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Egg Production and Egg Quality Traits of Local and Exotic Chicken Breeds Reared in Two Agroecologies under Traditional Management System

Serkalem Assefa[2], Aberra Melesse[*1], Sandip Banerjee[1]

[1]School of Animal and Range Sciences, Hawassa University, P.O. Box 05, Hawassa, Ethiopia
[2]Department of Animal Sciences, Worabe University

***Corresponding Author:** Aberra Melesse, School of Animal and Range Sciences, Hawassa University, P.O. Box 05, Hawassa, Ethiopia*

ABSTRACT

This study was conducted to assess egg production and egg quality traits of exotic breeds (Bovans brown, Koekoeck and Sasso) and local chickens reared in two agroecologies under traditional management system. For the assessment of the egg production traits, 200 households were randomly selected from lowland and midland agroecologies. The egg quality traits were assessed from local and exotic chickens reared by the households in both agroecologies. The results indicated that the number of eggs per hen per year was 49.1, 134, 117, and 138 for local, Sasso, Bovans and Koekoeck breeds, respectively. The Sasso breed reared in the lowland produced the highest egg number followed by Bovans being higher ($p<0.05$) than Koekeock and local chickens. The egg weight and yolk index values for Sasso breed reared in the lowland agroecology were higher ($p<0.05$) than those of other chicken breeds. Koekoeck and Sasso chicken breeds reared in midland had higher ($p<0.05$) shape index and shell thickness values than those of the lowland. All chicken breeds raised in the lowland were superior ($p<0.05$) in all external egg quality traits than those of the midland. All internal egg quality traits of Koekoeck chickens reared in the midland agroecology were superior to those of lowland. In conclusion, the Sasso chickens in the lowland agroecology were superior in most performance traits. Koekoeck hens in the midland agroecology were better in most internal egg quality traits. It is thus recommended to rear the Sasso breeds in the lowland agroecology while the Koekoeck in the midland for enhanced productivity.

Keywords: *Bovans brown chicken; Koekoeck chicken; Sasso chicken; local chicken; agroecology; egg quality*

INTRODUCTION

Ethiopia is representative of countries where traditional poultry plays a dominant role in total poultry production which represents an important part of the national economy in general and rural economy in particular [1]. In Ethiopia, farmers for whom it may be the only form of savings and their own consumption, raise the majority of the local chickens under the traditional management system. This poultry production system is characterized by small flock sizes, low input and output due to absence of proper husbandry practices [2]. Assessment of the prevalent chicken production and productivity might be an essential prerequisite to improve the chicken production strategies and to provide guidelines for the policy makers [1,3]. The indigenous chicken population of Africa in general and that of Ethiopia in particular is under the threat of genetic erosion following the introduction of exotic stock from developed countries [2].

Lack of recorded data on the productive performance of chicken reared under the traditional production system makes it difficult to assess their importance especially the contributions of previous projects to improve the poultry production under smallholder settings [3]. There are also several studies being undertaken by the different researchers in different areas of the country when it comes to the egg production efficiency of the local and the exotic chickens reared under traditional management system [4,5,6]. Over the years, the previous Bureau of Agriculture now Livestock and Fishery Resources office have been distributing large numbers of exotic chickens to many parts of the country and Boricha District of Sidama zone being no exception. However, the production potential and egg quality traits of

chicken genotypes have not been systematically assessed and documented. Therefore, this study was conducted to assess the genetic based variations in egg production and egg quality traits of exotic and local chickens reared in two agroecologies under traditional management system.

Materials And Methods

Description of Study Area

The study was conducted in Boricha district, which is situated at 6°49' 59.99" N and 38°29' 59.99" E in Sidama Zone, southern Ethiopia. The average annual temperature of the study area varies between 21.9 ºC to 25.4 ºC. The mean annual rainfall of the study area varies from 1200 to 1599 mm. The district has mainly two agro-ecological zones, the midland with altitude ranging from 1500 to 2000 m above sea level and lowland with less than 1500 m above sea level.

Assessing of the Egg Production Potentials

To study the egg production characteristics of local and exotic chickens, a multi-stage sampling procedure was used. Accordingly, two agroecologies (midland and lowland) were purposively selected from the district based on their chicken population size and production potentials. Two Peasant Associations (PAs) that rear both local and exotic chickens were then selected purposively from each agroeology. Finally, 50 households from each PA were randomly selected from the record list of Animal and Fishery Resources Office of the district with a total of 200 households. Data on husbandry practices, flock structure, production constraints, flock size and egg production characteristics of chickens were then collected by face-to-face interviewing using a semi-structured questionnaire.

Assessing the Egg Quality Parameters

Egg Collection Protocols

The sampling procedure of agroecologies and PAs for egg collection was the same as to the one stated here above. Four hundred eighty eggs were collected from households that rear exotic and local chickens. The maximum care has been taken to collect eggs that have been stored not more than a week after being laid. Moreover, the freshness of the eggs was cheeked by immersing them in water during egg collection process. The collected eggs were properly labeled according to breed and agroecology.

Assessing the Egg Quality Parameters

Eggs were weighed using triple beam balance. Egg length and width and yolk diameter was measured using digital caliper. A tripod micrometer was used to measure the heights of albumen and yolk. Yolk colour was measured by using the Roche Yolk Colour Fan. Shell thickness was determined by taking the average thickens of the large end, the center and narrow end [7]. Individual Haugh unit was calculated according to the equation of Haugh [8]. Egg shape index was computed by dividing egg width by egg length and yolk index by dividing yolk height by yolk diameter.

Statistical Analysis

Data on quantitative traits were analyzed by two-way ANOVA using GLM (SAS, 2012, ver. 9.4) by fitting the two agroecologies (lowland and midland) and four breeds (Koekock, Sasso, Bovans and local) as main effects and the interactions among them. Mean comparisons were conducted using Tukey's Studentized Range (HSD) Test and values were considered significant at $p<0.05$.

Results

Egg Production Traits

As indicated in Table 1, the number of eggs laid per clutch was higher in the midland than in lowland except for Koekoek chicken, which was not significantly different in both agroecologies. The number of eggs per hen per year was significantly higher for all breeds reared in the midland than those of the lowland agroecology.

Table1. *Egg production traits of local and exotic chicken breeds reared in mid and lowland agroecologies (Mean±SD)*

Parameters	Lowland	Midland	Overall mean
Age at first egg laying (d)			
Local	224±27.9^{Ba}	252±39.3^{Aa}	238±36.8
Sasso	147±22.2^{Bb}	162±24.6^{Ab}	155±24.6
Bovans brown	152±20.3^{Bb}	167±16.0^{Ab}	157±20.1
Koekoek	148±17.5^{Bb}	184±27.3^{Ab}	174±29.6
Number of eggs per clutch			

Local	12.4±2.4^{Bb}	14.2±2.7^{Ab}	13.3±2.7
Sasso	23.8±2.8^{Ba}	26.0±2.6^{Aa}	25.1±2.9
Bovans brown	23.9±3.6^{Ba}	27.3±1.7^{Aa}	25.0±3.5
Koekoek	24.7±6.8^{a}	26.8±3.1^{a}	26.2±4.4
Number of egg per hen per year			
Local	44.6±12.5^{Bc}	53.7±10.8^{Ab}	49.1±12.5
Sasso	129±24.3^{Ba}	137±20.2^{Aa}	133±22.3
Bovans brown	103±20.2^{Bb}	144±20^{Aa}	117±28.0
Koekoek	115±30.6^{Ba}	148±29^{Aa}	138±32.4

^{A,B}*Means between agroecologies within breeds with different superscript letters are significant*

$^{a\text{-}c}$*Means between breeds within agroecologies with different superscript letters are significant*

The average age at first egg of all exotic chickens was significantly lower than local chickens under both agroecologies (Table 1). Similarly, the number of eggs per clutch and length of clutch per exotic chicken breeds was significantly higher than local chickens in all agroecologies. Sasso and Koekoek chicken breeds reared in lowland produced significantly higher number of egg per hen per year as compared with other chicken breeds. However, in the midland there is no significant difference between exotic chicken breeds.

Egg Quality Traits

External Traits

As shown in Table 2, there was significant ($p<0.05$) effect of agroecologies and breeds on all of external egg quality traits except for egg shape index. The interaction of agroecology by breed was also significant for all parameters. The Sasso chickens reared in the lowland were significantly superior in all observed external egg qualities.

Table2. *Effect of agroecology, breed, and their interactions on external egg quality traits (Mean±SD)*

Agroecology	Breed	Egg length (mm)	Egg width (mm)	Egg shape index (%)	Shell thickness (mm)
Lowland	Bovans brown	54.8±1.7^{a}	41.0±1.5^{a}	74.9±3.7	0.287±0.02^{a}
	Sasso	55.0±4.2^{a}	39.2±2.6^{b}	71.5±5.8	0.275±0.02^{bc}
	Keokeok	53.2±4.8^{a}	38.1±1.8^{c}	71.9±4.9	0.267±0.02^{c}
	Local	49.6±3.8^{b}	35.6±2.9^{d}	71.8±3.2	0.279±0.03^{ab}
Midland	Bovans brown	55.6±1.9^{a}	41.2±1.6^{a}	74.2±3.6	0.289±0.02^{ab}
	Sasso	54.9±2.2^{a}	40.6±1.5^{ab}	73.9±3.6	0.301±0.02^{a}
	Keokeok	52.5±4.0^{b}	39.4±4.0^{b}	74.9±3.5	0.283±0.03^{b}
	Local	43.3±5.01^{c}	29.3±4.1^{c}	67.7±4.8	0.281±0.02^{b}
Sources of variations					
Agroecology (AE)		<0.0001	0.0006	0.6963	<0.0001
Breed (B)		<0.0001	<0.0001	<0.0001	<0.0001
AE x B		<0.0001	<0.0001	<0.0001	<0.0003

$^{a\text{-}c}$*Means between breeds within agroecology with different superscript letters are significant*

The findings indicated that the egg length of the Bovans hens varied across the agroecologies with higher values recorded among the eggs laid in the midlands (Table 2). Koekoeck and Sasso chicken breeds reared in midland had higher ($p<0.05$) egg width, shape index and shell thickness values than those reared in the lowland. On the other hand, local chickens reared in the lowland had better ($p<0.05$) external egg qualities (except shell thickness) than those reared in the midland.

Egg shape index values were higher in Bovans followed by Sasso and Koekoeck chickens. The study further indicated that the shell was the thickest among the eggs from Bovans and Sasso chickens while it was the thinnest among those laid by the Koekoeck hens. Local chickens were inferior in all external egg qualities except for shell thickness. Surprisingly, all chicken breeds reared in lowland agroecology were better in all external egg quality parameters compared with those reared in midland.

Internal Traits

As shown in Table 3, the effect of agroecology was significant for all internal egg quality traits except for egg weight and yolk colour. Similarly, the effect of breed was significant for

all internal egg quality traits except for Haugh unit. The interaction effect of agroecology by breed was highly significant for all traits. The study indicated that egg of the Sasso hens reared in the lowlands were heavier than those of other genotypes. The eggs of the exotic chickens reared in the midlands were heavier ($p<0.05$) when compared to those from the local chickens. In the lowland, yolk index was highest ($p<0.05$) among eggs from Sasso and local chickens when compared to other genotypes. Conversely, local chickens reared in the midland produced eggs with higher yolk index than those of the exotic chickens. Yolk colour was significantly higher only in Koekoeck chickens reared in the lowland agroecology. Haugh unit values of the eggs laid by the Koekoeck and local hens reared in the midlands were higher ($p<0.05$) when compared to the other genotypes.

Table3. *Effect of agroecology, breed, and their interactions on internal egg quality traits (Mean±SD)*

Agroecology	Breed	Egg weigh (g)	Yolk index (%)	Yolk colour	Haugh unit
Lowland	Bovans brown	49.5±4.9^{b}	37.8±4.6^{b}	9.9±1.3^{b}	78.6±7.4
	Sasso	53.8±4.9^{a}	41.9±4.6^{a}	10.8±2.3^{b}	78.5±8.0
	Keokeok	43.9±6.89^{c}	37.5±4.6^{b}	11.9±2.4^{a}	77.2±4.7
	Local	41.2±4.5^{d}	40.4±5.9^{a}	10.1±1.9^{b}	76.6±5.3
Midland	Bovans brown	52.0±3.8^{a}	40.7±4.7^{b}	10.3±1.7	80.0±8.5^{ab}
	Sasso	51.0±4.3^{a}	40.2±3.9^{b}	10.4±1.7	78.4±7.1^{b}
	Keokeok	49.9±5.6^{a}	42.9±7.3^{b}	10.5±1.8	81.9±7.6^{a}
	Local	39.5±4.8^{b}	50.0±8^{a}	11±1.9	81.3±6.6^{ab}
Sources of variations					
Agroecology (AE)		0.0625	<.0001	0.6120	<.0001
Breed (B)		<.0001	<.0001	<.0001	0.6494
AE x B		<.0001	<.0001	<.0001	0.0111

$^{a-c}$ *Means between breeds within agroecology with different superscript letters are significant*

Egg weight and yolk index values were higher ($p<0.05$) in Bovans reared in the midland agroecology than other breeds reared in the lowland (Table 3). Sasso breeds reared in the lowland had higher ($p<0.05$) egg weight and yolk index values than those of the midland. All internal egg quality traits of Koekoeck chickens reared in the midland were superior to those raised in the lowland agroecology.

The overall comparison of breeds and agroecologies for external and internal egg quality parameters is presented in Table 4. Accordingly, egg shape index values were higher in Bovans followed by Sasso and Koekoeck chickens. The highest shell thickness was recorded in Bovans and Sasso chickens while the lowest in Koekoeck chickens. Local chickens were inferior in all external egg qualities except for shell thickness. Surprisingly, all chicken breeds reared in lowland agroecology were better in all egg quality parameters compared with those reared in midland.

Sasso chicken breeds had the highest egg weight followed by Bovans, Koekoeck and local chickens that differed significantly from each other. The yolk index was higher ($p<0.05$) for local chickens compared with the exotic chickens. No significant difference was observed between breeds in Haugh unit values. The highest yolk colour values were observed in both Koekoeck and Sasso chicken breeds being higher ($p<0.05$) than those of Bovans and local chickens are. All internal egg quality values were higher ($p<0.05$) for those chickens reared in the midland than those of lowland.

Table4. *Some selected external and internal egg quality traits of local and exotic chickens as affected by breed and agroecology (Mean±SD)*

Fixed factors	Shape index (%)	Shell thickness (mm)	Egg weight (g)	Yolk index (%)	Haugh unit	Yolk color
Breed						
Bovans brown	74.5±3.6^{a}	0.29±0.02^{a}	50.7±4.58^{b}	39.2±4.83^{b}	79.3±8.01	10.1±1.55^{b}
Sasso	72.7±5.0^{b}	0.29±0.03^{ab}	52.4±4.80^{a}	41.0±4.36^{b}	78.5±7.55	10.6±2.01^{ab}
Koekoek	73.4±4.5^{ab}	0.28±0.03^{c}	47.3±6.36^{c}	40.2±6.65^{b}	79.6±6.73	11.2±2.22^{a}
Local	69.8±4.6^{c}	0.28±0.02^{bc}	40.4±4.69^{d}	45.2±8.54^{a}	79.0±6.39	10.5±1.91^{b}
Agroecology						

Lowland	72.5±4.7	0.28±0.02[a]	47.3±7.0[b]	39.4±5.27[b]	77.8±6.52[b]	10.6±2.14
Midland	72.7±4.9	0.29±0.03[b]	48.2±6.87[a]	43.5±7.32[a]	80.4±7.56[a]	10.5±1.78

[a-c] *Row means with different superscript letters are significant*

DISCUSSION

Egg Production

The exotic chickens performed better in most of the production traits (irrespective of the agro ecologies) and may be ascribed to the superior breeding and moderately good adaptation to the agroecologies due to their genetic constitution. However, the numbers of eggs produced (annually) of the native chickens are far below the reports of Aman *et al.* [9] and Desalew *et al.* [10] from Wolayita and Kembata-Tambaro zones and in East Shewa, respectively. This may be due to the types of husbandry practices provided by the households to the chickens as well as the quality and quantity of the feed available in the respective locations. Hence, the development agents in the study area need to appraise the poultry keepers about improved practices and package of poultry husbandry aimed at poverty alleviation.

The age at maturity of the Sasso chickens were earlier with the shortest age to lay when compared the genotypes studied. These findings are in close agreement with those of Aman *et al.* [9] who observed that the Sasso chickens reared at Wolayita and Kembata zones of southern Ethiopia had a lower age at maturity when compared to the other exotic chicken genotypes. The observations may be partly explained by their enhanced adaptability to the studied agro ecologies, thereby favoring them over the other genotypes of chickens included in this study.

The Bovans brown hens had also a lower age at maturity when compared to the Koekoek, the findings being in agreement with the observations of those of Desalew *et al.* [10]. This might be attributed to the smaller size of the Bovans browns when compared to Koekoek chickens of the same age. Thus, requiring low amount of nutrients of their maintenance and thereby attaining the shorter age of maturity with the levels of feed available to them. Moreover, the Bovans are better in feed conversion efficiency than the Koekoek chickens. This may be because the Bovans are hybrids while the Koekock is a synthetic breed that has been stabilized over decades.

The numbers of eggs laid annually per clutch of the local chickens was in accordance with the reports of Alem [11]. However, the numbers of eggs per clutch of the exotic chickens were fewer than Rhode Island Red (RIR) chickens as reported by the same author. This might be explained by the fact that synthetic breeds and hybrids require a better management for the expression of their genetic potentials. The numbers of annual eggs laid by Sasso, Bovans, Koekoek and local chickens were lower than what was reported by Aman *et al.* [9] and Dessalew *et al.* [10] which may also be attributed to suboptimal management, age of the chickens and feed availability in the areas studied.

Egg Quality Traits

The findings from the study indicated that the external egg quality traits of the different genotypes studied were influenced by the agroecologies, which could be attributed to the quality and quantity of feed available. Studies by Sekeroglu *et al.* [12] has also indicated that feed from warmer climates (lowlands) usually have low protein with higher crude fiber contents when compared to the feed obtained from the midlands. Chickens are not able to utilize feed with high crude fiber, which in turn can influence their growth and egg production potentials [5,13]. While the variations in the egg length and width can be associated with the genetics of the birds, the shell thickness is closely correlated with the deposition of calcium, which is metabolized from the skeleton of the birds and the dietary sources [7]. The shell thickness of an egg could be also influenced by environmental temperature (which is expected to be more frequent in the lowland agroecology) that would result in reduced blood flow through shell gland as a result of increased respiratory panting to remove excess heat from the bird's body [14].

The internal egg quality traits are influenced by the quality and quantity of the feed supplied to the chickens apart from the genotypes of the birds as reported by Aberra *et al.* [7] and Assan [15]. The quality of the feed is grossly influenced by both pre and post-handling process as well as the way the feed is stored [16]. According to the reports of Zaman *et al.* [17], the protein content of the feed also influences the albumin content in the eggs. The

findings further indicated that the egg quality parameters varied across the genotypes with Sasso chicken being better adapted in the lowlands (this was also observed across the other traits discussed above). However, the egg quality traits of Bovans brown and Koekoek indicated that these breeds are better suited to the midlands, which concurs with the findings of Getachew *et al.* [18] from Chelliya district of Ethiopia.

The egg weight of Sasso hens were the heaviest indicating that these breed could be best suited for the areas studied. Studies by Jatoi *et al.* [19] and Mesba *et al.* [20] indicated that there was significant correlation between body and egg weight of the chickens. For Koekoek chickens, the egg weight is in accordance with the findings of Desalew *et al.* [10] for the same breed.

The yolk index of eggs from local hens was in accordance with the results of Mesba *et al.* [20] for local chickens and their F1 crosses with Koekoek chickens. Similar findings were also reported by Bikila *et al.* [21] for local chickens. The yolk color of both Bovans brown and Koekoek hens were lighter than the findings reported by Dessalew *et al.* [10], which can be due to the types of feed consumed. The yolk color is mainly influenced by the pigmentation in the feed not by breed. The yolk color of both Bovans and Koekoek hens as observed in present study were better than those reported by Desalew *et al.* [10] for exotic chickens reared under the farmers' management. However, the Haugh unit of both chickens was similar with the findings of Desalew *et al.* [10]. The Haugh unit of eggs from the local chickens was comparable to those reported by Fisseha *et al.* [3]. The Haugh unit is mainly influenced by the albumen height and egg weight.

CONCLUSION

The egg production traits of Sasso hens reared in the lowlands were higher than the other genotypes while Bovans brown and Koekock chickens performed better in the midlands. The egg weight of the exotic chicken was generally higher than that of the local chickens, with variations observed across the genotypes. The numbers of eggs and the egg quality traits of the Sasso chickens reared in the lowlands exceeded the other genotypes, while the same was true for Bovans and Koekock hens raised in the midland agroecology. From the present study, Sasso hens might be recommended for smallholder farmers in the lowland area while Bovans brown might be suitable for midland agroecology.

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