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Awareness of Farmers on Newcastle Disease, its Vaccination and Antibody Titer in Commercial Chickens in Jos South, Nigeria

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ABSTRACT

Newcastle disease is a highly contagious viral disease which affects existing or developing poultry industries. This study was performed to assess the level of awareness of farmers on Newcastle disease and its control through vaccination and also to determine the level of Newcastle disease virus antibody (Ab) titer in commercial layer chicken sera using haemagglutination inhibition test in Jos South Local Government Area, Plateau State, Nigeria. A structured questionnaire was shared to farmers to fill. Thirty four farms were visited and nine districts were randomly selected. A total of 354 sera were collected from commercial chickens; ten from each flock. There was a high level of awareness of farmers (100%) on ND and its vaccination (100%) and all the farmers (100%) had vaccinated their chickens against ND. The HI test revealed that, out of the 354 sera tested, 9 (2.5 %) chickens were negative for NDV Abs, which means had NDV antibody titer below the minimum protective titer of $\log_2$ 3 and 345 chickens (97.5%) were positive for NDV Abs; had NDV antibody titer above $\log_2$ 3. It was concluded that the level of awareness of farmers on ND and its control through vaccination was incredibly high, also, the level of protection to ND in vaccinated chickens was also very high, in that a higher percentage of the chickens had NDV Antibodies between $\log_2$ 6 and $\log_2$ 8, however, inspite of these, ND is still a continual threat to the poultry industry in Nigeria. It is therefore recommended that, other biosecurity measures, such as good management practice, proper hygiene and surveillance be emphasized and ensured, in order to prevent ND infection among flocks.

Key words: Newcastle disease, Antibody titer, Haemagglutination inhibition, Commercial chickens

INTRODUCTION

For the past 50 years, poultry production has recorded greater changes than in any other world's livestock sub sector of the agricultural production sector (David, 2000). Current trends in livestock production indicate that the global production of poultry meat and dairy will double by 2050 (David, 2000). Newcastle disease (ND) is one of the most important animal diseases in the world; both for the number of animals affected every year and the severe economic impact on the poultry industry (Thompson, 2015). ND is a highly contagious viral disease which is caused by Newcastle disease virus (NDV) which belongs to the Family, Paramyxoviridae and Genus, Rubulavirus (Alexander, 1997). The disease has been reported to be the most important poultry disease (Sonaiya et al., 2000).

ND is also the most important cause of mortality in chickens and many species of domesticated and wild birds have been found susceptible to this disease; mortality of 100% is common (Nguyen, 1992; Wernery et al., 1992; Alders and Spradbrow, 2001; Saidu and Abdu, 2008). ND usually affects the respiratory, gastrointestinal and nervous systems with common signs of listlessness, increased respiratory rate, yellowish to greenish diarrhea and weakness followed later by prostration and death (Chansiripornchai and Sasipreeyajan, 2006).

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The NDV has been reported endemic in many developing countries of Africa such as Kenya (Njue et al., 2001and Njagi, 2010); Cameroon (Ekue et al., 2002 and Mai et al., 2014); Tanzania (Salam et al., 2002); Ethiopia (Chaka et al., 2013); Egypt (Mohammed et al., 2011) and Nigeria (Sa'idu et al, 2004; El –Yukuga et al., 2009; Musa et al., 2009; Yakubu, 2010; Okwor and Eze, 2010 and Salihu et al., 2012).

The first recorded and confirmed outbreak of ND in Nigeria was between December, 1952 and February, 1953 in and around the city of Ibadan, the Oyo State capital (Hill et al., 1953). The disease has been a notable problem in the country since then (Oladele et al., 2002). ND is widespread in domestic and exotic chickens (Fatumbi and Adene, 1979). The most dreaded poultry disease in Nigeria as reported by Abdu et al. (1992) is ND. Fatumbi and Adene, (1979); Adu et al. (1986); Echeonwu et al. (1994); Sa'idu et al. (1994); Alders and Spradbrow, (2001), also reported that ND is enzootic in Nigeria. Olabode et al. (1992) reported that ND is a threat to poultry industry in Nigeria and it continues to cause havoc to different species of poultry.

Newcastle disease is characterized by signs, such as coughing, gasping, sneezing and rales, nervous signs, greenish-white diarrhea and cessation of egg production (Alexander, 1997 and 2001). ND has become endemic in Nigeria in both local and commercial poultry with annual epidemics recorded in highly susceptible flocks (Halle et al.,1999; Saidu and Abdu, 2008) with pockets of outbreaks occurring between the annual epidemic periods.

Commercial chickens in Nigeria are exclusively exotic chickens which are reared intensively or semi-intensively. In most parts of the country, ND is seen and diagnosed throughout the year in commercial flocks and the incidence varies with season (Chabauf, 1990; Alders and Spradbrow, 2001).

Newcastle disease is an economically important disease of poultry for which vaccination is carried out as a preventive measure in many countries. Orakaja et al. (1999) reported vaccination as the only safe option in control strategies of infection (Orakaja et al., 1999). Mariana et al. (2016) also reported that vaccination of chickens is able to prevent internal egg contamination, reducing egg shell surface contamination and reducing shedding from digestive and respiratory tracts in virulent NDV challenged hens (Mariana et al., 2016).

Nevertheless, outbreaks of ND have been reported in vaccinated poultry populations (Van Boven et al., 2008). Vaccination is practiced widely and different types of vaccines are available but the most successful and widely used ones are the mild live virus vaccines known as the Hitchner B1 and La Sota types (Rathore *et al*., 1987 and Aliyu et al., 2014). The typical vaccination schedule in layers in Plateau state, Nigeria is as follows; the birds are vaccinated against Newcastle disease (Hitchner B1) intraoccular at day one of age on the hatcheries before being sold; they are also given Lasota vaccine orally via the drinking water at the third week of age; at week six of age, they are given kumorov vaccine either subcutaneously or intramuscularly; between week eleven and fifteen, they are given Lasota vaccine orally via drinking water; at week sixteen of age, they are given kumorov vaccine either subcutaneously or intramuscularly and at every three months interval, they are also given kumorov vaccine either subcutaneously or intramuscularly; and the typical schedule of vaccination in broilers is as; birds are given first dose of Lasota vaccine orally at two weeks of age via the drinking water and at forth week of age, they are given the second dose of Lasota vaccine orally via the drinking water.

Newcastle disease alone accounts for more than 50% of total losses in Africa's poultry flocks (Ezeibe et al., 2006 and Musa et al., 2009). In response to the threat presented by ND, several attempts have been made to put in place vaccination programmes to prevent epidemics of disease. However, outbreaks have been reported in vaccinated populations (Okwor et al., 2010).

Serological tests are useful tools in the diagnosis of infection. Haemagglutination Inhibition (HI) test is the most commonly used test for detection of immune response in affected birds (Alexander and Senne, 2008). Value of serology in diagnosis of disease depends on the vaccination history of birds and on prevailing disease conditions (OIE, 2012). Because NDV can cause a wide variety of disease presentation, it is important to enhance the awareness of field personnel (Thompson, 2015). In view of this and the economic importance of ND, this study was carried out in order to determine the level of awareness of farmers on ND and its control through vaccination and also to determine ND virus antibody titre using haemagglutination inhibition test in commercial chicken sera in Jos South Local Government Area, Plateau State, Nigeria.

MATERIALS AND METHODS

The birds that were sampled in this study were layers (commercial birds). Layers of between age eighteen weeks and twenty four weeks were sampled. A Structured questionnaire was given to farmers. The farmers' awareness of ND and its vaccination, type of

ND vaccine given, route of administration of ND vaccine, whether or not cold chain was maintained and how it was maintained, service provider, any outbreak or infection with NDV and how the disease was treated; all these information were obtained from the farmers. Table one shows the typical Newcastle disease vaccination in layers and broilers in Plateau state, Nigeria.

Convenience sampling procedure was used to select nine districts under Jos South L.G.A. These districts were; Federal low cost, Rantya, Bukuru, Rayfield, Da zarmangada, Dung village, Dadinkowa, Gyel and State low cost. Furthermore, 1- 3 farms (depending on the number of farms in each district) were also randomly selected from each of the districts and 10 to 20 birds were selected at random from each flock, depending on the number of farms in each district and the flock size, respectively. Structured questionnaire was administered to farmers. Two milliliters of blood was collected aseptically via the wing vein of each bird, using a 21–G sterile hypodermic needle and 5 ml syringe in adult birds (layers) and 23-G sterile hypodermic needle and 2 ml syringe in young birds (pullets). The samples were labeled with the name and location of the farm, type of bird and date of collection. The blood samples were kept in a slanting position at room temperature to allow for clotting and sera formation. The sera were separated by transferring into a labeled sterile bottle for HI test which was stored frozen at -20°C and sent in a cold pack to regional laboratory for avian influenza and other transboundary animal diseases at the National Veterinary Research Institute (NVRI), Vom, Plateau State, Nigeria. Newcastle disease antigen and ND positive and negative serum were obtained from the National Veterinary Research Institute, Vom, Nigeria. The HI test was carried out by the method described by Office Internationale des Epizooties (2005).

Preparation of chicken red blood cell suspension

A total of 4 ml of blood was collected aseptically from ND antibody- negative chicken in a disposable syringe containing 1 ml of Acid Citrate Dextrose (ACD) as anticoagulant. Cells were washed three times in Phosphate Buffered Saline (PBS) of pH 7.2 by centrifuging at 447.2 g for 5 minutes (Allan and Gough, 1984). One percent RBC (packed cell V/V) suspension was prepared by adding 99 ml of Phosphate Buffered Saline (PBS) to 1 ml of washed RBC.

Statistical analysis

Data obtained through questionnaire administration were noted. The number recorded for each question was then converted into percentages and tabulated. The Statistical Package for Social Sciences (SPSS) program, version 12 was used to analyze data. Values of $P \leq 0.05$ were considered significant.

Table 1. Typical Schedule of Newcastle Disease Vaccination in Layers and Broilers in Plateau State, Nigeria

Type of bird	Age of bird at administration	Name of vaccine	Type of vaccine	Route of administration
Layer	Day one	Hitchner B1	Live	Intraoccular
	Three weeks	Lasota	Live	Oral via drinking water
	Six weeks	Kumorov	Live	Subcutaneous or intramuscular
	Between eleventh and fifteenth weeks	Lasota	Live	Oral via drinking water
	Sixteenth weeks	Kumorov	Live	Subcutaneous or intramuscular
	At three months Interval	Kumorov	Live	Subcutaneous or intramuscular
Broiler	Two weeks	Lasota	Live	Oral via drinking water
	Four weeks	Lasota	Live	Oral via drinking water

RESULTS

The questionnaire administered to farmers revealed that all of the commercial poultry farmers (100%) were aware of ND and had vaccinated their birds against ND (Table 2).

Out of the 354 sera tested, 9 (2.6 %) chickens were negative for NDV Abs, that is, had NDV antibody titer below the minimum protective titer of $\log_2$ 3 (that 7 (2.0%) chickens had NDV Ab titer of $\log_2$ 1 and 2 (0.6%) chickens had NDV Ab titer of $\log_2$ 2). 345 (97.5%) chickens were positive for NDV Abs, that had NDV antibody titer $\log_2$ 3 and above $\log_2$ 3 (Table 3). Results in table 3 indicated that a higher percentage of the chickens (64.2%) had protective NDV antibodies between $\log_2$ 6 and $\log_2$ 8.

Table 2. Awareness of Newcastle disease and its vaccination in commercial chickens and Respondents (farmers) in Jos South Local Government Area, Plateau State, Nigeria.

Awareness of Newcastle disease and its vaccination in commercial chickens	Respondents (farmers) (%)
Yes	34 (100)
No	0 (0)
Total	34 (100)

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Table 3. Distribution of Newcastle disease virus antibody titers and the corresponding number (percentage) of chickens in February, 2015 in Jos South local Government Area, Plateau State, Nigeria.

Antibody Titre (log_2)	2^1	2^2	2^3	2^4	2^5	2^6	2^7	2^8	2^9	2^{10}	2^{11}	2^{12}
Number of chickens	7	2	2	11	12	30	37	160	38	28	16	11
(Percentage)	2.0%	0.6%	0.6%	3.1%	3.4%	8.5%	10.5%	45.2%	10.7%	7.9%	4.5%	3.1%

Sera with NDV antibody titre ≥ log_2 3 were considered positive.

DISCUSSION

The result of this study showed that all the farmers (100%) involved in commercial poultry production in Jos South Local Government Area, were aware of ND. This observation points to the fact that ND is indeed of great economic importance as it is said to be enzootic in Nigeria as reported by Sa'idu et al. in 1994 and also said to be a major disease problem of poultry in many other countries of the world, especially in Africa and Asia as reported by Spradbrow (1992); Awan et al. (1994) and Oladele et al. (2005).

This study also showed that commercial chickens in Jos South LGA of Plateau State, had NDV antibodies. This indicated that farmers in this area often vaccinate their birds against ND. This supports the report by Sa'idu et al. (2006) that commercial poultry are routinely vaccinated against ND.

The OIE (2000) recommended that haemagglutination Inhibition (HI) antibody titer between log_2 0 and log_2 3 is considered negative because they produce no antibody against the virus while HI antibody titer between log_2 3 and log_2 12 is protective for chickens because it produces antibodies against the virus (Alders and Spradbrow, 2000 and Aldous et al., 2003). An HI antibody titer of log_2 4 and the above ones is indicative of exposure to the virus at one time or the other and eventual production of neutralizing antibodies to protect the chicken up to the point of sale (Joseph et al., 2014). The high HI antibody titer may be due to an infection by a virulent strain of the virus such as mesogenic strains which are viruses causing clinical signs consisting of respiratory and neurological signs with low mortality and lentogenic strains which are viruses causing mild infection of the respiratory tract without visible morbidity and mortality (Seal et al., 2000).

A ND-HI titer of log_2 3 (i.e, 1:8) and above is generally accepted as an indicative of specific immunity (Allan and Gough, 1974; Spradbrow et al., 1980 and Jagne et al., 1991). Using this criterion in this present study, 2.6% of the total number of commercial chickens tested, showed no serological evidence of specific immunity to NDV while 97.5% of the total number of chickens tested showed serological evidence of the presence of NDV. It is noteworthy that the majority of the chickens tested had a protective level of antibodies to NDV. The HI test revealed that 9 of the chickens tested showed a NDV Ab titer of < log_2 3 (1:2 to 1:4). This result showed that the serum antibody titers were too low to protect the birds from NDV infection. Similar results had been described by Awan et al. (1994). There are several possible reasons for this low level of protection in these birds; these may include, vaccine failure, impaired immune competence due to immunosuppressive diseases. Low NDV antibody prevalence is suggestive of an inter-epidemic phase or early phase of ND infection (Awan et al., 1994). Problem of ND outbreak or infection is envisaged and expected in these particular chickens unless the vaccination practice is improved substancially. 345 (97.5%) out of the total number of chickens tested had NDV Ab titer that varied between log_2 3 and log_2 12. Differentiation between vaccine titer and field challenge is difficult (Awan et al., 1994). In practice, a high antibody titer is indicative of a recent infection (Luc et al., 1992). The wider range of NDV Ab titer in some chickens may be due to natural infection with pathogenic field strain which is known to produce higher antibody titer than vaccination (Luc et al., 1992).

In Nigeria, ND has been noted to be more common during the cold harmattan periods and this is in agreement with the observations of high prevalence from November to February (Abdu et al., 1992 and Saidu et al., 1994). The harmattan period of November to February in Nigeria is characterized by wind drop in ambient temperature, dryness and other harsh weather conditions and this is believed to lower the immune status of birds making it possible for ND to manifest in commercial birds that have ordinary or lowered herd immunity to ND. Some migratory birds and birds of prey are common during this period of harmattan and their role in the epidemiology of ND may be very important.

Newcastle disease was reported prevalent in most parts of the Northern Nigeria with outbreaks seen in Bauchi State (Nwankiti et al., 2010); Borno State (El-Yuguda et al., 2009); Jigawa State (Wakawa et al., 2009); Nassarawa State (Salihu et al., 2012);

Kaduna State (Nwanta et al., 2006) and Plateau State (Musa et al., 2009). A study carried out by Lawal et al. (2015) in Gombe State, Northeastern, Nigeria, revealed an overall prevalence rate of 55.5% of ND in the State. This concurred with previous studies by Nwankiti et al. (2010) who reported prevalence rate of 56.3% in Bauchi State, Northeastern Nigeria. However, it was relatively higher than the prevalence rates of 51.9% as reported by Musa et al. (2009) in Plateau State; 52.2% reported by Sadiq et al. (2011) in Borno State and lower than 73.3% reported by Nwanta et al. (2006) in Kaduna State, Northwestern Nigeria. The most commercial poultry farmers in the study area claimed to have been vaccinating their flocks. Mariana et al. (2016) reported in their study that vaccination of chickens is able to prevent internal egg contamination, reducing egg shell surface contamination and also reducing shedding from digestive and respiratory tracts in virulent NDV challenged hens (Mariana et al., 2016).

In the US, however, the virus has been eradicated due to stringent adherence to poultry management rules and any virulent strains are of foreign origin from places where strict compliance to management regulations and good sanitary practices is lacking (Qin et al., 2008).

The higher NDV antibody titer of between $\log_2$ 8 to $\log_2$ 12 in this present study may be suggestive of ND infection and this seems consistent with the findings of Sa'idu et al. (2006) and Nwanta et al. (2006), where both reported the disease to be common during the dry harmattan period (November – March) with cold stress also been reported to exacerbate the epidemiology of the ND. Alders and Spradbrow (2001) reported that the windy harmattan encourages the spread of the NDV. Although, Aliyu et al. (2015), has a contrary findings. The results of the study by Aliyu et al. (2015) showed that the difference in the prevalence of ND in the dry season and in the rainy season was significant. The findings in that study were not in agreement with reports made by Sa'idu et al. (1994) and Halle et al. (1999) on the seasonality of ND, which revealed that the highest prevalence of the disease occurred between October and March, possibly because of the cold weather with high wind velocity (Abdu et al., 1992).

Shafqat et al. (2015) presented a field data suggesting that, despite high levels of anti-NDV antibody titers of >$\log_2$ 3 HI in 99% of the tested birds in different farms and localities, there was a very high incidence of the disease (Shafqat et al., 2015).

One of the reasons attributed to this change in findings was that poultry farmers are more enlightened about the need for reporting disease outbreak to Veterinary clinic, thus, it was deduced under probability that the high prevalence in the layers may be due to arbitrary vaccination of birds within the egg production period.

Exclusive dependence on the erratic power supply for vaccine storage may lead to vaccine failure (Okwor et al., 2009). The availability of poor quality vaccines and presence of rampant unreliable vaccination schedules against ND could have contributed to the increased rate of the disease. However, the history of vaccination program is very important in the interpretation of results.

CONCLUSION

In conclusion, there is a high level of awareness of farmers in Jos South Local Government Area, Plateau State, of Newcastle disease and its control through vaccination. High percentage of chickens that were positive to NDV Ab in this study indicates that ND is a common and endemic disease of chickens; also, the level of protection of commercial chickens in this study was found satisfactory.

It is therefore recommended, that strict regulations must be adopted against outbreak of NDV infection, such as restriction of movements in and around the farms. Biosecurity measures and continuous surveillance must also be applied. Continual boosting of immunity of birds with NDV vaccine must also be included in order to reduce economic losses usually caused by Newcastle disease outbreak. Farmers must also source and vaccinate their flocks with the help of veterinarians and in accordance with the recommended vaccination program.

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Competing interests

Authors have declared that no competing interests exist as regards this manuscript.

REFERENCES

Abdu PA, Mera UM and Sai'idu LA (1992). Study of chicken mortality in Zaria, Nigeria, In:

Proceeding of National Workshop on Livestock and Veterinary services, Vom, Plateau State, Pp 51- 55.

Adu FD, Edo U and Sokale B (1986). Newcastle disease: The immunological status of Nigerian local chickens. Tropical Veterinarian, 4: 149–152.

Alders R and Spradbrow P (2000). Newcastle Disease in village chickens, A field manual Maputo, Mozambique, p 46.

Alders R and Spradbrow P (2001). Controlling Newcastle disease in Village chicken. A field Manual. Australian Centre for International Agricultural Research. Monograph, 2; 37.

Aldous EW, Mynn JK, Banks J and Alexander DJA (2003). Molecular epidemiological study of avian paramyxovirus type 1 (Newcastle disease virus) isolates by phylogenetic analysis of a partial nucleotide sequence of the fusion protein gene. Journal of Avian Pathology, 32: 239-256.

Alexander DJ (1997). Newcastle disease and other avian *paramyxoviridae* infection In: Calnik BW, Barries H, Beard CW, McDougold I, Saif UM. ed. Disease of Poultry. Ames, Iowa State University Press, pp. 541-569.

Alexander DJ (2001). Newcastle disease. Brochure of Poultry Science, 42: 5-22.

Alexander DJ and Senne DA (2008). Newcastle disease and other avian paramyxoviruses. Zavala,

L.D. (ed), Omnipress, pp135-141.

Aliyu HB, Sa'idu L, Abdu PA and Oladele SB (2014). Response of commercial chickens to challenge with Newcastle disease virus (Kudu 113 Strain) following immunization with different Newcastle disease vaccines. Presented at 51st Congress of Nigerian Veterinary Medical Association held in Kaduna. pp 151.

Aliyu HB, Sa'idu L, Abdu PA and Olaele SB (2015). Retrospective analysis of Newcastle disease diagnosed at the poultry clinic of Ahmadu Bello University, Zaria, Nigeria. Sokoto Journal of Veterinary Sciences, 13: 3.

Allan WH and Gough RE (1974). A standard haemagglutination inhibition test for Newcastle disease. In: A comparison of macro and micro methods. Veterinary Record, 95: 120-123.

Allan WH and Gough RE (1984). A standard haemagglutination inhibition test for Newcastle disease (2) In: Vaccination and challenge. Veterinary Record, 95: 147-149.

Arshad M, Ajmal M, Rauf A, Rizvi A and Naeem M (1988). Isolation of Newcastle disease virus from pigeons, starlings and sparrows from Faisalabad and Lahore districts, Pakistan. Pakistan Journal of Zoology, 20 (4): 367-371.

Awan MA, Otte MJ and James MD (1994). The epidemiology of Newcastle disease in rural poultry: a review. Avian Pathology, 23: 405 – 423.

Chabauf N (1990). Disease prevention in small holder village production in Africa. Proceedings of the International Conference on Small Holder Rural Poultry Production, Oct. 9- 13,Greece, pp:129-137.

Chansiripornchai N and Sasipreeyajan J (2006). Efficacy of live B1 or ulster 2C Newcastle disease vaccines simultarneously vaccinated with inactivated oil adjuvant vaccine for protection of newcastle disease virus in broiler chickens. Acta Veterinary Journal, 48: 1-4.

Chaka H, Goutard F, Gil P, Abolnik C, Almeida R, Bisschop SPR, Thompson PN (2013). Serological and molecular investigation of Newcastle disease in household chicken flocks and associated markets in Eastern Shewa zone, Ethiopia. Tropical Animal Health and Production, 45: 705-714.

David S (2000). Poultry – their health and management: Introduction. In: Poultry and Management. 4th Edition. Blackwell, 108, Cowley Road, Oxford, OX4 IJF.

Echeonwu GON, Iroegbu CW and Emeruwa AC (1993). Recovery of velogenic Newcastle disease virus from dead and healthy free - roaming birds in Nigeria. Avian Pathology, 22 (2): 383-387.

Ekue FN, Pone KD, Mafeni MJ, Nfi AN and Njoya J (2002). Survey of the Traditional Poultry Production System in the Bamenda area, Cameroon. FAO/IAEA Co-ordinated Research Programme on Assessment of the Effectiveness of Vaccination Strategies against Newcastle Disease and Gumboro Disease Using Immunoassay based Technologies for Increasing Farm yard Poultry Production in Africa. Available: http://www.iaea.or.at/programmes/nafa/d3/public/2-surveyekue (Accessed on September 29, 2013).

El-Yuguda AD, Dokas UM and Baba SS (2005). Effects of Newcastle disease and infectious bursal disease vaccines, climate and other factors on the village chicken

population in North-Eastern Nigeria. Scientific Journal of Food, Agriculture and Environment, 3:55-57.

El–Yuguda AD, Baba SS, Ibrahim UI and Brisibe F (2009). Newcastle disease and infectious Bursal disease among village chickens in Borno State, Nigeria. Family Poultry, 18: (1 and 2):16-23.

Ezeibe MCO, Nwokike EC, Eze JI and Eze IC (2006). Detection and characterization of Newcastle disease virus from feaces of healthy free-roaming chickens in Nsukka, Nigeria, Tropical Veterinarian, 24 (4): 76 –80.

Halle PD, Umoh JO, Sa'idu L and Abdu PA (1999). Prevalence and seasonality of Newcastle disease in Zaria, Nigeria. Tropical Veterinarian, 17 (1):53 -62.

Hill DH, Davis OS and Wilkes GEH (1953). Newcastle disease in Nigeria. British Veterinary Journal, 109 (2):385-391.

Jagne J, Aini I, Schat K, Pennel A and Touray O (1991). Vaccination of village chickens in Gambia against Newcastle disease using heat-resistant, food-pelleted V4 vaccine. Avian pathology. 20: 721-724.

Joseph AO, Sulaiman LK, Meseko CA, Ismail S, Sulaiman I, Ahmed SJ and Onate EC (2014). Prevalence of Newcastle disease Antibodies in Local chickens in Federal Capital Territory, Abuja, Nigeria. International Scholarly Research Notices. Article ID 796148. http:// dx,doi.org/10.1155/2014/796148.

Lawal JR, Jajere SM, Mustapha M, Bello AM, Wakil Y, Geidam YA, Ibrahim UI and Gulani IA (2015). Prevalence of Newcastle Disease in Gombe, Northeastern Nigeria: A Ten-Year Retrospective Study (2004 – 2013). British Microbiology Research Journal 6, (6): 367-375.

Luc P, Hong N and Chinh V (1992). Level of anti-Newcastle disease virus antibodies in industrial poultry at various ages and seasons. Agricultural food industry, 9: 348-350.

Mai HM, Qadeer MA, Bawa IA, Sanusi M, Tayon KN, and Sa'idu I (2014). Seroprevalence of ND in Local chickens in Mezam division of North-west Cameroon. Microbiology Research International, 2 (1): 9-12.

Mariana S, Leonardo S, Kira M and David S (2016). Vaccination of chickens decreased Newcastle disease virus contamination in eggs. Avian pathology, pp 38-45.

Mohammed HA, Kumar S, Paldurai A and Samal SK (2011). Sequence analysis of fusion protein gene of Newcastle disease virus isolated from outbreaks in Egypt during 2006. Virology Journal, 8 (237):01-04.

Musa U, Abdu PA, Dafwang II, Umoh JU, Sa'idu L, Mera UM and Edache JA (2009). Seroprevalence, seasonal occurrence and clinical manifestation of Newcastle disease in rural household chickens in Plateau State, Nigeria. International Journal of Poultry Science, 8 (2): 200-204.

Nguyen TD (1992). Poultry production and Newcastle disease in Vietnam. In: Newcastle disease in village chickens; control with thermostable oral vaccines. Spradbrow P.B. (Ed). Proceeding No. 39. Australian Centre for International Agricultural Research, Canberra, Australia, pp: 169-170.

Njagi LW, Nyaga PN, Mbuthia PG, Bebora LC, Michieka JN, Kibe JK and Minga UM (2010). Prevalence of Newcastle disease virus in village chickens in varied agro- ecological zones in Kenya. Livestock Research for Rural Development, 22 (5).

Njue SW, Machari JM, Gacheru SG and Mbugua HCW (2001). A survey of the disease status of village chickens in Kenya In: Proceedings of the 10th Conference of the Association of Institutions for Tropical Veterinary Medicine (AIMVT). Copenhagen, Denmark, 20-23, August, 2001; 36.

Nwankiti OO, Ejekwolu AJ, Ibrahim I, Ndako JA and Echeonwu GON. (2010). Detection of serum antibody levels against Newcastle disease in local Chickens in Bauchi Metropolis, Bauchi State, Nigeria. African Journal of Clinical and Experimental Microbiology, 11 (2): 95-101.

Nwanta JA, Umoh JU, Abdu PA, Ajogi I and Alli-Balogun JK (2006). Management of losses and Newcastle disease in rural poultry in Kaduna state, Nigeria. Nigerian Journal of Animal Production, 33 (2): 274-285.

Office Internationale des Epizooties (OIE) (2005). Manual of Standards for Diagnostic Tests and Vaccines. 4th Edition, Paris, France.

Office Internationale des Epizooties (OIE) (2012). Newcastle disease. In: OIE terrestrial manual. Manual of Standards for Diagnostic Tests and Vaccines for terrestrial animals. Chapter 2.3.14. World Organization for Animal Health. Paris, France.

Okwor EC, Eze DC and Uzuegbu MO (2009). The effect of storage conditions on the potency of Newcastle disease vaccine La Sota. International Journal of Poultry Science, 8 (10): 999-1002.

Okwor EC and Eze DC (2010). The Annual Prevalence of Newcastle disease in chickens reared in South Eastern Savannah zone of Nigeria. Research Journal of Poultry Science, 3 (2): 23-26.

Orajaka LJE, Adene DF, Anene BM and Onuoha EA (1999). Seroprevalence of Newcastle disease in Local chickens from South East derived Savannah Zone of Nigeria. Revue d'Elevage Medicine Veterinari des Tropicaux, 52: 185 – 188.

Oladele SB, Nok AJ, Esievo KAN, Abdu P and Useh NM (2005). Haemagglutination inhibition antibodies, rectal temperature and total protein of chickens infected with a local Nigerian isolate of velogenic Newcastle disease virus. Veterinary Research Communications, 29: 171 – 179.

Pearsoon GL and Mc Cann MMK (1975). The role of indigenous wild, semidomestic and exotic birds in the epizoology of velogenic viscerotropic Newcastle disease in Southern California. Journal of American Veterinary Medicine Association. 167 (7) : 610-614.

Qin ZM, Tan LT, Xu HY, Ma BC, Wang YL, Yuan XY and Liu WJ (2008). Pathotypical Characterization and Molecular Epidemiology of Newcastle Disease Virus Isolates from Different Hosts in China from 1996 to 2005. Journal of Clinical Microbiology, 46 (2): 601-611.

Rathore BS, Verma KC, Singh SD and Khera SS (1987). Epidemiological studies on Ranikhet disease vaccinal failures in chickens. Indian Journal of Comparative Microbiology and Immunology of Infectious Diseases, 8 (2): 175-178.

Sadiq MA, Nwanta JA, Okolocha EC and Tijanni AN (2011). Retrospective (2000 - 2009) study of Newcastle Disease (ND) cases in Avian species in Maiduguri, Borno State, North Eastern Nigeria. International Journal of Poultry Science, 10 (1): 76-81.

Sa'idu L, Abdu PA, Umoh JU and Abdullahi US (1994). Disease of Nigerian indigenous chickens. Bulletin of Animal Health and Production in Africa, 42(1): 19-23.

Sa'idu L, Tekdek LB and Abdu PA (2004). Prevalence of Newcastle disease antibodies in domestic and semi-domestic birds in Zaria, Nigeria. Veterinarski Arhiv, 74: 309-317.

Sa'idu L, Abdu PA, Tekdek LB, Umoh JU, Usman M and Oladele SB (2006). Newcastle disease in Nigeria. Nigerian Veterinary Journal, 27: 23-32.

Salihu AE, Chukwuedo AA, Echeonwu GON, Ibu JO, Chukwuekezie JO, Ndako J, Junaid

SA (2012). Seroprevalence of Newcastle Disease Virus Infection in Rural Household Birds in Lafia, Akwanga and Keffi Metropolis, Nasarawa State, Nigeria. International Journal of Agricultural Sciences. 2(2):109-112.

Salum MR, Mtambuki A and Mulangila RCT (2002). Designing a vaccination regime to control Newcastle disease in village chickens in the Southern zone of Tanzania. Proceedings of the joint 17th Scientific Conference of the Tanzania Society for Animal Production and the 20th Scientific Conference of the Tanzania Veterinary Association held in Arusha, Tanzania on 3rd to 5th December, 2002; 299-305.

Seal BS, King DJ, Sellers HS (2000). The avian response to Newcastle disease virus. Developmental and Comparative Immunology, 24: 257-268.

Shafqat FR, Abdul W, Tasra B, Bushra N, Nadia M, Abid H, Nazir AL and Tahir Y (2015). Presence of Virulent Newcastle Disease Virus in Vaccinated Chickens in Farms in Pakistan. Journal of Clinical Microbiology, 53:1715-1718.

Sonaiya EB, Brankaert RDS and Guaye EF (2000). The scope and effect of family poultry research development (INFPD). Food and Agriculture Organization Animal Production and Health, Pp. 1 – 18.

Spradbrow PB (1992). Newcastle disease in village chickens: control with thermostable oral vaccines., Proceedings of International Workshop, Kuala cumpur, Malaysia, pp: 1-10.

Spradbrow PB (1993). Newcastle disease in village chickens. Poultry Science Review, 5 (2): 57- 96.

Spradbrow PB, Ibrahim AL, Chulan U, Milliken G, Shapcott R and Kingston D (1980). The response of Australian chickens naturally infected with avirulent Newcastle disease virus. Australian Veterinary Journal, 56: 580-584.

Thompson R (2015). Newcastle disease; a review of field recognition and current methods of laboratory detection. Journal of Veterinary Diagnostic Investigation, volume 23:4, pp 637-656.

Van Boven M, Bouma A, Fabri THF, Katsma E, Hartog L and Koch G (2008). Herd immunity to Newcastle disease virus in poultry by vaccination. Avian Pathology, 37 (1): 1-5.

Wakawa AM, Abdu PA, Umoh JU, Sa'idu L and Miko RB (2009). Serological evidence of mixed infections with avian influenza and Newcastle disease in village chickens in Jigawa State, Nigeria. Veterinarski Arhive, 79 (2):151-155.

Wernery U, Remple D, Neumann U, Alexander D, Manvel R and Kaaden O (1992). Avian Paramyxovirus serotype 1 (Newcastle disease virus) infections in falcons. Journal of Veterinary Medicine Series B., 39 (3): 153-158.

Yakubu A (2010). Indigenous chicken flocks of Nassarawa State, Nigeria: Their characteristics, husbandry and productivity. Tropical and Subtropical Agro-ecosystems, 12 (1): 69- 76.