



## Quinolone Resistance in Bacterial Isolates from Chicken Carcasses in Abeokuta, Nigeria: A Retrospective Study from 2005-2011.

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### SUMMARY

Quinolone resistance in bacteria from food animals is now globally recognized as a serious veterinary and public health problem. To determine the rate of quinolone resistance in pathogenic bacteria isolated from samples from dead chickens submitted for microbiological examination, a six-year retrospective study (April, 2005 – March, 2011) was carried out. Data from records of bacteriological investigations at a Veterinary Teaching Hospital in Nigeria were evaluated. Two hundred bacterial isolates including *Escherichia coli* (95; 47.5%), *Salmonella* serotypes (78; 38.0%), *Klebsiella* (17; 8.5%) and *Staphylococcus aureus* (12; 6.0%) were isolated from chicken carcasses within the six-year period. On the overall, the isolates were resistant to ciprofloxacin (40.5%), enrofloxacin (21.0%), nalidixic acid (9.5%) and norfloxacin (44.0%). Overall, resistance to quinolones (except nalidixic acid) was highest in *S. aureus* (ciprofloxacin, 58.3%; enrofloxacin, 33.3%; and norfloxacin, 83.3%) followed by *Klebsiella spp* (ciprofloxacin, 41.2%; enrofloxacin, 29.4%; and norfloxacin, 64.7%), *E. coli* (ciprofloxacin, 40.0%; enrofloxacin, 23.2%; and norfloxacin, 41.1%) and least in *Salmonella* (ciprofloxacin, 38.6%; enrofloxacin, 14.5%; and norfloxacin, 36.8%). However, resistance to nalidixic acid was highest in *Klebsiella spp* (23.5%) followed by *S. aureus* (16.7%), *E. coli* (9.5%) and least in

*Salmonella* (5.3%). There was a general decline in quinolone resistance in the last three years (2009-2011) of this investigation. Quinolone resistance in avian pathogenic bacteria could lead to increase in economic loss from bacterial infection and refractory to treatment. Their possible transmission to humans is of public health significance.

**KEY WORDS:** Bacterial isolates, Commercial poultry chickens, Quinolone resistance.

### INTRODUCTION

In Nigeria, the poultry industry has good potentials for the attainment of food security, poverty eradication and foreign exchange earnings (Bourn *et al.* 1992). However, the realization of these potentials is hampered by many obstacles among which is the morbidity and mortality caused by infectious diseases resulting in high economic losses (Pritchett *et al.* 2005). Infections caused by *Escherichia coli*, *Salmonella* serotypes and other members of the enterobacteriaceae are among the common bacterial diseases of poultry birds (Kabir, 2010).

In most cases, bacterial diseases are treated with antimicrobial agents. These

agents are also administered in feed and water as prophylactic measure to forestall outbreak of infections. However, over dependence on antimicrobials has placed selection pressure on pathogenic bacteria leading to the emergence and spread of antimicrobial resistance as commonly encountered in the treatment of bacterial diseases (WHO, 1998). In the poultry industry, it has been observed that more and more bacterial diseases of poultry are becoming resistant to commonly used antimicrobial (Gross, 1994; Kilonzo-Nthenge *et al.*, 2008; Ogunleye *et al.*, 2008).

The emergence of antimicrobial resistance in pathogenic bacteria constitutes a serious problem in the control of infectious diseases. Many infections which were hitherto successfully treated based mainly on the clinician's past experience are increasingly becoming more refractory to traditional therapy (OIE, 2008). This may necessitate a longer duration of therapy, an increase in dose or a change of drug. The consequences of these are reduction in the level of production, increase in the cost of production and a threat to availability of animal protein to human population. Antimicrobial resistance therefore could be a major limitation to the growth of the poultry industry.

The increasing incidence of resistance to the first-line antimicrobial has led clinicians and farmers to resort to using newer generation antimicrobials such as quinolones (especially the fluoroquinolones) which are considered more effective in combating the resistant bacteria (Alo and Ojo, 2007). Quinolones are now widely being used in the treatment of all kinds of bacterial infection both in humans and in animals (Pidcock, 1996). However, there has been emergence of resistance to the quinolones among bacteria following their introduction for

use in the treatment of infectious diseases (Conly, 2002). This trend is on the increase (Ogunleye *et al.*, 2008; Overdevest *et al.*, 2011).

In Nigeria, only few reports are available on the prevalence and patterns of quinolone resistance in common bacteria pathogens of avian origin (Ogunleye *et al.*, 2008). This study investigated the occurrence of quinolones resistance in common bacterial pathogens isolated from cases of chicken mortality from commercial poultry farms in Ogun State, Nigeria; over a period of six years (April, 2005 to March, 2011)

## **MATERIALS AND METHODS**

Data were extracted from the laboratory records of bacteriological investigations carried out on samples taken from chicken carcasses submitted to the Microbiology laboratory of the Veterinary Teaching Hospital, Federal University of Agriculture, Abeokuta from April, 2005 to March, 2011. Information provided in the records included date of sample collection, source of sample, nature of sample, media for bacterial isolation, bacterial isolates identified, antimicrobial susceptibility testing method and result of the susceptibility test. Records showed that the samples included liver, spleen, lung, heart and ovaries which were aseptically collected during post mortem examination.

### **Bacterial isolation and identification:**

Bacterial isolation was by inoculation of samples onto both MacConkey and 5% blood agars incubated aerobically at 37 °C for 18 – 24 hours. Isolates were identified by cultural characteristics, microscopy, biochemical tests (oxidase, catalase, substrates utilization) coagulase tests (*Staphylococcus aureus*) as described by Barrow and Feltham (1993).

#### **Antimicrobial susceptibility test:**

Antimicrobial susceptibility testing was by disk diffusion method and interpretation of breakpoint was based on the guidelines provided by Clinical and Laboratory Standards Institute (2000). For the purpose of the present study, only susceptibility of bacteria isolates to the quinolones, namely: ciprofloxacin (10 µg), enrofloxacin (5 µg), nalidixic acid (30 µg) and norfloxacin (10 µg) manufactured by Oxoid® (Basingstoke, UK) were considered.

#### **Statistical analysis**

Prevalence rates were expressed in percentages and represented in bar chart.

#### **RESULT**

Within the six years under review, 200 bacterial isolates were recovered from samples of dead chickens submitted for microbiological examination. These comprised of *E. coli*, 95 (47.5%); *Salmonella*, 78 (38.0%); *Klebsiella spp*, 17 (8.5%); and *Staphylococcus aureus*, 12 (6.0%) (Table 1). *Escherichia coli* and *Salmonella* were detected in each year of the study period while no *Klebsiella spp* was detected in the fifth and sixth year respectively (Table I). *Staphylococcus aureus* was encountered only in first and second years (Table I).

Of the 200 isolates, 81 (40.5%) were resistant to ciprofloxacin, 42 (21.0%) to enrofloxacin, 19 (9.5%) to nalidixic acid and 88 (44.0%) were resistant to norfloxacin (Table II). On the overall, resistance to quinolones (except nalidixic acid) was highest in *S. aureus* (ciprofloxacin, 58.3%; enrofloxacin, 33.3%; and norfloxacin, 83.3%) followed by *Klebsiella spp* (ciprofloxacin, 41.2%; enrofloxacin, 29.4%; and norfloxacin, 64.7%), *E. coli* (ciprofloxacin, 40.0%; enrofloxacin, 23.2%; and norfloxacin,

41.1%) and least in *Salmonella* (ciprofloxacin, 38.6%; enrofloxacin, 14.5%; and norfloxacin, 36.8%) (Figure 1). However, resistance to nalidixic acid was highest in *Klebsiella spp* (23.5%) followed by *S. aureus* (16.7%), *E. coli* (9.5%) and least in *Salmonella* (5.3%).

#### **DISCUSSION**

This study revealed a high incidence of the enterobacteriaceae especially *E. coli* and *Salmonella* in cases of mortalities in chickens. *Escherichia coli* and *Salmonella* were consistently detected throughout the six-year period under review. In each year, *E. coli* accounted for over 40% of all isolates while *Salmonella* accounted for between 25% and 49% of the isolates. Other bacterial pathogens such as *Klebsiella* and *Staphylococcus aureus* were also detected. All over the world, diseases caused by *E. coli* and *Salmonella* serotypes are commonly reported as responsible for morbidity and mortality in poultry chickens (Bajuwa et al., 1992; Kilonzo-Nthenge et al., 2008; Kabir, 2010). Previous studies have shown that *E. coli* and *Salmonella* are common causes of morbidity and mortality in the study area (Ogunleye et al., 2008; Agbaje et al., 2010). In the present study, the detection of other bacterial pathogens such as *Klebsiella* and *Staphylococcus aureus* varied within the six-year period. *Klebsiella* was detected consecutively for four years and accounted for about 3.3% to 15.7% of the total isolates. *Staphylococcus aureus* was only detected in the first and third year. Previous studies (Turtura et al., 1990; Kilonzo-Nthenge et al., 2008) have identified *Klebsiella species* in chickens. *Klebsiella species* have been recognized as secondary bacterial agents responsible for complications in other diseases (Bleich et al., 2008). Also, previous studies have reported the isolation of *Staphylococcus aureus* from chickens (Capita et al., 2002; Persoons et

*al.*, 2009) corroborating the findings in the present study.

The increasing incidence of antimicrobial resistance among clinical bacterial isolates is a global phenomenon that has generated a lot of concerns in human and veterinary clinical practices. The quinolones have been described as an exceptionally important and rapidly developing group of antimicrobial drugs introduced into human and veterinary medicine for a wide variety of antimicrobial purposes (Orden *et al.*, 2000). The efficacy of these antimicrobial agents in the treatment of infectious diseases is being threatened by the emergence of resistant bacterial strains. In the present study, there was a high rate of quinolone resistance among the bacterial isolates. Generally, the highest rate of resistance was to norfloxacin followed by ciprofloxacin. Resistance to nalidixic acid was the lowest. Salehi and Bonab (2006) reported high rate of quinolone resistance (ciprofloxacin, 67%; norfloxacin, 68%; enrofloxacin, 78%; and nalidixic acid, 100%) in avian pathogenic *E. coli* isolates similar to the range observed in the present study. However, the rate of nalidixic resistance in the present study did not at any point exceed 50% in all the bacterial species identified. Other workers also reported rates of quinolone resistance among *E. coli* isolates of chicken origin similar to those observed in the present study (Miles *et al.*, 2006). In contrast to the findings in the present study, a lower rate of quinolone resistance that range from 0.5% to 5.9% for nalidixic acid and 0.0% to 4.9% for enrofloxacin and ciprofloxacin were reported in *Escherichia coli* isolates of ruminant origin (Orden *et al.*, 2001). Similar to the findings in the present study, Agbaje *et al.*, (2010) reported high rates of quinolone resistance in *Salmonella*. However, Forrest *et al.* (2009) did not

detect fluoroquinolone resistance in non-typhoidal *Salmonella* isolated from humans. Oyekunle *et al.* (2003) also reported a zero quinolone resistance in *Salmonella*. In the present study, the highest levels of quinolone resistance were in *Staphylococcus aureus* followed by *Klebsiella*, *E. coli* and least in *Salmonella*. This probably suggests a higher rate of emergence of quinolones resistance in other bacteria other than the enterobacteriaceae. Although the rate of resistance was particularly high in the first three years (April 2005 – March 2008), it appeared that there was a decline in the incidence of resistance to the quinolones over the last two years (April 2009- March 2011). The reason for this decline is not clear and needs to be investigated.

The high rate of quinolone resistance among avian pathogenic bacterial isolates in the present study may be related to high antibiotic usage in poultry production (Alo and Ojo, 2007; Ogunleye *et al.*, 2008). In Nigeria, quinolones are increasingly being preferred over other antimicrobial agents both as prophylaxis in raising chicks and as therapeutic agents in treatment of bacterial infections (Alo and Ojo, 2007). In the study area, norfloxacin and enrofloxacin are commonly used in poultry production while nalidixic acid ciprofloxacin are rarely used (Ogunleye *et al.*, 2008). Since the mode of action of the quinolones is similar, resistance to a member may induce resistance to others members. An association has been described between the emergence of fluoroquinolone resistant zoonotic pathogens and the use of these drugs in animals (Blanco *et al.*, 1997). In addition, antimicrobial resistance traits in bacteria are often resident within transmissible mobile genetic elements which can be shared among bacteria (Lee *et al.*, 2006). Resistant bacteria may transfer their resistant traits to other bacteria

within the same environment through mobile genetic elements such as plasmids and transposons (Lee *et al.*, 2006). Exchange of resistant genetic materials is particularly common among enteric bacteria. This contributes significantly to the persistence, spread and overall prevalence of antimicrobial resistance among bacteria within a community.

zoonotic bacteria implicated in human food-borne infections (Mead *et al.*, 1999).

Resistance of avian pathogenic bacteria to quinolones may lead to increase in economic loss from bacterial infections that are refractory to antibiotic therapy. Resistance to quinolones among avian pathogens is also of public health implication as the resistant bacterial strains could be transmitted to humans. *Escherichia coli*, *Salmonella* and *Staphylococcus aureus* are among major

**TABLE I: Rate of occurrence of four bacteria pathogens in chicken carcasses in Abeokuta, Nigeria over a six-year period.**

Year (Number of isolates)	Number (%) of identified bacterial species				
	<i>E. coli</i>	<i>Salmonella spp</i>	<i>Klebsiella spp</i>	<i>Staphylococcus aureus</i>	Total (%)
I	23 (45.1)	13 (25.5)	8 (15.7)	7 (13.7)	51 (100.0)
II	15 (50.0)	14 (46.7)	1 (3.3)	0	30 (100.0)
III	17 (41.5)	15 (36.6)	4 (9.8)	5 (12.2)	41 (100.0)
IV	16 (50.0)	12 (37.5)	4 (12.5)	0	32 (100.0)
V	17 (51.5)	16 (48.5)	0	0	33 (100.0)
VI	7 (53.8)	6 (46.2)	0	0	13 (100.0)
Total (%)	95 (47.5)	76 (38.0)	17 (8.5)	12 (6.0)	200 (100.0)

Year I: April 2005- March 2006

Year III: April 2007- March 2008

Year V: April 2009- March 2010

Year II: April 2006- March 2007

Year IV: April 2008- March 2009

Year VI: April 2010- March 2011

TABLE II: Rates of quinolone resistance in bacterial isolates from dead chickens from commercial poultry farms in Abeokuta, Nigeria over a six-year period (Mach, 2005 to April, 2011).

Year	Bacterial Isolates	Number of isolates	Norfloxacin n (%)	Ciprofloxacin n (%)	Enrofloxacin n (%)	Nalidixic acid n (%)
I	<i>E. coli</i>	23	14 (60.9)	10 (43.5)	0	8 (34.8)
	<i>Salmonella</i>	13	11 (84.6)	7 (53.8)	0	3 (23.1)
	<i>Klebsiella spp</i>	8	6 (75.0)	2 (25.0)	0	4 (50.0)
	<i>Staphylococcus aureus</i>	7	7 (100.0)	4 (57.1)	0	2 (28.6)
	<b>Sub-total</b>	<b>51</b>	<b>38 (74.5)</b>	<b>23 (45.1)</b>	<b>0</b>	<b>17 (33.3)</b>
II	<i>E. coli</i>	15	9 (60.0)	9 (60.0)	4 (26.7)	0
	<i>Salmonella</i>	14	9 (64.3)	7 (50.0)	0	0
	<i>Klebsiella spp</i>	1	0	0	0	0
	<i>Staphylococcus aureus</i>	0	0	0	0	0
	<b>Sub-total</b>	<b>30</b>	<b>18 (60.0)</b>	<b>16 (53.3)</b>	<b>4 (13.3)</b>	<b>0</b>
III	<i>E. coli</i>	17	13 (76.5)	12 (70.6)	14 (82.4)	0
	<i>Salmonella</i>	15	6 (40.0)	6 (40.0)	8 (53.3)	0
	<i>Klebsiella spp</i>	4	4 (100)	4 (100)	4 (100.0)	0
	<i>Staphylococcus aureus</i>	5	3 (60.0)	3 (60.0)	4 (80.0)	0
	<b>Sub-total</b>	<b>41</b>	<b>26 (63.4)</b>	<b>25 (60.9)</b>	<b>30 (73.2)</b>	<b>0</b>
IV	<i>E. coli</i>	16	3 (18.8)	3 (18.8)	3 (18.8)	1 (6.3)
	<i>Salmonella</i>	12	2 (16.7)	3 (25.0)	2 (16.7)	1 (8.3)
	<i>Klebsiella spp</i>	4	1 (25.0)	1 (25.0)	1 (25.0)	0
	<i>Staphylococcus aureus</i>	0	0	0	0	0
	<b>Sub-total</b>	<b>32</b>	<b>6 (18.8)</b>	<b>7 (21.9)</b>	<b>6 (18.8)</b>	<b>2 (6.3)</b>
V	<i>E. coli</i>	17	0	4 (23.5)	0	0
	<i>Salmonella</i>	16	0	6 (37.5)	0	0
	<i>Klebsiella spp</i>	0	0	0	0	0
	<i>Staphylococcus aureus</i>	0	0	0	0	0
	<b>Sub-total</b>	<b>33</b>	<b>0</b>	<b>10 (30.3)</b>	<b>0</b>	<b>0</b>
VI	<i>E. coli</i>	7	0	0	1 (14.3)	0
	<i>Salmonella</i>	6	0	0	1 (16.7)	0
	<i>Klebsiella spp</i>	0	0	0	0	0
	<i>Staphylococcus aureus</i>	0	0	0	0	0
	<b>Sub-total</b>	<b>13</b>	<b>0</b>	<b>0</b>	<b>2 (15.4)</b>	<b>0</b>
Overall total		200	88 (44.0)	81 (40.5)	42 (21.0)	19 (9.5)

Year I: April 2005- March 2006  
 Year III: April 2007- March 2008  
 Year V: April 2009- March 2010

Year II: April 2006- March 2007  
 Year IV: April 2008- March 2009  
 Year VI: April 2010- March 2011

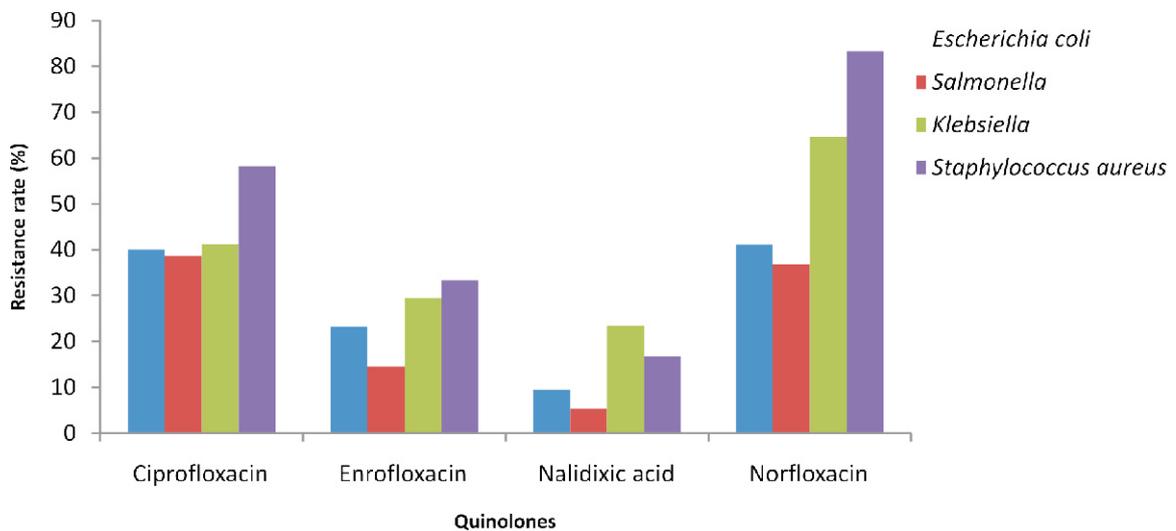


Figure 1: Overall quinolone resistance in bacterial pathogens isolated from chicken carcasses over a six-year period

## REFERENCES

- AGBAJE, M., DAVIES, R., OYEKUNLE, M. A., OJO, O. E., FASINA, F. O. and AKINDUTI, P. A. (2010). Observation on the occurrence and transmission pattern of *Salmonella gallinarum* in commercial poultry farms in Ogun State, South Western Nigeria. *Afr. J. Microbiol. Res.*, 4 (9): 796–800.
- ALO, O. S. and OJO, O. (2007). Use of antibiotics in food animals: A case study of a major veterinary outlet in Ekiti State, Nigeria. *Nig. Vet. J.*, 28 (1): 80-82.
- BAJUWA, N. Z., SIDDIQUE, M., and JARED, M. T. (1992). Pathogenesis of *Escherichia coli* in previously *Mycoplasma gallisepticum* infected layer chicks. *J. Isl. Acad. Sci.*, 5 (2): 123–126.
- BARROW, G. I. and FELTHAM, R. K. A. (1993). Cowan and Steel's Manual for Identification of Medical Bacteria. 3<sup>rd</sup> Ed. Cambridge University Press.
- BLANCO, J. E., BLANCO, M., MORA, A., and BLANCO, J. (1997). Prevalence of bacterial resistance to quinolones and other antimicrobials among avian *E. coli* strains isolated from septicemic and healthy chickens in Spain. *J. Clin. Microbiol.*, 35: 2184-2185.
- BLEICH, A., KIRSCH, P., SAHLY, H., FAHEY, J., SMOZEK, A., and HEDRICH, H. J. (2008). *Klebsiella oxytoca*: opportunistic infections in laboratory rodents. *Lab. Anim.*, 42: 369–375.
- BOURN D., WINT, W., BLENCH, R. and WOOLLEY, E. (1992). Nigerian livestock resources survey. *FAO World Anim. Rev.*, 78 (1): 49-58. <http://www.fao.org/docrep/t1300t/t1300tog.htm>.
- CAPITA, R., ALONSO-CALLEJA, C., GARCÍA-FERNÁNDEZ, M. C., and MORENO, B. (2002). Characterization of *Staphylococcus aureus* Isolated from Poultry Meat in Spain. *Poult. Sci.*, 81:414–421.
- CLINICAL AND LABORATORY STANDARDS INSTITUTE (CLSI) (2008). Performance standards for antimicrobial disk and dilution susceptibility tests for bacteria isolated from animals; Approved standard-Third edition Vol 28 (8), CLSI document M31-A3, 1–112. Clinical and Laboratory Standards Institute, 940 West Valley Road, Wayne Pennsylvania, USA.
- CONLY, J. (2002). Antimicrobial resistance in Canada. *Can. Med. Assoc. J.*, 167(8): 885-891
- FORREST, G. N., WAGNER, L. M., TALWANI, R., and GILLIAM, B. L. (2009). Lack of fluoroquinolone resistance in non-typhoidal *Salmonella* bacteremia in HIV-infected patients in an urban US setting. *J. IAPAC*, 8 (6): 336–341.
- GROSS, W.G. (1994). Diseases due to *Escherichia coli* in poultry. In: *Escherichiacoli* in domestic animals and humans. C. L. Gyles, ed. CAB International, Wallingford, U.K. pp 237-259.
- GUNDOGAN, N., CITAK, S. and YALCIN, E. (2011). Virulence Properties of Extended Spectrum  $\beta$ -Lactamase-Producing *Klebsiella* Species in Meat Samples. *J. Food Prot.*, 74 (4): 559–564.
- KABIR S. M. L. (2010). Avian colibacillosis and Salmonellosis: A closer look at epidemiology, pathogenesis, diagnosis, control and public health concerns. *Int. J. Environ. Res. Pub. Hlth.*, 7: 89–114
- KILONZO-NTHENGE, A., NAHASHON, S. N., CHEN, F. and ADEFOPE, N. (2008). Prevalence and

- Antimicrobial Resistance of Pathogenic Bacteria in Chicken and Guinea Fowl. *Poult. Sci.*, 87: 1841-1848.
- LEE, J. C., KANG, H. Y., OH, J. Y., JEONG, J. H., KIM, J., SEOL, S. Y., CHO, D. T., and LEE, Y. C. (2006). Antimicrobial resistance and integrons found in commensal *Escherichia coli* isolates from healthy humans. *J. Bacteriol. Virol.* 36:133-139.
- MEAD, P. S., SLUTSKER, L., DIETZ, V., MCCAIG, L. F., BRESEE, J. S., and SHAPIRO, C. (1999). Food-related illness and death in the United States. *Emerg. Infect. Dis.*, 5: 607-625.
- MILES, T. D., MCLAUGHLING, W. and BROWN P. D. (2006). Antimicrobial resistance of *Escherichia coli* isolates from broiler chickens and humans. *BMC Vet. Res.*, 2:7.
- OGUNLEYE, A. O., OYEKUNLE, M. A. and SONIBARE, A. O. (2008). Multidrug resistant *Escherichia coli* isolates of poultry origin in Abeokuta, South Western Nigeria. *Vet. Arhiv*, 78 (6): 501-509.
- OFFICE INTERNATIONAL DES EPIZOOTIES (OIE) (2008). Laboratory Methodologies for Bacterial Antimicrobial Susceptibility Testing. *OIE Terrestrial Manual* 56-65. [www.oie.int](http://www.oie.int)
- ORDEN, J. A., RUIZ-SANTA-QUITERIA, J. A., CID, D., DÍEZ, R., MARTÍNEZ, S. and DE LA FUENTE, R. (2001). Quinolone resistance in potentially pathogenic and non-pathogenic *Escherichia coli* strains isolated from healthy ruminants. *J. Antimicrob. Chemoth.*, 48: 421-424.
- ORDEN, J. A., RUIZ-SANTA-QUITERIA, J. A., CID, D. and DE LA FUENTE, R. (2000). Quinolone resistance in bacteria of animal origin and implications on human health. *Research Adv. Antimicrob. Agents Chemoth.*, 1: 35-48.
- OVERDEVEST, I., WILLEMSEN, I., RIJNSBURGER, M., EUSTACE, A., XU, L., and HAWKEY, P. (2011). Extended-spectrum  $\beta$ -lactamase genes of *Escherichia coli* in chicken meat and humans, the Netherlands. *Emerg. Infect. Dis.*, 17 (7): 1216-1222.
- OYEKUNLE, M. A. SHODIYA, S. A. and JIMOH, I. K. (2003). Reservoir of Antimicrobial Resistant Salmonellae among poultry in a Local Government area in Ogun State, Nigeria. *ASSET Series A*, 3 (4): 71-380.
- PERSOONS, D., VAN HOOREBEKE, S., HERMANS, K., BUTAYE, P., DE KRUIF, A., and HAESEBROUCK, F. (2009). Methicillin-Resistant *Staphylococcus aureus* in Poultry. *Emerg. Infect. Dis.*, 15(3): 452-453.
- PIDDOCK, L. J. V. (1996). Does the use of antimicrobial agents in veterinary medicine and animal husbandry select antibiotic-resistant bacteria that infect man and compromise antimicrobial chemotherapy? *J. Antimicrob Chemoth.*, 38: 1-3.
- PRITCHETT, J., THILMANY, D. and JOHNSON, K. (2005). Animal Disease Economic Impacts: A Survey of Literature and Typology of Research Approaches. *Int. Food Agribus. Mgt. Rev.*, 8 (1): 23-45.
- SALEHI, T. Z., and BONAB, S. F. (2006). Antibiotic susceptibility pattern of *Escherichia coli* strains isolated from chickens with colisepticaemia in Tabriz province, Iran. *Int J. Poult. Sci.*, 5 (7): 677-684.
- TURTURA, G. C., MASSA, S., and GHAZUINIZADEH, H. (1990). Antibiotic resistance among coliform bacteria isolated from

*Ojo, O. E. et. al. Quinolone Restance in Bacterial Isolates from Chicken Carcasses in Abeokuta*

carcasses of commercially slaughter chicken. *Int J. Food Microbiol.*, 11 (3-4): 351–354.

WORLD HEALTH ORGANIZATION (WHO) (1998). Use of quinolones in food animals and potential impact on