Hatchability, Fertility and Egg Quality Traits of Improved Horro Chicken Crossed with Koekoek and Kuroiler Chicken Breed

[1]Shambel Taye, [2]Gebeyehu Goshu and [1]Solomon Abegaz

[1]Ethiopian Institute of Agricultural Research, Debre Zeit Agricultural Research Center, P.O. Box: 32, Bishoftu, Ethiopia

[2]Addis Ababa University, College of Veterinary Medicine and Agriculture, P.O. Box: Debre Zeit, Ethiopia

Key words: *Albumen*, egg weight, genotypes, fertility, hatchability, *Yolk, Shell weight*

Corresponding Author:
Shambel Taye
Ethiopian Institute of Agricultural Research, Debre Zeit Agricultural Research Center, P.O. Box: 32, Bishoftu, Ethiopia

Page No.: 20-24
Volume: 21, Issue 1, 2022
ISSN: 1680-5593
Journal of Animal and Veterinary Advances

Abstract: The study aimed to evaluate the hatchability, fertility and egg quality traits of exotic dual purpose chicken crosses of Koekoek (K) and Kurioler (Ku)) with an improved Horro chicken (H) under reciprocal mating. The experiment was carried on seven genotypes, including three pure lines (H, K, Ku) and their direct crosses (K×H, Ku×H and reciprocal crosses (H×K, H×Ku). A total of 446 a-day-old chicks from the seven genotypes were distributed randomly to pens with three replications per genotype in a completely randomized design. A total of 700 hatching eggs; 100 of eggs from each genotype were collected and hatched for determination of egg fertility and hatchability traits in percentage. After the start of three month of egg laying, 15 eggs per genotypes were randomly selected and used for external and internal egg quality traits determination. In comparing fertility of crossbreds, no significant ($p>0.05$) differences were observed among genotypes and the fertility rate ranged from 86.2 to 91.44% for Ku×H and H×K respectively. The highest hatchability from fertile egg was recorded for Kuroiler (86.02%) followed by improved Horro chickens (80.73%). No significant differences were observed among the genotype for all egg quality traits, except for egg weight, shell weight and albumen width. In comparing whole genotypes, significantly highest ($p<0.05$) egg weight was observed for Ku×Ku, Ku×H and H×K crossbred hens whereas the lowest egg weight was observed for improved Horro and the other genotypes have shown comparable performance for most studied egg quality traits including egg weight. Slightly quite improvement was observed among the crossbred of both Kuroiler- crosses and Koekoek-crosses in fertility and hatchability traits. Hence, some of internal and external egg quality traits are found to be improved in crossbred chicken than the improved Horro chicken in the crossbreeding schemes.

INTRODUCTION

Chicken eggs and meat are the major sources of animal-based proteins for human being. Through continual genetic manipulation, recent chicken has become the most efficient domestic animal in quality protein production. For increasing world population and urbanization, with decreasing number of people directly involved in agriculture and increasing demands for animal protein, needs increase and sustainable poultry production which are suitable for family production system[1]. Indigenous chicken genotypes despite their better adaptability to the low input scavenging/semi-scavenging system their production in terms of egg and growth is low[2]. In addition to this they have good fertility and traits comparing to exotic ones. Genetic improvement can be performed by crossbreeding through upgrading to a superior parent breed by frequent backcrossing, or through with in-line selection. Beside to this, usually entails a two-way cross between a local breed and improved exotic, with the intention of combining the better production quality of the improved exotic with the local chicken breed adaptability to harsh environments.

Fertility and are important parameters that should be studied before finalizing the cross-breeding program for backyard poultry. Wolc and Clori[3] described that the fertility and are susceptible to genetics and environmental factors arising from various source and there are several factors that influence of eggs like pre-incubation storage time, fertility and incubation condition. Similarly, the fertility of an egg is affected by factors directly related to the laying hen such as her ability to mate successfully, store sperm, ovulate an egg cell and finally produce a suitable environment for the formation and development of the embryo[4]. Fertility also depends on the ability of cock to mate successfully, quantity and quality of semen deposited[4,5]. The crossbreeding of indigenous chickens with appropriate exotic chicken breeds can bring solutions to the development of productive and good in egg quality traits chicken breeds that are suitable for family poultry production. In Ethiopia, there was little genetic improvement work was done on indigenous chickens through crossbreeding with exotic chicken breeds under reciprocal mating. In addition to this, scarce information is available on the comparative hatchability, fertility and egg quality traits performance of crossbred hen. Therefore, the present study was aimed to evaluate the hatchability, fertility and egg quality traits of Koekoek and Kuroiler chicken breeds crosses with improved Horro to produce intermediate productive crossbred hen for semi-intensive poultry production.

MATERIALS AND METHODS

Study area: The study was carried out at the Debre Zeit Agricultural Research Center National Poultry Research Farm, which is located at 45 km south east of Addis Ababa, at an altitude in the range of 1900 to 1995 meters above sea level and at 8.44°N latitude and 39.02°E longitude. The area has a bimodal rainfall pattern with a long rainy season from June to mid-September and a short rainy season from February to May. The average annual rainfall, maximum and minimum temperatures for the area are 892 mm, 28.3°C and 8.9°C, respectively.

Experimental bird mating and plan: The present work was done on one improved local chicken called Horro of twelve generation of selection and two exotics (Potchefstroom koekoek (K) and Kuroiler) chicken breeds. The crossbreeding study was started by randomly picking of 105 hens and 33 cocks as foundation parental breeds. Mating was started at 21 weeks of age using the two exotic breeds (Koekoek and Kuroiler) and improved Horro chicken as a parental-line. In the first generation of the crossbreeding experiment, Hens of each of the two exotic breeds and improved Horro were randomly divided into three breeding groups. The first group of hens of each of the three breeds was naturally mated with cocks from their own breed while the second group was artificially mated with semen of cocks from improved Horro chicken. Similarly, Hen of improved Horro chicken mated artificially with semen of cocks from two exotic breeds. Artificial insemination was required because of the big size difference between improved indigenous Horro and the other exotic chicken breeds. Within the same breed, male to female ratios of 1 to 5 were used in pen mating arrangements. The cocks were assigned to mate the hens at random, with a restriction to prevent birds from mating with common grandparents. Accordingly, seven genetic groups of H♂" H♀, K♂×K♀, Ku ♂×Ku♀, H♂×K♀, K♂×H♀, H♂×Ku♀ and Ku♂×H♀ chick's combination were obtained. To get adequate semen for artificial insemination two cocks were used per replication (a total of six cocks) for each type of cross as opposed to only one cock per replication in the pure mating. A total of 446 unsexed day-old chicks were obtained from all genetic groups. Chicks from each genotype were distributed randomly between pens using a completely randomized design with three replications.

Experimental bird management and Egg incubation: The birds were provided with water *ad libtum* and standard feed as per the requirement at each specific growth stage. Starting chicks were fed on a ration containing 20% of CP and 2,950 kcal kg^{-1} for up to 8 weeks and the grower ration were contain 18% CP and 2,850 kcal kg^{-1} from 9-18 weeks. At beginning of 19 weeks layer's ration containing 17-18% CP and 2,750 kcal kg^{-1} was formulated. All chickens were inspected daily for their health status and vaccinations was provided against common disease. Fertile eggs that were incubated to produce experimental chicks were evaluated for fertility and hatchability at 28 weeks of age. The eggs were incubated in Pass reform incubators with standard temperature and humidity facilities of 99.5 to 99.75°F and 55-60% for 18 days in setter compartment. Subsequently, the temperature was decreased to 98.5°F whereas a relative humidity was increased to 65-70% in the hatchery compartment, from the 19th day to hatching time. The eggs were also turned automatically through 45° in the incubator. On the 18th day of incubation, egg candling was performed to identify fertile and clear eggs. Candling was performed with a mass candler in a dark room. The fertile eggs were seen to be opaque, with a system of veins indicating the embryo's development inside the egg, whereas the infertile eggs were translucent under the light.

A total of 700 hatching eggs; 100 from each crossbred were collected and hatched. The percentage of fertility from the total egg set per pen was calculated as the number of set egg minus the number of infertile eggs at candling per pen divided by the number of set eggs per pen times 100. The percentage of the hatchability of total egg set was calculated from the number of day-old-chick divided by the total number eggs set times 100. The percentage of hatchability of fertile eggs were calculated from the number of day-old chicks divided by the difference between the number of eggs set and the number of eggs found to be infertile at candling, times 100.

Fifteen eggs per pen or genotypes were randomly selected and used for analysis. Egg weight, yolk weight and shell weight measurement were determined by sensitive balance. Egg shape (width and length), yolk width and albumen width were measured by digital caliper whereas albumen height and yolk height were measured at the height of the chalazae at the midpoint between thinner and outer circumference of the white with a Micrometer gauge. The internal egg quality measurements were made by carefully making a hole around the sharp end of the egg that was wide enough to enable both the albumen and the yolk to move through without mixing their contents. The egg width (W) and length (L) were used to measure egg shape index with the formula:

$$ESI = \frac{W}{L} \times *100$$

Yolk index was calculated from the height (YH) and width (YW) of the yolk with the formula[6]:

$$YI = \frac{YH}{YW} \times 100$$

The Haugh Unit score was calculated for individual eggs by using the following formula:

$$HU = 100 \log_{10} (H+7.5-1.7W^{0.37})$$

where, H, W is recorded height of the albumen in mm and weight of egg in grams, respectively[7]. Yolk color was determined by Roche Yolk Color Fan with 15-color index that range from very light-yellow color to very dark yellow color.

Experimental design and statistical analysis: Completely Randomized Design (CRD) design was used and all the data were analyzed using General Linear Models (GLM) Procedure of Statistical Analysis System (9.0 version). When significant differences were detected, treatment means were compared by Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Fertility and hatchability traits: Fertility and hatchability traits of different genotypes is presented in Table 1. In comparing fertility of crossbreds, no significant (p>0.05) differences were observed among genotypes and the fertility rate ranged from 86.2% for Ku X H to 91.44% for HxK. In chickens, fertility refers to the overall actual reproductive capacity of males and females as reflected by their ability to produce progeny when mated together. In this study, the improved Horro (78.5%) and Kuroiler (70.27%) chicken breeds had a significant (p<0.05) higher fertility rate than others, but the rest of genotypes had comparable fertility percentages. However, H x K crosses showed a significantly (p<0.05) higher fertility rate followed by K×H (90.12%) crosses than all genotypes. The results agree with Dessie and Ogle (2001) who had reported the higher fertility for local chicken than exotic breeds. These results in line with Kuroiler chicken but disagree for Koekoek chicken breeds in the current study. Consequently, the fertility rate showed little improvement due to crossing of both Koekoek-crosses and Kuroiler crosses. Egg fertility on the 18th day of candling among cross bred and pure bred were shown to results a significant difference (p<0.05) except for Koekoek. This result was in agreement with Wondemenh[2] who had reported that a significant difference between exotic (Koekoek and Fayoumi) and native chicken breeds (Horro). No significant difference were observed among the crossbred of both Kuroiler-crosses and Koekoek-crosses (p>0.05) in fertility rates.

Along with its strong relationship with chick products, hatchability is an economically important feature in chicken farming[3]. Egg hatchability is heritable to some extent, although it is determined by a complex genetic makeup as well as the surrounded environment. The present result showed that a slightly better fertility rate in improved Horro and Koekoek chicken breeds than the report of Woldegiorgiss[2] for the same breeds. Meanwhile, crossbred hen eggs had superior fertility rate than their counterparts. Hatchability rate were comparable among crossbred genotypes and their correspondence, except for Kuroiler chicken breeds from fertile eggs, which had a higher hatchability rate and Koekoek chicken breeds having the lowest hatchability rate. Adedeji *et al*.

Table 1: Fertility, hatchability of total eggs set and fertile eggs of the improved Horro (H), Koekoek (K), Kurolier (Ku) chicken breed and their crosses

	Genotype combination							
Traits	H×H	H×K	K×H	K×K	H×K	Ku×H	K×Ku	SE
Fertility (%)	78.54[b]	91.44[a]	90.12[a]	88.31[a]	87.48[a]	86.62[a]	70.27[c]	4.43
HFE (%)	80.73[ab]	73.75[ab]	79.23[ab]	58.42[b]	82.61[ab]	76.83[ab]	86.02[a]	13.41
HTES (%)	63.36	67.21	71.48	51.60	71.99	65.88	60.44	11.21

[a-c]Means between Genotypes in the same row with different superscript letters are significant (p<0.05) different; HFE: Hatchability from fertile eggs, HTES: Hatchability from total egg set, %: Percentages, HxH-Horro×Horro, HxK-Horro×koekoek, KxH-Koekoek×Horro, KxK-Koekoek×Koekoek, HxKu-Horro×Kuroiler, KuxH-Kuroiler×Horro, KuxKu-Kuroiler×Kuroiler, SE-standard error of means.

Table 2: Means±SE for Exterior and interior egg quality traits for chicken genotypes

	Genotype combination							
Traits	H×H	H×K	K×H	K×K	H×Ku	Ku×H	Ku×Ku	SE
EWT (g)	46.18[b]	52.68[a]	49.44[ab]	49.33[ab]	49.33[ab]	52.05[a]	54.00[a]	2.60
EL (mm)	53.25	54.53	55.00	54.27	53.98	53.77	55.96	2.26
EW (mm)	40.13	41.66	42.77	42.10	40.40	40.60	41.38	2.15
SW (g)	4.59[ab]	5.02[a]	4.75[ab]	4.48[ab]	4.78[ab]	3.8[b]	4.78[ab]	0.60
ST (mm)	0.39	0.38	0.37	0.34	0.36	0.38	0.36	0.034
ESI	75.42	76.41	77.17	77.55	74.83	75.49	73.93	2.17
YH (mm)	17.30	17.93	17.43	18.50	17.96	17.46	18.20	1.09
AW (mm)	48.32[b]	67.13[ab]	66.36[ab]	71.35[a]	70.86[a]	61.52[ab]	71.60[a]	10.97
YW	37.64	38.39	37.91	38.23	39.44	39.53	38.71	1.07
YC	2.66	2.00	2.66	2.00	2.66	2.00	1.66	0.69
YWT (g)	14.60	15.22	14.97	15.22	16.34	15.74	16.62	1.34
AH (mm)	6.90	6.42	5.91	5.98	6.44	5.89	6.01	0.68
YI	0.46	0.47	0.46	0.48	0.45	0.44	0.47	0.028
HU	87.05	81.96	79.40	80.26	82.34	79.51	79.30	4.45

[a-b]Means between genotypes in the same row with different superscript letters are significantly (p<0.05) different, HH: Horro×Horro, H×K: Horro Koekoek, K×H: Koekoek×Horro, K×K: Koekoek×Koekoek, H×Ku: Horro×Kuroiler, Ku×H: Kuroiler×Horro, Ku×Ku: Kuroiler×Kuroiler. EWT: Egg weight (g), EL: Egg length (mm), EW: Egg width (mm); ESI: Egg shell index, AH: Albumen height (mm), YH: Yolk height (mm), YW: Yolk width, YI: Yolk index, SW: Shell weight (g), ST: Shell thickness, HU: Haugh

reported that a significant variation among purebred and crossbred chickens progenies in hatchability rates.

External and internal egg quality measures: Effect of genotypes on external and internal egg quality traits at peak of the egg production stage were presented in Table 2. The external and internal quality of egg is important in egg production to determine the productive and reproductive measures of poultry. Mainly egg quality is affected by age and genotypes. No significant differences were observed among the genotype for all egg quality traits, except for egg weight, shell weight and albumen width. A non-significant difference in yolk color in the present study is in disagreement with the finding of Alewi *et al*.[8] but, similar with other reports Kedija *et al*.[9]. In comparing the pure genotypes, significantly higher (p<0.05) egg weight and albumen width (p<0.05) were scored for pure line Kuroiler and Koekoek chicken breeds than improved Horro chicken. A significant difference in egg weight, shell weight and Albumen width egg quality parameter observed in the current study were similar to the findings of Kedija *et al*.[9]. The highest egg weight in current study was observed for Kuroiler (54.00 g) followed by Ku×H (52.05 g) and H×K (52.08 g) whereas the lowest egg weight was observed for improved Horro chicken. Similar to the current findings Alewi *et al*.[8] and Kedija *et al*.[9] had reported higher egg weight for Rhode Island Red and Dominant Red Barred than native chicken ecotypes, respectively. This might be due to higher body weight of Kuroiler and the other aforementioned chicken breeds. Egg weight in the current reports for Kuroiler and Koekoek were lower than RIR (58 g) and DRB (55.28 g) as reported by Bekele *et al*.[10] and Kedija *et al*.[9] respectively. But, Kuroiler showed comparable egg weight with crosses of Dominant Red Bared with Horro chicken ecotype.

CONCLUSION

Slightly quite improvement was observed among the crossbred of both Kuroiler-crosses and Koekoek-crosses in fertility and hatchability traits than the improved Horro chicken in the crossbreeding schemes. In comparing crossbreed chickens, higher egg weight was observed for Ku×H and H×K followed by H×Ku and K×H crossbred. In the present study some of the egg quality parameters were slightly improved through cross breeding of both Koekoek and Kuroiler-crosses with improved Horro chicken and their correspondence reciprocal crosses. This shows positive effects of crossbreeding in improving local chickens. Quality egg can be preferred based on genotypes and external features of respective of eggs.

ACKNOWLEDGMENT

We would like to express our gratitude to the Ethiopian Institute of Agricultural Research for funding the research work and also Addis Ababa University for partial financing of the research work.

REFERENCES

1. Thornton, P.K., 2010. Livestock production: Recent trends, future prospects. Philos. Trans. R. Soc. B: Biol. Sci., 365: 2853-2867.
2. Woldegiorgiss, W.E., 2015. Genetic improvement in indigenous chicken of Ethiopia. Ph.D., Thesis Wageningen University
3. Wolc, A. and V.E. Olori, 2009. Genetics of hatchability-egg quality from the perspective of a chick. http://www.cabdirect.org/abstracts/20103247216.html
4. Brillard, J.P., 2003. Practical aspects of fertility in poultry. World's Poult. Sci. J., 59: 441-446.
5. Wilson, H.R., N.P. Piesco, E.R. Miller and W.G. Nesbeth, 1979. Prediction of the fertility potential of broiler breeder males. Worlds Poult. Sci. J., 35: 95-118.
6. Adebambo, A.O., 2011. Combining abilities among four breeds of chicken for feed efficiency variation: A preliminary assessment for chicken improvement in Nigeria. Trop. Anim. Health Prod., 43: 1465-1466.
7. Haugh, R.R., 1937. The haugh unit for measuring egg quality. US Egg Poultry Magazine, 43: 552-555.
8. Alewi, M., A. Melesse and Y. Teklegiorgis, 2012. Crossbreeding effect on egg quality traits of local chickens and their F1 crosses with Rhode Island Red and Fayoumi chicken breeds under farmers' management conditions. J. Anim. Sci. Adv., 2: 697-705.
9. Hussen, K., W. Esatu, G. Goshu and S. Abegaz, 2020. Crossbreeding effect on egg production traits of horro ecotype crossed with exotic dominant red barred d 922 chickens: A step towards synthetic breed development in ethiopia. Brit. J. Poult. Sci., 9: 01-17.
10. Bekele, F., T. Adnoy, H.M. Gjoen, J. Kathle and G. Abebe, 2010. Production performance of dual purpose crosses of two indigenous with two exotic chicken breeds in sub-tropical environment. Int. J. Poult. Sci., 9: 702-710.