al*., 2024). However, little has been reported on the contribution of farming practices (inappropriate use, incorrect dosage, non-compliance with withdrawal periods) to the use of antibiotics and the presence of antibiotic residues in poultry meat. In addition, previous studies (Gomez & Mbaga, 2023; Gomez & Mbaga, 2024) have shown an average level of biosecurity and a high cost of treatment for avian diseases on broiler farms in the Pwani region, suggesting that these farmers purchase and use large quantities of veterinary medicines. The aim of this study was, therefore, to determine the presence of residues of the five antibiotics commonly used on these farms in broiler meat and to identify the farming practices likely to lead to contamination of broiler meat by antibiotic residues in the study region.

2 Materials and methods

2.1 Study area

This study was carried out in the Pwani region, specifically in Kibaha Council Town and the adjacent town of Mlandizi. In Tanzania, commercial poultry farming is mainly practised in Dar es Salaam, Pwani, Arusha, Mwanza and Tanga regions, with the Pwani region having the highest number of commercial poultry farms (layers or broilers) (FAO, 2007).

Geographically, situated in the middle Eastern side of Tanzania's Mainland, the Coast or Pwani Region is between S6°-8° and E37°30-40. Dar es Salaam Region and the Indian Ocean are boarded by Pwani Region in the East, North by Tanga Region, South by Lindi and West by Morogoro Region. It is in these areas that small and medium-sized broiler rearing is most widespread in the Pwani region.

2.2 Choice of sampling method

To identify the farms where broiler meat samples were acquired in the Pwani region, the non-probability sampling method known as "snowball sampling" (Orounladji *et al*., 2022) was used. This sampling method was chosen due to the lack of precise statistical data on the broiler population and the number of broiler farmers in Tanzania (FAO, 2007; Msoffe *et al*., 2018; EKN, 2020). It is a sampling method based on networking (Kone *et al*., 2018). As a result, the first farmer to be surveyed then nominated other farmers in the same area who could also be surveyed (Marpsata & Razafindratsima, 2010; Kouassi *et al*., 2019).

2.3 Sampling design

This study is subdivided into three parts: (i) the field survey (which collected information on the respondents' rearing practices); (ii) the collection of broiler meat samples (for laboratory analysis); and (iii) the laboratory analysis phase (for the presence of residues of the top five antibiotics most commonly used by respondents in the study area).

2.4 Phase one: Field survey

A total of 78 broiler farmers were interviewed individually using a questionnaire. The questionnaire administered included questions relating to the length of time broilers have been reared in the Pwani region, the diseases affecting broiler flocks and the veterinary medicines used to treat the diseases. Additional questions were also administered to farmers in the Pwani region, such as the type of treatment (no treatment of diseases, treatment by a veterinarian, endogenous treatment and self-medication) practised by respondents, the reasons for using veterinary medicines, and the frequency of use of veterinary medicines. The survey was conducted over three months (November 2021 to January 2022).

2.5 Phase two: Collection of broiler meat samples

Based on the preliminary results of our questionnaires, we selected eight farms for meat sampling: the farms selected for broiler meat collection were those that used at least two of the five antibiotics considered in the search for antibiotic residues in meat and that had birds ready for disposal. On the eight farms selected according to the above two characteristics, a sample of three broilers aged between four and six weeks per farm was taken, giving a sample size of n = 24. After the broilers had been slaughtered, 100 g of the breast from each chicken was taken, stored in a zip-lock bag, labelled accordingly and then immediately stored in a cooler with ice cubes before being transported to the laboratory (Nonga *et al.*, 2009).

2.6 Phase three: Laboratory analysis

2.6.1 Laboratory analysis method

The samples were taken to the Government Chemist Laboratory Authority-Tanzania (GCLA-Tanzania) for analysis. The meat samples collected were analysed using liquid chromatography-tandem mass spectrometry (LC-MS/MS). In this study, and given the circumstances in the field, this method was only used to screen for the antibiotics under investigation (ENO, OTC, LX, TS and TDX). LC-MS/MS was chosen because it is a modern, rapid method that is widely used for screening for tetracyclines, quinolones and macrolides (the families to which the antibiotics investigated in this study belong) and for detecting multi-residues (Granelli *et al.*, 2009; Parent, 2009; Chafer-Pericas *et al.*, 2010; Kantati, 2011; Renaud, 2012; Zamouma *et al.*, 2020).

2.6.2 Reagents and devices used in laboratory analysis

The reagents used for antibiotic residue detection in these broiler breast meat samples are 70 % methanol (HPLC grade), acetonitrile (ACN) (HPLC grade), formic acid, Milli Q water and 0.1 M EDTA. Apparatus and supplies used during this laboratory analysis are: weigh balance; Votex machine; nitrogen evaporator and nitrogen generator; centrifuge machine 4000 rpm and microcentrifuge 13000 rpm; 1000 μl micropipette and 1000 μl sterile tips; laboratory blender; scissor; tongs; timer; conical centrifuge tubes 15 ml and 50 ml, beaker 50 ml, 100 ml and 500 ml, Eppendorf tubes 1500 μl, 1500 μl LC vial, test tubes, graduated measuring cylinder 10 ml, 50 ml and 100 ml.

2.6.3 Sample preparation

The samples were extracted at one go with 70 % methanol, diluted with distilled water and injected into the LC-MS/MS following the procedure of Granelli *et al.* (2009) and adapted for this study. The chromatography was performed on a Hypersil Gold aQ C18 column (2.1*100 mm, 1.9 μm). For the mobile phase, 0.1 % formic acid in Milli Q water 0.1 % (mobile phase A) and formic acid in acetonitrile (mobile phase B) were used. The gradient was from 5 % B to 100 % B in 13 min, was maintained at 100 % B until 20 min and returned to 5 % B at 30 min. Each injection lasted 7 minutes and the flow rate and injection volume were 0.3 ml min^{-1} and 10 μl, respectively. The temperature of the column was 40 °C. To obtain the 0.1 M EDTA, 37.224 g EDTA was dissolved in water in a 1000 ml volumetric flask. Then, the flask was filled with distilled water until the graduation limit was reached. The 70 % methanol was obtained by mixing 350 ml Methanol with 150 ml water in a 500 mL volumetric flask. The 0.1 % Formic acid used in mobile phase A was obtained by adding 500 μl of formic acid to 499.5 ml of distilled water. 0.1 % formic acid used in mobile phase B was obtained by adding 500 μl of formic acid to 499.5 ml of acetonitrile. In summary, 200 μl of 0.1 M EDTA (ethylenediaminetetraacetic acid) was added to 2 g of homogenised tissue. After spiking, the antibiotics were extracted from the tissue using 5 ml of 70 % methanol. After extraction, the samples were centrifuged at 4,000 rpm for 10 minutes. The supernatant was concentrated to 1 ml in the nitrogen evaporator; then transferred to a 1500 ml Eppendorf tube and centrifuged again at 13,000 rpm for 5 minutes. After centrifugation, 800 ml of the contents were transferred to a 1,500 ml Eppendorf tube and vortexed. Finally, 10 ml of the contents of the 1500 ml vial were removed and injected into the LC-MS/MS machine for analysis. In addition to the LC vials containing the extracts of the 24 tissue samples to be analysed, other LC vials containing a spiked sample and a blank sample were added. The spiked sample was prepared following the same procedure but was free of animal tissue. A blank sample was only solvents without adding a sample was used as method blank. 200 μl of 0.1 M EDTA was taken to a 15 ml conical centrifuge tube and put in the dark for 15 mins then followed all other steps as a sample.

2.7 Statistical analysis

The analysis of the data in this study focused on descriptive statistics, as these correspond best to the results of the survey and laboratory analysis. The data collected was stored and processed in an Excel spreadsheet (Microsoft Corporation, WordNet 3.0 Copyright 2006 by Princeton University, Version 2023).

3 Results

Overall, chicken rearing (the main source of income on the farms surveyed) was combined with other income-generating activities such as farming. On average, farmers in the region were 52 years old and had been rearing broilers for about 9 years. The domestic animals reared on the surveyed farms were not limited to broilers. Local chickens, laying hens and other animals such as cattle, sheep and rabbits were also present.

Table 1 indicates the avian diseases identified in this study. The most common were infectious coryza, coccidiosis, chronic respiratory disease, salmonellosis, and omphalitis (Table 2). Most of these diseases occurred during the first two weeks of rearing, except for coccidiosis and Newcastle disease, which could happen at any time during the rearing period. According to the interviewees, the type of treatment frequently used was treatment prescribed by a veterinary officer or self-medication (use of a veterinary product on the breeder's own initiative to treat diseases without consulting an animal health officer).

Table 1: *Categorisation of diseases found on the 78 surveyed broiler farms in the Pwani region (Tanzania).*

Cause of disease	*Disease*
Bacteria	Infectious coryza Chronic respiratory disease Salmonellosis
Virus	Infectious bursal disease or Gumboro Newcastle Disease
Parasites	Coccidiosis
Mismanagement	Omphalitis
Nutritional deficiencies	Deficiency of minerals

Table 2: *Categorisation of diseases found on the 78 broiler farms surveyed in the Pwani region (Tanzania).*

Disease	*Freq.**	*Treatment*†
Infectious coryza	54	1, 3
Coccidiosis	43	1, 3
Chronic respiratory disease	15	1, 2
Salmonellosis	14	1, 3
Omphalitis	10	1, 3
Deficiency of minerals	4	1, 3
Infectious bursal disease or Gumboro	3	1, 2, 3
Newcastle Disease	1	2, 3

*Frequency of citations; †0: no treatment; 1: veterinarian; 2: traditional treatment; 3: self-medication.

The treatment of these diseases involved the use of veterinary medicines, especially antibiotics (69 % of veterinary drugs used) by most of the respondents (Fig. 1A and 1B). These veterinary drugs were used for prophylaxis (19 % of veterinary drug use) or antibiotic therapy (81 %).

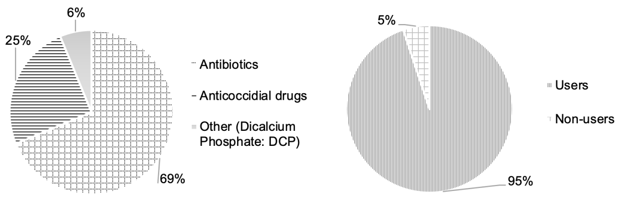

Fig. 1: *Type of veterinary drugs used (left) & rate of veterinary medicine users (right) on the 78 broiler farms surveyed in the Pwani region (Tanzania).*

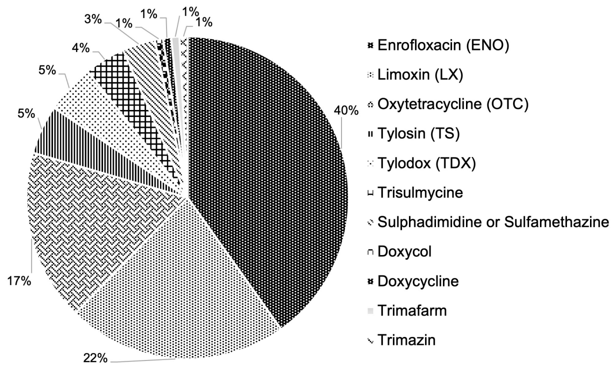

Fig. 2: *Types of antibiotics used on the 78 broiler farms surveyed in the Pwani region (Tanzania).*

The antibiotics commonly used by respondents were enrofloxacin (ENO), limoxin (LX), oxytetracycline (OTC), tylosin (TS) and tylodox (TDX) (Fig.2). As far as anticoccidials were concerned, the one most frequently used was amprolium (Fig.3).

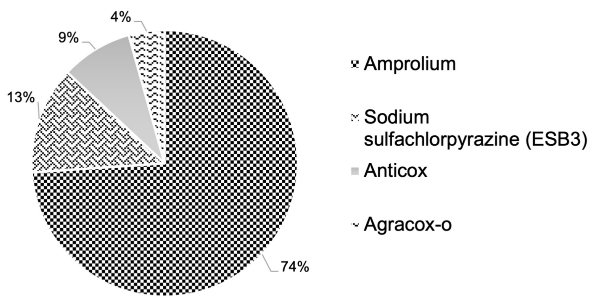

Fig. 3: *Anticoccidial used on the 78 broiler farms surveyed in the Pwani region (Tanzania).*

The diseases treated by the five commonly used antibiotics (ENO, LX, OTC, TS and TDX) are shown in Table 3. It should be noted that these antibiotics were used to treat bacterial (infectious coryza, etc.), parasitic (coccidiosis) and viral (Gumboro) diseases.

Table 3: *Frequency of use of the top five used antibiotics by type of disease on the 78 broiler farms surveyed in the Pwani region (Tanzania).*

Antibiotics	*Disease**	*Freq.*†
Enrofloxacin (ENO)	Infectious coryza (34)	3 to 1
	Chronic respiratory disease (8)	3
	Used during brooding (4)	3
	Gumboro* (1)	3
Limoxin (LX)	Infectious coryza (20)	3 to 1
	Chronic respiratory disease (4)	3
	Coccidiosis‡ (1)	1
	Gumboro‡ (1)	3
	Omphalitis (Navel disease) (1)	2
Oxytetracycline (OTC)	Used during brooding (12)	3
	Infectious coryza (3)	3
	Omphalitis (Navel disease) (1)	2 to 1
Tylosin (TS)	Infectious coryza (3)	3
	Coccidiosis‡ (2)	3
	Salmonellosis (1)	3
	Used during brooding (1)	3
Tylodox (TDX)	Infectious coryza (3)	1 to 2
	Chronic respiratory disease (2)	3
	Used during brooding (1)	3

*Number of responses in brackets; †Frequency of use of antibiotics 1: very frequent; 2: moderate; 3: occasionally; ‡Non-bacterial diseases not effectively treated by antibiotics.

For laboratory tests to detect residues of the five antibiotics (ENO, LX, OTC, TS and TDX), meat samples were taken from broilers aged four weeks (n = 3) on one selected farm and five to six weeks (n = 21) on the remaining seven farms. These analyses showed that all 24 samples from the eight farms studied were negative for the five antibiotics in searching. However, samples from four-week-old birds tested positive for another antibiotic, sulfamethazine (SF), which was not initially one of the five antibiotics selected for this study.

4 Discussion

In this study, the field survey revealed that broiler farmers in the Pwani region were mainly confronted with respiratory diseases (infectious coryza and chronic respiratory disease), followed by enteric diseases (coccidiosis), systemic diseases (salmonellosis) and Omphalitis. Our results are similar to those of MLD (2006), Nonga *et al.* (2009), Nonga *et al.* (2010), Pare (2012), Swai *et al.* (2013), Msoffe *et al.* (2018), Chota *et al.* (2021), Mdegela *et al.* (2021), et Mouiche *et al.* (2022), who noted that the diseases cited in this study were among the most common poultry diseases. Viral diseases (Newcastle disease and Gumboro) represented only a small proportion of the diseases mentioned by respondents, mainly due to compliance with the vaccination plan for broilers against these diseases (Gomez and Mbaga, 2023). This considerable susceptibility of broilers could be explained by several factors, such as the quality of day-old chicks (DOC), rearing conditions and genetics. Omphalitis (inflammation of the navel) only occurred in the event of poor hygiene conditions in hatcheries, transport and chick starting (ASA, 2005; Kariuki *et al.*, 2023). According to Rahmatallah *et al.* (2018), poor DOC quality leads to infection of the yolk sac and a high prevalence of respiratory diseases. According to Gomez & Mbaga (2023), chicken farmers in the Pwani region faced a high mortality rate (11.7 %) with average biosecurity practice within the surveyed farms, suggesting a high prevalence of avian diseases. It should also be noted that bred broilers are exotic breeds often poorly adapted to African environmental conditions (Pare, 2012).

The high prevalence of avian diseases in this study area could be the main reason for the increased use of veterinary medicines. It seems that the majority of respondents used veterinary medicines during the rearing period. Use was either prophylactic (especially at the start of rearing) or therapeutic. This result is consistent with the results of Nonga *et al.* (2010), Rahmatallah *et al.* (2018), Kimera *et al.* (2020), Vana *et al.* (2020), Chota *et al.* (2021), Mdegela *et al.* (2021) et Ulomi *et al.* (2022), where many livestock keepers used veterinary medicines for prophylaxis, metaphylaxis and antibiotic therapy in several African countries. According to Kariuki *et al.* (2023), some DOC vendors tend to encourage poultry keepers to use veterinary drugs, rather than emphasizing adherence to biosecurity measures to prevent omphalitis and early mortalities. Another factor that could influence the use of veterinary medicines in this study is the easy accessibility and uncontrolled use of these products on the market, which would favour self-medication, which was the most common type of treatment used by the respondents. Self-medication (use of a veterinary product on one's own initiative to treat diseases without consulting an animal health worker) could be conditioned by easy access (without prescription or restriction) to veterinary drugs, knowledge of the brands of veterinary drugs, the lack of regulations on the use of veterinary drugs in several African countries, the lack of extension and veterinary advisory services, and the dependence of livestock farmers on their personal experience (Nonga *et al*., 2009; Nonga *et al*., 2010; Okombe *et al*., 2016; Mouiche *et al*., 2022; Mudenda *et al*., 2022; Vana *et al*., 2020; Ulomi *et al*., 2022; Kariuki *et al*., 2023). This situation (self-medication) could partly explain the use of different veterinary medicines for the same diseases. For example, the results showed that coccidiosis was treated either with antibiotics (ENO, LX, TS) or with anticoccidial (amprolium, ESB3, anticox). While there was a significant prevalence of diseases on the farms surveyed associated with the remarkable use of veterinary medicines, all of the respondents said they occasionally used veterinary medicines. This could mean that none of the interviewees recorded the care of the birds and were unaware of the frequency of use of these veterinary drugs. According to Mouiche *et al*. (2022), the absence or poor management of treatment records would lead farmers to misuse veterinary medicines.

Laboratory results exhibited that all samples were negative for the five antibiotics concerned (ENO, LX, OTC, TS and TDX). However, samples from four-week-old birds tested positive for another antibiotic, sulfamethazine (SF), which was not initially one of the five antibiotics selected for this study. According to the literature (Fei *et al*., 2023; Chandrakar *et al*., 2023; Kamouh *et al*., 2023; Sani *et al*., 2023; Abdel-Wahhab *et al*., 2024), the five antibiotics researched and the one tested positive in broiler meat in this study are among the antibiotics from the families (tetracyclines, quinolones, beta-lactams, sulphonamides, aminoglycosides and macrolides) most commonly used in poultry production and whose residues are the most sought-after in animal products.

What's more, the laboratory where the samples were analysed had developed a special adaptation for the LC-MS/MS method which, after injecting the samples into the LC-MS/MS machine, made it possible to read all the chemical compounds contained in each sample. This made it possible to detect the presence of another antibiotic in samples from four-week-old broilers. Remember that sulphonamides, used in the treatment and prevention of diseases such as infectious coryza, avian typhoid and coccidiosis, have a low purchase cost, which makes them easily accessible to farmers and could lead to their inappropriate use. Uncontrolled use of sulphonamides could increase the incidence of bacteria that are resistant to them and the presence of their residues in meat if their withdrawal periods are not respected (Helal *et al*, 2024; Irani *et al*, 2024).

The negative results of the samples analysed in this study could be explained by the absence of use of these antibiotics by the farmers during the periods preceding the purchase and slaughter of these broilers on the one hand, and by the age at which these animals were slaughtered on the other. The duration of broiler rearing observed in this study was four weeks, which is short compared with the standard six weeks (39-42 days) required for broiler rearing (Guérin, 2004). Furthermore, most of these antibiotics are prescribed for a treatment period of three to five days, and their withdrawal times vary from one antibiotic to another. For example, the withdrawal times for ENO, OTC and TS are seven and three days respectively after the last dose administered (Khatun *et al*., 2018; Chota *et al*., 2021). In contrast, sulphonamides, the antibiotic family to which FS belongs, have a withdrawal time of up to 16 days after the last administration of the antibiotic (Chota *et al*., 2021), which could justify its presence in the meat of animals aged four weeks at the time of laboratory analysis.

These results reveal, on the one hand, that the four-week rearing period practised by farmers is insufficient to raise broilers properly and, on the other hand, that it is important to respect the withdrawal period for the various veterinary medicines. The farmers who kept broilers in stock for more than four weeks may have unknowingly allowed the withdrawal period, likely contributing to the non-detection of antibiotics in the laboratory samples. Hence the failure to detect antibiotics in laboratory samples. According to several authors (Nonga *et al*., 2009; Nonga *et al*., 2010; Zerbo, 2014; Ahmed & Ben Hamida, 2019; Mudenda *et al*., 2022), failure to observe the withdrawal period for veterinary medicines exposes consumers of poultry products to health risks (allergies, poisoning, etc.). Non-compliance with the withdrawal period could be linked to a lack of knowledge or ignorance of its impact (contribution to antibiotic resistance, presence of ARs in meat and eggs, etc.). According to Prajapati *et al*. (2018), the short lifespan of broilers could also encourage farmers not to comply with waiting times for veterinary medicines. The other reason is that farmers are forced to dispose of (early sell) broilers when they are less than five weeks old, due to rising production costs (steadily increasing costs of feed and rearing inputs), while the selling price of broilers has remained stagnant over the years. Ultimately, this could hurt the general health of the population (hypersensitivity reactions, cancer, bacterial resistance in humans, toxicity, allergies, changes in the intestinal flora, etc.) (Mohamed Said, 2015; Gaudin, 2016; Vana *et al*., 2020), requiring holistic intervention.

5 Conclusion and recommendation

This study exhibited the extensive use of veterinary medicines, especially antibiotics, to combat the avian diseases that were rife in the study area. Several factors predispose to such situations, such as the accessibility of veterinary medicines, self-medication and the ineffectiveness of regulations on the use of veterinary medicines. The four-week rearing period seems inadequate, leading to non-compliance with waiting periods for the various veterinary drugs, and is a factor that favours the presence of drug residues in broiler meat. Consequently, rearing broilers for more than four weeks, assuming that prophylactic measures and antibiotic treatments have been taken earlier (from zero to four weeks), presents little danger, as it will allow the antibiotics to be withdrawn and the meat product to be made fit for consumption. It is recommended that broiler farmers be made aware of the application of biosecurity, the use of veterinary medicines and their impact in the event of misuse.

Conflict of interest

The authors declare that they have no conflict of interest.

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