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Original Article

Evaluation of Three Final Hybrid Layer Chicken Strains Under On-Station Management

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ABSTRACT

Three final hybrid strain of chicken were evaluated for production performance under typical floor housing system in Jimma, Ethiopia. One hundred fifty of each of Dominant Sussex, Lohman Brown and Novo Brown breed of day-old chicks obtained from Debre Zeit Agriculture Research center was placed at Jimma University College of Agriculture and Veterinary Medicine (JUCAVM) brooder house on standard commercial starter's ration in completely randomized design with three replicates. At the end of the brooding period, each group was transferred to growers and layer's house and switched to standard growers and layer's ration at an age of 8 and 20 weeks, respectively. Finally, all the data collected on performance of the experimental breeds of chickens were subjected to statistical analysis to test the breeds' performance under Jimma condition. The results obtained showed that the mean daily body weight gain (BWG) recorded from Novo Brown and Dominant Sussex breeds of chicks during brooding period were significantly higher ($P<0.05$) than Lohman Brown. Mean live weight of 573g/head was attained by Novo Brown and Dominant Sussex chicks at an age of two months, the value of which was significantly ($P<0.05$) higher than that of Lohman Brown. Moreover, Novo Brown growers had significantly higher mean weekly BWG than the other two breeds ($P<0.05$), followed by Dominant Sussex. All the three breeds tested, performed better during the brooding period than during the rearing period in terms of feed conversion ratio (FCR). Novo Brown breed of chicks consumed less feed and brought significantly higher mean daily BWG both during brooding and rearing periods ($P<0.05$) compared to the others, indicating that Novo Brown was superior to the other two breeds in FCR. Mortality from hatching to 2 months of age (8%) was higher for Dominant Sussex, compared to 1.3% of

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mortality recorded from each of the other two breeds. Mortality rate from 9 to 20 weeks of age was higher for Dominant Sussex than for the other two breeds. There were no significant differences (P>0.05) among the three breeds tested in age at the first egg. The hen day egg production rate and egg weight of Dominant Sussex was better than other two breeds. In summary, the results of this experiment indicated that the Novo Brown breed of chicken performed better than Dominant Sussex and Lohman Brown breeds of chickens under Jimma condition in most of the economically important production traits studied.

Keywords: Dominant Sussex D104, Performance evaluation, Lohman Brown, Novo Brown, On-station management

INTRODUCTION

Recent estimates put the Ethiopian poultry population at about 60million out of which 90.85, 4.76, and 4.39% is reported to be indigenous, hybrid and exotic chickens respectively (CSA, 2016/17). The poultry sub-sector in Ethiopia could be characterized into three major production systems based on some selected parameters such as breed, flock size, management practices, technological input and level of bio-security exercised (Bush, 2006). The three production systems are backyard (traditional) poultry production, small-scale modern poultry and large scale commercial poultry. Each of these production systems sustainably coexist and contribute to the socio-economic status of different target societies (Tadelle *et al*., 2003a).

The backyard (traditional) poultry production system is entirely dominated by indigenous chickens and characterized by low input-output and periodic devastation of the flocks due to disease outbreaks (Tadelle *et al*., 2003b). The indigenous chickens are low in productivity owing to their low egg production performance, slow growth rate, late sexual maturity, pronounced broodiness and high chick mortality. Poor management practice and veterinary services also contribute to the low productivity of the indigenous chickens. It has been seen that improvement of basic husbandry practice and health care improve the performance of indigenous chicken, but not to an economically acceptable level (Burley, 1957; Tek *et al*., 1986; Abebe, 1992).

To meet the ever-increasing demand for meat and eggs, and expansion of commercial poultry production, introduction of superior/exotic breed has been proposed as one of the plausible options. As a result, the Ethiopian Institute of Agricultural Research, Debre Zeit Agriculture Research Center (DZARC)introduced three-layer parent breeds namely Dominant SussexD104, LohmannBrown and Novo Brown for testing and further use in Ethiopia. The parents were tested at DZARC and Hawassa University. For future use in Ethiopia, the performance of these final hybrids need to be tested in different agro-ecologies and controlled management systems. This being the case this study is conducted to test their performance under intensive floor management system.

MATERIALS AND METHODS

Study site

This experiment was conducted at Jimma University College of Agriculture and Veterinary Medicine (JUCAVM), located at 357 km Southwest of Addis Ababa and at

about 7^0 33' N latitude and 36^0 57' E longitudes. The altitude of JUCAVM is 1700 meters above sea level. The mean maximum and minimum temperature of the study area is 26.8^0C and 11.4^0C, respectively and the mean maximum and minimum relative humidity is 91.4% and 39.92%, respectively. The mean annual rainfall of the area is 1500mm (BPEDORS, 2000).

Management of Experimental Chicks

A total of 500 unsexed day-old chicks of the three strains were brought from DZARC and housed at JUCAVM brooder house. One hundred fifty chicks of Dominant Sussex D104, Lohman Brownand Novo Brown breeds were randomly selected from the total of 500 chicks. The selected chicks of each breed were placed in separate pens on standard commercial starters ration for 7 days. At the end of the 7 days, each group (strain) of 150 chicks was further sub-divided into three groups, each with 50 chicks of equal mean group weight (total of 9 groups each with 50 chicks). Each group was randomly assigned to one of the nine individual experimental pens, well prepared in advance. Each pen was equipped with all the required chick brooding facilities and had an area of $6m^2$ (3m x 2m) concrete floor adequately covered with sawdust. Finally each group of 50 experimental chicks was randomly assigned to the experimental pens in completely randomized design with 3 replicates. All the groups of the experimental chicks were placed on commercial standard starters ration for the study period of 8 weeks. At the end of brooding period, the males and females were separated and both the female and male groups were transferred to individual grower's house, equipped with all the necessary facilities and switched to commercial standard growers ration for study period 9-20 weeks. At the end of 20 weeks, a total of 270 female pullets (90 from each of three strain) were transferred to layers house equipped with all the layers house equipment's and switched to standard layers ration . Known amount feed was offered 3 times a day and the ort were collected and weighed. Adequate clean water was made available all the times. The experimental pens were cleaned and disinfected before the arrival of the chicks and thoroughly cleaned every time during the study period. Sick birds were isolated, and when dead post mortem examination was carried out to determine the cause of mortality. Dead birds were disposed of properly. Whenever the litter got wet, it was replaced with dry and clean one to make sure the pen is clean at all times. Mortality and disease conditions were recorded as occurred. The birds were vaccinated against common diseases indicated in the vaccination calendar, like Marek's (immodestly after hatching at DZARC), New castle disease (NCD) and Gumboro, at the appropriate age as recommended by veterinarians. In addition, the Oxtetracycline plus (OTC plus) and Amprolium was given when necessary. Strict sanitary measures were followed during the experimental period.

Data Collection

Growth performance

The parameters used in differentiating the production performances of the three experimental breeds included mean BW, body weight gain (BWG), feed consumption, feed conversion ratio (FCR), survival rate, age at first laying and BW at first laying. Feed intake was measured by subtracting the amount of refused from the amount

offered on DM basis. Body weight was taken on weekly basis. The mean FCR was measured as the amount of feed consumed per unit BWG.

Egg production

The production traits used to differentiate the experimental breeds was including egg weight, egg mass and egg production rate per day. The egg weight was measured using sensitive balance by collecting eggs daily and weighted in group immediately after collection for each replication and average egg weight was computed by dividing the total egg weight to the total number of eggs. After mean weight has been determined, the egg mass per pen on daily bases was computed North (1984). The mean feed efficiency for egg production was determined as the ratio of gram egg mass from gram dry matter consumed (Ensminger *et al*., 1990). Eggs were collected daily from each pen. The sum of the collections was recorded as egg production for that day. The number of birds alive per replicate on each day was also recorded. Rate of lay for each replicate was expressed as the average percentage hen-day egg production (HDEP) following the method developed by Hunton (1995).

Egg quality

A total of 135 eggs (45 eggs per breed strains) were collected after two months of the first egg laid and the temperature and humidity in the egg storage room were kept at an optimum level 14°C to 20°C and 75% relative humidity to slow down the loss in quality. Data were taken from the stored eggs on the 2nd day after collection. In the determination of egg quality, the external and internal egg quality measurements were obtained by carefully making an opening around the sharp end of the egg, large enough to allow passage of both the albumen and the yolk through it without mixing their contents together. The yolk was carefully separated from the albumen and placed in a petri dish for weighing. Simultaneously, the associated albumen was placed on another petri dish and weighed. After each weighing, the petri dishes were washed in clean tap water and wiped with dry cotton cloth before next weighing (Veena *et al*., 2015). The egg weight, albumen weight and yolk weight measurement was determined by sensitive electric balance. The shell thickness was measured at three regions (large, middle and small end) using a micrometer gauge and the averages were used. Albumen height and yolk height were measured by tripod micrometer unit. The egg shape index was calculated from egg width and length with the formula SI=W/L *100(Anderson *et al*.,2004). The yolk index was calculated from the width and heights of the yolk by formula YI= YH/YD *100(Doyon *et al*.,1986), and the yolk color was measured with the use of Roche color fan (Haugh, 1937). The breaking strength was also measured with the use of Egg Force Reader (06-UM-001 Version D) apparatus.

Statistical analysis

The overall trial period of 65 weeks (from the beginning of Week 1 to the end of Week 65) was split to 7periods.That is brooding phase (1-8), grower phase (9-19), egg production phase (20-28, 29-36, 37-44, 45-52 and 53-60 weeks). Differences between strains were tested using analysis of variance (ANOVO) procedures of SAS general

linear model (GLM) to compare treatment means (SAS, 2002). Least significance difference (LSD) at 5% significance level was used for comparison of means. The following model was used.

$Y_{ij} = \mu + T_i + e_{ij}$,
Where,
Y_{ij} = is the overall observation (FCR, feed intake, body weight…..).
T_i = effect of the i^{th} breed (i=1, 2, 3)
μ = population mean
e_{ij} = Random error.

RESULTS AND DISCUSSION

Brooding Performance

The mean hatching and final BW, total feed intake, BWG and FCRof Novo Brown, Lohman Brown and Dominant Sussex final hybrid chicks were presented in Table 1. The mean hatching BWof Lohman Brown breed of chicks was significantly lower than that of Novo Brown and Dominant Sussex.

Table1: Least square mean of hatching and final body weight, total weight gain, feed intake, feed conversion ratio and mortality during brooding period

Parameter	Strains			
	Novo Brown (Mean±SE)	Dominant Sussex (Mean±SE)	Lohman Brown (Mean±SE)	Sig.
Hatching BW (g/head)	39.1^{a}±00	38.4^{a}±00	35.2^{b}±00	0.003
Final BW (g/head)	573.3^{a}±5.6	574^{a}±7.0	547.16^{b}±12.2	0.028
Total BWG during brooding(g/head)	534.2^{a}±5.6	535.6^{a}±13.7	511.9^{b}±12	0.028
Total feed intake during brooding (g/head)	1654.8^{b}±55	1698.9^{b}±13	1919.1^{a}±62	0.002
FCR (g feed/ g gain)	3.09^{b}±0.15	3.17^{b}±0.10	3.74^{a} ±0.61	0.010
Mortality during brooding (%)	1.3±0.01	1.8±0.1	1.3±0.03	

Means with different superscripts in a row are significantly different at $P < 0.05$; BW: body weight; FCR: feed conversion ratio; Sig.: significance level

This could be attributed to genetic built upof the birds. The total feed intake during the brooding phase of Lohman Brown was significantly higher than that of Novo Brown and Dominant Sussex while Lohman Brown had significantly lower FCR and BWGas compared to the other two breeds of chicks during brooding period. The mortality rate from hatching to 8 weeks of age was lower for Lohman Brown and Novo Brown than for Dominant Sussex, indicating that Lohman Brown and Novo Brown had better survival rate during brooding period as compared to the Dominant Sussex chicks. Mean total chick mortality to an age of 8 weeks of 5-6 and 5-10% were reported from modern commercial poultry farms and government owned breeding and multiplication poultry centers in Ethiopia (CACC, 2003) as cited by Solomon (2008). The survival rate of all the three exotic breeds of chicks tested in the current experiment were found

to be better than RIR breed of chicks tested under intensive management system in Ethiopia, Pakistan and Bangladesh. Mean mortality of 18.9, 20 and 12.5% was reported from RIR chicks kept under intensive brooding management system in North West Ethiopia, Pakistan and Bangladesh, respectively (Halima *et al*., 2006; Tabinda *et al*., 2012 and Barua *et al*., 1992).

Growth Performance during Rearing

The growth performance of the experimental chickens during growing period (9-20 weeks) is shown in Table 2. Lohman Brown pullets had significantly higher total feed intake during the growing period (9-20 weeks) than the other two breeds (P<0.05), followed by Dominant Sussex indicating that the total feed consumption of Novo Brown pullets was the lowest of all. The mean feed intake of the Lohman breeds at 20 weeks approximated to those recommended in their Company Management Guide, which is about 7 kg/h at 20 weeks of age (Lohman, 2000). Lohman Brown pullets (7.64) had significantly lower FCR value than the Novo Brown pullets (P<0.05). The meanBWG during growing period at an age of 20 weeks were 1.4, 1.3 and 1.2 kg/head was attained by Novo Brown, Dominant Sussex and Lohman Brown pullets, respectively, all the values of which are significantly different from each other (P<0.05). Thus Novo Brown pullets had significantly(P<0.05) better growth performance followed by Dominant Sussex and Lohman Brown, respectively. Mortality during the growing period (9-20 weeks) was lower for Novo Brown followed by Lohman Brown. Higher mortality of 8.1% was recorded from Dominant Sussex. In this study, the mortality occurred during the brooding period was lower than that occurred during the growing period in all the three breeds studied; no particular infectious disease was reported during the experimental period from repeated diagnosis of dead birds (post mortem) by JUCAVM veterinary school.

Table 2: Least square means of bodyweight, average feed intake and feed conversion ratio and mortality during growing period of three strains

Parameter	Novo Brown (Mean±SE)	Lohman Brown (Mean±SE)	Dominant Sussex (Mean±SE)	Sig.
Body weight (g/head/12 weeks)	1333^{a}±9.1	1113^{c}±29.5	1235^{b}±23.3	0.028
Total feed intake(g/head/12 weeks)	4888^{c}±160.8	5288^{a}±40.9	5039^{b}±26.6	0.008
Feed conversion ratio (9-12 week)	6.4^{a}±0.22	7.16^{b}±0.54	6.8^{ab}±0.15	0.001
Mortality during rearing (%)	3.5^{b}±0.03	5^{c}±0.01	8.1^{a}±0.03	0.008

Means with different superscripts in a row are significantly different at P<0.05; SE: standard error; Sig.: significance level

Layer performance

Age and weight at first egg, egg mass, average egg production performances (% in weeks) during laying phase (20 to 60 weeks of age) for the three strains are shown in Table 3. In the current study 137 days for Lohman Brown and 140 days for both Novo Brown and Dominant Sussex was recorded as age at first egg. The average egg

production of Dominant Sussex was significantly higher than the Lohman Brown and followed by Novo Brown during the 37 to 60 weeks of age. There was a significant difference (P<0.05) among strains in average weekly egg production (% in weeks) during the laying phase (37 to 60 weeks of age). The average egg production of Dominant Sussexwas almost similar with the standard production given by the breeding company (81.2%/week) but the average egg production of Lohman Brown strains was lower than the standards (87.0%/week). The difference between the results obtained during this investigation and the results obtained by breeders' company might be attributed to genotype-environment interactions. The environment where the strains were developed might be different with the testing environment of the current study.

As shown in Table 3, Dominant Sussex breeds had significantly higher egg mass production (40.5) than Lohman Brown breeds whose average egg mass production was 35.9 (P<0.05), this might be due to their higher egg number and egg weight of Dominant Sussex layers. In the current experiment Dominant Sussex experimental layers tended to show higher mortality rate than the others.

Table 3. Least square means of age at first egg and egg production (% lay in weeks), egg weight, egg mass, feed intake and feed conversion efficiency of three strains

Parameters	Strains			
	Dominant	**Novo**	**Lohman**	**Sig.**
Age at first laying(days)	140±0.01	137±0.03	140±0.02	0.035
Weight at first laying (g/head)	1373^{a}±9.1	1148^{c}±29.5	1274^{b}±23.3	0.000
Hen day egg production				
20-28 week (%)	54.16 ±5.9	53.80±6.1	49.64±6.1	0.86
29-36 week (%)	72.94±3.0	72.16±2.3	67.38±2.3	0.30
37-44 week (%)	75.8^{a}±0.3	72.10^{b}±0.8	67.7^{c}±0.8	< 0.001
45-52 week (%)	78.6^{a}±0.4	75.10^{b}±0.6	70.5^{c}±0.6	< 0.001
53-60 week (%)	81.4^{a}±0.3	78.10^{b}±0.8	73.3^{c}±0.8	< 0.001
Egg weight(g)	59.4^{a}±0.43	57.1^{b}±0.7	57.3^{b}±0.61	0.01
Egg mass (g/day/bird)	40.5^{a}±0.52	38.1^{ab}±0.91	35.9^{b}±0.35	0.013
Feed intake(g/head)	119.3^{b}±4.88	112.4^{b}±0.8	133^{a} ±4.56	0.026
Feed Conversion Ratio(g feed/g egg mass)	2.93^{b}±0.18	2.93^{b}±0.14	3.7^{a}±0.27	0.013
Mortality	2.63^{b}±0.50	2.83^{b}±0.16	3.58^{a}±0.16	0.013

Means with different superscripts in a row are significantly different at P<0.05; Sig.: significance level

Egg Quality

The least square means of egg quality parameters at 45 weeks of Lohman Brown, Novo Brown and Dominant Sussex strains are presented in Table 4. There was a significant difference (P<0.05) among the test strains in terms of egg weight (g), yolk weight (g) and albumen height (mm); however, there were no significant differences (P>0.05) among the threelayers in average shell thickness (mm), shell strength, average yolk weight (g), shell weight (g), yolk weight ratio (%), albumen weight ratio (%), shell weight ratio (%), egg shape index, yolk color (color fun), yolk height (mm)

at 45 weeks of age. The mean egg weight of Novo Brown and Lohman Brown was 57.1 g and 57.3 g, respectively and Dominant Sussex had significantly larger (P<0.05) mean egg weight (59.4g) than thetwo strainswhich might arise from the breed differences. Dawud *et al*., (2018) reported mean egg weight of 58.4 and 56.3 forDominant Sussex and Lohman Brownparent stock kept under intensive management at Hawassa University, respectively. The values of which were comparable to the mean egg weight range (57-59.4 g) obtained from the current study. Lohman Brown had significantly higher specific gravity of eggs (1.077) than the others (P<0.05). Ikgadimeng (2013) reported that specific gravity of 1.087, 1.083, 1.087, 1.090, 1.083, 1.084 and 1.084g/cm^{3}was obtained from Hyline Brown, Hyline Silver, Lohman Brown, Lohman Silver, Black Australorp, New Hampshire and Potchefstroom Koekoek kept under control housing system at an age of 48 weeks in South Africa, respectively. The difference in specific gravity of eggs collected from different breeds could be attributed to breed, agro ecology, damaged/cracked shell and age of the eggs collected (Von haaren-kiso *et al*., 1985)

The egg shell strength of Dominant Sussex (3.32 kg/cm^3) was significantly weaker than the others (P<0.05).The weaker shell strength from Dominant Sussex layers may due to their higher egg weight, this is confirmed by Butcher and Miles (2003) reported that small size eggs have stronger shells than large size ones because hens have a predetermined capacity to deposit calcium in the shell, which results in the same amount of calcium being spread over a large area, in the case of large eggs.Similarly, different breed of laying hens vary significantly in egg shell quality, egg size and production as a result of genetic selection (De Ketelaere *et al*., 2002).

Table 4: Least square means of egg quality parameters at 45 weeks age of Dominant Sussex, Novo Brown and Lohman Brownchicken strains

Parameter	Strains			
	Dominant Sussex	Novo Brown	Lohman Brown	Sig.
Egg weight(g)	58.7^b±1.05	58.1^b±0.78	60.67^a±0.64	0.048
Albumin weight(g)	36.2±0.69	35.9±0.44	37.3±1.22	0.195
Yolk weight(g)	14.2^b±0.08	14.3^{ab}±0.55	16^a±0.17	0.001
Shell weight(g)	8.3±0.42	7.9±0.29	7.4±0.54	0.091
Shell strength(kg/cm)	4.49^a±0.09	4.85^a±0.32	3.32^b±0.16	0.001
Albumin weight ratio (%)	61.6	61.8	61.5	0.195
Yolk weight ratio (%)	24.2^b	24.6^{ab}	26.4^a	0.001
Egg shell weight ratio (%)	14.2	13.6	12.1	0.091
Specific gravity(g/cm^3)	1.076^a±0.002	1.077^{a}0.001	1.074^b±0.001	0.010
Albumin height(mm)	7.96^b±1.02	9.38^a±0.65	7.55^b±0.22	0.046
Yolk height(mm)	17.2±0.14	17.4±0.21	17.3±0.23	0.339
Yolk color	5.3±0.42	5.3±0.28	5.7±0.3	0.058
Shell thickness(mm)	0.42±0.01	0.38±0.003	0.38±0.009	0.076

Means with different superscripts in a row are significantly different at P<0.05; Sig.: significance level

Lohman Brown had the highest value of albumen height than the others two(P<0.05), which may be due to genetic makeup of the breed. Similarly, Silversides and Scott

(2001) reported that the breed of bird affects the quality of eggs. In comparison, albumin height of 7.22mm and 6.25mm was recorded for Isa White and Isa Brown in Canada, the values of which was lower than all the others (Silversides and Scott, 2001). Relatively lower mean albumin height of 6.3, 6.92, and 5.64 mm was also reported for Isa Brown, Bovan Brown and Potchefstroom Koekoek in East Shewa, respectively (Tadesse *et al*., 2012). The mean albumin height recorded in the present study was also higher than that recorded for Ethiopian local chicken (Moges *et al*., 2010b) and the Tanzanian local chickens (Nonga *et al*., 2010), indicating the albumen height of hybrid layers is superior to that of local chickens.The yolk weight of the eggs laid by the Dominant Sussex had the highest weight (16.02g) than the yolk weight of the other two breeds ($P<0.05$).This observed significant differences might be due to higher egg weight in Dominant Sussex, 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); Aygun and Yetisir (2010).

CONCLUSION

Based on the results of the current study thus can be recommended that Novo Brown and Lohman Brown along with other basic input setup could be included into technical poultry extension packages. Dominate Sussex also recommended for improved egg production even though had less survival rate. Further on station evaluation of these breeds of chickens in different areas should be done in order to recommend them for wider areas of the country.

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