

Full Length Research Paper

## Study on productive performances and egg quality traits of exotic chickens under village production system in East Shewa, Ethiopia

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The study was conducted to determine productive performances and egg quality traits of Isa Brown (IB), Bovan Brown (BB) and Potchefstroom Koekoek (PK) under village production system in Ada'a and Lume districts of East Shewa, Ethiopia. A total of 180 randomly selected smallholder farmers were included in the study from six purposively selected Peasant Associations (PAs) from the two districts. Information was obtained on average eggs/year and age at first laying, while hen's body weight was measured directly during survey and egg collection. The average egg production/year was 276.1, 266.32, and 187.04 eggs for IB, BB and PK, respectively. The average age at first laying was 160.5, 165.5 and 153.3 days for IB, BB and PK, respectively. The strain BB was superior for egg weight, yolk height, albumen height (AH), albumen weight, Haugh unit (HU) and eggshell thickness than IB and PK. The IB was found to be superior to BB and PK for yolk weight, whereas PK was superior to IB and BB for yolk colour. In this study, the egg quality traits obtained from these layers was a good quality at village level, while to better conclude on the average number of egg /bird/year, it may need further study through considering the amount and types of feed supplement by farmers and proper recording on the number of eggs laid.

**Key words:** Exotic chicken, productive performances, egg quality traits.

### INTRODUCTION

Poultry production has an important economic, social and cultural benefit and plays a significant role in family nutrition in the developing countries. It has been estimated that 80% of the poultry population in Africa is found in traditional scavenging systems (Gueye, 2000). The poultry sector in Ethiopia is characterized into three

major production systems viz. large commercial, small-scale commercial and village or backyard poultry production system, each can sustainably coexist and contribute to solve the socio-economic problems of different target societies (Tadelle et al., 2003a). The Central Statistics Agency (CSA, 2005) report revealed

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that 97.8% of the total poultry population comprises indigenous birds, while 2.2% are exotic breeds. The backyard (traditional) poultry production system is characterized by low input, low output and periodic destruction of large proportion of the flock due to disease outbreaks (Tadelle et al., 2003b).

With the aim of improving poultry productivity, there has been a substantial effort to introduce improved hybrid layer chickens particularly Isa Brown (IB), Bovan Brown (BB) and dual purpose hybrid Potchefstroom Koekoek (PK) to smallholder farmers under backyard management in Ada'a and Lume districts. In the layer reference for more than 30 years everywhere in the world, IB is the most efficient layer in the poultry industry producing many high quality eggs and adapts itself to all climates and environments (ISA, 2010). The PK was bred from crosses between the Black Australorp and the White Leghorn and is recognized as a locally South African developed breed. This breed is one of the most promising breeds, it is second to White Leghorn, Fayoumi in terms of hen-housed egg production per hen and hatchability, respectively (Grobbelaar et al., 2010).

However, lack of recorded data on the productive performance of chicken makes it difficult to assess the importance and contributions of the past attempts to improve the sector (Moges et al., 2010a). In addition, most of the exotic breeds studied under village production system are not a high yielding hybrid type used in the international poultry industry (FAO, 2010). The quality of eggs laid could be one indication of productivity and the overall care given for improved chicken at village level. In view of the above, a systematic study to evaluate productive performance and egg quality traits of improved poultry chicken under village production system was conducted in Ada'a and Lume districts, Eastern Shewa, Ethiopia.

## MATERIALS AND METHODS

### Description of study areas

Lume district is located at 70k m from Addis Ababa in East Shewa, Ethiopia with an altitude ranges from 1500 to 2300 m above sea level (m.a.s.l) and mean temperature of the area ranged from 22 to 34°C (CSA, 2005). Ada'a district is located at 47 km from Addis Ababa with an altitude ranging from 1500 to 2250 m.a.s.l. (ILRI, 2005) and mean temperature ranged from 21.6 to 31.5°C (DZARC, 2006).

### Sampling and selection of study households

Sampled households in the study were determined by  $N = 0.25/SE^2$ , where,  $N$  = Sample size,  $SE$  = Standard error (Arsham, 2005). Three Peasant Associations (PA's) from each district were selected based on the extent and intensity of improved chicken distribution. The list of households, who adopted improved layer chicken, from each PAs was taken as sampling frame. From the total of 215 households in 3 PAs in Lume and 203 households in 3 PAs in Ada'a districts, 180 households (90 from each district) were selected using systematic random sampling.

### Management of chicken before distribution to smallholder

Chicks were managed for 3 months at model poultry farms under similar management before distribution to smallholder farmers. Light duration was 23 h in the first 5 days and decreased to 14 h at 5 weeks. During a 3-month, layer chick ration for 4 weeks, grower ration for 12 weeks and water were provided under intensive management system. The purpose of this approach is to provide vaccination for major diseases, to decrease chick mortality as well as to provide an adaptation period before distribution to households. Village chicken vaccination particularly against Newcastle disease (ND) is more economically beneficial than the provision of daytime housing, supplementary feeding, cross breeding and control of broodiness (Udo et al., 2001). Thus, day old chicks were vaccinated against ND, infectious bursal disease, fowl typhoid and fowl pox. In Ada'a district, there was provision of a 3-month adaptation period before distribution to smallholder farmers' as in Lume district.

### Management used after distribution to smallholder farmers

The source of these layers distributed for smallholder farmers in both districts were from Alema large-scale poultry importer based at Debre Zeiet. Hybrids layers are carefully selected and specialized solely for the production of either meat or eggs, unsuitable for breeding purposes, especially for mixing with local village chicken and have very low mothering ability and broodiness (Sonaiya and Swan, 2004). Thus, supply of day-old chicks/pullet chain continues based on the interest of farmers every year to replace aged layers at village. The adaptation period helps the chick to grow at some level, in which able to scavenge their own feed at the village and protect from predators. About 95% farmers in both districts provided maize and wheat as additional supplements three times a day. Similarly, water was provided as free access by more than 96% of the farmers in both districts. Thus, provision of supplementary feed and watering was similar along the districts.

### Data collection

Information regarding productive performances in terms of number of egg produced/hen/year, pullet's age at first laying were collected from member(s) of the households managing the chicken. Mature body weights of IB, BB and PK laying hens were recorded using a weighing balance. A total of 137 fresh eggs (57 from IB, 56 from BB and 24 from PK) were collected from adult laying hens for egg quality evaluation during the field survey. Eggs weight was measured using a digital balance (g) and shell thickness (mm) using an electronic digital caliper (Mitutoyo, Japan). The eggshell thickness was measured at three different points in the equatorial shell and the average of the three was used as a trait. To determine the internal egg quality traits, eggs were broken onto a flat surface. The thick albumen height (AH) was measured at its widest part at a position half way between the yolk and the outer margin. Yolk height was measured using Tripod Micrometer (TSS, England). The yolks were carefully separated from the albumen. Albumen and yolk weight were determined by weighing with electronic sensitive balance separately. The yolk colour was determined using the Roche Colour Fan, a standard colorimetric system ranged from 1 to 15. Individual Haugh units (HU) were calculated as:  $HU = 100 \log (AH - 1.7 EW^{0.37} + 7.6)$ , where  $HU$  = Haugh unit,  $AH$  = Albumen height and  $EW$  = Egg weight (Haugh, 1937).

### Data management and analysis

The data were analyzed using SPSS software version 17 (SPSS,

**Table 1.** Types and source of improved chicks used in Ada'a and Lume districts.

Type and sources of chicks	District			
	Ada'a		Lume	
	Frequency	%	Frequency	%
<b>Improved chicken used</b>				
IB	0.0	0.0	86	95.6
BB	65	72.2	4	4.4
PK	25	27.8	0.0	0.0
<b>Source of chicks</b>				
Purchased from private hatcheries	76	84.4	72	80
Naturally hatched at home	14	15.6	18	20

**Table 2.** Mean annual egg production of IB, BB and PK type chickens in two districts.

Improve chicken	N	Number of eggs laid/hen/year	
		Mean	SD
IB	86	276.1 <sup>a</sup>	11.03
BB	69	266.32 <sup>b</sup>	8.7
PK	25	187.04 <sup>c</sup>	13.49

<sup>a-c</sup>Means in a column with no common superscripts differ significantly ( $p < 0.05$ ).

2007). Differences in productive performances and egg quality traits were compared using means generated from one-way analysis of variance (ANOVA).

## RESULTS AND DISCUSSION

### Types and sources of improved chicks

Results of the type and source of improved chicks are presented in Table 1. The study revealed that most of the respondents used IB in Lume, whereas BB and PK were used in Ada'a district. This distribution design was to evaluate the productive performances of these layers in these study areas.

In both districts, the majority of the respondents purchased layer chicks from private hatcheries; this could be due to lack of self-replacing and brooding/mothering ability of such hybrid layers. However, in the past decades, chicken productivity in Ethiopia mainly focused on the use of imported temperate breeds such as White and Brown Leghorns, Rhode Island Red, New Hampshire, Cornish, Australoup and Light Sussex (DZARC, 1991). Previously, the above breeds were used for poultry improvement program, the present change to the type layers used in these study areas could be due to the availability of hybrid layer chicks at large commercial farms located at Debre Zeit, the main town of Ada'a district. However, only 15.6 and 20% respondents hatched fertile eggs using broody local chicken ecotypes at home in Ada'a and Lume districts, respectively.

### Egg production

Information on the egg production performance of different types of chicken reared in the two districts are presented Table 2. The IB laid a highest number of eggs ( $276.1 \pm 11.03$ ) followed by BB ( $266.32 \pm 8.7$ ) and PK ( $187.04 \pm 13.49$ ). Mean annual egg production of three type chicken indicated highest egg production in IB followed by BB and PK and the differences were significant ( $p < 0.05$ ). This could be attributed to difference in genetic potential of different strains used. This was in agreement with the reports of Majaro (2001) and Yakubu et al. (2007).

The average number of eggs/year/hen reported in this study was higher than those reported by Lemlem and Tesfaye (2010) for White Leghorn, Rhode Island Red and Fayoumi chicken under village household condition; this might be attributed to the differences in genotype of the bird and feeding management used. In addition, it was significantly higher than local chickens, which lay 55 to 80 eggs/year (Dessie and Ogle, 2001). This good performance of hybrid layers with supplementation of maize and wheat is in agreement with the findings of Vries (1993) and Altamirano (2005).

### Age at first laying and mature hen body weight

Results of age at first laying and mature hen body weight are presented in Table 3. Mean age at first laying were  $160.5 \pm 13.5$ ,  $165.5 \pm 13.2$  and  $153.3 \pm 6$  days for IB, BB

**Table 3.** Mean age at first laying and mature hen body weight of exotic chickens in Ada'a and Lume districts.

Improved chicken	N	Age at first laying (days)	Mature Hen body weight (kg)
		Mean $\pm$ SD	Mean $\pm$ SD
IB	86	160.5 $\pm$ 13.5 <sup>a</sup>	1.54 $\pm$ 0.17
BB	69	165.5 $\pm$ 13.2 <sup>a</sup>	1.55 $\pm$ 0.26
PK	25	153.3 $\pm$ 6 <sup>b</sup>	1.64 $\pm$ 0.31

<sup>a-b</sup>Means in a column with no common superscript differ significantly ( $p < 0.05$ ).

and PK, respectively. There was no significant difference between IB and BB strains on age at first laying. However, PK was observed to be significantly early maturing type layers than IB and BB under village management condition. This observed difference in age at first egg of three strains under the present study could be due to genetic and environmental differences, which is in agreement with the reports of Demeke (2004), Fassill et al. (2010) and Lemlem and Tesfaye (2010).

The adult female body weights were 1.54, 1.55 and 1.64 kg for IB, BB and PK chicken groups, respectively. There was no statistically significant difference among the three layer hens in adult live body weight. As the laying hen body weight increased, egg production decreased and egg weight and feed consumption increased, because heavy birds consume more feed and lay larger eggs with large egg yolk than light hens (Leeson et al., 1997). In the present study, there was no significant difference recorded among IB, BB and PK laying hens on adult live body weight. However, the quality of eggs from these chicken indicated that the eggs were within the range of to be ranked a good quality ( $>70$  HU) (TSS, 1999), suggesting good productive performance with the current live body weight recorded under village production system.

### Egg quality traits

The results on egg quality traits are presented in Table 4. Average egg weight of PK ( $48.84 \pm 6.77$  g) was significantly lower than that of IB ( $58.75 \pm 7.29$  g) and BB ( $60.27 \pm 6.03$  g). The average egg weight of PK was significantly lower ( $p < 0.05$ ) than average egg weights of IB and BB. This difference could be expected since IB and BB commercial strains developed for egg weight improvement (Hocking et al., 2003). The present findings agreed with the observations of Tixier-Boichard et al. (2006). The average egg weight recorded for IB and BB under village level was relatively higher than the average egg weight reported by Tulin and Ahlers (2009) for village/scavenging production system ( $52.24$  g). The difference observations on egg weight among different strains of chicken in the present study could be genetic differences.

The mean yolk heights were 17.84, 17.84 and 17.41 mm for BB, PK and IB and there were no statistically

significant difference for yolk height; this disagreed with the report of Niranjani et al. (2008) who reported significant difference on yolk height for chicken under backyard management. Average AHs were  $6.3 \pm 1.85$ ,  $6.92 \pm 1.62$  and  $5.64 \pm 1.55$  mm for IB, BB and PK, respectively and there was a statistically significant difference between BB and PK on AH ( $p < 0.05$ ). There was significant difference between BB and PK on AH. However, yolk and AH recorded in the present study were higher than recorded for local chicken reported in Ethiopia by Moges et al. (2010b) and in Tanzania by Nonga et al. (2010). This reflects the superiority of hybrid layers for albumen and yolk height.

The average yolk weight of the three chicken groups in this study was not significantly different. This finding was in agreement with the report of Tulin and Ahmet (2009) for eggs produced under village management system. The yolk colour value for PK ( $10.79 \pm 1.98$ ) and IB ( $9.74 \pm 3.13$ ) were significantly higher than yolk colour value of BB ( $7.77 \pm 3.15$ ). The average yolk colour recorded for BB was significantly lower than from IB and PK. Similar yolk colour values recorded in Bure and Fogera districts for local chicken by Moges et al. (2010b) indicating the yolk colour is a function of feed not breeds (Demeke, 2004). However, in the present study, the highest yolk colour value in PK might indicate good scavenging ability of PK as being an indigenous hybrid and could get enough green grass required to bring the higher yolk colour value.

The average albumen weights IB was not statistically different from BB, while PK was significantly lower ( $p < 0.05$ ) than IB and BB groups. The average albumen weight in PK was significantly lower than IB and BB; the observed significant differences could be due to low egg weight in PK, since egg weight influences the weight of components of eggs especially egg albumen and yolk. These results agreed with the findings of Zhang et al. (2005) and Aygun and Yetisir (2010). The mean HUs were 78.78, 81.68 and 76.57 for IB, BB and PK, respectively and did not differ significantly. The HU is an expression relating egg weight and the height of thick albumen. The average HU was not significantly different among IB, BB and PK. The present finding on HU was lower than the observation of Tulin and Ahmet (2009) who reported HU of 85.82 for village chicken eggs.

The average eggshell thickness measured for IB, BB and PK were  $0.31 \pm 0.05$ ,  $0.33 \pm 0.037$ , and  $0.29 \pm 0.026$

**Table 4.** Egg quality traits of exotic chickens in Ada'a and Lume districts.

Trait	Improved chicken		
	IB (N = 57)	BB (N = 56)	PK (N = 24)
	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD
Egg weight (g)	58.75 $\pm$ 7.29 <sup>a</sup>	60.27 $\pm$ 6.03 <sup>b</sup>	48.84 $\pm$ 6.77 <sup>ab</sup>
Yolk height (mm)	17.41 $\pm$ 1.52	17.84 $\pm$ 1.67	17.84 $\pm$ 0.81
Albumen height (mm)	6.30 $\pm$ 1.85 <sup>a</sup>	6.92 $\pm$ 1.62 <sup>a</sup>	5.64 $\pm$ 1.55 <sup>b</sup>
Yolk weight (g)	16.14 $\pm$ 1.89	15.97 $\pm$ 1.77	15.90 $\pm$ 3.57
Yolk colour	9.74 $\pm$ 3.13 <sup>a</sup>	7.77 $\pm$ 3.15 <sup>a,b</sup>	10.79 $\pm$ 1.98 <sup>b</sup>
Albumen weight (g)	33.37 $\pm$ 5.85 <sup>a</sup>	34.54 $\pm$ 5.67 <sup>b</sup>	25.54 $\pm$ 3.94 <sup>a,b</sup>
Haugh Unit (HU)	77.78 $\pm$ 13.28	81.68 $\pm$ 11.28	76.57 $\pm$ 12.18
Shell thickness (mm)	0.31 $\pm$ 0.05 <sup>a</sup>	0.33 $\pm$ 0.037 <sup>a,b</sup>	0.29 $\pm$ 0.026 <sup>b</sup>

<sup>a-b</sup>Means in a row with common superscripts differ significantly ( $p < 0.05$ ).

mm, respectively. The eggshell thickness of BB was significantly higher than IB and PK groups ( $p < 0.05$ ). Higher eggshell thickness for IB and BB than PK could be due to these layers and are developed for egg quality improvement; it is in agreement with Hocking et al. (2003). The average eggshell thickness in PK was only significantly lower than BB. The difference in eggshell thickness in the present study could be layer strain difference; this is in agreement with Khan et al. (2004) and Zita et al. (2009) who reported the effect of layer type difference, environmental conditions and feed quality on eggshell thickness.

## CONCLUSION AND RECOMMENDATIONS

The present study indicated that hybrid layers lack self replacing ability at village level due to their low mothering ability and broodiness and higher demand for exotic chicken by farmers' to rear under improved village production system; thus, adequate supply of improved hybrid layer chicks is essential in these study areas. The egg quality from hybrid layers was a good quality at village level, while the average number of eggs/bird/year may need further study through considering the amount and types of feed supplement by farmers and exact record on the number of eggs laid to better conclude on their productive performances.

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