Occupational and Environmental Health Concerns on Unsafe Acts and Conditions in Selected Poultry Production Sites in Ido/Osi Ekiti State

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ABSTRACT

Aims: The aim of this research work is to establish the occupational and environmental burden of unsafe acts and conditions in backyard poultry production sites in the area of study in order to validate the compliance level of poultry farmers to common safety regulations.

Place and Duration of Study: Microbiology Department, Ekiti State University, Ado-Ekiti, from February 2017 to December 2019.

Methodology: A well-structured questionnaire was administered to farm managers and residents within the area of study. Data on poultry management attitudes and history of water use were collected. The coordinates of the poultry sites, natural water bodies, source area and their relative distances were determined using the Geographical System Information Software, Mapit GIS. Fecal droppings from poultry birds were randomly sampled with a sterile swab stick and transferred into a sealed, factory-packed polythene bag. The suspension of the fecal droppings was streaked on Eosin Methylene Blue agar plates and incubated at 37 °C for 18-24 hours. Waste-water, soil from disposal sites, and poultry feed samples were also collected in sterile universal bottles, serially diluted and cultured. *E. coli* isolates were characterized using relevant biochemical tests. The modified paper disc-diffusion method was used to determine the isolates' sensitivity to nine tested antibiotics, and the results were interpreted based on the procedures of the clinical and laboratory standard institutes.

Results: Majority of the poultry farms under survey, 83 % adopted the intensive ranging system of farming while few adopted the free range system. Layers were the most reared, 50 %. There was no documented health, safety and regulatory protocols used on all the farms leading to variations in poultry management practices. Accumulated poultry droppings were periodically disposed between 3-4 days into human environment such as open fields, flowing water bodies and pits. Among the three adopted waste disposal options, disposal into open field was rampant, 67 %. Also, some of the poultry farmers, 42 % applied the collected poultry droppings as farm yard manure. Family members constitute the major labor force, 92 % on the farm. There were contacts between few of the farmers and their clients during routine farm activities. Majority of the farmer, 83.3 % were not kitted with commonly-used personal protective equipment while coverall was only used by few. The five natural water bodies found within the area of study were majorly used for agricultural, domestic, and, recreational purposes. There was history of diarrhea in some respondents, 12 % with exposure to the water bodies. Data on socio-demographic characteristics show that majority of the poultry managers were young, married-male with tertiary education. The relative distance of poultry farms to residential site is ≤ 6 meters while the proximity of poultry farms to natural water sources is between 160 meters to 4,596 meters. Records on antibiotic susceptibility test show that multiple antibiotic-resistant bacteria were present in poultry droppings, waste water and soil from poultry waste disposal sites. Bacterial resistance to the fluoroquinolones, sulphonamide, tetracycline, aminoglycoside and penicillin were considerably high.

Conclusion: The findings on unsafe act audit of the poultry production sites assert that safety of public health is dependent on the quality of water and soil in the environment.

Unsafe acts and conditions with the inherent occupational and biological hazards in poultry production sites are attributed to non-functional health, safety and environment management system. Poultry droppings constitute biological hazard to humans. Human exposure to these biological hazards present in the environment predisposes the public to infections. Human and environmental health can be improved by reviewing the national guidelines and standards for environmental pollution control.

Keywords: [Poultry, Safety, Unsafe Acts and Conditions, Waste]

Abbreviations: [P.P.E- personal protective equipment, MARB- multiple antibiotic resistant bacteria, H. S. E- health, safety and environment, H. S. E. M. S- health, safety and environment management system, ALARP- as low as reasonably practicable, E. I. A- environmental human assessment.

1. INTRODUCTION

Most food animal production farms in Nigeria lack waste treatment facilities. Humans residing close to livestock farms and animal waste dump sites may be exposed to antibiotic resistant bacteria normally present in poultry waste [1]. Animal feces are alleged to be potential source of strains of antibiotic resistant bacteria. These bacteria constitute a threat to human health when they contaminate water, and different food sources that are consumed by man [2]. Antibiotics are used for prophylactic, metaphylactic and therapeutic benefits in food animal production farms such as poultry [3]. Poultry and other farm animals are the key reservoirs for multiple antibiotic resistant *E. coli* and the use of antibiotics in animal production sites is considered the most important factor that promotes the development, selection and spread of antibiotic resistant microorganisms [4].

Poultry birds can be infected with antibiotic resistant bacteria [2]. During indiscriminate waste disposal, these bacteria can be directly discharged with fecal material from animal sources into water and soil in the environment. Antibiotic resistant bacteria and their genes are pollutants to human environment and are transmissible to humans via interaction with environmental reservoirs such as soil, water, and animals [5]. Antibiotic resistant bacteria have been found in many water sources such as drinking wells, rivers and effluents from waste-water treatment plants. These bacteria can cause and spread bacterial diseases such as typhoid fever through contaminated water [6, 7]. Antibiotic resistant bacteria may reach humans indirectly along the food chain through consumption of contaminated food, direct contact with infected animals or biological substances such as blood, urine, feces, saliva released to the environment. Besides, consumption of food contaminated with bacteria may directly lead to infection such as diarrhea caused by *Salmonella typhi, Campylobacter* spp. and pathogenic strains of *E. coli* (EHEC) [8]. The resistant bacteria can potentially cause infections and spread to man [9, 10]. Poultry farmers and their families are occupationally exposed and at risk of infection with the multiple antibiotic resistant bacteria from their animals [11, 12 and 13].

2. MATERIALS AND METHODS

Research tools

A well-structured questionnaire was administered to farm managers and residents within the area of study. Data on safety regulatory measures, poultry management practices and use of natural water bodies were collected.

Provenance

The coordinates of the source area (poultry sites), natural water bodies, human residence and their relative distances were determined using the geographical system information software Mapit GIS as described by [14].

Study population and site

The study population comprises 12 poultry farms, their managers and 50 residents living close to the five identified natural water sources. Poultry birds such as broilers, turkeys and free range birds were reared in the selected poultry farms in Ido/Osi, Ekiti State.

Collection and culturing of samples

Fresh fecal droppings from poultry birds were randomly sampled with a sterile swab stick and transferred into a freshly procured, sealed, factory-packed polythene bag. Farm feed, water and soil from disposal sites were also collected in sterile universal

containers. The samples were immediately transferred to the Microbiology Laboratory, Ekiti State University, Ado-Ekiti. They were cultured within 2 hours of collection [15, 1].

Antibiotic susceptibility test

Antibiotic susceptibility testing was carried out on the *E. coli* isolates using the modified agar disc-diffusion method following the procedures of clinical and laboratory standard institutes, 2013. Antibiotic discs (Oxoid) comprising ciprofloxacin (5 µg), tetracycline (30 µg), ofloxacin (5 µg), trimethoprim/sulfamethozazole (1.25/23.75 µg), gentamycin (10 µg), amoxicillin-clavulanic acid (20/ 10 µg), ceftaxidime (30 µg), meropenem (10 µg) and cefriazone (30 µg) were used. The test was standardized using Mac Farland standard of 0.5 [16; 17].

Statistical analysis

Statistical analysis was carried out using SPSS version 20.0 for the analysis of percentages [18].

3. RESULTS AND DISCUSSION

The poultry farming types and management attitudes of the poultry farms in Ido/Osi are represented in **Table 1**. Documented safety regulatory document was not available on all the sampled farms. Few of the poultry farmers under survey, 16.7 % adopted the free range system of farming while majority practiced the intensive system. Layers were the most reared. Accumulated poultry wastes were frequently disposed into open fields, pits and natural water bodies between 3 to 4 days. Among the three waste disposal options adopted on the farms, disposal into open field was the most adopted, 67 %. Besides, the collected poultry droppings were used as farm-yard manure by a significant breeders' population, 42 %. Family members were the major source of labor, 92 % engaged as workers on the farm. There was contact between few poultry farmers, 8 % and their clients during routine farming activities. Well was the main source of water used by majority, 83 % of the farms. Hand glove was not used by majority 83.3 % while coverall was used by few of the farmers, 8 % as personal protective equipment.

The socio-demographic characteristics of the poultry farmers in the area of study are shown in **Table 2**. The data show that the business of poultry farming was mainly practiced by a population of married men with tertiary education (83 %). The age category of majority of the farming population 75 % was between 40-49 years old.

The geographical coordinates of the area of study is represented in **Table 3**. The area of study is located between latitudes 7.85408 to 7.8927 and longitudes 5.1833 to 5.1658.

The proximity of poultry sites to natural water sources and human residence in the area of study is shown in **Table 4**. All the sampled poultry farms (100 %) were located in close proximity to residential sites. The distance of the poultry farms to human residential sites is between 4 meters to 6 meters while the proximity of poultry farms to natural water sources is between 160 meters to 4596 meters.

The natural water sources located within the area of study and their uses is shown in **Table 5.** The water bodies consist of spring and streams. They were used for religious, domestic, recreational, agricultural and construction purposes. Besides, about 12 % of the respondents exposed to the natural water bodies had a previous history of diarrhea attributable to consumption of contaminated water in the environment.

The antibiotics percentage resistant profile of *E. coli* isolated is shown in **Table 6.** Results on antibiotic susceptibility test show that multiple antibiotic-resistant bacteria were present in poultry droppings, waste water and soil from poultry waste disposal sites. Bacterial resistance to the fluoroquinolones, sulphonamide, tetracycline, aminoglycoside and penicillin were considerably high

The unsafe act audit of the poultry production sites links the safety of human health with the quality of water and soil in the environment. Unsafe acts and conditions with the inherent occupational hazards in poultry production sites are under-reported and the menace is attributed to non-functional health, safety and environment management system. Majority of the farmers adopted intensive system of farming but few still reared free range birds. Free range birds are liable to spread antibiotic resistant bacteria in human environment. Poultry wastes into human environment constitute an unsafe condition and further contribute to air, soil and water pollution. Also, contaminated open fields, pits and natural water sources used as disposal sites are reservoir of antibiotic-resistant bacteria present in poultry droppings. This observation is in agreement with the

findings of [1] that wastes generated on food animal production farms in Nigeria were dumped in heaps on farmlands or remote locations inside or close to water bodies. The use of collected poultry droppings as farm yard manure by a significant farming population increases human exposure to antibiotic resistant bacteria. Family members constitute the labor force on majority of the under-studied farms. Though engagement of family members as labor is considered cheap, they may be occupationally exposed to biological hazards such as multiple antibiotic resistant bacteria from poultry and consequently cripple family health. This findings agrees with [19] that workers such as veterinarians, poultry farmers, abattoir workers and those directly in contact with animal products are occupationally exposed and at risk of contracting infection from multiple antibiotic resistant bacteria. Besides, the non-use of personal protective equipment (P. P. E) during routine farming operations is an indicator that less attention was paid to bio-safety regulations. Non-usage of P. P. E constitutes an unsafe act that endangers the health of poultry workers. Agencies that promote H. S. E standards and policies prohibiting unsafe acts and conditions in poultry production sites should be mobilized in order to prevent spread of zoonosis of bacterial origin to man. The predominance of educated male population in the business of poultry underscores the importance of energy, commitment and education in effective poultry management operations. Besides, disease prevention and control in poultry management demands training and regular presence of poultry farmers on site. The status of marriage confers the responsibility of co-managing poultry farms on family members via delegation of duties. These findings are consistent with [18] who recorded 72 % male and 71 % poultry farming population with tertiary education.

The consumption of the natural water bodies sighted in the area of study for domestic religious, agricultural, recreational and construction purposes increases human exposure to multiple antibiotic resistant bacteria present in the environment. Besides, about 12 % of the respondents who were exposed to the natural water bodies had a previous history of diarrhea attributable to consumption of contaminated water in the environment. This finding agrees with [8] that antibiotic resistant bacteria may reach humans indirectly along the food chain through consumption of contaminated food and direct contact with infected biological substances. Though backyard poultry farming is practiced for economic and security purposes, it should be checked through adequate licensing operations and E. I. A. An inventory of potential hazards of poultry farming activities to the environment and public health should be carried out prior to and after localization of poultry sites to limit human exposure to risks associated with the occupation. The H. S. E. M. S should undertake public sensitization program on the inherent risks associated with biological hazards in poultry production sites in order to reduce it to ALARP.

Bacteria that are resistant to high profile antibiotics like the fluoroquinolones, sulphonamide, tetracycline, aminoglycoside and penicillin are threat to public health. Safety in poultry production can be achieved and environmental health improved by reviewing the national guidelines and standards for environmental pollution control. An inclusive strategy involving voluntary participation of poultry farmers and other stakeholders in health, safety and environment management system should be adopted to reduce the risks associated with poultry production to as low as reasonably practicable.

Table 1: Poultry farming types and management attitudes of the poultry farms in Ido/Osi, Ekiti State

Characteristics		Frequency (%)
Ranging style of bird	Intensive	10 (83.3)
	Extensive	2 (16.7)
Types of bird	Pullet/Layer	6 (50)
	Turkey	2 (16.7)
	Broiler	2 (16.7)
	Cockerel	1 (8.3)
	Local breed	1 (8.3)
Age of birds (months)	>6 months	7 (58.3
	2- 5 month	4 (33.3)
	1 month	1 (8.3)
Scale of production	Commercial	10 (83.3)
	Subsistence	2 (16.7)
Predominant waste disposal options	Open field	8 (66.7)
	Buried	3 (25)
	Into running water	1 (8.3)
Droppings used as farm yard manure	No	7 (58.3)
	Yes	5 (41.7)
Period of disposing litters	3-4 days	12 (100)
Attendance to client during activities	No	11 (91.7)
	Yes	1 (8.3)
Use of glove as personal protective equipment	No	10 (83.3)
	Yes	2 (16.7)
Personal protective equipment used	Coverall	1 (100)
Major type of labour engaged on farm	Family members	11 (91.7)
	Others	1 (8.3)
Employment of services of consultant	No	10 (83.3)
	Yes	2 (16.7)
Water source	Regular	10 (83.3)
	Not regular	2 (16.7)
Major source of water on farm	Well	10 (83.3)
	Borehole	2 (16.7)
Major source of feed consumed	Purchased	9 (75)
	Self-composed	3 (25)
Name of purchased feed	Brand A	1 (11.1)
	Brand B	8 (88.9)
Use of documented safety regulations	No	12 (100)

* Intensive (caged), * Extensive (free range), numbers in parenthesis are percentage values.

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Table 2: Socio-demographic characteristics of the poultry farmers

Characteristics		Frequency	Percentage (%)
Age of poultry farmers	30-39	1	8.3
	40-49	9	75
	50-59	1	8.3
	60 and above	1	8.3
Gender	Male	10	83.3
	Female	2	16.7
Level of education	Primary/ below	1	8.3
	Secondary	1	8.3
	Tertiary	10	83.3
Marital status	Single (widow)	1	8.3
	Married	11	91.7

Table 3: Geographical system positioning coordinates of the area of study

Poultry sites	Latitude	Longitude
A	7.8927	5.1688
B	7.8668	5.1659
C	7.8667	5.1658
D	7.8667	5.1658
E	7.8740	5.1802
F	7.8566	5.1778
G	7.8547	5.1761
H	7.87234	5.1792
I	7.85408	5.1833
J	7.86719	5.1736
K	7.86588	5.1738
L	7.86148	5.1749

Source CODE: A-Z

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Table 4: Proximity of poultry sites to natural water sources and human residence

Farm code	human residence	Distance of poultry sites to: natural water bodies				
		OGS	IGS	APL 1	APL 2	IJK
A	10	2458.8	2995.1	3231.9	1144.5	4595.9
B	10.5	1566.8	596.1	1156.2	1867.6	1442.4
C	10.5	1566.8	596.1	1156.2	1867.6	1442.4
D	6.0	859.3	1090.9	2054.9	1628.2	2643.6
E	5.0	1396.5	1717.8	800.35	1715.2	2836.9
F	4.3	1516.8	974.6	1900.2	3007.2	625.5
G	8.0	1663.1	1110.4	2161.3	3449.6	815.3
H	8.0	999.2	990.9	379.4	1942.6	2155.8
I	4.0	1807.1	1464.7	1814.2	3626.0	989.0
J	4.5	389.7	565.7	1164.2	785.1	1442.4
K	4.6	473.4	159.5	1141.6	2153	1530.5
L	12	958.8	369.2	1529.6	2714.7	1233.2

Key: A-L (farm code), OGS 1- Ogudu stream, IGS - Igemo spring,, APL1- Apalogbo I stream, APL2-Apalogbo II stream, IJK-Ijokole stream, * distance recorded in meters

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Table 5: Natural water sources located within the area of study and their uses.

No	Water bodies	Types	Percentage of use of the water bodies (%)							Previous history of diarrhea attributable to water use
			Fishing	Domestic	Farming	Recreational	Construction	Religious	None	
1	Ogudu	Stream	-	1 (10)	3 (30)	2 (20)	2 (20)	2 (20)	-	2 (20)
2	Igemo	Spring	-	1 (10)	-	-	-	-	9 (90)	-
3	Apalogbo I	Stream	2 (20)	1 (10)	3 (30)	-	3 (30)	-	1 (10)	1 (10)
4	Apalogbo II	Stream	1 (10)	3 (30)	1 (10)	5 (50)	-	-	-	3 (30)
5	Ijokole	Stream	-	3 (30)	5 (50)	-	-	-	2 (20)	-
	Total		3 (6)	9 (18)	12 (24)	7 (14)	5 (10)	2 (4)	12 (24)	6 (12)

Key: A-L (farm code), 1-Ogudu stream, 2-Igemo spring, 3-Apalogbo (I stream),4-Apalogbo (ii) stream, 5-Ijokole stream**.**
***** Total number of respondents is 50
Numbers in parenthesis are percentage values

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Table 6: Antibiotics percentage resistant profile of *E. coli* isolated

		Cephalosporin		Penicillin	Fluoroquinolone		Aminoglycoside	Caberpenem	Sulfonamide	Tetracycline	
Source code	N	CRO (%)	CAZ (%)	AMC (%)	CIP (%)	OFX (%)	CN (%)	MEM (%)	SXT (%)	TET (%)	n (%)
A	5	0	0	5 (100)	4 (80)	3 (60)	4 (80)	0	3 (60)	4 (80)	4 (80)
B	3	1 (33.3)	1 (33.3)	3 (100)	1 (33.3)	1 (33.3)	1 (33.3)	0	1 (33.3)	3 (100)	3 (100)
C	3	1 (33.3)	1 (33.3)	3 (100)	1 (33.3)	2 (66.7)	3 (100)	0	2 (66.7)	2 (66.7)	3 (100)
D	5	1 (20)	1 (20)	5 (100)	4 (80)	5 (100)	5 (100)	0	2 (40)	3 (60)	5 (100)
E	6	0	0	5 (83.3)	5 (83.3)	5 (83.3)	3 (50)	2 (33.3)	4 (66.7)	5 (83.3)	6 (100)
F	5	1 (20)	1 (20)	5 (100)	5 (100)	5 (100)	1 (20)	3 (60)	4 (80)	4 (80)	5 (100)
G	8	5 (62.5)	5 (62.5)	2 (25)	8 (100)	6 (75)	3 (37.5)	3 (37.5)	6 (75)	7 (87.5)	8 (100)
H	11	9 (81.9)	8 (72.7)	7 (63.6)	11 (100)	9 (81.9)	8 (72.7)	1 (8.7)	11 (100)	11 (100)	11 (100)
I	13	13 (100)	12 (92.3)	9 (69.2)	11 (84.6)	12 (92.3)	13 (100)	9 (69.2)	10 (76.9)	10 (76.9)	12 (92)
J	12	11 (91.7)	10 (83.3)	7 (58.3)	12 (100)	10 (83.3)	7 (58.3)	7 (58.3)	10 (83.3)	11 (91.7)	12 (100)
K	14	9 (64.3)	10 (71.4)	10 (71.4)	12 (85.7)	12 (85.7)	12 (85.7)	7 (50)	11 (78.6)	10 (71.4)	12 (86)
L	5	5 (100)	4 (80)	4 (80)	5 (100)	5 (100)	4 (80)	4 (80)	5 (100)	1 (20)	5 (100)
F/W	-	-	-	-	-	-	-	-	-	-	-
DS	4	4 (100)	3 (75)	3 (75)	3 (75)	3 (75)	4 (100)	2 (50)	4 (100)	2 (50)	4 (100)
Total	94	60 (63.8)	56 (60)	68 (72.3)	82 (87.2)	78 (83)	68 (72.3)	38 (40.4)	73 (77.7)	73 (77.7)	90 (95.7)

Keys: n=number of isolates, N- Number of isolates showing multiple antibiotic resistance, F/W- isolates from feed and water, DS-number of isolates from disposal site, OFX-Ofloxacin; CIP-Ciprofloxacin, GN-Gentamycin; AMC-Amoxycillin-clavulanate, CRO Cefriaxone; MEM-Meropenem, CAZ= Ceftaxidime TET= Tetracycline, SXT= Trimethoprim/Sulfamethoxazole.
Source A- pullets, B- layers, C- broilers, D- broilers, E-,turkeys, F-,turkey, G-layers, H-layers, I- layers, J-cockerels, K-local birds, L-layer

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4. CONCLUSION

We have demonstrated that unsafe act audit of poultry production sites in this research links the safety of public health with the quality of water and soil in human environment. Unsafe acts and conditions with the inherent occupational and biological hazards in poultry production sites are attributed to non-functional health, safety and environment management system. Poultry droppings constitute biological hazard to public health. Human exposure to these biological hazards present in the environment predisposes the public to infections. Further studies that determine the die-off rates of these multiple antibiotic-resistant bacteria in abiotic conditions are required to determine the role of the environment as a source of spread.

ACKNOWLEDGEMENTS

The Poultry farmers who participated in the research and Technologists from Ekiti State University, Ado-Ekiti are appreciated for their painstaking directed to ensuring a comprehensive microbiological analysis.

COMPETING INTERESTS

Authors declare that no competing interests exist.

AUTHORS' CONTRIBUTIONS

Author A designed the study and managed the analyses of the study. Author B wrote the protocols, first draft of the manuscript and managed the literature searches. All authors read and approved the final manuscript.

CONSENT (WHERE EVER APPLICABLE)

Not applicable

ETHICAL APPROVAL (WHERE EVER APPLICABLE)

Not applicable

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