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EVALUATION OF THE GROWTH AND CARCASS YIELD CHARACTERISTICS OF CROSSBRED NAKED-NECK AND FRIZZLE COCKEREL PHENOTYPES REARED UNDER HOT AND HUMID ENVIRONMENTS

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ABSTRACT

An experiment was carried out to evaluate the growth and carcass yield of four crossbred F_3 naked-neck and frizzle cockerel phenotypes. These crossbred third generation cockerels were generated from a successive generations of reciprocal crossing between crossbred heterozygous naked-neck (50% indigenous naked-neck and 50% Lohman Brown) and frizzle (50% indigenous frizzle and 50% Lohman Brown) stocks. Two hundred and forty (240), two-week old cockerels, sixty (60) each of the four phenotypes were randomly assigned to a CRD experiment with three replicates for a period of up to 14 weeks. The selected cockerels were put in a partitioned open-sided deep-litter house, with 20 birds in each compartment and provided with broiler chick and layer grower mash *ad lib* during the brooding and growing stages, respectively. Results obtained showed no significant phenotype effect on day-old body weight, however, the naked-neck and frizzle phenotypes consumed significantly more feed and were more feed efficient after four weeks onwards. Results from carcass yield also showed a significant gene effects with cockerels expressing the naked-neck and frizzle traits in the double heterozygous state producing significantly higher meat yield than their single heterozygous sibs with the latter also producing higher meat yield than their normally feathered sibs. It was concluded that there is positive interactive effects between the naked-neck and frizzle genes evidenced by the superior performance of the naked-neck and frizzle phenotypes as compared to their normally feathered sibs.

Keywords: cockerels, crossbred, frizzle, genes, phenotype, naked-neck, normal.

INTRODUCTION

Although, the indigenous village chicken is the most prominent class of livestock in the country and constitutes about 60-80% of the total poultry population, (Aryee and Kutame, 1991), their productivity levels are low because of poor nutrition and low genetic potential. In an effort to address the problem of low productivity in local chickens, high-yielding exotic breeds have been introduced through cockerel exchange programme by the government. This intervention is bedevilled with many challenges; prominent among them is the birds' inability to adapt to the hot and humid environment, resulting in reduced feed intake and retarded growth (Cowan and Michie, 1988). A number of major heat-tolerant genes or gene complexes like naked-neck, ptylopody, polydactyly and frizzle have been identified in the genome of Ghanaian local chicken populations (Hagan, 2010). These unique genes have been reported to ameliorate tropical heat stress and enhance the performance of chickens under hot and humid environments (Hernandes *et al*., 2002 and Cahaner *et al*., 2008). The presence of the naked-neck gene results in 20-30% less feather coverage overall, with the lower neck of the bird appearing almost naked while the frizzle gene on the other hand is reported to reduce the insulating properties of the feather cover (reduce feather weight) and make it easier for the bird to radiate heat from the body, (Horst and Mathur, 1992).

A breeding programme aimed at developing a locally highly productive chicken breed in the country using naked-neck and frizzle genes is underway at Akate Farms in Kumasi, Ghana (Hagan, 2010). Efforts are being made to develop the male chicks (which were hitherto destroyed after hatching) into easily managed and less expensive meat type chickens, which could be used to complement the government efforts of giving rural farmers improved cockerels to rear so as to increase their protein intake, ensure food security and also to provide employments. Cockerel (the egg type male chicks) rearing is fast becoming an indispensable component of family poultry development with the rapidly increasing trends of commercial layer farming. Meat from cockerels is preferred to broilers because it is tastier than that of broilers (Huque *et al*., 2004). Again, cockerel production and management is easier than broiler production particularly in the rural areas where modern facilities including electric supply are not available. Consumers' choice, lower chick price, lower mortality and morbidity, lower management cost, lower initial investment, better market demand, low abdominal fat, less disease susceptibility, more organoleptic preference, family labor utilization and easy management are the strategic advantages for cockerel rearing in family poultry farming (Huque *et al*., 2004). The objective of this work was therefore to study the growth performance and carcass yield of four developed crossbred cockerel naked-neck and frizzle phenotypes.

METHODOLOGY

Experimental population

There is an on-going breeding work at Akate Farms aimed at developing a local experimental cockerel population which is fast growing and inherent with the thermo-regulatory genes (naked-neck and frizzle). The programme is necessitated by the popularity of meat from cockerels and the government policy of distributing cockerels to local farmers to keep at their backyard to increase their protein intake and supplement their income. The cockerel populations used in this experiment were the offspring of Lohmann Brown (Holland Strain) commercial dam line and local heterozygous naked-neck and frizzle sire lines. The local heterozygous naked-neck and frizzle sire lines were crossed with the dam lines of commercial Lohmann brown (exotic breed used by most farmers) strains as an exotic normally feathered highly egg-producing strains. The F_1 crossbred (naked-neck and frizzle) were crossed inter se. At the end of the third generation, four main phenotypes, namely: combined naked-neck frizzle, naked neck only, frizzle only and normally feathered birds were obtained. The male chicks generated from the cross are being developed into fast growing meat type chickens and were therefore used for this study.

Study site

The experiment was carried out at Akate Farms located at Antoa in the Ashanti region of Ghana. The experimental area lies in the transitional forest zone and is between latitude 6.35^0 and 6.40^0 and longitude 1.30^0 to 1.35^0, with an elevation ranging between 250-300m above sea level. The average minimum temperature is about 21.5^0C and a maximum average temperature of about 32.5^0C. The average humidity in the study area is 84.16% at 0900GMT and 60% at 1500GMT. The double maximum rainfall is about 214.3mm in June and 165.2mm in September.

Management of the crossbred phenotypes

During the first two weeks at the brooder house, the chicks were individually weighed using an electronic sensitive top-loading balance of 2kg capacity and readability of 0.01g. After two weeks when they had developed enough feathers for ease of identification into the various phenotypic groups, they were separated into the four main phenotypic groups: naked-neck only, frizzle only, naked-neck frizzle and normally feathered. The classification was done according to the morphological expression of the naked-neck (Na) and frizzle (F) genes. Birds without any expression of the major genes were classified as normally feathered (na/naf/f). The room temperature during the first day of brooding was kept at 34^0C and gradually reduced to 32^0C and to 30^0C during the brooding period. The average minimum and maximum room temperatures recorded during the growing period were 21.3^0C and 31.8^0C. Plastic chick drinkers and wooden feeders were used to provide water and feed *ad lib* during the brooding period. They were fed with chick mash containing 18% crude protein and 3000 Kcal/kg metabolizable energy.

In all, there were three brooder houses, each partitioned into four for the four groups. After 5 weeks of brooding, they were moved from the brooder house and kept in partitioned open-sided deep-litter pens with 20 cockerels in each compartment. The crossbred phenotypes were fed grower mash containing 15% crude protein and 2650 (Kcal/kg) metabolizable energy. The feed and water were supplied *ad lib*. There were 12 hours of natural light which was supplemented with artificial lighting throughout the experimental period. This enabled the cockerels to eat during the night. All the necessary prophylactic measures were followed. The chicks were vaccinated against Newcastle disease during the second and fourth weeks of rearing while Gumboro vaccine was administered in the third and fifth weeks. Coccidiostat (Amprolium) was also administered through the drinking water bi-weekly. The phenotypes were reared under the same environmental, managerial and hygienic conditions. Care was taken to reduce feed wastage to the barest minimum by using the hanging fountain type of feeders.

Experimental design

Two hundred and forty (240), two-week old cockerels, 60 each of the four phenotypic groups were randomly assigned to a Completely Randomized Design (CRD) experiment for a period of up to 14 weeks. The experiment was carried out from October, 2010 to January, 2011 at Akate Farms in Kumasi, Ghana.

Data collection and statistical analysis

The body weight, feed intake and carcass yield of the four phenotypes were taken weekly. With these, the growth rate, weight gain and feed conversion ratios were derived. Body weights (g) were taken at day old and weekly thereafter. The data collection and analysis were done in two phases, brooding phase (week 1-5) and growing phase (week 6-14). The rearing phase mortalities were also recorded for the various phenotypic groups. Weight gain was determined as the difference between the final and initial body weight. Growth rate was therefore calculated as the weight gain divided by age of the bird. From the apparent feed intake values obtained, and the relevant weight gains, the feed conversion ratio was estimated. At the end of the 14 weeks, five cockerels from each of the four groups were randomly selected and slaughtered for carcass parameters.

Before slaughter the cockerels were deprived of feed but not water for 10 hours to ensure easy evisceration procedure and also to know their actual live weights. The birds were weighed before slaughter and weighed again after bleeding to determine blood weight by difference. Feathers were manually plucked after scalding in hot water, air dried and weighed. The carcasses obtained after defeathering, evisceration and removing the head, neck and the GIT, were weighed. The carcass, thigh, wing and breast were expressed as a proportion of the live body weight.

The data obtained were subjected to one-way analysis of variance with phenotype effect using the General Linear Model (GLM) procedure of the GenStat (Discovery Edition 4). When significant differences among means were found, means were separated using least significant difference (lsd) test. The linear model below was used for the data analysis.

$$Y_{ij} = \mu + g_i + \varepsilon_{ij}$$

Where
Y_{ij} = Performance of the jth cockerel of the ith phenotypic group
μ = Overall general mean common to all observations
g_i = Fixed effect due to ith phenotype (i = 1, 2, 3, 4)
ε_{ij} = Random error effects peculiar to each observation

RESULTS AND DISCUSSIONS

The growth chart of the four phenotypes is presented in Figure-1. It could be seen that all the phenotypes were similar in growth during the first five weeks of growth. This might be due to the fact that at that age the phenotypes had not developed enough feathers to realize the full benefits or potential of the thermoregulatory genes (Gowe and Fairful, 1995). The crossbred day-old chicks in this present study (Table-1) were heavier than day-old chicks of some developed local breeds like Fayoumi (29.9g) (Katule and Mgheni, 1990). The observed overall mean hatching weight and the overall mean body weights of the four phenotypes at all ages in this study were better than those reported for indigenous chickens of similar ages and under similar management in the tropics (Fayeye *et al*., 2005; Halima *et al*., 2006). The weights were comparable to some selected commercial crossbred indigenous Creole chickens (Segura-Correa *et al*., 2005) and crosses between Egyptian local and European breeds (Saadey *et al*., 2008). The average chick weights of the crossbred chicks in this present study were also comparable to other crossbreeds (Iraqi, *et al*., 2002 and Azharul, *et al*., 2005) and strains of commercial layers reported by Ojedapo *et al*. (2008). This positive phenomenon might be harnessed to develop the birds into broilers in the future.

At five weeks and beyond (Table-1) when the chicks had developed enough feathers, the naked-neck and frizzle phenotypes began to reach their full genetic potential for growth as evidenced by the significantly ($P<0.05$) higher body weight as compared to the other phenotypes. This is due to heavier body weights and faster growth rates associated with naked-neck and frizzle genes.

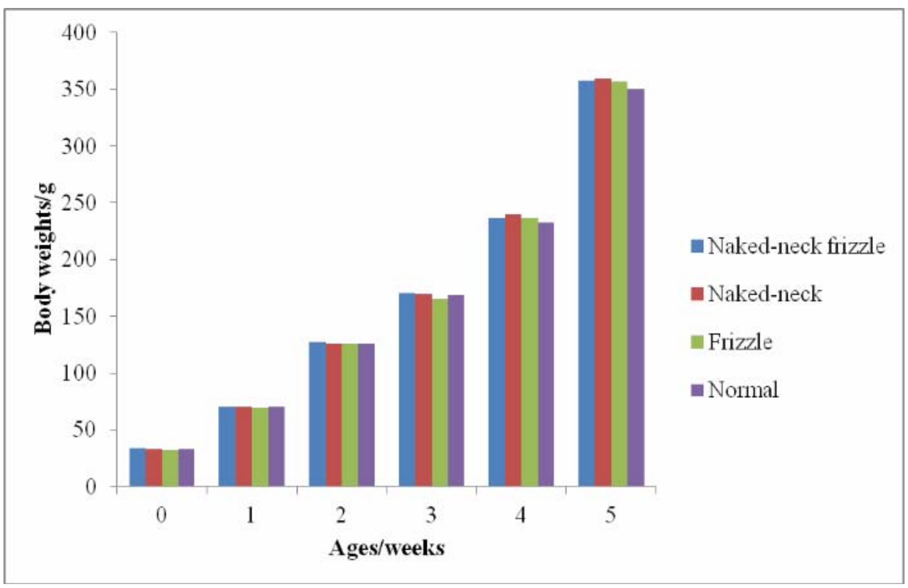

Figure-1. Body weights of the four crossbred cockerel phenotypes during the brooding stage.

With respect to feed consumption during the first five weeks of rearing, there was no significant difference among the four phenotypes. There was however significant ($P<0.05$) phenotype effects on feed intake after five weeks of age, with the naked-neck frizzle phenotypes consuming significantly more feed than their normally feathered sibs and also being more feed efficient and achieved significantly heavier body weight. This confirms the assertion that the genes are associated with better feed conversion (Horst, 1999; Cahaner *et al*., 2008 and Mahrous *et al*., 2008). Recent studies on the incorporation of naked-neck and frizzle genes into broiler lines showed superiority of naked-neck and frizzle broiler lines over normally feathered counterparts in terms of growth, feed efficiency, dressing percentage and other important traits (1996; Ibe, 1993 and Younis and Cahaner, 1999). The outstanding performance of the naked-neck and frizzle phenotypes seems to suggest that these genetic groups

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were better adapted to hot and humid tropical production environment than their normally feathered sibs. This supports the reports of Nwachukwu *et al*., 2006; Younis and Cahaner, 1999 and Mahrous *et al*., 2008 that crossbred birds with the heat-tolerant traits achieved greater efficiency of thermoregulation than birds without the genes. This is due to the greater surface area exposed to the atmosphere which enhances rapid heat dissipation in naked-neck and frizzle birds. The implication is that crossbred naked-neck and frizzle cockerels could be developed in future into tropical meat-type (broiler) chickens since they can consume and convert feed efficiently under high ambient temperatures as can be seen in this study.

The naked-neck and frizzle genes either singly or in combination have been shown to confer consistent superiority in body weights, feed conversion, egg production and disease resistance at moderate (25^{0}C) to high (32^{0}C) ambient temperatures (Mahrous *et al*., 2008). The superior performance at high ambient temperatures is as a result of their ability to dissipate heat by convection, making naked-neck and frizzle birds suffer less from heat stress than their normally feathered counterparts (Yahav *et al*., 1998; Adedeji *et al*., 2006). Again, under hot and humid environments, naked-neck and frizzle phenotypes would conserve and channel the energy that would otherwise have been used to dissipate heat to productive functions like growth, thereby making them grow faster and increase in weight (Yalcin *et al*., 1997; Patra *et al*., 2002).

In terms of mortality, there was no significant genotype effect. Post-mortem results on dead birds however did not show any signs of infection. According to Merat (1990) the naked-neck and frizzle genes are most useful at high ambient temperatures of 30^{0}C and above where most of the advantages like higher growth rate, higher feed efficiency, slaughter yield and meat yield became pronounced. Horst (1989) also reported that the *Na* and *F* genes interacted well to improve the performance of stocks reared under heat stress. Most of the deaths were as a result of cockerels fighting and causing injuries resulting in death.

Table-1. The performance of the four crossbred cockerel phenotypes at different ages.

Parameters	**Cockerel Phenotypes**				
	Naked-neck frizzle	**Naked-neck**	**Frizzle**	**Normal**	**±SEM**
BW at day-old/g	33.5	33.2	32.5	33.1	0.14
BW at 5 weeks/g	357.3^a	359.3 ^{a}	356.8^a	350.2^b	0.39
WG (1-5 wks)/g	324.4^a	326.5^b	324.6^b	317.5^c	0.34
TFI (1-5wks)/g	790.9	791.7	788.1	790.5	0.22
FCR (1-5wks)	2.2^c	2.4^b	2.4^b	2.6^a	0.05
BW at 6 weeks/kg	542.7^a	544.6^a	542.2^a	536.6^b	1.1
BW at 14 weeks/g	1,605^a	1,411^b	1,410^b	1,305^c	6.49
WG (6-14wks)/g	1063.5^a	866.6^b	868.1^b	768.7^c	0.30
TFI (6-14 wks)/g	2,566.1^a	2,497.3^c	2,497.1^c	2,501.2^b	4.29
FCR (6-14 wks)	2.4^c	2.9^b	2.9^b	3.3^a	0.10
Mortality (1-14)/%	2.6	2.2	2.8	2.3	0.30

Means in a row with different letters are significantly different at the 5% level
BW = body weight; WG = weight gain; TFI = total feed intake; FCR = feed conversion ratio

The presence of Na and F alleles in both single and double heterozygous state significantly increased relative blood weight compared to their sibs which were double recessive for the genes (Table-3). Higher blood volume associated with birds carrying naked neck and frizzle genes might be due to higher haemoglobin concentration and packed cell volume associated with these genes (Luger *et al*., 1998; Raju *et al*., 2004) as a consequence of greater oxygen demand. Also, the higher blood proportion associated with these genes may increase blood supply to organs and muscles. The effects of naked-neck and frizzle genes on feather distribution and feather structure were clearly established in this present work. The results obtained showed that the genes either in single or double segregation state significantly reduced feather coverage compared to normally feathered counterparts. This reduced feathering is advantageous in facilitating better heat dissipation and tolerance to low protein diet. The insignificant ($P<0.05$) difference between the single heterozygous and the normally feathered cockerels in terms of carcass yield was in contrast with findings of Merat (1990) and Galal and Fathi (2001) who found gains of 1.5-2.0 percent to 2.5-3.0 percent for Na/Na and Na/na as against their normally feathered.

The higher ($P<0.05$) meat/carcass yield (carcass weight, breast, leg and thigh) observed in the crossbred double heterozygous confirm the findings of Younis and Cahaner (1999) and Galal *et al*. (2007) that combining the naked-neck genes with another heat-tolerant gene like frizzle resulted in a very favourable additive effect on both productive and carcass yield characteristics. The higher dressing percentage might be attributable to the higher body weight and less losses due to the reduced feathers in the naked-neck and frizzle phenotypes. The mechanism involved in higher meat yield in chickens with reduced plumage, according to Merat (1990) are: less feather production leaving more protein for synthesis of other tissues (muscle/meat), more rapid dissipation of heat resulting in less appetite depression and consequently better growth under high ambient temperature, and lower carcass fat content resulting from higher proportion of lipids being used for thermo-regulation.

Table-2. Mean carcass parameters of the crossbred cockerel genotypes.

Parameters	Cockerel Phenotypes				
	Naked-neck frizzle	Naked-neck	Frizzle	Normal	±SEM
Percent blood/%	11.7[a]	11.3[a]	11.5[a]	8.7[b]	0.30
Percent breast/%	16.3[a]	14.1[b]	13.7[b]	12.9[b]	0.63
Percent leg/%	5.1[a]	4.0[b]	3.9[b]	3.8[b]	0.34
Percent wing/%	10.3	10.1	10.2	9.9	0.29
Percent thigh/%	28.5[a]	27.3[b]	27.5[b]	27.0[b]	0.26
percent feather/%	12.3[b]	14.5[a]	14.1[b]	14.7[a]	0.42
Dressed wt/g	1051.2[a]	981.8[b]	987.1[b]	975.7[b]	5.45
Dressing percent/%	74.48[a]	71.50[b]	72.11[b]	71.95[b]	0.40
Live weight/g	1445.6[a]	1405.5[b]	1410.1[b]	1395.0[b]	7.88

Means in a row with different letters are significantly different at the 5% level

CONCLUSIONS

From the results of the study it could be concluded that the phenotypes showing the genes in the double and single heterozygous states were superior in growth and carcass yield parameters studied as compared to their normally feathered sibs, even under moderately warm environments. The positive interactive effect existing between the naked-neck and frizzle genes could therefore be harnessed by using the genes in combination in chicken development programmes under hot and humid environments. The high growth rate seen in the crossbred cockerels could also be harnessed by developing the cockerels into easily managed and less expensive meat-type chickens.

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