



Evaluation of poultry processing practices, related public health laws and diseases of chickens at slaughter: A pilot study in Kaduna state

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Abstract

Poultry processing procedures and environment are integral to the quality and safety of meat derived from poultry. The existing practices used in the slaughter and processing of poultry and the disposition of poultry workers towards poultry inspection in four major live bird markets in Kaduna were evaluated using structured questionnaires administered to 30 marketers, 51 processors, 19 marketers/processors and each market manager respectively. Background public health regulations related to poultry production and processing as provided within the Meat Law (1968), Food and Drug Act (1974) and Animal Diseases (Control) Act (1988) were also assessed for gaps that could compromise quality and safety of poultry products in Nigeria. The diseases detectable at postmortem inspection of 1000 poultry carcasses processed in these live bird markets were documented. Live bird market workers were all males mainly between 20-39 years of age and had secondary school education (64%). Majority (51%) consist of poultry processors, largely ignorant of public health laws. Up to 95% and 74% of the workers will welcome routine ante-mortem and post mortem inspection respectively. Lesions related to Newcastle disease had the highest frequency of occurrence (41.6%) amongst inspected birds. Existing laws have made provisions to ensure that animal production and processing are coordinated for the benefits and health of the general populace. Laws evaluated have gaps that could compromise various stages of quality assurance along the poultry value chain, lack specificity in terms of addressing specific issues of poultry hygiene and did not adequately empower the veterinary services to enforce measures that will ensure safe poultry products. Hence, the revised Animal Disease Control Edict and Meat Hygiene Act should be passed into law, Nigerian live poultry market workforce needs training on poultry processing precautionary public health measures, and the use of protective clothing should be made mandatory.

Keywords: Inspection, Legislation, Poultry, Processing, Public health

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Introduction

There has been considerable growth of the Nigerian poultry sector, with a significant contribution from backyard poultry flocks. These low level poultry production subsector, together with free range chickens, supply the majority of poultry in Nigerian live bird markets (Adene & Oguntade, 2008). However, this type of production has limited provisions for biosecurity and poultry health.

Therefore birds reach the market without adequate veterinary care and supervision.

The consumer expects to get meat from healthy birds under conditions which will assure elimination of diseased material and freedom from contamination and adulteration. It is common knowledge that the application of the principles of meat hygiene cannot be entrusted to butchers and similar personnel since they are primarily concerned

with profits, and other interests not always. The high prevalence of poultry diseases in Nigeria including zoonotic diseases (Aboaba & Smith, 2005; Muhammad *et al.*, 2010; Durosinlorun *et al.*, 2010; Solomon *et al.*, 2011), raises concern about the quality and safety of poultry slaughtered for human consumption. In addition, during poultry processing, carcasses are introduced into a common bath that permits cross-contamination between infected and uninfected carcasses. Defeathering and scalding processes may permit cross-contamination between infected and uninfected carcasses (Berrang *et al.*, 2000; Nde *et al.*, 2007).

The cleanliness and wholesomeness of poultry bear a direct relation to the kind of facilities that make up the environment (Ghafir *et al.*, 2007; Sampers *et al.*, 2010). The role of modern organized slaughtering procedure is to segregate dead and moribund animals from otherwise healthy ones, condemn parts of the carcasses with signs of systemic disease, condemn parts of the carcasses affected with localized disease or abnormalities, and reduce microbial contamination from enteric pathogens, while preventing the introduction of chemical and physical hazards into finished products (Gracey, 1986).

It is therefore necessary that each step in the dressing of the carcass and related activities receive the attention of a trained inspector. The extent of consumer protection provided by an inspection service depends upon the effectiveness of the inspection system and the authority of the inspection agency to enforce relevant public health regulations (Libby, 1975).

The advent of highly pathogenic avian influenza (HPAI) in the country in 2006 has brought to light the need for appropriate re-organization of poultry production and processing. There are very few standard poultry processing facilities. The public health problems that emanated from the decay of infrastructure and lack of control in the slaughter of red meat is also visible in poultry processing throughout Nigeria. Most of the existing facilities in the country are in poor conditions in terms of the location, hygiene and other biosecurity indices, hence creating opportunity for the spread of poultry diseases and zoonoses (AICP, 2008; Pagani *et al.*, 2008).

Until recently, there were no dedicated live bird markets (LBM) and poultry processing facilities. Most of the processing facilities are also devoid of formal dedicated veterinary inspectors. In some selected

consistent with good practices of food handling. urban LBMs, the marketers have been trained and educated on the dangers of HPAI to poultry and humans (AICP, 2008). It is not clear how far these measures will impact on the safety of poultry products and the control of other zoonotic infections transmissible through meat. The problems associated with poultry processing has not received sufficient attention in Nigeria, hence the need for the evaluation of prevailing live bird market operations to assess the public health problems related to poultry processing in the country.

This study assessed the existing processing practices including the disposition of people working in the live bird markets towards poultry inspection. Also, the study determined the types of diseases occurring in slaughtered chickens at postmortem and the gaps in three key legislations governing the poultry value chain from production to marketing.

Materials and Methods

Evaluation of practices and disposition of people working in live bird markets to poultry inspection

This aspect of the study was carried out in Kaduna and Zaria, the two main cities in the state. The two largest live bird markets: Abubakar Gummi and Sokoto Road live bird markets in Kaduna and Samaru and Sabon Gari live bird markets in Zaria were selected to investigate the existing practices and the readiness of people working in the live bird markets to have their birds inspected. The two live bird markets in Kaduna were recently improved by the Federal Government as part of the Avian Influenza Control Project (AICP) while the Zaria live bird markets are the typical traditional live bird markets in Nigeria. Two structured questionnaires were developed and administered to the market leaders and workers respectively to ascertain the status of poultry processing facilities and how they are used, public health precautionary measures such as the use of biosecurity measures and hygienic practices, and also assess the opinion of live bird marketers and butchers on poultry inspection. Four questionnaires, one per market, were administered to the official leader of the market. A total of 100 of the second questionnaire were administered to 30 marketers, 51 processors and 19 marketers/processors (based on their readiness and cooperation). The responses were then analyzed using SPSS 16.0. A digital camera was used to record proceedings in the markets and document procedures and practices in order to observe deviation from best practices and gaps in processing.

Determination of the types of diseases at post-mortem in slaughtered chickens

A total of 1000 chickens were examined at slaughter in order to determine the prevalent diseases of poultry slaughtered in the four live bird markets. A maximum of 10 carcasses were examined by random selection when large number of the same type of birds from the same source were dressed to avoid bias. Post-mortem examination as described by Parkhurst & George (1997) was carried out and the observed lesions recorded systematically in a recording sheet template. All lesions and findings were recorded on an adopted record sheet, tentative diagnosis or decision about the disease involved was based on matching lesions with standard descriptions of the disease using Jordan (1990), Calnek *et al.* (1997) and Parkhurst & George (1997), as guides. Tentative diagnosis was then drawn from the observed lesions. The data was then entered into an Excel spreadsheet (Microsoft Excel, 2007) and analyzed to draw logical conclusions.

Assessment of gaps in legislation governing the poultry value chain

Relevant laws related to Veterinary Public Health and poultry health were identified which include; Animal Disease (Control) Act 1988 (FRN, 1988), Meat Law of 1968 (NCS), Food and Drug Law 1974 (FRN, 1974). These laws were derived from the laws of the federation of the Federal Republic of Nigeria. These laws were evaluated based on their provisions on various aspects of the poultry value-chain. A checklist consisting of all the stages in poultry production including: production of birds, transportation, registration and establishment of poultry slaughter facilities, ante-mortem and post-mortem inspection, disposal of diseased animals, notification of disease, marketing of poultry products, seizure or destruction of poultry was used to assess the provisions of the laws. The gaps that could predispose to public health problems were noted and recorded in an analysis table.

Results

Disposition of people working in Live Bird Markets to poultry inspection

Demographic characteristics, knowledge and perceptions of workers in live bird markets on public health legislation in poultry processing: The live bird market workers were all found to be of the male gender with age ranging from 10-80 years of age. The age group 20-39 years had the highest frequency of occurrence (79%) whilst age group 60-79 years had the least (1%). Most of the workers had

secondary school education (64%) Only 5% had higher education. The workers could be grouped into three categories namely: the live bird marketers (sell birds from farms and other sources), the poultry processors (slaughter and dress poultry at specified fees), and live bird marketers/poultry processors (practice the combination of the first two). Majority (51%) of live bird market workers in the four LBMs studied were poultry processors whilst live bird marketers/poultry processors are of the least occurrence (19%) (Table 1)

Majority (97%) of the live bird market workers claimed to have some knowledge on public health laws guiding poultry processing but on further questioning 72% attested to the fact that only resident market laws are known whilst 28% know only the Islamic (Halal) meat processing regulations (Table 2)

On ante mortem and post mortem inspection, 95% of live bird market workers will welcome ante-mortem inspection always, 4% prefer it on a need to know basis (occasionally) whilst 1% think it is not necessary. Similarly, 74% of live bird market workers agreed to have post-mortem inspection of poultry carcasses always, 10% want it occasionally whilst 16% think it is not necessary (Table 3).

Types of diseases observed at post-mortem in slaughtered chickens: On post-mortem inspection of 1000 poultry carcasses, 116 (11.6%) were found to be apparently healthy; Newcastle disease had the highest frequency of occurrence 416 (41.6%). Other diseases observed were, Chronic respiratory disease 2 (0.2%), Coccidiosis 298 (29.8%), Colibacillosis 18 (1.8%), Fowl typhoid 34 (3.4%), Helminthosis 3 (0.3%), Scaly legs mite infestation 1 (0.1%), Infectious bursal disease 1 (0.1%) (Table 4)

Mixed infection cases observed were:

Chronic respiratory disease and Coccidiosis 66 (6.6%), Fowl cholera and Coccidiosis 6 (0.6%), Mareks and Coccidiosis 39 (3.9%) (Table 4)

Assessment of gaps in legislations as regards poultry production/processing

From the evaluation of the laws, it was noted that the laws have made some salient provisions to ensure that animal production and processing are coordinated for the benefits and health of the consumers and the general populace. Evaluation of these legislations reflected the interest of the country in animal production at the time these laws were drafted. However, not much emphasis is placed on poultry production and processing and the small provisions are not actively enforced. The

provisions and the gaps in these legislations are Production of birds: Thorough evaluation of the Animal Disease (control) Act (1988), Meat Law (1968), Food and Drugs Act (1974) revealed some notable gaps such as the low cost of licensing poultry farms and the absence of official certification of farms for presence or absence of diseases or current vaccination status of birds (Table 5).

Transportation of birds: The evaluation check of the Animal Disease (control) Act (1988), Meat Law (1968), Food and Drugs Act (1974) showed no specific regulations governing the movement of poultry within the country, no specification of types of vehicles or modes of transporting birds from one point of the poultry value chain to another (Table 6).

Regulations and establishment of poultry slaughter facilities: The assessment of Animal Disease (control) Act (1988), Meat Law (1968), Food and Drugs Act (1974) showed focus was mainly on the slaughter of red meat hence no specific provisions for hygienic slaughter of poultry (Table 7).

Medication of poultry: Animal Disease (control) Act (1988), Meat Law (1968), Food and Drugs Act (1974) check revealed that none of the laws specifically

analyzed herewith:

described regulations for use of drugs in live poultry or the use of additives in poultry feed and drinking water (Table 8).

Ante mortem and post mortem inspection of poultry: The Animal Disease (control) Act (1988), Meat Law (1968), Food and Drugs Act (1974) were not categorical on ante mortem inspection of poultry (Table.9) and there is no harmony between the Meat Law (1968), Food and Drugs Act (1974) as regards who is in charge of post mortem inspection of poultry (Table 10).

Marketing of poultry and poultry products: The evaluated regulations i.e. Animal Disease (control) Act (1988), Meat Law (1968), Food and Drugs Act (1974) provided for some level of control of the marketing of poultry or poultry products for the purposes of imports (Table 11).

Seizure or destruction of poultry: The Animal Disease (control) Act (1988), Meat Law (1968), Food and Drugs Act (1974) sufficiently provide for the protection of both poultry and humans through seizure or destruction of diseased poultry or poultry products (Table 12).

Table 1: Background information of live bird market workers

Personal Data	Number Interviewed	Percentage
Gender: Male	100	100
Female	0	0
Age Group (years):		
Less than 20	5	5
20-39	79	79
40-59	15	15
60-79	1	1
Education Status:		
Informal Education	13	13
Primary School	18	18
Secondary School	64	64
Higher Education	5	5
Occupation:		
Live bird Marketer	30	30
Poultry Processor	51	51
Live bird Marketer/Poultry Processor	19	19

Table 2: Knowledge of live bird market workers on public health laws guiding poultry processing

Knowledge	Number Interviewed	Percentage
Knowledge on Regulations:		
Yes	97	97
No	3	3
Category of known Regulation:		
Federal laws	0	0
State laws	0	0
Local Government Regulations	0	0
Resident market Regulations	72	72
Islamic meat processing Regulations (Halal)	28	28

Table 3: Poultry inspection practice and willingness of live bird market workers to have birds inspected

Practice	Number Interviewed (Percentage)	Willingness of LBM (Percentage)
Ante mortem inspection of birds:		
Practiced always	61(61)	95(95)
Practiced occasionally	30(30)	4(4)
Not practiced	9(9)	1(1)
Post mortem inspection of birds:		
Practiced always	42(42)	74(74)
Practiced occasionally	49(49)	10(10)
Not practiced	9(9)	16(16)
Who inspects the birds (if practiced):		
Livestock Superintendent/Veterinary Assistant	0(0)	
Poultry processors	46(46)	
Veterinary Doctor	53(53)	
Others (students/researchers)	1(1)	

Table 4: Types and nature of diseases at postmortem in slaughtered chickens

Observed condition	Frequency	Percentage
Apparently Healthy	116	11.6
Chronic Respiratory Disease	2	0.2
Chronic Respiratory Disease and Coccidiosis	66	6.6
Coccidiosis	298	29.8
Colibacillosis	18	1.8
Fowl Cholera and Coccidiosis	6	0.6
Fowl Typhoid	34	3.4
Helminthosis	3	0.3
Infectious Bursal Disease and Coccidiosis	1	0.1
Mareks and Coccidiosis	39	3.9
Newcastle Disease	416	41.6
Scaly Legs	1	0.1
Total	1000	100

Table 5: Laws and edicts related to production of birds

Animal Diseases (Control) Act (1988)	Meat Law (1968)	Food and Drugs Act (1974)	Remark
Poultry farms and hatcheries must be licensed by the state Chief Veterinary Officer and registration license obtained. The owner is responsible for maintaining reasonable hygienic conditions on the farm and vaccinating the birds. Annual payable fee for a registration license stipulated for various categories of farms.	No provisions regarding the production of birds.	The sale of any food article containing filthy, harmful, poisonous, adulterated, disgusting, rotten or diseased substances that is unfit for human consumption is prohibited. The manufacture, preparation, preservation, packaging or store of food, drug for sale under insanitary conditions is prohibited.	<ul style="list-style-type: none"> • Only few poultry farms are practically licensed. • The cost of licensing of poultry farms is too low, less than the current value of one chicken. There is no provision of official certification of farms for presence or absence of diseases or vaccination status of birds.

Table 6: Laws and edicts related to transportation of bird

Animal Diseases (Control) Act (1988)	Meat Law (1968)	Food and Drugs Act (1974)	Remark
Provides that a permit must be obtained from the Director to import or export any animal, hatching egg or poultry and these may be subjected to examination, disinfection, inoculation and quarantine at the risk and expense of the owner as the Director deems necessary. Similarly the law provides for movement of trade animals.	There is a general provision for the conveyance and carriage of animals, carcasses or meat and inspection of meat coming into any designated area.	No regulation regarding the transportation of birds.	There are no specific regulations governing the movement of poultry within the country. There is also no specification of types of vehicles or modes of transportation of poultry from farms to markets and or slaughter.

Table 7: Laws and edicts related to registration and establishment of poultry slaughter facilities

Animal Diseases (Control) Act (1988)	Meat Law (1968)	Food and Drugs Act (1974)	Remark
No provision regarding poultry slaughter facilities.	Provides the procedure for establishing a slaughter house, specification for construction, facilities, utilities, equipment, provisions for personnel, handling of products and waste products. Animals intended for human consumption must be slaughtered in a registered slaughter house. Veterinary officer may prohibit use of unsanitary premises for animals or meat and can also prevent undue suffering by animals.	No regulation regarding poultry slaughter facility.	The focus of the law is on red meat slaughter not poultry hence no specific provisions for poultry. Law enforcement in slaughter houses is absent or weakly practiced.

Table 8: Laws and edicts related to medication

Animal Diseases (Control) Act (1988)	Meat Law (1968)	Food and Drugs Act (1974)	Remark
Made provisions for vaccination of birds and rearing of poultry which allows for the use of veterinary drugs for the control and prevention of diseases.	No provisions regarding drug use in poultry.	The law defined 'drug' as an item for use in both humans and animals. Under the law animal products such as meat, milk and eggs also fits the definition 'food'. However, the law has no jurisdiction on live animals. It provides for the control of drug residues in animals and their products in general, without specific reference to poultry.	None of the laws specifically describe regulations for use of drugs in live poultry or the use of additives in poultry feed and drinking water.

Table 9: Laws and edicts related to ante-mortem inspection of birds

Animal Diseases (Control) Act (1988)	Meat Law (1968)	Food and Drugs Act (1974)	Remark
The law provides that a Veterinary Officer may for the purpose of examining a diseased animal take blood smears and apply such tests as he may consider necessary. This provision can be applied to examination of poultry at post-mortem.	The Meat Law specifically provided that animals should only be slaughtered after being inspected ante mortem and found healthy. Animals showing any signs of sickness must be segregated from all other animals and must be slaughtered separately, as is usually done during ante-mortem inspection.	No provisions as regarding the ante-mortem inspection of poultry.	None of the laws was categorical on ante-mortem inspection of birds. In general terms, the Meat Law made some provisions. However, there is the need for description of ante-mortem conditions in poultry and appropriate regulatory requirements for handling diseases ante-mortem.

Table 10: Laws and edicts related to post-mortem inspection of birds

Animal Diseases Control) Act (1988)	Meat Law (1968)	Food and Drugs Act (1974)	Remark
No provisions regarding post mortem inspection of birds.	Post mortem inspection is provided for by this law which states that 'post-mortem inspection must be made when the carcass is being dressed'. Until this inspection has been completed all parts of the carcass must remain identifiable with the carcass.	No provisions regarding the post-mortem inspection of birds. However, this law allows for inspection of any food item (poultry meat) that is found to be unfit for human consumption or contain diseased substance or is adulterated.	There is no harmony between the Meat Law (1968) and Foods and Drugs Act (1974) as regards who is in charge of post-mortem inspection of poultry since the FDA law made no mention of a Veterinary Officer in its execution or any other animal health authority.

Table 11: Laws and edicts related to marketing of poultry and poultry products

Animal Diseases (Control) Act (1988)	Meat Law (1968)	Food and Drugs Act (1974)	Remark
No provisions regarding marketing poultry products like meat. There are however, the provisions for importation of hatching eggs and live birds.	This law categorically stated that "the sale of any meat not derived from an animal slaughtered in a registered slaughter house is prohibited" and generally provides for the mechanism of conveyance and storage of meat which could include poultry meat and ways of disposal of undesirable meat to protect the public from buying unsafe meat.	Prohibits the sale or advertisement of food, including meat that is adulterated and other provisions that protect the public from exposure to unsuitable food products like poultry meat.	All the three legislations provide for some level of control of the marketing of poultry or poultry products or for the purposes of imports.

Table 12: Laws and edicts related to seizure or destruction of poultry

Animal Diseases (Control) Act (1988)	Meat Law (1968)	Food and Drugs Act (1974)	Remark
Any animal/product imported without a permit shall be seized or caused to be destroyed immediately on arrival by the Director or authorized Officer.	Any animal (including poultry) found to be diseased on slaughter may be destroyed by a Veterinary Officer.	No provisions regarding seizure of poultry/poultry products. However, when poultry or poultry products are transformed or processed to meat or other forms of foods, they are within the mandate of this law that provides for its confiscation or destruction in fulfillment of the provisions of the law.	The existing legislations provide sufficient provisions for protecting both poultry and humans through seizure or destruction of diseased poultry or poultry products.

Discussion

Most (79%) of the people working in the live bird markets are males within the age group of 20-39 years, therefore are within the age group amenable to change and training. The preponderance of males in the live bird markets contrasts with what is observed in other parts of the country where women are predominant (AICP, 2008). Most individuals working in the live bird markets have at least secondary school education (64%) and up to 5% possess higher education. This is encouraging since literacy level is closely tied to uptake of public health messages and risk perception (Abdullahi *et al.*, 2009). Workers within the live bird markets have little or no knowledge about regulations guiding the slaughter of poultry as is reflected from the fact that most attested to know only their resident market laws or Islamic laws. This presents a big challenge use no protective clothing, observed no public health precautionary measures, and have poor biosecurity practices. Therefore, these workers and

and is a reflection of lack of public knowledge about veterinary and public health laws generally in the society. It also indicates the need for the harmonization of existing legislations into a clear and concise law that will govern poultry value chain. Poultry inspection is currently not carried out in the assessed live bird markets. This can be achieved only if there is a demand made by the veterinary authorities.

Live bird marketers are willing to have their birds inspected; this is a positive observation. With the increasing interest in poultry production in the country, poultry inspection may perhaps be more accepted by the stakeholders than red meat inspection. From the questionnaires administered to the market leaders and the observations made during the course of this study, live birds marketers the public in general are at risk of contacting zoonotic poultry diseases.

The disease with the highest prevalence is Newcastle disease (NCD) which is a reflection of the endemic status of the disease and as the most important poultry disease in Nigeria (Snoeck *et al.*, 2009; Solomon *et al.*, 2011). Even though NCD may have limited impact on public health its detection in birds meant for slaughter highlights the need for greater stringency in disease control at the level of production. Also, many of the infectious agents found in poultry that also impact negatively on carcass quality and safety such as *Salmonella*, *Campylobacter*, *Listeria*, and *Escherichia coli* may not be detectable at post mortem. These pathogens have been of serious concern in many countries where poultry inspection is routine (Lindblad *et al.*,

2006; Nde *et al.*, 2007; Voidarou *et al.*, 2011). Therefore, the greater emphasis should be in proactively preventing carcass contamination through production of healthy birds. Existing regulations need to be upgraded. As a first step, there is an urgent need to fast track the passing into law of the revised Animal Disease Control Act and the Meat Hygiene Act. Secondly, there is also a need for a deliberate program of training for the work force in Nigerian live poultry markets on precautionary public health measures as regards poultry processing. The use of protective clothing including hand gloves must be enforced for all meat handlers. Biosecurity measures must be enforced at the level of production.

References

- Abdullahi MI, Oguntunde O & Habib AG (2009). Knowledge, attitudes, and practices of avian influenza among poultry traders in Nigeria. *The Internet Journal of Infectious Diseases*, **8** (2).
- Aboaba OO & Smith SI (2005). Occurrence of *Campylobacter* species in poultry farms in Lagos area of Nigeria. *Journal of Environmental Biology*, **26**(Suppl. 2): 403-408.
- Adene DF & Oguntade AE (2008). Poultry sector country review. In: *FAO Animal Production and Health Division Publication*. Pp 1-87.
- (AICP) (2008). *Development of Live Bird Markets in Nigeria, Avian Influenza Control Project. Consultant Report to Animal Health Component of the Avian Influenza Control and Human Pandemic Preparedness and Response Project*, Abuja. Pp 10-50.
- Berrang ME, Dickens JA & Musgrove MT (2000). Effects of hot water application after defeathering on the levels of *Campylobacter*, coliform bacteria, and *Escherichia coli* on broiler carcasses. *Poultry Science*, **79**(11): 1689-1693.
- Calnek BW, Barnes HJ, Beard WC, Mcdougald RL & Saif YM (1997). *Diseases of Poultry*, tenth edition, Iowa State University Press Ame, Iowa. Pp 82, 131-138.
- Durosinlorun A, Umoh JU, Abdu PA & Ajogi I (2010). Serologic evidence of infection with H5 subtype influenza virus in apparently healthy local chickens in Kaduna State, Nigeria. *Avian Diseases*, **54**(Suppl. 1): 365-368.
- FRN (Federal Republic of Nigeria) (1974). Food and Drug Act (Decree No. 35), Supplement to Official Gazette No. 61, 55: A191-A206.
- FRN (Federal Republic of Nigeria) (1988). Animal Diseases (Control) Act (Decree No. 10), Official Gazette No. 13, 75: A477-A501.
- Ghafir Y, China B, Dierick K, Dezutter L & Daube G (2007). A seven-year survey of *Campylobacter* contamination in meat at different production stages in Belgium. *International Journal of Food Microbiology*, **116**(1): 111-120.
- Gracey JF (1986). Chemical Residues in Meat. *Meat Hygiene*, Eight edition. Bailliere Tindall, London. Pp 191-210.
- Jordan FTW (1990). *Poultry Diseases*, Third edition. Bailliere Tindall, London. Pp 54-95, 123-131.
- Libby JA (1975). *Meat Hygiene*. Lea & Febiger, Philadelphia. Pp 10-13.
- Lindblad M, Lindmark H, Lambertz ST & Lindqvist R (2006). Microbiological baseline study of broiler chickens at Swedish slaughterhouses. *Journal of Food Protection*, **69**(12): 2875-2882.
- Muhammad M, Muhammad LU, Ambali AG, Mani AU, Azard S & Barco L (2010). Prevalence of *Salmonella* associated with chick mortality at hatching and their susceptibility to antimicrobial agents. *Veterinary Microbiology*: **140**(1-2): 131-135.
- NCS (North-Central State of Nigeria) (1968), *Meat law of Kaduna State*, Arewa Publishing Press, Kaduna. Pp 2-23.
- Nde CW, McEnvoy JM, Sherwood JS & Logue CM (2007). Cross contamination of turkey

- carcasses by *Salmonella* species during defeathering. *Poultry Science*, **86**(1): 162-167.
- Pagani P, Abimiku JE & Emeka-Okolie W (2008). *Assessment of the Nigerian poultry market chain to improve biosecurity*. Food and Agriculture Organization of the United Nations, Nigeria Consultative Mission, November 2008- Nigeria. <http://www.fao.org/docrep/012/ak778e/ak778e00.pdf>, retrieved 15-04-2011.
- Parkhurst C & George J (1997), *Poultry Meat and Egg Production*, CBS Publishers and Distributors, New Delhi. Pp 126-156.
- Sampers I, Jacxsens L, Luning PA, Marcelis WJ, Dumoulin A & Uyttendaele M (2010). Performance of food safety management systems in poultry meat preparation processing plants in relation to *Campylobacter* spp. contamination. *Journal of Food Protection*, **73**(8): 1447-1457.
- Snoeck CJ , Ducatez MF, Owoade AA, Faleke OO, Alkali BR, Tahita MC, Tarnagda Z, Ouedraogo JB, Maikano I, Mbah PO, Kremer JR & Muller CP (2009). Newcastle disease virus in West Africa: new virulent strains identified in non-commercial farms. *Archives of Virology*, **154**(1): 47-54.
- Solomon P, Abolinik C, Joannis TM & Bisschop S (2011). Virulent Newcastle disease virus in Nigeria. Identification of a new clad of 5f from live bird markets. *Virus Genes*, **44**(1): 98-103.
- Voidarou C, Vassos D, Rozos G, Alexopoulos A, Plessas S, Tsinas A, Skoufou M, Stavropoulou E & Bezirtzoglou E (2011). Microbial challenges of poultry meat production. *Anaerobe*, **17**(6):341-343.