LAYING PERFORMANCE AND EGG QUALITY OF TWO STRAINS OF CHICKEN THE *Gallus gallus* SPECIES AND THEIR F 1 CROSSES RAISED IN A SEMI-INTENSIVE SYSTEM

[1]B.Soro, [2]C.V. Yapi-gnaore, [1]*D.P. Sokouri, [3]G.J. Nemlin and [1]A.S.P.N'guetta

[1] Université Félix Houphouet Boigny

[2] Centre International de Recherche-Développement sur l'Elevage en zone Subhumide (CIRDES), 01 BP 454 Bobo-Dioulasso 01, Burkina Faso.

[3] Centre National de Recherche Agronomique (CNRA)
01 BP 1740 Abidjan 01, Côte d'Ivoire.

*E-mail: didiersokouri@yahoo.fr

ABSTRACT

An experiment was conducted to compare the laying performance and egg quality of Ivorian local chicken, French Red Label and their cross from first filial generation under semi-intensive system. This study was carried to assess the effect of genetic group on the laying performance and egg quality traits. The analysis of the data on 250 eggs revealed that the genetic group had significant effect (P<0.05) on all the traits studied. Total weight of eggs produced per chicken over 14 days showed superiority for Label chickens (372 g) compared to the local ones (290 g). Significant higher egg weights (P<0.05) were observed In Red Label. The shape indices ranged from 76.3±0.53 for hybrid chicken to 73.8±0.56 for local chicken. A high percentage of yolk (38.7%) characterises the eggs of local poultry compared to the Label one (31.1%). It has been shown that the genetic origin of the chicken does not significantly (P>0.5) affect nutritional values and taste of the egg. Red Label and their crossbreeds are so accepted by consumers as well as local chicken. Moreover, the positive heterosis values obtained with hybrid subjects for some traits revealed that all these observations could be decisive in choosing improvement strategies of local poultry laying performances.

Keywords: Heterosis, laying performance, Local chickens, Red Label chicken

INTRODUCTION

Today poultry production has reached an important global development. It increased from 10 million tons in 1960 (Watt Publishing Co, 1996) to 80 million tons in 2004 (N'Dri, 2005). In recent years, poultry is the second most produced meet in the world after pork. The chicken alone represents 85% of world production of poultry (N'Dri, 2005).

In Africa, family poultry is operated by more than 80% of the population, mostly rural. It plays an important role in both rural and urban economies and is closely linked to socio-cultural and religious life of the farmers (Fotsa *et al.*, 2008). It requires low input levels, contributes significantly to food security, poverty alleviation, and sound environmental management of natural resources. It also represents a source of employment for disadvantaged groups. Traditional chickens contribute a significant proportion of meat production (25-70%) and eggs (12% to 36%) [Guèye, 2003].

In Côte d'Ivoire, poultry production is an essential part of livestock production. The current poultry population is estimated at be 33 million birds of which 23.5 million are indigenous chickens (representing 70% of the national poultry population), 6.4 million broilers, and 2.3 million layers from semi-industrial farms (Anonymous, 2007).

Despite the quantitative importance and the undeniable social role, traditional poultry farming system remains a secondary activity in rural zone. There is lack of information regarding this poultry production system both in terms of the structure of livestock, production techniques and productivity (Hofman, 2000). Poultry genetic resources in traditional farming system are built with a lot of poultry populations which are often poorly characterised (Fotsa, 2008). These poultry populations are raised with minimal investment and without dependence on modern inputs. Depending on climatic conditions, losses in these traditional system can be as hight as 80 % (Belot and Hardouin, 1981). This explains the low productivity reported in various research works (Menfo, 1981; Fotsa and Manjeli, 2001; Youssao *et al*., 2010). However, this low productivity may be due not only to the farming system, but also to a limited genetic potential or insufficiently exploited in breeding programmmes poorly conducted by farmers.

Many exotic breeds introduced into developing countries in general, and in Côte d'Ivoire in particular, express a wide range of performances depending on farming conditions, and / or genetic type (Hofman, 2000). The main objective of this study was to contribute to the improvement of egg production from local chickens through crossbreeding in a semi-intensive farming system.

MATERIALS AND METHODS

Study area

The study was carried out in the research station of the National Center of Agronomic Research (CNRA) of Lamé from November 2008 to April 2009. This station is located in the Department of Alépé (Altitude 23 m; Latitude 5°26'N; Longitude 3°50'E ;) in the south of Côte d'Ivoire. This Department profits from the climatic conditions of equatorial type, characterised by two rainy seasons: the large (from March to July) and the small (from September to November). These two seasons are intercalated by a dry season. Average pluviometry is close to 1600 mm per annum. The monthly average temperatures vary between 26 and 32^{o}C and the relative humidity of the air excees 90% (FAO, 2005).

Birds

All chickens for this study came from the stock of birds that was used in a previous project, DURAS DCG 1-08 which was carried out on CNRA Lamé research station. These birds are consisted of local chickens of the South and Center ecotypes, Red Label chickens and their F 1 crosses. The local chickens came from chickens bought in villages in the forest and savanna area. The first chicks of label were imported from France. The F 1 crosses resulting from the crossing between local and Label chickens. All the chicks were fed with the same diet during growth. During the rearing periods, all chicks were medicated similarly and regularly and they were subjected to the same standard managerial, hygienic and climatic conditions. All the birds were 68 weeks old and came from the hatching obtained on 26th May 2008. A total of 250 hen eggs were collected from breeding flocks of 14 local chickens; 5 hens came from the Red Label type and 11 hybrids were obtained.

Design of the experiment

The hens of each type were weighed individually and then distributed in different compartments of the barn at 5 to 10 individuals per group. Each of the barn compartments used for keeping the birds measured 2 m x 2 m. Disease and parasite control consisted of vaccination against Newcastle, coccidiosis and gumboro.

The birds were kept under the deep litter system with wood shavings. They were fed layer mash (17.5% CP and 2700 Kcal ME/Kg) at 125 g of feed per bird per day with access to outdoor runs. They were also provided with fresh water ad libitum. Egg production and collection were made over a period of 14 days.

Eggs were collected twice daily, labelled and stored for not more than 7 days at room temperature (25°C) before physical and chemical analysis.

Egg characteristics

Eggs were evaluated for internal and external egg quality traits. The external egg characteristics were egg number and weight (g), total weight of eggs per hen, egg shape index (cm), and shell colour. The weight and egg shape index ([D / L] x100; L= length of egg and D = diameter of egg) were measured using weight scale and digital caliper, respectively. Shell colour was categorised into three classes; white, light brown and brown. For internal egg quality traits, individual eggs were broken out on a flat white tile being cautious not to break the vitelline membrane. The yolk and albumen were then carefully separated and placed in separate Petri dishes, which were initially weighed and then weighed again. The difference in the weight of each Petri dish after and before the introduction of the yolk or albumen was taken as the weight of the yolk and albumen, respectively employing the formula:

Proportion of white = (white weight / egg weight) x 100; Proportion of yolk = (yolk weight / egg weight) x 100.

Nutritional values and sensory characteristics of eggs were determined through different approaches as follows: Water content and dry matter. The principle is based on the drying of the material in a steam room until constant weight. About 5 g of frozen egg is thawed in a closed bowl. The sample is carefully mixed and to decant in a capsule nickel, provided with a glass baguette. Weigh to the nearest in the mg. Add 20 ml of alcohol to 40 % and mix carefully with the egg to obtain the flocculation of proteins. The mixture is evaporated on a boiling bain-marie and placed in the steam room in 103-105°C and dried at 3 at 4 am until constant weight. Water content and dry mater are expressed as a percentage according to the formula: (Water content (%) = ([G1-G2] / E) x 100, where G1 = weight before drying; G2 = weight after drying; E = weight. Dry matter (%) = 100-percentage of water content). Crude ash, the analysis is based on the AOAC method (AOAC, 1980); it involves in eliminating by incineration in 550 °C all the organic matter contained in a trial grip of 5 g. The residue cooled in a desiccator is weighed every five minutes until constant weight. Ash is expressed as a percentage according to the formula: ([M2-M0] / [M1-M0]) x 100, where: M0= weight of the empty dish; M1 = weight of the capsule with the test sample; M2: weight of the capsule and crude ash). Content of total sugars expressed as glucose, total sugars were evaluated by the technique from Dubois *et al.*, 1956). Total crude protein content (N x 6.25), protein content was determined by the technique from BIPEA (1976). Fat, content sample (MG) was expressed as a percentage of the initial sample weight according the following expression: MG = M3-M2 / M1 x 100; M1= sample weight; M2: weight of the metal cup, M3: weight of the metal container and the ether and dried extract residue. Sensory analysis employed a hedonic test through the use of a tasting sheet. It uses category scales ranging from "very good: 5" to "very bad: 1" with a variable numbers of intermediate categories.

Heterosis effect
Heterosis was also assessed; it was expressed under the following formula:

$$H_{line}(\%) = \frac{\bar{Y}_{F1} - \left(\frac{\bar{Y}_{P1} + \bar{Y}_{P2}}{2}\right)}{\frac{\bar{Y}_{P1} + \bar{Y}_{P2}}{2}} \times 100$$

$\bar{Y}_{P1}$ = Average measured on the parent 1; $\bar{Y}_{P2}$ = Average measured on the parent 2 and $\bar{Y}_{F1}$ = Average measured on the first generation of hybrid F1

Statistical analysis
Data were analysed using Statistica 6.0 software with "genetic type" as the independent variable and liveweight, yolk weight, albumin weight etc. as the dependent variable. Comparison of treatment means was made using the Newman-Keuls test at 5% significance level. A chi-square test was used to compare egg for the colour distribution between the three chicken genotypes.

RESULTS AND DISCUSSION
Average body weight varied from one genetic type to another. The Label rouge weighed significantly higher ($P < 0.05$) than those of local chickens and those of their crosses (Table 1). The average body weight of Labels was the highest with a deviation of 34 % and 7 % from mean liveweight of local chickens and F1crosses respectively. The gap difference between local hens and the F1 hybrid, based on hybrid weight was 29 %. These results reveal considerable and significant ($P < 0.05$) differences between the local chicken, Label Rouge and their crosses. The weights of local chickens raised on the experimental farm were higher than those obtained in rural area (about 1kg for adult chicken) in Côte d'Ivoire (Anonymous, 2003). This can be explained by the constraints of breeding-farm characterised by scavenging animals, the use of very low-input (food) and the lack of veterinary service in rural area (Fotsa, 2008). Label chickens have been used to evaluate effect of tropical conditions on the performance of a selected strain in France. These results are similar to the conclusions of Kadigi *et al.* (1998) in Malawi and Fotsa *et al.* (2007) in Cameroon. This is the result of genetic improvement which have been carried out on Label Rouge which give superiority of this improved breed over the slow growing local chicken populations. Moreover this study showed that crossbred

chickens had a higher growth rate than that of local chicken. The same trend was observed by Youssao *et al.* (2009a).

Physicochemical parameters of eggs

There was a significant difference (P <0.05) between the genetic types of chickens for all the egg's physical characteristics studied. The laying performance of the Label hens was better (P<0.05) than the other genetic types with an average of 11 eggs produced per hen over 14 days. During the same period average production in local and hybrid chickens was 6 and 9 eggs per hen, respectively. The total eggs weight per hen was significantly (P<0.05) higher for the Labels (372 g) than the local chickens and hybrids which average 291 and 334 g, respectively. Eggs from Label hens were significantly (P <0.05) the heaviest. The average weight of egg from this poultry was 55 g. Eggs from crossbred chickens weighed 49.3 g, in average. The average weight for eggs from local chicken was 42.6 g (Table 1). The difference between the egg weight of Label chickens and the local poultry of 12 g was significant (P<0.05). This difference was about 7 g between crossbred animals and local chicken and 6 g between Labels and hybrids. The difference in egg weight for Label chickens compared to the local ones aged of 68 weeks was consistent with what has been reported in Cameroon in laying chickens that were 36 weeks old (Fotsa, 2008). This observation was also made by Nthimo (2004) in Lesotho between Rhode Island Red chickens (lines of normal size and brown eggs laying type) and local ecotypes from Lesotho and Nigeria, raised in a controlled environment. Egg weight is affected by environmental factors; food restriction (Shaler and Pasternak, 1993) and parental average body weight (Mekki *et al.*, 2005).

The average egg shape index was lower in local chickens with 73.8%. Labels and hybrids had comparable values; 76.2 and 76.3%, respectively (Table 1). The values obtained in Cameroon by Fotsa (2008) are all higher than those obtained in this study. In effect, this author reported egg shape index values of 75.25 % and 76.69 % for local ecotypes in central and south regions of Cameroon, respectively and 78 % for Label chickens, all aged 36 weeks. Production factors such as age of laying flock and feed could be the main cause of this difference in egg shape.

Table 1: Least squares means of laying performance.

	Genetic types		
Variables	**Local**	Hybrid **Local/Label**	**Label**
Average body weight (g)	1217.0±55.11^{c}	1709.1±145.3^{b}	1842.4±166.52^{a}
Total eggs weight /chicken (g)	290.9±9.31^{c}	334.1±7.71^{b}	372.6±14.07^{a}
Average egg weight (g)	42.6±0.69^{c}	49.3±0.53^{b}	55.0±0.81^{a}
Shape index (%)	73.8±0.56^{b}	76.3±0.53^{a}	76.2±0.40^{a}
Number of eggs / chicken	6^{c}	9^{b}	11^{a}

Within a row, values with the same superscript are not significantly different at P>0.05

In local chickens, egg shell colour was predominantly white with 53.27% of the birds producing white eggs. It was light brown in hybrid chickens (87.96 % of light brown eggs). In the Label chickens 54.10 % of eggs were brown (Figure 1). This colour is characteristic of local chicken's eggs and it marks a difference with brown eggs from exotic strains. According to Lang and Wells (1987) and Kennedy and Vevers (1973), the brown colour eggs is mainly due to pigments protoporphyrine-IX. These pigments are generally localised in the cuticle of the egg. The clear brown eggs colour (46.73%) observed in local chickens could suggest the introduction of commercial birds in village flocks. The distribution of commercial feed to these chickens in the present study could explain this result. The main chemical component of egg shell is calcium which may have different levels in feed. Because of the differences in farming system, the uptake of calcium may also be different.

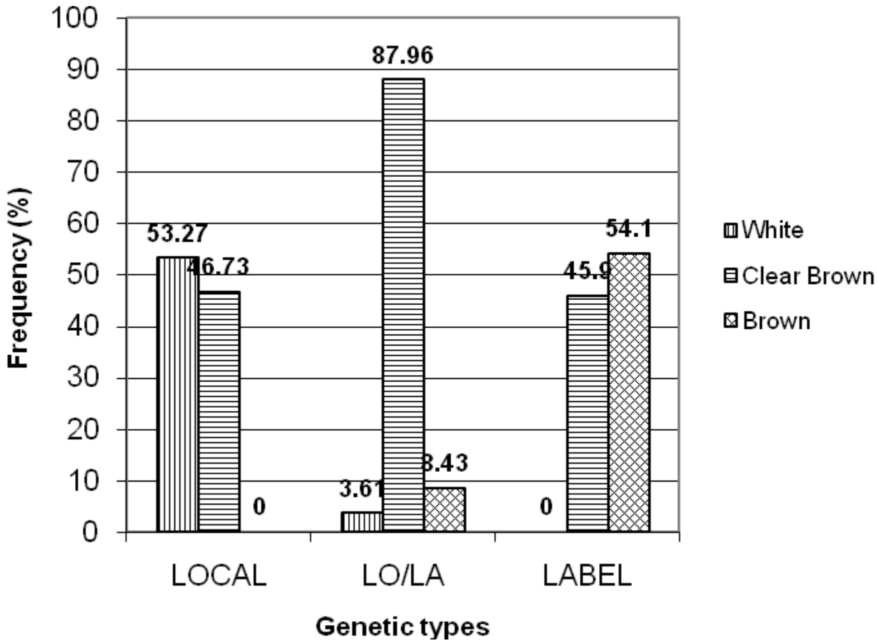

Figure 1. Frequency of different colours of the shell eggs as genetic types
LOCAL: Local chickens.
LO/LA: Hybrid from Local and Label chickens.
LABEL: Red Label strain

There were significant differences ($P < 0.05$) between genetic types in terms of the percentages to the total egg weight of albumen, yolk and shell weights. The percentage of yolk was higher in eggs from local hens with 38.7 %. In Label chickens, the yolk represented 31.1 % of the total egg weight. The percentage of yolk was 35.8 in the hybrid chickens. Therefore, the percentage of albumen in Label chickens was the highest (59.4 %). However, eggs from this genetic type had the lowest percentage of shell weight (9.3 %). On the other hand, local and hybrid chickens presented comparable values with 10.3 and 9.9 % respectively. These results presented higher values of percentage of yolk and lower values of percentages of albumen like those reported by Fotsa (2008) both for local chickens and Labels. The percentage of yolk in eggs from local poultry was superior to the other genetic types. These results are similar to those obtained by Fotsa (2008) and could indicate that a high percentage of yolk is a characteristic of local chickens. On the other hand, the average composition of egg in its major constituent substances (water, fat, protein, ash, carbohydrates) based on 100 g of consumable fresh egg did not show any significant difference between the genetic types (Table 2). This result indicate that egg without shell of hen contains approximately 74 % water and 26 % of dry matters, among which 12 % is fats, 12 % is proteins and 0,9 % is ashes. Egg is poor in carbohydrates with approximately 1, 4 %. This nutritive composition of egg in its major elements (water, proteins, lipids, carbohydrates) obtained in this study in the three genetic types, is consistent with results from Nys and Sauveur (2004) on exotic strains in France.

Table 2: Least squares means for egg components and nutrient contents in 100 g of consumable fresh eggs.

	Genetic types		
Variables	**Local**	**Hybid Local/Label**	**Label**
Average proportion of yolk (%)	38.7±0.61[a]	35.8±0.44[b]	31.1±1.22[c]
Average proportion of albumen (%)	51.1±0.64[c]	54.2±0.49[b]	59.4±1.22[a]
Average proportion of shell (%)	10.3±0.11[a]	9.9±0.12[b]	9.3±0.12[b]
Water (%)	71.2±0.64[a]	73.5±1.54[a]	74.6±1.47[a]
Dry matter (%)	28.8±0.63[a]	26.5±1.54[a]	25.4±1.47[a]
Carbohydrates (%)	1.5±0.34[a]	1.4±0.43[a]	1.3±0.25[a]
Fats (%)	12.2±0.41[a]	12.2±0.51[a]	12.0±0.34[a]
Ashes (%)	0.9±0.00[a]	0.9±0.07[a]	0,9±0,00[a]
Proteins (%)	11.1±1.62[a]	11.7±2.63[a]	12.5±1.53[a]

Values with the same letters on the same row are not significantly different at P>0.05

Eggs produced by all genetic types of chickens studied had comparable organoleptic characteristics. In effect, the analysis of variance (ANOVA) showed no significant (P >0.05) differences between the three types of chickens for taste, odour, white, yolk and preference of the egg (Table 3). This would suggest that genetic origin of chicken does not affect nutritive composition of the egg. These results show that the sensory quality of eggs from Label and hybrid chickens could match also characteristics desired by consumers as those of local chicken. These observations are in agreement with those of Fotsa (2008) in Cameroun and Youssao *et al.* (2009b) in Benin on local chickens and Label Rouge. These authors showed that the meat of crossbreeds is appreciated as well as those of the Label Rouge and local chickens, contrary to the broiler chicken which are little appreciated compared to local chicken. Label Rouge and their crossbreeds are so accepted by consumers of these countries as well as local chicken.

Heterosis effect

Heterosis effect for some traits measured on hybrid chickens was in general positive and varied from -2 to +12 %. It is much more pronounced for body weight with +12% all other traits studied. The only negative value for heterosis (- 2 %) was obtained with "Proportion of albumen" (Table 4). These results suggested that some performances of crossbreeds are generally higher than those of the mean parents. The label is a breed selected for meat production. According to Falconer and Mackay (1996), in general the expression of the genotype of the individuals of the first generation (F1) was higher than the average of the values of the parental genotypes contrary to that should occur if there were simple additive inheritance for a character. The variability of the heterosis obtained in this study is due to the fact that the relative value of a crossing depends on the genes which are put in presence and not the absolute value of each one of these genes (Ricard, 1990).

Table 3. Results of panelists sensory evaluation of eggs from three genotypes.

	Genetic types		
Variables	**Local**	**Hybrid Local/Label**	**Label**
Taste	3.3^{c}	3.3^{b}	3.2^{a}
Odour	3.6^{c}	3.6^{b}	3.3^{a}
Egg white colour	1.6^{c}	1.6^{b}	1.6^{a}
Yolk colour	2.5^{b}	2.7^{a}	2.5^{a}
Preference	3.5^{c}	3.5^{b}	3.4^{a}

Values with the same letters on the same row are not significantly different at P>0.05

The hybrid performance is not simple additive product of genetic material from both parent, but the result of variation in expression of the two set of the gene within the hybrid results (Youssao *et al.*, 2009b).

Table 4. Magnitude of heterosis for some traits in chickens.

Traits	**Heterosis (%)**
Average body weight	+ 12
Total eggs weight /chicken	+ 1
Average egg weight	+ 1
Shape index	+ 2
Number of eggs / chicken	+ 6
Proportion of yolk	+ 3
Proportion of albumen	- 2
Proportion of shell	+ 1

CONCLUSION

Better laying performances can be obtained from local chickens in a breeding system intermediate between traditional poultry farming and industrial poultry farming. Genetic origin of chicken does not affect organoleptic and nutritive composition of the egg. However, it had an effect on all the physical traits of egg studied. In this farming method, the average superiority of hybrids between the local type and Red Label, may suggest the use of the Label in rational crossbreeding in order to improve egg production of local chickens without affecting sensory and nutritional qualities of these eggs.

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