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Full Length Research Paper

Comparison of growth performance, carcass characteristics and meat quality of Benin indigenous chickens and Label Rouge (T55×SA51)

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A study on growth performance, carcass traits and meat quality was carried out on Savannah and Forest ecotype chicken of Benin, using Label Rouge (T55 X SA51) as a control genotype. All the animals were fed *ad libitum* with three diets (starter, grower and layer feed). They were individually weighed at hatching and during the growing stage, and the daily feed intake was recorded. A sample of 12 males of each genetic type was slaughtered for carcass characteristics. Sensory analysis was done on each genetic type after boiling or roasting. The Label Rouge chickens were heavier than the local chickens at hatch (P<0.001). At the end of 40 weeks, the weight of the Label Rouge was double that of the Savannah ecotype and 2.8 times that of the Forest ecotype. The feed efficiency of the Label Rouge was higher than that of the local chickens (P<0.001). The genetic type influenced tenderness and juiciness, with the local Savannah chicken being the most tender and juiciest (P<0.001). However, the cooking method and the carcass cut influenced tenderness only. The overall assessment of the meat of the Label Rouge chickens was similar to that of the local chickens, whereas the assessment of the meat was significantly lower for local chickens of Forest ecotype compared to the Savannah ecotype (P<0.001). The local chickens would therefore be suitable for improving traditional poultry production, whereas controlled crossbreeding programmes using Label Rouge could be recommended to improve local chicken weight.

Key words: Growth, carcass, sensory characters, indigenous chicken, Label Rouge.

INTRODUCTION

Food security is the most important challenge of the Food and Agriculture Organization (FAO) and aims at satisfying the demand of a growing world population. In the sector of animal production, poultry breeding is an opportunity to increase animal proteins production. In Benin, with much of the efforts provided by the government, meat production has failed to meet consumers' needs, and this deficit is compensated by meat import which is increasing (FAOSTAT, 2008). For a sustainable production and food security of animal proteins, meat production should take into consideration

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the indigenous chicken population which accounts for 80% of the local production of chicken meat.

In Benin, local chickens of the species *Gallus gallus* of the two main climatic areas (savannah and forest) showed significant differences in live weight and morphological features (Bonou, 2006). The aim of this study was to determine whether these differences in growth performance were due to environmental effects or to differences in the genetic make-up and breeding mode of local chickens. To carry out this work, performance of a sample of local chickens from both savannah and forest regions was evaluated in a controlled environment of an experimental station. The evaluation procedure included parameters such as growth, carcass traits and meat quality. A control genotype of slow-growing chickens from a Label Rouge cross (T55 X SA51) was included in order to connect this comparison of savannah and forest local chickens with similar comparisons realised in other coastal countries of West Africa (Ivory coast and Ghana) within the context of a project supported by the DURAS programme for Promoting Sustainable Development in Agricultural Research Systems (Youssao, 2006).

MATERIALS AND METHODS

Study area

The study took place on the Experimental Farm of the Ecole Polytechnique d'Abomey-Calavi (EPAC), located in Abomey-Calavi in Atlantic Department. This area exhibits climatic conditions of sub-equatorial type, characterized by two rainy seasons: major (from April to July) and minor (from September to November). These two seasons are separated by a dry season. Average rainfall is close to 1200 mm per year. The monthly average temperatures vary between 27 and 31°C and the relative air humidity fluctuates between 65%, from January to March, and 97%, from June to July.

Animals and management

Young local chickens were purchased from the savannah (n = 48) and forest (n = 40) regions in order to set up a breeding nucleus at the Experimental Farm of EPAC. The females had not yet started to lay. After one month of adaptation, they were separated by area of origin and divided into groups of 6 (5 hens and 1 cock). Eggs were collected, weighed and incubated per area. At hatch, two groups of chicks were constituted per area. To coincide with the hatching of the local chicks, 204 Label Rouge chicks resulting from crossing T55 line and SA51 line were imported from the SASSO Group of France (Couvoir 7203, Sicamer, Route du Grand Lucé, 72440, Volnay, France). In all, the study of growth performance was carried out on: 199 Label Rouge chicks (98 males and 101 females), 139 chicks of the Savannah ecotype (54 males and 85 females), and 145 chicks of the Forest ecotype (65 males and 80 females).

Each group of chicks were kept in confinement of 40 m² of area at the Experimental Farm of EPAC and fed ad libitum with three diets. A starter diet with 2880 Kcal ME/kg and 186 g/kg of crude protein was used from hatch to 2 months of age; a grower diet with 2970 Kcal ME/kg and 178 g/kg crude protein was used from 2 months of age to 22 weeks age; and a layer diet with 2800 Kcal onset of lay tothe end of the experiment. The composition and the nutrient contents of each diet are given in Table 1. Newcastle disease, avian infectious bronchitis, Gumboro disease, fowl pox and Marek's disease vaccines were administered. Samples of faeces were analysed monthly in order to evaluate the effectiveness of the antiparasitic treatments, and to make sure that coccidiosis and gastro-intestinal parasites did not influence animal growth. The chickens were individually weighed at hatching (P0), at 2 weeks of age (P2), at 4 weeks of age (P4) and then once per month. The average daily gain (ADG) was calculated for each period. Daily feed intake was recorded and feed efficiency (feed intake / weight gain) was calculated.

Carcass characteristics

A sample of 12 males of each ecotype was slaughtered at the age of 24 weeks for the carcass evaluation. One day before slaughter, all chickens were fasted over-night, killed the following morning by exsanguination, scalded in boiling water and manually plucked. The live weight of the chicken was taken before slaughtering. The carcasses were stored at 4°C for 24 h. The legs were cut at the tibiotarsus-metatarsal articulation and the head was separated from the neck at the cranium-atlas junction. The abdominal and thoracic cavity organs were then removed, as well as the abdominal fat. The carcass weight as well as weights of the waste products and the giblets (head, legs, liver, heart, gizzard and proventriculus) was determined. The various cuts taken were the following: the breast, the whole thigh-drumstick, the wings and the rest of the carcass.

Sensory analysis

The sensory analysis was done on each genetic type. Each carcass was cut in two halves, one of which was tasted after cooking in water and the other after being roasted. The carcass cuts (drumstick, thigh and breast) were cooked in water in a separate pot without flavoring and salt, within a time proportional to their weight on the basis of 1 h/kg. After cooking, the pieces were tasted. Similarly, the carcass cuts were roasted without flavoring, oil and salt within a time proportional to their weight.

For each method of cooking, each judge received in a plate of different color a part of each corresponding cut belonging to each ecotype (for example 5 judges each received one piece of drumstick of each genetic type) and filled out a questionnaire. The judges rated the three most important characteristics for meat quality: tenderness, juiciness and flavor intensity, on scales of 1 to 5. In addition, each judge gave an overall score of appreciation varying from 1 to 10. For tenderness, a score of 1 corresponded to very tough, 2 to tough, 3 to acceptable, 4 to tender and 5 to very tender. For the juiciness, 1 corresponded to very dry, 2 to dry, 3 to acceptable, 4 to juicy and the 5 to very juicy. Scores for the intensity of flavor were very weak (1); weak (2); acceptable (3); high (4) and very high (5).

Statistical analysis

Parameters of the growth curve were estimated with the Gompertz equation, according to Laird et al. (1965):

$$BW_t = BW_0\, e^{L(1-\exp(-Kt))/K}$$

where, BW_t is the recorded body weight at age t, BW_0 the estimated weight at hatching, L the initial specific growth rate (1/BWt) × (dBWt/dt) when t→0) and K is the maturation rate or the exponential factor of decay of the specific growth rate. Age at inflexion (TI) at which the growth rate is maximum, was calculated as follows:

Table 1. Composition and nutrient contents of the starting, growing and laying diets.

Composition	Starting diet	Growing diet	Laying diet
Soy cakes (g/kg)	12	7.5	15.5
Wheat bran (g/kg)	10	17.5	7
Corn (g/kg)	60	59	59
Cotton cakes (g/kg)	8	6.5	6
Fish meal (g/kg)	7	7	9
Lysine (g/kg)	0.2	0.2	0.2
Methionine (g/kg)	0.2	0.2	0.2
Salt (g/kg)	0.2	0.2	0.2
Oyster shell (g/kg)	2	1.5	2.5
Premix (g/kg)	0.25	0.25	0.25
Total (g/kg)	**100**	**100**	**100**
Nutrient levels			
Metabolisable energy (kcal/kg)	2880.5	2969.6	2800.0
Crude protein (g/kg)	18.6	17.2	20.1
Lysine (g/kg)	0.91	0.78	0.92
Methionine + Cystine (g/kg)	0.63	0.58	0.72
Calcium (g/kg)	1.11	0.91	1.35
Phosphate digestible (g/kg)	0.28	0.27	0.35

$$TI = \left(\frac{1}{K}\right)\ln\left|\frac{L}{K}\right|$$

These parameters were estimated by non-linear regression with the NLIN procedure of SAS (Statistical Analysis System, 1999), taking into account all available weights from hatch to slaughter. Observations were weighted by the ratio of the phenotypic variance of slaughter weight to the phenotypic variance of BWt, in order to take into account the increase of variance of body weight with age. The data were analysed by a linear model. This model was adjusted to the data and included the fixed effects of the genetic type and the sex. The interaction between sex and genetic type was not significant and consequently was not considered in the model:

$$Y_{ijk} = \mu + B_i + S_j + e_{ijk}$$

where, Y_{ijk} is the weight, the average daily gain, the initial specific growth rate, the maturation rate or age at inflexion of the k^{th} hen of the i^{th} breed and the j^{th} sex; μ is the overall mean; B_i is the fixed effect of the i^{th} breed (Savannah ecotype, Forest ecotype and Label Rouge); S_j is the fixed effect of the j^{th} sex (female and male) and e_{ijk} is the residual error.

Sexual dimorphism was not observed before 16 weeks in the group of local chickens and therefore the daily feed intake and the feed efficiency were only calculated per genetic type. The carcass traits were compared per genetic type because only the males were slaughtered. As for the sensory qualities, the model included the fixed effect of genetic type, the cooking mode (boiled or roasted) and the carcass piece (thigh or breast). The interactions between genetic type and cooking method or between genetic type and carcass cut were not significant and were omitted from the final model.

For each parameter, the general linear models procedure was used for the variance analysis. The F test was used to determine the significance of each effect of the model. Pair-wise means were compared using Student t-test. Comparisons between growth performances were also made between the three genetic types per sex.

RESULTS

Growth performance

Table 2 presents live weight means of Label Rouge and local chicken according to the age. The Label Rouge chickens were significantly heavier than the Savannah and Forest indigenous chicken ecotypes (P<0.001) at all ages. During the first 8 weeks, the Savannah and Forest chickens had similar weights. Beyond the 8th week, the Savannah chickens were significantly heavier than the Forest chickens (P<0.01). At the end of the experiment, the weight of the Label Rouge was twice that of the Savannah chickens and 2.8 times that of the Forest chicken ecotype. Moreover, from hatch to the 4th week, males and females had similar weights (P>0.05) but differences between the weights of the two sexes were observed from the 8th week (P<0.05). From the 8th week onwards, the weight of the males was significantly higher than that of the females (P<0.001). At the end of the experiment, the males weighed 1704 g as against 1376 g for the females. Sexual dimorphism for the weights at8, 16 and 40 weeks was respectively, 4.9, 6.4 and 11% for Label Rouge, 6.4, 17.4 and 42% for the Savannah ecotype, and 12.8, 23.2 and 42% for the Forest ecotype. Figure 1a presents the comparison between the growth

Table 2. Least squares means of live weight of Label Rouge and Benin indigenous chickens.

Live weight (g)	Effect of population of origin			Sex effect		RSD	R^2	Test of significance for the effect of population	Test of significance for the sex effect
	Label	Savannah	Forest	Female	Male				
P0	43.0^{a}	26.8^{b}	26.2^{b}	32.1a	31.9^{a}	3.3	0.86	***	NS
P2	147.2^{a}	49.8^{b}	46.5^{b}	80.7^{a}	81.6^{a}	19.2	0.87	***	NS
P4	386.8^{a}	102.9^{b}	95.1^{b}	191.9^{a}	198.6^{a}	47.32	0.9	***	NS
P8	1099.6^{a}	220.8^{b}	201.0^{b}	491.9^{a}	522.3^{b}	120.6	0.93	***	*
P12	1548.3^{a}	390.4^{b}	315.3^{c}	690.5^{a}	812.2^{b}	140.9	0.95	***	***
P16	1747.8^{a}	738.6^{b}	430.6^{c}	870.9^{a}	940.4^{b}	182.9	0.92	***	***
P20	2009.3^{a}	824.4^{b}	590.7^{c}	1087.5^{a}	1195.4^{b}	169.4	0.86	***	***
P24	2290.0^{a}	887.9^{b}	705.9^{c}	1242.5^{a}	1413.5^{b}	294.2	0.86	***	***
P28	2171.3^{a}	1068.9^{b}	832.9^{c}	1233.9^{a}	1481.5^{b}	300.1	0.81	***	***
P32	2388.9^{a}	1129.8^{b}	888.5^{c}	1323.8^{a}	1614.3^{b}	325.5	0.83	***	***
P36	2506^{a}	1154^{b}	895.9^{c}	1398^{a}	1639^{b}	368.6	0.81	***	***
P40	2539^{a}	1202^{b}	879.9^{c}	1376^{a}	1704^{b}	375.6	0.79	***	***

Pi = weight at i weeks, RSD : residual standard deviation; R^2 : coefficient of determination; * : P<0.05 ; *** : P<0.001 ; NS : P>0.05. The means between the classes of the same line followed by different letters differ significantly with the threshold of 5%.

curve of the female Local chicken and the female Label Rouge, whereas Figure 1b presents the comparison between the growth curve of the male Local chicken and the male Label Rouge.

From hatch to two months of age, the average daily gain was higher (P<0.001) for the Label Rouge than for indigenous chickens, whereas it was similar for the two local ecotypes. At the end of the 2nd month, the average daily gain of the Label Rouge reached a peak at 25.42 g/d, whereas this peak was observed at 20 weeks for the Savannah and Forest ecotypes. From the 8th to the 16th weeks, the Label Rouge had an average daily gain higher than those of the savannah chickens, whereas the Forest chickens presented the lowest gains (P<0.001). Beyond the 20th week, the average daily gain decreased progressively for each genetic type (Table 3).

For the growth curve parameters, the initial specific growth rate, the maturation rate and the age at inflection varied according to the chicken genotype (P<0.001). The initial specific growth rate (0.10/day) and the maturation rate (0.03/day) of Label Rouge were higher than those of indigenous chicken. Between local chickens, the initial specific growth rate of savannah ecotype (0.02/day) was lower (P<0.01) than that of the forest ecotype (0.03/day). However, the savannah and the forest chicken ecotypes had the same maturation rate (0.02/day). The age at inflection of the Label Rouge (54.5 day) was lower (P<0.001) than those of the savannah ecotype (112.3 day), but the age at inflection of the forest ecotype chickens (135.2 day) was the highest (P<0.001). When considering the three chicken genotypes, the maturation rate was the same for the male and the female (0.02/day) and no significant difference was observed between the age at inflection of the male (63.6 day) and the one of the female (64.1 day). However, the initial specific growth rate of the female (0.08/day) was lower (P<0.01) than that of the male (0.09/day). The coefficients of variation of the weight at 4, 16 and 40 weeks were, respectively, 17.4, 13.1 and 17.8% for Label Rouge, 24.9, 29.4 and 27.3% for the Savannah ecotype, and 26.4, 27.3 and 19.3% for Forest ecotype. The coefficients of the variation of the age at inflexion were 18.2, 31.8 and 38.1 for Label Rouge, Savannah ecotype and Forest ecotype chicken, respectively. Table 3 presents the growth curve parameters of Label Rouge and local chicken.

The feed consumption of the Label Rouge was higher than that of the local chickens and its feed

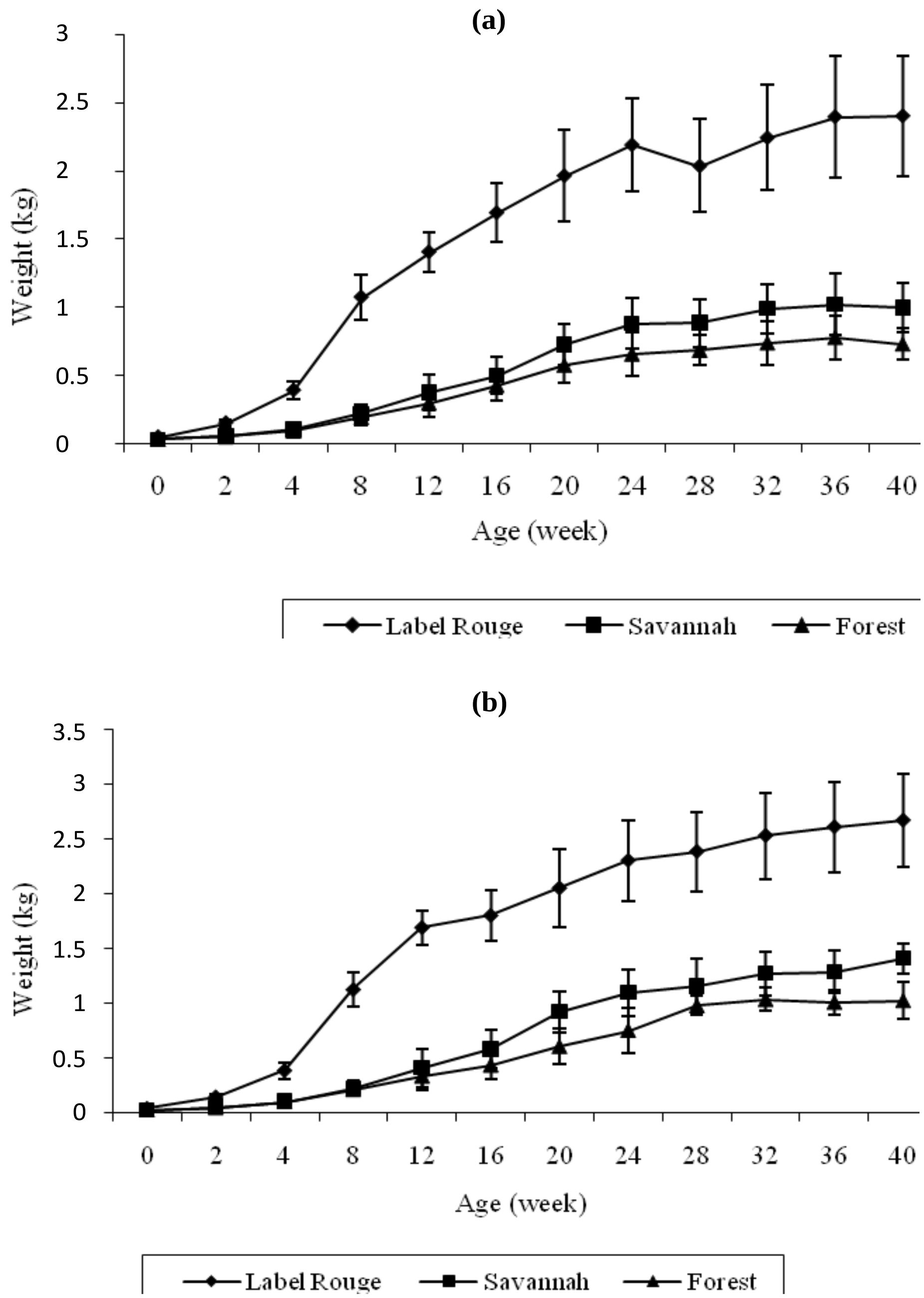

Figure 1. Comparison of the growth curve (means ± SD) between: (a) female Local chicken and female Label Rouge; (b) male Local chicken and male Label Rouge. SD, Standard deviation.

conversion ratio was higher from the 12th week onwards (Figure 2).

From 8 to 12 weeks, the feed efficiency values were 3.9, 4.0 and 5.7 for savannah ecotype, forest ecotype and Label Rouge chickens, respectively. These feed efficiency values doubled between 12to 16 weeks for the savannah ecotype (6.9), forest ecotype (8.0) and Label Rouge (13.4).The highest feed efficiencies were observed for the Label Rouge chicken.

Carcass characteristics

The Table 4 presents the carcass characteristics of local chickens and Label Rouge. The savannah local chickens had higher live weights at slaughter than those of the forest local chickens and were significantly lighter (P<0.001) than those of the Label Rouge chickens. The same tendency was observed at slaughter for the hot carcass weights, the wet carcass, thighs, drumsticks,

Table 3. Least square means of growth performance of the Label Rouge and indigenous chickens of Benin savannah and forest ecotype.

Variable	Effect of population of origin			Sex effect		RSD	R^2	Test of signifiance for race effect	Test of signifiance for sex effect
	Label Rouge	Savannah ecotype	Forest ecotype	Female	Male				
ADG $_{0-2}$ (g/d)	7.44^a	1.64^b	1.45^b	3.47^a	3.55^a	1.36	0.82	***	NS
ADG $_{2-4}$ (g/d)	17.3^a	3.8^b	3.47^b	8.02^a	8.36^a	3.38	0.8	***	NS
ADG $_{4-8}$ (g/d)	25.4^a	4.14^b	3.71^b	10.7^a	11.5^a	4.47	0.85	***	NS
ADG $_{8-12}$ (g/d)	16.3^a	5.93^b	4.02^c	7.25^a	10.3^b	5.37	0.58	***	***
ADG $_{12-16}$ (g/d)	9.8^a	6.56^b	4.81^c	7.36^a	6.81^a	5.02	0.2	***	NS
ADG $_{16-20}$ (g/d)	10.5^a	8.43^b	5.78^b	7.74^a	8.72^a	6.24	0.1	***	NS
ADG $_{20-24}$ (g/d)	11.7^a	6.79^b	5.35^b	7.14^a	8.74^b	6.15	0.2	***	*
ADG $_{24-28}$ (g/d)	5.5^a	4.95^a	3.69^a	3.94^a	5.47^a	5.15	0.05	NS	NS
ADG $_{28-32}$ (g/d)	9.2^a	3.13^b	2.57^b	5.14^a	4.79^a	6.72	0.13	***	NS
ADG $_{32-36}$ (g/d)	5.99^a	4.39^{ab}	2.3^b	4.13^a	4.32^a	5.33	0.08	*	NS
ADG $_{36-40}$ (g/d)	4.84^a	4.29^a	1.47^b	2.67^a	4.4^a	6.42	0.05	*	NS
K (1/d)	0.03^a	0.02^b	0.02^b	0.02^a	0.02^a	0.005	0.23	***	NS
L (1/d)	0.10^a	0.019^b	0.029^c	0.08^a	0.09^b	0.02	0.35	***	**
Ti (d)	54.5^a	112.3^b	135.2^c	63.6^a	64.1^a	13.9	0.19	***	NS

ADG_{i-j} = Average daily gain from i^{th} to j^{th} week; RSD, residual standard deviation standard; R^2, coefficient of determination; *P<0,05; **P<0,01; ***P<0,001; NS, P>0,05 ; L, initial specific growth rate; K, maturation rate; TI, age at inflection. *The means between the classes of the same line followed by different letters differ significantly with the threshold of 5%.*

wings and legs. No abdominal fat was observed at slaughter in both indigenous chickens and Label Rouge. The breast, heart, liver and the head weights of savannah chickens tended to be higher than those of forest chickens but the differences were not significant. On the other hand, the breast weight, heart, liver and the head weights of Label Rouge chickens were twice heavier than those of local chickens (P<0.001). The Label Rouge chickens had a significantly higher breast proportion than the Savannah and Forest ecotypes (P<0.001). No significant difference was observed between the percentages of thigh-drumstick or those of the wings for the three genetic types.

Meat quality

Table 5 shows the sensory characteristics of the meat of local chickens and Label Rouge by cooking method and carcass cut. Relative to the genetic type, the meat of Label Rouge chickens and that of Forest chickens was less tender and less juicy (P<0.001) than that of Savannah chickens, whereas the flavour was identical for the three genetic types. The boiled meat was more tender (P<0.001) than that roasted, whereas the juiciness and the flavour were identical for the two methods of cooking. The thigh was less tender (P<0.001) than the breast; however, these two cuts were identical in juiciness and flavour. The overall assessment of the meat of Label Rouge chickens did not differ from that of the local chickens, whether from the Savannah or the Forest, whereas it differed between the local chickens, with a lower value for the Forest ecotype. Relative to the method of cooking, the boiled meat was more appreciated than the roasted one.

DISCUSSION

Since the experimental chickens were all reared under the same housing and management conditions and compared at the same age, diff-

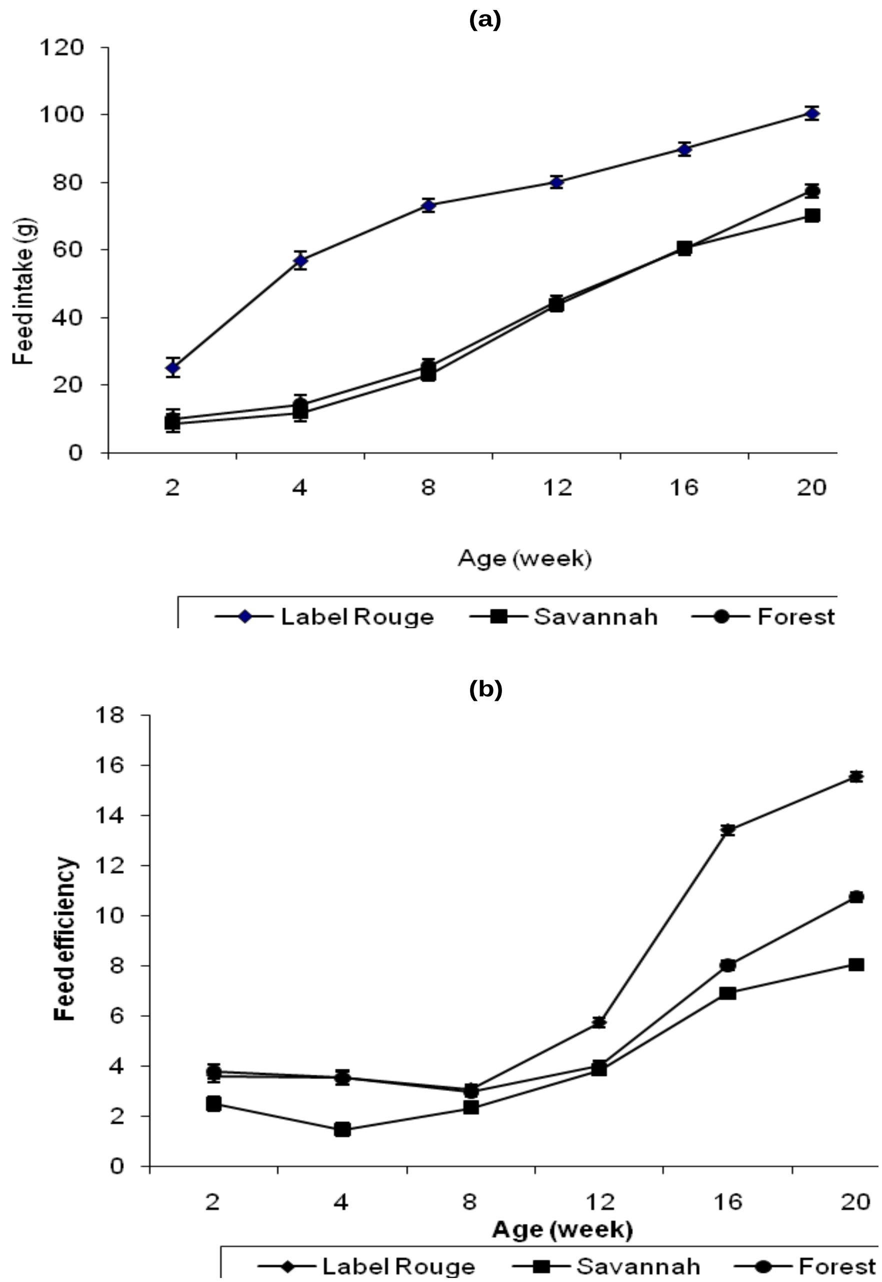

Figure 2. Mean (±SD) feed intake (a) and means (±SD) feed efficiency (b) of Label Rouge and local chicken from two to 20 weeks of age. SD, Standard deviation.

erences between genotypes would indicate genetic effects.

Growth performance

Body weights of the local chickens of the savannah ecotype were higher than those of the forest ecotype. This result is consistent with the field data recorded during the survey on the phenotypic characterisation of indigenous poultry populations of the species *G. gallus* of savannah and forest regions of Benin (Youssao et al., 2009). Therefore, the difference of growth between the two ecotypes was not due to differences between local environments but to genetic differences. According to Bonou (2006), in the traditional breeding system of Benin, the average adult weight of the indigenous females of savannah (1085 g) was higher ($P<0.001$) than those of the females of the forest (845.6 g).

Similarly, the males of Savannah were heavier ($P<0.001$) than those of the Forest with respective weights of 1309 and 1046 g. Although these values are

Table 4. Carcass characteristics of Savannah, Forest and Label Rouge chickens

Variable	Label Rouge (N=12) †		Savannah (N=12) †		Forest (N=12) †		Test of significance	R²
	Mean	SD	Mean	SD	Mean	SD		
Live weight (g)	2717[a]	429	1215[b]	178	992[c]	49	<0.001	0.90
Hot carcass weight (g)	1977[a]	184	913[b]	135	743[c]	45	<0.001	0.94
Wet carcass weight (g)	1937[a]	240	921[b]	139	750[c]	41	<0.001	0.92
Carcass yield 1h (g/kg)	739[a]	91	752[a]	27	752[a]	71	NS	0.01
Carcass yield 24h (g/kg)	719[a]	55	758[a]	25	758[a]	67	NS	0.12
Breast (g)	457[a]	86	184[b]	24	151[b]	16	<0.001	0.88
Thigh and drumstick (g)	652[a]	60	295[b]	46	249[c]	15	<0.001	0.94
Wings (g)	229[a]	21	118[b]	22	89[c]	8	<0.001	0.92
Breast (g/kg)	235[a]	21	201[b]	14	201[b]	15	<0.001	0.5
Thigh and drumstick (g/kg)	339[a]	32	321[a]	16	332[a]	6	0.109	0.12
Wings (g/kg)	119[a]	7	133[a]	44	118[a]	8	0.362	0.06
Heart (g)	8.5[a]	1.4	6.6[b]	1.1	5.9[b]	0.2	<0.001	0.55
Neck (g)	148[a]	9.5	76.7[b]	19.7	60	4.3	<0.001	0.9
Liver (g)	34.7[a]	4.8	10.75[b]	4.6	8.7[b]	1.9	<0.001	0.9
Gizzard (g)	51.0[a]	8.4	21.67[b]	6.3	21.3[b]	3.9	<0.001	0.83
Head (g)	102[a]	8.1	54.7[b]	4.9	50.5[b]	4.7	<0.001	0.94
Legs (g)	104.8[a]	5.8	44.6[b]	10.9	37.2[c]	2.7	<0.001	0.94
Rest (g)	366[a]	87.4	198[b]	33.5	152[c]	8.1	<0.001	0.75
pH1	6.4[a]	0.1	6.5[a]	0.1	6.5[a]	0.1	0.648	0.02
pH24	6.2[a]	0.03	6.2[a]	0.1	6.2[a]	0.04	0.692	0.02

NS, P>0.05; R², coefficient of determination; SD, standard deviation. Carcass yield 1 h = hot carcass / live weight; Carcass yield 24 h = wet carcass / live weight; breast yield = breast / wet carcass; thigh and drumstick yield = thigh and drumstick / wet carcass; wings yield = wings / wet carcass. † Males of each genetic type were slaughtered at the age of 24 weeks. The means between the classes of the same line followed by different letters differ significantly with the threshold of 5%.

Table 5. Means (±standard error) of sensory characteristics of local chickens and Label Rouge meat based on cooking method and carcass cuts.

Variable	Origin			Cooking mode		Carcass cut		Test of significance
	Label Rouge	Savannah	Forest	Boiled	Braised	Thigh	Breast	
Tenderness	3.3±0.12[a]	3.8±0.12[b]	3.2±0.12[a]	3.7±0.09[a]	3.1±0.11[b]	3.3±0.10[a]	3.5±0.10[b]	<0.001
Juiciness	3.1±0.11[a]	3.5±0.11[b]	3.0±0.11[a]	3.1±0.09[a]	3.3±0.10[a]	3.1±0.09[a]	3.3±0.09[a]	0.019
Flavor	3.1±0.12[a]	2.9±0.12[a]	3.2±0.12[a]	3.0±0.09[a]	3.1±0.10[a]	3.1±0.09[a]	3.0±0.09[a]	0.028
Assessment	7.0±0.25[a]	7.0±0.25[a]	6.7±0.25[b]	7.2±0.09[a]	6.9±0.21[b]	6.9±0.33[a]	7.1±0.37[a]	0.021

The means between the classes of the same line followed by different letters differ significantly with the threshold of 5%.

lower than those recorded in the present study, the same ranking between Savannah and Forest ecotypes was observed, which confirms that this difference is of genetic origin.

A similar observation was made by Fotsa (2008) in Cameroon where the savannah-West/West local chickens were found to be heavier than chickens from the forest and central regions, all chickens being compared on the same experimental farm located in the Savannah-West/West region. In Zimbabwe, Pedersen (2002) reported higher body weights of 2714 and 1756 g at 27 weeks for male and female indigenous chickens, respectively. These differences may be due to a combination of genetic effects, management and environmental factors. Chick weight for indigenous chickens was also close to the result of Youssao et al. (2007), who obtained an average weight of 27.5 ± 3.3 g at hatch for indigenous chicks in the District of Abomey – Calavi. Mourad et al. (1997) reported a lesser hatching weight of 22.8 g for indigenous chicks on the Plateau of Sankara Faranah in Guinea. The differences observed in hatching weight can be related to genetic diversity, and also influenced by egg weight and age of the dam, as well as feeding conditions of the dam. The with other studies is not straightforward and indicates only the range of variability of the weight at the hatching. Furthermore, the hatching weight is also influenced by the day of weighing because hatching can take, on average, 3 days.

The Label Rouge chickens used as a control genotype were also raised in Ghana and in Ivory Coast, where they reached the weights of 1397 and 1665 g at 12 weeks of age (Youssao et al., 2007). Better performances were obtained in France where the average weight of the Label Rouge was 2392 g at 12 weeks of age (Sauveur, 1997). These differences observed between the Label Rouge chickens in Benin, Ghana and the Ivory Coast were due to management factors such as food, medical follow-up, control of the animals, etc., because the chicks came from the same parental cross at the same period of time. On the other hand, the differences observed between the Label Rouge chickens raised in France and those respectively raised in Benin (Abomey-Calavi), Ghana and in Ivory Coast, could be related both to management and to climatic differences (temperate vs. tropical hot and wet climate).

High temperature is known to reduce growth rate in connection with the reduction of feed consumption. Numerous studies reported that heat reduced body weight by 24.3 to 33 % and weight gain by 16.0 to 43.4% as compared to a normal temperature (Settar et al., 1999; Yunis and Cahaner, 1999). According to Tesseraud and Termin (1999), a chronic exposure to heat reduces significantly the basal metabolism and increases the proportion of dietary energy retained in fat tissues. However, the dissection showed the absence of measurable abdominal fat in all chickens of the study, whatever the genetic type. Thus, chronic heat exposure was not the single factor responsible for the reduced growth rate since the expected increase in fatness was not observed. The growth curve of the local chickens was characterized by a slow initial growth rate and a late inflexion point, but the CoqArd breed exhibited even greater values of TI with 94.48 days for females and 74.40 days for males (Youssao et al., 2010). The Label Rouge growth curve parameters were close to the mean values of L (0.132/d), K (0.029/d) and TI (55.0 d) reported by Mignon-Grasteau and Beaumont (2000) and N'Dri et al. (2006).

The feed efficiency of Label Rouge chickens was high beyond 12 weeks, thus, it is not economically profitable to raise it in tropical zone beyond this age. Economically, the 10th week is advised because the feed conversion at the 12th week is 7.7 against 4.29 for the 10th week and for a live weight of 1691 g. From 0 to 16 weeks, the feed efficiency was 4.94, 4.35 and 4.31, respectively for local chicken populations of the Center, the Forest and the Savannah-West of Cameroon and 4.62 for the Label Rouge (Fotsa, 2008). As in Benin, the Label Rouge had a feed efficiency, a feed intake and a live weight higher than those of Local chicken.

Characteristics of the carcasses

Since the Label Rouge chickens were twice as heavy as the local chickens, it was logical that their carcass portions were double the weight of those of the local chickens.These results are similar to that of Fotsa and Manjeli (2001), Fotsa et al. (2007), Kokoszyński and Bernackic (2008) and Fotsa (2008) who obtained a better growth in the improved chicken stock. Yet, relative carcass yield did not differ between local chickens and Label rouge; proportion of thighs and drumsticks as well as proportion of wings did not differ. Only breast yield differed between genetic types, showing the effect of past selection on meat production in Label rouge chickens. Indeed, according to Sante et al. (2001), the breast weight in relation to carcass weight is an important criterion in the broiler poultry production. Thus, the carcass weight and the higher breast proportion of the Label Rouge chicken make it a better broiler chicken as compared to the indigenous chicken. According to the literature, the mean yield for slow-growing chickens ranged between 13.4 and 26% for breast, between 24.6 and 37.4% for leg and between 17 and 4% for abdominal fat (Lewis et al., 1997; Quentin et al., 2003; Janocha et al., 2003; Sengül et al., 2003; N'Dri et al., 2006). Except for the result on abdominal fat, the other results of our study are within the range of values cited in the literature. The extremely low abdominal fat found in this study is similar to recent results of Fotsa (2008), who observed that the carcasses of Label Rouge and local chickens raised in similar conditions in Cameroun were extremely lean, without abdominal fat.

Whereas local chickens were slaughtered at their usual slaughter age, the Label Rouge was slaughtered at an advanced age as compared to production conditions in France (slaughter age at 81 days). It would be useful and practical to undertake a study aimed at comparing the three genetic types according to their slaughter age. A similar comparison was made in France by Quentin et al. (2003) with an aim of comparing the carcass composition and some meat quality parameters of the chickens at fast growth (F), average growth (M) and slow growth (S), fed with 3 increasing protein and energy concentration diets. It is apparent from this study that for chickens slaughtered at the commercial age, F chickens had higher yield of pectoral muscles (*Pectoralis major + minor*) and a lower abdominal fat content as compared to M chickens and S chickens (P<0.05). The density of the diets used did not have any effect on the carcass composition, the ultimate pH and the water loss of the chicken meat (Quentin et al., 2003).

Although the Label Rouge is regarded as a slow growing stock, they have a fast growth compared to local chickens and slow growth compared to standard chickens. The speed of growth can influence the body composition of the animals, abdominal fat being deposited later during the growth period, after the inflexion point. Thus, at equal age, the Label chicken is characterized by higher carcass muscle yield (2 to 4 points) and a lower abdominal fat content, than the standard chicken (Sauveur, 1997). In the same way, the Label chicken being slaughtered at an older age as compared to the standard broiler appears to have equal abdominal fat content at 12 weeks as that of a standard broiler of 8 weeks old and its eviscerated carcass yield was similar to that of standard chickens (Sauveur, 1997). According to Sandercock et al. (2009), genetic variation for relative weight of abdominal fat, spleen, and heart was moderately high and greater at 10 than at 6 weeks of age. Broiler carcasses had a relatively high proportion of abdominal fat and smaller spleen and heart weights than traditional lines (Sandercock et al., 2009). The study on the aspects of meat and eating quality of broiler chickens reared under standard, maize-fed, free-range or organic systems carried out by Brown et al. (2008) reveals some significant differences between rearing systems, with fillet muscles from birds grown under the standard system having a higher ultimate pH. According to Debut et al. (2005), acute heat stress affected blood Ca^{2+} and Na^{+} concentration and increased glycaemia and glycolytic potential of thigh muscle. Both acute heat stress and shackling before slaughter were experienced as stressful events by all types of birds.

In this study, all genotypes exhibited a very slow growth so that the time of fat deposition had not yet been reached at 16 weeks age of slaughter. Consequently, all carcasses showed very little fat. Considering meat quality, pH an indicator of meat quality, did not differ between genetic types. Breast and thigh pH were similar to those reported for the T hai indigenous chicken and commercial broilers (Wattanachant et al., 2004), while consistent with values reported in the literature (Holownia et al., 2004; De Marchi et al., 2005; Musa et al., 2006). The variability of the ultimate pH of poultry is lower than the one of falling speed of the pH (Sante et al., 2001) and it is perhaps the reason why the difference between pH1 and pH24 was very weak in this study.

Meat quality

Meats of Label Rouge chickens and those of local chickens of the Forest were less tender and less juicy than those of Savannah chickens, whereas the flavour was identical for the three genetic types. According to Wattanachant et al. (2004), the shear values of the indigenous chicken muscles, either raw or cooked, were significantly higher than those for the commercial broiler muscles. The meat of the indigenous chickens, especially of the Thai chickens, was higher in shear force and collagen content (thigh only) than meat of the imported breeds (Jaturasitha et al., 2008). It is generally considered that tenderness of poultry meat depends on the quality of connective tissue (collagen), the myofibrillar structure and the structural interactions between fibres, the extracellular matrix and the breed genotype (Sante et al., 2001; Wattanachant et al., 2004). The differences between savannah and forest chicken ecotypes cannot be due to the difference in growth rate, since the label exhibited the fastest growth but did not differ from the forest chicken ecotype for meat tenderness and juiciness. The piece of meat, either thigh or breast, influenced only the tenderness, higher for breast.

The boiled meat was tender than those roasted, whereas the juiciness and the flavour were identical for the two cooking methods. The overall assessment distinguished the meat of savannah local chickens from the meat of forest ecotype chickens, with a preference for the savannah ecotype, but the meat of Label Rouge chickens was ranked at an intermediate level between savannah and forest local chickens so that Label rouge could not be significantly be preferred from either one or the other ecotype. According to Beaumont and Chapuis (2004), the gustatory quality of chicken is especially determined by the slaughter age. The best quality for a more advanced age is clearer for the thighs than for the fillets. The tasting superiority of chicken with slow growth (chicken Label Rouge, biological chicken) is regularly shown by panel tasting and sensory analysis. In this study, all chickens were slaughtered at the same age, but at a quite different body weight, yet, they did not differ markedly for meat quality except for tenderness.

Conclusion

The possibility to compare local chickens from two different ecological regions showed that these two local populations had a different growth potential when raised in a similar environment. Thus, the phenotypic differences observed *in situ* for these two populations have a true genetic basis. The addition of a control genotype with the Label Rouge chickens showed that the environmental conditions were rather harsh, since these chickens exhibited quite a delayed growth, by several weeks as compared to their usual performance in France. Yet, these chickens had a much better growth rate than local chickens. It was quite remarkable to observe that Label rouge chickens produced a meat which fully satisfied the local consumers. The use of Label Rouge chickens could be proposed to produce high sensory quality chicken meat in Benin, but the adaptation of this genotype to village conditions, such as scavenging and natural incubation were not investigated in this study. The genetic resources of local chickens would therefore be considered to improve traditional poultry production, whereas crossbreeding programmes could be suggested for experimental poultry stations.

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