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Effects of the naked neck phenotype and feed withdrawal on growth performance and carcass characteristics of F1 crossbred broilers from a cross between local naked neck males and Hubbard Flex 15 broiler females

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An eleven-month experiment was conducted to establish the influence of phenotype and feeding systems on growth performance and carcass characteristics of F1 crossbred broilers. One hundred normal feathered broiler breeder females were mated with 10 naked neck males to obtain the F1. Two hundred and seventy-two chicks obtained from the F1 generation and from four hatches were randomly assigned into four treatments (naked neck full feeding, naked neck feed withdrawal, normal feathered full feeding and normal feathered feed withdrawal) in an RCBD 2 × 2 factorial arrangement and studied for 12 weeks. The naked neck broilers had superior ($P < 0.05$) weight and better feed conversion compared to their normal feathered counterparts. Chickens on full feeding had higher ($P < 0.05$) feed intake in comparison to their counterparts on feed withdrawal. Normal feathered birds had higher ($P < 0.05$) average rectal temperature compared to the naked neck ones. Mortality was lower ($P < 0.05$) in naked neck birds compared to their normal feathered siblings. Birds on feed withdrawal had higher ($P < 0.05$) average rectal temperature in contrast to their counterparts on full feeding. The naked neck gene improves growth performance, carcass yield and survivability hence should be incorporated into broiler breeding programmes for tropical countries.

Key words: Broiler, carcass, feed withdrawal, naked neck, phenotype, traits.

INTRODUCTION

Poultry production is among the most profitable undertakings that can enhance the livelihood of low-income earners. According to Ja'afar-Furo and Gabdo (2010), it requires less capital (compared with other

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businesses) to start this lucrative business venture in the rural setting. Amos (2006) also stated that raising poultry on small scale has a rapid financial return. Adomako et al. (2010) made it clear that though keepers of indigenous birds benefitted immensely from their production, genetic and management problems hindered productivity. They indicated that some of the general challenges the poultry industry faces are high temperatures, genetic resources, unavailability of capital, disease prevalence, marketing, financing and poor management systems. Yaron et al. (2004) indicated that hot and humid climates experienced in the tropics negatively affect commercial broiler production. The optimum temperature range for birds is 19 to 22°C for layers and 18 to 22°C for broilers (Lin et al., 2006). When birds are exposed to temperatures above 31°C their heat production is increased (Yunianto et al., 1997). Yahav and McMurtry (2001) indicated that high ambient temperatures result in a reduction of body weight due to energy demands through thermoregulation and decline in feed intake. Numerous methodologies have been proposed to enhance the production performance of broilers in hot humid conditions. Cahaner et al. (1992) indicated that selection of heat tolerant commercial chickens such as the naked neck is one of such strategies. Daghir (1995) also observed that making cool drinking water always available and employing dietary modifications such as feed withdrawal is another option. Horst and Mathur (1992) documented that the naked neck gene causes 40% reduction in the feather coverage of poultry. According to Yalcin et al. (1997) and Patra et al. (2002), when chickens are raised under hot conditions, birds with the naked neck gene attain better growth, improved feed conversion ratio, higher breast weight, and better carcass characteristics when compared with birds without the naked neck gene. Savory and Maros (1993) indicated that practicing full feeding causes birds to be obese and they tend to display symptoms of heat stress, difficulty in walking and finally increased mortality due to skeletal abnormalities. Feed restriction is a method of feeding where time, duration and amount of feed are limited, and it has a bearing on whether a bird is able to obtain the same body weight as full fed animals (Ballay et al., 1992; Yu and Robinson, 1992). In general, either feed restriction could be quantitative or qualitative restriction, that is, quantitative restriction is related to limiting the amount of feed daily given to the animals while a qualitative restriction is related to nutrient dilution in the diet (Leeson and Zubair, 1997).

De Beer and Coon (2007) also indicated that one of such methods include rotating the time of contact with feed and the time when the feed has been taken away. One other method prescribed by Novele et al. (2009) involves restricting the amount of daily feed offered to the animals for sometimes. Renema et al. (1999) indicated that body characteristics in terms of differences in reproductive organs, fat pad sizes and shank length were similar in chickens on both full feeding and restricted feeding systems. Novele et al. (2009) also reported that early period 75% *ad libitum* restriction feeding gave an economic advantage over *ad libitum* feeding mainly by enhancing feed utilization. Therefore, the objective of this study was to determine the influence of the naked neck phenotype and feed withdrawal on growth performance and carcass characteristics of F1 crossbred broilers.

MATERIALS AND METHODS

Study location and duration of the experiment

The study's location was the Poultry Section of the Department of Animal Science, Kwame Nkrumah University of Science and Technology, Kumasi Ghana. The entire experiment lasted for a period of eleven months: October 2016- August 2017.

Experimental birds and design

100-day-old Hubbard Flex 15 commercial broiler chicks were raised for approximately five months and crossed with 10 six-month-old naked neck cockerels. The eggs obtained from the mating between the normal feathered broiler females and the naked neck males were collected over approximately a two months period and then hatched. Four hatches were obtained and they were used as blocks. A total of 272-day-old naked neck and normal feathered chicks were randomly allotted to the four blocks. There were four treatments (naked neck full feeding, naked neck feed withdrawal, normal feathered full feeding and normal feathered feed withdrawal). Each treatment was replicated four times in an RCBD 2×2 factorial arrangement. There were 68 birds per treatment. For birds on the feed withdrawal regime, their feed was taken out of the pen between 10:00 am and 4:00 pm every day throughout the experimental period.

Housing and feeding

Parents of the first filial generation were kept in 10 deep litter pens while the first filial generation was housed in 16 deep litter pens. Each pen measured 1.8 m × 1.2 m, giving a floor space of 2.16 m^2. All the 16 pens were used as a brooder during the first two weeks and heat was supplied by means of two 100-watt incandescent bulbs per pen. Brooding temperatures ranged from a minimum of 27°C to a maximum of 39°C. Temperature in the poultry house after the brooding period depended on the temperature of the outside air. The parents of the first filial generation were given a starter diet containing 22% crude protein (CP) and 2940.8 kcal metabolizable energy (ME)/kg, a grower diet containing 16% CP and 2769.2 kcal ME/kg and a finisher diet containing 18% CP and 2754 kcal ME/kg while the first filial generation was fed a starter diet containing 22% CP and 2940.8 kcal ME/kg and a finisher diet that contained 20% CP and 3150.64 kcal ME/kg. Water was made available to the birds throughout the experimental period.

Traits measured on the first filial (F1) generation

Growth performance

Performance traits such as initial weight, weekly feed intake, weekly

weight gain, weekly feed conversion ratio, rectal temperature and mortality were measured.

Carcass characteristics

At the end of twelve weeks, one male and one female from each treatment were slaughtered for carcass analysis. In all, carcass yield measured included: live weight, bled weight, defeathered weight, head weight, neck weight, wings weight, back weight, breast weight, thigh weight, leg weight, shank length, visceral weight, full gizzard weight, empty gizzard weight, full intestine weight, empty intestine weight, liver weight and heart weight.

Statistical analysis

All data collected on the first filial (F1) generation were subjected to the analysis of variance procedure of the GenStat statistical package version 11.1 (2009) and differences were deemed significant at $p<0.05$.

Ethical statement

The Animal Ethics Committee of Kwame Nkrumah University of Science and Technology, Kumasi approved protocols used in this study.

RESULTS AND DISCUSSION

Growth performance

There was no significant difference ($P>0.05$) between the naked neck and the normal feathered birds with respect to initial weight and weekly feed intake. The naked neck birds, however, gained higher ($P<0.05$) weight and had better FCR compared to their normal feathered counterparts (Table 1). Feed intake was not different between the two phenotypes because the experiment was done in the rainy season with moderate ambient temperature, which suppressed the potential of naked neck birds in this trait under high ambient temperature conditions. This result is consistent with the findings of Lou et al. (1992), Cahaner et al. (1993), Eberhart and Washburn (1993), who demonstrated that the full potential of naked neck broilers over their normal feathered siblings, is manifested when raised at constantly high environmental temperatures usually above 30°C. The result is however contrary to the findings of Fathi et al. (1993) and Khan (1998), who reported that the naked neck birds by virtue of the more exposed skin are able to dissipate heat better and thereby increasing their food intake.

The significantly higher weekly weight gain of the naked neck birds could be attributed to the 20 to 40% less feather cover in the naked neck birds, which reduces substantially the requirement for dietary nutrition to supply protein input for feather production. The findings of this research agree with the discoveries of Eberhart and Washburn (1993), who stated that feather reduction in naked neck birds enhances their ability to dissipate heat through bare areas compared to birds not having the gene. Superior feed conversion ratio by the naked neck birds, when compared with the normal feathered ones, agrees with the results of an investigation by Yalcin et al. (1997) and Patra et al. (2002), on chickens raised under hot climatic conditions. They reported that in high temperature conditions, birds with the naked neck gene possessed higher breast weight, better growth rate, and improved feed conversion ratio and carcass yield. The higher ($P < 0.05$) amount of feed consumed by birds that were on full feeding compared to those on feed withdrawal (Table 1) was due to their unhindered access to feed. This result is contrary to that of Tumova et al. (2002), who indicated that intake of feed decreased by restricted feeding, which brought about a better feed efficiency when compared with those under unrestricted feeding. The results of this work agree with the findings of Sekoni et al. (2002), who showed that controlled feeding did not influence the feed conversion ratio of birds. Novele et al. (2009) also showed that feed restriction at early age of birds for a short period stimulated compensatory growth so that at the market age feed restricted birds performed similarly to those of the full fed groups.

Rectal temperature and mortality

There was no significant difference ($P>0.05$) between the naked neck birds and the normal feathered ones in terms of rectal temperature in the morning. However, the normal feathered birds had higher ($P<0.05$) average rectal temperature in the afternoon and mortality when compared with their naked neck counterparts (Table 2). The lower body temperature in the naked necks in the afternoon was due to the higher thermoregulatory ability of these birds (Adomako et al., 2014). The lower mortalities obtained by the naked neck chickens in contrast to the normal feathered ones support the fact that the naked neck birds are able to adapt well to high temperature conditions and as such have high survivability. The result of this work supports the findings of Mahrous et al. (2008), who assessed the growth of heterozygous naked neck and normal feathered chickens and concluded that the normal feathered birds recorded a significantly ($P\leq0.05$) higher mortality in contrast to the naked neck chickens. El-Safty et al. (2006) also observed that naked neck birds had improved ability to secrete Acute Phase Protein (APP), which gives protection to birds against infection or any pathogenic invasion.

Birds on feed withdrawal had higher ($P<0.05$) rectal temperature in the morning compared to those on full feeding. However, the two feeding systems did not show any significant differences ($P>0.05$) between them with regard to rectal temperature in the afternoon and mortality. Again the phenotype × feeding system interaction did not show significant differences ($P>0.05$) for the traits measured (Table 2). The observation that

Table 1. Effects of phenotype and feeding system on growth performance of broilers.

Phenotype	Trait			
	Initial weight (g)	Mean weekly feed intake(g)	Mean weekly weight gain(g)	Feed conversion ratio
Naked neck	38	485.6	174.4[a]	2.79[a]
Normal feathered	40	462.5	157.5[b]	2.94[b]
SEM	1.67	16.79	6.13	0.0636
Feeding system				
Full feeding	39	493.1[a]	172.5	2.87
Feed withdrawal	39	455.0[b]	159.4	2.87
SEM	1.65	15.84	6.11	0.0554
P-value				
Phenotype	1.000	0.202	0.02	0.05
Feeding system	1.000	0.049	0.06	0.97
Phenotype × Feeding system	1.000	0.692	0.77	0.97

[a-b]Indicates significant difference between means within the same column ($p<0.05$). SEM: Standard error of means. P value: probability values. Source: GenStat statistical package version 11.1 (2009).

Table 2. Effect of phenotype and feeding system on rectal temperature and mortality.

Phenotype	Trait		
	Rectal temperature morning (°C)	Rectal temperature afternoon (°C)	Mortality (%)
Naked neck	41.27	41.33[b]	4.4[b]
Normal feathered	41.27	41.63[a]	20.6[a]
SEM	0.027	0.13	4.41
Feeding system			
Full feeding	41.24[b]	41.46	16.2
Feed withdrawal	41.30[a]	41.50	8.8
SEM	0.014	0.18	4.46
P-value			
Phenotype	1.000	0.049	0.005
Feeding system	0.050	0.78	0.13
Phenotype × Feeding system	0.063	0.83	0.75

[a-b]Indicates significant difference between means within the same column ($p<0.05$). SEM: Standard error of means. P value: probability values.
Source: GenStat statistical package version 11.1 (2009).

the birds on feed withdrawal had a significantly higher rectal temperature than their counterparts on full feeding is contrary to the hypothesis of this work as it was expected that feed withdrawal would reduce metabolism and thereby reduce heat production. The result of this study is again contrary to the findings of Oyedeji and Atteh (2005), who indicated that skip-a day feeding for 3 weeks starting from day-old would enhance carcass quality and reduce sudden death syndrome, which is frequently related to birds that are on *ad libitum* feed intake. Mahmood et al. (2005) and Ali et al. (2013) also reported significant positive effect of feed restriction on survivability in heat stressed broiler chickens.

Carcass characteristics

The naked neck birds had higher ($P<0.05$) defeathered

Table 3. Effects of phenotype and feeding system on carcass characteristics of crossbred broilers.

Phenotype	Trait										
	Live weight (g)	Bled weight (g)	De-feathered weight (g)	Weight of head (g)	Weight of neck (g)	Weight of back (g)	Weight of breast (g)	Weight of thigh (g)	Weight of wings (g)	Weight of legs (g)	Shank length (cm)
Naked neck	2350	2138	2045[a]	85.9[a]	85.6[a]	275	338.4	344	211.2	94.4[a]	7.95
Normal feathered	2330	1854	1641[b]	71[b]	72.5[b]	251.2	338.1	389	196.2	71.2[b]	7.73
SEM	195.48	155	143.4	2.75	3.73	11.31	3.69	62.2	16.94	6.1	0.1193
Feeding system											
Full feeding	2294	2110	1925	80.4	79.4	262.5	343.1[a]	450[a]	220	82.5	7.89
Feed withdrawal	2180	1881	1761	76.5	78.8	263.8	333.8[b]	382[b]	187.5	83.1	7.79
SEM	191.23	146.48	142.34	3.56	3.46	10.20	3.71	62.2	16.87	6.21	0.220
P-value											
Phenotype	0.445	0.1	0.02	<0.001	0.007	0.065	0.869	0.488	0.399	0.004	0.092
Feeding System	0.414	0.174	0.283	0.193	0.871	0.914	0.032	0.025	0.087	0.921	0.424
Phenotype × Feeding system	0.376	0.332	0.872	0.285	0.871	0.255	0.869	0.29	0.069	0.216	0.424

[a-b]Indicates significant difference between means within the same column (p<0.05). SEM: Standard error of means. P value: probability values.
Source: GenStat statistical package version 11.1 (2009).

weight, head weight, neck weight and leg weight compared to the normal ones (Table 3). There was however no significant difference (P>0.05) between the two phenotypes for live weight, bled weight, back weight, breast weight, thigh weight, wings weight and shank length. The naked neck phenotype recording higher defeathered weight was because the heat-tolerant naked neck gene is responsible for the reduction of plumage cover. This result is in line with the findings of Singh et al. (1996), who stated that naked neck broilers gained around 3% more weight compared to their normal feathered siblings when they are reared under hot conditions. They further indicated that this advantage was virtually tripled at high ambient temperature of around 32°C. According to Merat (1986), this gives them 1.8 to 7.1% more flesh in contrast to the normal feathered counterparts when the carcass is dressed. He also indicated that the reduction of plumage in the naked neck chickens furthermore retains protein, which is used for the development of muscle tissues.

There was no significant difference (P >0.05) between the two feeding systems for all the carcass traits measured, except breast weight and thigh weight, where birds on full feeding had higher (P >0.05) values compared to their counterparts on feed withdrawal (Table 3). The phenotype ×feeding system interaction also did not show significant difference (P >0.05) for all the traits measured.

The birds on full feeding showing significantly higher breast and thigh weights compared to their sibs on feed withdrawal is consistent with the work by Melnychuk et al. (2004), who observed that birds that were fed on on *ad libitum* basis had higher average breast weight in contrast to their counterparts on feed restriction.

Internal organs

The naked neck birds had higher (P<0.05) values for most of the internal organs traits measured compared to their normal feathered sibs (Table 4). There was, however, no significant differences (P>0.05) between the feeding systems for all the traits measured (Table 4). Again the phenotype × feeding system interactions also yielded no significant difference (P>0.05) for all the internal organs traits measured (Table 4). The significantly higher weight observed in the naked neck birds for some of the internal organs measured

Table 4. Effects of phenotype and feeding system on internal organs of crossbred broilers.

Phenotype	Trait						
	Visceral Weight (g)	Full gizzard Weight (g)	Empty gizzard weight (g)	Full intestines weight (g)	Empty intestine weight (g)	Liver weight (g)	Heart weight (g)
Naked neck	319	91.9[a]	58.8[a]	129.4[a]	70.6[a]	39.8	43.50[a]
Normal feathered	272	71.2[b]	38.8[b]	83.1[b]	46.9[b]	34.2	32.62[b]
SEM	22.2	4.41	5.95	9.68	4.41	2.85	1.930
Feeding system							
Full feeding	299	83.8	55.0	104.4	61.2	37.5	39.12
Feed withdrawal	292	79.4	42.5	108.1	56.2	36.5	37.00
SEM	20.4	4.23	5.60	8.76	4.43	2.76	1.852
P- value							
Phenotype	0.064	0.001	0.008	<0.001	<0.001	0.086	<0.001
Feeding system	0.764	0.348	0.065	0.708	0.286	0.734	0.299
Phenotype × Feeding system	0.218	0.497	1.000	0.618	0.417	0.865	0.574

[a-b]Indicates significant difference between means within the same column ($p<0.05$). SEM: Standard error of means. P value: probability values.
Source: GenStat statistical package version 11.1 (2009).

compared to their normal feathered counterparts, is similar to the findings of Younis and Cahaner (1999), who reported that the giblet proportion was significantly higher in naked neck birds, indicating increased activity of liver and heart to support the metabolic rate in these chickens to overcome heat stress.

Conclusion

The presence of the naked neck gene in broilers enhanced growth performance, carcass characteristics and survivability. However, the feed withdrawal did not generally influence the overall growth performance, mortality and carcass characteristics of crossbred broilers.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests

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