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Effect of crossbreeding on production performances and egg quality traits between improved local cocks and Isa Brown chickens

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ABSTRACT

The low performance level of local chicken in the Niger poultry production system is mainly due to the fact that the local chickens have low genetic potential. Therefore, this study aimed to investigate the production performances and egg quality characteristics of hens obtained by crossbreeding of Isa brown hybrid hens and improved local cocks (Magia) (ISA-A) in comparison with commercial Isa brown hybrid hens (ISA-B). The experiment was arranged in a completely randomized design with two-layer genotypes (40 hens per genotype) used in this study. These two genotypes were housed in a floor system when hens were 19 weeks of age at a stocking density of 10 birds/m^2. Production performance parameters and egg quality characteristics were recorded throughout the experimental period, which lasted 21 weeks. The ISA-A hens achieved higher values for egg production (P=0.000) as compared to the Isa Brown hybrid genotype, and the mean laying rate was about 7% higher for the ISA-A hens than that of ISA-B hens. The egg production period for ISA-A hens peaked at a rate of 83.67%, which was higher than for ISA-B with 74.03% at 29 weeks. However, no significant differences (P>0.05) in average egg weight and feed intake were observed between ISA-B and ISA-A layers. Moreover, egg quality characteristics were not significantly affected by genotype (P>0.05). In conclusion, this study showed that crossbreeding between Magia cocks and commercial Isa brown layer hens might be an alternative method for improving Niger's local chickens.

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Keywords: Laying Hens, Magia, Genotype, Egg Laying Rate.

INTRODUCTION

The use of crossbreeding for genetic improvement has been implemented for the past few decades in several African countries to improve the performance of indigenous chicken genotypes (Chebo et al., 2022). It has been demonstrated that crossbreeding can be more efficient than selective breeding because it can increase productivity within a shorter time (Kgwatalala and Segokgo, 2013) and have yielded positive results (Itafa et al., 2021). Numerous studies have shown that crossbreeding indigenous chicken genotypes with exotic breeds improves the performance of the indigenous chicken. Adeleke et al. (2013) reported that crossbreeding significantly improved the fertility and hatchability traits of the crossbred local frizzle chicken genotype in Nigeria. On the other hand, Yonas (2020) suggested that improving

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the local chicken through selective breeding is preferable to crossbreeding with non-adaptive exotic breeds. The genotype is one of the most important factors, influencing not only egg weight but also other egg characteristics. The genotype affects mainly egg weight and eggshell characteristics. Several studies have shown heavier eggs in brown hens than in white ones (Ledvinka et al., 2000; Leyendecker et al., 2001; Vits et al., 2005). Indigenous chickens are often used in crosses with exotic breeds to improve egg production traits (Momoh et al., 2010, Dzungwe et al., 2024; Hailemariam et al., 2023; Sungkhapreecha et al., 2022; Taye et al., 2022; Wang et al., 2022). The effect of genotype on yolk and albumen quality characteristics was observed by Islam and Dutta (2010). They found significantly higher eggs quality characteristics traits in Rhode Island Red (RIR) and Cobb 500 than in indigenous chickens' eggs. The poultry production in Niger, long dominated by traditional systems, is gradually transforming around urban centers to become a real economic activity. Across the country, traditional poultry farming represents 98% compared to 2% for modern poultry farming. In Niger, poultry farming has not yet experienced similar development to that of countries in the sub-region. The indigenous chicken population constitutes 54.7% of the livestock. The yield of indigenous chicken remains low, and the performance in terms of egg and meat production is very low due to climatic constraints and the traditional nature of the activities. Thus, the national production of poultry products remains insufficient. Numerous studies have shown that egg production potentials of indigenous chicken are assumed to be 30–60 eggs/year/hen with a mean of 38 g egg weight under farmers' management conditions, but commercial laying hens can produce as many as 325 eggs/year (Assefa et al., 2019; Hailu et al., 2019; Abiyu et al., 2019). The performance of indigenous hens in terms of egg and meat production is very low. The indigenous chickens display a slower growth rate and a lower egg-laying capacity compared to improved breeds (El-Tahawy and Habashy 2021; Kassa et al., 2021; Ochora et al., 2023). In fact, the Niger indigenous chicken has an average weight of one-kilogram fifty-two grams (1.052) for females and one kilogram five hundred twenty-three grams (1.523) for males (Guisso et al., 2023a). In Niger, the day-old chicks are imported from France, Belgium, or Nigeria. Considering all these reasons mentioned above, the improvement of indigenous chickens as well as the production of day-old chicks in Niger is essential because this will reduce this dependence on importing day-old chicks. Therefore, this study aimed to investigate the performance of production and egg quality characteristics of hens obtained by crossbreeding of Isa brown hybrid hens and improved local cocks (Magia) and their comparison with commercial Isa brown hybrid hens.

MATERIALS AND METHODS

Study site and breeder flock

The experiment was carried out in a poultry research farm at the Djibo Hamani University, Faculty of Agriculture, Department of Animal Production and Food Technology. Hatching eggs were obtained from a crossbreeding between improved local cocks (Magia) and Isa brown commercial egg layers hens.

Incubation, hatching conditions and chicks rearing system

A total of 200 eggs were transferred to the incubator with a capacity of 1050 eggs and were preheated for 6 h at a temperature of 30°C. A standard single-stage incubation program was used during the setter, and the set point temperature was 38°C during the first five days of incubation and was reduced gradually to 37.7°C at day 6 of incubation until day18. The relative humidity was maintained at 55% during the entire incubation process. The eggs were turned once every hour until day 18 of incubation, at which time they were transferred to baskets and placed in hatching cabinets, maintained at an average air temperature and relative humidity of 37.2°C and 70% RH, respectively. After hatching, the chicks were taken from the machine and placed in a rearing cage. Two days before hatching,

100 commercial Isa brown hybrid day-old chicks were obtained to compare their performances during experimental period. The chicks of the two genotypes were individually numbered and reared in a floor system and fed with a commercial feed until they were 19 weeks of age, age at which the study began.

Experimental design

The experiment was arranged in a completely randomized design with two-layer genotypes (40 hens per group) of Isa Brown hybrid hens (ISA-B), and the hens obtained from a crossbred between improved local roaster (Magia) and Isa brown commercial egg layers (ISA-A) were used in this study. These two genotypes were housed in a floor system when hens were 19 weeks of age in a stocking density of 10 birds/m^2. Each treatment group was replicated four times in a completely randomized design (CRD), each making up 10 hens per replicate. Production performance parameters (including egg production, daily egg mass, feed consumption, feed conversion efficiency and hen's body weight) were recorded weekly throughout the experimental period, which lasted twenty weeks (21 weeks). The daily photoperiod consisted of 16 h light and 8 h darkness and laying hens were fed a standard commercial diet as ad libitum**.** 30 eggs at 34 weeks of hen age laid by each group of hens were collected for egg quality evaluations. The day after oviposition, eggs from each genotype randomly selected were weighed and the egg shape index determined, then broken to determine the yolk and albumen weights, albumen and yolk heights, yolk and albumen indexes, and Haugh units (HU). A total of 60 eggs were examined.

Statistical analysis

The statistical analysis of the data on production performance parameters and egg quality characteristics was performed by one-way analysis of variance, using the GLM procedure of SAS (SAS and GUIDE, 2004). The model used for the statistical analyses of production performance parameters and egg quality characteristics was $Yij = \mu + PIi + eij$, where Yij was the dependent variable, μ was the overall mean, PIi was the genotype (i = ISA-A or ISA-B), and eij was the error term. Differences among the treatment means were determined using Tukey's multiple range test. Statistical significance was determined at $P<0.05$.

RESULTS

Sexual maturity and egg production

The hens in the flock matured sexually (onset of egg production) on average at 133.0 days, i.e. 19 weeks of age in both genotypes (Figure 1). At this time, the average egg and body weight values were 42.75 g and 1251 g in ISA-B and 41.81 g and 1322 g in ISA-A, then the egg weight slowly increased to an average, more than 50.0 g during the laying period in both genotypes (Figure 1). The egg weight increased with the layer's age in both genotypes. The peak egg production period was noted after 10 weeks of egg production at 29 weeks (Figure 1) with the average egg-laying rate at 83.67% and 74.03% in ISA-A and ISA-B respectively. Furthermore, at this age, egg and body weights of the birds increased to an average of 51.71 g and 1468 g in ISA-A and an average of 50.31 g and 1342 g in ISA-B. At the age of 32 weeks, the laying rate decreased by about 42.85% and 31.15% in ISA-A and ISA-B, respectively. At 40 weeks of age, the laying rate decreased by about 16–17% in both genotypes. However, at this age, an increase in body weight of about 1570 g and 1480 g in ISA-A and ISA-B hens was observed, respectively.

Production performances

Significant differences were observed between the ISA-A and ISA-B genotype groups in terms of laying rates (P=0.000). The ISA-A hens demonstrated higher egg production, with an average laying rate about 7% higher than the ISA-B hens (P=0.000). Specifically, the ISA-A group peaked at an egg production rate of 83.67% (SE=2.95%), while the ISA-B group peaked at 74.03% (SE=2.95%) (P=0.025). However, there were no significant differences (P>0.05) between the two groups when it came to average daily egg

weight, daily feed intake per bird, or feed conversion ratio.

Characteristics of internal egg quality

The effect of genotype on eggs quality of eggs obtained from ISA-A and ISA-B genotypes are shown in table 2. The results of analysis show that egg weight, egg shape index, Haugh unit, albumen and yolk heights, albumen and yolk weights and albumen and yolk indexes were not significantly affected by genotype (P>0.05).

Picture A : ISA-A genotype hens

Picture B: ISA-B genotype hens

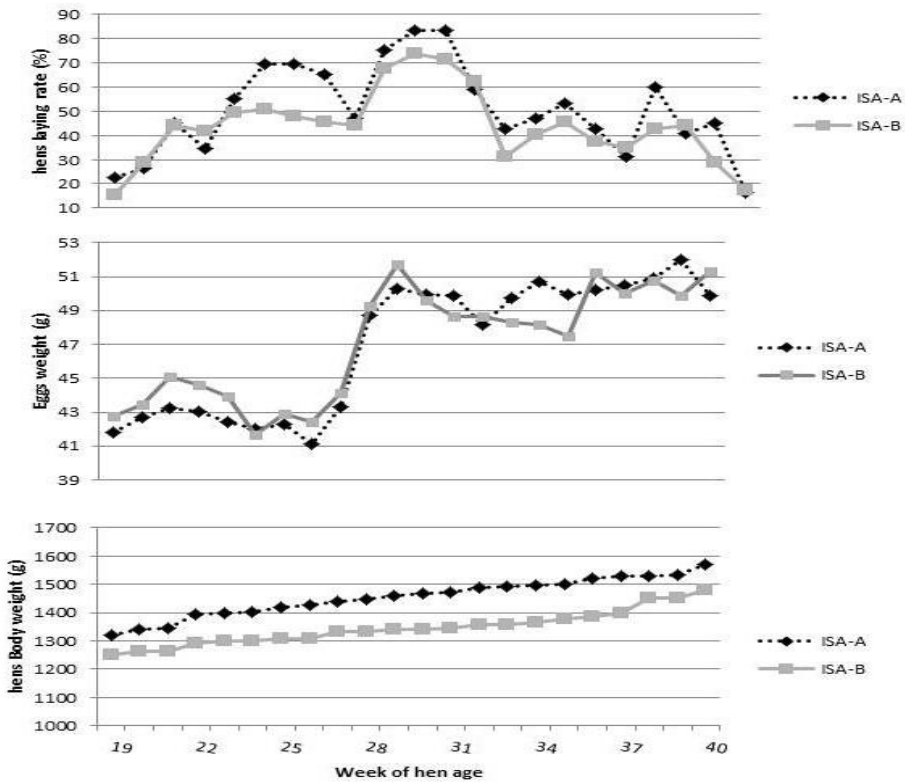

Figure 1: Effect of genotype on production performances.

Table 1: Effect of genotypes on the production performances.

Genotype	Egg Laying rate (%)	Egg laying rate at peak (%)	Daily feed intake per day (g)	Daily Egg weight (g)	FCR
Isa-A	50.72[a]	83.67[a]	70.51	47.60	3.697
Isa-B	43.94[b]	74.03[b]	68.47	47.99	3.374
SEM	1.24	2.95	1.29	0.33	0.38
P-value	0.000	0.025	0.269	0.414	0.561

[a–b] Means within a column with no common superscript letter are significantly different (P<0.05), ISA-A: hens obtained by a crossbreeding between improved local cock (Magia) and commercial Isa brown layer hens; ISA-B: commercial Isa brown layer hens, FCR: feed conversion ratio.

Table 2: The effect of genotype on eggs quality characteristics.

Genotype	Egg Weight (g)	Egg shape Index (%)	Albumen Weight (g)	Yolk weight (g)	Haugh Unit	Albumen height (mm)	Yolk height (mm)	Albumen Index (%)	Yolk Index (%)
ISA-A	50.23	78.54	23.09	12.00	82.69	6.37	15.22	10.34	41.93
ISA-B	50.08	78.51	23.82	12.00	83.17	6.52	15.68	11.28	43.46
SEM	1.436	0.256	1.161	0.547	1.601	0.279	0.557	0.525	1.664
P-value	0.950	0.931	0.663	1.000	0.832	0.700	0.565	0.217	0.521

ISA-A: hens obtained by a crossbreeding between improved local cock (Magia) and commercial Isa brown layer hens; ISA-B: commercial Isa brown layer hens

DISCUSSION

Production performance

In this study, indigenous chicken improvement showed promising results. The ISA-A crossbred hens had the highest average egg-laying rate throughout the experiment, including the peak period, while the ISA-B hybrid hens had the lowest. Specifically, the laying rate of ISA-A hens was 7.24% higher than that of the ISA-B commercial hybrids. These results corroborated the study of Ochora et al. (2023), who reported Crossbred chickens exhibited hybrid vigor in terms of egg production under free range and semi-intensive systems. Similar findings were observed in Horro selective breeding research, where egg production in local chickens increased by 21% from the fourth to the sixth generation after 24 weeks of laying (Woldegiorgiss, 2015). Moreover, Improved Horro chickens saw a significant boost in egg production, reaching a 124% increase (75 additional eggs) by week 45 (Woldegiorgiss, 2015; Wondmeneh et al., 2016). Multiple studies have demonstrated the positive effects of crossbreeding on egg production, consistently showing better performance in crossbreeds compared to Indigenous chickens (Sola-Ojo and Ayorinde, 2011; Habte et al., 2013; Alem, 2014). For example, Negawo (2007) reported that

crossbreeding Rhode Island Red (RIR) with local chickens led to a higher egg-laying rate and increased egg weight in on-farm conditions, with hybrids producing eggs weighing 50.23 g compared to the 42.76 g from local chickens. Improved Indigenous chickens also outperformed their indigenous counterparts in all measured traits in controlled conditions. However, the obtained results of the present study showed a positive effect of genetic improvement of Niger local chickens when compared with the results of Guisso et al. (2022b), who reported that on the station, the Niger local hens at the start of the laying period were 19 weeks old and weighed an average of 919 g and the laying peak was reached in the fourth week and lasted for 12 weeks. They also reported that the average egg laying rate, daily feed intake per bird, consumption index, and egg weight were 40.70%, 75.20 g, 6.97, and 37.50 g, respectively, while our results from the present study showed that hens obtained by crossbreeding between indigenous cock and Isa brown hybrid hens at 19 weeks exhibited better average laying rate, egg weight, daily feed intake per bird, and feed conversion ratio were 50.72%, 70.51 g, 3.69, and 41.81 g, respectively with an average live body weight of 1322 g at 19 weeks of age. The reason why Niger local hens had significantly lower feed consumption and feed conversion ratio when compared with local improved hens of the present study lies in their significantly lower productive needs because of much lower egg production and egg weight.

Characteristics of internal egg quality

In the present study, all egg quality characteristics were not significantly affected by genotype, eggs obtained from Isa brown hybrid hens exhibited statistically similar internal egg quality characteristics than those from eggs of hens obtained by crossbreeding between local cock and Isa brown hens. Rakonjac et al. (2021) reported that New Hampshire eggs had a higher content of yolk and a smaller content of albumen when compared with Isa Brown eggs. Suk and Park (2001) also reported that eggs from native breeds have a higher content of yolk and a smaller content of albumen when compared with eggs from hybrid hens. On the other hand, Zita et al. (2009) found that eggs from Moravia BSL hens exhibited the highest egg weight and yolk index, while eggs from Hisex Brown had the best albumen proportion than eggs from Isa Brown hybrid hens. Wang et al. (2022), reported the crossbreeding between indigenous and elite layer lines results in overall egg qualities. Considering the obtained results of the present study in albumen and yolk weights and Haugh unit (23.09 g, 12 g, and 82.69, respectively) of eggs from crossbreeding between indigenous cock and Isa brown hybrid hen, the positive effect of local chickens genetic improvement can be seen when compared with the obtained results of Guisso et al. (2022b) on the physical and chemical characteristic of eggs obtained from Niger local hens on the station who found a lower albumen and yolk weights and Haugh unit value (11.1 g, 6.82 g and 76.2, respectively).

Conclusion

This study highlights the potential of crossbreeding Magia cocks with commercial Isa Brown layer hens as an effective strategy to improve local chicken breeds in Niger. By adopting this approach, farmers could significantly reduce their dependence on expensive imported day-old chicks. The results indicate that crossbreeding with locally improved cocks can enhance egg production, feed efficiency, and egg quality, offering a cost-effective solution for poultry farmers. Investing in the improvement of local breeds may help mitigate the financial burden of importing day-old chicks. Future research should focus on developing a Niger-specific parent stock that can rival or outperform imported commercial breeds, ultimately supporting the country's sustainable poultry production.

COMPETING INTERESTS

The authors declare that they have no competing interest.

AUTHORS' CONTRIBUTIONS

All authors conceived and planned the experiments. AHM carried out the experiments and the statistical evaluation. All authors contributed to the interpretation of the results. All authors took the lead in writing the manuscript and provided critical feedback and helped shape the research, analysis and manuscript. All authors have read and approved the final version of the manuscript.

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