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Effect of Genetic Type and Sex on Reproductive, Growth, Survival Performance and Thermal Tolerance Index of the Local Chicken (*Gallus gallus*) of the Western Highlands of Cameroon

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Abstract: Reproductive performance of local chicken from the Western Highlands of Cameroon has been significantly influenced by the genetic type, the naked neck chicken displaying the best laying performance. Fertility rate was higher (P<0.05) in rural (64.2%) than urban (43.5%) areas but the hatching rate were comparable (62.3 and 59.7%). The feathered tarsus chicken got the highest body weight (P<0.05) throughout the test. Within each breed, the males were significantly (P<0.01) heavier than females regardless of age. The growth rate of local chicken was significantly influenced (P<0.05) by the genetic type from hatching to week 4 and very significantly (P<0.01) between the 4th and 16th week. The genetic type of local chicken significantly influenced (P<0.05) the feed efficiency during the period 12-16 weeks, while the sex effect on this parameter was very significant during the period from 8th to 12th week, whereas the interaction of these two sources of variation was not significant regardless of the period. Feathered tarsus chickens were less resistant, having only 61.4% of survived chicks. On the contrary, the normal feathering chickens were the most rustic, with 85.6% survival rate.

Key words: Genetic type, reproduction, growth, local chicken, Cameroon

INTRODUCTION

In Cameroon, poultry accounts for 10% of domestic meat consumption, approximately 2.5 kg of meat (FAO, 2005) and 20 eggs per capita per year (Ekue *et al*., 2002). Local chicken is 90% of the traditional poultry sector and constitutes about 80% of the 35 million head of poultry nationwide (Fotsa *et al*., 2007). It is represented by four genetic types (Fotsa and pone, 2001; Keambou, 2007; Fotsa *et al*., 2011) and plays an important role in the coverage of animal protein needs and occupies a prominent place in the socio-cultural life of people from rural and suburban areas. Despite this, it remains poorly characterized and subjected to many constraints. Previous studies have suggested that solutions to these constraints would, among other things, a better understanding of the genetic potential of local chickens and its valuation. The incidence of feathering major genes on productivity of local chicken is not yet sufficiently studied in Cameroon, yet this information is essential for evaluating hardiness indicators prior to the establishment of genetic improvement programs.

The local chicken from the western highlands of Cameroon is characterized by its great phenotypic and phaneroptic diversity and by the presence of major genes of economic interest (Keambou *et al*., 2007; Keambou and Manjeli, 2009). This diversity could provide a basis for genetic improvement of this species. Hence for, particular attention is been paid to the genetic potential and the zootechnical performance of different genetic types of local chickens identified by Keambou (2006) in urban and rural areas of the western highlands of Cameroon. Most local chickens and eggs sold in rural markets come from village production systems, where reproductive parameters are not always under control. This control, however, is the basis for the improvement of flock size and productivity of the species. This study aims to contribute to the knowledge of the parameters of reproduction and growth of genetic types of local chickens from the western highlands of Cameroon.

MATERIALS AND METHODS

For the evaluation of reproductive performance according to the genetic type of local chicken, 64 hens and 8 roosters of four genetic types (naked neck, feathered Tarsus, crested and Normal plumage) apparently healthy and at sexual maturity were purchased in households and markets in the western

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highlands of Cameroon. These breeders were quarantined for 14 days, after which they were divided into identical lodges with wood litter floors, in 4 breeding pens based on genetic type, with a sex ratio of 1/8. All breeding pens received the same dietary and prophylaxis treatment. A total of 905 eggs were obtained and artificially incubated to produce 624 chicks.

Flock management and data collection: Upon hatching, the chicks were weighed and transferred to chicks pens designed for this purpose, on wood chip bedding. Throughout the test period, the animals had free access to water and food were available at all times, containing 21.01% CP and 2909.06 kcal ME startup and 18.70% CP and 3010.17 kcal ME to finish. The weighed subsequently made on a weekly basis until the end of the trial and mortalities recorded as and when they occurred.

Upon hatching, the chicks were weighed and transferred to hatcheries designed for this purpose, on wood chip bedding. Throughout the test period, the animals had free access to water and food that were continuously, containing 21.01% crude proteins and 2909.06 kcal metabolizable energy as starter diet and 18.70% crude proteins and 3010.17 kcal ME as finisher diet. The weighing and other data were subsequently made on a weekly basis until the end of the trial and mortalities recorded as and when they occurred.

Data analysis: Data were analyzed using Excel (2000) and SPSS 12.0. The two-factor ANOVA was used to test the effects of genetic type, sex and their interaction on growth parameters according to the following statistical model:

$$Y_{ij} = \mu + G_i + S_j + GS_{ij} + e_{ijk}$$

Where:

Y_{ij} = Parameter's value of the kth individual, of the ith genetic type and jth sex
μ = General mean of the parameter's value
G_i = Fixed effects of genetic type (i = 1-4)
S_j = Fixed effects of sex (j = 1-2)
G_{sij} = Effects of sex x genetic type interaction
e_{ijk} = Residual error

Means shown to be significantly affected by the factors of variation were separated using the Duncan multiple range test.

RESULTS

Reproductive performances according to genetic type

The analysis of variance of the effects of genetic type on laying performances of the local chicken from the western highlands of Cameroon is shown in Table 1.

It comes from Table 1 that the genetic type had a highly significant effect (p<0.01) on laying performances.

The analysis of variance of the effects of genetic type on fertility, embryonic mortality and hatchability of the local chicken from the western highlands of Cameroon is presented in Table 2.

Thus, the genetic type has very significantly (P<0.01) influenced fertility, early and late embryonic mortality and hatching rate of local chicken.

Parameters of reproductive performance according to the genetic type of local chicken are presented in Fig. 1. The normal feathering and crested chickens showed the best fertility of eggs (96.4 and 96.5%, respectively). Moreover feathered tarsi chicken have the lowest fertility of eggs (84.6%), highest early and late mortality rates (11.17 and 17.12%, respectively), lowest hatching rate (71.8%) and the longer interval between laying cycles

Table 1: Degrees of freedom and mean square of laying performance according to the genetic type of local chicken form the western highlands of Cameroon

		Mean squares				
Source of variation	df	Egg weight	Length of laying cycle	Laying rate	Consumption index	Interval of laying cycles
Genetic type	3	70, 45**	474, 68**	197, 79**	0, 16**	49, 05**
Residual error	32	2, 18	10, 17	8, 37	0, 03	5, 51

**: Significant at 1%.

Table 2: Mean squares and degree of freedom of fertility, embryonic mortality and hatching rates according to the genetic type of local chicken from the western highlands of Cameroon

		Mean square			
			Embryonic mortality		
Source of variation	df	Fertility	Early	Late	Hatching
Genetic type	3	7017.49**	1206.00**	2192.59**	5241.65**
Residual error	893	0.16	0.07	0.04	0.22

**: Significant at 1%.

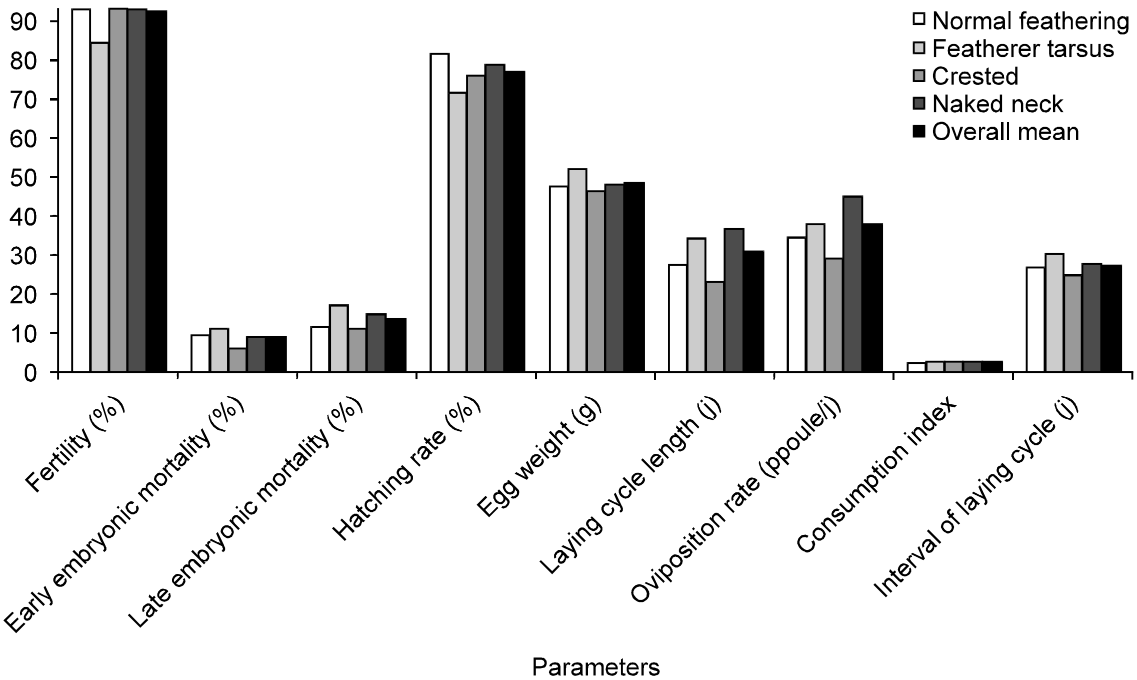

Fig. 1: Parameters of reproductive performances of genetic types of local chickens from the western highlands of Cameroon

Table 3: ANOVA of weight at age type according to the genetic type and sex of local chickens Highlands of West Cameroon

Source of variation	df	Means square of body weight				
		0th week	4th week	8th week	12th week	16th week
Genetic type (P)	3	167.5*	14975.2*	15280.7*	599885.5*	99672.6*
Sex (S)	1	55.2**	20936.5**	968383.2**	6927088.1**	8055408.6**
P x S	3	0.7 ns	703.9 ns	359.3 ns	2208.50 ns	6647.8 ns
Error residual	462	3.8	624.8	2023.0	3337.3	6213.4

*: Significant at 5%, **: Significant at 1%, ns: Non significant.

(30.4 days). However, the eggs of the feathered tarsi chicken are heavier (52.2g). In addition, the neck naked chicken laying cycle was the longest (36.9 days) and its oviposition rate the highest (45 hens/d).

Growth performance according to the genetic type and sex: Table 3 presents the results of the analysis of variance of the effects of genetic type and sex on body weight at given age of the local chickens of the western highlands of Cameroon.

From Table 3, it follows that there's been a significant influence of the genetic type ($P<0.05$) and sex ($P<0.01$) on the live weight of local chickens from hatching to the 16th week.

Table 4 presents the weekly live weights and coefficients of variation from hatching to the 8th week in both sexes in genetic types of local chickens of the western highlands of Cameroon.

Regardless of sex, feathered tarsus chicken obtained the highest weight ($P<0.05$) throughout the trial, followed by naked neck and normal plumage chicken, while the crested chicken presented the lowest live weight from the hatching at the 8th week.

Within each breed, the roosters were significantly ($P<0.01$) heavier than hen regardless of age. In addition, sexual dimorphism based on the body weight becomes more marked as and as the age of the animals advances.

Whatever the genetic type and sex, the coefficients of variation of body weight generally increase gradually with age until the 5th-6th week after which they tend to decrease.

The analysis of variance showed that the interaction between genetic type and sex was not significant regardless of age, except in the 9th week. In contrast, the genetic type and sex considered separately had significant effects from hatching to the 16th week. At hatching, roosters were 2.5% heavier than the hens and sexual dimorphism increased gradually to reach a maximum ranging from 43.0 to 46.9% between the 11th and 14th week before is slightly reduced to 26.6-39.3% between the 15th and 16th week.

Table 4: Weekly weight and coefficients of variation according to the genetic type and sex of local chicken of western highlands of Cameroon

		Weeks									
		Hatching		1		2		3		4	
Genetic type	Sex	Mean±SD	CV	Mean±SD	CV	Mean±SD	CV	Mean±SD	CV	Mean±SD	CV
Normal feathering	M	31.97±2.07^{a}	6.5	45.48±7.89^{a}	17.4	64.53±8.42^{a}	13.1	106.56±24.57^{a}	23.1	131.50±28.93^{a}	22.0
	F	30.96±2.50^{b}	8.1	43.56±7.49^{b}	17.2	61.52±7.15^{b}	11.6	98.27±15.95^{b}	16.2	144.18±30.62^{b}	21.2
	M & F	31.41±2.36^{B}	7.5	44.44±7.71^{A}	17.3	62.88±7.86^{B}	12.5	102.02±20.64^{AB}	20.2	137.29±30.27^{B}	22.0
Fethered tarsus	M	33.19±1.96^{a}	5.9	48.16±8.71^{a}	18.1	76.20±17.29^{a}	22.7	111.70±25.31^{a}	22.7	143.15±30.20^{a}	21.1
	F	32.55±1.92^{b}	5.9	46.46±7.21^{b}	15.5	67.15±11.03^{b}	16.4	103.22±19.39^{b}	18.8	162.98±38.67^{b}	23.7
	M & F	32.84±1.96^{C}	6.0	47.23±7.94^{B}	16.8	71.33±14.90^{D}	20.9	107.14±22.63^{AB}	21.1	152.33±35.64^{C}	23.4
Crested	M	30.28±1.55^{a}	5.1	44.11±7.26^{a}	16.5	60.85±6.34^{a}	10.4	100.58±17.34^{a}	17.2	120.80±21.40^{a}	17.7
	F	29.42±1.77^{b}	6.0	41.19±4.55^{b}	11.1	57.92±5.33^{b}	9.2	94.01±16.72^{b}	17.8	129.23±22.21^{b}	17.2
	M & F	29.81±1.72^{A}	5.8	42.51±6.08^{A}	14.3	59.25±5.96^{A}	10.1	97.01±17.25^{A}	17.8	124.65±22.08^{A}	17.7
Naked neck	M	31.40±2.06^{a}	6.6	46.22±7.59^{a}	16.4	69.22±8.77^{a}	12.7	105.35±20.40^{a}	19.4	130.63±25.62^{a}	19.6
	F	30.84±2.58^{b}	8.4	43.32±6.45^{b}	14.9	63.51±8.37^{b}	13.2	96.71±16.05^{b}	16.6	142.63±29.08^{b}	20.4
	M & F	31.08±2.38^{B}	7.7	44.53±7.07^{A}	15.9	66.03±8.98^{C}	13.6	100.67±18.61^{AB}	18.5	136.09±27.80^{B}	20.4

a, b in the same column, values with the same superscripts are not significantly different ($P\geq0.01$), SD: Standard deviation. M: Male, F: Female
A, B, C on the same column, values with the same superscripts are not significantly different ($P\geq0.01$).

Table 4: Continued

		Weeks							
		5		6		7		8	
Genetic type	Sex	Mean±SD	CV	Mean±SD	CV	Mean±SD	CV	Mean±SD	CV
Normal feathering	M	183, 64±42, 44^{a}	23, 1	223, 32±51, 75^{a}	23, 2	294, 78±53, 54^{a}	18, 2	401, 16±58, 35^{a}	14, 5
	F	170, 51±35, 67^{b}	20, 9	208, 15±43, 02^{b}	20, 7	259, 15±48, 25^{b}	18, 6	310, 22±38, 52^{b}	12, 4
	M & F	176, 51±39, 30^{A}	22, 3	215, 08±47, 63^{AB}	22, 1	275, 42±53, 58^{AB}	19, 5	350, 96±66, 23^{AB}	18, 9
Fethered tarsus	M	195, 92±42, 38^{a}	21, 6	235, 48±49, 70^{a}	21, 1	307, 62±55, 08^{a}	17, 9	416, 24±64, 67^{a}	15, 5
	F	183, 50±36, 34^{b}	19, 8	220, 06±43, 84^{b}	19, 9	267, 95±46, 10^{b}	17, 2	328, 10±42, 33^{b}	12, 9
	M & F	189, 25±39, 58^{B}	20, 9	227, 19±47, 09^{B}	20, 7	286, 31±54, 02^{B}	18, 9	368, 89±69, 42^{B}	18, 8
Crested	M	172, 01±26, 47^{a}	15, 4	214, 73±42, 91^{a}	20, 0	285, 06±43, 99^{a}	15, 4	387, 29±50, 90^{a}	13, 1
	F	162, 26±26, 48^{b}	16, 3	201, 18±39, 77^{b}	19, 8	254, 87±41, 86^{b}	16, 4	300, 55±35, 99^{b}	12, 0
	M & F	166, 71±26, 81^{A}	16, 1	207, 18±41, 57^{A}	20, 1	268, 67±45, 26^{A}	16, 8	340, 18±61, 26^{A}	18, 0
Naked neck	M	182, 98±36, 66^{a}	20, 0	213, 88±34, 77^{a}	16, 3	285, 58±43, 09^{a}	15, 1	408, 85±51, 32^{a}	12, 6
	F	167, 39±28, 33^{b}	16, 9	203, 07±25, 30^{b}	12, 5	252, 19±39, 73^{b}	15, 8	312, 98±33, 10^{b}	10, 6
	M & F	174, 48±33, 18^{A}	19, 0	207, 99±30, 34^{A}	14, 6	267, 60±44, 41^{A}	16, 6	356, 56±63, 85^{AB}	17, 9

a, b in the same column, values with the same superscripts are not significantly different ($P\geq0.01$), SD: Standard deviation. M: Male, F: Female
A, B, C on the same column, values with the same superscripts are not significantly different ($P\geq0.01$).

Regardless of sex, feathered tarsus chicken was heavier than its counterparts of naked neck, crested and normal plumage during the first five weeks, heavier than the naked neck and crested types at the 6th and 7th week and more than crested and normal feathering chickens from the 8th to the 16th week. Crested chicks were lighter than the feathered tarsi one at any age and lighter than the naked neck genetic type from the 8th week.

Whatever the genetic type and sex, the coefficients of variation of body weights were low at hatching, ranging between 5.1 and 8.4 depending on the breed but rose to 15.1-23 7% between the 3rd-7th week before stabilizing between 5.6 and 12.1% from the 10th week.

Table 5 presents the results of the analysis of variance of the effects of genetic type and sex on growth rate at given age of the chicken of western highlands of Cameroon.

As shown in Table 5, the genetic type significantly influenced ($P<0.05$) the growth rate of local chickens from hatching to the 4th week and very significantly ($P<0.01$) between the 4th and 16th week, except for the period from the 8th to the 12th week of the genetic type had no significant effect on this parameter.

Figure 2 shows the evolution of growth rates based on sex in the genetic types of local chickens.

It is clear from Fig. 2 that, regardless of the genetic type and sex of local chickens, the growth rate has a decreasing pace from hatching to the 16th week. However, in the first month after hatching and regardless of sex, feathered tarsus chicken presented the higher growth rate ($P<0.05$), statistically similar to that of laying naked neck and normal feathering, while the crested chicken had the lower growth rate ($P<0.05$). Between the 12th and the 16th week, naked neck and feathered tarsus chickens were those keeping the higher growth rates, respectively 36.3 and 35.6%.

The analysis of variance of average daily weight gain according to the genetic type and sex of the local chicken in the western highlands of Cameroon is presented in Table 6.

Although the sex affects very significantly ($P<0.01$) the weight gain in local chickens between hatching and the 16th week, the effects of genetic type were highly significant ($P<0.01$) only during the 1st, 3rd and 4th months but not significant in the 2nd month.

Figure 3 shows the evolution of average daily gain as a function of genetic type and sex of local chickens in the western highlands of Cameroon.

Whatever the genetic type, the roosters have a higher growth rate than hen from hatching to 12th week, after which time the average daily gain of roosters underwent a shift to join that of females at the 16th week.

Table 7 shows the correlations between the growth rate and average daily gain at different ages in local chickens in the western highlands of Cameroon.

Table 5: ANOVA of the effects of genetic type and sex on the growth rate at given age of local chickens of western Highlands of Cameroon

Source of variation	df	Means square in weeks 0-4th	4-8th	8-2th	12-16th
Genetic types (P)	3	311.435*	1717.342**	74.082^{ns}	177.908**
Sex (S)	1	1775.524*	18742.655**	16212.691**	9014.068**
P x S	3	26.985^{ns}	205.124^{ns}	18.170^{ns}	26.938^{ns}
Erreur résiduelle	462	191.321	189.413	48.501	19.651

*: Significant at 5%, **: Significant at 1%, NS: Non significant.

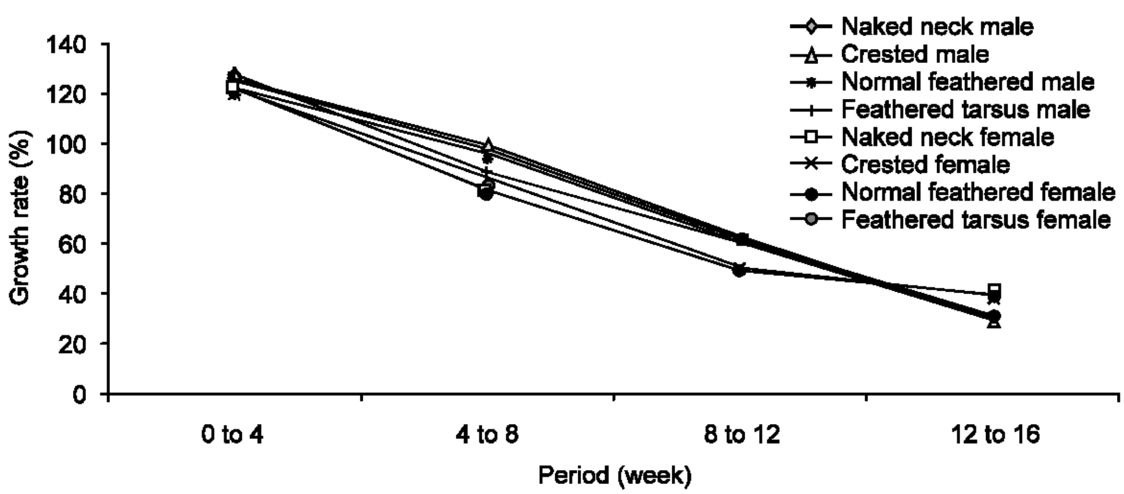

Fig. 2: Evolution of growth rate according to the sex and the genetic types of local chickens

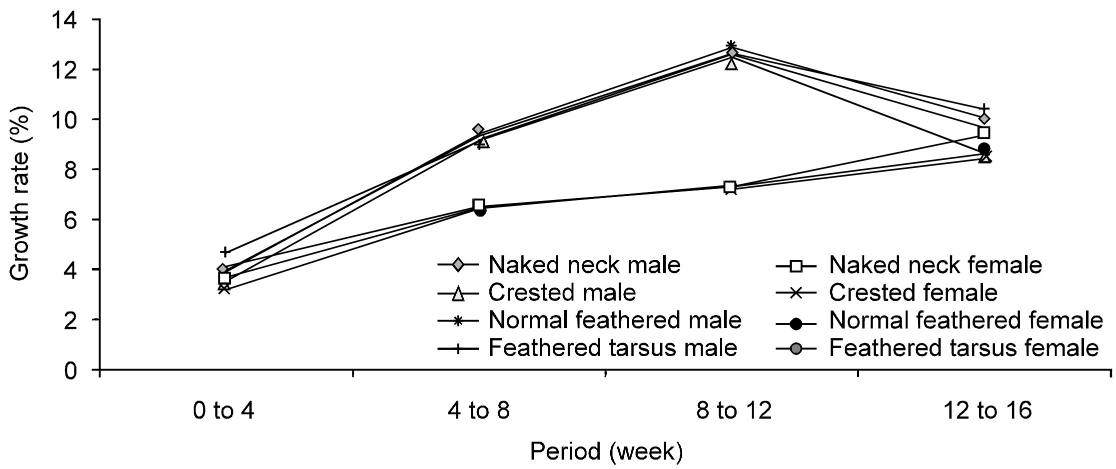

Fig. 3: Evolution of average daily weight gain as a function of genetic type and sex of local chickens

Table 6: ANOVA of the effects of genetic type and sex on average daily weight gain at given age of the local chicken in the western highlands of Cameroon

		Mean square of live weight in weeks			
Source of variation	df	0-4	4-8	8-12	12-16
Genetic types (P)	3	14.413**	1.386^{ns}	3.270*	38.942**
Sex (S)	1	24.277**	898.314**	3353.584**	58.225**
P x S	3	1.187^{ns}	1.306^{ns}	1.646^{ns}	4.721^{ns}
Residual error	462	1.754	2.014	1.038	2.278

*: Significant at 5%, **: Significant at 1%, NS: Non significant.

Table 7: Correlations between growth rate and average daily gain at given age in local chickens of the western highlands of Cameroon

		Growth rate				Daily weight gain (DWG)			
	Weeks	0-4	4-8	8-12	12-16	0-4	4-8	8-12	12-16
Growth rate	0 - 4	1							
	4 - 8	-0, 68**	1						
	8 -12	0, 01 ^{ns}	0, 05^{ns}	1					
	12 - 16	-0, 09*	-0, 24**	-0, 59**	1				
DWG	0 - 4	0, 84**	-0, 63**	-0, 02^{ns}	-0, 15**	1			
	4 - 8	-0, 12**	0, 73**	0, 05^{ns}	-0, 47**	0, 05	1		
	8 - 12	0, 19**	0, 26**	0, 75**	-0, 73**	0, 32**	0, 62**	1	
	12 - 16	0, 17**	0, 07^{ns}	-0, 19**	0, 49**	0, 30**	0, 34**	0, 15**	1

**: Significant correlation at 0.01. *: Significant correlation at 0.05.

The correlations between the growth rate for the period 8-12th weeks with those periods of 0-4 and 4-8 weeks were not significant (P≥0.05). Other correlations that were significant between growth rates at different ages are all negative. In addition, only the correlation between DWG period from 0-4th and 4-8th weeks was not significant. All correlations between DWG of the other growth periods were positive and highly significant (P<0.01). Furthermore, correlations between growth rate and DWG at different periods of growth are highly variable.

The analysis of variance of the effects of genetic type and sex on feed consumption at different ages of the local chicken is presented in Table 8.

The genetic type of local chickens significantly influenced (P<0.05) the feed efficiency during the period 12-16th weeks. The effect of sex very significantly influenced this parameter during the period from the 8th to the 12th week, while the interaction of these two sources of variation is not significant regardless of the period.

Figure 4 shows the indices of food consumption as a function of genetic type and sex of the local chicken.

The average index of consumption is generally high regardless of sex (7.48 on average). At equal sex roosters and hen of the tarsus feathered genetic type presented the highest consumption indices as compared to those of their counterparts of other genetic types. On the contrary, crested roosters and normal feathering hens are those who made a better use of the food. Whatever the type genetics, feed efficiency is better in roosters.

Table 8: ANOVA of the consumption index based on genetic type and sex of the local chicken

		Mean square of consumption index/period		
Source of variation	df	8-12	12-16	8-16
Genetic type (P)	3	0.40^{ns}	1.32*	0.63*
Sex (S)	1	82.95**	1.24^{ns}	15.98**
P x S	3	0.08^{ns}	0.27^{ns}	0.16
Residual error	16	0.14	0.14	0.35

*: Significant at 5%, **: Significant at 1%, NS: Non significant.

Table 9: Survival rates according to the genetic type of local chicken in the western highlands of Cameroon

	Genetic type			
Paramèters	Normal feathering	Fathered tarsus	Crested	Naked neck
Survival rates (%)	85, 60	61, 40	68, 80	76, 25

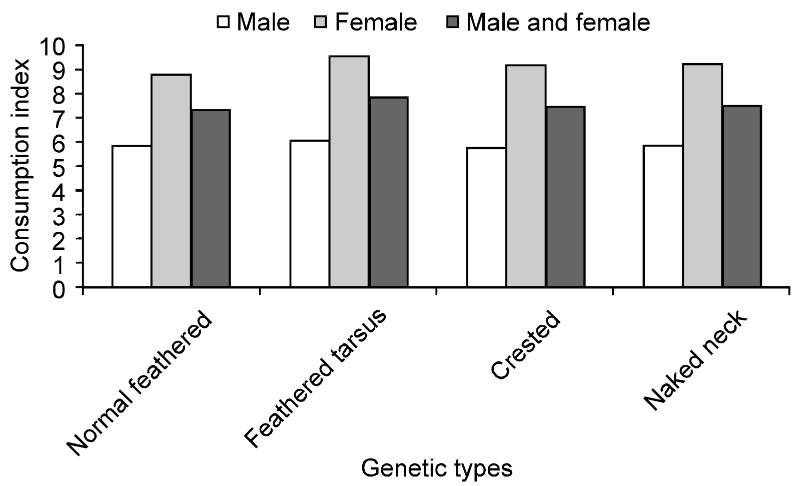

Fig. 4: Indices of consumption according to the genetic type and sex of local chicken in the western highlands of Cameroon

Table 9 shows the survival rates according to the genetic type of local chicken in the western highlands of Cameroon.

Survival rates vary greatly between genetic types. Feathered tarsi chicken was less resistant to the conditions of our study, with only 61.4% of chicks survived until the 16th week of breeding. On the contrary, normal feathering chickens were the most rustic, with 85.6% survival rate at the end of the test. Crested and naked neck chicken had intermediate survival rates, respectively 68.80 and 76.25%.

The analysis of variance of the effect of sex and genetic type on thermal tolerance of the local chicken in the western highlands of Cameroon is presented in Table 10.

There is a significant effect of genetic type (P<0.01) and sex (P<0.05) on the index of thermal tolerance of local chickens. On the contrary, the interaction effect of these two factors was not significant ($P \geq 0.05$).

Figure 5 compares the thermal tolerance index based on genetic type and sex of the local chicken in the western highlands of Cameroon.

Naked neck chickens are more thermo-tolerant, followed by the crested ones, while feathered tarsus genetic type is the less heat tolerant. In general, females have better supported thermal stress than males.

The morphological, biometric growth performance and thermal tolerance of the local chicken Highlands of West Cameroon are significantly (P<0.05) affected by the genetic type. However, ignorance of the parameters of the growth curve of each genetic type does not allow to better assess differential rates of weight development, the effects of sex, or a possible selection criteria for choosing the best candidate for genetic improvement.

DISCUSSION

On-station laying performances in the four genetic types are quite high. This would be due to the effects of system and breeding techniques improvements (removal of eggs from the nest) on laying performances. Indeed, Campbell (2003) reported that the regular collection of eggs greatly increases the rate of lay. However, the laying performances are lower than that reported by Horst (1989), Van Marle-Koster and Casey

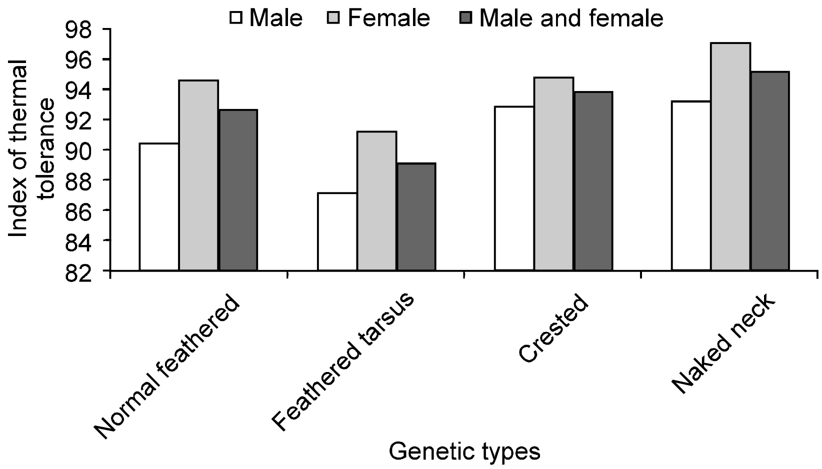

Fig. 5: Index of thermal tolerance according to the genetic type and sex of local chicken in the western highlands of Cameroon

Table 10: ANOVA of the index of thermal tolerance according to genetic type and sex of the local

Source of variation	df	Mean square of the index of thermal tolerance
Type genetic (P)	3	124.47**
Sex (S)	1	157.55*
P x S	3	51.35ns
Error residual	16	29.89

*: Significant at 5%, **: Significant at 1%, NS: Non significant.

(2001). These differences could be due to genetic variation between strains of local chicken used in Egypt (Fayoumi) and South Africa (Koekoek) respectively. Superiority naked neck type for laying performance was due to the indirect effects of gene Na (Horst, 1989).

Fertility, embryonic mortality and hatching rates corroborate those obtained by Smith (1990). Low hatchability recorded in crested, feathered tarsus and naked neck chicken as compared to their normal feathering counterpart could be explained by the influence of different major genes or polygenes carried by these animals. Indeed, Horst (1989) mentioned some negative effects of naked neck gene Na on hatchability of eggs, especially the increase in embryonic mortality and reduced hatchability by about 10%. In addition, the Cr gene of the crest is recognized as reducing the hatchability without being explicitly lethal (Keambou, 2006).

Growth performance in this study are higher than those of Hoque *et al.* (1975), Demeke (2004), Halima *et al.* (2006) but consistent with those of Mafeni *et al.* (1997). The superiority of the feathered tarsus type confirms the action of Pti genes series on improving the weight, while the inferiority crested type allow to suggest the depressive effect of Cr gene on body weight and consumption index of local chickens. On the contrary, Hako (2008) mentioned an ameliorative effect of the Cr gene on body measurements such as length of tarsus, body and wings. Sexual dimorphism observed in favor of males is in agreement with those obtained by Missohou *et al.* (1998) and Perez *et al.* (2004). It is known that androgens stimulate the growth and feed efficiency of young males and increase energy production (Campbell *et al.*, 2003). A low dose of testosterone in synergy with growth hormone induce maximum growth while estrogen in females are involved in the regression and blocking of epiphyseal cartilage of long bones, thus slowing growth (Sturkie, 1976). This is why a large variability in growth performance and body size was observed from the 8th week. The inflection of the growth curve of local chickens from the 12th week is also due to hormonal activity (Hako, 2008). At high dose during puberty, testosterone and estrogen inhibit the effects of growth hormone on epiphyseal cartilage. Therefore, the fusion of long bones leads to growth arrest (Craig, 1999; Campbell *et al.*, 2003).

The average temperature in the study area ranged between 14 and 30°C, hence minima and maxima outside the neutral thermal zone of the chicken (18-25°C). This confirms the hypothesis that the chicken have just needed to regulate their body temperature. The superiority of the naked neck and crested chicken regarding thermal tolerance may be the result of genetic determinism acting indirectly on the body temperature through anatomical and/or physiological predispositions. Indeed, naked neck and crested chickens have a low body weight/unit area ration (Hako, 2008) which is consistent with the rule of Bergmann (1847) cited by Campbell *et al.* (2003) and justifies the ability to efficiently dissipate heat by conduction, convection, radiation and evaporation. This ability was increased in the naked neck chicken, whose responsible Na gene reduces the density of plumage by approximately 40% (Merat, 1986). This is consistent with the rule of Wilson (1854) cited by Campbell *et al.* (2003) mentioning the influence of the density of plumage on the thermal regulation. The two rules mentioned above also justify the low capacity of thermo-tolerance of feathered tarsi chickens which is also heavier and having the densest plumage with a full or partial recovery of the tarsi. However, the observed variability for thermo-tolerance in populations of local chickens in the western highlands of Cameroon may also be related to the multiplicity of plumage colors as suggested by the rule Gloger (1833) cited by Campbell *et al.* (2003). The low thermo-tolerance in males as compared to females may be due to the activity of androgens which are activators of metabolism and therefore promote thermogenesis (Hako, 2008) that the roosters were difficult to control.

Conclusion: Reproductive performances are influenced by the genetic type. Naked neck type generally has the best laying performance and therefore may be more suitable for mass selection for improved production of eggs from local chickens.
Growth performance is affected by the genetic type and sex of the local chicken in the western highlands of Cameroon. Feathered tarsus genetic type has the highest weight regardless of age. Similarly, males were significantly heavier than females regardless of genetic type and sexual dimorphism on the basis of body weight is more pronounced with age. Whatever the genetic type and sex, the coefficients of variation of weight were low at hatching. The feathered tarsus chickens and naked neck showed the highest growth rates. In addition, weight gain and feed efficiency of chickens local in the western highlands of Cameroon were also significantly affected by the genetic type and sex. Whatever sex, the feathered tarsus chicken presented the highest consumption indices, while crested male and normal feathering female made the better use of food. Survival rates were significantly affected by the genetic type of local chickens of the western highlands of Cameroon. The feathered tarsi local chicken is the most susceptible, while its counterpart of normal plumage is more rustic. In addition, the genetic type and sex significantly influenced the thermal tolerance index of local chickens of the western Highlands of Cameroon. The naked neck chicken is the most thermo-tolerant, the feathered tarsus genetic type is less heat tolerant and in general females are more heat stress tolerant than males.

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