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Occurrence of Antimicrobial Residues in Broiler Chickens from selected Farms and Markets in Kano Metropolis, Nigeria

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Abstract

The indiscriminate use of antibiotics in animal meant for human and animal's consumption lead to occurrence of antibiotic residues which threaten the health of both animals and humans. The aim of the study was to detect the presence of antimicrobial residues in broiler chicken in Kano state, Nigeria. Samples of fresh breast muscle, thigh muscle, liver and kidney were collected from 100 birds and examined using microbial inhibition test and ELISA test to determine the occurrence of antimicrobial residues and Enrofloxacin residues. A questionnaire was also administered to 33 workers and managers of the selected bird's farms to assess their knowledge on the use of antibiotics and presence of antimicrobial residues. The result of the study revealed that 43% of the studied birds tested positive to antibiotic residue. Kidney samples recorded the highest (43%) residue present while thigh muscles (35%) recorded the least. The result indicated that among the birds detected with positive antibiotic residues, 36.4% were also positive for Enrofloxacin residue. All the respondents were using one or more antibiotic for treatment, prophylaxis or both and to a lesser extent as growth promoters. Majority (55.5%) of the respondents were not aware of the presence of residues in poultry. Most of the respondents (63.7%) have knowledge of withdrawal period but all of them were not observing withdrawal practice before disposing their birds. Doxycycline antibiotic was found to be the most indiscriminately use antibiotic, while erythromycin and chloramphenicol are the least. The study advocates the need for awareness campaigns for the farmers on the correct way of administering the antibiotics with special emphasis on withdrawal periods as well as continuous monitoring of the residues for public health reasons.

Key words: Antibiotic residue, Broiler chicken, Enrofloxacin residue

INTRODUCTION

Poultry production is an important source of livelihood for rural and urban dwellers in Nigeria, as it provides employment and income. Poultry products constitute a major source of animal protein in Nigeria and a source of healthy meat worldwide because of its white meat constituent (Ezenduka, 2014). According to Food and Agriculture Organization (FAO) Africa Sustainable Livestock 2050 report, the Nigerian poultry industry comprises about 180 million birds, producing 650,000 tons of eggs and 300,000 tons of poultry meat in 2013 (FAOSTAT, 2018). This achievement was related to improved productivity via genetic selection, feed

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formulation, and better health management practices at the farm, along with the use of disease preventive measures (Apata *et al.,* 2009).

Antimicrobial drugs have been widely used in veterinary practice for prophylactic, therapeutic and additives purposes since 1950. Some of the commonly used antibiotics in poultry industries in developing countries like Nigeria are penicillin, amoxicillin, oxytetracycline, doxycycline, streptomycin, gentamicine, tylosine and sulfonamides (Kabir *et al*., 2004; Petrovic *et al*., 2006; Yusuf 2014; Ezenduka *et al*., 2019). Enrofloxacin which is a second generation floroquinolone antibiotic is also one of the commonly use antibiotic due to its broad spectrum of activity with good bioavailability after oral administration and good to excellent tissues distribution (Fagbamilla *et al*., 2010).

The misuse and incorrect application of antibiotics carries the risk of their residues' presence in edible tissues of the chicken, which can cause toxicity and allergies in hypersensitive consumers (Gabriel *et al*., 2012). Some antibiotics residues were indirectly carcinogenic, teratogenic or contribute to the developments of antibiotic resistances among microbial strains (Pavlov *et al*., 2007; Nisha *et al*., 2008). Veterinary drugs in poultry meat and eggs may be produced by exposing chickens to drugs or contaminated in number of ways. These drugs tend to accumulate in tissues forming residues with concentration above their Maximum Residues Limits (MRLs) if withdrawal periods were not observed (Ezenduka, 2019).

Most of the antibiotics used in Nigerian poultry industries are labeled in different trade names, some of which are the combinations of two or more chemical substances to make them extra potent, while some are incorporated with several multivitamins and most of these antimicrobials are administered orally to the birds in drinking water or mixed with feeds (Sasanya *et al*., 2005; Lawal *et al*., 2015). Unfortunately, Kabir *et al*. (2004) earlier noted that in Nigeria there is no strict legislation that governs antibiotic residues in animal tissues. Gabriel *et al.* (2012) noted that in most developing countries including Nigeria serious attention is not given to the sector but rather, it is left in the hands of individuals and businessmen whose interest is to maximize their profit even when consumers' health may be compromised.

Detection of antibiotic residues in meat possesses no risk to consumer's health, if the levels fall below the maximum residues stipulated by the world regulatory bodies (Abbasi *et al*., 2012) However, existence of antibiotic residues above MRLs in food stuff can pose hazard to human health (Javadi, 2011). And this necessitates constant assessment of antibiotic residues to establish safety levels.

Kano state is the most populous state in Nigeria (National Bureau of Statistics, 2020) and the study observed that there is an increase among people in the state that are consuming poultry meat as their protein source and delicacy. Reviewed literature indicated that the occurrence of antimicrobial residues has previously been reported in some other locations within Nigeria, however, there is dearth of literature on the detection of antibiotics residues in chicken in Kano state. The study was aimed at detecting the presence of antibiotic residues in broiler chicken and determine the occurrence of enrofloxacin from the positive residue samples with a view to provide evidence to support proactive measures in protecting consumers' health.

MATERIALS AND METHODS

Study area

Kano state is located in North–western Nigeria between longitude $11^{0}30'$N and latitude $8^{0}30'$E and has a population size of 9,383,682 people (National population census, 2007). It has a total area of 20,131Km² and density of 470/km² (1,200/sqml). Ecologically, the state is located within Sudan savannah region. Poultry farming is one of the livestock farming mostly practiced in the state and some households have backyard poultry or just local birds on free range around the compound. Consumption of poultry meat and eggs is part of the food habit/culture of the population.

There are one hundred and fifty eight (158) birds markets in the state (Kano state Ministry of Agriculture and Natural Resources, 2014), though broiler chicken markets are densely populated within metropolitan LGAs.

Sample size determination and sample collection

Sample size was determined by formula used by Thrusfield (1997) at 95% confidence level and using 64% residue prevalence reported by Eezenduka *et al*. (2014). The sample size was calculated to be 354.04 and rounded off to 400.

Apparently, healthy broiler chicken in the cage meant for public consumption were sampled and chickens not meant for sale, dead or sick bird were excluded from the study. A total of one hundred (100) birds were selected from farms and some major poultry markets within Kano metropolis using systematic random sampling, from which 400 samples were collected. Fresh thigh and breast muscles, liver and kidney were collected immediately after chicken was slaughtered (according to the Halal method of slaughter) and packed in a zip lock and transported in container packed with ice pack to the Murtala Mohammed Specialist Hospital (MMSH) Kano laboratory and processed immediately or stored at -20^{o}C.

Ten (10) Local chickens from local poultry markets and 15 broiler chickens were used as control. The broiler birds were raised from day old chick to table size without antibiotics. At four weeks old the birds were divided into three groups A, B and C. Group A were slaughtered immediately and the sample was collected for laboratory investigation. Two antibiotics gentadox and enrosam were added to the drinking water of chickens in Groups B and C for four days. On the 5th day group B chickens were slaughtered and samples collected. Group C continue using plain water (from 5th day) for the period of 15 days and on day 16 the group C were also slaughtered. The procedure was adopted from Clanjak *et al.* (2011).

Sample processing

Five (5) grams of each organ was weighed, cut into pieces and crush for some minutes using pestle and mortar. The crushed sample was then transferred into 10ml test tube that contains 5mls of distilled water and centrifuge at 5000rpm for 5-10 minutes. The supernatant was decanted and stored in a sample bottle for analysis as described by Ezenduka (2019) and Clanjack *et al*. (2011).

Detection of Antibiotic residues using Microbial Inhibition Test

Microbial inhibition test was used to screen the samples for evidence of antibiotic residues according to the methods of Fagbamilla *et al*. (2010) and Huber *et al.* (1969).

Isolates of *Bacillus Subtilis* were obtained from Department of Veterinary Public Health Ahmadu Bello University` (A.B.U) Zaria and used for the Microbial Inhibition Test. To get pure colonies, the isolates were sub-cultured on Nutrient agar and incubated at 37°C for 24 hours. The identities of the colonies were confirmed using microscopical and biochemical test procedures.

Following confirmation, fresh pure colonies of *Bacillus subtilis* were inoculated in prepared nutrient broth and incubated for 18-24 hours. Small amount of broth culture was then transferred to transparent test tube and the turbidity of the suspension was adjusted using normal saline to match 0.5 Mac Farland's standard.

Mueller Hilton agar (MHA) plates were prepared according to the manufacturer's instructions. The prepared plates were then inoculated with the standardized inoculum. Sterile 12 mm diameter Whatman filter paper disc were prepared and placed into Juices (extracted from the chicken meat samples prepared above) until it was saturated, excess juice was allowed to drain along the walls of the tube, then with sterile forceps, the impregnated disc were gently placed on the inoculated MHA plates and labeled accordingly and incubated at 37^{o}C for 20 hours, after which presence or absence of zone of inhibition was noted. The difference between the diameter of the zone of inhibition and that of the disc was calculated. Any disc with a difference of 1$\geq$ and 2$\geq$mm was considered positive for meat and offal respectively.

Detection of Enrofloxacin using ELISA

ELISA test was carried out to confirm the presence of enrofloxacin in the positive samples detected with antibiotic residue. The test was conducted according to the manufacturer's instruction (BIOTUVA LIFE SCIENCES UK). The kit was first equilibrated to room temperature before starting the assay. Exactly 40 milliliters of washing buffer was diluted with 800 milliliters of distilled water and kept aside for usage. Then, 475 µl of washing solution and 25µl of the samples were added to empty test tubes to get a working solution. Exactly, 50µl of working solution was then added into each well followed by 50µl of HRP-Conjugate reagent, then 50 µl of antibody to each well. The Elisa strip plate was then sealed with adhesive membrane and gently oscillated for five seconds. The plate was then incubated at 37^{o}C for 30 minutes. Using a washing solution, the plate was washed three times after peeling off the closure membrane and dried using tissue paper. 50µl of substrate A and substrate B were then added into each well and then incubated at room temperature for 15 minutes, this was followed by adding 50 µl of stopping solution to each well to terminate reaction. The absorbance OD value at 450nm was then read using a micro titer reader plate.

Assessment of the knowledge of the poultry farm workers and managers on the use of antibiotics and presence of antimicrobial residues

A Questionnaire was administered to thirty-three (33) respondents (care taker, manager or owner of the selected poultry farm) to provide information on their respective profiles, types of drugs (antibiotic) use, frequency and purpose of use, the times of administration of drugs to animals, drugs sources, consulting personnel, adherence to the recommended withdrawal period, knowledge of antibiotic residues as well as selling conditions of the birds. The questionnaire was administered upon their consent and willingness to participate in the study.

RESULTS

The study revealed that out of the 100 studied birds, 43% tested positive with antibiotic residue (Table 1). Kurmi live birds market had the highest positive sample of 10% while Kurna market had the lowest positive samples of 4% (P=0.7089) (Table 1).

Table 1: Antibiotic Residue Detection among the Studied Birds

Market	No. of birds	Antibiotic Residue Positive (%)	Negative (%)	P-value
Wambai	18	6 (33.3)	12 (66.7)	0.7089
Sabon Gari	18	9 (50.0)	9 (50.0)	
Sharada	18	6 (33.3)	12 (66.7)	
Kurmi	18	10 (55.5)	8 (45.50	
Tarauni	18	8 (44.4)	10 (54.6)	
Kurna	10	4 (40.0)	6 (60.0)	
Total	**100**	**43 (43%)**	**57 (57%)**	

Key: χ^2=2.9410, df=5, P=0.7089; p >0.05

The study showed that among the control birds, all the five broiler birds (category B) that were raised from a day old to 4 weeks without antibiotics and then placed on gentadox and enrosam antibiotics for another 4 days and then slaughtered on 5th day were positive with antibiotic residues. Whiles those (category A) not exposed to the antibiotics after 4 weeks and those (category C) that were placed on Gentadox and Enrosam for another 4 days and stopped, and continued with plain water for 15 days and then slaughtered on the 16th had no antibiotic residue (Table 2). Additionally none of the local birds had residue (Table 2).

Table 2: Antibiotic Residue Detection among the Studied Birds and Control Birds

Category of birds	Number Studied	Number Positive with antibiotic residue (%)
1. Studied birds (Broiler)	100	43 (43)
2. Control birds		
A. Broiler bird (day old up to 4 weeks without antibiotics and then slaughtered)	5	0 (0)
B. Broiler bird (day old up to 4 weeks without antibiotics, then placed on Gentadox and Enrosam antibiotics for another 4 days and then slaughtered on 5th day)	5	5 (100)
C. Broiler bird (day old up to 4 weeks without antibiotics, then placed on Gentadox and Enrosam for another 4 days and stopped, and continued with plain water for 15 days and then slaughtered on the 16th day)	5	0
D. Local birds	10	0

The result showed that kidney samples recorded the highest positive sample of 43 followed by liver samples (40) while Breast (35%) and thigh muscle (35%) recorded the lowest number of positive sample with 35% each (P=0.999) (Table 3).

Table 3: Distribution of Antibiotic Residue according to Type of Sample

Market	Breast muscle	Thigh muscle	Liver	Kidney	P value
Kofar Wambai	6	4	6	6	0.999
Sabon Gari	7	7	8	9	
Sharada	5	6	5	6	
Kurmi	9	10	10	10	
Tarauni	6	6	7	8	
Kurna	2	2	4	4	
Total	**35 (35%)**	**35 (35%)**	**40 (40%)**	**43 (43%)**	

Key: χ^2=1.7273, df=15, P=0.999; p >0.05

The results of the study revealed that of the birds sampled with positive antibiotic residues 36.4% were positive for enrofloxacin residue (Table 4). Birds sampled from Sabon Gari market had the highest positive enrofloxacin residue of 13.6% while none of the samples from Kurmi and Kurna markets was positive (Table 4). The occurrence of enrofloxacin among the sampled birds was found to be insignificantly associated with the type of market (P=0.2301) (Table 4).

Table 4: Enrofloxacin Detection among Birds with Positive Antibiotic Residue

Market	Number of Sample Studied	Number Negative	Number Positive (%)	P value
Wambai	4	3	1 (4.6)	0.2301
Sabon Gari	4	1	3 (13.6)	
Sharada	4	2	2 (9.1)	
Kurmi	4	4	0 (0)	
Tarauni	4	2	2 (9.1)	
Kurna	2	2	0 (0)	
Total	22	14	8 (36.4)	

χ^2=6.8750, df=5, P=0.2301; p >0.05

The result of the study showed that breast muscle, liver and kidney recorded the highest enrofloxacin residue of 8 (36%) while thigh muscle had 7 (31%) positive samples (Table 5). However, the occurrence of enrofloxacin residues according to the type of samples was not statistically significant (P=0.9853) (Table 5).

Table 5: Enrofloxacin Detection among Birds with Positive Antibiotic Residue according to Type of Sample

Sample	No. of sample	Positive (%)	Negative (%)	*P* value
Breast muscle	22	8 (36)	14 (64)	0.9853
Thigh muscle	22	7 (31.8)	15 (68.2)	
Liver	22	8 (36)	14 (64)	
Kidney	22	8 (36)	14 (64)	
Total	88	31 (35)	57 (65)	

Key: χ^2=0.1494, df=3, P=0.9853; p >0.05

The results showed that 67% of the respondents were males while 33% were females (Table 6). Majority of the respondents were producers (57.6%) followed by farm managers (24.2%) and caretakers (18.2%) (Table 6) Most of the respondents have post primary (45%) and tertiary education (30%) respectively (Table 6). Additionally, 21% of the respondents have less than 1 year experience in poultry production business, all the rest have up to >10 years of experience (Table 6). Forty five (45%) of the respondents have 50 to 100 birds and majority (82%) of the

farms use commercial/industrial feeds for feeding their birds, while 18% of them were using both commercial/industrial and self-formulated feeds (Table 6).

Table 6: Characteristics and Experience of the Respondents

Characteristics	Frequency (n)	Percentage (%)
Gender		
Male	20	67
Female	13	33
Total	**33**	**100**
Status of the respondent		
Producers	19	57.6
Care takers	06	18.2
Farm managers	08	24.2
Total	**33**	**100**
Education level		
Primary level	01	3
Post primary level	15	45
Tertiary level	10	30
No formal education	07	24
Total	**33**	**100**
Years of Experience		
Less than 1 year	07	21
1 – 5	09	27
6 – 10	09	27
Above 10 years	08	24
Total	**33**	**100**
Farm capacity		
Less than 50 birds	05	12
51 – 100	15	45
101 – 500	09	27
Above 500	04	15
Total	**33**	**100**
Type of Feed		
Commercial/Industrial	27	82
Commercial/Industrial + Self-formulated	06	18
Total	**33**	**100**

All of the respondents indicated that they utilize market and household/individuals as their market outlet, whereas, 18% of them also use hotels/restaurants (Table 7). The study revealed that Veterinarian (18%) and drug sellers (18.2%) are responsible for disease diagnosis in the birds market whereas 27% of the Veterinarian, 15% of drug sellers and 3% of owners are responsible for drug prescription (Table 7).

The results revealed that 46% of the respondents claimed they administer antibiotic to the birds during the first week after being hatched and subsequently whenever the bird is sick and only 6% of the respondents said antibiotics are administered to birds on disease condition only (Table 7). Additionally, 52% of the respondents were using antibiotics for treatment and prevention in their farms, while 27% of the respondents were using antibiotics for treatment, prevention and growth promotion purpose and all of the respondents indicated that they use oral route for antibiotic drugs administration (Table 7). Majority of the respondents (70%) including literate among them were not reading information on the leaflet/sachet/container of the drug (Table 7).

Table 7: Market outlet, disease diagnosis and treatment, frequency and purpose of antibiotic use in the farm by the respondents

Characteristics	Frequency	Percentage (%)
Market outlet		
Market and household	27	81.8
Hotel, market and household	6	18.2
Total	**33**	**100**
Disease diagnosis		
Veterinarian	6	18.2
Owners	3	9
Drug sellers	6	18.2
Others (Manager/Caretaker/friends)	18	54.6
Total	**33**	**100**
Drug prescription after diagnosis		
Veterinarian	9	27
Owners	1	3
Drug sellers	5	15
Others (Manager/Caretaker/friends)	18	55
Total	**33**	**100**
Frequency of Use of antibiotic		
Daily	2	06.1
When birds are sick	2	06.1
First days of life and sick	16	48.5
Daily and sick	1	03.0
weekly and sick	5	15.1
First day of life, weekly and sick	7	21.2
Total	**33**	**100**
Purpose for Antibiotic Use		
Treatment	7	21.2
Treatment and prevention	17	51.5
Growth promotion, treatment and prevention	9	27.3
Total	**33**	**100**
Reading of information on the leaflet/sachet/container		
Yes	23	70
No	10	30
Total	**33**	**100**

For antibiotic residues awareness, 52% of the respondents said they were never informed about antibiotic residues by a Veterinarian or animal health practitioner and 54.5% indicated that they do not have awareness on residues effect and about 67% of the respondents did not believe drug residues pose a risk to human health (Table 8). Majority of the respondents (67%) indicated that they were keeping medication record. Similarly, 63.6% of the respondents stated that they have knowledge of drugs withdrawal period (Table 8). However, all the respondents confirmed that they did sell birds on treatment for public consumption (Table 8).

Table 8: Respondent awareness of residues, withdrawal period, believe of residues and percentage of respondent selling birds on treatment

Characteristics	Response (n=33)	Frequency	Percentage (%)
Residue awareness	Yes	15	45.5
	No	18	54.5
Knowledge of withdrawal period	Yes	21	63.6
	No	12	36.4
Believe of residue effects	Yes	11	33.3
	No	22	66.7
Selling birds on treatment	Yes	33	100
	No	0	0

Among the 12 listed antibiotics doxycycline was found to be the most indiscriminately used with 17.4% of the respondents reported to have been using it for both prevention and treatment, followed by tylosine with 13.8% (Table 9). However, erythromycin and chloramphenicol were the least used antibiotics with 0.6% (3) each (Table 9).

Table 9: Rate of use of antibiotics by respondents

Antibiotics	Frequency (n)	Percentage (%)
Doxycycline	29	17.4
Tylosine	23	13.8
Tetracycline	21	12.6
Ciprofloxacin	21	12.6
Penicillin	15	09.0
Gentamycin	15	09.0
Enrofloxacin	14	08.4
Neomycin	14	08.4
Sulfonamides	08	04.8
Erythromycin	01	0.60
Chloramphenicol	01	0.60
Others	05	03.0
Total	**167**	**100**

DISCUSSION

The study detected a high (43%) occurrence of antibiotic residue among the studied birds although the occurrence of the antibiotic residues among the birds of the different markets was not statistically significant (P=0.7089). This however is not surprising, considering the indiscriminate use of antibiotics in poultry farming as reported by earlier studies (Bamidele *et al*., 2022; Awogbemi *et al*., 2018; Oluwasile *et al*., 2014). Previous studies conducted in Nigeria, reported higher prevalence of antibiotic residues of 80%, 64% and 60% by Onwumere-Idolor *et al.* (2022); Ezenduka (2019); Ezenduka *et al.* (2014) respectively. Compared with these reports, the findings of this study indicated that although the occurrence of residues among birds of the studied area is not as high as those reported in other regions of Nigeria yet there is need to enact strict measures governing the use of antibiotics in chicken farming by the relevant authorities.

In consistence with the observation of the present study, prevalence of antimicrobial residues in broiler chicken has earlier been recorded in many developing countries. For instance, Nonga *et al*. (2009) and Shareef *et al*. (2009) reported 70% and 52% antibiotic residues in broiler chicken respectively, while Sapkota *et al*. (2019) and Raut *et al*. (2017) reported a lower rate of 13% in Kathmandu valley and 22% in Nepal. Sapkota *et al.* (2019) explained that the

differences in results could be due to various reasons, such as the use of different bacteria as test organism and their varied susceptibility to different antibiotics, inconsistencies in sample size, the variation of the practice of antibiotic use in different locations and differences in the methods for detection. Other possible reasons could be the abusive use of antibiotics for curative, prophylactic or growth promotion purposes and non-adherence to drug withdrawal period.

According to the present study, the kidney samples recorded the highest positive sample (43%) followed by liver samples while breast and thigh muscle recorded lowest number of positive samples. The highest concentration of antibiotic residue in kidney and liver could be attributed to the fact that they are both organ of excretion and there is high blood flow in them for purification and intoxication respectively. Thus, all drugs including antibiotics are eventually eliminated from body after being metabolized largely by the kidney in urine and by excretion in the bile secreted by liver.

Compared with the findings of the present study, other studies reported high presence of antibiotic residues in different organ of birds (poultry). Onwumere-Idolor *et al*. (2022) recorded antibiotic residue prevalence of 40% (muscle), 55% (liver) and 60% kidney. Ezenduka *et al.* (2014) detected antimicrobial residues in organ distribution as follows: kidney (60%), liver (54%), gizzard (30%) and muscle (11%). Karmi (2014) reported 56% and 44% prevalence of antibiotic residues in breast and thigh muscle respectively in Egypt. Another study in Bangladesh reported prevalence of residue of tetracycline in livers (40%), kidneys (24%), thigh muscles 20% and 24% breast muscles. Salehzadeh *et al*. (2006) also detected tetracycline residues above maximum residues limits, which were 27.77%, 95.55% and 18.88% in muscles, liver and kidney samples respectively.

The study findings revealed the occurrence of enrofloxacin residue in 36.4% of the studied birds, with breast muscle, liver and kidney recording highest positive samples while thigh muscles recorded the least ($p=0.9853$). The high presence of enrofloxacin residues reported in the present study implies that, the use of this antibiotic in broiler production is likely being abused. In consistence with the reports of this study, other studies by Naeem *et al*. (2006) and Aslam *et al*. (2016) documented enrofloxacin in poultry tissues from Lahore and Faisalabad, Pakistan, respectively. In contrast, Weiss *et al*. (2007) and Roudaut and Fournet (2017) had in different studies reported the absence of enrofloxacin in Italian and French poultry tissues, respectively but concluded that exposure to antibiotics is still higher in the poultry compared to other livestock sectors, and also that their results might not be guaranteed for citizens in low poultry producing countries due to lower control frequency arising from trade imbalance. These observations are in agreement with the report by Klein *et al*. (2018) on global antibiotic consumption between 2000 and 2015 that confirmed an increase in the consumption of broad-spectrum agents like the fluoroquinolones and macrolides in low and medium-income countries like Nigeria with clear implications in adverse drug-related events. Additionally, heavy usage of enrofloxacin in poultry has been linked with increased Salmonella infections (Morales-Barrera *et al.,* 2016).

The study findings revealed that majority (67%) of the respondents were males. This result supports the findings of Adesiyan (2014) and Awogbemi *et al.* (2018) who reported male dominance in poultry production. Olorunwa (2018) attributed the male dominance in broiler production to the more tasking and energy consuming nature of broiler production. In a related study Alabi *et al.* (2020) attributed poor participation of female in poultry farming to

poor economic status of the women in the society. However a study by Soyemi (2014) indicated that poultry production is dominated by female which may be attributed to the importance of women attached to the wellbeing of household and need for income generating activities.

All the respondents in this study were practicing intensive poultry production system. In a related study by Awogbemi *et al.* (2018) reported that 90% of the farmers were practicing intensive system of production. This observation may not be unconnected with the fact that broiler rearing needs strict movement control and confinement either in houses or cages for the protection from climatic conditions, thieves and predators.

The findings of the study implies that majority (97%) of respondents were literate. This finding support the findings of Awogbemi *et al.* (2018), which also show that most of the poultry farmers are educated. The reported high respondents with formal education may be due to the location of the study area in which educational facilities are easily accessible. Although most of the farmers were literate, it was observed they don't read drugs leaflet or container information, but majority of them were keeping medication record in a book or kept container/sachets of the drugs used in the farm. In contrast, Elum *et al.* (2017) lamented high level of illiteracy among livestock farmers in Rivers state Nigeria.

Majority of the farms (45%) selected had a flock capacity of 51-100 birds with a small number of farms having a capacity exceeding 500 birds. Compared with the present study, a survey conducted in Ogun state by Oluwasile *et al.* (2014) reported that majority of the farms had higher flock size of 500-2000 birds. Olurunwa *et al.* (2018) explained that the dominant small scale of most farms are attributed to high cost required to operate large scale poultry enterprises, inadequate capital by farmers, diseases burdens and market glutting in many times.

Only 24% of the farmers visited in this study had an experience of more than 10 years in poultry farming and this is similar to the findings of Bamidele *et al.* (2022). Studies by Ettah *et al.* (2021) also revealed that 74.4% of the farmers had an experience of less than 10 years. Xu *et al.* (2020) observed that most farmers in Northwestern china had between 10 and 19 years farming experience. The farmers' years of experience are expected to serve as a guide for better management and disease control and it may likely result into better understanding of residues, withdrawal periods and training needs.

The findings of the present study showed that all the farmers preferred mixing antibiotics in drinking water (oral route) and this support previous finding of Ferdous *et al.* (2019), Awogbemi *et al.* (2018) and Sirdar *et al.* (2012) who reported that 97%, 83% and 75.83% of the farmers respectively are conducting mass medication via drinking water. This is because drugs are evenly homogenized in water and sick birds continue to drink but will not eat (Sirdar *et al.*, 2012) and also oral medication did not require the help of technical person.

With regards to the purpose of antibiotics use, the findings of the present study indicated that over 50% of the respondents were using antibiotics for treatment and prevention in their farms, while some of the respondents were using antibiotics for treatment, prevention and growth promotion purpose. This observation is similar to reports by Awogbemi *et al.* (2018) and Sidar *et al.* (2012) who reported that most farms used one or more antibiotics for therapeutics, prophylactics and to a lesser extent for growth promotion and only 12% of the

farmers are using antibiotic on sick occasions. About 70% of the farmers used antibiotic as prophylaxis in the first days of birds live and some use antibiotics weekly and little percentage (9%) of the respondents were using antibiotics from 0 day to last days of production without any reason. Al-Mustapha *et al.* (2020) reported that some poultry farmers (34.4%) thought antibiotics can be used to treat viral, parasitic and fungal diseases. This might be due to the use of antibiotics to treat secondary bacterial infections associated with viral diseases such as New Castle Disease (NCD) or fowl pox. Adelewo *et al.* (2014) reported that 86% of the poultry farmers used antibiotics for growth promotion**.**

The antibiotics usage pattern observed in this study showed that poultry farmers in Kano relied heavily on antimicrobial medication for prevention and control of disease in their farms. This observation implies that since the main consumers of poultry and its products are humans, several serious health problems could possibly be associated with the continuous exposure to the antibiotics. Earlier, Pavlov *et al.* (2007) explained that humans may have an allergic reaction, spreading of drug-resistant micro-organisms, carcinogenic effect, and potentially harmful effects on intestinal micro-flora. Ezenduka *et al.* (2014) reiterated that some antibiotics are directly toxic, like chloramphenicol which causes aplastic anemia, while allergic reactions and toxic side effects may have fatal consequences.

All the respondents used livestock markets as their outlets and almost all of them also sell their birds to households but some of the respondents (18%) sell their birds to hotels and restaurants in addition to live bird vendors and households. This makes the market an ideal site for sample collection.

The respondents of this study reported they obtained information on the appropriate antibiotics to use in the farm from variety of sources. Only 36% of the respondents were obtaining information from Veterinarian or qualified animal health professionals. Some of them admitted to relying on directives from drug stores vendors, friends or previous experience. These findings are similar to that of Chah *et al.* (2022) who reported that 30.7% of the poultry farmers were accessing information on the appropriate use of antibiotics from Veterinarian. Farmer's ignorance or unavailability of trained animal health Practitioners/Veterinarian at the time of diseases havoc and immunization push the farmers to prescribe for their own flock (Rose *et al*., 1996). This practice could account for the indiscriminate use of antibiotics and fuel the development of antimicrobial resistance. It is noteworthy to mention that, indiscriminate use of antibiotics can be alleviated by increasing Veterinarian responsibilities, training programs and mass awareness and monitoring. This will go a long way to address the unguided antibiotic prescription by drug vendors, friends and farmers instead of Veterinarian, as well as guides appropriate drug selection from reputable pharmaceutical companies as sub-standard antibiotics are unable to kill whole pathogens and may lead to potential risk of antimicrobial resistance. Ferdous *et al.* (2019) stated that the bigger picture lies in lack of public health education, awareness program for food safety and enforcement laws.

For antimicrobial use withdrawal practice, more than half of the respondents do not have knowledge of withdrawal period as only 45% of them are aware of drugs withdrawal period and 33% of them believe or think drug residues pose a risk to human health but all of them do not follow the withdrawal period guide as 100% of the farmers were disposing birds on medication. This finding is comparable with those of Afakye *et al.* (2020) Ferdous *et al.* (2019) and Nonga *et al.* (2009) who reported that almost all poultry farmers do not respect drugs

withdrawal practice. Some farmers complained that no Veterinarian provides them with knowledge of withdrawal period. Ferdous *et al.* (2019) stated that, although Veterinarian are aware of drugs withdrawal period and residues knowledge, they do not create mass awareness due to socio-economic constraints of the country as farmers have no insurance or governmental support for the loss of business.

The study findings showed that respondents with tertiary education were more aware and have better attitudes and perception on antibiotic residues. A related study by Al-mustapha *et al.* (2020) reported that majority of poultry farmers did not believe that antibiotic residues is a major health threat, hence suggested that the national action plan for antibiotic residue (NAP-AMR) should be focused on raising awareness of antimicrobial residues in these farmers.

Out of the 12 antibiotics studied, doxycycline was found to be the most indiscriminately used antibiotic, with 88% of the respondents reported to have been using it for both prevention and treatment, followed by tylosine (70%). However, erythromycin and chloramphenicol are the least used antibiotics. Several studies have estimated the antibiotics usage and antibiotic resistance in livestock and showed that gentamicin and tetracycline were the most commonly used antibiotics reported by farmers, their popularity among farmers might be because they are very cheap and readily available. Nonga *et al.* (2010) reported tetracycline as the most widely used antibiotics in Africa while a study by Reinhardt (2005) revealed that tylosine and enrofloxacin used for the treatment of mycoplasma and infectious coryza are the most commonly used antibiotics in poultry. Similarly, the results obtained by Ajayi e*t al*. (2017) revealed that NCO (Neomycin, Chloromphenicol and Oxytetracycline) were the most widely used antibiotics in Akure. Sirdar *et al.* (2012) also reported oxytetracycline, colistin, tylosin and enrofloxacine as the most widely used antibiotics in Khartoum Sudan. The most commonly sold antimicrobial classes in the major livestock, especially in poultry production in 15 countries from Europe, Asia, and Australia, were penicillins, tetracyclines, macrolides, and aminoglycosides, especially since each of these classes has been in use for more than 50 years (Page *et al.*, 2012).

The study observed that, this rapid increase in the use of antibiotics may not be unconnected with the increase in world population which leads to increase in food demand including poultry meat. Thus, poultry farmers may be pushed towards intensive farming for maximum production resulting to excessive use of antibiotics which may result in the present of residues. The study recommends implementation of systematic surveillance of antibiotic residue in food of animal origin by relevant authorities to establish safety of these food products for consumption as well as educating farmers on the danger of improper and uncontrolled use of medicinal products especially antibiotics.

CONCLUSION

The study recorded high prevalence of antibiotic residue of 43% among broiler chicken in the study area with kidney samples recording the highest residue content. Among the positive samples 36.4% were positive for enrofloxacin residue. The study established that majority of the respondents were not aware of the presence of residues in poultry and although most of them have knowledge of withdrawal period yet all of them were not observing withdrawal practice before disposing their birds. The study advocates enlightenment campaigns for the farmers on the correct way of administering the antibiotics with special emphasis on withdrawal periods and continuous monitoring of the residues for public health reasons.

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