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Influence of Crossbreeding of Sasso and Faso Chickens on Some Hatching Events and Post-Hatch Performances

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Abstract

The impact of crossbreeding between exotic and selected indigenous chickens on growth performances is well-documented. However, there is a scarcity of data on the hatching events of the progenies. The objective of this study was to determine the effect of a cross between Sasso and Faso chickens on hatching events and post-hatching performance. A total of 360 hens from the Sasso breeders' hens (200) and Faso hens (160) strains were assigned to 12 individual breeding pens with 30 hens per pen (6 replicates per group). The mating ratio was 1:10. The crosses were: Sasso x Sasso (SS), Faso x Faso (FF) and Faso x Sasso (FS), with roosters of the alternative strain to obtain crossbred. 1,200 hatching eggs (400 eggs/crossing group) were studied. Before the start of incubation, each egg was numbered and weighed. The eggs were set incubated using 37.8°C and 60% relative humidity. At d 18 of incubation, eggs were candled according to genotypes and those with evidence of living embryos were transferred from the turning trays to hatcher baskets. Between 455 and 510 h of incubation, the transferred eggs were checked every 3h for hatching events. After hatching at 21.5d, chickens were reared for 12 weeks. During this period, body weights, feed intake and mortality were recorded. The results indicated that the initial egg weights and one-day-old chick weights from the FS group were significantly higher ($p<0.0001$) compared to the FF group but the SS group recorded the highest egg weight and day-old chick weight. The fertility and hatchability were significantly higher ($p<0.0001$) in the SS group followed by the FS group and F group. Crossbreeding did not impact external and total incubation duration but Faso embryos pipped earlier ($p=0.0267$) than both Sasso and crossbred embryos. Feed intake, body weight, body weight gain and feed conversion ratio were significantly ($p<0.05$) improved in the crossbred compared to Faso indigenous chicken. The mortality rate was significantly higher ($p=0.0005$) in the SS group compared to FS and FF groups. It can be concluded that there is a higher genetic variation in Sasso and Faso genotypes and this variation resulted in higher growth performances for crossbred chickens.

Keywords

Crossbreeding, Sasso, Faso, hatching events, post-hatch performance

1. Introduction

The growth rate of indigenous genotype chickens is generally much slower compared to those of commercial broilers. While broilers under the typical intensive rearing may reach 2.0 kg live weight at five weeks of age, indigenous-breed male birds often weigh no more than 1.0 kg at 20 weeks [1]. This is a reflection of true genotype differences. These differences lead to a large genetic variability which could be used to improve local chicken performance. Indeed, in many regions, local indigenous and commercial genotypes have been crossed in attempts to provide birds that are tolerant to local conditions while also capable of reasonable performance. Crossbreeding is a means of improving the growth performance of poultry and it produces superior crosses for growth traits which are influenced by various genetic and non-genetic factors. It also maximizes the expression of heterosis, or hybrid vigour, in the cross, normally reflected in improved fitness characteristics.

Several studies have confirmed that crossbred animals showed better performances over the indigenous breeds in body weight at different ages [2, 3]. [4] found that the average body weight of crossbred was significantly higher than Sinai (an indigenous genotype) when it was crossed with Hubbard. [5] crossed Sasso (S), Mandarah (M), Golden Montazah (G) and Rhode Island Red (R) and showed that crossbreeding improved growth rate, especially during the early interval of age (4-6 weeks). Additionally, bycrossing Fayoumi (F) and Rhode Island Red (RIR), [6] showed that F x RIR crosses were heavier than RIR x F at hatch.

On the other hand, many African countries have used crossbreeding programmes to improve their local chickens. For instance, the Bangladesh programme is based on crosses between Rhode Island Red (RIR) males and Fayoumi females to produce the F1 Sonali cross-bred. The cross-bred Sonali fowl has proved to be the highest-yielding and most profitable breed combination in several comparisons under semi-scavenging conditions in Bangladesh [7].

Many local chicken improvement programs have been undertaken in Togo. One of the first approaches was mixing the exotic chickens, dominantly Sasso strains, with indigenous chickens in order to improve the productivity of the local birds. According to [8], this scheme failed to work because the introduced breeds could not adapt to the low feeding and extensive management. In addition, this approach involved the crossing of unselected indigenous chickens with exotic breeds. However, it is known that the crossing between the adapted local chicken and exotic breeds can exploit the resistance of the first and the growth performances of the latter at the same time in the tropical environments to produce adapted and more productive genetic types [9]. This study aimed to investigate the effect of crossing an exotic chicken (Sasso) with a selected indigenous chicken (Faso) on hatching events and post-hatch growth.

2. Material and methods

The experiment was conducted at the Poultry Research Center of Avétonou, Institut Togolais de Recherche Agronomique (ITRA-Togo).

2.1 The mating plan

A total of 360 hens from the Sasso breeders' hens (200) and Faso hens (160) strains were distributed in 12 individual breeding pens with 30 hens per pen (6 replicates per group). The mating ratio of 1:10 was used. The first and the second group were mated with roosters from the same strain, whereas the third, with roosters of the alternative strain to obtain the cross-breeding. The breeding programme used for the strains were: Sasso × Sasso (**SS**), Faso × Faso (**FF**), and crosses; Faso cocks × Sasso hens (**FS**). Hatching eggs were collected daily according to the specific crossing and were incubated.

2.2 Incubation Management

A total of 1, 200 hatching eggs (400 eggs/crossing group) were studied. Before the start of incubation, each egg was numbered and weighed. The eggs were set for incubation at 37.8°C and 60% of relative humidity. At d18 of incubation, eggs were candled according to treatments and fertile eggs were transferred from the turning trays to hatcher baskets.

3. Pipping, Hatching Events, Hatchability, and Chicks Quality Determination

Between 455 and 510 h of incubation, the eggs transferred into the hatchers were checked individually every 3 h for hatching events according to the method of [10]. According to this method, eggs in which the beak of the embryo penetrated the inner shell membrane (internal pipping, IP) were transferred to a new basket and checked individually every 3 h for eggs in which the shell over the air cell is then cracked (external pipping, EP). The external pipped eggs were kept in separate baskets to determine individual hatching times. The hatched chicks were left in the incubator until the machine was stopped at 510h. The individual times of IP, EP and hatching were recorded to determine the average time and duration of IP, EP and hatch. At IP, EP, or hatching stages, incubation duration was defined as the time between setting and the occurrences of these events for each egg. Then, the timing of the occurrence of hatching events was used to calculate their duration as follows:

IP duration (dIP) = duration between IP and EP

EP duration (dEP) = duration between EP and hatching, and

Hatching duration (dHatch) = duration between IP and hatching

The total incubation duration was defined as the duration between setting and hatching. On the day of the hatch, the numbers of the hatched chicks were recorded according to treatments to determine fertile hatchability (**FH**). Eggs that failed to hatch were counted, opened, and visually evaluated to determine embryonic mortality (**EM**). Day-old chicks were then weighed according to treatments to determine the average 1-day-old chick weight. Chick's quality was determined using the Tona scoring method [11]. According to this method, physical parameters including reflex, down and appearance, eyes, theconformation of legs, navel area, yolk sac, remaining membranes, and yolk were scored. The chick quality score was defined as the sum of the scores assigned to each quality parameter.

$$\text{FH (\%)} = \frac{\text{total number of hatched chicks at the end of incubation}}{\text{number of fertile eggs transferred to hatching baskets at ED 18}} \text{ X } 100 \quad (1)$$

$$\text{EM (\%)} = \frac{\text{total number of unhatched but fertil e eggs at the end of incubation}}{\text{number of fertile eggs transferred to hatching baskets at ED 18}} \text{ X } 100 \quad (2)$$

3.1 Post-hatch growth

After hatching, a total of 300-day-old chicks for all treatments were individually weighed and then transferred into randomly assigned floor pens in groups of 100-day-old chicks per pen according to the crossing groups, with 4 replicates (25 birds/replicates) in each treatment. The chicks were raised for 12 weeks of age on a diet containing 20.88% crude protein (CP) and 2.900 kcal metabolizable energy (ME). Feed and water were offered *ad libitum* during the experimental periods. Chick's body weight (g) and feed intake (g) were recorded during the experimental period. These data were further used to calculate feed conversion ratio and body weight gain. The mortality was recorded daily and was used to calculate the mortality rate.

3.2 Statistical analysis

A commercial scientific 2D graphics and statistics Software GraphPad Prism 7 (GraphPad software Inc., California, USA) was used to analyse the data. Hatchability, embryo mortality and mortality rate were analysed by chi-square test. The effect of crossing on initial egg weight, day-old chick weight, hatching and post-hatch growth parameters (feed intake, body weight, feed conversion ratio) were subjected to one-way analysis of variance (ANOVA). When the overall p-Value was statistically significant ($p < 0.05$), further comparisons among means were made using Tukey's test. The model was as follows:

$Yi = \mu + \alpha i + \varepsilon i$,

Where Yi= egg weights, chicks quality characteristics, durations of incubation; and post-hatch weights, feed intake, body weight and feed conversion ratio of the egg from crossing i, μ = overall mean, αi = the main effect of crossing i,εi = random error

4. Results

4.1 Effect of crossing on initial egg weight and 1-day old chick weights

The effect of crossbreeding on initial egg weight and 1- day-old chick weight is shown in Figures 1 and 2. The initial egg weight and one-day-old chick's weight from Sasso breeder's (SS) were significantly higher ($p<0.0001$) compared to FS and FF groups. However, the initial egg weights and one-day-old chick weights from the FS group were significantly higher ($p<0.0001$) compared to the FF group.

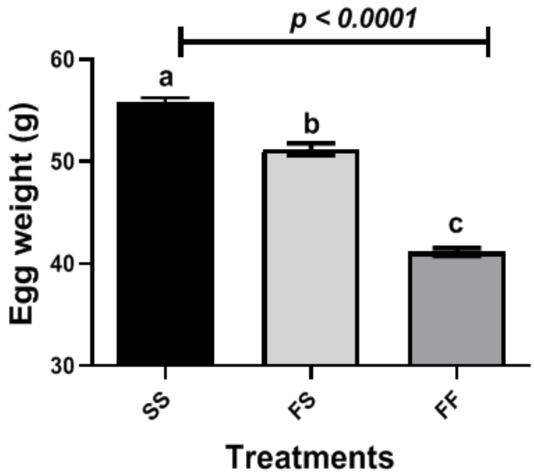
4.2 Effect of crossing on eggs fertility, hatchability, embryo mortality, internal, external pipping and total incubation durations

The effect of crossbreeding on egg fertility, hatchability, embryo mortality, internal, external pipping and total incubation durations is shown in Table 1.

Significant differences were found in the fertile eggs, hatchability, embryo mortality and internal pipping durations according to the treatments. Eggs from the SS group showed a higher ($p<0.0001$) fertility and hatchability compared to eggs from FS and FF groups. However, the fertility and the hatchability of eggs from the FS group were higher ($p<0.0001$) compared to eggs from the FF group. Embryo mortality was higher ($p<0.0001$) in the FF group compared to SS and FS groups. The internal pipping duration was significantly delayed ($p=0.0267$) in the FS group compared to the FF group, but there was no significant difference in the external pipping and total incubation durations among the treatment groups.

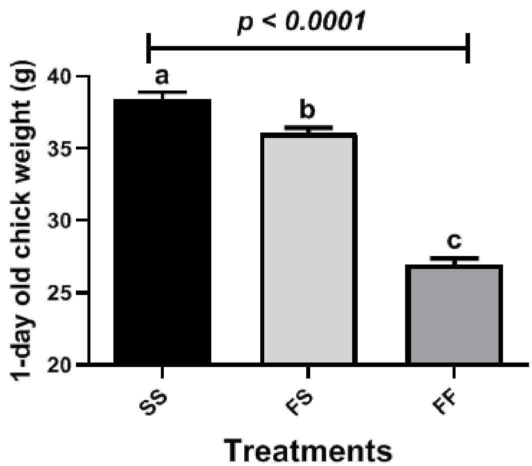
4.3 Effect of crossing on one-day-old chick quality parameters

The effect of crossing on one-day-old chick quality parameters is shown in Table 2.



a,b,c means data sharing no common letter are significantly different; p<0.05, SS : Sasso x Sasso, FS : Sasso x Faso and FF : Faso x Faso

Figure 1. Effect of crossing between Faso and Sasso chickens on egg weight.



a,b,c means data sharing no common letter are significantly different; p<0.05, SS : Sasso x Sasso, FS : Sasso x Faso and FF : Faso x Faso

Figure 2. Effect of crossing on 1-day old chick weight according to genotypes.

Table 1. Effect of crossing between Sasso and Faso chickens on fertility, hatchability, embryo mortality and hatching events

Items	Treatments			*p Value*
	SS	FS	FF	
% Fertility	92.02 ± 0.02[a]	78.2 ± 0.20[b]	47.36 ± 0.36[c]	*<0.0001*
% Chicks	94.21 ± 2.09[a]	65.14 ± 2.83[b]	27.03 ± 2.09[c]	*<0.0001*
Embryo mortality (%)	5.39 ± 0.39[c]	34.43 ± 0.43[b]	72.49 ± 0.49[a]	*<0.0001*
duration of IP (h)	476.5 ± 0.39[ab]	477.9 ± 0.67[a]	475.3 ± 0.55[b]	*0.0267*
duration of EP (h)	488.2 ± 0.69	489.9 ± 1.20	486.3 ± 1.94	*0.2033*
Total duration of incubation (h)	500.1 ± 0.60	501.5 ± 0.87	500.3 ± 1.64	*0.382*

a,b,c means between genotypes, data sharing no common letter are significantly different; p<0.05, SS : Sasso x Sasso, FS : Sasso x Faso and FF : Faso x Faso

Table 2. Effect of crossing between Sasso and Faso chickens on chicks quality parameters

Items	Genotypes			*p Value*
	SS	FS	FF	
Reflex	6.00 ± 0.01	6.00 ± 0.01	5.40 ± 0.60	*0.3874*
Aspects of downs and appearance	10.00 ± 0.01[a]	10.00 ± 0.01[a]	8.80 ± 0.33[b]	*0.0003*
Eyes	16.00 ± 0.00	16.00 ± 0.00	16.00 ± 0.00	*0.984*
Legs	16.00 ± 0.00	16.00 ± 0.00	16.00 ± 0.00	*0.984*
Abdomen	10.80 ± 1.20	12.00 ± 0.01	12.00 ± 0.01	*0.38*
Aspects of navel area	9.00 ± 1.00[a]	6.00 ± 0.01[b]	6.60 ± 1.07[ab]	*0.02*
Remaining membrane	8.40 ± 0.72	9.20 ± 0.853	8.40 ± 0.72	*0.6925*
Remaining yolk	13.20 ± 0.85	12.40 ± 0.40	14.00 ± 0.89	*0.3165*
Average score for all chickens	89.40± 2.19	87.60 ± 1.6	87.20 ± 2.87	*0.7197*

[a,b]means between genotypes, data sharing no common letter are significantly different; p<0.05, SS : Sasso x Sasso, FS : Sasso x Faso and FF : Faso x Faso

Overall, total scores were similar among the three groups. According to each chicken quality parameter, scores were similar across the three groups except for the aspects of downs and appearance, and the navel area. The aspects of downs and appearance scores were significantly lower (*p=0.0003*) for chicks from the FF group compared to chicks from SS and FS groups. The FS group had the lowest (*p=0.02*) navel area score and no significant difference was observed between SS and FF groups.

4.4 Effect of crossing on chick's weight

The effect of crossing on chicks' weight up to 12 weeks is shown in Figure 3. The chicks' weight was significantly higher (*p< 0.0001*) in the SS group compared to FS and FF groups, but the weights of the crossbred chickens were significantly heavier (*p< 0.0001*) than FF group chicks.

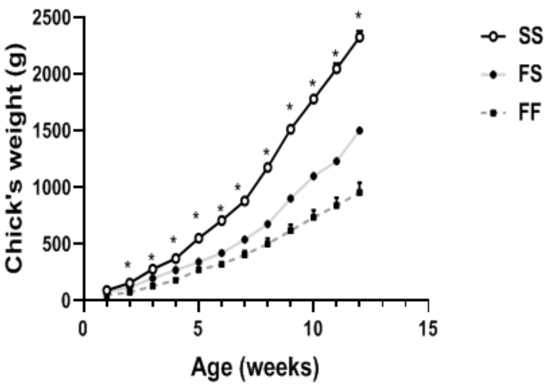
4.5 Effect of crossing on feed intake, body weight gain, feed conversion ratio and mortality rate

Figure 4 shows the effect of crossing on feed intake. Feed intake was significantly higher (*p<0.0001*) for crossbred compared to FF group chicks, but the highest (*p<0.0001*) feed intake was recorded in the SS chicks.

Overall, the body weight gain of the SS group was significantly higher (*p<0.0001*) compared to FS and FF groups; however, the bodyweight of the FS group was significantly higher (*p<0.0001*) than the FF group (Figure 5).

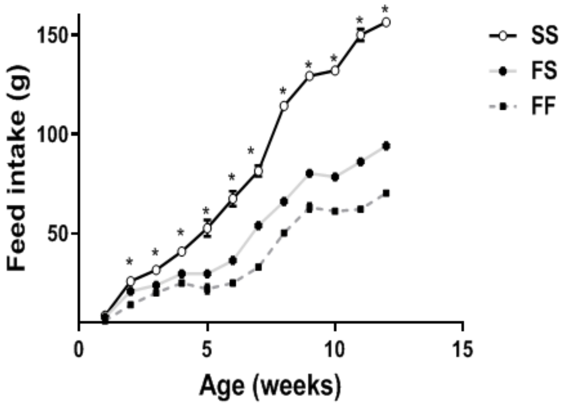
The feed conversion ratio of the FF group was significantly higher (*p<0.0001*) compared to SS and FS groups (Figure 6), but no significant difference was found between SS and FS groups (*p=0.8526*).

As indicated in Figure 7, crossbreeding affected (*p=0.0005*) the percentage of chicks' mortality significantly. SS group had the highest mortality rate and there was no significant difference between FS and FF groups.



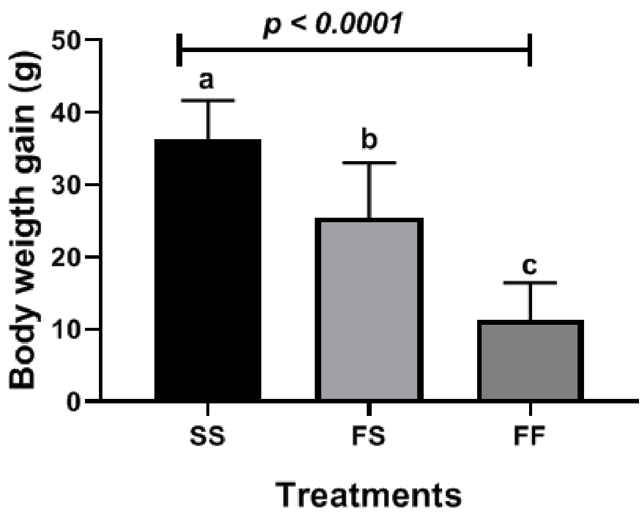
[*]means significant difference between genotypes; P<0.05, SS: Sasso x Sasso, FS: Sasso x Faso and FF: Faso x Faso

Figure 3. Effect of crossing on chick's weight up to 12 weeks according to age.



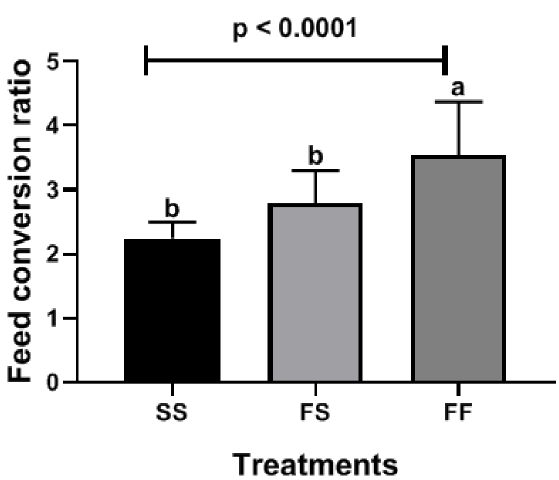
*means significant difference between genotypes; P<0.05, SS: Sasso x Sasso, FS: Sasso x Faso and FF: Faso x Faso

Figure 4. Effect of crossing on feed intake up to 12 weeks according to genotype.



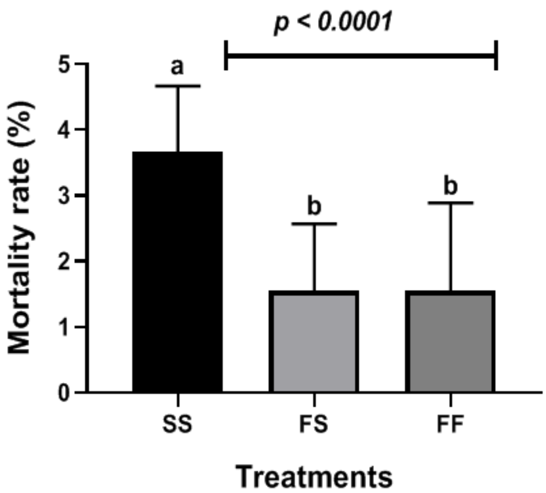
[a,b,c]means data sharing no common letter are significantly different; P<0.05, SS: Sasso x Sasso, FS: Sasso x Faso and FF: Faso x Faso

Figure 5. Effect of crossing on body weight gain according to treatments.



[a,b,]means data sharing no common letter are significantly different; P<0.05, SS: Sasso x Sasso, FS: Sasso x Faso and FF: Faso x Faso

Figure 6. Effect of crossing on feed conversion ratio according to genotype.



[a,b]means data sharing no common letter are significantly different; $P<0.05$, SS: Sasso x Sasso, FS: Sasso x Faso and FF: Faso x Faso

Figure 7. Effect of crossing on mortality rate according to genotype.

5. Discussion

It is well known that crossbreeding is one of the tools for exploiting genetic variation. The main purpose of crossing in chicken is to produce superior crosses. In the current study, the highest average of day-old chick weight was recorded in pure line Sasso than Faso chickens. Similarly, a significant higher day-old chick body weight of exotic birds was reported by [12]. In the present report, crossbred genotypes had better performance for day-old chick weights than Faso chickens. This result indicates that crossbreeding was beneficial in improving the bodyweight of indigenous Faso chickens with almost 9.1g at day old of age. In comparing the whole genotype, pure line Sasso had higher weights at day-old age, followed by crossbred (FS) and Faso chicks. Similarly, [13] reported that one-day-old chick weights among local, exotic and crossbred genotypes were significantly different and higher day-old chick weights were reported in exotic purebred. Significant body weight differences at day old age among genotypes may be due to the larger egg weight of Sasso chickens than the other genotypes and this suggests the effect of heterosis on crossbred chicks. Indeed, [14] indicates that hatchability and the hatchling weights followed the egg weight pattern in the parental population. Thus, the higher hatchability observed in Sasso groups could be attributed to egg weight which was higher in Sasso pure line compared to other genotypes. This difference could be related to the positive correlation between egg weight and hatchability ($r^2 = 1$) on one hand, egg weight and day-old chick weight ($r^2 = 0.99$) on the other hand [15]. The lowest hatchability observed in the F group could be attributed to the higher embryonic mortality observed in this group compared to FS and S groups. The mating between Faso cocks and Sasso hens improved fertility by30.86% compared to the Faso strain. However, no significant difference was found between external pipping and total incubation duration. These results indicate that crossbreeding did not affect these parameters. However, Faso embryos pipped earlier than Sasso and the crossbred embryos. This result could be related to differences in pCO_2 in the air chamber. [16] showed that the duration of internal pipping is related to respiratory gases in the air chamber. Overall, the chick quality score was similar across the groups. It would be difficult to compare these results to the previous study because there is less information about the effect of crossbreeding on hatching parameters in the literature.

Bodyweight gain was significantly different among genotypes in the present study. The obtained results are in line with the findings of [17], [18] and [19] who reported breed differences in body weights. [20] also reported that body weight at various ages among the improved breed and local ecotypes of chickens differed significantly. The body weight gain in all the ages studied was higher in pure line Sasso than in other genotypes. Faso chicken had lower body weights at all ages than the crossbred. This result confirms the report of [21] who showed that the bodyweight of exotic chickens was higher than indigenous chickens and their crossbreds. Similarly, another report also confirms the higher body weight difference of the exotic chicken over the local chicken. This confirms the observation that the highest performance is expected in the exotic breed (exotic Sasso) which had been selected purposely for higher performance in that trait and the genetic variation between exotic and indigenous chicken can be used to improve local chicken. The significant difference in body weight observed in the current study is an indication that genotypes have different genetic potentials for growth. The feed intake at all ages was higher in the SS group followed by the FS group and FF group. A significant genotype effect on feed intake among chickens has been reported by [22]. The authors showed that there was a higher feed consumption in exotic chicks than in indigenous chickens.

The feed conversion ratio was significantly different among genotypes in the present study. The feed conversion ratio was improved in crossbred chickens compared to the indigenous chickens. This explains the better positive impact of crossbreeding program on improving performance in growth traits of Faso chicken. Similar findings have been reported by different authors [12, 19, 22] showing higher feed conversion potentials in the exotic as well as crossbred chickens than the indigenous chickens. Indeed, the report of [23] indicates that the feed conversion ratio of crossbred chickens was better than indigenous chickens. Hence, the current result shows a large variation in growth and feed utilization potentials between pure line genotypes and crossbred genotypes which agrees with other previous reports from Ethiopia and other countries [4, 24, 25].

In general, the current result confirmed that genotypes had a significant impact on the growth traits of chickens. In comparing all genotypes, pure Sasso, which has been selected for a high growth rate, had the best performance in terms of body weight gain and feed conversion efficiency followed by crossbred than the pure Faso chicken. These results show that crossbreeding provided offspring with higher potential traits when compared to purebred Faso chicken. Similarly, the report of [26] indicates that the crossbred chicken of indigenous with exotic chicken performed better and had higher values of weight gain and feed consumption.

The Sasso genotype had the highest mortality rate and the least mortality percent was recorded in Faso genotype chickens and crossbred. Hence, breeding programmes may have an impact on decreasing the mortality of chickens. Similar to our finding, [27] showed that crossbreeding improved chicken viability.

It can be concluded that there is a higher genetic variation between Sasso and Faso genotypes and this variation resulted in higher heterosis on growth parameters. The crossbred had higher body weights and a better feed conversion ratio than Faso local chicken. Crossbreeding can be used to improve indigenous chicken performance. However, further studies are needed on increasing the performance and adaptability of crossbred in the village production system.

Ethics approval

The present study was approved by the Institutional Animal Ethics Committee guidelines of the Regional Center of Excellence on Poultry Sciences, University of Lome, Togo (CERSA-UL).

Author contributions

A.B conceived, designed, performed the study and write the paper. **Y.L** supervised and approved the experimental design of the study, critical revision of the manuscript and final approval for paper submission. **K.A.K, K.T**, **B.B.B, T.P.T, B.B** participated in the practical work, **O.E.O** and **K.V** for constructive criticism.

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