Research Article

Growth Performances, Carcass and Egg Characteristics of the Local Chicken and its First Generation Reciprocal Crossbreds with an Exotic Strain in Cameroon

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Abstract | With the aim of improving the productivity of local chicken, reciprocal crossbreeding experiments were carried out to compare the performances of Hubbard rooster x local chicken (HL) and local rooster x Hubbard female (LH) to those of pure Hubbard (HH) and local (LL) breeds simultaneously reared in the same conditions in the Western Highlands of Cameroon. The main result showed that the effect of genetic type has significantly influenced the studied parameters. The analysis of egg characteristics revealed that the HH and LH crossbreds produced eggs of statistically comparable weight (P>0.05) of 70.28 ± 0.62g and 69.51 ± 0.58g, respectively. These eggs proved to be heavier and of significantly higher measurements (P<0.05) than those of the LL and HL crossbreds, which in turn presented best shape indices of respectively, 73.95 ± 1.20 and 72.79 ± 0.65. The study of growth, conformation and carcass revealed that HH chicks significantly consumed more feed (P>0.05) than the three others genetic type throughout the study period and had the best performances (P>0.05) from the first to the seventh week for all considered parameters. The final weight of HH was 1504.69 ± 88.07g, followed by LH (762.78 ± 122.68 g), then HL (451.17 ± 62.13 g) and finally LL (422.31 ± 20.94 g). On the other hand, LH chicks had better mean daily weight gain (31.34 ± 16.78) and feed conversion (2.86 ± 0.06) than LL (4.19 ± 0.57) and HL (12, 08 ± 5.29). But whatever the period, HH chicks made the best feed conversion (2.04 ± 0.07 and 2.58 ± 0.17 for the starting and growing period), carcass yield and heart weight (72.28 ±1.13 % and 12.2 ± 2.33 g). On the contrary, there was no significant difference for the liver and crop weight (12.20 ± 3.65 g; 13.56 ± 2.65 g and 10.07 ± 3.16 g; 12.00 ± 1.77 g) respectively for HL and LL.

Keywords | Aviculture, Cameroon, Crossbreeding, Productivity

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INTRODUCTION

In developing countries, village poultry is of very significant importance as a major source of meat and table egg and as a source of income (Zaman et al., 2004), mainly for the most deprived populations. Genetic resources making up that aviculture in traditional farming system are formed of a multitude of often poorly characterized populations. In Cameroon, village poultry is made up of 70% of local chickens population (Fotsa et al., 2007), and about 24% of exotic strains (Tchoumboué et al., 2000; Fotsa and Manjeli, 2001; Téleu and Ngatchou, 2006; Fotsa et al., 2007). The remaining 6% being made up of ducks, geese, guinea fowl.

Although numerically significant, local chicken remains the poor parent in term of investment and its productivity remains low as compared to exotic strains (Mafeni et al., 2005). Yet it is agreed that the local chicken is extremely well suited to tropical environmental conditions through natural selection. The exploitation of the good adaptive characteristics of the local chicken would better be carried out through controlled crossbreeding programs with high performant exotic strains to exploit the phenomenon of heterosis and produce high yielding chickens adapted to the farming systems of tropical rural areas.

Crossbreeding indeed improve heterozygosity of non-additive gene causing heterosis, important in extreme environmental conditions. In fact, crossbreeding constitute one major tools for the exploitation of genetic variation and hybrid vigour by combining different important characteristics of each breed (Hanafi and Iraqi, 2001) and exploitation of maternal genetic effects or related to sex, associated with specific combinations between breeds or strains. The analysis of the combining aptitudes and the differences between zootechnical performances of the crossbreeds allow identifying the best possible combinations for the exploitation of hybrid vigour according to desired objectives (Mekki et al., 2005). Crossbreeding between adapted local chicken and high yielding exotic strain would enable to exploit both the rusticity of the first and zootechnical performances of the second in the tropics to produce adapted and more productive genetic types.

Beugre et al. (2007) and Gnakari et al. (2007) evaluated the production performance in a substitution crossbreeding between terminal Hubbard rooster and the local hen, but ignorance of the reciprocal crossbreds' performance does not give choice options on the most advantageous direction of crossbreeding for rapid and efficient genetics progress.

It is in that perspective that we set as objective to contribute to improving the productivity of the local chicken by comparative evaluation of its performances to that of an exotic strain and their reciprocal crossbreds under the same breeding conditions.

MATERIALS AND METHODS

The study was conducted at the Application and Research farm of the University of Dschang (FAR-UDs) in Western Cameroon (5° 20'-7° 00 'and 10° 03'- LN 12° 00 'E. The climate is of Sudano Guinean altitude type. The temperature ranges are from 16 to 27°C and relative humidity between 40% during the driest months (January-February) and 100% during the wettest months (July-August). The rainfall, with an annual average of 2000 mm are distributed in one season from March to November (Keambou et al., 2007).

Parental pens consisted of an exotic sub-terminal broiler (Hubbard) strain in pure breed (HxH), local normal feathered chicken from western highlands of Cameroon in pure breed (LxL) and their reciprocal crosses (HxL and LxH) for a sex ratio of 1/8. The crosses were made by natural service. Maintenance of parental was made in accordance with the recommendations of the Hubbard breeding guide (Hubbard, 2006). According to the direction of the crossings, eggs were collected, cleaned, graded and stored at room temperature in a room for a maximum of 7 days before incubation.

At hatching, the chicks were identified by a ring placed on the left leg. Body weight and body measurements were then recorded before transfer to brooding area according to genetic groups. Each box was equipped with a deep litter of wood shavings. The breeding density was 8 chickens/m^2.

During the week, the feed given to each lodge was weighed and by weekends, early mornings, body weight and individual measurements were recorded and leftover of feed weighed. The animals had *ad libitum* access to feed and water. The prophylaxis plan was modelled after the standard from that in use at the FAR-UDs. The characteristics of the feed distributed are presented in Table 1.

Table 1: ration composition of breeders and chicks

Ingredients	Proportion in the ration in %	
	Breeders	Chicks
Corn	62.5	60
Cotton	10	3
Soya meal	0	25
Fish meal	7.5	1
Oyster shell	3.5	2
Bone meal	10	4
CAMV	6	5
Salt	0.5	0
Total	100	100
Crude protein	17.92	22.3
Calcium	6.06	2.76
Phosphorus	2.32	1.03
Lysine	0.82	1.09
Methionine	0.42	0.36
Metabolisable energy	2745.75 Kcal	2885.60 Kcal
Fat content	4.59	3.63

Hundred eggs per genetic type were used for eggs' characterisation, while a total of 2015 chicks were used for the evaluation of production performances.

The study parameters were the feed consumption, growth performances, eggs and carcass characteristics.

Statistical Analysis

Data collected were submitted to one factor (genetic type) analysis of variance, separation of means was made using the Duncan test each time that there were significant differences between them. These data were analysed using SPSS 12.0 statistical software threshold 5%.

Table 2: Early live weight of the chicks according to age and genetic type

Age (week)	LL		HH		HL		LH	
	n	x ± se	n	x ± se	n	x ± se	n	x ± se
0*	58	31.38 ± 1.17^{b}	82	43.40 ± 0.43^{c}	36	26.48 ± 0.94^{a}	39	43.20 ± 1.82^{c}
1	58	50.67 ± 1.55^{a}	82	97.80 ± 2.22^{c}	36	52.43 ± 4.70^{a}	39	66.77 ± 4.33^{b}
2	58	85.27 ± 2.92^{a}	79	201.22 ± 5.17^{c}	36	86.92 ± 8.19^{a}	39	128.99 ± 7.08^{b}
3	58	109.14 ± 4.10^{a}	78	320.83 ± 11.97^{c}	36	125.31 ± 12.90^{a}	39	190.17 ±25.04^{b}
4	58	147.13 ± 5.56^{a}	77	502.77 ± 22.54^{c}	36	180.97 ± 19.10^{ab}	39	273.56 ±37.11^{b}
5	58	206.51 ± 8.33^{a}	57	764.07 ± 36.47^{c}	36	254.54 ± 23.46^{a}	39	394.44 ±56.02^{b}
6	58	332.23±17.37^{a}	46	1079.06±70.56^{c}	36	366.55 ± 49.28^{a}	39	543.33 ± 4.11^{b}
7	58	422.31±20.94^{a}	46	1504.69±88.07^{c}	36	451.17 ± 62.13^{a}	39	762.78±122.68^{b}
Mortality (%)		0.00		43.90		0.00		0.00

a, b, c on the same line, the values assigned with the same letter are not significantly different (P> 0.05); * hatching , x ± se = mean ± standard error; n = numbers; LL= ♂L x ♀L; HH= ♂H x ♀H; HL= ♂H x ♀L; LH= ♂L x ♀H

RESULTS

Growth Performances

The weekly changes in food consumption as a function of the genetic type is illustrated in Figure 1.

Figure 1 shows that for all genetic groups, consumption increases with chicks' age, reflecting the fact that the metabolic needs change with age. Furthermore, consumption is generally intermediate between that of parental Hubbard strain and that of the local chicken (LL) in pure breed throughout the duration of the test. However crossbreds HL showed the lowest consumption between the 2nd and 3rd week. Which makes sense because the Crossbreds are of intermediate format and weight between the local chicken (lighter) and the Hubbard strain selected for rapid growth. Comparing the reciprocal crosses, the HL from the Hubbard rooster x local female crossing, with a lower consumption, would be economically more advantageous if only these parameters was to be considered.

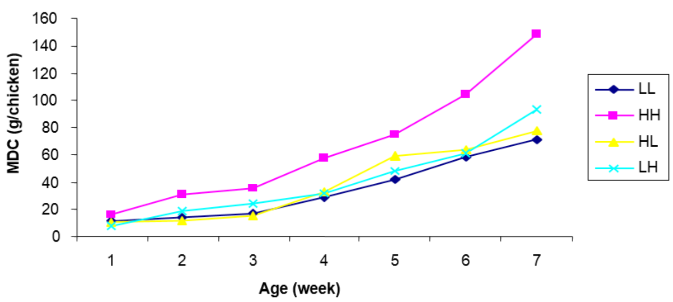

Figure 1: Evolution of the average early daily consumption according to genetic type and age
LL= ♂L x ♀L; HH= ♂H x ♀H; HL= ♂H x ♀L; LH= ♂L x ♀H

The weekly changes in the average weight according to the genetic type of chicks is presented in Table 2 and illustrated in Figure 2.

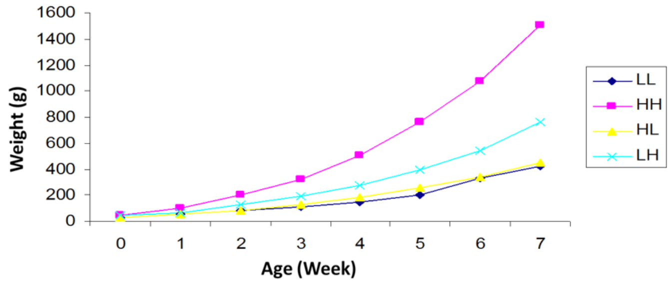

Figure 2: Evolution of the early live weight of the chicks according to genetic type
LL= ♂L x ♀L; HH= ♂H x ♀H; HL= ♂H x ♀L; LH= ♂L x ♀H

From Table 2, we can observe that the weight at hatching the various genetic types is significantly different ($p \leq 0.05$). However, the HH and LH chicks were statistically of similar weight ($P > 0.05$), and higher than those of the other two genetic types (LL and HL). At hatching, the HL chicks have the lowest weight ($p \leq 0.05$) compared to LH and LL. HH chicks exhibit faster growth (Figure 2), followed by LH, while the LL and HL are comparable ($P > 0.05$) in general for this parameter. At the seventh week which is the end of the trial , the HH chicks have the highest weight (1505g) ($p \leq 0.05$) compared to that of the two crossbreds LH (763G) and HL (451 g), while LL has the lowest weight (422g) ($p \leq 0.05$), confirming the small size of the local chicken. Using the Hubbard strain as a mother, would promote weight gain. The advantage of the Crossbreds would be linked to their rusticity to tropical conditions. This resulted in a zero mortality rate compared to that of a Hubbard strain which, although heavier, has suffered a significant loss (43.90%). Between reciprocal crossbreds, the LH also appears advantageous for the weight of the chicks.

The weekly evolution of the daily weight gain of chicks of different genetic types is presented in Table 3.

It comes from Table 3 that, the pure bred Hubbard, that was selected for high growth rate, have the best daily

Table 3: Daily weight gain evolution (g/j) according to age (week) and genetic type

Age (week)	LL		HH		HL		LH	
	n	x ± se	n	x ± se	n	x ± se	n	x ± se
1	58	2.76 ±0,79[a]	82	7.77 ± 2.25[b]	36	3.71 ± 1.50[a]	39	3.37± 2.05[a]
2	58	4.94 ±1.42[a]	82	14.78 ± 4.1[c]	36	4.93 ± 1.42[a]	39	8.89± 5.66[b]
3	58	3.41 ±1.67[a]	79	18.19 ±8.88[b]	36	5.48 ± 1.93[a]	39	8.74± 3.62[a]
4	58	5.43 ±1.32[a]	78	24.24 ±12.1[b]	36	7.95 ± 2.57[a]	39	11.91±5.48[a]
5	58	8.48 ±2.46[a]	77	29.44±13.07[c]	36	10.51±1.96[ab]	39	17.27±9.17[b]
6	58	17.96±8.64[a]	57	37.36±16.03[b]	36	16.00±10.61[a]	39	21.27±12.19[a]
7	58	12.87±5.00[a]	46	60.80±12.27[c]	36	12.08 ± 5.29[a]	39	31.34±16.78[b]

a, b, c on the same line, the values assigned with the same letter are not significantly different (P> 0.05); * hatching, x ± se = mean ± standard error; n = numbers; LL= ♂L x ♀L; HH= ♂H x ♀H; HL= ♂H x ♀L; LH= ♂L x ♀H

weight gain at the end of the trial (60.80 g), followed by LH chicks (31.34 g) while the pure local breed and the HL crossbred obtained the lowest gains. Once more, the LH crossbred could be more advantageously used to take advantage from the rusticity of the local chicken. However, economical studies are needed to confirm these allegations. The consumption index in the various genetic groups at the starting and finishing period is summarised in Table 4 and illustrated by Figure 3.

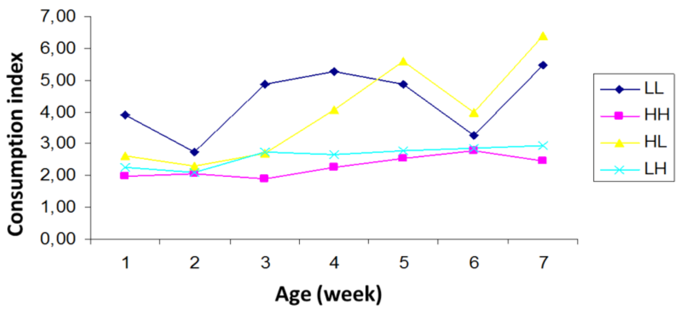

Figure 3: Weekly evolution of the consumption index according to genetic type
LL= ♂L x ♀L; HH= ♂H x ♀H; HL= ♂H x ♀L; LH= ♂L x ♀H

Table 4: Periodical consumption index according genetic type

Age (week)	LL	HH	HL	LH
1 – 4	4.19	2.04	2.93	2.43
5 – 7	4.54	2.58	5.33	2.86

LL= ♂L x ♀L; HH= ♂H x ♀H; HL= ♂H x ♀L; LH= ♂L x ♀H

It comes from the analysis of Table 4 that the HH chicks have the best consumption index at the starter phase (2,04) follow by LH (2.43) and HL (2.93), while LL had the bad feed efficiency (4,19). At the finishing phase, consumption indices of LH and HH are less than 3, while those of HL and LL reach 5.33 and 4.54 respectively, making these two genetic types the poor feed users. The comparison of the two reciprocal crossings show that chicks from local rooster and Hubbard female are more efficient that their reciprocal homologues. Figure 3 shows that the evolution of the consumption indices of chicks from exotic mothers (HH and LH) are almost parallel, prove that LH make good use of feed than LL and HL.

Characteristics of Eggs

It comes from the analysis of Table 5 that the weight, measurements and shape index of eggs vary significantly (p ≤ 0.05) according to the genetic types. Eggs from LH and HH crossbreds are statistically comparable (p> 0.05) in weight, length and width and significantly higher (p ≤ 0.05) than those from HL and LL. However, although variable depending on the genotype or direction of crossing, shape indices of eggs from different genetic types are lower than the international standard index of conditioning (75). Thus the use of the Hubbard as mother strain will allow to keep a fairly high egg weight although slightly decreasing the shape index, and will give the benefit of maternal effects to the crossbred chicks, their weight at hatch being correlated to the weight of the egg.

Carcass yield and Organs Proportions

Table 6 shows the carcass yield and proportions of the various organs at seven weeks depending on the genetic types.

From Table 6 that for all carcass traits studied (live weight, carcass, liver, gizzard and heart), there is no significant differences (P> 0.05) in chicks from local hens which are the lightest otherwise (p ≤ 0.05) of the four genetic groups. life weight, carcass and heart weight of HH chicks were significantly higher (p ≤ 0.05) compared to those of LH chicks, which is not the case for the weight of the liver and gizzard, chicks from exotic hens not showing significant differences (P> 0.05) between them for these parameters.

The carcass yield of animals from exotic hens is better than that of their counterparts from local mothers. In addition, liver and gizzard of LH and HH, presented the lowest proportion in relation to body weight. For almost all of the studied parameters, Hubbard parental strain HH chicks showed the best performance. The second best performance is that of LH Crossbreds. They would be entitled in

Table 5: Weight, length, width and shape index of eggs according to the genetic type

Crossings	n	Weight (g)	Length (mm)	Width (mm)	Shape index
		x ± se	x ± se	x ± se	x ± se
LXL	100	47.39 ± 0.74[b]	55.95 ± 0.44[a]	41.36 ± 0.71[b]	73.95 ± 1.20[c]
HXH	100	70.28 ± 0.62[c]	63.18 ± 0.65[c]	43.92 ± 0.19[c]	69.67 ± 0.64[a]
HXL	100	45.40 ± 0.37[a]	53.17 ± 0.27[b]	38.69 ± 0.32[a]	72.79 ± 0.65[bc]
LXH	100	69.51 ± 0.58[c]	62.28 ± 0.71[c]	44.19 ± 0.33[c]	71.15 ± 1.02[ab]

a, b, c on the same column, the values assigned the same letter are not significantly different (P> 0.05); x ± se = mean ± standard error; n = size

Table 6: carcass yield and organs' proportion at the 7th week according to genetic type

Absolute weight of organs (g)	Genetic types			
	LL x ± se	HH x ± se	HL x ± se	LH x ± se
Live weight	358.30 ±52.28[a]	1608.33±150.56[c]	415.63 ± 63.29[a]	1230.00±45.37[b]
Semi-eviscerated carcass	220.33 ±36.99[a]	1161.66±103.94[c]	258.90 ± 44.77[a]	836.66 ±39.83[b]
Liver	12.00 ± 1.02[a]	39.90 ± 3.56[b]	13.56 ± 1.53[a]	32.76 ± 3.18[b]
Crop	10.07 ± 1.82[a]	29.37 ± 1.60[b]	12.20 ± 2.11[a]	24.63 ± 2.18[b]
Heart	2.63 ± 0.44[a]	12.2 ± 1.35[c]	2.43 ± 0.44[a]	8.13 ± 0.55[b]
Carcass yield (en % du poids vif)				
Semi-eviscerated carcass	61.16 ± 2.53[a]	72.28 ± 1.13[c]	61.84 ± 2.78[a]	67.97 ± 1.27[b]
Liver	3.41 ± 0.40[b]	2.49 ± 0.17[a]	3.33 ± 0.43[b]	2.67 ± 0.50[ab]
Crop	2.78 ± 0.37[b]	1.84 ± 0.14[a]	2.92 ± 0.32[b]	2.01 ± 0.38[a]
Heart	0.73 ± 0.31[a]	0.76 ± 0.10[a]	0.60 ± 0.16[a]	0.66 ± 0.12[a]

a, b, c on the same line, the values assigned with the same letter are not significantly different (P> 0.05); * hatching, x ± se = mean ± standard error; n = numbers; LL= ♂L x ♀L; HH= ♂H x ♀H; HL= ♂H x ♀L; LH= ♂L x ♀H

addition to their good performance, the hardiness of native chickens.

DISCUSSION

The weight of the eggs obtained from the local chicken are close to those reported by Mafeni et al. (2005) and slightly higher than those of Zaman et al. (2004) (43.5 g). Interbreeding could be the cause of the difference in weight obtained in crosses where females are local. In fact, local chicken reared in its natural environment is likely to contain mixed blood, because no prior selection has been carried out within the Cameroonian chicken populations and there is no control of reproduction. Moreover, permanent ramblings of cull animals are likely to affect the gene pool of local chicken, which in turn influence the egg weight. The weights of the eggs from this study are significantly higher than the results obtained in Ivory Coast by Beugre et al. (2007) as well with the local breed than with Hubbard strain. This difference may be related to either a real existence of genetic variability between the Ivorian and Cameroonian chicken or the effects of different environments. The great difference in egg weight we obtained between the different types of crossings is due to the fact that HH and LH chickens consume enough food to meet their energy needs (Gnakari et al., 2007). But their LL and HL counterparts do not consume enough. This feeding behaviour as shown by Diomandé (2001) and Mignon and Faure (2002), impacts on production and morphological quality of the egg. For it is in the food that the hens derive the necessary elements for the formation of the egg (energy and plastic material, protein and calcium). The shape indices obtained in the range of 73 for LL and HL and 71 for HH and LH are similar to those reported by Moussounda (2009) and lower than the required standard of 75 for eggs to be conditioned in the standardised packages. Although pure breed Hubbard was selected under the environmental conditions of temperate regions on the basis of the shape index of their eggs, respecting international packaging standards, their introduction in a tropical environment is likely to change that character.

The results regarding feed consumption corroborate those Kjaer and Mench (2003). In fact, exotic chickens ingest more food than African chickens in the same breeding conditions. This is what emerges from the work of Gnakari et al. (2007) who obtained 352 and 736 g per chick for the entire starting period, respectively for African chickens and exotic chickens. The high consumption of LH also observed at the finishing compared to LL and HL is probably related to genetic factors of the different breeds, and to genetic characteristics that they have inherited from their parents, especially from the exotic mother, as they are LH and HH that consume the most. In addition, the HH and LH chicks had the best performances compared to other genetic types in regard to body growth, weight gain and feed efficiency. The superiority of LH chicks compared to HL is consistent with results reported by Willeke (1982) and Mafeni et al. (2005) wich indicate that the maternal effect would be responsible for weight gain and all the performances related thereto. Gnakari et al. (2007) obtained for starting and finishing feed conversion ratios of 2.2; 1.3 and 1.8 respectively for the African chicken, exotic chicken and the crossbreds (F1). While at the finishing for the same animals they noted food efficiencies of 3.1, 1.6 and 2.6, respectively. This difference could be due to genetic types and local environmental factors. The fact that the consumption index of local chickens was higher than that of HH and LH shows that there should be more efforts to improve local chicken that to date is a bad feed user, just like HL. The French Ministry of Cooperation (1980) indicates that the feed conversion less or equal to 3 means good feed processing and thus the ability to have high growth rate. In view of the results recorded in the Crossbreds, LH chicks meet these criteria. The interaction of polygenes, pleiotropy and epistasis could also be the reasons why, in the case of the Crossbreds, LH does not fully express the same amount of character than in HH.

The analysis of the carcass characteristics at seven weeks of age revealed the existence of variations between weight and proportions of organs according to genotypes. The proportions of gizzard, liver and heart of the four types genetic in this study are higher than those reported by Ricard et al. (1994). These differences could be due to genetic differences on the one hand but also the effects of the environment. In fact, the phenotypic expression is the result of the sum of interactions between genes and the environment to which the animal is subjected. Similarly, carcass yield significantly higher in the exotic chicken over local chicken is contrary to the results of Jaturasitha et al. (2002) who found similar values in local chicken and broilers (64.54% against 65 64%). The same observation is done for the proportions of the organs. The significant difference obtained between LH and HL on carcass yield can find an explanation in the paternal gene effects of local roosters that would slightly influenced, by the phenomenon of additivity, maternal effects of Hubbard strain, without inhibiting them completely. Although of local father, LH has a higher carcass yield compare to LL and HL. The analysis of the proportions of the organs and carcass performance confirms the superiority of LH on HL on one hand but especially on the local chicken in pure breed.

CONCLUSION

The characteristics of the eggs, the growth performances and carcass characteristics were significantly influenced by genetic type. The crosses involving exotic mothers (a HxH and LxH) produced statistically comparable egg weight, length and width, and significantly higher than those of the other two crosses. In addition, the cross HxL produced eggs whose characteristics were significantly lower than those of LxH suggesting that the latter crossing would be better for egg production compared to HxL crossing. For all parameters studied, the chicks from the two reciprocal crosses have underperformed the HH chicks, but were superior to chicks from the local chicken in pure breed. Raising LH chicks would be better for growth parameters and carcass characteristics.

CONFLICTS OF INTEREST

There is no conflict of interest.

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AUTHOR'S CONTRIBUTION

Christian Tiambo Keambou being team leader and principal investigator planned experiment, collected data and performed statistical analysis. Sylvere Mboumba, Celestine Bembide, Toussaint Mezui Mezui and Annie Marie Yvonne Tedongmo helped in collection of data. Blaise Arnaud Touko Hako assisted in experimental planning and statistical analysis. Yacouba Manjeli acted as general supervisor and edited the first draft.

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