A 5-YEAR RETROSPECTIVE STUDY ON THE MAJOR CAUSES OF POULTRY MORBIDITY AND MORTALITY DIAGNOSED AT THE CENTRAL VETERINARY LABORATORY, KENYA

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ABSTRACT. This study is to retrospectively determine the major conditions diagnosed for whole bird poultry carcasses presented at the Central Veterinary Laboratory for post-mortem. Post-mortem reports of whole bird carcasses presented from January 2009 to December 2013 were reviewed. Details collected and analysed for each report included the primary disease diagnosed, secondary infections, bird type, age, production system, farm flock size, farm location and season. Data was entered into SPSS descriptive studies and summary measures. Eight hundred and forty one (841) cases were reviewed during the study period. Bacterial diseases accounted for 380 cases (45.2%), 223 viral cases (26.5%) and 182 (21.6%) parasitic conditions. Non-infectious diseases were reported in 52 cases (6.2%). Collibacillosis (n=303, 79.7%) was the most common bacterial condition while IBD (n=108, 48.4%) was the most common viral condition. Coccidiosis (n=95, 52.2%) was the most common parasitic condition reported. Sample submission trends and distribution of production systems may have influenced the distribution patterns of diseases reported

Keywords: avian leucosis, coccidiosis, collibacillosis, helminthiasis, infectious bursal disease

INTRODUCTION

The agricultural sector contributes 30% of Kenya's gross domestic product, 60% of the country's foreign earnings and employs 70% of the country's work force (MALF, 2013). Poultry farming and trade in poultry products account for 30% of the total agricultural earnings. The Food and Agriculture Organization and the Ministry of Agriculture estimated that 20,000 metric tonnes of poultry meat valued at 3.5 billion Kenya shillings and 1.3 billion eggs valued at 9.7 billion Kenya shillings are consumed annually (Nyaga, 2007). The Kenya National Bureau of Statistics estimates the poultry population at 30 million birds from the 2009 livestock census (KNBS, 2013) of which 80% are indigenous birds reared extensively in rural areas. Broilers and layers reared intensively in urban and peri-urban areas account for 20% of the poultry population.

Broilers and layers dominate urban and peri-urban areas due to the proximity of such farms to large markets. The capital city Nairobi County and its satellite counties; Kiambu, Kajiado and Machakos counties is evidence to this fact. From the 2008 country poultry sector review by FAO, it was noted that out of the 21,652 layer farms in the country, 11,500 (52%) farms are in Nairobi County while Kiambu County holds 3,530 (16%) of these farms. Out of the 37,000 broiler farms in the country, 23,600 (63%) of farms are in Nairobi followed by Kiambu county with 10,500 (28%) of the farms (Nyaga, 2007).

The poultry sector in Kenya is hindered by various challenges that include diseases, weak technical support and credit facilities, access to markets and high feed costs. (Miheso, 2015). Poultry diseases are known to vary in frequency, space and time. Their is paucity of epidemiological data of poultry diseases in Kenya. Government reports suggest that Newcastle disease, fowl pox, infectious bursal disease, fowl typhoid, colibacillosis, mycoplasmosis, coccidiosis and helminthiasis are the major poultry diseases among poultry flocks in Kenya (Miheso, 2015). Policy makers and officials in the industry routinely rely on these government reports for decision making despite the fact these reports are based on a tentative diagnosis from case history and clinical signs (Miheso, 2015). There was almost no data on prevalence of avian leucosis (Al) until 2014 after a prospective study to determine the sero-prevalence of avian leucosis virus among poultry flocks in Nairobi county reported a sero-prevalence of 12% (Miheso, 2015).

Just like any other livestock disease the diagnosis and surveillance of poultry diseases should be based on flock history, clinical signs and confirmed by post-mortem laboratory tests. Diagnosis based on clinical signs alone can result in further losses including increased deaths, inappropriate interventions and wastage of time, money and resources.

The main objective of this study is to determine the major and confirmed cases of poultry mortality in Kenya from carcasses submitted to the Central Veterinary Laboratory for post-mortem for the period 2009-2013.

MATERIALS AND METHOD

Study area

All cases studied where presented at the Central Veterinary Laboratory located in Kangemi town, Upper Kabete which is 1.3° south and 36.7° east of the capital city Nairobi.

Study design

Manually recorded post-mortem reports of poultry carcasses diagnosed at the Central Veterinary Laboratory were obtained and reviewed retrospectively from January 2009 to December 2013. The data was analysed based on the occurrence of primary diseases diagnosed and secondary infections.

In estimating disease proportions, a case was defined as a single bird from a farm that reported a disease outbreak and the primary diagnosis was determined based on case history, clinical signs, most significant post-mortem findings and laboratory test results.

Only whole bird carcass post-mortem reports were included in the study. Incomplete post-mortem reports of whole bird samples submitted with missing data such as submission dates, flock size, flock type or farm location were excluded from the study.

The Central Veterinary Laboratory has a standard operating procedure manual that sets out the procedures and criteria for sample submission, sample acceptability, sample identification and processing. On sample submission the sample is received by the receiving veterinary officer on duty. Sample details that were recorded include case history, number of samples submitted and date of submission.

For analysis purposes, data extracted included the primary confirmed diagnosis, flock size, flock type (production system), dates of outbreak, flock age and farm location.

To save cost for the farmer, only one and the most suitable sample which meets the inclusion criteria was admitted for post-mortem. This approach was based on the assumption that poultry diseases are of greater significance at flock level rather than an individual bird. Advice, recommendations and interventions to the farmer are to be implemented at flock level and not individual birds.

Tissue and organ samples collected from whole bird carcasses for further laboratory tests were selected based on the most significant pathological lesions as well as the tentative diagnosis derived from flock history and clinical signs reported at farm level.

Samples were submitted for bacteriology, virology, toxicology and parasitology. Bacteriology conducted were culture, isolation and antibiotic sensitivity tests. For virology, ELISA and AGID tests were used for suspected viral conditions. The Macmaster chamber was used to identify the presence of worm eggs and coccidia oocysts.

Statistical analysis

Data was entered in SPSS version 16. Eight hundred and forty-one (841) case submissions with primary poultry diseases diagnosed were reported during the five-year study period.

RESULTS AND DISCUSSION

Description of the study population

A total of 841 case submissions were reviewed for the period of January 2009 to December 2013, giving an average case submission rate of 168 cases annually.

2011 had the highest submissions of 25.1% (n=211) while 2012 had the lowest at 15% (126) (Figure 1).

Of the 841 cases submitted to the laboratory, the majority (n=513, 61%) of the birds came from farms in Kiambu county, followed by samples from farms in Nairobi county (n=214, 25.4%). The lowest number of cases (n=114, 13.6%) came from satellite counties i.e. Kajiado 9.3% (n=78), Machakos 2.5% (n=21) and Muranga 1.8% (n=15) (Figure 2).

Across all the five years, the cold and dry seasons (June-October) reported the most number of cases (n=394, 46.8%) while the short rainy seasons (November-December) had the lowest number of cases (n=125, 14.9%). The long rainy seasons in March-May and the hot dry seasons in January-February reported 195 (23.2%) and 127 (15.1%) cases, respectively (Figure 3).

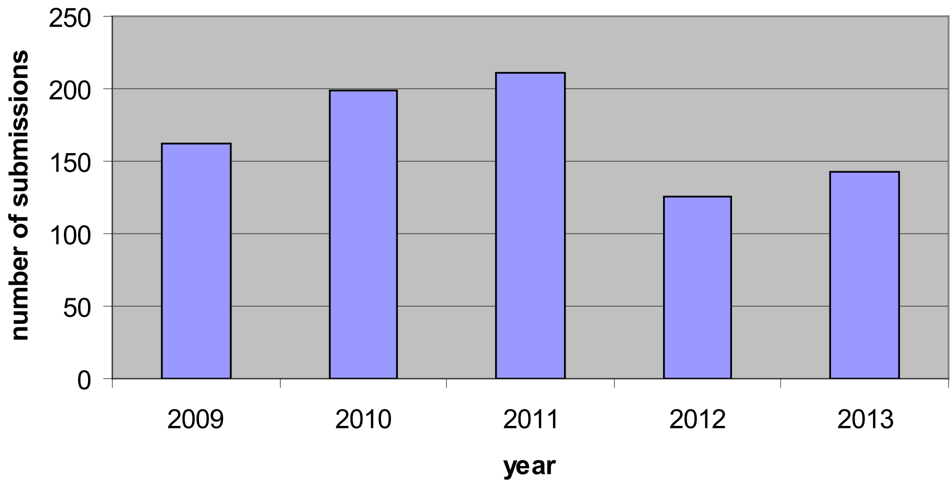

Figure 1. Number of cases submitted to CVL, Kenya from the year 2009 to 2013.

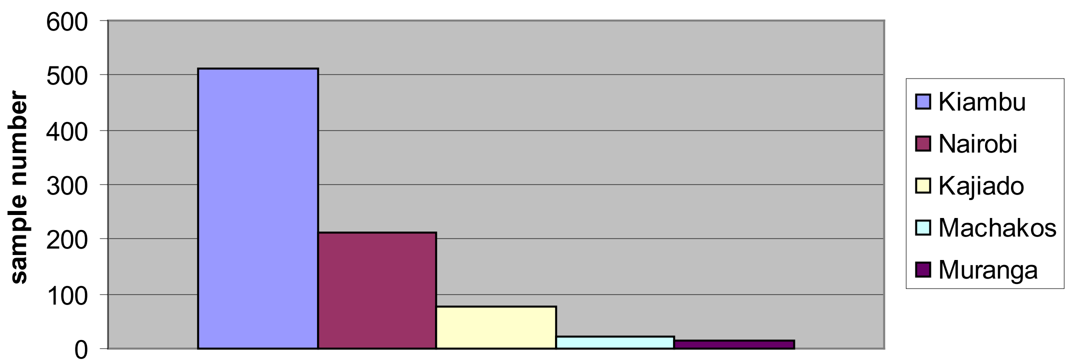

Figure 2. Number of samples received by CVL, Kenya according to county.

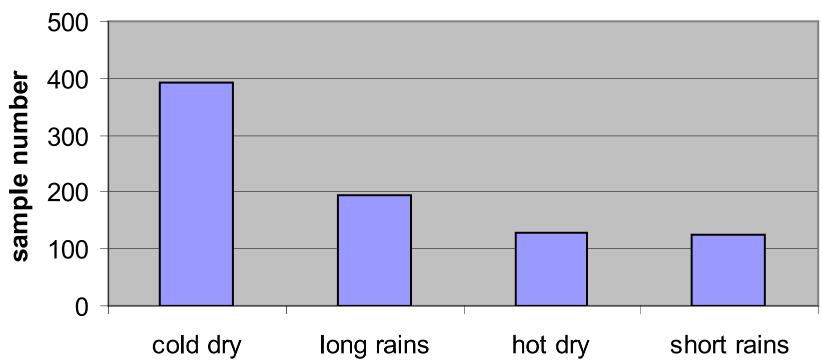

Figure 3. Number of samples received by CVL, Kenya according to season.

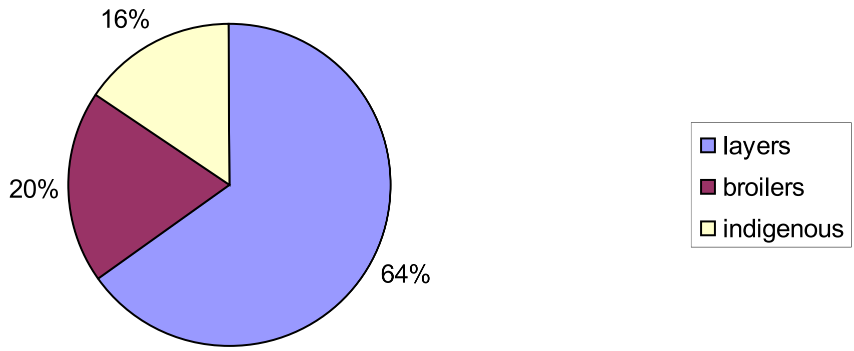

Figure 4. Percentage of poultry samples received by CVL, Kenya.

Table 1. Sample submission of flock types against flock sizes from 2009 to 2013.

Flock type	Submissions n (%)	Flocks<200 birds n (%)	Flocks >201 birds n (%)
Layers	546 (64.9%)	100 (18.3%)	446 (81.6%)
Broilers	164 (19.5%)	36 (22%)	128 (78%)
Indigenous/backyard	131 (15.6%)	100 (76.3%)	31 (23.7%)
Total	841 (100%)	236 (28.1%)	605 (71.9%)

Average flock size was 921 (95% CI [766, 1076]) birds per flock while the median flock size was 400 birds. The maximum number of birds in a flock was 30,000 birds (among layers) while the minimum were two birds from backyard flocks. Out of the 841 submissions, most samples (64.9%, n=546) came from layers while the least (15.6%, n=131) came from indigenous/backyard flocks. One hundred and sixty-four (19.5%) samples came from broiler farms (Figure 4).

Out of the 841 cases, the majority of cases (n=605, 72.1%) came from large flock farms (>201 birds) while the lowest number of cases (n=236, 28.1%) from small flock farms (<200 birds). Of the 546 layers, 18.3% (n=100) came from small flock-sized farms (<200 birds) while medium to large flock farms (>201 birds) submitted 81.6% (n=446) of the cases. Of the 164 broiler birds, 78% (n=128) came from medium to large flock farms while 22% (n=36) came from small flock farms. Among the 131 local breeds submitted, 76.3% (n=100) of birds came from small flock farms while 23.7% (n=31) came from medium to large flock farms (Table 1).

Prevalence of primary diseases

Infectious diseases

Majority of infectious diseases diagnosed were bacterial 45.2% (n=380, 95% CI [45.11%, 45.29%]) followed by viral diseases 26.5% (n=223, 95% CI [26.41%, 26.59%]) and the lowest were parasitic conditions 21.6% (n=182, 95% CI [21.52%, 21.68%]).

Bacterial conditions

Of the 380 primary bacterial conditions, *E. coli* infections were the most reported and was isolated from 303 (79.7%) of the cases. *Salmonella* was isolated in 10 (2.63%) of the cases. Other septicaemia-causing microbes (*Klebsiella, Staphylococcus* and *Proteus*) were diagnosed in 61 (16.1%) of the bacterial conditions.

Viral conditions

Of the 223 primary viral conditions, IBD (n=108, 48.4%) was the most reported followed by AL (n=101, 45.3%). Four cases of fowl pox (1.8%) and five cases of Mareks (2.2%) were diagnosed from gross pathological lesions.

Newcastle disease (n=5, 2.2%) was reported and one case was co-infected with IBD.

Parasitic conditions

Of the 182 primary parasitic conditions, coccidiosis cases (n=95, 52.2%) were the most reported followed by helminth infections (n=87, 47.8%).

Yeast infections

Yeast infections were diagnosed in four (0.5%) of the 841 cases.

Non-infectious conditions

Among the non-infectious conditions diagnosed (n=52, 6.2%), metabolic disorders (ascites) and nutritional deficiencies were reported in 76.9% (n=40) of the cases.

Cases of poisoning were detected in 9.6% (n=5) of the total cases while traumatic cases were detected in 7.7% (n=4) of the cases. Cancer 7.7% (n=4) cases were also reported.

Disease occurrence across production systems (flock type)

Across the five major diseases diagnosed, the majority of the cases where reported among layers (Table 2).

Disease occurrence across seasons

The cold and dry seasons reported the majority of cases across all five major diseases (Table 3).

Disease occurrence across years

Prevalence of *E. coli* infections declined gradually over the first 4 years (2009-2012) but cases began to increase from 2012 to 2013 (Figure 5). Across the years, there were minor variations in the prevalence of IBD and the major parasitic diseases, and hence tend to be endemic in nature. From 2012 to 2013, cases of AL declined.

Mixed infections

Of the 101 and 108 cases of AL and IBD respectively, 37% (n=37) of AL cases and 38%

Table 2. Distribution of major diseases diagnosed in poultry carcasses submitted for post-mortem at CLV, Kenya across production systems (2009 to 2013).

Primary disease	Layers	Broilers	Backyard/local	Total
Infectious bursal disease	66 (61.1%)	26 (24.1%)	16 (14.8%)	108 (100%)
Avian leucosis	84 (83.2%)	8 (7.9%)	9 (8.9%)	101 (100%)
Coccidiosis	65 (68.4%)	11 (11.6%)	19 (20.0%)	95 (100%)
Helminthosis	66 (75.9%)	1 (1.1%)	20 (23%)	87 (100%)
E. coli	186 (61.4%)	78 (25.7%)	39 (12.9%)	303 (100%)

Table 3. Distribution of major diseases occurring across seasons.

Primary disease	Hot dry (Jan/feb)	Long rains (Mar/Apr)	Cold dry (May-Oct)	Short rains (Nov/Dec)	Total
Infectious bursal disease	11 (10.2%)	34 (31.5%)	48 (44.4%)	15 (13.9%)	108 (15.6%)
Avian leucosis	22 (21.8%)	23 (22.8%)	44 (43.6%)	12 (11.9%)	101 (14.6%)
Coccidiosis	10 (10.5%)	25 (26.3%)	49 (46.3%)	12 (16.8%)	95 (13.7%)
Helminthosis	16 (18.4%)	11 (12.6%)	45 (51.7%)	16 (17.2%)	87 (12.5%)
Collibacillosis	46 (15.2%)	64 (21.1%)	144 (47.5%)	49 (16.2%)	303 (43.7%)

Table 4: Mixed infections for major diseases.

	Colibacillosis	Infectious bursal disease	Avian leucosis	Coccidiosis	Helminthiasis
Colibacillosis	117	40	37	93	82
Infectious Bursal Disease	40	28	1	23	14
Avian Leucosis	37	1	6	29	18
Coccidiosis	93	23	29	57	73
Helminthiasis	82	14	18	73	26

(n=40) of IBD cases were co-infections with *E. coli*. Of the parasitic conditions, 38% (n=93) of coccidiosis cases and 43% (n=82) of worm cases were co-infected with *E. coli* (Table 4).

Study population and poultry demographics

Out of the 841 case submissions reviewed, 64.9% (n=546) of submissions were layer birds. Of the 841 submissions, 51% (n=513) came from farms in Kiambu county.

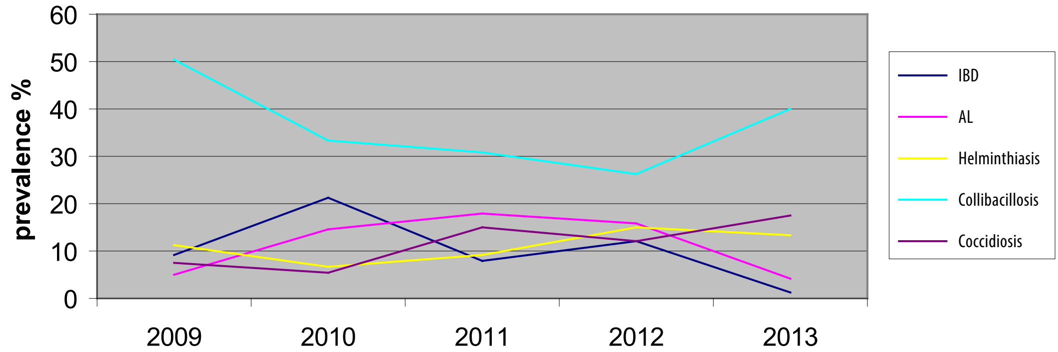

Figure 5. Prevalence of major diseases between 2009 and 2013.

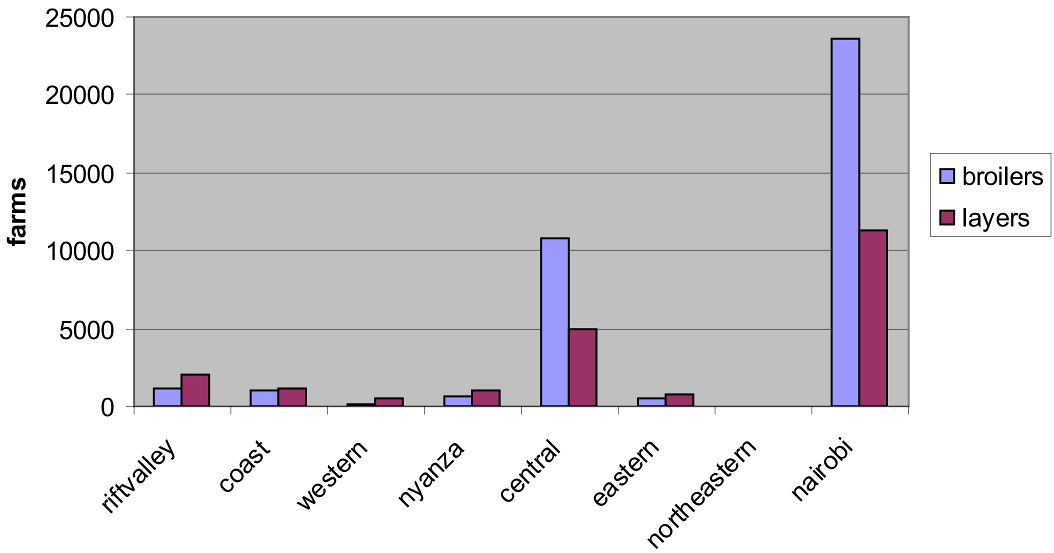

Figure 6. Geographical distribution of broiler and layer poultry farms in Kenya by Province.

These distributions are explained by the demographics of poultry farms in the country. Nyaga (2007) reported that Nairobi province had the highest number of broiler and layer farms at 23,661 and 11,311 farms respectively as well as the highest number of households (1,507,450) rearing local breeds. The province was followed closely with Central Province with 10,750 broiler farms, 4,900 layer farms and 115, 252 households rearing local breeds. North Eastern province had the least poultry populations with no broiler farms, 6 layer farms and 9,500 households rearing local breeds (Nyaga, 2007) (Figure 6).

Provinces were initially the administrative units but after the promulgation of the new constitution in 2008, counties became the administrative boundaries. As the capital city, Nairobi is the epicentre and main market for trade in poultry and poultry products from across the country. Historically, Nairobi and surrounding counties, i.e. Kiambu, Kajiado and Machakos counties, were associated with high poultry farming practices due to their proximity and ease of access to large markets. The majority of farmers in Nairobi and surrounding counties have commercialised their poultry production systems with many rearing layer and broiler flocks. This is confirmed by the 2014 livestock census by the Kenya National Bureau of Statistics and the Ministry of Agriculture, Livestock and Fisheries, stating that of the total population of 2,485,598 commercial birds within the four counties, Kiambu county has 67% (n=1,683,565) followed by Nairobi county with 13.8% (n=342,788), Kajiado county with 11.1% (n=276,291) and Machakos county with 7.4% (n=182,952) (KNBS, 2013).

Although Nairobi has the highest number of households rearing indigenous birds, the absolute numbers are low as most farms consist of small flock sizes. This is due to space limitations in urban areas since such birds are routinely reared under extensive free range production systems. Of the 2.2 million indigenous birds in the four counties, Machakos has the highest at 39% (862,590) followed by Kiambu with 36% (801,070) Nairobi with 12.6% (279, 397) and the lowest from Kajiado (12.1%, 267,913) (Figure 7).

The close proximity of urban and peri-urban farmers to the central veterinary laboratory and the relative high degree of specialisation among them may explain why these farmers are more likely to utilise diagnostic laboratory services compared to other farmers, in an attempt to optimise flock health and maximise profits.

Main causes of mortality in poultry samples submitted at the Central Veterinary Laboratory, Kabete.

Of the infectious conditions, bacterial diseases accounted for most (45%) of the cases followed by viral diseases (27%) and the least were parasitic diseases (22%).

The study not only highlighted some of the major diseases associated with poultry mortality in Nairobi and its surrounding counties but also confirms some of the significant poultry diseases routinely encountered by extension workers and reported in government annual reports.

Non-infectious conditions that included metabolic disorders and nutritional deficiencies were also noted in 52 (6.2%) of the cases but tend to cause mortalities singly. They may also involve immuno-suppressing birds which predisposes birds to co-infections.

Bacterial Diseases

Colibacillosis

Of the bacterial diseases, the most common was *E. coli* isolated in 80% of the cases. Virulent strains of *E. coli* (sero-types O1, O2, O78), also known as avian pathogenic Escherichia coli (APEC), are the causative agents of colibacillosis in poultry.

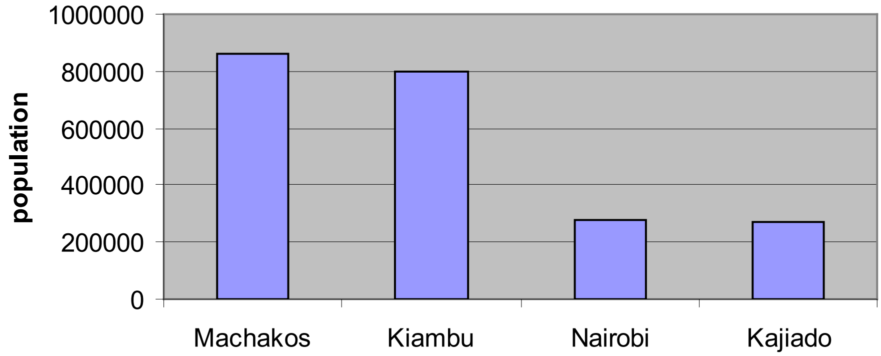

Figure 7. Indigenous poultry population in four counties.

These findings are in agreement with other studies where colibacillosis is the principal cause of morbidity and mortality associated with heavy economic losses to the poultry sector globally (Lutful Kabir, 2010).

A study on the major causes of mortality in poultry in Nairobi and its environs (Maingi and Shepelo, 2014) revealed that bacterial septicaemias and egg peritonitis were among the leading causes of mortality in layers flocks from Nairobi and Kiambu counties. Studies have also reported that *E. coli* has detrimental effect on the poultry industry, acting both as a primary or secondary pathogen. Of the 101 and 108 cases of AL and IBD respectively, 37% of AL cases and 38% of IBD cases were co-infections with *E. coli*. Of the parasitic conditions, 38% of coccidiosis cases and 43% of worm cases were co-infected with *E. coli*. Apart from its economic impact in the poultry sector, *E. coli* are zoonotic and of great public health concern.

Other microbes of the family Enterobacteriacea, i.e. *Klebsiella* and *Proteus,* were isolated from 16% of the cases. A study on the isolation of enterobacteria in broiler carcasses from commercial establishments in Fort Aleza, Brazil revealed that all broiler carcasses were contaminated with bacteria of the family Enterobacteriacea of which *Proteus* and *Klebsiella* were isolated from carcasses at frequencies of 66% and 11.8% respectively (Cardoso *et al.,* 2006). Their presence is an indicator of poor hygiene and faecal contamination during handling either for examination, slaughter or processing.

Viral Diseases

Infectious Bursal Disease

Infectious bursal disease (IBD) was the most reported viral disease accounting for 48.4% of the cases. IBD is a highly contagious global disease that poses serious threat to the profitability of poultry farms. The disease was first encountered in Kenya in 1991 (Mutinda *et al.,* 2013) however there is a paucity of epidemiological studies of IBD in Kenya (Githinji *et al.,* 2016). Despite such challenges IBD is still considered a prevalent disease among poultry in farms in Kenya (Githinji *et al.,* 2016) and many farmers have abandoned poultry farming after experiencing its devastating effects. The viruses is not only associated with high mortalities but immune-suppression rendering birds susceptible to other opportunistic infections and vaccine failures.

Avian Leucosis

Avian leucosis (AL) was reported in 45.3% of cases. Information on AL infections in Kenya was lacking until 2015 where a prospective study from 2003 to 2012 estimated sero-prevalences of 1.4% and 13.3% in 2003 and 2012 respectively among poultry flocks in Nairobi county and environs (Miheso, 2015). However it was postulated that this apparent increase was from the change of diagnostic approach from a clinical and pathological approach to the current ELISA serological tests which have sensitivity and specificity values of 99% and 100% respectively (Miheso, 2015)

Of the 101 cases reported, 5% were detected among broiler birds and 3% of these cases in birds <16 weeks old. Infection in broilers and young birds is suspected to be from vertical transmission from infected parent stock or from administration of contaminated vaccines routinely manufactured from chick embryos (Miheso, 2015). Currently there is neither known vaccine nor effective therapeutic protocol. Disease prevention and control depends on bio-security and breaking both the vertical transmission routes in breeding stocks by culling transmitter birds and the horizontal transmission by culling shedders (Miheso, 2015).

Parasitic Diseases

Coccidiosis

Coccidiosis was the most reported parasitic disease. Coccidiosis affects poultry globally and is estimated to cost the poultry sector about 2.4 billion dollars every year with regards to disease treatment, control and prevention (Zhang *et al.,* 2013). Eimeria oocysts are ubiquitous and almost always present where poultry are reared (Zhang *et al.,* 2013).

Use of coccidiostats in feeds has significantly reduced the incidence of severe clinical coccidiosis however prevalence of sub-clinical infections have increased and so is its impact (Zhang *et al.,* 2013).

Sub-clinical infections reduce productivity and immuno-suppression in the birds, thereby rendering them prone to vaccination failures and susceptibility to other infections such as colobacillosis and Mycoplasmosis (Zhang *et al.,* 2013.). Out of the 240 pure and mixed coccidiosis cases, about 40% of the infections were co-infected with *E. coli.*

Helminthiasis

Helminths were the second most reported parasitic diseases. Helminthiasis is a constraint to poultry farmers globally (Sundar *et al.,* 2015). *Ascaridia galli* and *Heterakis gallinarum* are the most prevalent species. These is in agreement with several studies that nematodes and, in particular, the common poultry round worm *(A. galli)* and *H. gallinarum* are the most prevalent worms affecting poultry across all production systems and breed (Kahn and Line, 2005). *A. galli* infestation reduces productivity by reducing weight gain and egg production. They are also known to immuno-suppress birds and render them susceptible to other infectious diseases such as Newcastle disease (Pleidrup *et al.,* 2014). A study on the influence of immune response after early vaccination with Newcastle disease showed that birds infected with A. galli had lowered humoral and cell mediated immune response and less antibody titers compared to worm free controls which elicited high antibody titres (Pleidrup *et al.,* 2014). Out of the six cases of Newcastle disease, 50% were co-infected with helminths. *Heterakis* worms can also transmit the protozoa *Histomonas meleagridis.*

Limitations

The over representation of layer birds from Kiambu county farms may have biased some findings.

CONCLUSION

Colibacillosis is major bacterial disease among poultry flocks in Nairobi and its environs. IBD is the most significant viral infection followed closely by AL. Of the parasitic diseases, coccidiosis was the most important followed by helminthiasis. *Ascaridia* and *Heterakis* species were the most reported worm types and most diseases reported had presented as co-infections with multiple pathogens.

Despite the Central Veterinary Laboratory being a National Laboratory, the majority of poultry farmers utilising its services were farmers from Nairobi county and its environs (Kiambu, Kajiado and Machakos counties). There is need to sensitise and create awareness among farmers and animal health workers to utilise such laboratory services to confirm the diagnosis of poultry diseases. This is because misdiagnosis could arise from observing clinical signs alone. In isolation of other diagnostic tests, misdiagnosis may lead to increase losses, and waste of money and resources due to the purchase of wrong drugs, the implementation and adoption of inappropriate control strategies and creating unwarranted public alarm.

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