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Egg Production Performance of the Local Kabyle Hen and its Crossbreeds with ISA-Brown Strain in Semi-Intensive Conditions

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Abstract: A cross between the ISA-Brown industrial strain and an Algerian local (Kabyle) breed was compared with the Algerian local (Kabyle) hen. The comparison during the egg production period was done in individual cages, in a ventilated henhouse without any particular isolation. The same commercial diet has been provided over three time periods (35 to 36 weeks, 50 to 51 weeks and 65 to 66 weeks of age). Egg number and body weight at first egg was significantly lower in the Kabyle local breed. Mortality was almost equal during the breeding period and the egg production periods for the two genotypes. The Kabyle hen eggs, in spite of a weight which was lower (43.70 to 53.37 g according to the age), gave yolk to albumen ratio similar to the ISAKAB cross (0.52 to 0.58 according to age). Finally, the ISAKAB cross was better in terms of egg production and egg quality than the local hen, in test conditions.

Key words: Algeria, biodiversity, Kabyle, local hen, egg production, egg quality

INTRODUCTION

For millennia, bird eggs and particularly chicken eggs constitute an essential food source for humans (Nau *et al*., 2003). The egg is considered by WHO as a "perfect natural food", belonging to this small category of complete proteinic foods. It contains the nine essential amino acids (Stadelman and Pratt, 1989). It constitutes a rich source of proteins, lipids, minerals and vitamins which can be extracted again easily. Proteins are a vital component of human nutrition, needed in all physiological functions of the body. The low cost of the egg makes it an easily accessible source of proteins and lipids (Nys and Sauveur, 2004). Eggs are accepted all over the world and are not forbidden by any culture or religion (Bessadok *et al*., 2003).

The evolution of life styles and consumption habits with the development of fast food has increased its demand. Indeed the egg proteins are ingredients which are incorporated in many foods (Mine, 2002). Egg production and consumption through the world have tripled since the sixties and continue to increase regularly (Gillin and Sakoff, 2003).

Nowadays, eggs are more than a source of dietary food. Their antioxidant effects, cryoprotector, antibacterial, antiviral, antihypertensive, emulsifying and coagulant (Nau *et al*., 2003; Mine, 2002; Mine and Kovacs-Nolan, 2003) allowed their use in a variety of industrial sectors (agriculture, pharmaceutical, cosmetic, etc.)

Mirroring Europe, consumer demand in the Maghreb has changed; food production must respect higher hygiene standards, the environment and animal welfare (Lamine, 2005).

The local hen breeds throughout the world are among the most threatened animal genetic resources (FAO, 2008). In Algeria, a major food importing African country, eggs are produced locally under intensive systems using imported industrial hen strains.

In this context, the present study has been conducted to characterize egg production by a local Kabyle hen breed and its crossbreed with the ISA-Brown industrial strain, both quantitatively and qualitatively. Indeed, the use of crossbreeds could help in the inclusive development of a semi-intensive egg production sector, adapted to rural environments. It would further give economic rationale for the conservation of the local breeds, needed as parental strains.

MATERIALS AND METHODS

Breeding: A flock of 253 local Kabyle chicks and 218 crossbred chicks (Kabyle male x Isa-Browns female; hereafter ISAKAB) were bred. The chicks have been installed at the same time (April 21, 2009) in two chicken coops with ventilation (six areas for animal of 6 m^2 each). A commercial starting diet at 18% of crude proteins and 2 700 kcal/kg of metabolizable energy has been distributed ad libitum until the age of 12 weeks,

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followed by commercial growing diet at 16.5% of crude proteins and 2 700 kcal/kg of metabolizable energy.
The temperatures and relative humidity have been daily recorded. During this period, the temperatures varied from 22 to 35°C and 17 to 26°C for respectively the maxima and the minima. The relative humidity varied between 60 to more than 97% for the maximum and 42 to 80% for the minimum.

Experimental conditions during the egg production periods: Chicks have been transferred during week 19 to a henhouse without heat insulation, with windows, equipped with cages, stacked by three. Each cage contained a hen and there was a common feeding trough for five cages. The tested genotypes have been distributed randomly in the cages. One hundred chicks per crossing have been installed at the beginning of the experiment. The duration of natural lighting was 12 hours and 15 minutes at the 19th week and has been increased by adding 30 minutes of artificial light per week to reach 16 hours and 15 minutes at the 26th week.
During the experimental period (19th to the 72nd week of age), a commercial farinaceous diet has been distributed. The composition of this diet was recorded in Table 1. The ambient temperatures have been noted during the egg control period with 13 to 30°C and 9 to 16°C respectively for the maxima and the minima. The relative humidity varied from 75 to 99% for the maximum and 50 to 85% for the minimum.

Controls and measures

Egg production performances: The egg production has been daily recorded for each hen for all the production period. The hens' body weights have been measured individually at the age of first egg. Mortality has been registered daily from the 1st to the 72nd week of age.

Egg quality: The external and internal quality of the eggs has been assessed every 15 weeks (35-36, 50-51 and 65-66 weeks of age of the hens). For each hen, the two eggs laid during the first and the second week of the study were analyzed and the averages of the four eggs for each period (35-36, 50-51 and 65-66 weeks of age of the hens) were taken in consideration in the statistical analysis. In the recorded mortalities of Table 2, only the eggs of 50 hens for each genotype were taken into consideration in this study. For each age of study, 400 eggs were concerned.
After numbering the new-laid egg (collected the same day), some measurements are taken. After breaking the egg at the equator, the height of the albumen has been measured with a tripod micrometer placed in a middle distance. The Haugh units have been calculated by the Haugh (1937) formula. The shell thickness has been measured by a swab of the shell membranes on three points of the equator with an electronic micrometer. The mean of these three values was considered in the data analysis. Tyler *et al.* (1964) reported that the shell of the egg is finer but nearly uniform in the equatorial zone.
The yolk and shell weights have also been measured to determine the yolk and shell proportions as well as the weight of shell by surface units.

Table 1: Feed mix composition for starting, growth and laying diets

	Mix (%)		
Ingredients	Starting	Growth	Laying
Soybean cake	32.00	30.00	20.00
Wheat	37.00	31.00	11.00
Corn	25.00	33.00	50.00
Soy oil	2.30	2.00	3.00
Calcium phosphate	1.50	1.80	1.00
Minerals (Vitamins, micronutrients)[1]	1.10	1.0	1.00
Calcium carbonate	1.08	1.20	7.50
Methionine	0.02	0.20	0.10
Alfalfa	-	-	2.40
Beets molasse	-	-	1.50
Wheat middlings	-	-	2.50
Composition			
Metabolizable energy (kcal/kg)	2870.00	2950.00	3060.40
Fat content (g/kg)	55.13	52.18	54.53
Lysine (g/kg)	12.45	8.46	11.28
Methionine (g/kg)	5.39	3.45	4.36
Calcium (g/kg)	9.50	38.00	10.00
Phosphorus (g/kg)	6.03	5.62	5.68
Dry matter (g/kg)	612.9	749.60	561.26
Crude protein (g/kg)	220.00	170.00	189.00

[1]: Vitamin A 13500 UI/kg, Vitamin D3 3.000 UI/kg, Vitamin E 25 mg/kg, Copper sulfate 15 mg/kg

Table 2: Mortality during the breeding period and the egg production period according to the typical genetics

Periods	Genotype		
(Weeks, (%))	Kabyle	ISA-Kabyle	P
0-19	13.04	9.63	NS
19-36	24.00	15.00	*
36-51	17.11	15.29	NS
51-66	15.87	18.06	NS
66-72	9.43	6.70	NS
EPP (19-72)	51.00	45.00	**

ns, *, **: p>0.05, p<0.05, P<0.1, respectively; BW: Body weight; EPP: Egg production period

Statistical analysis: The statistical analysis has been done with the SAS software (2001). The Generalized Linear Model has been used to do an analysis of variance on each parameter, in order to determine the differences between the two studied lines at each age and their statistical significance. For each parameter, the Least Squares Mean (LSmean) as well as the Standard Error (SE) have been calculated.
The following model has been used:

$$Y_{ijk} = \mu + A_i + B_j + (AB)_{ij} + e_{ijk}$$

Where:

- Y : The egg quality parameters
- μ : General mean
- A_i : Fixed effect of the genotype
- B_j : Fixed effect of the age
- $(AB)_{ij}$: Effect of the interaction of the genotype and age
- e_{ijk} : A random residual effect

RESULTS AND DISCUSSION

Mortality rates during the study period are indicated in Table 2. Table 3 and 4 present, for the 35 to 36 weeks, 50 to 51 weeks and 65 to 66 weeks periods, the values for the various variables of production, the quality of the eggs per genetic type, with the significance of the variation source of the "genotype", the "age" and the interaction "age x genotype", respectively.

Mortality: The overall mortality was 13.04 and 9.63% for, respectively, the Kabyle and ISAKAB genotype until the 19th week of age. During the breeding period in cage, this mortality reaches 51 and 45%, respectively.

The Table 2 shows for all periods a similar mortality between the two studied genotypes. No pathology could explain this higher level of mortality. On the other hand,

Table 3: Laying performances of local Kabyle breed and ISAKAB genotype under experimental semi-intensive conditions (LsMeans±SE)

	Genotype			
Parameters	Kabyle	ISA-Kabyle	Level of significance	R^2
BW at first egg (g)	1334.05±15.26[a]	1538.03±15.38[b]	***	0.38
Age at first egg (days)	165.96±1.25[a]	140.76±1.26[b]	***	0.58
Eggs layed per year	173.44±2.45[a]	194.20±2.36[b]	***	0.21

***: p<0.0001; BW: Body weight

Table 4: Egg quality parameters in local Kabyle breed and ISAKAB genotype under experimental semi-intensive conditions (Ls Means ± SE)

		Genotype		Level of significance			
Parameters	Age	KABYLE	ISAKAB	Genotype	Age	Genotype x Age	R^2
Egg weight (g)	35-36	43.70±0.34[a]	49.99±0.27[b]	***	***	***	0.72
	50-51	49.54±0.27[a]	53.70±0.26[b]				
	65-66	53.37±0.30[a]	57.13±0.29[b]				
Albumen weight (g)	35-36	25.38±0.27[a]	29.38±0.22[b]	***	***	*	0.56
	50-51	28.63±0.21[a]	31.41±0.21[b]				
	65-66	30.05±0.24[a]	32.78±0.26[b]				
Yolk weight (g)	35-36	13.60±0.22[a]	15.48±0.17[b]	***	***	***	0.52
	50-51	16.03±0.17[a]	17.00±0.17[b]				
	65-66	17.98±0.19[a]	18.91±0.21[b]				
Shell weight (g)	35-36	4.72±0.09[a]	5.14±0.07[b]	***	**	NS	0.13
	50-51	4.88±0.07[a]	5.28±0.07[b]				
	65-66	5.34±0.08	5.48±0.09				
Albumen percentage (%)	35-36	58.08±0.37	58.76±0.29	**	***	NS	0.10
	50-51	57.81±0.28	58.51±0.28				
	65-66	56.31±0.32[a]	57.31±0.34[b]				
Yolk percentage (%)	35-36	31.09±0.35	30.94±0.28	*	***	NS	0.14
	50-51	32.33±0.28	31.65±0.27				
	65-66	33.68±0.31	33.10±0.33				
Shell percentage (%)	35-36	10.83±0.17[a]	10.30±0.14[b]	NS	***	NS	0.08
	50-51	9.86±0.14	9.84±0.13				
	65-66	10.01±0.15	9.60±0.16				
Shell thickness (10^{-2} mm)	35-36	34.89±0.43[a]	38.48±0.34[b]	***	***	**	0.33
	50-51	33.70±0.33[a]	36.42±0.33[b]				
	65-66	32.75±0.37	33.60±0.40				
Shape index[1]	35-36	76.98±0.14[a]	77.83±0.11[b]	***	***	NS	0.62
	50-51	75.79±0.11[a]	76.81±0.11[b]				
	65-66	74.29±0.13[a]	74.86±0.13[b]				
Y:A ratio (%)	35-36	52.34±0.95[a]	55.75±0.75[b]	NS	***	**	0.11
	50-51	55.70±0.74	54.17±0.72				
	65-66	59.77±0.83	57.79±0.89				
Haugh Units (HU)	35-36	90.02±0.54	89.76±0.43	NS	***	NS	0.48
	50-51	84.30±0.42	83.38±0.41				
	65-66	80.59±0.48	81.45±0.51				

[1]: egg length/width x 100; Y:A: yolk to albumen ratio; ns, *, **, ***: p>0.05, p<0.05, p<0.01, p<0.0001, respectively

Benabdeljelil and Merat (1995) and Benabdeljelil *et al*. (2003) have reported that the poor adaptation of local breeds to the cages was a possible cause for that increased mortality.

Production performances: The age at first egg presented highly significant differences ($p<0.0001$) between the genetic types, the local Kabyle breed having been least precocious and the crossbred ISAKAB the most precocious. Table 3 indicates that the ISAKAB have an egg production significantly superior to that of the Kabyle genotype during the egg production period.

For each period, mean egg weight difference between genotypes was around 4g. For the laying rate and the body weight at first egg, an advantage has been observed for the ISAKAB crossbred, reflecting the more precocious age at first egg for the latter (Table 3). The start of egg laying occurred at 166 days. Among local breeds of the Maghreb, this appears late compared to the Mandarah hen, an Egyptian breed, for instance, which starts laying at 139 days, as well as to the Moroccan local poultry, which starts laying at 174 days (Raach-Moujahed *et al*., 2011). However, the present individual production of 173 eggs per year is higher than that of the different known local breeds of Maghreb, namely the Dandarawi (Egypt, 128 eggs/year) and the Fayoumi (Egypt, 141 eggs/year) (Raach-Moujahed *et al*., 2011), as well as Tunisian and Moroccan local poultry (127 and 78 eggs per year respectively) ((Bessadok *et al*., 2003; Raach-Moujahed *et al*., 2011).

Therefore, the crossing had the more marked advantage for the precociousness of egg production and egg weight. For the number of eggs laid per year, its superiority is of about 21 eggs. Cross-breeding with the Isa-Brown has, therefore, led to more productive individuals, still using local genetic resources. In an earlier work, Tixier-Boichard *et al*. (2006) demonstrated that the crossbreeding of the Egyptian Fayoumi breed with the Isa-Brown strain leads to improved performances.

For the weights of the egg component, the shell thickness, the shape index, the differences between the two genotypes were significant ($p<0.01$).

No difference has been recorded between the two genotypes for the yolk to albumen ratio and the Haugh units. In the present experimental conditions, the ISAKAB crossbred proved more performant than the Kabyle hen for all the assessed production parameters.

Conclusion: The present results suggest that, in the prospect of developing small-scale semi-intensive egg production in Algeria, several crossbred of the local breed with hybrid strains may be used in order to achieve standard productivity while controlling risks that accompanies the use of purely hybrid animals in suboptimal conditions. This use would require the evaluation of different possible crossbreeding schemes, using different hybrid strain, to adequately choose strategies fitting the variable contexts met in Algeria. To be sustainable, the use of crossbreeding must critically include a plan for the conservation of the native genetic pool on which the strategy is founded.

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