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Full Length Research

Quantitative feed restriction effects on morphometric traits and body weight of white cockerels

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ABSTRACT: The study was carried out to determine the effect of a skip-a-day type of feed restriction on growth performance, of white cockerels. A total of eighty-four day-old chicks of white cockerels were used. There were four treatment groups replicated thrice: Treatment 1: Control treatment (Fed full for the entire period of the study); Treatment 2: Skip-a-day on the sixth week and fed full thereafter; Treatment 3: Skip-a-day on the eighth week and fed full thereafter and Treatment 4: Skip-a-day on the tenth week and fed full thereafter. Routine vaccination and medication were strictly adhered to. Commercial chicks and growers mash formulated to meet the requirement of the National Research Council for cockerels were used for the study. The analysis of the wing size, lengths of shank, thigh, body, and beak, body weight, and breast girth were done across various treatments. The results showed that at 6 weeks, significant differences ($p < 0.05$) were observed in wing size and beak length, while no disparities ($p > 0.05$) were found in shank, thigh, and body lengths. At 8 weeks, significant differences ($p < 0.05$) emerged in wing length, shank, thigh, and body length among treatments. Conversely, no significant differences ($p > 0.05$) were noted in beak length. At 10 weeks, only body weight exhibited significant differences ($p < 0.05$) among treatments. At 12 weeks, significant ($p < 0.05$) variations were observed in wing size, shank length, thigh length, and body length. However, no significant differences ($p > 0.05$) were detected in body weight and breast girth. Overall, the skip-a-day feeding regime influenced certain morphometric traits of the cockerels, being best in Treatment 2, across the different age groups. These findings contribute to a better understanding of dietary interventions in poultry management practices.

Keywords: Body weight, cockerels, feed restriction, morphometric traits, skip-a-day.

INTRODUCTION

Cockerel production plays a crucial role in poultry development, especially in the context of the burgeoning commercial layer farming industry in Nigeria. With an increasing trend in commercial layer farming, there is a significant surplus of male chicks, often disposed of due to the lack of avenues for their utilization. However, harnessing these male chicks for meat production presents multifaceted advantages including mitigating environmental pollution, enhancing nutrition, boosting income, and generating employment opportunities. Additionally, rearing cockerels offers strategic benefits such as consumer preference for their meat, lower production costs, reduced mortality rates, and easier management compared to broiler production, particularly in regions lacking modern infrastructure (Rahman, 2003).

Feed constitutes a substantial portion of production costs in poultry farming, typically ranging from 60 to 70% (Wilson and Beyer, 2000). Thus, improving feed efficiency is imperative for overall productivity enhancement (Novel *et al*., 2009). One viable method for achieving this is through feed restriction, either quantitatively or qualitatively, which temporarily limits bird's access to nutrients, thereby regulating growth and development (Khetani *et al*., 2009). Feed restriction strategies aim to induce compensatory growth, characterized by accelerated growth rates following a period of nutrient restriction

(Novel *et al*., 2009). This approach not only improves feed efficiency and reduces maintenance requirements but also yields leaner meat at a lower production cost (Navidshad *et al*., 2006; Mahmud *et al*., 2008). Ibrahim and Al-Taleb (2002) demonstrated that early physical feed restriction stimulated compensatory growth in birds, leading to comparable performance with the full-fed treatment group.

Moreover, feed restriction holds promise in reducing undesirable fat deposition in birds, addressing concerns related to metabolic diseases and human health implications (Garner *et al*., 2002; Scott, 2002). Various quantitative and qualitative feed restriction programs have been explored to curtail fat deposition, enhance feed efficiency, and meet consumer demands for leaner meat products (Tolkamp *et al*., 2005; Navidshad *et al*., 2006; Mahmud *et al*., 2008). This aligns with the evolving consumer preference for leaner meat, driven by increased awareness of the health implications associated with excessive fat consumption (Zubair and Leeson, 1994; Wolin *et al*., 2016). However, feed restriction effects on body weight and linear body measurements in chicken cockerels are not fully understood. In this context, this study aims to investigate the impact of quantitative feed restriction on the morphometric traits of white cockerels, thereby contributing to the optimization of cockerel production and meeting consumer demands for quality poultry meat.

MATERIALS AND METHODS

Study location and climate

The study was conducted at the Poultry Unit of the Teaching and Research Farm, Faculty of Agricultural Sciences, Ekiti State University, Ado-Ekiti, Nigeria. Ekiti State is located between 5°10' and 5°28' east of the Greenwich meridian and 7°10' and 7°45' north of the Equator. According to Owolabi and Adebayo (2013), Ekiti State experiences a tropical climate with seasonal wet and dry periods. Ado-Ekiti, its capital, sees double maximum rainfall in July and September, with severe thunderstorms marking the onset and end of the rainy season. Humidity ranges from 63 to 90%, and temperatures vary between 20°C (68°F) and 32°C (90°F). Prevailing south-westerly and north-easterly trade winds characterize the rainy and dry seasons, respectively. The southern part is characterized by tropical forests, while the northern areas are dominated by guinea savanna (Owolabi and Adebayo, 2013).

Preparation of experimental site

The poultry house was thoroughly cleaned, washed with detergent, disinfected, and fumigated with a 40% formaldehyde solution to eliminate potential disease-causing microorganisms. After treatment, the site was left to rest for one week. The house was adequately covered and pre-heated prior to the arrival of the birds to create a suitable brooding environment.

Birds acquisition and management

Day-old white cockerels were purchased from a reputable hatchery in Ibadan, southwestern Nigeria. A total of eighty-four chicks were used for the study. Upon arrival, the chicks were provided with multivitamins dissolved in water and prophylactic doses of antibacterial drugs *ad libitum*. They were brooded for 7 days before being randomly assigned to four treatments of 21 chicks each. Each treatment was replicated thrice, with 7 chicks per replicate, using a Completely Randomized Design (CRD). Routine vaccination against Newcastle disease, Marek's disease, and Gumboro disease were administered according to a predetermined schedule. Intracox® was provided at specific intervals, and antibiotics were administered as needed.

Experimental treatments

The study comprised four treatment groups:

Treatment 1 (Control): Birds in this group were fed *ad libitum* throughout the study period.

Treatment 2: Skip-a-day feeding method was implemented during the sixth week, followed by *ad libitum* feeding thereafter.

Treatment 3: Skip-a-day feeding method was implemented during the eighth week, followed by *ad libitum* feeding thereafter.

Treatment 4: Skip-a-day feeding method was implemented during the tenth week, followed by *ad libitum* feeding thereafter.

Data collection

Data on body weight, and linear body measurements were recorded throughout the experiment. Body weight was measured using the Big Dutchman Swing 20 weighing scale, with initial weights taken upon arrival and subsequent measurements taken weekly. Linear body measurements, including breast girth, leg length, thigh length, wing length, and body length, were recorded weekly basis using the general, flexible, retractable, and foldable tape graduated in centimetres (Fajemilehin, 2017).

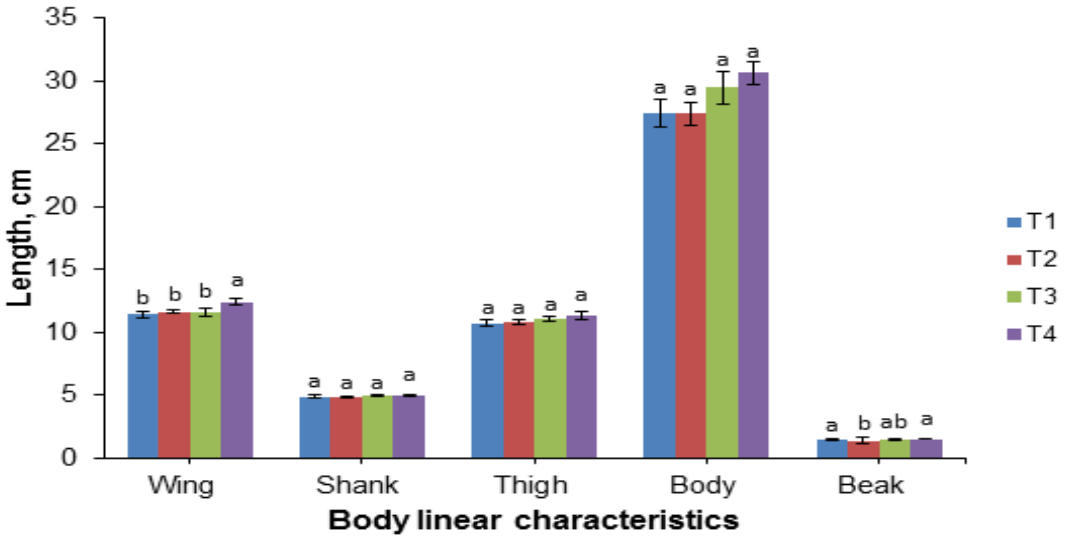

Figure 1. Linear body measurement characteristics of white cockerels at 6 weeks of age under skip-a-day feeding regime.The vertical bars are the standard deviation from the mean.Bars with different letters differed significantly at 5% level of probability by Tukey test.

Statistical analysis

The data obtained were subjected to analysis of variance (ANOVA) using the SPSS version 11 analytical package and differed means separated using the Turkey test of the same statistical package.

RESULTS

Linear body measurement traits of white cockerels at 6 weeks of age under a skip-a-day feeding regime

The study conducted on white cockerels at 6 weeks of age under a skip-a-day feeding regime revealed several noteworthy findings as shown in Figures 1 and 2. In Figure 1, when considering wing size, Treatments 1, 2, and 3 displayed statistical similarities ($p > 0.05$), whereas Treatment 4 significantly differed ($p < 0.05$) from them. Conversely, no significant differences ($p > 0.05$) were detected in shank length, thigh length, and body length across all Treatments. In beak length, Treatments 1, 3, and 4 showed resemblances ($p > 0.05$), while Treatment 2 emerged as significantly different ($p < 0.05$) from Treatments 1 and 4. Moreover, Treatments 2 and 3 demonstrated statistical similarity ($p > 0.05$) in beak length.

In terms of body weight and breast girth as shown in Figure 2, Treatments 1, 3, and 4 exhibited similarities ($p > 0.05$). However, Treatment 2 stood out as the lowest and differed significantly ($p < 0.05$) from the others. Similarly, breast girth in Treatment 3 showed comparability ($p > 0.05$) to Treatments 1 and 2, while Treatment 4, the highest, differed ($p < 0.05$) significantly from Treatments 1, 2, and 3 and also Treatments 1 and 2 demonstrated a significant difference ($p < 0.05$) between each other.

Linear body measurement characteristics of white cockerels at 8 weeks of age under a skip-a-day feeding regime

The findings from the study on white cockerels at 8 weeks of age under a skip-a-day feeding regime are depicted in Figures 3 and 4. Wing size in Treatments 1 and 2 demonstrated statistical similarities ($p > 0.05$) as did the wing length in Treatments 2, 3, and 4. However, the wing length in Treatment 1 differed significantly ($p < 0.05$) from Treatments 3 and 4. In shank and thigh lengths, Treatments 1, 2, and 3 exhibited statistical similarities ($p > 0.05$), while Treatment 4 differed significantly ($p < 0.05$) from them. In body length, Treatment 1 showed similarities ($p > 0.05$) to Treatments 2, 3, and 4, while Treatments 3 and 4 which were similar ($p > 0.05$) differed significantly ($p < 0.05$) from Treatment 2. Beak length showed similarities ($p > 0.05$) among Treatments 1, 3, and 4. The three treatments differed ($p < 0.05$) from the lower value obtained in Treatment 2.

In terms of body weight, Treatments 1, 2, and 4 exhibited similarities ($p > 0.05$). However, Treatment 3 stood out and differed significantly ($p < 0.05$) from Treatments 1 and 4. Treatments 2 and 3 showed statistical similarity ($p > 0.05$). In breast girth, Treatments 2 and 4 displayed significant differences ($p < 0.05$), whereas Treatments 1, 2, and 3 showed similarities ($p > 0.05$).

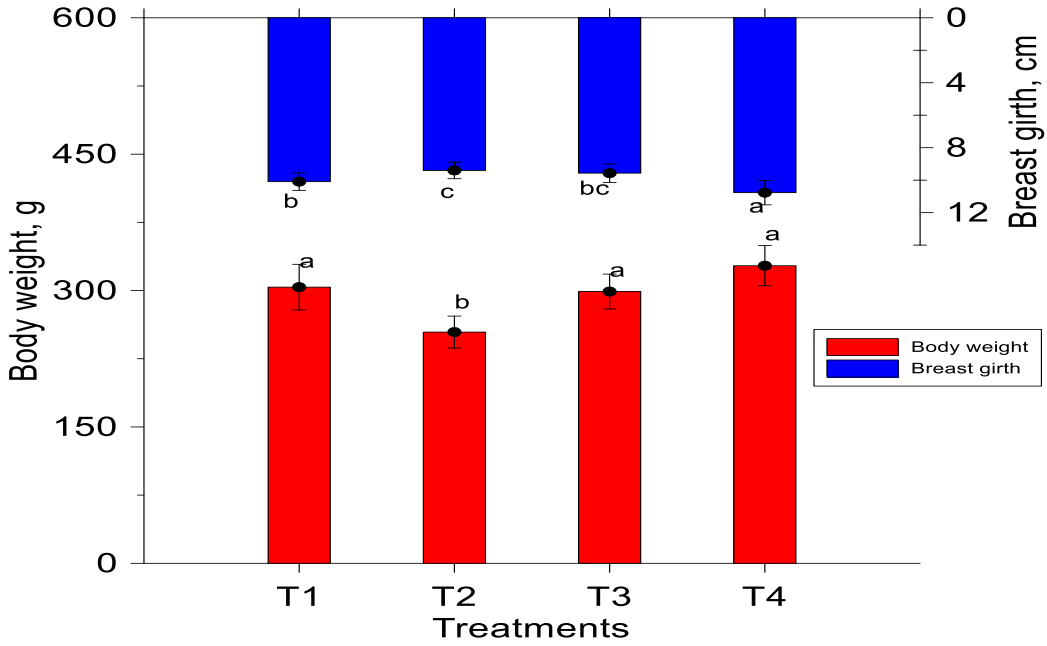

Figure 2. Differences in body weight and breast girth of white cockerels at 6 weeks of age under skip-a-day feeding regime. The vertical bars are the standard deviation from the mean. Bars with different letters differed significantly at 5% level of probability by Tukey test.

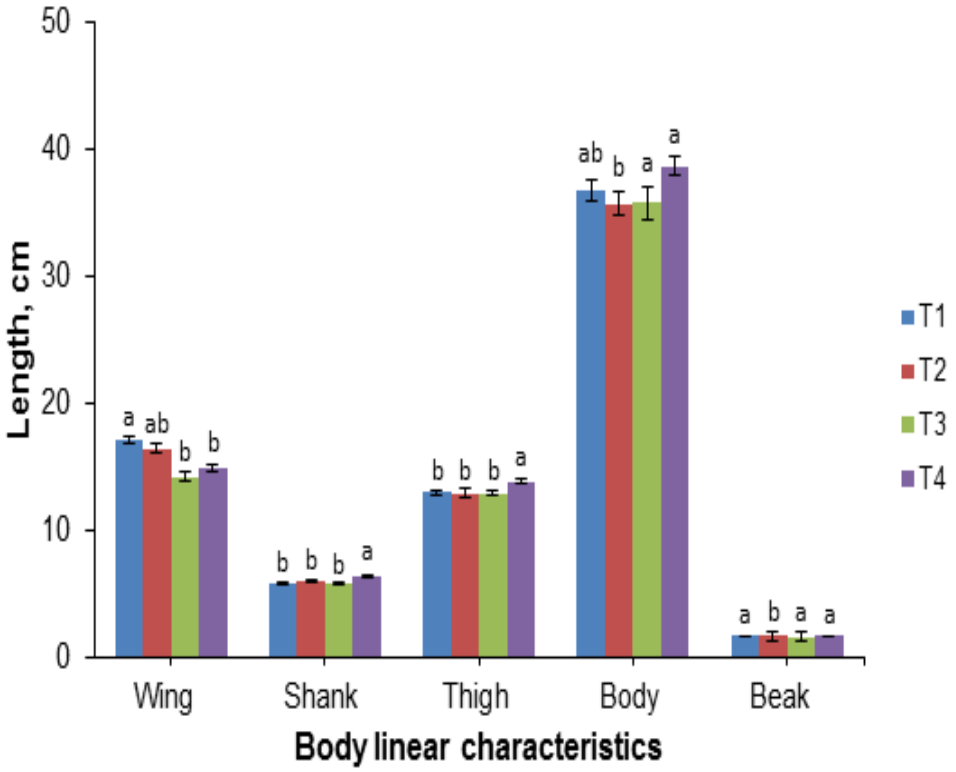

Figure 3. Body linear measurement characteristics of white cockerels at 8 weeks of age under skip-a-day feeding regime. The vertical bars are the standard deviation from the mean. Bars with different letters differed significantly at 5% level of probability by Tukey test.

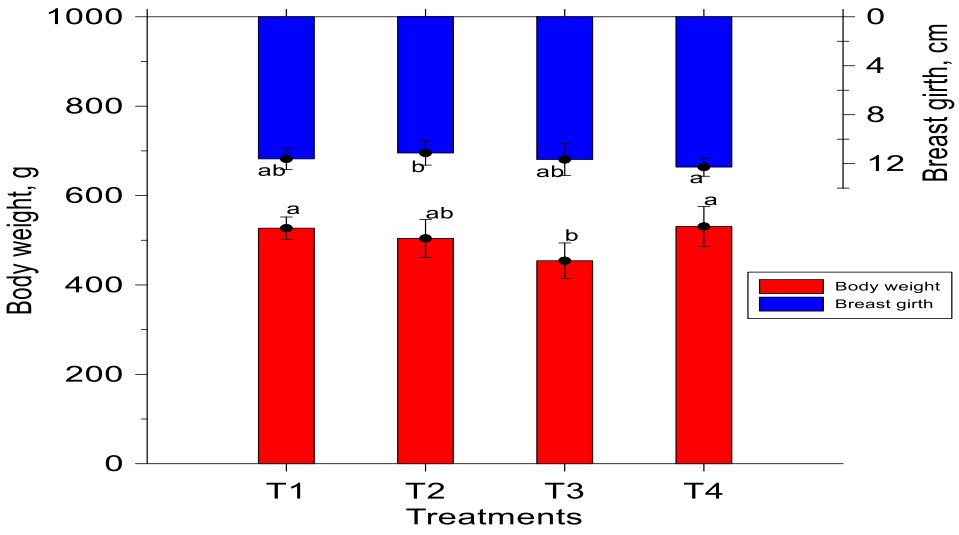

Figure 4. Differences in body weight and breast girth of white cockerels at 8 weeks of age under skip-a-day feeding regime. The vertical bars are the standard deviation from the mean. Bars with different letters differed significantly at 5% level of probability by Tukey test.

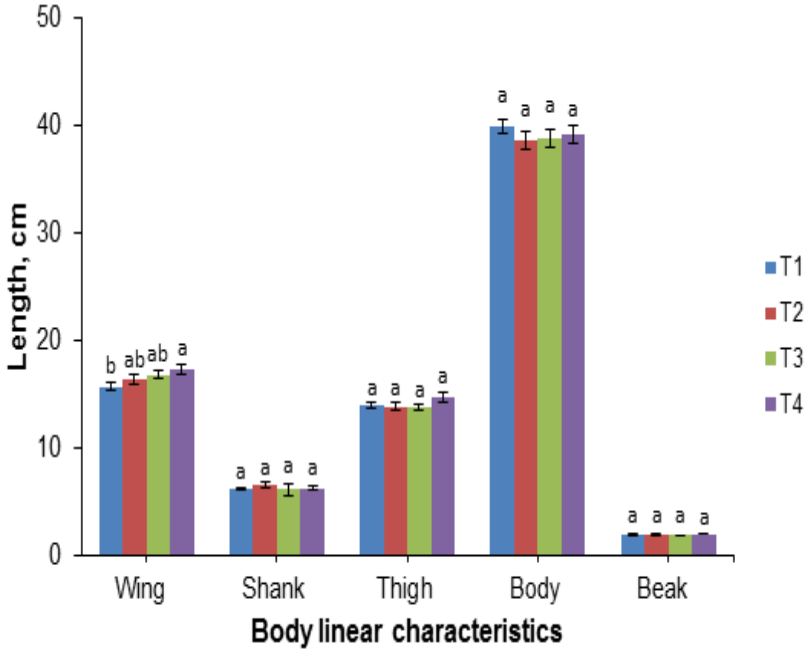

Figure 5. Body linear measurement characteristics of white cockerels at 10 weeks of age under skip-a-day feeding regime. The vertical bars are the standard deviation from the mean. Bars with different letters differed significantly at 5% level of probability by Tukey test.

Linear body measurement characteristics of white cockerels at 10 weeks of age under a skip-a-day feeding regime

Figures 5 and 6 showed the results of the study conducted on white cocks at 10 weeks of age. Wing sizes were comparable ($p > 0.05$) among Treatments 1, 2, and 3, and among Treatments 2, 3, and 4. Treatments 1 and 4 did, however, differ ($p < 0.05$) statistically. Fascinatingly, for all treatments, the shank, thigh, body, and beak lengths all

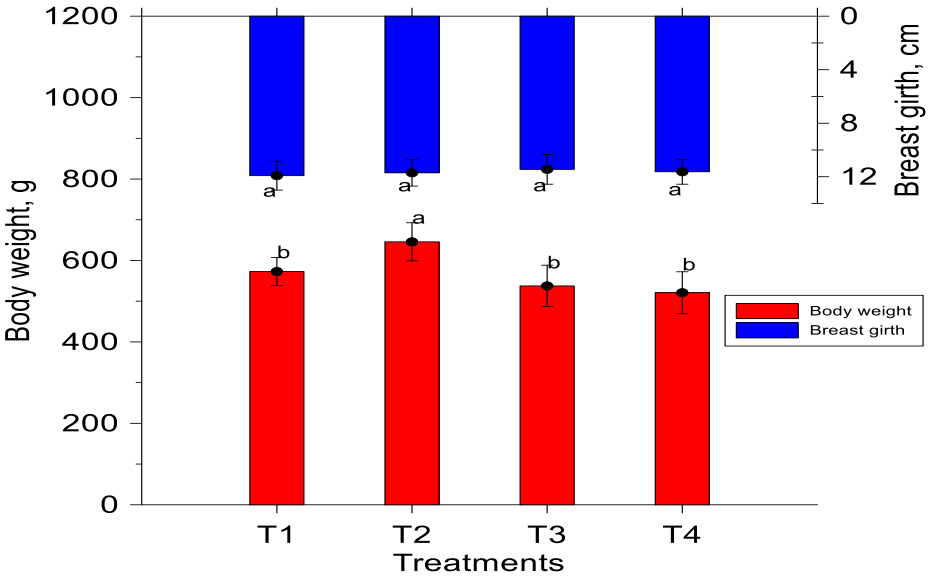

Figure 6. Differences in body weight and breast girth of black cockerels at 10 weeks of age under skip-a-day feeding regime. The vertical bars are the standard deviation from the mean. Bars with different letters differed significantly at 5% level of probability by Tukey test.

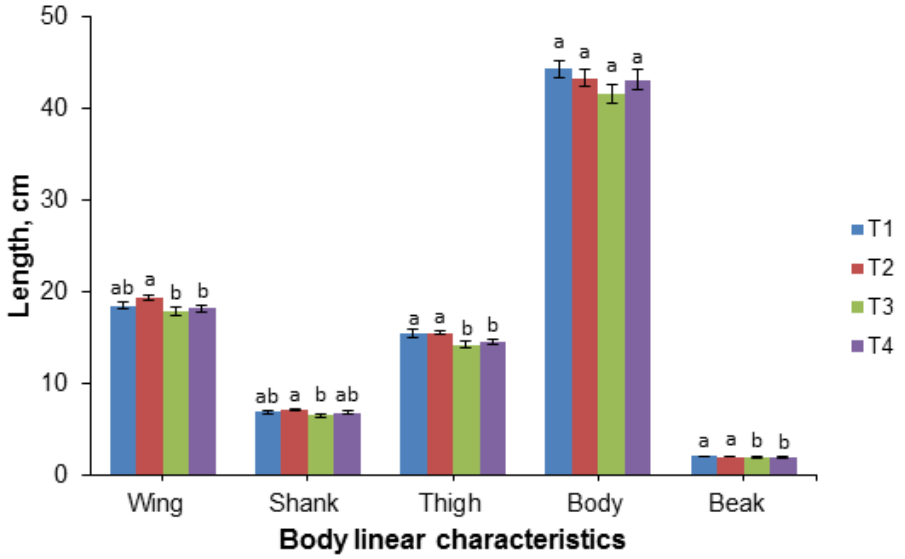

Figure 7. Body linear measurement characteristics of white cockerels at 12 weeks of age under skip-a-day feeding regime. The vertical bars are the standard deviation from the mean. Bars with different letters differed significantly at 5% level of probability by Tukey test.

had comparable ($p > 0.05$) values. In body weight, Treatment 2 was highest and different ($p < 0.05$) from Treatments 1, 3, and 4, which showed similarities ($p > 0.05$). However, in breast girth, comparable ($p > 0.05$) values were found for all treatments.

Linear body measurement characteristics of white cockerels at 12 weeks of age under a skip-a-day feeding regime

Figure 7 shows the linear body measurements of white

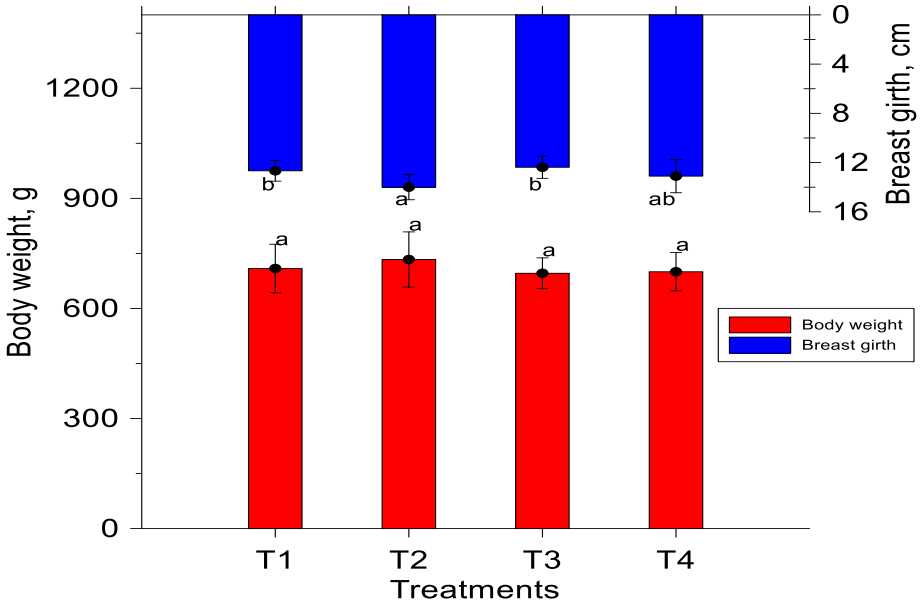

Figure 8. Differences in body weight and breast girth of white cockerels at 12 weeks of age under skip-a-day feeding regime. The vertical bars are the standard deviation from the mean. Bars with different letters differed significantly at 5% level of probability by Tukey test.

cockerels at 12 weeks of age while Figure 8 shows the body weight and breast girth at the same age group. The wing size in Treatment 2 differed ($p < 0.05$) from Treatments 3 and 4 while Treatment 1 was similar ($p > 0.05$) to Treatments 2, 3 and 4. The shank length in Treatment 2 differed ($p < 0.05$) from Treatment 3 while Treatments 1, 3 and 4 were similar ($p > 0.05$). Similarities ($p > 0.05$) were obtained between treatments 1 and 2 and between treatments 3 and 4 in thigh and beak lengths but the two groups differed ($p < 0.05$) in both traits. The body length in all the Treatments showed similar ($p > 0.05$) values. In Figure 8, the body weights in all the Treatments were similar ($p > 0.05$). The breast girth in Treatment 2 differed ($p < 0.05$) from Treatments 1 and 3 while Treatments 1 and 3 were similar ($p > 0.05$) to Treatment 4.

Linear body measurement characteristics of white cockerels at 14 weeks of age under a skip-a-day feeding regime

Figure 9 showed the linear body measurements of white cockerels at 14 weeks of age while Figure 10 showed the body weight and breast girth at the same age group. The result showed that in wing size, similar ($p > 0.05$) values were obtained between Treatments 1 and 2, and between Treatments 3 and 4. The two groups however differed ($p < 0.05$). The shank length in Treatment 1 is similar ($p > 0.05$) to Treatments 2, 3 and 4 while Treatments 2 and 3 differed ($p < 0.05$). In thigh length, Treatments 1, 2, and 3 were similar ($p > 0.05$) but differed ($p < 0.05$) from Treatment 4. The body length among Treatments 1, 2 and 4 were similar ($p > 0.05$) but differed from Treatment 3. In beak length, similar ($p > 0.05$) values were obtained across the treatments. Figure 10 showed similar ($p > 0.05$) values in the body weight across treatments. The breast girth in Treatments 1 and 2 differed ($p < 0.05$) from Treatment 4 while Treatments 1, 2 and 4 were similar ($p > 0.05$) to Treatment 3.

Linear body measurement characteristics of white cockerels at 16 weeks of age under a skip-a-day feeding regime

Figure 11 showed the linear body measurements of white cockerels at 16 weeks of age under a skip-a-day feeding regime while Figure 12 showed the body weight and breast girth at the same age group. The wing size and thigh length were similar ($p > 0.05$) in Treatments 2, 3 and 4 while Treatment 1 differed ($p < 0.05$) from them in both traits. In shank length, Treatment 1 is similar ($p > 0.05$) to all the other treatments while Treatments 2 and 3 were similar ($p > 0.05$), they differed ($p < 0.05$) from Treatment 4. The thigh length in Treatment 1 differed ($p < 0.05$) from the similar ($p > 0.05$) values obtained in Treatments 2, 3, and 4. The body lengths in Treatment 1, 3 and 4 were similar ($p > 0.05$) while Treatment 2 differed ($p < 0.05$) from them.

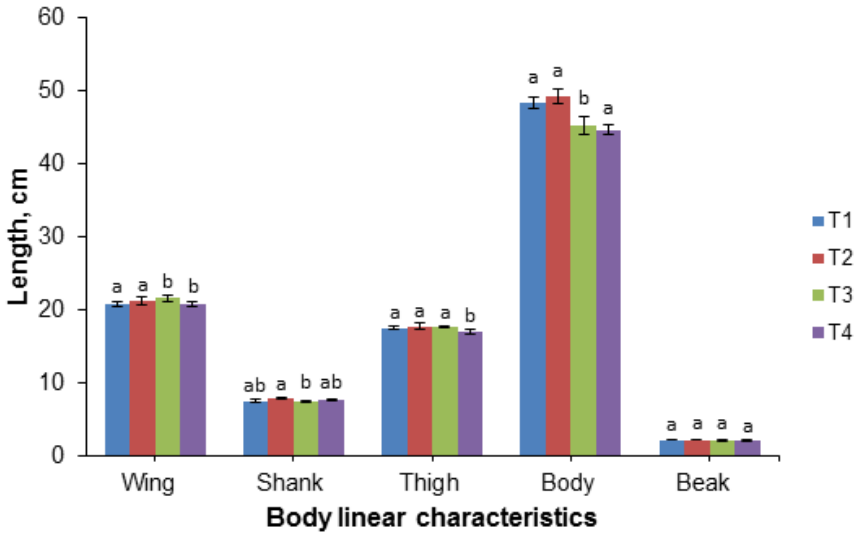

Figure 9. Body linear measurement characteristics of white cockerels at 14 weeks of age under skip-a-day feeding regime. The vertical bars are the standard deviation from the mean. Bars with different letters differed significantly at 5% level of probability by Tukey test.

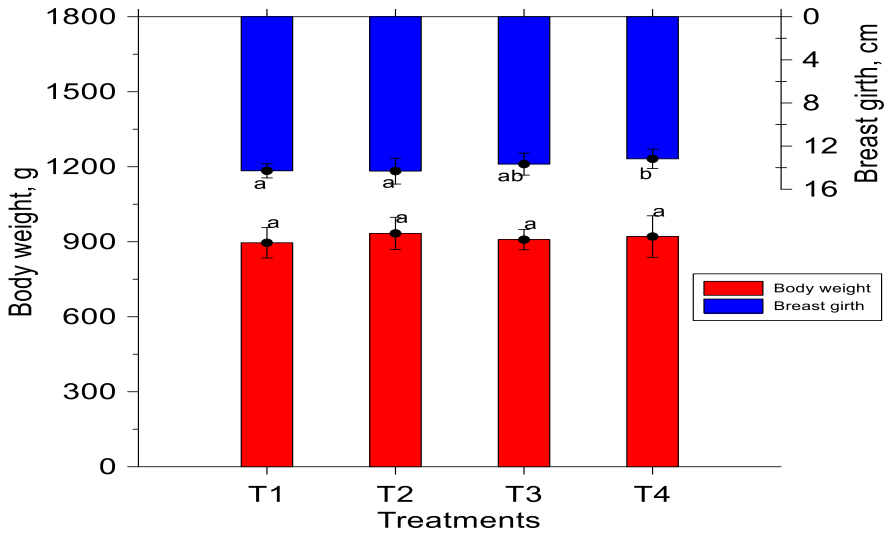

Figure 10. Differences in body weight and breast girth of black cockerels at 14 weeks of age under skip-a-day feeding regime. The vertical bars are the standard deviation from the mean. Bars with different letters differed significantly at 5% level of probability by Tukey test.

The result in Figure 12 showed that body weight and breast girth were similar ($p > 0.05$) across the Treatments.

Temporal distribution of body weight of white cockerels subjected to skip-a-day feeding regime

Figure 13 shows the body weights of the white cockerels in all the treatments from the beginning to the end of the experiment. At week 6, the least value was obtained in Treatment 2 with similar ($p > 0.05$) values among the other Treatments. At the 8th week, similarities ($p > 0.05$) were obtained among Treatments 1, 2 and 4 on one hand and between Treatments 2 and 3 on the other hand. At the 10th week, similarities ($p > 0.05$) were obtained among Treatments 1, 3, and 4 with Treatment 2 recording the

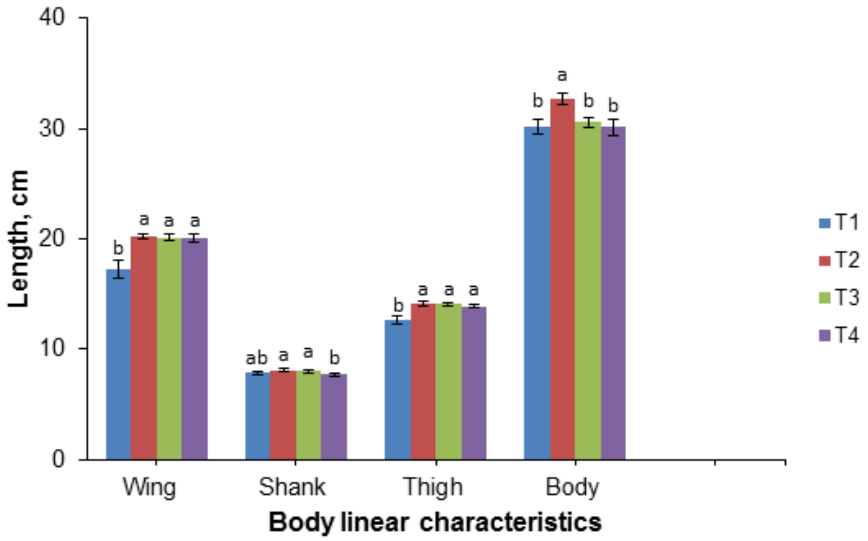

Figure 11. Body linear measurement characteristics of white cockerels at 16 weeks of age under skip-a-day feeding regime. The vertical bars are the standard deviation from the mean. Bars with different letters differed significantly at 5% level of probability by Tukey test.

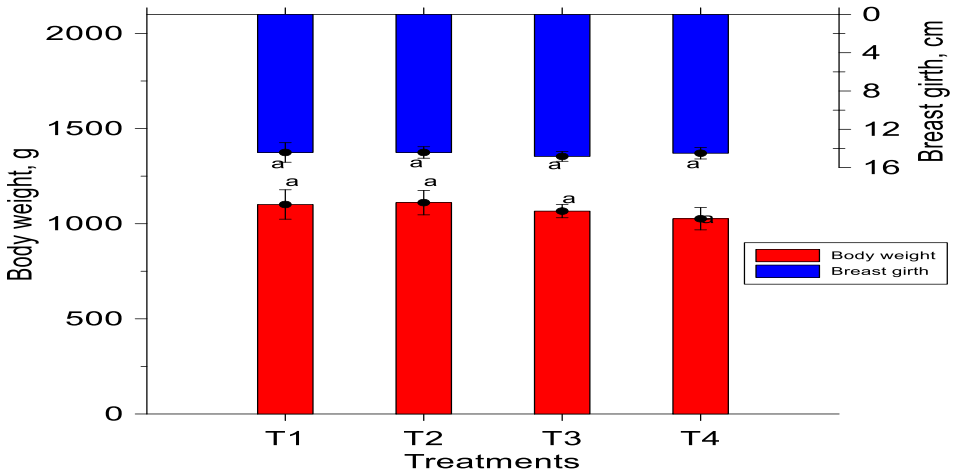

Figure 12. Differences in body weight and breast girth of black cockerels at 16 weeks of age under skip-a-day feeding regime.The vertical bars are the standard deviation from the mean.Bars with different letters differed significantly at 5% level of probability by Tukey test.

highest ($p < 0.05$) value. At 12, 14 and 16 weeks of age, there were no weight differences ($p > 0.05$) across all the Treatments.

Temporal distribution of breast girth of white cockerels subjected to a skip-a-day feeding regime

Figure 14 shows the breast girth of the white cockerels in all the treatments from the beginning to the end of the experiment. At week 6, the least value was obtained in Treatment 2 with a similar ($p > 0.05$) value to Treatment 3. Also similar ($p > 0.05$) to Treatments 2 and 3 but Treatment 4 differed ($p < 0.05$) from them all. At the 8th week, similarities ($p > 0.05$) were obtained between Treatments 1 and Treatments 2, and between Treatments 3 and 4. Treatments 2 and 4 differed ($p < 0.05$) significantly. At the 12th week, Treatment 1 had similarities ($p > 0.05$) with Treatments 3 and 4 while Treatment 2 differed ($p < 0.05$) from Treatments 1 and 3 but similar ($p>0.05$) to Treatment

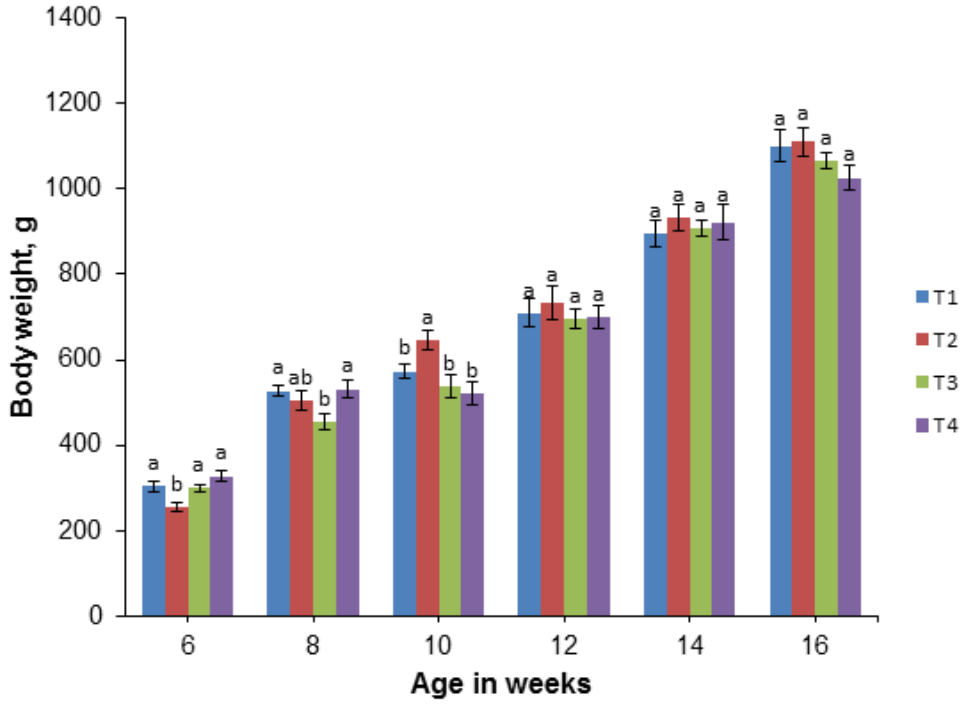

Figure 13. Temporal distribution of body weight of white cockerels subjected to skip-a-day feeding regime. The vertical bars are the standard deviation from the mean.Bars with different letters differed significantly at 5% level of probability by Tukey test.

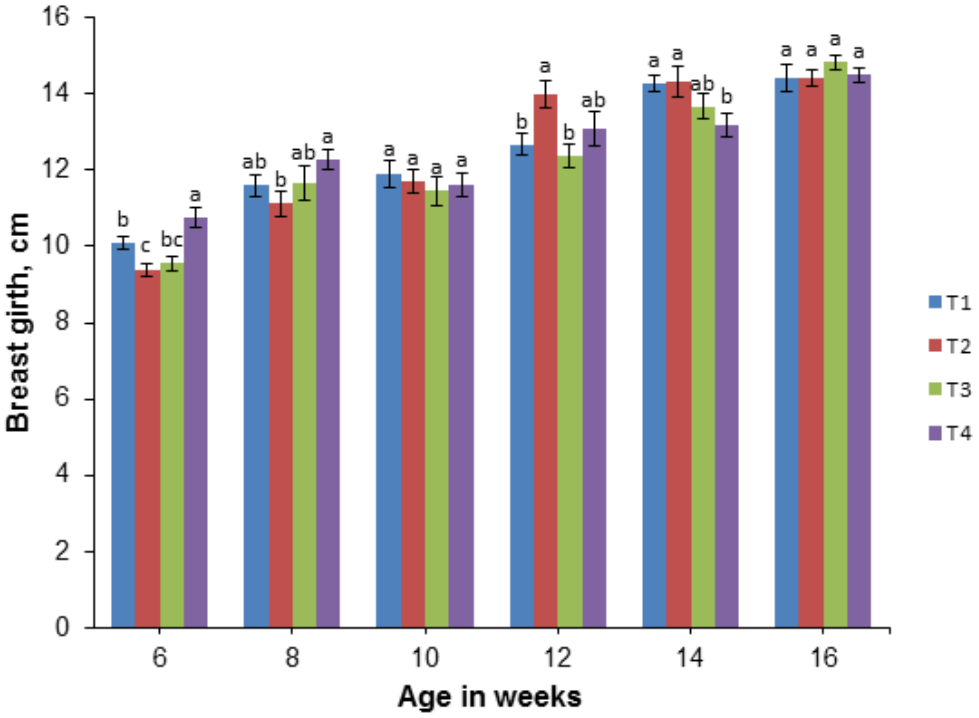

Figure 14. Temporal distribution of breast girth of white cockerels subjected to skip-a-day feeding regime. The vertical bars are the standard deviation from the mean. Bars with different letters differed significantly at 5% level of probability by Tukey test.

4. At the 14th week, Treatments 1, 2 and 3 had similar ($p > 0.05$) values while Treatment 4 differed ($p < 0.05$) from Treatments 1 and 2. At the 14th week, Treatments 1, 2 and 3 had similar ($p > 0.05$) values while Treatment 4 differed ($p < 0.05$) from Treatments 1 and 2.

DISCUSSION

Overall, the study showed that the morphometric traits of the cockerels specifically, their wing size, breast girth, and beak length were affected by their skip-a-day feeding schedule in all age groups. Yang *et al*. (2021) noted modifications to linear body parameters like leg length and breast breadth. In a similar vein, Yang *et al*. (2017) observed changes in linear body measurements in ducks after feed restriction. These findings imply that quantitative feed restriction can affect linear body measurements in poultry, as seen in this study. To establish precise feeding strategies for maximum growth and performance in poultry farming, more research is required to fully understand the impacts of feed restriction on linear body measurements in chicken cockerels.

The effects of quantitative feed restriction on the body weight of chicken cockerels have been the subject of numerous studies. Asghari *et al*. (2019) investigated how different feed restriction levels affected the growth performance of native Iranian cockerels in comparison to *ad libitum* feeding. The authors discovered that mild feed restriction led to slower but more effective growth. In a study on broiler chicks, Rezaei *et al*. (2012) discovered that feed restriction decreased body weight gain while increasing feed conversion efficiency. These results imply that quantitative feed restriction can change growth rates and feed consumption efficiency, which in turn can affect body weight.

Significant variations in breast girth and body weight which are parameters associated with muscular development were noted in this investigation. The birds that were restrictedly fed at six weeks of age recorded the highest value at week ten. In comparison to 850 and 1000 g for cockerels by Sarkar *et al.* (2008) and 750 and 1000 g acquired by Roy *et al*. (2006) for cockerels of the same age group, the live weights achieved in this study at 8 and 10 weeks of age were low. The weight of the cocks at 16 weeks of age obtained in this study is lower than the 1500–2000 g that Leenstra (2014) recommends for cocks at an average age of 16 weeks. The discrepancy could be explained by variations in the breeds of cocks procured, how they were managed, and the locations of the experimental sites.

The birds' gradual physiological adaptation to the various feeding schedules may be the reason why feed restriction systems have no discernible impact on body weight. This adaptation has likely improved the efficiency of the feed conversion to meat (Hassanien, 2011). The findings of this investigation corroborated those of other writers who claimed that feed restriction had no appreciable impact on chicks' body weight gain (Mahmood *et al.,* 2005; Mahmud *et al.*, 2008; Adeyemo *et al.*, 2013; Połtowicz *et al*., 2015). The outcome, however, is at variance with the findings of some other researchers who reported higher adult body weights in the two feeding systems (Ohtani and Leeson, 2000; Lee and Lesson, 2001) in broilers and (Bruggeman *et al*., 2005; Hocking and Robertson, 2005) in laying birds during the growing phase. Also, it contradicts the report by Urdaneta-Rincon and Leeson (2002), Saleh *et al*. (2005), Zhan *et al*. (2007), Benyi *et al*. (2010), and Benyi *et al*. (2011), which showed that feed-restricted broilers had reduced body weight. It also contradicts the findings of Zubair and Leeson (1994), who claimed that under-nutrition during an animal's early life causes more harm than under-nutrition later in life. Furthermore, it contradicts the results of Li *et al*. (2011), who found that early feed restriction of broilers at levels of 70 and/or 80% for 7 to 10 days considerably reduced slaughtered weight.

Conclusion

In summation, significant differences were evident in body weight, wing size, breast girth, and beak length among the Treatments, highlighting the nuanced impact of the skip-a-day feeding regime on some morphometric traits of the cockerels. The skip-a-day feeding regime influenced certain physiological aspects of the cockerels, particularly body weight across different age groups. These findings contribute to a better understanding of dietary interventions in poultry management practices.

CONFLICT OF INTEREST

The authors declare the they have no conflict interest.

REFERENCES

Adeyemo, G. O., Badmus, R. T., Longe, O. G., & Ologhobo, A. D. (2017). Effect of Ad-libitum, split and restricted feeding on performance, digestibility and welfare of broiler chicken. *Biotechnology Journal International,* 18(3), 1-7.

Asghari, A., Aghajanzadeh-Golshani, A., Zare-Shahneh, A., & Akhlaghi, A. (2019). Effects of quantitative feed restriction on ggrowth performance, carcass characteristics, and blood parameters of Iranian native cockerels. *Poultry Science*, 98(8), 3303-3310.

Benyi, K., Acheampong-Boateng, O., & Norris, D. (2011). Effects of strain and different skip-a-day feed restriction periods on the growth performance of broiler chickens. *Tropical Animal Health and Production*, *43*, 871-876.

Benyi, K., Acheampong-Boateng, O., Norris, D., & Ligaraba, T. J. (2010). Response of Ross 308 and Hubbard broiler chickens to feed removal for different durations during the day. *Tropical Animal Health and Production*, *42*, 1421-1426.

Bruggeman, V., Onagbesan, O., Ragot, O., Metayer, S., Cassy, S., Favreau, F., Jego, Y., Trevidy, J. J., Tona, K., Williams, J. & Picard, M. (2005). Feed allowance-genotype interactions in broiler breeder hens. *Poultry Science*, *84*(2), 298-306.

Fajemilehin, S. O. K. (2017). Discriminant analysis of sexual dimorphism in zoometrical characters of normal feathered Yoruba ecotype adult local chicken in the tropical forest zone of Nigeria. *Journal of Animal Science and Veterinary Medicine*, *2*(4), 139-144.

Garner, J. P., Falcone, C., Wakenell, P., Martin, M., & Mench, J. A. (2002). Reliability and validity of a modified gait scoring system and its use in assessing tibial dyschondroplasia in broilers. *British Poultry Science*, *43*(3), 355-363.

Hassanien, H. H. M. (2011). Productive performance of broiler chickens as affected by feed restriction systems. *Asian Journal of Poultry Science, 5*(1), 21-27.

Hocking, P. M., & Robertson, G. W. (2005). Limited effect of intense genetic selection for broiler traits on ovarian function and follicular sensitivity in broiler breeders at the onset of lay. *British Poultry Science*, *46*(3), 354-360.

Ibrahim, I. K., & Al-Taleb, S. S. (2002). The relationship between feed restriction at an early age and the occurrence of compensatory growth in light hybrid chickens. *Mutah Lil Buhuth wad-Dirasat*, *17*(2), 27-37.

Khetani, T. L., Nkukwana, T. T., Chimonyo, M., & Muchenje, V. (2009). Effect of quantitative feed restriction on broiler performance. *Tropical Animal Health and Production*, *41*, 379-384.

Lee, K. H., & Leeson, S. (2001). Performance of broilers fed limited quantities of feed or nutrients during seven to fourteen days of age. *Poultry Science*, *80*(4), 446-454.

Leenstra, F. (2014). Raising cockerels as part of free range egg production. Low Input Breeds Technical Note 4.6.

Li, L., Zhao, G., Ren, Z., Duan, L., Zheng, H., Wang, J., & He, Y. (2011). Effects of early feed restriction programs on production performance and hormone level in plasma of broiler chickens. *Frontiers of Agriculture in China*, *5*, 94-101.

Mahmood, S., Hassan, S., Ahmed, F., Ashraf, M., Alam, M., & Muzaffar, A. (2005). Influence of feed withdrawal for different durations on performance of broilers in summer. *International Journal of Agriculture and Biology*, *7*(6), 975-978.

Mahmud, A., Khattak, F. M., Ali, Z., & Pasha, T. (2008). Effect of early feed restriction on broiler performance, meal feeding on performance, carcass characters and blood constituents of broiler chickens. *Journal of Animal and Veterinary Advances*, *8*, 2069-2074.

Navidshad, B., Shivazad, M., Shahneh, A. Z., & Rahimi, G. (2006). Effect of feed restriction and dietary fat saturation on performance and serum thyroid hormones in broiler chickens. *International Journal of Poultry Science, 5*(5), 436-440.

Novel, D. J., Ng'Ambi, J. W., Norris, D., & Mbajiorgu, C. A. (2009). Effect of different feed restriction regimes during the starter stage on productivity and carcass characteristics of male and female Ross 308 broiler chickens. *International Journal of Poultry Science*, *8*(1), 35-39.

Ohtani, S., & Leeson, S. (2000). The effect of intermittent lighting on metabolizable energy intake and heat production of male broilers. *Poultry Science*, *79*(2), 167-171.

Owolabi, J. T., & Adebayo, W. O. (2013). Climate Variability and Physiological Comfort Measurement in Ado Ekiti, Ekiti State, Nigeria. *Journal of Natural Sciences Research*, *3*(15), 128-131.

Połtowicz, K., Nowak, J., & Wojtysiak, D. (2015). Effect of feed restriction on performance, carcass composition and physicochemical properties of the m. pectoralis superficialis of broiler chickens. *Annals of Animal Science*, *15*(4), 1019-1029.

Rahman, M. (2003, February). Growth of poultry industry in Bangladesh poverty alleviation and employment opportunity. In *Proceedings of 3rd International Poultry Show and Seminar, Organized by World's Poultry Science Association-Bangladesh Branch* (pp. 1-7).

Rezaei, M., Hajati, H., Golian, A., & Nassiri-Moghaddam, H. (2012). Effect of quantitative feed restriction on body weight gain, feed intake, carcass characteristics and some blood parameters in broiler chickens. *Journal of Animal Physiology and Animal Nutrition*, 96(3), 431-438.

Roy, K. R., Chowdhury, S. D., Sultana, N., Moshad, M. A. A., & Hasan, M. N. (2006). Production potentiality and economics of rearing cockerels from a commercial layer strain. Bangladesh Veterinarian, *23*(2), 83-87

Saleh, E. A., Watkins, S. E., Waldroup, A. L., & Waldroup, P. W. (2005). Effects of early quantitative feed restriction on live performance and carcass composition of male broilers grown for further processing. *Journal of Applied Poultry Research*, *14*(1), 87-93.

Sarkar, P.K., Mandal, A. B., & Naskar, S. (2008). Influence of dietary energy and protein on productive performance of white leghorn chicken in tropical climate. *Indian Journal of Poultry Science*, 43(1), 70-76.

Scott, T. A. (2002). Evaluation of lighting programs, diet density, and short term use of mash as compared to crumbled starter to reduce incidence of sudden death syndrome in broiler chicks to 35 d of age. *Canadian Journal of Animal Science*, *82*(3), 375-383.

Tolkamp, B. J., Sandilands, V., & Kyriazakit, I. (2005). The Effect of Early Feed Restriction during Rearing on the Performance of Broiler Breeders during Rearing and Lay. *Poultry Science*, 84,1286-1293.

Urdaneta-Rincon, M., & Leeson, S. (2002). Quantitative and qualitative feed restriction on growth characteristics of male broiler chickens. *Poultry Science*, *81*(5), 679-688.

Wilson, K. J., & Beyer, R. S. (2015). Poultry nutrition information for the small flock. Kansas State University Agricultural Experiment Station and Cooperative Extension Service. Retrieved from https://krex.k-state.edu/server/api/core/bitstreams/ecde99d7-6fe2-495b-a984-82512a9c7edc/content

Wolin, K. Y., Carson, K., Colditz, G. A., & Obesity Prevention Foundation (2016). *Obesity and cancer*. The Obesity Society

Yang, G., Fu, Y., Lin, S., & Zhang, L. (2017). Effect of quantitative feed restriction on growth performance, carcass traits, and meat quality in Cherry Valley ducks. *Poultry Science*, *96*(6), 1544-1550.

Yang, X., Guo, Y., Xu, X., & Wu, Y. (2021). Effect of quantitative feed restriction on growth performance, carcass characteristics and meat quality of Turkey cockerels. *Animals*, 11(3), 705.

Zhan, X. A., Wang, M., Ren, H., Zhao, R. Q., Li, J. X., & Tan, Z. L. (2007). Effect of early feed restriction on metabolic programming and compensatory growth in broiler chickens. *Poultry Science*, *86*(4), 654-660.

Zubair, A. K., & Leeson, S. (1994). Effect of varying period of early nutrient restriction on growth compensation and carcass characteristics of male broilers. *Poultry Science*, *73*(1), 129-136.