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Knowledge, practices, and antibiotics use patterns among animal production farmers in Calabar Metropolis

Aniekanabasi Jonathan Okon[1], Uchechi Esther Chibuzor-Eke[1], Ibiang Arikpo Oka[2], Lilian Eberechukwu Eyam[1], Margaret Inemesit Akpan[1], Simon Alain Inah[1]
[1]Department of Public Health, Faculty of Allied Medcal Sciences, University of Calabar, Calabar, Cross River State, Nigeria
[2]Department of Microbiology, Faculty of Biological Scences, Cross River State University of Technology, Calabar, Cross River State, Nigeria

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ABSTRACT

Inappropriate use of antibiotics alongside improper waste/wastewater disposal can contribute to the emergence and dissemination of antibiotic resistance. This research aimed to assess the knowledge, practices, and patterns of antibiotic usage among animal farmers in Calabar Metropolis. Employing a descriptive cross-sectional approach, a structured questionnaire was utilized to elicit information from 137 animal farmers. Data were analysed using SPSS version 25, with Chi-square statistics being employed to ascertain associations between different variables. The findings indicated a high level of knowledge regarding antibiotic use and the repercussions following its misuse on the environment, with 74.5% exhibiting high levels of knowledge. Majority (92.7%) of the respondents used antibiotics for various purposes in the farm. About 55% of respondents who used antibiotics had training on antibiotics use. Majority (79.6%) of the respondents had poor waste/wastewater disposal practices. Associations were found between farmers' knowledge level on antibiotic resistance and level of antibiotics use (p=0.031). Moderate antibiotic use was more among farmers with high knowledge level. An association was also found between farmers' training on antibiotics use and farmers' level of antibiotics use (p=0.043). Mandatory and targeted training for animal production farmers on proper and judicious antibiotic use is expedient to safeguard public health.

Corresponding Author:

Aniekanabasi Jonathan Okon
Department of Public Health, University of Calabar
Calabar, Cross River State, Nigeria
Email: aniekanjj@gmail.com

1. INTRODUCTION

The prevalence of antibiotic usage in animal production has shown an upward trajectory, especially evident in developing nations such as Nigeria [1]. While several developed countries have implemented measures to curtail antibiotic consumption due to its role in driving the global surge of antibiotic resistance, many farmers in economically disadvantaged regions lack access to comprehensive public health regulations [2]. The repercussions of this situation manifest in two significant ways: firstly, the introduction of antibiotic residues into the environment intensifies the selective pressure that fuels the emergence of antibiotic resistance in environmental microorganisms [3], [4]; secondly, the improper disposal of waste from abattoirs presents substantial hazards to both the environment and public health [5], [6]. Wastewater, in particular, serves as a pivotal environmental reservoir for antimicrobial resistance (AMR), providing an optimal breeding ground for AMR bacteria (ARB) and antimicrobial-resistant genes (ARGs) to persist [7]. These resistant bacteria have the potential to infect both humans and animals, leading to infections that are more challenging to treat compared to those caused by non-resistant counterparts [8]. Consequently, communities receiving such wastewater, often observed in Nigeria, may face significant challenges [9], [10].

The transfer of antibiotic resistance through the exchange of genetic material among bacteria, be it vertically or horizontally, represents a noteworthy threat to human health [11]. In fact, antibiotic resistance is a pressing global health concern. In the United States alone, over 2.8 million cases of antibiotic-resistant infections occur annually, leading to more than 35,000 deaths [12]. Similarly, antimicrobial-resistant pathogens result in over two million infections and around 23,000 deaths annually in the USA, and approximately 25,000 deaths across Europe [13], [14]. The escalating issue of antibiotic misuse in animal production can be attributed, at least in part, to a lack of comprehensive awareness regarding the potential environmental and public health repercussions associated with such practices. For instance, a study conducted by Benavides *et al.* [15] within the context of low-income small-scale farmers in Peru unveiled a concerning trend, with almost half of the participants demonstrating only limited comprehension of antibiotics. Similarly, Phares *et al.* [16] revealed a dearth of understanding among farmers concerning the intricate impacts of antibiotics on soil properties and related processes. These revelations collectively emphasize the pressing need for intensified efforts in raising awareness and providing educational interventions within this domain.

Several studies have explored antibiotic usage patterns among animal farmers, shedding light on prevalent practices. For instance, Dyar *et al.* [17] observed that certain classes of antibiotics were frequently stored and used in pig farms. Research in Nigeria by Oyebanji [18] demonstrated varying degrees of antibiotic knowledge among farmers, with approximately 50% being aware of antibiotic resistance. Ozturk *et al.* [19] reported that a subset of participants acknowledged the importance of antibiotic resistance, with a majority recognizing the role of inappropriate antibiotic use in fostering resistant bacteria. Al-Mustapha *et al.* [20] found that the majority of poultry farmers surveyed in Kwara State possessed awareness of antibiotic resistance. Furthermore, studies have delved into the specific antibiotics used and the purposes they serve. For example, Xu *et al.* [21] identified commonly used antibiotics in animal production, while Oluwasile *et al.* [22] highlighted the predominant therapeutic and prophylactic use of antibiotics among farmers in Ogun State, Nigeria. Agoba *et al.* [23] investigated the administration methods of antibiotics in fish farming, and Ve and Agyare [24] explored the most frequently employed antibiotic classes in poultry farms. The management of poultry and livestock waste also emerged as a significant concern. Olarinmoye *et al.* [25] examined waste management practices in Ogun State, revealing a diversity of approaches. Meanwhile, in another study, Omofunmi *et al.* [26] underscored the need for improved wastewater treatment practices, given that a substantial proportion of generated wastewater was being released into the environment without proper treatment.

Adequate knowledge on the effect of misuse of antibiotics on the environment and public health is imperative for improving practice regarding antibiotics use in animal production. The present study determined the knowledge, waste disposal practices and antibiotics use patterns across poultry, fish and pig farms in Calabar Metropolis, Cross River State. Information is provided on the level of knowledge of animal production farmers on antibiotic resistance and its effect on the environment. Level of antibiotic use in the animal production farms is generally high. Waste disposal practices in the animal production farms which could lead to introduction of antibiotic residues into the environment are prevalent in the study. This is a risk factor for antibiotic resistance in the environment and could be implicated in public health. The study has shown that high knowledge level is associated with moderate use of antibiotics and that having attended training on antibiotics use is associated with low use of antibiotics in the animal farms. This calls for targeted and regular training for animal production farmers on the effect of antibiotics misuse on the environment and health.

2. RESEARCH METHOD

The study was conducted in Calabar, the capital city of Cross River State in Nigeria. Calabar Metropolis encompasses two Local Government Areas (LGAs): Calabar Municipality and Calabar South. The population primarily consists of civil servants and traders, with farming and fishing also prevalent due to its location along the waterfront. Positioned within Nigeria's rainforest belt, Cross River State is situated between latitudes 04 °N and 15 °N and longitudes 8 °E and 25 °E. Calabar Municipal Council serves as the headquarters of the Southern Senatorial District and boasts an estimated population of 2888.967 million inhabitants. Employing a descriptive cross-sectional design, this study employed structured questionnaires to gather insights from farmers regarding their practices concerning antibiotic usage and waste disposal. The sample size, determined using Yamane's formula, resulted in 137 participants being included in the study, considering a 10% allowance for non-response. The questionnaire, consisting of four sections, aimed to extract relevant information. The data collected underwent analysis using IBM SPSS Statistics (Version 25.

To gauge respondents' knowledge of antibiotics and resistance, their answers were categorized as either correct (1) or incorrect (0). A mean score of 4 was used to differentiate high and low knowledge levels, with scores above the mean categorized as high and those below as low. Five questions assessed antibiotic usage, with responses rated as 1 for specific single reasons for antibiotic use, singular antibiotic usage, consistent completion of antibiotic treatments, usage frequency on a fortnightly or monthly basis, and adherence to antibiotic withdrawal periods. A score of 2 was assigned to multiple reasons for antibiotic use, multiple antibiotic usage, incomplete antibiotic treatments, daily or weekly antibiotic usage, and non-observance of antibiotic withdrawal periods. The threshold mean score of 5 was utilized to determine the level of antibiotic use. Respondents falling within scores of 1 to 5 were classified as low antibiotic users, those scoring 6-7 were considered moderate users, and those with scores of 8-10 were labeled high antibiotic users. The study adhered to ethical guidelines, securing approval from the Cross River State Research Ethics Committee located at the Ministry of Health Headquarters in Calabar (REC No. CRSMOH/RP/REC/2022/229). Additionally, all participants provided verbal informed consent after receiving comprehensive information about the study's objectives, significance, benefits, and the strict confidentiality measures in place to protect the information provided.

3. RESULTS AND DISCUSSION

3.1 Result

3.1.1. Socio-demographics characteristics of respondents in the study area

Majority (42.3%) of the respondents were between ages 39-48 years. Majority were male (57.7%), had attained tertiary education (40.9%). About 83.9% of the farms assessed were poultry farms, 9.5% were fish farms and 6.6% were piggery farms. Considering their roles in farms, 45.3% of the respondents were farm managers, 53.3% were farm workers, and 1.5% of the respondents were engaged to carry out other farm activities. Majority of the respondents (32.8%) had 4 to 6 years of experience as animal production farmers. Majority (63%) of the farm workers never had any form of training on antibiotics administration while only 37% had. For the details, see Table 1.

Table 1. Socio-demographic characteristics of respondents

Variables	Number of respondents (N)	Percentage (%)
Age		
18-28 years	26	19.0
29-38 years	34	24.8
39-48 years	58	42.3
49 and above	19	13.9
Sex		
Male	79	57.7
Female	58	42.3
Marital status		
Married	58	42.3
Single	56	40.9
Divorced	8	5.8
Separated	6	4.4
Widow/widower	9	6.6
Educational status		
No formal education	18	13.1
Primary	37	27.0
Secondary	26	19.0
Tertiary	56	40.9
Farm type		
Poultry	115	83.9
Fish farm	13	9.5
Pig farm	9	6.6
Role in farm		
Manager	62	45.3
Farm worker	73	53.3
Others	2	1.5
Years of experience		
0-3 years	35	25.5
4-6 years	45	32.8
7-9 years	37	27.0
10 and above	20	14.6
Training on antibiotic use		
Trained	47	37
Not trained	80	63

3.1.2. Farm workers' knowledge of antibiotics and resistance

Knowledge on the proper use of antibiotics and resistance recorded among respondents as presented in Table 2, shows that on average, an encouraging 74.5% of the participants exhibited a commendable knowledge of antibiotics and resistance. The majority of respondents (62.0%) knew antibiotics to be chemical substances designed to either eliminate or impede the proliferation of bacteria. About 77% of respondents were aware of the effects of antibiotics when overused. Approximately eighty percent (80%) were aware that resistant bacteria can spread from animals to the environment while 72.3% knew that antibiotic residues in the environment can lead to antibiotic resistance. Overall, 102 (74.5%) farmers had a high level of knowledge about antibiotics and resistance and 35(25.5%) had low knowledge level regarding antibiotics and resistance.

Table 2. Farmers' knowledge of antibiotics and resistance (N=137)

Questions	Frequency (N)	Percentage (%)
Antibiotics are chemical substances that kill or inhibit growth of bacteria		
Yes	85	62.0
No	52	38.0
There are negative effects if antibiotics are overused		
Yes	106	77.4
No	31	22.6
Antibiotics resistance occurs when your body no longer responds to antibiotics		
Yes	99	72.3
No	38	27.7
Do bacteria become resistant to antibiotics?		
Yes	115	83.9
No	22	16.1
Resistant bacteria can spread from animals to the environment		
Yes	110	80.3
No	27	19.7
Antibiotics-resistant bacteria in the environment can spread to Humans		
Yes	103	75.2
No	34	24.8
Antibiotics residues in the environment can cause antibiotics resistance		
Yes	99	72.3
No	38	27.7
Overall knowledge level		
High	102	74.5
Low	35	25.5

3.1.3. Antibiotics use patterns in animal farms in the study area

Table 3 presents results on antibiotic use patterns in animal production farms. Majority (92.7%) of respondents used antibiotics while 7.3% do not use antibiotics in their animal farms. Reasons for using antibiotics in animal production farms were, for growth promotion (7.3%), treatment of disease (5.8%), disease prevention (8.0%) while 37.2% used antibiotics for all the reasons aforementioned. In terms of antibiotics commonly administered to farm animals, 34.3% of the respondents administer tetracycline, 19% administer gentamicin, followed by Augmentin (18.2%), followed by Cotrimoxazole (10.9%), while 8%, 1.5%, and 0.7% administered ceftazidime, streptomycin, and ampicillin respectively. On the mode of antibiotics administration, 62% of respondents were included in the water for drinking while 4.4% were through injection. About 62% of person that administers antibiotics to farm animals were farm workers while 4.4% were an animal scientist. Approximately 55% of respondents reported always completing antibiotic treatment for farm animals while 2.2% never completed farm animals' antibiotic treatments. Regarding antibiotics withdrawal period, 69.3% of the respondents observed antibiotics withdrawal period while 23.4% did not. Overall, the level of antibiotic use in animal production farmers were: 36 (28.5%) low level of antibiotic use, 44(34.3%) used antibiotics moderately and 47(37.2%) had a high level of antibiotic use in animal farms.

Table 3. Antibiotics use pattern in animal farms in the study area

Variables	Number of respondents (N)	Percentage (%)
Antibiotic usage	127	92.7
Use	10	7.3
Do not use		
Reasons for using antibiotics in farm		
Growth promotion only	10	7.3
Disease treatment only	08	5.8
Disease prevention only	11	8.0
Growth promotion and disease prevention	12	8.8
Growth promotion and disease treatment	16	11.7
Disease treatment and prevention	19	13.9
All of the above	51	37.2
Antibiotics commonly administered to farm animals		
Augmentin	25	18.2
Gentamicin	26	19.0
Streptomycin	2	1.5
Tetracycline	47	34.3
Cotrimoxazole	15	10.9
Ceftazidime	11	8.0
Ampicillin	1	0.7
Mode of administration		
Included in the water for drinking	85	62.0
Through injection	6	4.4
Included in feed	36	26.3
Person that administers antibiotics		
Farm manager	18	13.1
Veterinarian	18	13.1
Animal scientist	6	4.4
Farm worker	85	62.0
Treatment completion		
Never	3	2.2
Sometimes	76	55.5
Always	48	35.0
How frequently are antibiotics used		
Daily	5	3.6
Weekly	37	27.0
Fortnightly	13	9.5
Monthly	72	52.5
Observation of antibiotics withdrawal period		
Yes	95	69.3
No	32	23.4
Overall level of antibiotic use		
Low	39	28.5
Moderate	47	34.3
High	51	37.2

3.1.4. Waste/Wastewater disposal practices in animal farms in the study area

Table 4, shows that 40.1% of the respondents dispose of wastewater by channeling into drainage canal, 38% dispose in an open pit, 19.7% dispose of in the bush or nearby farmland while 2.2% disposed in the stream or river. About 15% of respondents reported treating wastewater before disposal. On the method of wastewater disposal, 65% of the respondents used manual scrapping with shovel while 0.7% dispose of through flushing. Regarding disposal of solid waste, 81.8% of the respondents practiced open dumping while 2.9% burry their solid waste. The study also revealed that about 58% and 31% of the respondents practice open dumping of animal faeces and leftover antibiotics respectively.

3.1.5. Test of Association between farmer's knowledge on antibiotic resistance and level of antibiotics use

A notable correlation emerged between the extent of farmers' comprehension regarding antibiotic resistance and their corresponding antibiotic usage patterns (p=0.031). Moderate level of antibiotic use was predominant among farmers with high knowledge level on antibiotics and resistance Table 5.

3.1.6. Test of association between farmers' training on antibiotics and level of antibiotics use

An association was found (p=0.043) between farmers' training on antibiotics use and farmers' level of antibiotics use using chi-square analysis is shown in Table 6. Low level of antibiotic use was more prevalent among those who had attended training on antibiotics use.

Table 4. Waste/Wastewater disposal practices in animal farms in the study area

Variables	Number of respondents (N=137)	Percentage (%)
Disposal of wastewater		
Channeling into drainage canal	55	40.1
Bush/farmland	27	19.7
Stream/river	3	2.2
Open pit	52	38.0
Treatment of wastewater before disposal		
Yes	20	14.6
No	117	85.4
Method of waste/wastewater removal from farm		
Manual scrapping with shovel	89	65.0
Slopped floor system	24	17.5
Flushing	1	0.7
Others	23	16.8
Disposal of solid wastes		
Composting	15	10.9
By burning	6	4.4
Burry it	4	2.9
Open dumping	121	81.8
Disposal of animal faeces		
Open dumping	80	58.4
Buried it	33	24.1
By burning it	24	17.5
Disposal of leftover antibiotics		
Open dumping	43	31.4
Burry it	49	35.8
Burn it	35	25.5

Table 5. Test of association between farmers' knowledge and level of antibiotics use

Farmers' knowledge level	Level of antibiotics use N (%)			X^2	p-value
	Low level	Moderate	High level		
Low	15 (42.9)	6 (17.1)	14 (40.0)	7.652	0.031
High	24 (23.5)	41 (40.2)	37 (36.3)		
Total	39 (28.5)	47 (34.3)	51 (37.2)		

Table 6. Test of association between farmers' training on antibiotics use and level of antibiotics use

Training on antibiotics use	Level of antibiotics use N (%)			X^2	p-value
	Low level	Moderate	High level		
Trained	22(46.8)	11(23.4)	14(29.8)	11.929	0.043
Not trained	17(18.9)	36(40.0)	37(41.1)		
Total	39(28.5)	47(34.3)	51(37.2)		

3.2. Discussion

The outcomes of this investigation underscore that a significant majority of respondents exhibited a commendable level of knowledge concerning antibiotic usage and its potential impact on the environment. Their awareness extended to recognizing the consequences stemming from the excessive use of antibiotics, possibly attributed to their own experiences in antibiotic administration. These findings align with Al-Mustapha *et al.* [20] study, revealing a satisfactory understanding of antibiotic resistance among 69.6% of poultry farmers. Similarly, Oyebanji [18] reported that, on average, farmers possessed a certain degree of knowledge regarding antibiotic resistance. Nevertheless, a contrasting perspective is offered by Phares *et al.* [16], who highlighted the inadequacy of farmers' awareness regarding the effects of antibiotics on diverse soil properties and processes. This discrepancy might be attributed to differences in education levels and access to information concerning antibiotic resistance.

Addressing antibiotic use, the study divulged that a substantial portion of animal production farmers integrated antibiotics into their animal husbandry practices. This observation resonates with the report by Kimera *et al.* [27], which identified the predominant use of antimicrobial agents among livestock farmers. Of the farmers employing antibiotics, approximately half had received formal training on their usage. The application of antibiotics encompassed growth promotion, disease treatment, and preventative measures. Notably, multiple antibiotic usage was common across farms, with these agents being harnessed for therapeutic, prophylactic, and growth-enhancing purposes. This aligns with the findings of Phares *et al.* [16] that 13% of their surveyed animal farmers employed antibiotics for growth promotion. Similarly, Oluwasile *et al.* [22] reported a considerable percentage of antibiotic use for therapeutic (36.2%) and prophylactic (29.3%) intentions in Ogun State, Nigeria. The types of antibiotics employed in animal care revealed a preference for tetracycline and gentamicin, followed by Augmentin, Cotrimoxazole, and to a lesser extent, ceftazidime, streptomycin, and ampicillin. This trend corroborates Ve and Agyare [24] study on antibiotic classes utilized for various purposes in livestock farming. Xu *et al.* [21] also mirrored this trend, citing amoxycillin, oxytetracycline, and ceftriaxone as commonly used antibiotics.

Olarinmoye *et al.* [25]; Kamoga and Ssekyewa [28] , examined waste disposal practices and reported that respondents exhibited a range of methods, including channeling wastewater into drainage canals, open pits, farmlands, bushes, or nearby water bodies. These practices align with Omofunmi *et al.* [27] investigation, which also detailed effluent disposal methods such as open pits, drainage canals, bare lands, streams, and on-farm re-use. Most notably, the study highlighted that a significant number of respondents did not engage in wastewater treatment prior to disposal, a finding congruent with Omofunmi *et al.* [27] who report that 95% of generated wastewater was released into the environment without adequate treatment. Notably, a significant correlation emerged between the degree of respondents' knowledge on antibiotic resistance and their corresponding level of antibiotic use. The prevalence of moderate antibiotic usage was more pronounced among farmers possessing high levels of knowledge on antibiotics and resistance. This is in line with Ozturk *et al.* [19] findings, which indicated a moderately positive correlation between antibiotic knowledge scores and usage. Simegn, and Getachew [29], also reported similar findings. Our study also revealed that a greater proportion of individuals with training in antibiotic use exhibited lower levels of antibiotic use. Evidently, knowledge plays a pivotal role in shaping practices related to antibiotic application within animal production. Chah *et al.* [30], in their study also concluded that training small-scale farmers will improve their knowledge and practices regarding antibiotic use.

The study however had a few limitations: some antibiotic practices on the farm may have been under reported due to unwillingness to share the information. The sample size also may not have been large enough to enable generalization of the findings of this study.

4. CONCLUSION

The study indicates that farmers have a high level of knowledge on antibiotics and resistance. Majority of animal production farmers in the study use antibiotics for various reasons. The levels of antibiotic use in animal production were generally high. Majority of the respondents had poor waste/wastewater disposal practices. A noteworthy discovery emerged from the study, linking the level of knowledge among animal production farmers to their respective antibiotic usage patterns. This association underscores the pivotal role of knowledge in influencing the extent of antibiotic application within this sector. Moreover, attendance of training sessions on antibiotics use was also associated with the level of antibiotic usage. Notably, those who had undergone such training exhibited a lower propensity for antibiotic use. This calls for targeted and regular training for animal production farmers on the effect of antibiotics misuse on the environment and health.

Further studies could provide health education intervention to animial production farmers and further test effects of such interventions on knowledge and practices regarding antibiotics. Further more, polices regulating the use of antibiotics in animal production in Nigeria should be promoted and enforced.

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BIOGRAPHIES OF AUTHORS

Aniekanabasi Jonathan Okon is an environmental health scientist lecturing at the department of Public Health, University of Calabar, Calabar, Cross River State, Nigeria. She is currently involved in researches in the area of Water, Sanitation and Hygiene (WASH), solid waste management, food safety and hygiene, environmental exposures to toxins, and antimicrobial resistance in the environment. She has published over 30 articles in reputable international and local journals. She can be contacted at email: aniekanjj@gmail.com.

Uchechi Esther Chibuzor-Eke is a postgraduate student in the department of Public Health, University of Calabar, Calabar, Cross River State, Nigeria with specialization in environmental health. She has keen interest in antimicrobial restance in the environment. She can be contacted at email: uchechiekechibuzor@gmail.com.

Ibiang Arikpo Oka is a lecturer with the Cross River State University of Technology, Cross River State, Nigeria. He is also a postgraduate student in the department of Public Health, University of Calabar, Cross River State, Nigeria with area of specialization in Environmental health. He has research interests in Water, Sanitation and Hygiene (WASH) and antimicrobial resistance in the environment. He can be contacted at email: okaibiang@gmail.com.

Lilian Eberechukwu Eyam is an Epidemiologist lecturing at the Department of Public Health, University of Calabar, Calabar, Nigeria. She has a passion for researches involving youths and adolescents and several areas of Epidemiology and public health including human exposure to environmental hazards. She has over 10 publications in reputable international and local journals. She can be contacted at email: lilaringus@yahoo.com.

Margaret Inemesit Akpan is an Epidemiologist in the Department of Public Health, University of Calabar, Calabar, Nigeria. She is involved in several researches in Public Health including Cervical Cancer Among Women. She also has interest in researches on environmental risk factors. She has published over 30 articles in leading international and local journals. She can be contacted at email: magginem2000@yahoo.com.

Simon Alain Inah is an Environmental Health Scientist lecturing at the Department of Public Health, University of Calabar, Calabar, Nigeria. He has research interests in Occupational Health and Safety, Water, Sanitation and Hygiene (WASH) and environmental toxicology. He has published over 20 articles in leading international and local journals. He can be contacted at email: pharmalain2006@gmail.com.