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ORIGINAL ARTICLE

Evaluation of different traits from day-old to age at first eggs of Fayoumi and White leghorn chickens and their reciprocal crossbreeds

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ABSTRACT

Objective: This study evaluated the different traits from day-old to age at first eggs of Fayoumi and White leghorn (WLH) F1 chickens and their reciprocal crossbreeds.

Materials and Methods: In this study, 1,000 eggs were used to obtain experimental chicks. However, only 150 chicks were selected from each genotype for subsequent trial evaluation and reared on the same diet in a completely randomized design. The effects of genotype on each considered trait were analyzed by the statistical analysis system, and Duncan's multiple range test made a significant difference.

Results: Comparative evaluations made on all parameters illustrated significant differences ($p < 0.05$) throughout the study period. F1 acquired from WLH cocks and Fayoumi hens maximized weights almost at all ages during brooding, whereas pure line Fayoumi showed lower importance for the trait stages of growth. Offspring from the crossbreed of WLH cocks and Fayoumi hens had the highest weight gain than any other crossbreeds from 4 to 8 and 12 to 16 weeks of age. Pure line WLH and Fayoumi lay larger eggs and smaller eggs (41.67 and 34.00 g), respectively. The highest and smallest body weight at the age of first egg was 1,364.89 and 1,178.36 g in the main crossbreed and Fayoumi line. The main WLH cock and Fayoumi hens and reciprocal crossbreds advanced in age at first egg by 4 and 11 days, respectively.

Conclusion: The leghorn hen and Fayoumi cock crosses could be used to develop potential egg-laying lines than their reciprocal crossbreeds.

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Introduction

Crossbreeding is a method of genetic improvement [1]. It produces chickens that will be better in different economic traits, such as growth rate, feed efficiency, age at first egg, and carcass characteristics [1,2]. The superiority of crossbreeds over purebreeds in some of the above-mentioned productive and reproductive traits was confirmed by many scholars [3]. Many scholars evaluated the assessment of reciprocal crossbreeds for different breeds in different organizations, and the majority of the results showed better performance of the crosses by their maternal side parents [4–6]. A crossbreed of Fayoumi cock x Rhode Island Red hen shown better characteristics in all traits than its reciprocal crossbreed [6]. Additionally, the significant maternal effect on live weight at brooding age (0–8 weeks of age) was noted by Sabri et al. [5].

Fayoumi chickens have better productivity in a harsh environment, escaping from predators and are resistant to disease and adaptation. They lay fewer and smaller eggs and produce lower carcass characteristics because of their smaller body size [7,8]. On the contrary, White Leghorn (WLH) chickens have a higher potential for economic return as layers [9] and fast growers [8]. However, there was less information on evaluating any trait between Fayoumi and WLH crossbreeds so far. Hence, crossbreeding of Fayoumi and WLH is expected to improve the adaptive features and disease resistance that are lacking in WLH. Therefore, this study's objective was to evaluate body weight and body weight gain, feed intake and feed efficiency, and measure egg weight and body weight at first egg for Fayoumi and WLH crossbreeds and their reciprocal breeds.

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Materials and Methods

The experiment was conducted at the poultry farm on the main campus of Haramaya University. The campus is situated at a distance of 505 km from the capital city, Addis Ababa. A total of 352 WLH and Fayoumi chickens as model stocks were randomly obtained at 34 weeks of age, and each genotype was reared for 60 days in a separate coop (Table 1). Two weeks before the onset of egg collection, cocks were introduced to hens and both were managed together in a ratio of 1:10 to obtain hatching eggs used to produce day-old chicks. One thousand eggs (250 from each genotype) were selected and incubated on day 7 of post-oviposition.

A total of 600 chicks (150 from each genotype) were selected, wing tagged, and simultaneously evaluated until the age at first egg under the same management conditions. All genotypes were randomly assigned to three replicates, each consisting of 50 chicks. Male and female chicks were reared together for up to 12 weeks, and afterward, female chicks were only considered. Body weight was taken at hatch and subsequently measured at monthly intervals. Body weight gain was also derived from body weight by subtracting the initial weight from the final weight of two consecutive measurements. Other traits like feed intake and feed conversion ratio were recorded daily, whereas body weight at first egg, egg weight at first egg, and age at first egg were taken at 5% of egg production. A total of 36 eggs (nine eggs per genotype) were randomly selected and weighed at age at first egg. The effect of genotype was analyzed by the general linear model procedure of the Statistical Analysis System (SAS), and a comparison of means was made using Duncan's multiple range test when the *p*-value was <0.05.

Results and Discussion

Body weight and weight gain

There was a significant difference ($p < 0.05$) with regard to body weight among the studied genotypes (Table 2), and this was consistent with earlier study reports [10–13]. The F1 from WLH female and Fayoumi male crossbreeds had a heavier body weight at hatch and 20 weeks of age, whereas their reciprocal was heavier at 4, 8, 12, and 16 weeks. Similarly, Bekele et al. [14] reported that crossing between two chicken breeds resulted in improved body weight of one cross and reduced the reciprocal weight. Purebred Fayoumi demonstrated the lowest body weight throughout the study period among the other genotypes; this might be due to their smallest body size. This is in agreement with Falconer and Mackay [15], who reported a heterotic in crossbreds due to non-additive genetic effects.

Table 1. Breeding design of the model stocks and the chicken sample taken to obtain eggs.

Breeding design (genotypes)	Number of chickens		
	Male	Female	Total
Fayoumi (male) × Fayoumi (female)	8	80	88
Fayoumi (male) × WLH (female)	8	80	88
WLH (male) × Fayoumi (female)	8	80	88
WLH (male) × WLH (female)	8	80	88
Total	32	320	352

There was no significant difference in body weight gain between pure WLH and crossbreeds of WLH cocks and Fayoumi hens from the age of day-old to 4 weeks old (Table 2). The F1 generation from the cross of WLH cocks and Fayoumi hens recorded a higher weight gain at 4–8 and 12–16 weeks of age than its reciprocal crossbreeds. This variation might be due to the heavier body weight of the paternal effect on progenies. The present finding agreed with Fotsa et al. [16], who found that the parental aptitudes were superior to those of the F1 for daily weight gain. The offspring from the combination of WLH cocks and Fayoumi hens had the highest weight gain among any other combinations during brooding from 4 to 8 weeks of age and growing periods from 12 to 16 weeks. However, its reciprocal cross had exhibited the highest weight gain in female growers from 16 to 20 weeks of age. The superiority in weight gain in F1 exhibited by the main cross (WLH cocks and Fayoumi hens) over their purebred counterparts at 4–8, and 12–20 weeks of age suggested that they have the best weight gain among the others. The pure Fayoumi breed recorded the lowest weight gain among the other genotypes. The significant difference in weight gain among breed combinations in this research was due to the genotype and variations in body weight at different ages and their feed consumption and conversion.

Feed intake and conversion ratio

Feed intake was affected by genotype at different ages, as shown in Table 2. The Fayoumi breed consumed the lowest amount of feed throughout the study, which might be due to their small body weight. The main crossbreed significantly consumed more feed than its reciprocal at 4–8, 8–12, and 12–16 weeks of age. This observation is common knowledge that heavier birds consume more feed than lighter birds, and this idea is supported by many scholars [17,18]. Similarly, Abiola et al. [19] reported that variations in chickens' daily feed intake are due to the differences in weight and breed. The feed intake of reciprocal crossbreeds was statistically not significant ($p > 0.05$) from its main breed (WLH cock × Fayoumi hen) from day-old to 4 weeks old. However, consumption is more for the WLH breed than Fayoumi at all ages. The study's results revealed that there was a significant difference ($p < 0.05$) between the main cross and its reciprocal with regard to average feed intake

Table 2. Least square means of performance in Fayoumi and WLH and their reciprocal crossbreeds.

Traits (gm)	Cocks × Hens genotype/breed combinations				SL
	WLH male × WLH female	Fayoumi (F) male × female	WLH male × Fayoumi female	WLH female × Fayoumi male	
W0	30.15^{ab} ± 0.06	28.81^{b}±0.07	30.58^{ab} ± 0.3	31.00^{a} ± 0.79	*
W4	74.60^{a} ± 0.50	51.76^{c}±0.68	75.41^{a} ± 0.34	65.72^{b} ± 0.66	***
W8	466.67^{c} ± 0.88	451.67^{d} ± 0.88	557.00^{a} ± 1.53	472.34^{b} ± 0.33	***
W12	469.00^{b} ± 0.45	417.04^{c} ± 0.56	497.98^{a} ± 0.32	466.44^{b} ± 0.73	***
W12¥	413.33^{a} ± 0.21	386.67^{c} ± 0.33	412.22^{b} ± 0.11	412.22^{b} ± 0.11	***
W16¥	897.08^{b} ± 1.29	868.80^{c} ± 3.22	926.27^{a} ± 1.71	894.82^{b} ± 3.01	***
W20¥	963.29^{c} ± 0.90	943.89^{d} ± 0.71	1092.30^{b} ± 0.92	1095.55^{a} ± 0.8	***
BWG0-4	44.45^{a} ± 0.50	22.95^{c} ± 0.03	44.83^{a} ± 0.10	34.72^{b} ± 0.17	***
BWG4-8	392.07^{d} ± 0.66	399.91^{c} ± 1.55	481.59^{a} ± 1.88	406.62^{b} ± 0.87	***
BWG8-12	471.33^{a} ± 0.92	382.41^{d} ± 1.57	438.96^{c} ± 1.82	460.54^{b} ± 0.93	***
BWG12-16¥	483.75^{b} ± 1.11	482.13^{b} ± 3.55	514.05^{a} ± 1.64	482.60^{b} ± 2.94	***
BWG16-20¥	549.96^{d} ± o.85	557.22^{c} ± 1.03	680.17^{b} ± 1.01	683.33^{a} ± 0.66	***
FI0-4	18.71^{a} ± 0.64	16.98^{b} ± 0.31	17.69^{ab} ± 0.68	18.52^{ab} ± 0.36	*
FI4-8	30.23^{a} ± 0.06	24.82^{c} ± 0.71	29.20^{a} ± 0.13	27.51^{b} ± 0.26	**
FI 8-12	42.06^{ab} ± 0.43	39.82^{c} ± 0.21	42.22^{a} ± 0.65	40.87^{b} ± 0.34	***
FI12-16¥	47.25^{b} ± 0.14	46.52^{c} ± 0.30	48.21^{a} ± 0.07	45.23^{d} ± 0.12	***
FI16-20¥	66.91^{a} ± 0.90	62.38^{c} ± 0.31	64.35^{b} ± 0.55	66.40^{a} ± 0.33	***
FCR0-4	0.42^{c} ± 0.02	0.74^{a} ± 0.08	0.39^{c} ± 0.00	0.53^{b} ± 0.01	***
FCR4-8	0.08 ± 0.02	0.10 ± 0.02	0.06 ± 0.00	0.07 ± 0.00	NS
FCR8-12	0.09 ± 0.00	0.10 ± 0.01	0.10 ± 0.01	0.09 ± 0.01	NS
FCR12-16¥	0.10 ± 0.01	0.10 ± 0.01	0.09 ± 0.02	0.09 ± 0.01	NS
FCR16-20¥	0.12 ± 0.05	0.11 ± 0.02	0.09 ± 0.03	0.10 ± 0.02	NS
AAFEL(day)	167.00^{a} ± 0.57	167.00^{a} ± 1.15	163.00^{b} ± 0.57	156.00^{c} ± 0.58	***
EWFEL(gm)	41.67^{a} ± 0.88	34.00^{c} ± 0.61	37.00^{b} ± 0.57	39.00^{b} ± 0.58	***
BWAFEL(gm)	1257.22^{c} ± 4.94	1178.36^{d} ± 2.94	1357.22^{b} ± 4.90	1364.89^{a} ± 1.06	***

BWAFEL = body weight at age at first egg lay; AAFEL = age at first egg lay; WLH = White leghorn; EWFEL = egg weight at first egg lay; SL = significance level.

^{a,b,c,d}Means within a row with different lowercase letters are significantly different. W0, 4, 8, 12, 16, 20 = body weight at hatch at 4 ,8, 12, 16, and 20 weeks of age; BWG 0–4, 4–8, 8–12, 12–16, and 16–20 = body weight gain from 0 to 4, 4 to 8, 8 to 12, 12 to 16, and 16 to 20 weeks; FI 0–4, 4–8, 8–12, 12–16, and 16–20 = feed intake from 0 to 4, 4 to 8, 8 to 12, 12 to 16, and 16 to 20 weeks; FCR 0–4, 4–8, 8–12, 12–16, and 16–20 = feed conversion ratio at 0–4, 4–8, 8–12, 12–16, and 16–20 weeks.

¥Traits measured only for females, *,**, and *** =Significant at $p < 0.05$, 0.01, and 0.001, respectively.

during the brooding age of 4–8, 8–12, and 12–16 weeks and female growers (16–20 weeks). The variation could be due to the use of WLH as the paternal breed. This result is in disagreement with the result of Nwenya et al. [20], who reported a non-significant difference between the main cross and reciprocal in average feed intake.

Consistently, WLH cock and Fayoumi hen combinations were the most feed efficient among the other genotypes at the age of 0–4 weeks (Table 2). However, the feed conversion efficiency was not significant among genotypes starting from the age of 4–20 weeks, although the main and reciprocal crosses were more efficient than the pure lines. Likewise, a higher Feed conversion ratio (FCR) was reported by Kebede [8] for WLH compared to Fayoumi at a similar age group. A higher FCR in purebreds might be associated with higher feed intake and lower weight gain at the respective ages. This study's results are in agreement with Adedeji [21], who reported that genetic combinations were significantly affected by the feed conversion ratio.

Moreover, Chatterjee et al. [12] reported a low feed intake to body weight gain in chicken genotypes that could be attributed to low feed intake and chickens' genetic composition. This observation was similar in the present study. The cross between WLH cocks and Fayoumi hens was more feed efficient than its reciprocal except at 8–16 weeks. This implied that the existence of substantial influence of

maternal and paternal FCR. The FCR demonstrated that the use of WLH cock or Fayoumi hen would be economically beneficial because of less feed intake to weight gain than other counterpart offsprings.

Body weight and age at first egg

Crossbred groups differed significantly ($p < 0.01$) in body weight at age at first egg (BWAFEL) (Table 2). Similarly, the BWAFEL of WLH was superior to the Fayoumi counterpart, with a significant difference between them. This variation in BWAFEL might be subject to genetic variation and maternal influence of body weight at the age at first egg. Sowunmi et al. [22] reported that body weight at first egg depends largely upon age, genotype, and managements. The reciprocal crossbreed of WLH hen and Fayoumi cock was the heaviest at an age at the first egg over the others. The present study concurred with the study reported by Ahmed et al. [23] for F1 generations which resulted from Silver Montazah and Matrouh crosses. A superior exhibited by the F1 crossbreed progenies suggested that it had better growth potentials than pure lines.

This study's results discovered a non-significant difference ($p > 0.05$) between pure lines in terms of age at first egg. On the contrary, a significant difference was observed between the progenies obtained from pure lines and crosses (Table 2). Yahaya et al. [24] reported a significant difference between the pure lines and their crossbreds for age at sexual maturity. The progenies from the main (WLH male and Fayoumi female) cross significantly took a longer duration than its reciprocal cross at the age at first egg. The study's results also revealed that progenies from pure lines started laying on the same day of age. However, they were late to age at first egg than their crosses. This study's results are inconsistent with Yahaya et al. [24], who reported the earlier maturing of crossbreeds than purebreeds. The age at first egg for WLH was recorded in this study was consistent with the study reported by Kebede and Assefa [25], which was 165 days under an intensive production system in the same study area. Inconsistent with this finding the earlier age at first eggs were reported for WLH (153.25 ± 3.09) [26] and Fayoumi (144.29 days) [27]. A more extended period (231 days) was noted for Fayoumi by several researchers [2,28,29] under the traditional management system. This variation in age at the first egg for different breeds in different study areas might be due to the genotypes and management given to the chickens. Likewise, Zaman et al. [30] observed that variation in sexual maturity could be due to the feeding regime, intensity and duration of light, and temperature. The difference between the progenies from pure lines and crosses in age at first egg was significant ($p < 0.05$). Pure line progenies started a few days later than crosses (Table 2). This finding was contrary to Sowunmi et al.'s study [22], which reported an earlier age at sexual maturity in pure lines (175.65 days) than crosses (186.03 days). The main crossbred (WLH cock and Fayoumi hens) and reciprocal crossbreeds were advanced in age at first egg by 4 and 11 days, respectively. This could be attributed to the fact that crossbreeds often exhibit heterosis, which often shows non-additive effects [15].

Egg weight at first egg

The lowest and highest egg weight at age at first egg was recorded for Fayoumi and WLH, respectively (Table 2). There was a significant difference ($p < 0.05$) in egg weight between the two breeds, and this variation attributed to genotype, maternal effect, and body weight. The diverse age at the first egg of pullets might lead to higher differences in first egg weight, and this was in line with earlier studies [31,32] which noted a positive correlation between hen age and egg weight. The use of Fayoumi in a cross to WLH enhanced the egg weight, as compared to pure Fayoumi and it was significantly different from eggs produced from pure lines. Although the egg at age at the first egg of the main cross (WLH male and Fayoumi female) was heavier, it was not significantly different ($p > 0.05$) from its reciprocal crossbred. A non-significant difference was observed in egg weight at first egg between crosses, and this result is in agreement with the findings of Mshelia et al. [33] and Laly-John et al. [34].

Conclusion

The findings of this study indicated that the reciprocal cross (Fayoumi cocks with WLH hens) exhibited the highest body weight, while their main crossbreed was the best at all ages to 16 weeks. The crossbreeds of WLH cocks and Fayoumi hens recorded the heaviest at the age of first egg when compared to pure lines. The lowest feed consumption was recorded for pure Fayoumi throughout the study period. The progenies from WLH cock and Fayoumi hen cross significantly took longer than its reciprocal cross to the age of first egg. The FCR result showed that the use of WLH as cocks or Fayoumi as hens would be economically beneficial. The WLH breed consumed more feed consistently from day-old to 8 weeks. The crossbred of Fayoumi cocks and WLH hens should be recommended for their earlier sexual maturity. This study was conducted only on day-old to age at first egg. Therefore, further studies are recommended to evaluate the same traits after age at first egg to complete the study.

List of abbreviations

WLH = White leghorn
FCR = Feed coversion ratio
BWAFEL = Body weight at age at first egg

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Conflict of interest

The authors declare that they have no conflict of interest.

Authors' contributions

Kasaye Assefa Balcha is an MSc student who has undertaken the research work, carried out the trait measurements, analyzed the results, and drafted the manuscript. All the other co-authors gave inputs while preparing and correcting the manuscript. All the authors read and finally approved the publication of this research work.

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