Performance of three local chicken ecotypes of Ghana naturally exposed to velogenic Newcastle disease virus

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Summary

This study was to evaluate the performance of three Ghanaian local ecotypes that were exposed to a natural velogenic Newcastle Disease Virus (NDV) challenge. The birds at four weeks of age had been challenged with a lentogenic (vaccine) form of the virus and later exposed to velogenic NDV when their anti-NDV antibody titres had fallen below 1000. All the birds lost weight over the 21 days of exposure to the virus, with the Coastal Savannah ecotype showing the fastest weight loss albeit not significant ($p>0.05$). Lesion scores for all ecotypes were low and similar across ecotypes suggesting that the challenge was not severe. Heritability was zero for the lesion scores and low (0.01) for post-challenge growth rate across ecotypes. Hence, not much progress can be made in selection to improve post infection growth rate.

Keywords: local chicken ecotype, Newcastle disease virus, velogenic, performance

Introduction

In Africa, local chickens make an important contribution to the livelihoods of smallholder families who form the majority of rural and peri-urban dwellers. In Ghana, the local chicken population is estimated to be 25 million constituting 60-80% of the total chicken population in the country (MOFA, 2007; FAO, 2014). They serve as vital socio-economic assets, providing resource-poor peasant farmers with an important means of sustenance in the form of meat and eggs, as well as fulfilling financial exigencies and socio-cultural needs (Naazie *et al.*, 2007). These chickens are mainly raised under scavenging, low input-output production systems and have not been subjected to formal selection for any commercial production traits (Kayang *et al.*, 2015). Consequently, local chickens possess unique adaptive traits that permit them to thrive under such typically harsh climatic, nutritional and management conditions (Mwacharo *et al.*, 2006). Improving local chicken production has therefore been recognized as the key to better livelihoods especially for women and children, who are usually involved in rearing these chickens.

Local chicken production however faces significant threats through disease outbreaks, with Newcastle disease (ND) being the predominant and most devastating in Africa. In Ghana, 80% of homestead chicken is lost annually to this disease (Awuni, 2002), causing hardship to the resource-poor producers. The disease is caused by virulent strains of avian

paramyxovirus Type 1 (APMV-1) belonging to the genus *Avulavirus* in the family *Paramyxoviridae* of the order *Mononegavirales* (Alexander & Jones, 2000). Based on the severity of the disease in chickens, Newcastle disease virus (NDV) is categorized into several pathotypes including asymptomatic enteric (avirulence), lentogenic (low virulence), mesogenic (intermediate virulence), and velogenic (high virulence) (Alexander & Jones, 2000). The velogenic and mesogenic strains are responsible for ND outbreaks in many countries while the avirulent strains have been used as live vaccines to control the disease.

Despite the availability of inexpensive and effective vaccine to protect chickens against ND in Africa, the level of routine vaccination required to prevent the disease in smallholder farms is often not sustained. Furthermore, due to inadequate agricultural extension services, lack of cold storage to maintain the viability of the vaccine, and unreliable production and distribution systems, many efforts to implement ND vaccination programmes in Africa have been futile. However, with substantial evidence suggesting the existence of genetic variations in the susceptibility of chicken to NDV (Lamont, 1989; Adeyemo *et al*., 2012), an important complementary control strategy is genetic selection. This study was thus designed to determine the performance in terms of growth and severity of lesions in three local chicken ecotypes of Ghana naturally exposed to velogenic NDV, as part of a wider study aimed at developing a genomic tool to select and breed resistant chickens for smallholder farmers.

Materials and methods

Chicken populations

Mature local chickens were sampled from three major agro-ecological zones of Ghana corresponding to the three ecotypes, namely, Interior Savannah (IS), Forest (FO) and Coastal Savannah (CS). The sampling zones are described by Kayang *et al.* (2015). The chickens were grouped into pens comprising 25 sire half-sib families per ecotype with a mating ratio of 1 male to 8 females, to serve as the parental breeding flock for the experimental populations. Fertile eggs were hatched and the chicks transferred to a biosecure facility for lentogenic (vaccine) NDV challenge trials at four weeks of age following which they were relocated to another facility for natural exposure to velogenic NDV.

Natural exposure to velogenic NDV

Replicates of chickens previously challenged with lentogenic (vaccine) NDV were placed in the natural exposure trial facility and screened by ELISA to ensure that average anti-NDV antibody titres were below 1000. Sick chickens exhibiting clinical signs of ND were sourced from local bird markets or village farms and oropharyngeal swabs obtained and screened to confirm the presence of velogenic NDV using RT-qPCR. Tests were also done to rule out avian influenza virus. The sick chickens were mixed with naïve chickens in a biosecure enclosure for three days to increase the number of infected chickens after which the sick birds were distributed among the healthy chickens awaiting the trial in a ratio of 1: 50. Two trials each lasting 21 days were conducted, with the first involving replicates 1, 2 and 3 and the second involving replicate 4.

Data collection

Body weights were recorded on all chickens immediately before the trial, every three days during the trial and at the trial end point. Mortality was monitored three times a day to record dead chickens' IDs and the date and time of death. At the end of the trial all surviving birds were euthanized and post-mortem examinations conducted to score for hemorrhagic lesions in the trachea, proventriculus, intestines, and caecal tonsils. The lesions were scored on a scale ranging from 0 (no lesions) to 4 (extremely severe).

Data analysis

Variance components and LS means for post-natural NDV exposure growth rate and average lesion score were estimated using animal models implemented in ASReml4. We did not analyse survival days because there was no variation in the trait. We used two models for the traits, one with a dam effect included and the other without. We corrected for the random effect of dam, and systematic effects of ecotype, replicate, sex, challenge and pen. A genomic relationship matrix was used for the random bird effect.

Results and Discussion

Post-natural NDV exposure growth rate and lesion scores

The post challenge growth rates of birds from the three ecological zones are shown in Table 1. Birds of all ecotypes lost weight post-challenge with the Coastal Savannah ecotype losing more weight than the Forest and Interior Savannah ecotypes. The exposure to the ND virus was therefore severe enough to negatively affect weight gain. However, the changes in weight were not statistically significant ($p>0.05$). Means for lesion scores were generally similar and less than 1.0 indicating that, overall, the challenge had minimal impact on tissues. Perhaps, the birds had some residual resistance as a result of the lentogenic challenge to which they were earlier exposed.

Table 1. Least square means for post-challenge growth rate and lesion scores in Ghanaian local chicken ecotypes

Ecotype	Growth Rate (g/day ± SE)	Lesion Score (± SE)
Interior Savannah	-7.80 ± 1.43	0.94 ± .04
Forest	-7.20 ± 1.43	0.91 ± .04
Coastal Savannah	-8.60 ± 1.62	0.94 ± .05

Genetic parameters

The variance components for the post challenge growth rate and the lesion scores for all birds across ecotype are presented in Table 2. No additive genetic variance could be obtained for lesion score, perhaps because the lesions were not severe and so differences were minimal. Heritability for post-challenge growth rate was low.

Table 2. Variance components and heritability estimates for post-challenge growth rate and lesion scores in Ghanaian local chicken ecotypes.

Trait	N	Variance Component			h^2
		σ_a^2	σ_e^2	σ_p^2	
Post-challenge growth rate	662	1.79	137.40	150.45	0.01± 0.09
Lesion ccore	659	0.00	0.17	0.17	0.00 ± 0.00

Number of records. σ_a^2: additive genetic variance. σ_e^2: environmental variance. σ_p^2: phenotypic variance.

Conclusion

Ghanaian chicken ecotypes experience negative growth rates after being exposed to velogenic NDV. The heritability for post-infection growth rate is low and, hence, not much progress can be made in selection to improve this trait.

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