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Assessing Antibiotic Use in Selected Poultry Farms in N'Djamena, Republic of Chad

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Abstract

The emergence of multidrug-resistant bacteria undermines the efficacy of many commonly used antibiotics, rendering infections increasingly difficult to treat. This situation results in heightened morbidity and mortality rates, as well as escalating healthcare costs, thereby placing a considerable strain on public health systems globally. Consequently, urgent action is required to combat antibiotic resistance, the implementation of robust stewardship programmes, and the promotion of public awareness initiatives. The methodology employed was based on surveys conducted among various stakeholders in the veterinary sector (professionals, heads of veterinary drug outlets, veterinarians and para-veterinarians, poultry farmers), as well as on the analysis of records. The findings reveal that there is no quantitative data available on the use of veterinary antibiotics in Chad. Veterinary drug outlets supply these medicines to farmers without prescriptions. Furthermore, veterinarians are consulted in only 14% of cases, either upon the onset of symptoms or on a regular basis by certain poultry farmers for managing recurrent diseases. None of the veterinarians surveyed reported conducting laboratory tests for diagnostic purposes. Among the poultry farmers interviewed, 45.83% do not rely on a veterinarian or para-veterinarian for antibiotic prescriptions. Regarding drug administration, only 8% seek the assistance of a veterinarian or para-veterinarian for monitoring, while 92% prefer to consult pharmacists and administer the treatments themselves. The most commonly used antibiotic substances among poultry farmers are oxytetracycline (83.33%), enrofloxacin (54.16%), and tylosin (45.83%). Lastly, all broiler chickens in the finishing phase and eggs produced following antibiotic administration are sold without observing the prescribed withdrawal periods.

The study highlights an unregulated and largely empirical use of antibiotics in semi-industrial poultry farming in Chad, with minimal recourse to veterinarians and diagnostic analysis. This situation promotes the development of antimicrobial resistance, exacerbated by the absence of veterinary supervision, the failure to observe withdrawal periods, and the free sale of veterinary medicines.

Keywords

Livestock Farming, Antibiotics, Poultry Farms, N'Djamena, Chad

1. Introduction

The growing global human population imposes an enormous demand for food to ensure the survival of humanity. This exerts pressure on several food industries, notably poultry production systems, where growth-promoting agents are used to meet the increasing food demand. The poultry industry has expanded exponentially across the world. As it has developed, numerous diseases have become increasingly frequent and costly to control, leading to widespread reliance on veterinary medicines, most of which are antibiotics [1] [2].

To combat infections and promote poultry growth, stakeholders often resort to antibiotics, which are frequently used irrationally. Such misuse can lead to the presence of antibiotic residues in food products as well as the emergence and spread of antibiotic-resistant bacterial strains. This presents a serious public health threat, with estimates suggesting up to 10 million deaths per year and economic losses exceeding 100 billion USD by 2050 if no global action is taken. Africa and Asia are expected to be the hardest hit, due to the disproportionate burden of infectious diseases, overstretched healthcare systems, precarious living conditions, and inadequate health infrastructure [3].

In Africa, specifically in Togo, biosecurity and confinement have been positively associated with the presence of antibiotic residues in eggs. A study revealed inappropriate use of antibiotics by guinea fowl farmers in the Savanes region of Togo, leading to the presence of antibiotic residues in eggs [4]. Another study carried out on poultry farms in N'Djamena and the border regions of Hadjer-Lamis and Chari-Baguirmi (Chad) aimed to identify the presence of pathogenic micro-organisms and assess the level of biosafety practices. Out of 300 samples analyzed, 40.33% were found to be contaminated with pathogens. The most commonly identified microorganisms were *Salmonella paratyphi* (21.68%), *Citrobacter freundii* (12%), *Escherichia coli* (5.33%), and *Pseudomonas* spp. (1.33%). These findings reflect a significant level of contamination, posing a public health concern [5]. The study also highlights that biosecurity measures on many farms were inadequate. In Chad, the use of antibiotics to manage diseases in poultry farms, particularly in the capital N'Djamena, has led to a high prevalence of antibiotic residues, especially in eggs from laying hens (30.9%). Furthermore, alarming resistance rates

have been reported in *Salmonella* spp. (90%) and *E. coli* (100%) strains isolated from broiler chicken meat [6] [7].

Given these observations, understanding the methods of antibiotic use is essential to a better overview of current practices. This study was therefore undertaken to assess stakeholder behaviours within the sector and to enhance knowledge on the responsible use of antibiotics in poultry farming.

2. Materials and Methods

2.1. Materials

2.1.1. Geographical Location of Chad, Population, and Livestock Farming

Chad (Figure 1) is a landlocked country located between the 7th and 14th degrees of north latitude and the 13th and 24th degrees of east longitude. Serving as a bridge between the Maghreb and Central Africa, the country spans an area of 1,284,000 km^2, making it the fifth largest nation in Africa. Chad shares borders with Sudan to the east, Cameroon, Niger, and Nigeria to the west, Libya to the north, and the Central African Republic to the south.

Administratively, Chad is divided into 23 provinces, 107 departments, and 377 municipalities, with a total population of 17 million inhabitants, corresponding to a population density of 12 inhabitants per square kilometre [8].

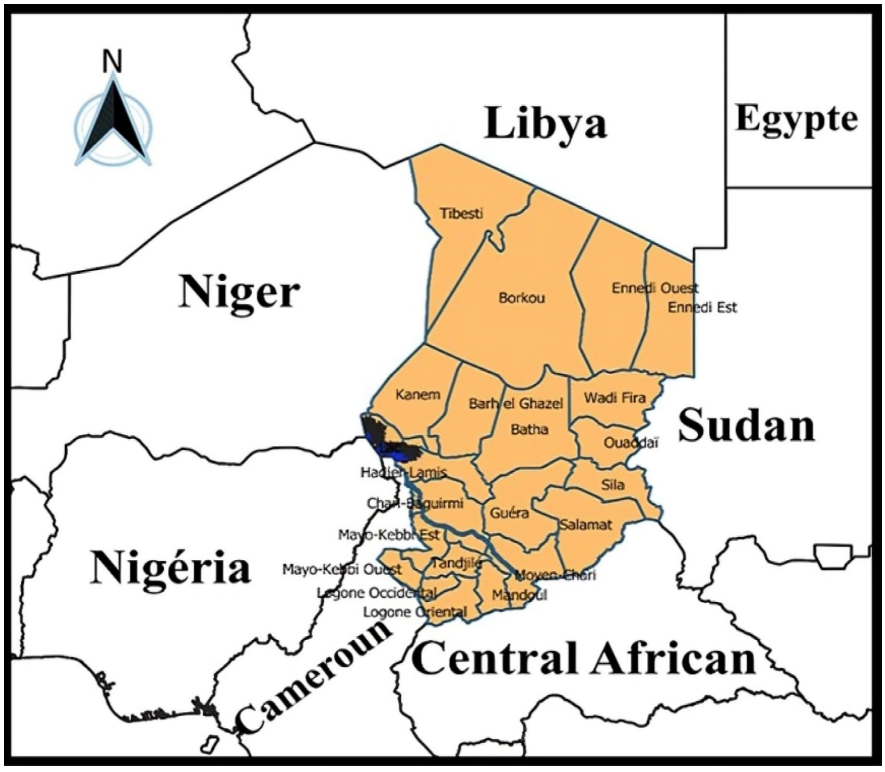

Figure 1. Map of the republic of Chad.

Chad is a Sahelian country with an agropastoral vocation, and its economy relies heavily on agriculture and livestock farming. Livestock farming plays a crucial role

in poverty reduction and serves as a key instrument for enhancing food security.

Indeed, the socio-economic importance of the livestock subsector is indisputable, with a national herd of 94 million animals of all species combined. The subsector sustains approximately 40% of the rural population, accounts for 53% of the rural sector's GDP, and provides employment to 80% of the active population [9].

2.1.2. Study Area Presentation

Study Framework

The study was conducted in poultry farms located in N'Djamena, the capital of Chad, which lies within the Sahelian zone and is characterised by an agro-pastoral orientation. Although geographically peripheral, N'Djamena is the main communication hub of the country and has experienced rapid population growth since the early 1980s. With an average annual growth rate of 7 percent, the population was estimated at over 1,700,000 inhabitants in 2022, representing nearly 10 percent of the country's total population [8].

2.2. Methods

2.2.1. Survey of Veterinary Officials and Archive Analysis

Field activities began with several surveys conducted in veterinary services, followed by consultation of archives, to gain an understanding of the overall situation regarding antibiotic use in livestock within the study area. These surveys involved key institutions such as the Sub-directorate of Hygiene and Public Veterinary Health and the Sub-directorate of Veterinary Pharmacy, both under the National Directorate of Veterinary Services (DSV) of Chad.

The interviews were guided by a questionnaire covering the following points:

- The level of antibiotic use in poultry farming;
- The quantities of veterinary antibiotics consumed in Chad;
- The specific quantities of antibiotics used in poultry production;
- The existence or not of a register of veterinary antibiotics marketed in Chad;
- The implementation of an antibiotic monitoring plan in Chad;
- The knowledge of withdrawal periods, antibiotic resistance, and antibiotic residues in food of animal origin;
- The number of poultry farms in the urban and peri-urban zones of N'Djamena;
- The number of veterinary clinics in the urban and peri-urban zones of N'Djamena;
- The number of veterinary drug outlets in the urban and peri-urban zones of N'Djamena.

Following the interviews with officials, archives were reviewed to gather information on the main veterinary drug outlets, veterinary clinics, and poultry farms within the urban and peri-urban zones of N'Djamena.

2.2.2. Survey of Veterinary Drug Retailers

The survey was conducted at veterinary drug outlets where veterinarians, para-

veterinarians, and poultry farmers typically procure their medications. The aim was to collect data on the following:

- Experience in the sale of veterinary medicines;
- Whether prescriptions are required for dispensing antibiotics;
- Types of antibiotic molecules sold for use in poultry farming;
- Quantities of antibiotics sold over the past six (06) months.

After completing this survey, addresses of poultry farmers, veterinarians, and para-veterinarians who regularly use these outlets were recorded to identify potential participants for the next stage of the study.

2.2.3. Survey of Veterinarians and/or Para-Veterinarians Managing Poultry Farms

This stage consisted of surveys targeting veterinarians and para-veterinarians responsible for managing poultry farm health issues. Topics included:

- The profiles of the veterinary personnel;
- The diseases encountered and diagnostic methods used;
- The level of knowledge regarding antibiotic use;
- The reasons for prescribing and methods of administering antibiotics;
- The attitudes and practices relating to antibiotic therapy;
- The possible adverse effects from the misuse of these medications;
- The measures taken in relation to withdrawal periods during antibiotic treatments.

2.2.4. Survey of Poultry Farmers

The survey among poultry farmers focused on:

- Health-related information about the surveyed poultry farms;
- Their level of collaboration with veterinary personnel;
- Their knowledge, attitudes, and practices concerning antibiotic use.

2.2.5. Sampling

Sampling of poultry farms was carried out using a non-probabilistic "snowball" method. Veterinary drug retailers identified volunteer veterinarians and para-veterinarians working in poultry farms, who in turn directed the survey team to poultry farms and farmers.

The study covered layer, broiler, and mixed-type poultry farms located in urban and peri-urban zones of N'Djamena. This method was chosen due to the absence of an exhaustive list of poultry farms and the reluctance of some poultry farmers to grant access to their premises. GPS was used to avoid duplication in the selection of poultry units.

2.2.6. Data Processing and Analysis

Data collection followed a daily schedule covering veterinary drug outlets, veterinary clinics, and poultry farms. Upon completion, data were entered into Epi Info 7 software and then transferred to Excel and Word for organisation into tables and figures.

3. Results

3.1. Survey of Veterinary Officials and Archive Analysis

The survey conducted with officials from the Directorate of Veterinary Services (DSV) revealed that the distribution of veterinary medicines in Chad is handled by multiple stakeholders, including wholesale importers, veterinary pharmacies, and retailers. However, no quantitative data exist on the types and quantities of veterinary antibiotics consumed in the country, particularly those intended for poultry.

The concepts of antimicrobial resistance and antibiotic residues in animal products are well understood by the officials interviewed. A national action plan to combat antimicrobial resistance within the framework of One Health exists, as well as regulations governing the use of veterinary medicines.

However, some officials believe that these regulations are poorly enforced, thus allowing unqualified individuals to possess, distribute, and use veterinary medicines. This situation is exacerbated by the illegal importation and sale of medicines of questionable quality and origin, as well as their misuse. This phenomenon is facilitated by the porous nature of national borders.

The officials also stressed that the misuse of antibiotics in livestock farming has direct consequences for public health.

Regarding the inventory of poultry farms in the urban and peri-urban zones of N'Djamena, no precise data could be obtained. According to the officials interviewed, many farms have ceased activity over the past two years due to the ban on importing day-old chicks from Cameroon and Nigeria, the main suppliers of poultry farmers in Chad. This measure was taken following outbreaks of avian influenza in those countries. Nevertheless, a directory containing contact details of some veterinary clinic managers, veterinary drug outlets, and a few poultry farmers was retrieved through archive consultation.

3.2. Survey of Veterinary Drug Retailers

3.2.1 General Information

During the survey conducted among the managers of veterinary drug outlets, various general pieces of information were collected and are presented in **Table 1**.

It emerges from this table that the majority of the surveyed establishments are wholesale importers, representing 71% of the total, followed by veterinary pharmacies (29%). Among the seven establishments surveyed, 72% have been operating for more than 10 years in the sale of veterinary medicines. Furthermore, the presentation of a prescription is not always required for the dispensing of medications, which is contrary to the Chadian pharmacy law. This 2004 law stipulates that—any dispensing of veterinary medicines or antibiotics must be based on a prescription issued by a veterinarian and must be documented through a secured prescription. The absence of retailers in these results is explained by their refusal to participate in the survey, due to mistrust, stemming from the informal and often fraudulent nature of their activities.

Table 1. Profile of the surveyed veterinary drug outlets.

Features	Profile of respondents	Number	Rate (in %)
Types of establishment	Importing wholesalers	05	71
	Veterinary pharmacies	02	29
Seniority	Less than 05 years old	01	14
	5 to 10 years	01	14
	More than 10 years	05	72
Prescription requirement	Yes	01	14
	No	06	86

3.2.2. Antibiotic Molecules Sold by the Surveyed Veterinary Drug Sales Establishments

The antibiotic molecules sold in the surveyed veterinary drug sales establishments were listed, and the results are presented in Table 2.

Table 2. Inventory of antibiotic molecules identified in the surveyed veterinary drug sales establishments.

Antibiotics	
Families	**Molecules**
Macrolides	Tylosin, Erythromycin
Polypeptides	Colistin
Tetracyclines	Oxytetracycline, Doxycycline, Chlortetracycline
Nitrofurans	Furaltadone
First generation quinolones	Fluméquine, Oxolinic acid
Second generation quinolones	Enrofloxacin, ciprofloxacin
Sulfonamides	Sulfadiazine, Sulfamethroxazole Trimethoprim
Aminosides	Streptomycin, Neomycin Kanamycin
Beta-lactams (Penicillins) (Cephalosporins)	Amoxicillin
	Ceftiofur

From this table, we understand that eight (08) families of antibiotics were identified, namely macrolides, polypeptides, tetracyclines, nitrofurans, quinolones, sulfonamides, aminoglycosides, and beta-lactams. However, the variety of antibiotic families marketed varies from one establishment to another.

This result is explained by the fact that veterinary drug sales establishments in Chad source their supplies from pharmaceutical companies of their choice. These observations are similar to the findings of Soromou *et al.* (2022) [10] in Dubréka

(Guinea) and Khalen (2013) [11] in Western Cameroon, where eight (08) families of antibiotics were also used in laying hens.

Furthermore, data on the quantity sold per antibiotic molecule were not provided by the managers of the sales establishments, citing confidentiality reasons.

3.3. Survey Results Among Veterinarians and Paraveterinarians Responsible for Poultry Farm Health

3.3.1. Timing of Veterinarian and Paraveterinarian Interventions in Farms

Regardless of the presence or absence of diseases in the farms, poultry farmers sometimes call upon animal health professionals to ensure medical care and health monitoring of their livestock. The data corresponding to the timing of these interventions are illustrated in **Figure 2**.

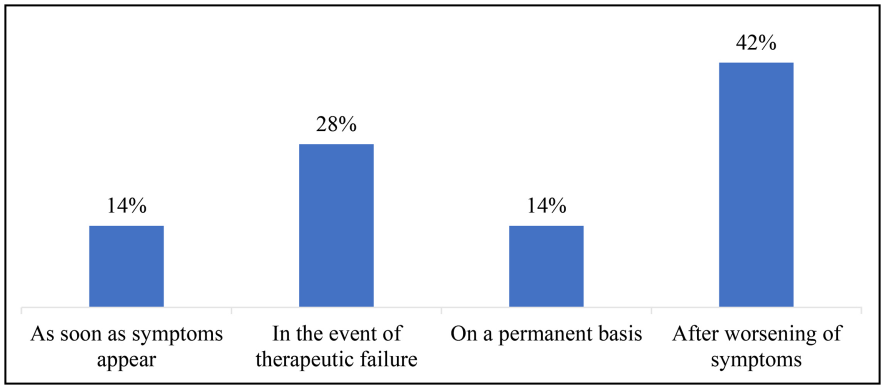

Figure 2. Timing of veterinarian and paraveterinarian interventions in farms.

Veterinarians and paraveterinarians in the urban and peri-urban areas of N'Djamena are consulted in 42% of cases after the worsening of symptoms, and in 28% of cases due to therapeutic failure. In contrast, 14% of poultry farmers seek their assistance at the onset of symptoms or on a regular basis. The timing of medical intervention is crucial. A visit at the onset of clinical signs, before the animals' condition worsens, allows the veterinarian to make a prompt diagnosis and act effectively to control not only direct losses (morbidity, mortality) and indirect losses (reduced weight gain, increased feed conversion ratio, decreased livestock population), but also the deterioration in the quality of products delivered to the consumer.

These results are lower than those reported by Henaoui and Dine (2013) [12], who observed that 55% of poultry farmers in the Chlef region of Algeria consult veterinarians at the first signs of illness. This difference may be explained by the high level of collaboration established between poultry farmers in Chlef and their veterinarians.

3.3.2. Diagnostic Methods

The information gathered on the diagnostic methods used by veterinarians is presented in **Table 3**.

Table 3. Diagnostic methods used.

Diagnostic methods	Number	Percentage rate
Clinical examination	24/24	100
Necroscopic examination	14/24	58
Laboratory examination	00	0.00

Clinical examination forms the basis of diagnosis for all surveyed veterinarians and paraveterinarians. 58% combine clinical examination with necropsy to establish a diagnosis. However, none of the respondents reported using laboratory tests.

The prescription of an antibiotic treatment depends largely on the diagnostic methods used. If clinical examination alone is not always conclusive, necropsy performed on a sufficient number of subjects may provide valuable information. These data should, in principle, be supplemented with laboratory analyses (bacteriology, serology, parasitology, histology).

In avian pathology, due to the similarity of symptoms among various diseases but with different causes, clinical and/or necropsy examination alone, without laboratory testing, is not always sufficient. A correct and complete diagnostic approach must include all key principles relating to the subjects examined, including medical history, clinical, anatomopathological, epidemiological data, and laboratory analyses.

These results differ from those reported by Naimi E (2022) [13], who observed that 53% of veterinarians in the Wilayas of Biskra, Algeria, collaborate with laboratories for diagnosing avian diseases. The lack of laboratory use by veterinarians and paraveterinarians in N'Djamena may be explained, on the one hand, by the high cost of laboratory tests, and on the other hand, by the need for rapid treatment without waiting for laboratory results, which sometimes take a considerable amount of time.

3.3.3. Use of Antibiotics

The proportion of surveyed veterinarians and paraveterinarians who resort to the use of antibiotics is shown in **Figure 3**.

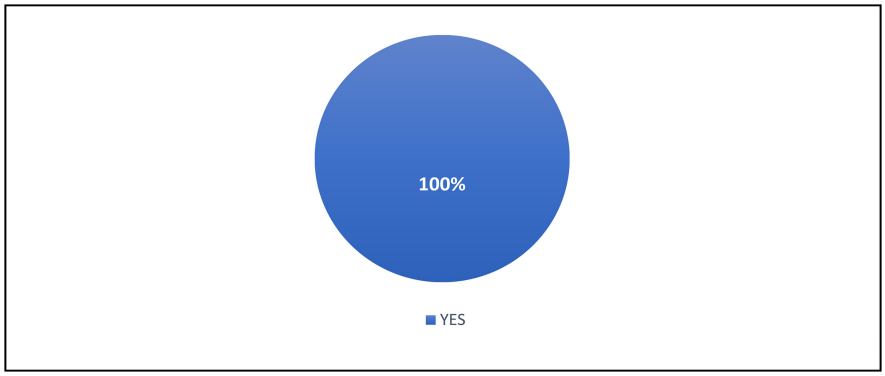

Figure 3. Rate of antibiotic use among respondents.

This figure shows that all respondents use antibiotics as part of the health management of their livestock. This result is consistent with the findings of Slatnia *et al.* (2008) [8], who reported that 100% of veterinarians prescribe antibiotics for the sanitary management of their farms.

3.3.4. Period of Antibiotic Use in Farms

Data related to the period of antibiotic use in farms are presented in Figure 4.

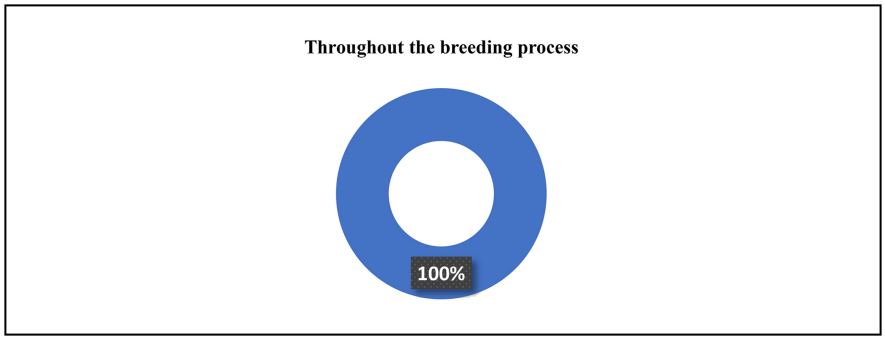

Figure 4. Period of antibiotic use in farms.

According to this figure, antibiotics are used throughout the entire farming cycle—that is, at all stages of production. This practice is now banned in some developed countries in Europe and America, where, as a precautionary measure, the use of antibiotics as growth promoters in animal feed is prohibited. These findings are consistent with those of Bodering *et al.* (2017) [7], who reported that 100% of semi-industrial farms in N'Djamena were subjected to continuous application of products containing antibiotics.

3.3.5. Attitudes Towards Therapeutic Failure

The behavior of veterinarians and para-veterinarians following therapeutic failure was observed, and the results are presented in Table 4.

Table 4. Attitude of veterinary personnel in response to therapeutic failure.

Attitude of respondents	Number	Rate (%)
Using the diagnostic laboratory	0	0,0
Increase in the dose of the same drug	1	15
Extension of the duration of the same treatment	4	57
Prescription of another drug	2	28
Total	**7**	**100.0**

Following the failure of an initial antibiotic treatment, 57% of respondents reported extending the duration of the same treatment, 28% opted for switching to

a different molecule, and 14% preferred increasing the dose of the same product. None of them sought laboratory assistance or performed an antibiogram, which could contribute to the emergence or spread of antibiotic resistance in livestock farms. Similar observations following treatment failure were also reported by Soromou *et al.* (2022) in the municipality of Dubréka, Guinea [10].

3.3. Concept of Withdrawal Period

Information regarding the knowledge of the withdrawal period by veterinarians and para-veterinarians, as well as whether or not it is taken into account during treatments, is presented in Table 5.

Table 5. Knowledge, attitudes, and practices related to the concept of withdrawal period.

Waiting times	Yes	No
Knowledge	7 (100%)	0 (00%)
Taking into account	0 (00%)	7 (100%)
Total	**7 (100%)**	**7 (100%)**

From this table, it appears that 100% of the veterinarians and para-veterinarians responsible for the health management of poultry farms are aware of the concept of withdrawal period, but do not apply it systematically. These findings are consistent with those of Soromou *et al.* (2022), who reported that all surveyed personnel claimed to have knowledge of the withdrawal period, but unfortunately, not all of them took it into account when prescribing antibiotics [10].

3.4. Concept of Antibiotic Residues in Animal-Derived Food Products (ADFPs)

Information regarding the knowledge of antibiotic residues among veterinarians and para-veterinarians is presented in Table 6.

Table 6. Knowledge, attitudes, and practices regarding the concept of antibiotic residues in animal-derived food products (ADFPs).

Antibiotic residues	Yes	No
Knowledge	5 (71.43%)	2 (28.57%)
Known consequences:		
✓ **Human toxicity**	2 (28.57%)	2 (28.57%)
✓ **Disease in men**	2 (28.57%)	
✓ **Antibiotic resistance**	1 (14.28%)	
Total	**7 (100%)**	

The concept of antibiotic residues in animal-derived food products is known by 71% of the respondents, while 29% are unaware of it. Regarding the consequences, 28% mentioned toxicity and diseases in humans, while 14% associated these residues with the emergence of antibiotic resistance. Although these responses lack detail, they generally reflect a certain level of awareness among veterinarians and para-veterinarians in the study area, as they are consistent with the risks associated with antibiotic residues reported in the literature, particularly by Dosso (2014) [14] and Khalen (2013) [11]. These risks include toxicity, fetotoxicity, allergic reactions, and the development of antibiotic resistance.

3.5. Concept of Antibiotic Resistance

Information regarding the knowledge of antibiotic resistance and its consequences among veterinarians and para-veterinarians is presented in Table 7.

Table 7. Knowledge, attitudes, and practices related to the concept of antibiotic resistance.

Antibiotic resistance	Yes	No
Knowledge	6 (85.71%)	1 (14.29%)
Known consequences:		
✓ **Therapeutic failure in animals**	5 (71.42%)	1 (14.29%)
✓ **Decline in production**	1 (14.29%)	
Total	7 (100%)	

The concept of antibiotic resistance is known by 85% of respondents, who identified therapeutic failure (71.42%) and reduced production (14.29%) as the main consequences. However, they consider these effects to be limited to animals, which demonstrates a partial understanding of the potential consequences of antibiotic misuse. According to Messai (2006), these effects occur on three levels.

- In animals (antibiotic resistance, therapeutic failure, reduced productivity);
- In the environment (impact on fauna and flora);
- In humans (development of multidrug-resistant bacteria, treatment ineffectiveness, etc.).

3.6. Survey Results from Poultry Farmers

3.6.1. Socio-Demographic Information of Surveyed Poultry Farmers

- ***Educational Level:***

In the survey conducted among poultry farmers, we examined the level of education of the respondents (see Table 8).

In terms of education, 25% of poultry farmers had a primary level of education, while 16% had received no formal education. Only 25% of respondents had attained post-secondary or university education. Thus, the educational level of poul-

try farmers remains relatively low, which may have a negative impact on their animal health and husbandry practices. A farmer, as a key stakeholder in poultry production, with limited education, may face difficulties in improving techniques and responding effectively to situations that could compromise the performance of their farms.

Table 8. Educational level of poultry farmers.

Level of study	Number	Percentage rate
No level	4	16
Primary	6	25
Secondary	8	32
Post-secondary	6	25
Total	**24**	**100**

These percentages differ from those reported by Bodering *et al.* (2017), who investigated the use of antibiotics in poultry farming in the cities of N'Djamena and Doba, Chad. Their study revealed that 50% of poultry farmers in N'Djamena had a university-level education [7]. This difference may be attributed to policies and vocational training initiatives implemented in the sector.

3.6.2. Flock Size

In order to assess the development of poultry farming in the N'Djamena area, the flock size of each surveyed poultry farmer was determined. The results are presented in Table 9.

Table 9. Poultry flock size.

Number of heads per band	Number	Percentage rate
Less than 5000	20	83
5000 to 10000	3	12
More than 10,000	1	4
Total	**24**	**100**

It should be noted that flock sizes vary from one poultry farmer to another. These differences may be attributed to several factors, including the financial capacity of the farmers, the availability of infrastructure, the level of experience in poultry farming, and access to feed and veterinary resources.

These results differ from those reported by Khalen (2013), who conducted a study on modern poultry farms in the Western Region of Cameroon, where 51% of the surveyed farms had flock sizes ranging from 5000 to 10,000 birds [11].

3.6.3. Type of Poultry Production

In order to determine the types of poultry production systems practiced by farmers in our study area, data were collected on the production orientation of the surveyed farms. The results are presented in Figure 5.

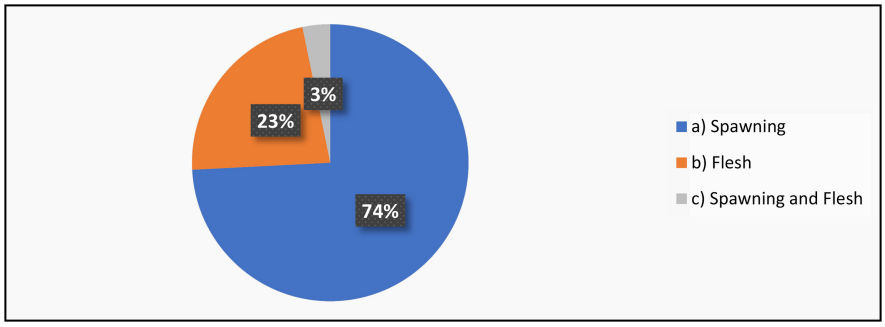

Figure 5. Type of poultry production.

Egg production is the primary activity in the surveyed farms. In contrast, these findings differ from the findings of Toe (2013) in Ivory Coast, who observed a predominance of broiler farms (68.6%) compared to layer farms (31.4%) [15].

3.7. Health Information on Farms

3.7.1. Existence of a Health Officer for Farm Monitoring

In order to determine the level of involvement of animal health professionals in farm health monitoring, information was collected on the presence or absence of a designated health officer for each surveyed farm. The results are presented in Figure 6.

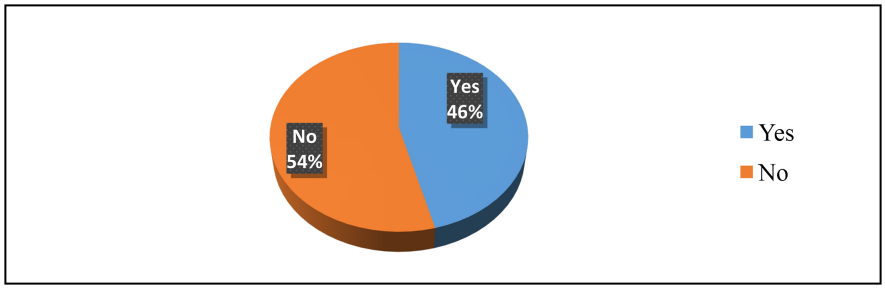

Figure 6. Status of the existence of health officers in charge of farm monitoring.

It should be noted that 46% of the surveyed farms have a designated health monitoring officer, while 54% do not. This situation may be explained by the preference of many farm owners to hire familiar personnel, thus excluding qualified professionals in this area.

These results are lower than those reported by Dosso (2014) who observed that 60% of farms in the Agnibilékrou district, Côte d'Ivoire, received veterinary assistance [14]. This difference may be explained by the presence of veterinary training institutions providing expertise in the field.

3.7.2. Profile of Health Monitoring Officers

The survey to determine the presence or absence of a health monitoring officer on farms led us to identify the profile of the health monitoring officers in the surveyed farms (see Table 10).

Table 10. Profile of health monitoring officers.

Agent profile	Number	Rate (in %)
Veterinarians	3	21.43%
Para-veterinary	11	78.57%
Total	14	100

Veterinary Para-professionals, including zootechnicians and other animal health professionals, represent the majority of health monitoring officers in the surveyed farms, with a rate of 78.57%, compared to 21.43% for veterinarians. This situation could be explained by the preference of Chadian veterinarians for working in public institutions, as well as their generally higher fees compared to other professionals.

These results are notably lower than those reported by Soromou *et al.* (2022), who found that 75% of the professionals working in farms in the Dubréka commune, Guinea, were veterinarians. This difference may be attributed to the presence of a veterinary school in Guinea, notably the Institute of Science and Veterinary Medicine of Dalaba, which trains qualified professionals in the field [10].

3.7.3. Poultry Farming Training and Profile

In order to assess the level of professionalism of poultry farmers in the urban and peri-urban areas of N'Djamena, we determined the level of poultry farming training of the respondents. The results are presented in Figure 7.

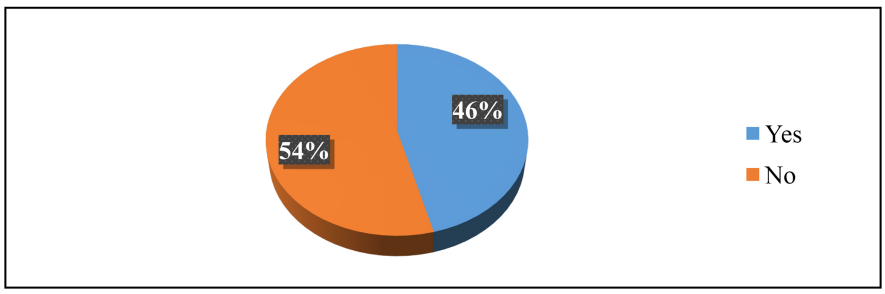

Figure 7. Training level of poultry farmers in poultry farming.

From Figure 8, we observe that 46% of the surveyed poultry farmers have received training in poultry farming, while 54% have not received any training in this field.

This rate is higher than that reported by Biagui (2012), who noted that only 19% of the surveyed farmers had a specialization in poultry farming [16]. This differ-

ence could be explained by the growth in training provided to farmers in recent years, especially due to initiatives from development organizations and improved access to new communication technologies. Additionally, the training organized by private veterinarians also contributes to enhancing the skills of poultry farmers.

3.7.4. Dominant Pathologies

In order to identify the health issues leading to the use of antibiotics in the farms, the dominant pathologies in the surveyed farms were recorded. The results are presented in Table 11.

Table 11. Diseases against which poultry farmers vaccinate.

Pathologies	Number	Percentage rate
Coccidiosis	14	58.33
Newcastle	10	41.66
Colibacillosis	09	37.50
Gumbor	06	25.00
Infectious bronchitis	05	20.83
Smallpox	05	20.83
Marek	03	12.50
Salmonellosis	03	12.50
Total	**24**	**100%**

The results show that coccidiosis infestation is the most common disease, affecting 58% of the visited farms. Newcastle disease (41%) ranks second in terms of prevalence, followed by colibacillosis (37%). Other diseases are also frequently observed in these farms, including Gumboro disease (25%), infectious bronchitis (20%), fowl pox (20%), and to a lesser extent, Marek's disease and salmonellosis. These findings could explain the high use of antibiotics. These results are consistent with those reported by Niyibizi (2012), who found that the dominant diseases in the Dakar region and its surroundings were coccidiosis, Gumboro disease, and Newcastle disease for viral diseases, and colibacillosis and salmonellosis for bacterial diseases [17].

3.7.5. Vaccination

To assess the vaccination coverage in poultry farms in N'Djamena, the diseases against which the poultry farmers vaccinate were recorded. The result is summarized in Table 12.

Here, we note that the diseases against which poultry farmers vaccinate are viral in origin, such as Newcastle disease, Gumboro, infectious bronchitis, and fowl pox.

The lack of vaccination against non-viral diseases may be explained by the fact that viral diseases are generally perceived as the most deadly in poultry farming.

Table 12. Diseases against which poultry farmers vaccinate.

Diseases	Number	Percentage rate
Newcastle	20	83.33
Gumboro	15	62.50
Infectious bronchitis	15	62.50
Fowl pox	10	41.66
Total	24	100%

3.7.6. Identity of Antibiotic Prescribers

To determine the causes of therapeutic failure, information was collected on those responsible for prescribing antibiotics on the farms. The result is shown in **Figure 8**.

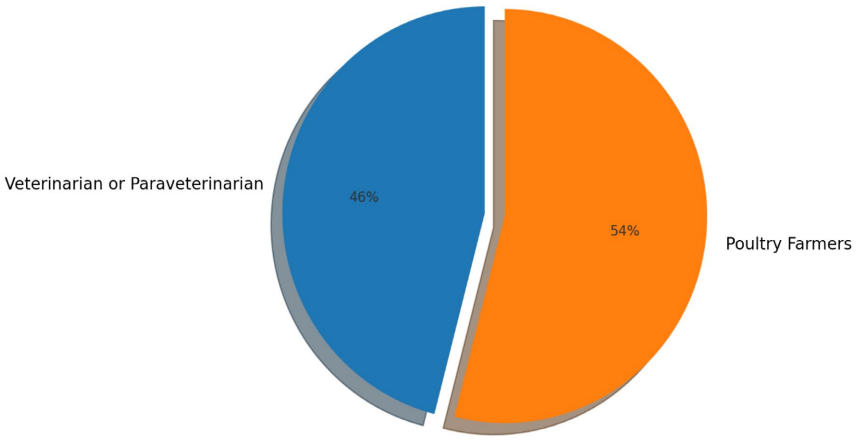

Figure 8. Profile of antibiotic prescribers in farms.

The rate of self-medication in the surveyed farms is 46%, which is lower than that reported by Soromou *et al.* (2022), where 70% of poultry farmers in the commune of Dubréka practiced self-medication [10].

3.7.7. Administrator of Antibiotics

Information on the person responsible for administering medication in the farms is presented in **Figure 9**.

Regarding the administration of medications, 8% of poultry farmers rely on the veterinarian or para-veterinarian in charge of the farm's health monitoring. However, the majority of poultry farmers (92%) prefer to consult pharmacists and administer the products to their animals themselves. In practice, some veterinarians provide prescriptions and then leave the administration of medications to the farmers. This situation could lead to consequences such as dosage errors, improper stor-

age practices, and inadequate preparation of medications. These findings are similar to those observed by Messai (2006), who found that 90% of farmers in the Wilayas of Algeria administered medications themselves [18].

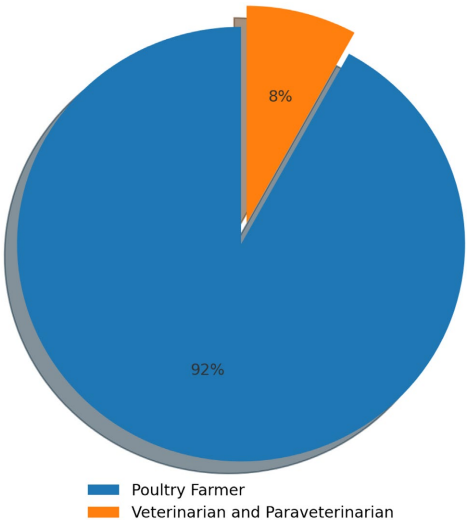

Figure 9. Profile of antibiotic administrators in farms.

3.7.8. Use of Antibiotics by Poultry Farmers

The results related to the use of antibiotics by poultry farmers are shown in **Figure 10**.

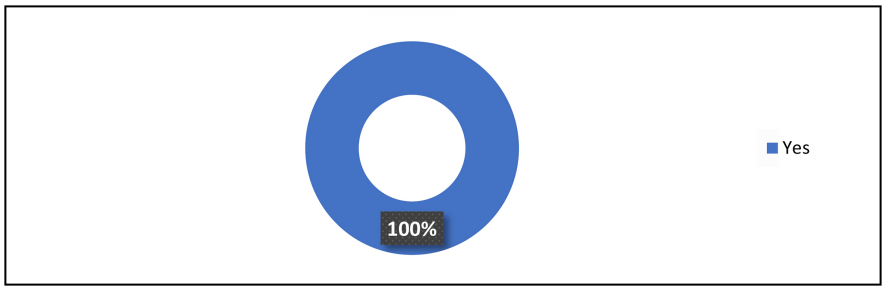

Figure 10. Use of antibiotics.

It appears from this figure that 100% of poultry farmers use antibiotics on their farms. This result is similar to the findings of Bodering *et al.* (2017), who studied the use of antibiotics in poultry farming in the cities of N'Djamena, where all the surveyed farmers also used antibiotics in their farms [7]. This demonstrates their widespread use throughout the farming cycle, as well as their accessibility without the need for a veterinary prescription.

3.7.9. Antibiotic Molecules Used by Respondents (see Table 13)

Oxytetracycline (83.33%), enrofloxacin (54.16%), and tylosin (45.83%) are the most commonly used antibiotic molecules by poultry farmers. These results align with those of Faye (2022), who indicates that tetracyclines and their combinations represent more than half (61%) of the usage in laying hen farms in the peri-urban area of Dakar [19].

Table 13. Antibiotic medications used in the surveyed farms.

Drugs used as antibiotics	Active ingredients	Number of poultry farmers	times
Oxyfurant 4	Oxytetracycline, Furaltadone	20 (83.33%)	6 days
Tetracolivit	Colistin, oxytetracycline, erythromycin, colistin, vitamins	16 (66.66%)	None
Nemovit	Oxytetracycline, neomycin, vitamins	11 (45.83%)	1 day for eggs, 7 days for meat
Limoxin	Oxytetracycline	08 (33.33%)	6 days
Anticox	Sulfadimerazine, trimetroprime	11 (45.83%)	12 days
Oxytetracycline 50% (in French)	Oxytetracycline	20 (83.33%)	None
Enrofloxacin	Enrofloxacin	13 (54.16%)	Not determined
Colistin	Colistin	07 (29.16%)	2
Oxyvit	Oxytetracycline and vitamin	13 (54.16%)	7
Tylodox extra	Tylosin and docycycline	07 (29.16%)	15 for meat 4 for eggs
Amprocox	Amprolium, sulfaquinoxaline, vitamins	09 (37.50%)	14 days meat, prohibited for laying hens
Aliséryl	Erythromycin, oxytetracycline, streptomycin, colistin, vitamins	09 (37.50%)	1 day for eggs 7 for meat
Tylosine 100%	Tylosine	11 (45.83%)	5 days
Flumesol	Fluméquine	02 (8.33%)	3 days

3.7.10. Supply of Antibiotic Medications

The data related to the supply of antibiotic medications is presented in Figure 11.

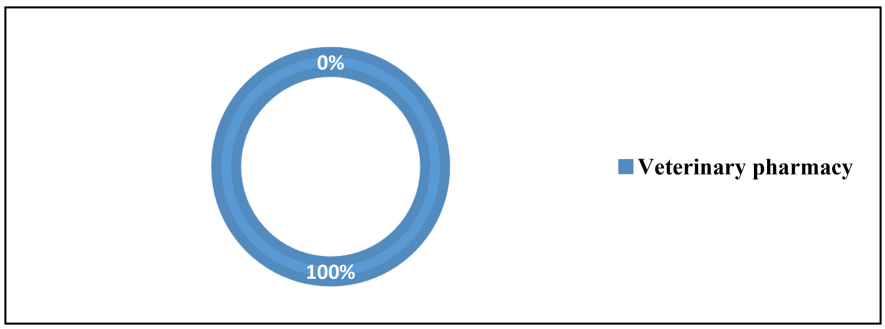

Figure 11. Supply of antibiotics.

The survey on the supply of antibiotics revealed that 100% of poultry farmers obtain their antibiotics from veterinary pharmacies. This can be explained by the perception that these pharmacies offer higher-quality products and provide poultry farmers with the opportunity to benefit from the advice of pharmacists. These results are similar to those of Bodering *et al.* (2017) [7], who also found that 100% of farmers in semi-industrial poultry farms sourced their antibiotics from phar-

macies.

3.7.11. Farmer's Attitude Toward Therapeutic Failure

Information regarding the poultry farmers' attitude in case of therapeutic failure was collected and is presented in Figure 12.

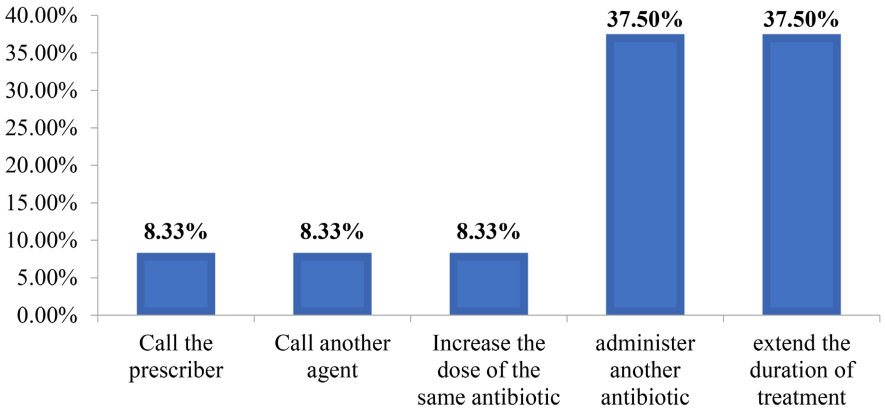

Figure 12. Farmer's attitude toward therapeutic failure.

The investigation into poultry farmers' attitudes toward therapeutic failure revealed that, in most cases (37.5%), farmers prefer to extend the duration of the same medication or administer another antibiotic. These results are similar to those of Soromou *et al.* (2022) [10], where 33% of poultry farmers in the urban commune of Dubréka extended the treatment without resorting to an antibiogram in the case of therapeutic failure.

3.7.12. Preparation and Administration of Antibiotics (see Table 14)

According to the table, it appears that 100% of poultry farmers administer antibiotics orally by mixing them with the drinking water, preparing the necessary amount of water for daily treatment. These results are comparable to those obtained by Zerbo (2014) and Khalen (2013) in poultry farms in Ouagadougou (Burkina Faso) and western Cameroon, where, in all the farms visited, the oral method is systematically used to administer medications by adding them to the drinking water [11] [20].

Table 14. Preparation and method of antibiotic administration.

How the product is administered	Preparing the daily amount	Preparation of the total quantity during the treatment period	Total
In drinking water	24 (100%)	0	24 (100%)
In the food	0	0	0
By injection	0	0	0
Total	**24 (100%)**	**0**	**24 (100%)**

3.7.13. Administration of Antibiotics to Finishing and Laying Chicken

The information on the administration of antibiotics to chickens in the finishing or laying phase is presented in Table 15.

It appears from the table that 100% of poultry farmers administer antibiotics to chickens in the finishing phase and to laying hens. This practice can be explained by the recognized effectiveness of antibiotics in treating various diseases in farms. Additionally, the farmers' lack of awareness regarding withdrawal periods, antibiotic residues, and antibiotic resistance contributes to this attitude. These results are similar to those reported by Dosso S. (2014), who observed that 100% of the farms surveyed did not consider withdrawal periods [14].

Table 15. Administration of antibiotics to chickens in the finishing or laying phase.

Administration of antibiotics to chickens in the finishing phase	Administration of antibiotics to laying hens		
	Yes	No	Total
Yes	24 (100%)	0	24 (100%)
No	0	0	0
Total	**24 (100%)**	**0**	**24 (100%)**

4. Discussion

The results of this study highlight several key trends in the use of antibiotics and poultry farming practices. First, it is evident that all the poultry farmers surveyed use antibiotics, which shows their widespread use in poultry farming. This finding is consistent with the work of Bodering *et al.* (2017) in N'Djamena, which indicates that 100% of farmers use these medications [7]. In Kenya, research carried out by Muloi *et al.* (2025) shows that half of farms have used antibiotics at least once in the last two months, mainly for self-administered therapeutic reasons [21].

In this study, we found that the variety of antibiotic families marketed varies across establishments. Eight antibiotic families were identified: macrolides, polypeptides, tetracyclines, nitrofurans, quinolones, sulfonamides, aminoglycosides, and beta-lactams. Other studies have reported that the most frequently used antibiotics include oxytetracycline, enrofloxacin, and tylosin. Tetracyclines and their combinations account for a significant proportion of treatments in modern poultry farming [19].

In the context of antibiotic use in poultry farming in Pakistan, 60% consisted of colistin sulfate and amoxicillin trihydrate, despite colistin being considered an antibiotic of last resort. Furthermore, a substantial proportion of antibiotic use in poultry farms (60%) and by poultry farmers (50%) occurred without a prescription from either human or veterinary health professionals [22]. In a study conducted in two Indian states, all veterinarians utilized tetracyclines, aminoglycosides, and cephalexin on the poultry farms. Over half (54.5%) stated antibiotics prevent diseases, and 72.7% said they treat and prevent diseases [23]. Huong *et al.*, (2021)

showed that the three main purposes of AMU were treatment of sick animals, disease prevention, and weight gain. Treatment accounted for 62.1% in chicken farming. The widespread use of antibiotics in poultry farming can be attributed to their easy accessibility and proven effectiveness against common infections [24].

Regarding procurement, all poultry farmers source antibiotics from veterinary pharmacies, which is explained by the guarantee of product quality and the opportunity to receive advice. This trend aligns with the observations of Bodering *et al.* (2017), who reported a similar rate of procurement from pharmacies in semi-industrial farms [7].

In case of therapeutic failure, a majority of farmers extend the treatment or switch to another antibiotic without consulting an antibiogram, which is similar to the findings of Soromou *et al.* (2022) in Guinea, where poultry farmers adopted the same strategy. This practice exposes farms to an increased risk of antibiotic resistance [10].

Furthermore, antibiotics are administered exclusively orally by diluting them in drinking water, as observed by Zerbo (2014) and Khalen (2013) in other regions of West Africa [11] [20]. This method has the advantage of ensuring homogeneous distribution of the medication but raises concerns about dose accuracy and adherence to withdrawal periods. Indeed, 100% of farmers market chickens in the finishing phase and eggs laid after antibiotic administration without respecting withdrawal periods, which poses a risk to public health. Non-compliance with withdrawal periods may be due to a lack of awareness of the health risks and a fear of economic losses, a phenomenon already reported by Dosso (2014) [14].

Coccidiosis, a parasitic disease caused by coccidia, is the most common disease in poultry farms, followed by viral diseases such as Gumboro and Newcastle diseases, as well as bacterial infections like colibacillosis and salmonellosis. It is also evident that the use of antibiotics by farmers often does not adhere to the prescriptions and usage guidelines defined by animal health professionals. This excessive and inappropriate use reduces the effectiveness of treatments and poses a major threat to human health by fostering antibiotic resistance. It is therefore essential to adopt a rigorous approach to reduce the overuse of antibiotics and limit inappropriate exposures. This approach should no longer be seen as an option but as an urgent necessity that requires the commitment of all stakeholders in the poultry sector.

5. Conclusion

The study highlights the unregulated and largely empirical use of antibiotics in semi-industrial poultry farming in Chad, with minimal involvement of veterinarians and diagnostic analysis. This situation fosters the development of antimicrobial resistance, further exacerbated by the lack of veterinary supervision, failure to observe withdrawal periods, and the unrestricted sale of veterinary medicines. To mitigate these risks, we recommend the implementation of stricter regulatory frameworks governing the use and distribution of veterinary antibiotics, alongside

the promotion of training programs for poultry farmers and the reinforcement of veterinary oversight in antibiotic prescription and administration.

Conflicts of Interest

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

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