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Effect of the "Naked neck" gene (Na) on the growth of indigenous chicken fed with suboptimal feed rations in Cameroon

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Abstract

The effect of the naked neck gene (Na) was assessed on growth parameters of the native chicken fed with two suboptimal rations (R1 and R2), and one optimal ration (R3) from 6 to 16 weeks of age. A total of 270 hens of 3 genetic types (homozygous (NaNa) naked neck, heterozygous (Nana) and normal type (nana) chicken) for three different feed rations including two sub-optimal rations (R1, R2) and one optimal ration (R3). Hence, 30 pullets per experimental unit for each genetic type receiving the same ration were used. The animals were subjected to the same experimental conditions except for the tested factor. The starter ration was served during the first six weeks then relayed by the experimental rations. A two-way ANOVA was used to test the main effects and interactions whereas the animal model was used for the estimates of the genotype and feed ration on the growth and related traits. Irrespective of the genotype, the highest growth parameter ($p<0.05$) was obtained with R3 with the lowest feed efficiency from 12 to 16 weeks. The mortality rate (MR) ranged from 3 to 9% cumulated at 6 and 8 weeks of age. The overdominance effect was confirmed for both the bodyweight (BW) and MR. The Na gene improved the weight gain from +1 to + 14 g from 10 to 16 weeks with optimal feed conditions against -6.67 to +4.33g with suboptimal feed. The more beneficial effect on FCR has been observed in homozygote NaNa with +1.07 to +1.27g and -0.43 to -1.63g for R3 and R1 respectively. This study confirms the importance of the Na gene as a good candidate to improve the growth rate and feed efficiency of native chickens. It also provides an effective protocol for the evaluation of major gene candidates for selection in low input production systems.

Keywords: Native chicken, Na-gene, feed efficiency, Feed ration, growth, Cameroon

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INTRODUCTION

Poultry meat production is the most important sector with 38.6% of total meat consumption as compare to other main livestock species including cattle (34.2%), pig (14.1), goat (9.83%) and sheep (3.30%) (INS 2017). Adding to annual production of 58,260 tonnes to 80,120 tonnes of eggs per year from 2010 to 2016, figures show how important is poultry contribution to food security and income generation in Cameroon. However, the poultry-egg value chain analysis showed that the poultry sector has been highly dependent on imported commercial broiler and layers.
According to the National report on animal genetic resources (2003), the local poultry population was estimated to 14,000,000 heads reared in backyards. From the same source, imported poultry drastically increased from 100,000 tons to 10,100,000 tons from years 1990 to 2000. The trend may not have changed during the last two decades. The fact is sufficient enough to raise an alarm for the preservation of genetic resources of the native chicken.

The native chicken of Cameroon is out bred in very challenging environmental conditions with very limited input. It constitutes a rich reservoir for tropical genes of interest for genetic improvement in view of improving production, adaptability and disease resistant traits (Fotsa *et al.,* 2011; Hako *et al.,* 2015 and 2021). The genetic diversity of the Cameroon native chicken has been assessed using microsatellite markers (Fotsa *et al.*,2009 and 2011, Keambou *et al.,* 2014). The performance evaluation on station revealed an improvement of production traits under good management conditions as well as favourable effects of naked neck gene and frizzle gene on the adaptability of the chicken to chronic heat stress (Hako *et al*., 2009). In the same line, the naked neck gene has been recommended as a good candidate for tropical poultry breeding with improved feed efficiency (Fathi *et al*., 2008, Patra *et al*., 2002 and Manyelo *et al*., 2020). Galal and Fathi (2001), Manyelo *et al*. (2020), and Tagny (2022) reported that the Na gene had a significantly positive effect on the live weight and thus weight gain of chickens. Therefore, it is rational to assess the effect of the naked neck gene on growth rate and feed efficiency in challenging feed conditions. This will release first-hand information for farmers and geneticists for a more resilient breeding strategy in low-input production systems.

Comparing production traits is commonly used to discriminate among different phenotypes of native chickens. In view of providing a more reliable and appropriate methods that takes care of the environmental and residual interactions, this study aims at estimating the mean effect of the Naked neck gene of native chickens feed with sub optimal protein and energy levels in the diet using the animal model.

MATERIALS AND METHODS

All animal material used in this research were not subjected to any restriction and were approved by the scientific committee of the University of Dschang.

Study location

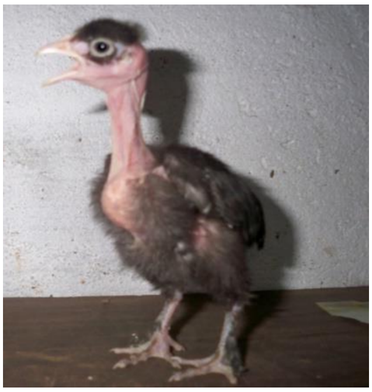
The study was carried out on station at the Research and Application Farm of the University of Dschang (FAR/UDs), located in the Western Highlands of Cameroon between latitude 5º and 7º North and longitude 8º and 20º East.

Animal material

The experimental birds were three genotypes of native chicken including the homozygote naked neck hens (NaNa), the heterozygote naked neck (Nana) and the normal feathered neck (nana). The heterozygote Nana bears a tuft of feathers on the middle and lower side of the neck. Meanwhile the non-carriers have a fully feathered neck. The experimental genotypes are presented in Figure 1. The importance of naked neck gene for factorial genetics is of high interest as there is a clear distinction between the homozygous carrier NaNa, the heterozygous Nana and the non-carrier nana. The NaNa genetic type has a complete naked neck with no feathers.

Experimental design and data collection

The trial was conducted on young pullets from 6 to 16 weeks of age. A 3X3 factorial design was adopted. A total of 270 hens of 3 genetic types (homozygous (NaNa) naked neck, heterozygous (Nana) and normal type (nana) chicken) for three (03) different feed rations including two sub-optimal rations (R1, R2) and one optimal ration (R3). Hence, 30 pullets per experimental unit for each genetic type receiving the same ration were used. The animals were subjected to the same experimental conditions except for the tested factor. The starter ration was served during the first six weeks then relayed by the experimental rations. The composition and bromatological value of the rations are presented in Table 1.



Homozygous naked neck chick (NaNa)

Heterozygous naked neck chick (Nana)

Normally feathered chick (nana)

Figure 1: Experimental genotypes

Table 1: Composition of the experimental rations and the starter ration

Composition	Experimental rations			
	Starter	Ration 1	Ration 2	Ration 3
Metabolizable energy (Kcal/kg)	2909.06	2623.07	2825.22	3100.09
Crude protein (%)	22.01	14.40	16.70	20.31
E/P ratio	132.22	182.15	169.17	152.63
Amino acids (%)				
Lysine	1.16	0.80	0.81	0.85
Methionine	0.41	0.35	0.33	0.36
Mineral salts (%)				
Total phosphorus	0.42	0.41	0.36	0.39
Calcium	1.17	1.20	0.97	1.11
Crude Fibre (%)	3.20	5.1 1	4.45	3.29

Data was collected at 6, 8, 10, 12 and 16 weeks of age. These included the live body weight (BW) obtained by weighing individual birds with the help of a digital scale (0.1g sensitivity), the average daily weight gain (ADG), the feed conversion ratio (FCR) and the mortality rate (MR) of the chickens. The average daily gains and feed conversion ratio were calculated using the following formulae:

$$ADG = \frac{Final\ weight\ (in\ grams)\ -\ Intitial\ weight\ (in\ grams)}{time\ period\ (day)}$$

$$FCR = \frac{Quantity\ of\ feed\ consumed\ in\ grams}{Average\ daily\ weight\ gain\ in\ grams}$$

Statistical analysis

The effect of the “naked neck” gene and feed ration on performance was tested using two-factor analysis of variance (ANOVA) and the means separated using Duncan's test at the 5% and 1% threshold when ANOVA revealed significant differences between genetic types. The SPSS 17.0 software was used for this purpose. The following statistical model was employed:

$Y_{ijk} = \mu + g_i + r_j + gr_{ij} + e_{ijk}$ (1) where;

Y_{ijk}= Performance (BW / ADG / FCR) of individual k of genetic type i and feed with diet j

μ = Population mean

g_i = Fixed effect of genetic type; i varying from 1 to 3

r_j = Fixed effect of feed ration; r varying from 1 to 3

gr_{ij} = Interaction between genetic type and feed ration

e_{ijk} = Residual effect of observations

Estimation of the fixed effect of the genetic type ($\mathbf{a_i}$)

The animal model was used according to the following equations:

$$Y = X\beta + Za + e$$

Where Y is the vector of performances (BW, ADG, FCR and MR), β the vector of the effects of the external factors (here, the means for feed rations $R1, R2$ and $R3$), a the vector of genetic values ($Na, Na * na$ and na), e the vector of residual or individual effects, X and Z the incidence matrix of the external and genetic values so that for an individual from each of the nine experimental unit :

$$\begin{bmatrix} y_{Na1} \\ y_{Na2} \\ y_{Na3} \\ y_{Nana1} \\ y_{Nana2} \\ y_{Nana3} \\ y_{na1} \\ y_{na2} \\ y_{na3} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \mu_{1Na1} \\ \mu_{1Na2} \\ \mu_{1Na3} \\ \mu_{1Nana1} \\ \mu_{2Nana2} \\ \mu_{3Nana3} \\ \mu_{1na1} \\ \mu_{2na2} \\ \mu_{3na3} \end{bmatrix} + \begin{bmatrix} 1 & 0 & 0 \\ 1 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 1 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 1 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} a_{Na} \\ a_{Na} \\ a_{Na} \\ a_{Nana} \\ a_{Nana} \\ a_{Nana} \\ a_{na} \\ a_{na} \\ a_{na} \end{bmatrix} + \begin{bmatrix} e_{Na1} \\ e_{Na2} \\ e_{Na3} \\ e_{Nana1} \\ e_{Nana2} \\ e_{Nana3} \\ e_{na1} \\ e_{na2} \\ e_{na3} \end{bmatrix}$$

For the same feed ration (fixed effect), the above equation becomes:

$$\begin{bmatrix} \mu_{Na} \\ \mu_{Nana} \\ \mu_{na} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \mu_1 \\ \mu_2 \\ \mu_3 \end{bmatrix} + \begin{bmatrix} a_{Na} \\ a_{Nana} \\ a_{na} \end{bmatrix} \leftrightarrow \begin{bmatrix} a_{Na} \\ a_{Nana} \\ a_{na} \end{bmatrix} = \begin{bmatrix} \mu_{Na} \\ \mu_{Nana} \\ \mu_{na} \end{bmatrix} - \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \mu_1 \\ \mu_2 \\ \mu_3 \end{bmatrix}$$

RESULTS

Live bodyweight and weight gain

The evolution of the live body weight from 6 to 16 weeks of age of native chicken according to their genotype and ration is presented in Table 2.

The effects of the genotype, the ration and their interaction were significant (P<0.05) from 8 to 16 weeks. Irrespective of the feed ration, the live bodyweight ranged from 233±29 grams (NaNa) to 769±62 grams (Nana) from 6 to 16 weeks of age. the Nana had the highest growth as compared to NaNa and nana. However, its superiority over nana was not significant (P>0.05). For the same genotype, R2 and R3 treatments were comparable (P>0.05), but superior to bird fed with R1. This implies that R2 feed ration may be optimal for the native chicken at the corresponding age. The evolution of the average weight gain according to genotypes and rations is presented in Table 3. Irrespective of genotype and Feed ration, the average weight gain decreased from the beginning to the 6 to 16 weeks of age. Nana had the highest WG (91 to 101 g for R1, 107 to 92g for R2 and 95 to 97g). The differences were more explained by the genotype effect (P<0.05 at 10 and 12 weeks, and P<0.01 at 16 weeks) than the Ration effect (P<0.05 at 16 weeks).

Table 2: Evolution of live bodyweight according to genetic type and feed ration

Genotype (G)	Feed rations (R)	Age in Weeks				
		6	8	10	12	16
Homozygous naked neck (NaNa)	R1	233±29	417±55c	562±63b	647±54b	723±66b
	R2	239±22	416±38c	579±55a	662±63 b	727±61b
	R3	255±33	424±27ab	573±50a	659±49b	738±56b
Heterozygous naked neck (Nana)	R1	245±44	437±31a	574±55a	665±41b	737±62b
	R2	235±35	426±26ab	582±43a	689±59a	762±45a
	R3	229±28	432±21a	587±29a	682±45a	769±62a
Nornal feathered neck (nana)	R1	241±32	425±29b	568±41ab	659±55b	729±67b
	R2	251±25	419±39c	571±24ab	673±41a	755±67a
	R3	249±28	427±52a	581±36a	675±64a	763±71a
Significance (*P<0.05. and ***P<0.01)	G	ns	*	*	**	**
	R	ns	*	*	*	*
	G*R	ns	*	*	**	*

Key: abc= between lines and within the same column, means with the same letter are statistically comparable, ns= Non-significant, R1=2623 Kcal Metabolizable energy (ME) and 14.4% crude protein (CP), R2= 2825 Kcal ME and 16.7% CP, R3= 3100 Kcal ME and 20.3% CP

The quantified effect of the Na gene on the evolution of the BW of the native chicken according to the three experimental rations (Table 4). Irrespective of the genotype, the maximum potential of the Na gene effect is more pronounced toward the beginning and toward the end of the experiment with R3 (+13 to +20 grams in NaNa, +13 to + 13 grams in Nana against +2 to +19 grams for the non-carrier. Although the differences were more explained by the genotype effect (Tables 2 and 3), Table 4 clearly show that a higher nutritional value of feed favourably infer to the genetic potential of the bird.

Feed conversion ratio

There is a possible explanation from the behavioural response in terms of either increased feed consumption or best feed utilisation, and therefore, increased feed conversion ratio as a compensation of the low nutritive value of the feed evidenced in Table 5.

It can be noted that, the ration with the highest nutritional value is also the one that is more consumed. However, from Table 5 and the weight gain in Table 3, it can be deducted that the birds are more efficient in converting the feed into nutrients when the nutrients are suboptimal in the feed. It is deducted (Tables 3 and 5) that Na-gene carriers are more efficient feed converters as compared to the non-carrier. This has also been confirmed with low nutrient value content of the feed (Table 6) where the FCR is reduced in NaNa (-0.43 to -1.63) with R1 and R2, Nana (-0.13 to -1.13 and -0.03 to -0.13 with R1 and R2) as compared with nana (-0.30 to -1.57 and +0.00 to +0.73 with R1 and R2).

Table 3: Evolution of the average weight gain according to genetic type and feed ration

Genotype (G)	Feed rations (R)	Age in Weeks				
		6	8	10	12	16
Homozygous naked Neck (NaNa)	R1	184±11	151±09	86±17ab	71±11ab	66±07c
	R2	177±13	163±15	83±09b	65±13b	102±17a
	R3	162±10	156±07	86±09ab	79±11a	106±15a
Heterozygous naked (Nana)	R1	192±15	137±12	91±08a	72±13ab	101±09a
	R2	191±14	156±10	107±10a	73±08 ab	92±10ab
	R3	173±12	155±17	95±09a	87±11a	97±10a

Normal (nana)	R1	184±17	143±12	91±07a	70±10 ab	86±10b
	R2	168±15	152±13	102±11a	82±09a	76±09c
	R3	178±16	154±14	94±10a	88±07a	89±11b
Significance *P<0.05. ***P<0.01	G	ns	ns	*	*	**
	R	ns	ns	ns	ns	*
	G*R	ns	ns	ns	ns	*

Key: abc: between lines and within the same column, means with the same letter are statistically comparable, ns= Non-significant, R1=2623 Kcal Metabolisable energy (ME) and 14.4% crude protein (CP), R2= 2825 Kcal ME and 16.7% CP, R3= 3100 Kcal ME and 20.3% CP

Table: 4 Mean effect of the naked neck gene on the evolution of body weight (in grams) of local chickens according to feed rations

Age in	NaNa			Nana			nana		
weeks	R1	R2	R3	R1	R2	R3	R1	R2	R3
6	-9.33	-3.30	12.70	-1.33	-11.30	12.70	-6.00	4.00	2.00
8	-2.00	-3.00	5.00	5.33	-5.67	0.33	1.33	-4.70	3.33
10	-9.33	7.67	1.67	-7.00	1.00	6.00	-5.33	-2.30	7.67
12	-9.00	6.00	3.00	-13.70	10.33	3.33	-10.00	4.00	6.00
14	-6.33	-2.30	8.67	-19.00	6.00	13.00	-20.00	6.00	14.00
16	-25.70	5.33	20.30	-14.70	1.33	13.30	-17.70	-1.70	19.30

Key: R1=2623 Kcal Metabolisable energy (ME) and 14.4% crude protein (CP), R2= 2825 Kcal ME and 16.7% CP, R3= 3100 Kcal ME and 20.3% CP

Mortality rate

The mortality rate of the experimental birds according to the genotype and experimental feed rations are here represented.

The mortality rate ranged from 3 to 9% cumulated at 6-8 weeks of age. As for the bodyweight and weight gain (Tables 2 and 3), Overdominance effect was confirmed for the mortality rate.

DISCUSSION

The effect of feeding programs and nutrient composition of feeds on the performance of chickens has largely been reviewed (Manyelo *et al*., 2020; Kalinda and Tanganyika, 2017; Nakkazi *et al*., 2015; Kuietche *et al.,* 2014; Magala *et al*., 2012; Raju *et al*., 2004). In this work, we tested the adaptability of three genotypes (NaNa Nana, nana) of Cameroon local hens to three feed rations with different levels of CP and ME. Results indicate that irrespective of the genotype, a better live weight and weight gain is obtained for the R3 ration (3100.9 Kcal ME/kg and 20.31% CP). Nevertheless, a higher feed conversion ratio for this same ration reveals wastage of feed. This therefore suggests a better feed efficiency for the R2 (2825 Kcal ME/kg and 16.70% CP) and R1 (2623 Kcal ME/kg and 14.40% CP) rations respectively. These results are consistent with the findings of Almeida and Zuber (2009) who concluded that irrespective of genotype (Nana or nana), the highest productive potential of local chickens could be attained if they are fed with a poorer ration.

Table 5: Evolution of feed conversion ratio according to genetic type and feed ration

Genotype (G)	Feed rations (R)	Age in Weeks				
		6	8	10	12	16

Homozygous naked Neck (NaNa)	R1	3.7±0.2	5.1±0.5	6.4±0.2	6.6±0.2	5.4±0.1b
	R2	3.5±0.3	4.7±0.2	6.9±0.5	6.9±0.4b	7.4±0.5ab
	R3	5.2±0.2	5.7±0.2	6.9±0.4	7.4±0.3b	8.3±0.4ab
Heterozygous naked neck (Nana)	R1	3.6±0.4	4.8±0.2	6.4±0.5	6.4±0.5b	6.5±0.7b
	R2	3.7±0.4	4.9±0.3	6.5±0.5	6.7±0.5b	7.5±0.6b
	R3	3.9±0.5	5.4±0.3	7.2±0.6	8.6±0.5ab	8.9±0.6ab
Nornal feathered neck (nana)	R1	3.6±0.3	4.9±0.6	6.8±0.6	8.2±1.1ab	9.1±0.9ab
	R2	3.9±0.4	4.7±0.3	7.6±0.3	10.2±0.6a	11.4±0.9a
	R3	4.2±0.3	5.6±0.5	7.7±0.5	11.3±1.2a	11.5±1.1a
Significance (*P<0.05, and ***P<0.01)	G	ns	ns	ns	*	*
	R	ns	ns	ns	ns	*
	G*R	ns	ns	ns	*	ns

Key: abc; between lines and within the same column, means with the same letter are statistically comparable, ns= Non-significant, R1=2623 Kcal Metabolizable energy (ME) and 14.4% crude protein (CP), R2= 2825 Kcal ME and 16.7% CP, R3= 3100 Kcal ME and 20.3% CP

Table 6: Effect of the naked neck gene on the evolution of feed conversion ratio in local chickens according to feed ration

Age in weeks	NaNa			Nana			nana		
	R1	R2	R3	R1	R2	R3	R1	R2	R3
6	-0.43	-0.63	1.07	-0.13	-0.03	0.17	-0.30	0.00	0.30
8	-0.07	-0.47	0.53	-0.23	-0.13	0.37	-0.17	-0.37	0.53
10	-0.33	0.17	0.17	-0.30	-0.20	0.50	-0.57	0.23	0.33
12	-0.37	-0.07	0.43	-0.83	-0.53	1.37	-1.70	0.30	1.40
16	-1.63	0.37	1.27	-1.13	-0.13	1.27	-1.57	0.73	0.83

Key: R1=2623 Kcal Metabolizable energy (ME) and 14.4% crude protein (CP), R2= 2825 Kcal ME and 16.7% CP, R3= 3100 Kcal ME and 20.3% CP

Table 7: Evolution of mortality rate (in percentage) conversion ratio according to genetic type and feed ration

Genotype (G)	Feed Ration	Age in Weeks				
		6	8	10	12	16
Homozygous naked Neck (NaNa)	R1	7.8	3.2	0.0	0.0	0.0
	R2	5.2	3.2	0.0	0.0	0.0
	R3	4.0	3.3	0.0	0.0	0.0
Heterozygous naked Neck (Nana)	R1	4.9	4.7	0.0	0.0	0.0
	R2	5.2	5.1	0.0	3.1	0.0
	R3	4.6	3.1	0.0	0.0	0.0
Nornal (nana)	R1	6.6	8.1	4.0	3.0	0.0
	R2	6.2	9.1	0.0	3.1	0.0
	R3	5.1	7.4	3.0	3.0	0.0

Key: R1=2623 Kcal Metabolisable energy (ME) and 14.4% crude protein (CP), R2= 2825 Kcal ME and 16.7% CP, R3= 3100 Kcal ME and 20.3% CP

The On-station performance of the three local chicken genotypes is comparatively high compared to their scavenging counterparts (Tagny, 2022; Bamidele *et al*., 2020; Haoua *et al*., 2015; FAO 2010). The live body weight and thus growth rate of chickens is generally influenced by a series of factors including genotype, sex, age, production systems, diet, stocking density, ambient temperature and activity (Haoua *et al.,* 2015; Khobondo *et al*., 2015; Keambou *et al*., 2014; Magala *et al*., 2012). According to results, the performances (BW, ADG and thus FCR) of all chicken genotype studies were statistically the same from day old to 6 weeks of age. This however is not consistent with the findings of Adomako *et al.* (2014), Keambou *et al.* (2013) and Patra *et al*. (2002) who all reported a significant difference ($p<0.05$) in the live weights and weight gains between the Nana (crossbred) and nana (normal) chicken from hatching to the 6th week of age and beyond. This divergence in results can either be attributed to the diversity that exists within the naked neck genotype across geographical regions.

Since Crawford in 1976, several studies have been carried out on the naked neck (Na) gene (Hanzl and Soames, 1983; Yalcin *et al*., 1996 and 1997; Debb and Cahaner, 1999 and 2001; Patra *et al*., 2002, Raju *et al.,* 2004; Hako *et al*., 2009 and 2015; Bamidele *et al*., 2020), and there have been several debates as to which strain (naked neck or normally feathered) is best suited for intensive or extensive system of production. In this trial carried out on station, the presence of the naked neck gene in either a homozygous (NaNa) or heterozygous (Nana) state significantly influenced ($P<0.05$) the relative weight and weight gain of the local chickens. Irrespective of the feed ration provided, the naked neck chickens (Nana and NaNa) had a better growth performance to the normally feathered chicken.

The best performance recorded for the heterozygote Nana reflects the phenomenon of over-dominance. These results are consistent with the findings of Fathi *et al.* (2008), Patra *et al*. (2002) and Galal and Fathi (2001) who reported that the Na gene had a significantly positive effect on the live weight and thus weight gain of chickens. Mahrous *et al*. (2008) equally obtained a significantly higher bodyweight and weight gain for naked neck chickens (NaNa and NaF) compared to their normally feathered and Frizzle counterparts (FF and nana) from the 8th to the 12th week of age. However, these results do not agree with those obtained of Almeida and Zuber (2009) who observed a better body weight and weight gain for the normally feathered chicken when fed with three different feed rations. This divergence in result can be explained by the fact that the trials carried out by Almeida and Zuber (2009) was done on free range thereby suggesting that the naked neck chickens are probably more adapted to an intensive system of production.

The naked neck gene (Na) is responsible for the reduced feather coverage in naked neck chickens. The Na gene reduces the feather mass by 20 to 40 % in heterozygous (Nana) and homozygous (NaNa) naked neck chickens compared to the normally feathered counterparts (Lin *et al.,* 2006; Merat, 1986). This reduction in the quantity of feather on the body surface prevents an excessive rise in body temperature during feed consumption and digestion, thereby minimising the adverse effect of heat stress on feed consumption, growth and survivability of the chickens. The naked neck chicken, due to its capacity to better dissipate heat, tends to consume more feed as compared to the normally feathered chicken (Patra *et al.* 2002). Irrespective of the genotype and the feed ration, the birds from this study had high values of FCR as compared to those from Mahrous *et al.* (2008) and Patra *et al*. (2002) but, consistent with those from Nakkazi *et al.* (2015) and Mapeta (1997). Results obtained from these trials indicates that birds carrying the naked neck gene either in a single state (Nana) or double state (NaNa) had a lower feed conversion ratio. Irrespective of the feeding ration, the homozygous naked neck chicken has the lowest of feed conversion ratios thereby indicating a better efficiency for this genotype. These results are consistent with the findings of Mahrous *et al.* (2008), who reported that the presence of the Na gene significantly increased feed efficiency of chicken from the 8th to the 12th week. Patra *et al.* (2002) and Alvarez *et al.* (2002) equally observed a better but non-significant feed efficiency in hens carrying the naked neck gene with. Concerning the mortality rate, data presented in table 4 showed that the NaNa genotype had a lower mortality rate compared to Nana and nana genotypes.

CONCLUSION

Conclusively, the naked neck gene has a beneficial effect on the best use of poor rations while the R2 ration (2825 Kcal ME/kg and 16.70% CP) gives the best results for the production of the indigenous chicken of Cameroon.
The findings are a contribution to appropriate feed formulation for the intensification of indigenous poultry production. However, divergent results among authors from different countries are either the results of a difference in the feathering intensity of the experimental birds, or the variability of the environmental factors like the temperature among others on the adaptability to sub optimal feed.

We therefore suggest detailed investigations on the effect of the naked neck gene on feather reduction as well as subsequent implications on adaptability to heat stress on Cameroon local chickens.

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Author contribution

HTBA designed the project, analysed the data and supervised the work. YSN drafted the paper and discussed the results. All the authors read and approved the final manuscript.

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