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Journal of Animal Science and Veterinary Medicine
Volume 10(1), pages 73-81, February 2025
Article Number: 25C79E7912
ISSN: 2536-7099
https://doi.org/10.31248/JASVM2025.535
https://integrityresjournals.org/journal/JASVM

Full length Research

The influence of strain on the chick quality and transfer efficiency of maternal antibody in broiler chickens at three days of age

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Received 7th January 2025; Accepted 27th January 2025

ABSTRACT: The selection of broiler strains with optimal growth performance and health parameters is critical for efficient poultry production. This study investigated the influence of strain on chick quality and maternally derived antibodies (MDAs) in different strains of broiler chickens at 3 days of age. The research was conducted at the Poultry Unit of the Teaching and Research Farm, Ekiti State University, Nigeria. Three strains of broiler chickens including Arbor Acres, Cobb-500, and Ross 308 were evaluated for qualitative and quantitative traits. The results showed that the frequency distributions of qualitative parameters were similar ($p>0.05$) among the strains, while significant differences ($p<0.05$) were observed in quantitative parameters such as body weight, net weight, and body length. The mean antibody titers for Infectious Bursa Disease Virus (IBDV), Newcastle Disease Virus (NDV), and Avian Retrovirus (ARV) were similar ($p>0.05$) among the strains. In conclusion, Cobb 500 and Arbor Acres can be considered superior to Ross 308 in this study, but the specific strain that performs best depends on the specific parameter being considered.

Keywords: Antibody titers, broiler chickens, chick quality, maternally derived antibodies, strains.

INTRODUCTION

The initial three days post-hatch are critical for broiler chicken development, encompassing rapid growth, organ maturation, and increased susceptibility to infectious diseases. This period significantly influences the long-term health, productivity, and economic value of broiler production. Visual appraisal of three-day-old chicks provides essential insights into their health and vigour through qualitative traits such as navel quality, crop fill, and hydration status, which are directly linked to reduced infection risk, sufficient nutrient uptake, and optimal physiological function (Gomes *et al*., 2009). Quantitative traits like chick weight, yolk-free weight, yolk sac residue, and chick length offer measurable indicators of vitality and future performance, correlating with post-hatch growth, nutrient utilization, and skeletal development (Pan *et al*., 2022).

Early post-hatch nutrition has been shown to significantly influence the performance and muscle growth of broiler chickens. Providing feed and water access in the hatcher can lead to higher final body weights and greater breast muscle development (Gaweł *et al*., 2022). Delayed access to feed early post-hatch can negatively affect the development and maturation of the gastrointestinal tract microbiota, which is crucial for nutrient absorption and overall health (Proszkowiec-Weglarz *et al*., 2022). Additionally, incubation conditions, such as temperature, humidity, and ventilation, play a vital role in embryo development and post-hatch performance (Tona *et al*., 2022).

Maternally derived antibodies (MDAs) play a pivotal role during this phase, offering critical immune protection against prevalent poultry diseases. The efficiency of MDA transfer from breeder hens to their offspring is influenced by genetic, nutritional, and management factors (Liu *et al*., 2023). Studies have shown that MDAs against pathogens such as Newcastle Disease Virus (NDV), Infectious Bursa Disease Virus (IBDV), and Avian Reovirus (ARV) are vital

for reducing early-life disease susceptibility in broiler chickens (Pan *et al*., 2022; Haems *et al*., 2024). Research indicates that maternal antibodies passively transferred across the placenta and into breast milk are critical for protection against infectious diseases and immune development during the first year of life (Langel *et al*., 2020). The transfer of maternal antibodies across the placenta during pregnancy can continue to protect the neonate for several months after birth while the neonatal adaptive immune system develops (Coler *et al*., 2024). Despite this, there is a lack of comprehensive research comparing the efficiency of MDA transfer across different broiler strains, a factor that could have significant implications for breeding programs and farm management practices.

The research gap lies in the limited understanding of how strain differences influence chick quality and the efficiency of MDA transfer. While previous studies have explored individual parameters such as growth traits or antibody titers, there is scant information on their combined impact across different broiler strains. Addressing this gap is crucial for optimizing strain selection to enhance early chick health, productivity, and immunity.

This study, therefore, aims to evaluate the influence of broiler strain on chick quality and the transfer efficiency of maternal antibodies at 3 days of age, contributing valuable insights for poultry breeders and farmers to improve broiler production outcomes.

MATERIALS AND METHODS

The experiment was conducted in the Poultry Unit of the Teaching and Research Farm, Faculty of Agricultural Sciences, Ekiti State University, Ado-Ekiti, Ekiti State, Nigeria. Three-day-old Chicks were evaluated using specified quality standards (Nekouei *et al*., 2022). Thirty chicks from each of the three Strains (Arbor Acres, Cobb-500 and Ross 308) were selected and examined for both qualitative and quantitative properties.

Qualitative traits were assessed through visual appraisal by an experienced veterinarian, including navel quality (noted as abnormal or normal), crop fill (reported as yes if the crop was round, soft, and full, otherwise no), and dehydration (graded as yes or no based on the feet's veins) and feather colour assessment. Qualitative characteristics, such as chick weight and yolk-free weight, were measured using a digital weighing scale (Willemsen *et al*., 2008), while chick length (measured from the beak tip to the third toe implantation) was measured using a digital calliper. These measurements, including yolk sac residue, provide precise measures of vitality, with chick weight influencing future growth and productivity, yolk-free weight indicating nutrient reserves, yolk sac residue reflecting nutrient utilization, and chick length correlating with skeletal growth (Pan *et al*., 2022).

Following visual assessments, blood samples were obtained from the chicks via heart puncture. The sera were separated and stored at -20°C for laboratory analysis. Commercially available enzyme-linked immunosorbent assay (ELISA) test kits (ID Screen® 310 rue Louis Pasteur, 34790 Grabels, France) were used to measure the levels of maternally derived antibodies (MDA) against Newcastle Disease Virus (NDV), Infectious Bursa Disease Virus (IBDV), and Avian Reovirus (ARV) in the frozen sera within a week of sample collection.

The data collected were analyzed using SPSS version 11. Prior to analysis, normality tests were conducted to ensure that the data met the assumptions of parametric analysis. A one-way analysis of variance (ANOVA) was employed to compare the mean values across the three strains. A post-hoc test was conducted to determine significant differences between means. Statistical significance was considered at $p<0.05$.

RESULTS

The frequency distribution of qualitative and quantitative traits for 3-day-old chicks (DOCs) in the three strains of broiler chickens

The frequency distributions of qualitative traits for the 90 studied 3-day-old chicks (DOCs) according to strain are presented in Figures 1-5. The visual appraisal score, as shown in Figure 1, revealed that all birds examined across the three strains had a 100% good visual scoring for overall health and vigour. The feather colour in Figure 2 showed that the feather colour was 100% deep yellow in Arbor Acres and 100% white in Cobb-500 and Ross 308. The navel quality score in Figure 3 showed variation among the strains, with 80% in Arbor Acres, 100% in Cobb 500, and 100% in Ross 308. The dehydration score in Figure 4 also showed strain differences, with 40% in Arbor Acres, 20% in Cobb 500, and 20% in Ross 308. Furthermore, the crop fill score, as displayed in Figure 5, was 80% across the three strains. Additionally, no physical abnormalities, including beak deformities, leg deformities, or visible injuries, were observed in any of the 90 chicks examined across the three strains.

The results of the ANOVA for quantitative traits, including body weight, yolk sac residue, net weight, and body length, are presented in Figures 6-9. Figure 6 displays the body weights of the three strains of broiler chickens. A comparison of the means revealed that Arbor Acres and Cobb 500 had statistically similar body weights ($p>0.05$). However, these values were significantly higher ($p<0.05$) than those recorded in Ross 308.

The yolk sac residue is displayed in Figure 7. The values did not differ statistically ($p>0.05$) among the three strains.

Figure 8 shows the net weight, indicating similar statistical values ($p>0.05$) between Arbor Acres and Cobb 500, which were statistically higher ($p<0.05$) than the value

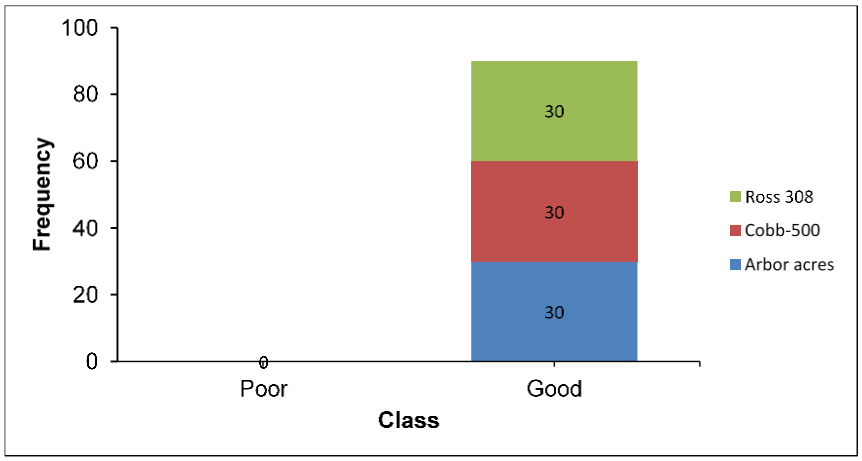

Figure 1. Frequency of visual scores of the different broiler strains.

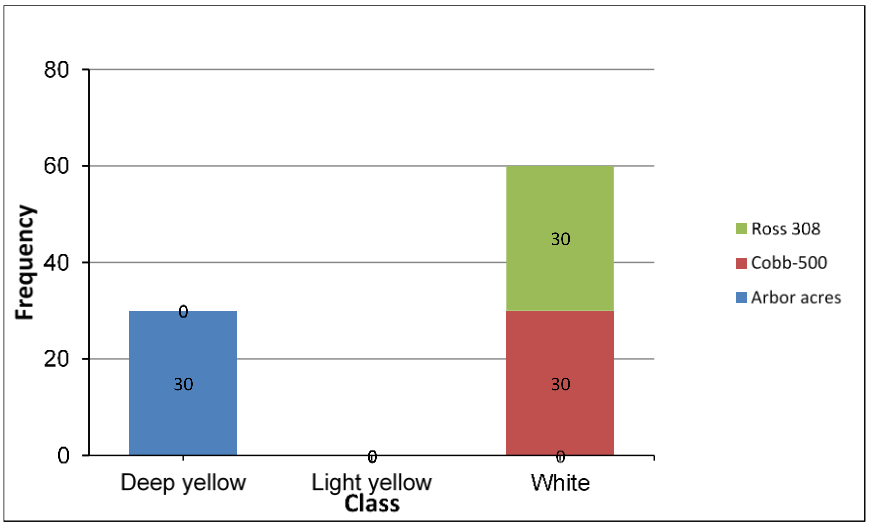

Figure 2. Frequency of feather colour of the different broiler strains.

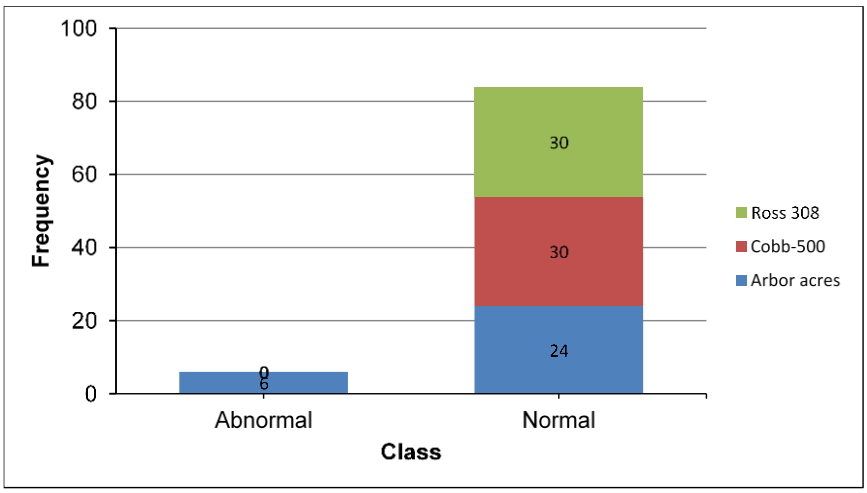

Figure 3. Frequency of navel quality of the different broiler strains.

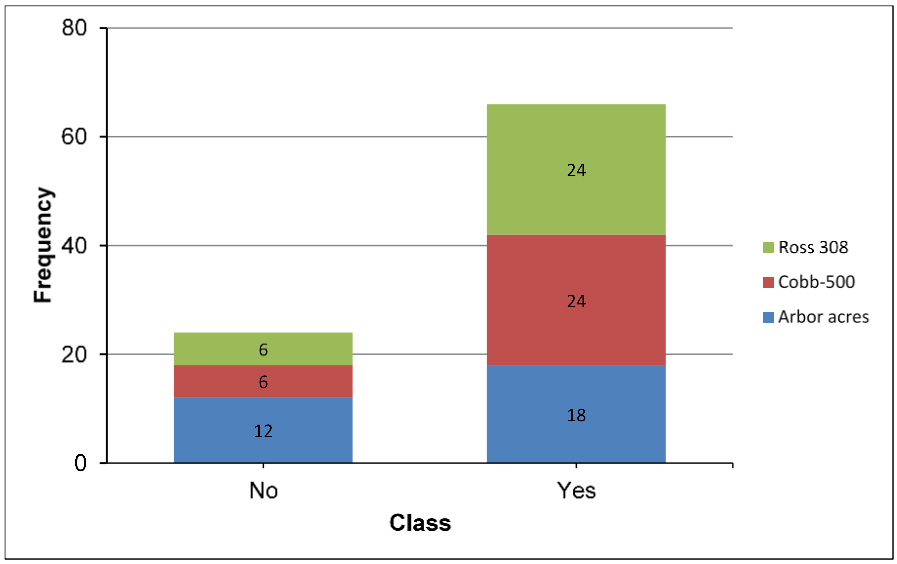

Figure 4. Frequency of dehydration of the different broiler strains.

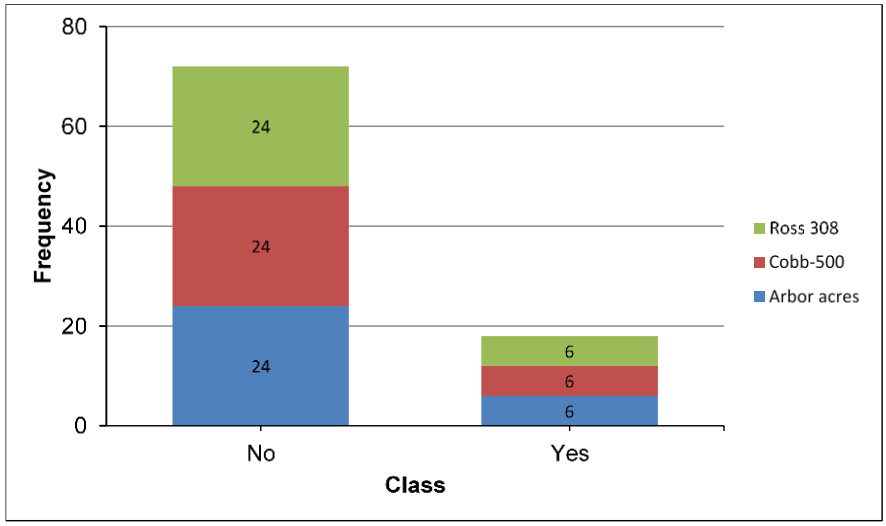

Figure 5. Frequency of crop filled of the different broiler strains.

obtained in Ross 308.

In contrast, the body length displayed in Figure 9 varied statistically ($p<0.05$) between Arbor Acres and Cobb 500, with Arbor Acres having a longer body length. Interestingly, no statistically significant differences ($p>0.05$) in body length were found between Arbor Acres and Ross 308 or between Cobb 500 and Ross 308 broiler strains.

The ELISA titers of the broiler strains are illustrated in Figures 10 to 12. The mean antibody titers (OD) for IBDV are shown in Figure 10, those for NDV are found in Figure 11, and ARV titers are shown in Figure 12. The values obtained in the three titers were statistically similar ($p>0.05$) among the broiler chicken strains. The strain-level ELISA titers for IBDV were below 3000 OD.

DISCUSSION

A study examining 3-day-old chicks from strains of broiler including: Arbor Acres, Cobb-500, and Ross 308 broiler strains investigated qualitative and quantitative traits, revealing excellent health across all strains, with a 100% absence of physical abnormalities, meeting commercial broiler production standards (Decuypere *et al*., 2007; NCC, 2020; Tabler *et al*., 2004). The high visual scores of physical abnormalities indicate exceptional quality, potentially leading to enhanced growth rates, improved health, and increased productivity (Galmarini *et al*., 2024; Tarro *et al*., 2020).

The observed variations in feather colour support the

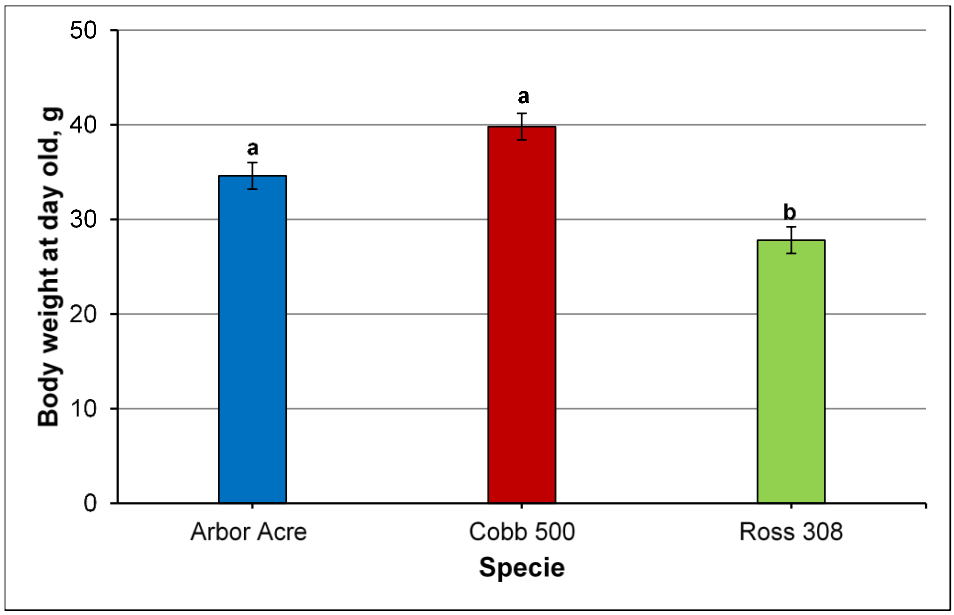

Figure 6. Body weight at day old of the different broiler strains. The capped vertical lines on the bars are the standard error of the mean. Bars with different letters differed significantly at a 5% level of probability by the Tukey test.

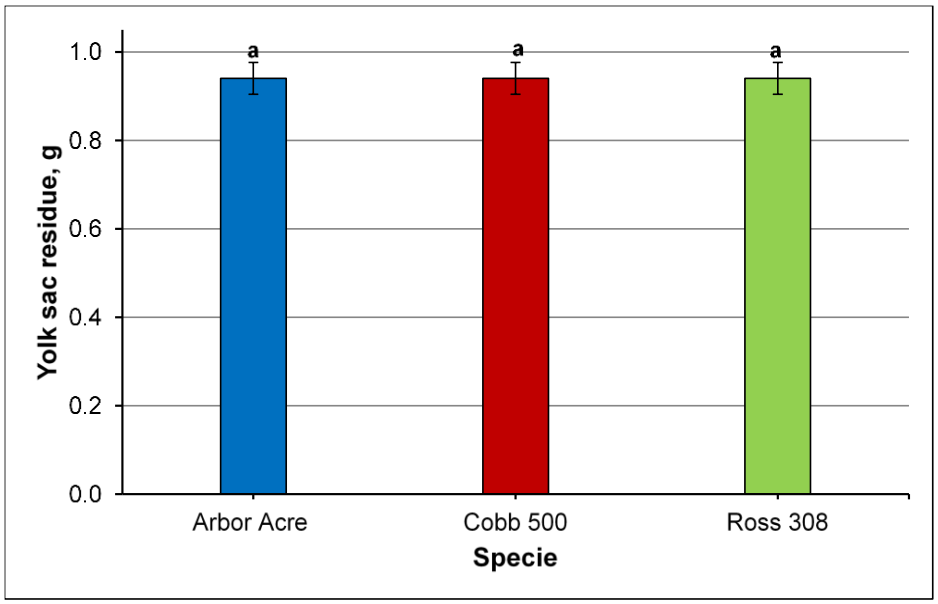

Figure 7. Yolk sac residue of the different broiler strains. The capped vertical lines on the bars are the standard error of the mean. Bars with different letters differed significantly at a 5% level of probability by the Tukey test.

notion that genetic variations and breed characteristics significantly influence feather colour, and that feather colour is polygenic (Davoodi *et al*., 2021). Notably, Arbor Acres' deep yellow feathers suggest better quality due to maximal yolk uptake (Petek *et al*., 2010). However, differences in navel quality scores and dehydration scores were observed, with Cobb 500 and Ross 308 showing a slight advantage over Arbor Acres in terms of these scores. Despite this, the normality of the navel region and low dehydration levels indicate robust chick health and resilience to stress and environmental conditions (Ould-Ali and Schulte-Drüggelte, 2013; Lohmann Breeders, 2014).

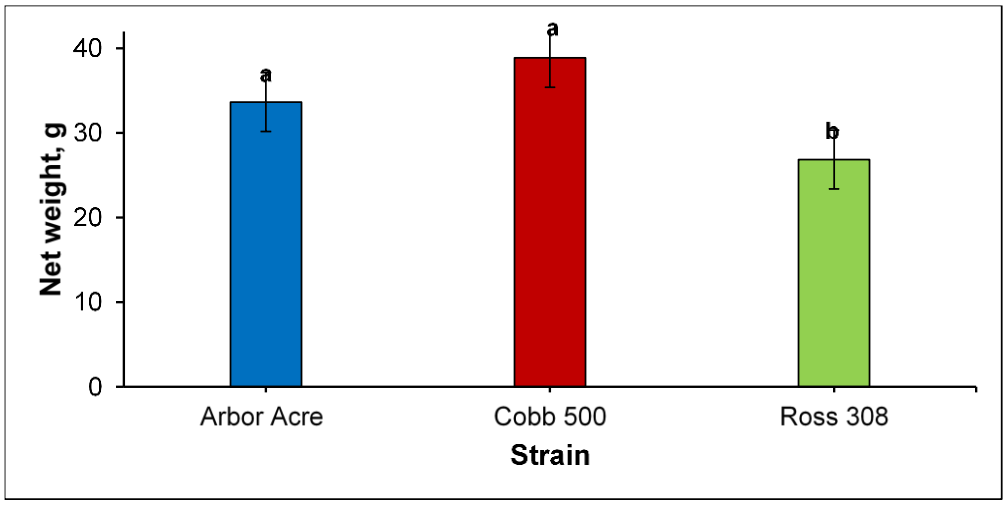

Figure 8. Net weight of the different broiler strains. The capped vertical lines on the bars are the standard error of the mean. Bars with different letters differed significantly at a 5% level of probability by the Tukey test.

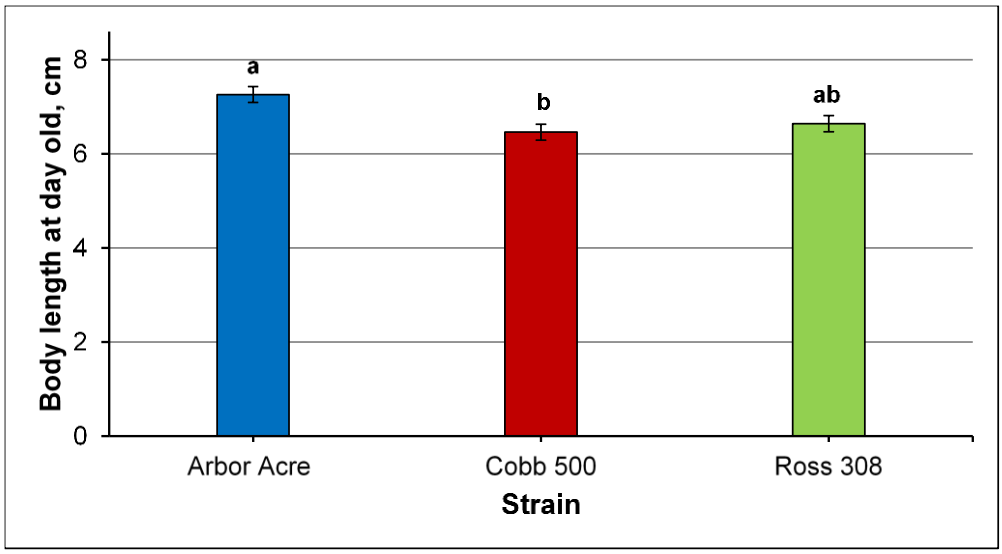

Figure 9. Body length at day old of the different broiler strains. The capped vertical lines on the bars are the standard error of the mean. Bars with different letters differed significantly at a 5% level of probability by the Tukey test.

Moreover, consistent crop fill across all strains is crucial for appetite development, early growth rate, skeletal development, and flock uniformity (Aviagen, 2019; Earlyfeed, 2023).

Quantitative analysis revealed significant differences in body weight and net weight among the strains, with Arbor Acres and Cobb 500 exhibiting higher values than Ross 308, indicating distinct growth potentials. However, research on the impact of genetic differences on broiler strain growth has yielded mixed results. For instance, Safari *et al*. (2021) found no significant differences in body weight and net weight between Cobb 500 and Ross 308 strains, suggesting environmental factors may play a more crucial role. In contrast, Das and Islam (2023) observed variations in feed intake and final body weight among strains, although these differences were not always consistent, and Ross 308 sometimes performed comparably to Cobb 500 and Arbor Acres. The findings of this study are consistent with those of Das and Islam (2023), Islam (2022), and Khalid *et al*. (2021), which also reported variations in growth potentials among broiler strains.

Cao *et al*. (2021) discovered that chicks with higher body weight at hatch maintained their weight advantage due to

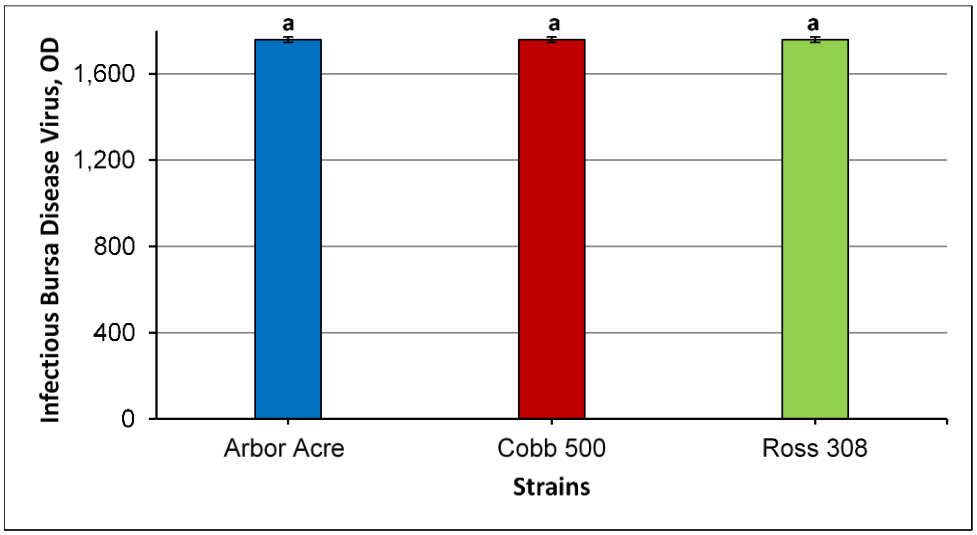

Figure 10. Infectious Bursa Disease Virus (IBDV) antibody titre (OD) of the three broiler bird strains. The capped lines on the bars represent the standard error of the mean. Bars with different letters differed significantly at a 5% probability level by the Tukey test.

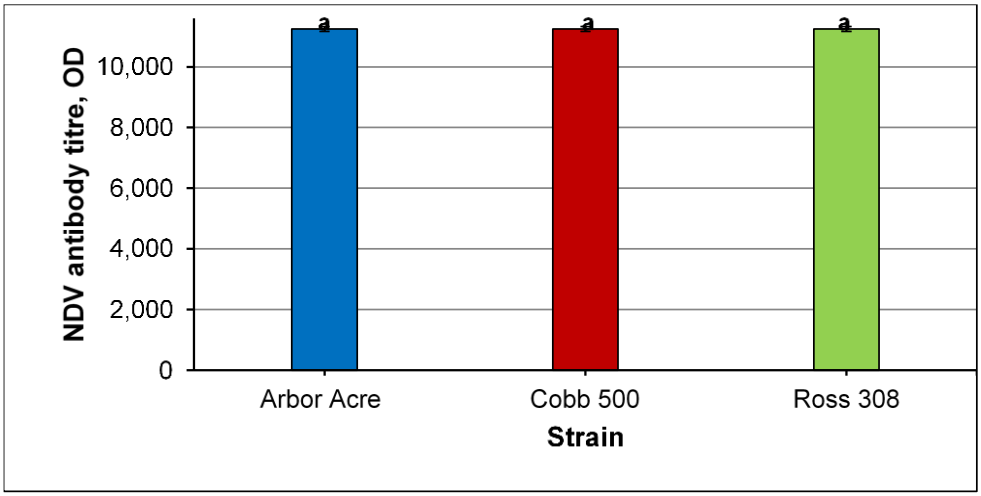

Figure 11. Newcastle Disease Virus (NDV) antibody titre(OD) of the three broiler bird strains. The capped lines on the bars represent the standard error of the mean. Bars with different letters differed significantly at a 5% probability level by the Tukey test.

increased feed intake, suggesting a positive correlation between initial body weight and subsequent growth. The differences in body weight at hatch among the strains can be attributed to genetic factors. Studies have shown that body weight at hatch has a high level of genetic heritability (Abo-Al-Ela *et al.,* 2021; Tzschentke and Riedel, 2021). High genomic heritability estimates for body weight at hatch demonstrate its solid genetic foundation (Petek *et al*., 2010). Additionally, research has indicated that lighter chicks tend to be more susceptible to illness and stress due to weakened immune responses and lower initial body reserves (Abo Ghanima *et al*., 2020; Tzschentke and Riedel, 2021). Cobb 500 and Arbor Acres exhibited the highest yolk-free body weight (YFBW) compared to Ross 308. This difference may be attributed to variations in nutrient absorption efficiency from the yolk sac among the strains. According to Islam *et al*. (2023), superior nutrient absorption can establish a robust initial nutritional foundation for growth and development.

The study's findings revealed significant breed-specific

differences in body length between Arbor Acres and Cobb 500. This variation may be attributed to differences in genetic factors influencing skeletal growth and development among the strains. Research has shown that genetic variations can affect the expression of genes involved in bone growth and development, leading to differences in body length (Dunn *et al*., 2013). Furthermore, hormonal regulation, particularly the role of growth hormone and thyroid hormone, can also influence skeletal growth and development, which may vary among different strains (Niwczyk *et al*., 2023; Hasan *et al*., 2024).

The ELISA titers obtained in this study revealed variable and suboptimal levels of maternal-derived antibodies (MDAs) against Infectious Bursal Disease Virus (IBDV) and Avian Retrovirus (ARV) among the three broiler strains. This finding is consistent with previous studies that reported similar variations in MDA levels among different broiler strains (Gharaibeh and Mahmoud, 2013). The lack of significant differences in ELISA titers among the strains suggests that genetic factors may not play a significant role in determining MDA levels against IBDV and ARV. Instead, environmental factors such as breeder flock health and nutrition may have contributed to the observed variations (Shane, 2005). The suboptimal MDA levels observed in this study highlight the need for enhanced immunity and biosecurity measures to effectively control IBDV and ARV infections in Nigerian broiler production systems.

The study revealed varying levels of performance among Arbor Acres, Cobb 500, and Ross 308 broiler strains in terms of chick quality, growth, and immune response. Cobb 500 demonstrated superior performance across several parameters. Based on its outstanding performance, Cobb 500 is recommended as the best strain for broiler production in Nigeria, considering its superior yolk-free body weight, better navel quality score, lower dehydration level, and improved immune response.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

Abo Ghanima, M. M., Abd El-Hack, M. E., Taha, A. E., Tufarelli, V., Laudadio, V., & Naiel, M. A. E. (2020). Stress and immunity in poultry: light management and nanotechnology as effective immune enhancers to fight stress. *Cell Stress and Chaperones, 26*(3), 457-472.

Abo-Al-Ela, H. G., El-Kassas, S., & El-Naggar, K. (2021). Stress and immunity in poultry: Light management and nanotechnology as effective immune enhancers to fight stress. *Cell Stress and Chaperones, 26*, 457-472.

Aviagen (2019). Assessing crop fill for optimal broiler management. *Aviagen Technical Document.* Retrieved from https://en.aviagen.com/assets/Tech_Center/BB_Resources_Tools/Broiler-Mgt/AVBR-Howto4-Assess-Crop-Fill-EN-17.pdf

Cao, C., Chowdhury, V. S., Cline, M. A., & Gilbert, E. R. (2021). The microbiota-gut-brain axis during heat stress in chickens: A review. *Frontiers in Physiology, 12*, 752265.

Coler, C., King-Nakaoka, E., Every, E., Chima, S., Vong, A., Del Rosario, B., VanAbel, R., & Adams Waldorf, K. M. (2024). Impact of infections during pregnancy on transplacental antibody transfer. *Vaccines, 12*(10), 1199.

Das S, and Islam MA (2023). Comparative growth, meat yield and blood lipid profiles of Arbor Acres, Cobb 500 and Lohmann broiler strains. *International Journal of Agriculture Environment and Bioresearch*, 8(3):55-63.

Davoodi, P., Ehsani, A., Torshizi, R. V., & Masoudi, A. (2021). New insights into genetics underlying plumage color. *Animal Genetics, 53*(1), 80-93.

Decuypere, E., Tona, K., Bruggeman, V., & Bamelis, F. (2007). The day-old chick: A crucial hinge between breeders and broilers. *CEVA Animal Health Asia, 3*(06), 1–12.

Dunn, C. W., Luo, X., & Wu, Z. (2013). Phylogenetic analysis of gene expression. *Integrative and Comparative Biology*, 53(5), 847-856.

Earlyfeed (2023). *A stockman's guide to day-old chicks: Crop fill check*. Earlyfeed Technical Bulletin. Retrieved from https://www.earlyfeednutrition.com/news/a-stockmans-guide-to-day-old-chicks-crop-fill-check

Galmarini, E., Marciano, L., & Schulz, P. J. (2024). The effectiveness of visual-based interventions on health literacy in health care: A systematic review and meta-analysis. *BMC Health Services Research, 24*(1), 718.

Gaweł, A., Madej, J. P., Kozak, B., & Bobrek, K. (2022). Early post-hatch nutrition influences performance and muscle growth in broiler chickens. *Animals, 12*, 3281.

Gharaibeh, S., & Mahmoud, K. (2013). Decay of maternal antibodies in broiler chickens. *Poultry Science, 92*(9), 2333–2336.

Gomes, M. B. C., Baião, N. C., Resende, M., Lara, L. J. C., & Martins, N. R. S. (2009). Effect of maternally derived antibodies on the performance and immunity of broilers induced by in ovo or post-hatching immunizations with a live vaccine against infectious bursal disease. *Brazilian Journal of Poultry Science, 11*(1), 57–63.

Haems, K., Strubbe, D., Van Rysselberghe, N., Rasschaert, G., Martel, A., Pasmans, F., & Garmyn, A. (2024). Role of maternal antibodies in the protection of broiler chicks against *Campylobacter* colonization in the first weeks of life. *Animals, 14*(9), 1291.

Hasan, S., Naseer, S., Zamzam, M., Mohilldean, H., Van Wagoner, C., Hasan, A., Saleh, E. S., Uhley, V., & Kamel-ElSayed, S. (2024). Nutrient and hormonal effects on long bone growth in healthy and obese children: A literature review. *Children*, *11*(7), 817.

Islam, M. A. (2022). Comparative growth, meat yield and blood lipid profiles of Arbor Acres, Cobb 500 and Lohmann broiler strains. *International Journal of Agriculture, Environment and Bioresearch, 8*(3), 55–63.

Islam, M. A., Islam, M. S., & Nishibori, M. (2023). Productive and reproductive performance of Cobb-500, Arbor Acre and Lohmann broiler parent stocks. *International Journal of Agriculture and Environmental Biotechnology, 8*(3), 817-828.

Khalid, N., Ali, M. M., Ali, Z., Amin, Y., & Ayaz, M. (2021). Comparative productive performance of two broiler strains in open housing system. *Advanced Life Sciences, 8*(2), 124-127.

Langel, S. N., Otero, C. E., Martinez, D. R., & Permar, S. R. (2020). Maternal gatekeepers: How maternal antibody Fc characteristics influence passive transfer and infant protection.

PLOS Pathogens, 1*6*(3), e1008303

Liu, M., Shen, X., Yu, Y., Li, J., Fan, J., Jia, X., & Dai, Y. (2023). Effect of different levels of maternally derived genotype VII Newcastle disease virus-specific hemagglutination inhibition antibodies on protection against virulent challenge in chicks. *Viruses, 15*(9), 1840.

Lohmann Breeders (2014). *Importance of normal navel conditions and low dehydration levels*. Lohmann Breeders Technical Bulletin.

NCC (2020). *National Chicken Council. Animal welfare guidelines and audit checklist for broilers*. NCC Technical Bulletin, p.3.

Nekouei, O., Yau, D., MacKinnon, B., Magouras, I., Conan, A., Elsohaby, I., Paudel, S., & Pfeiffer, D. U. (2022). Quality assessment of day-old chickens on the broiler farms of Hong Kong. *Animals, 12*(12), 1520.

Niwczyk, O., Grymowicz, M., Szczęsnowicz, A., Hajbos, M., Kostrzak, A., Budzik, M., Maciejewska-Jeske, M., Bala, G., Smolarczyk, R., & Męczekalski, B. (2023). Bones and hormones: Interaction between hormones of the hypothalamus, pituitary, adipose tissue and bone. *International Journal of Molecular Sciences*, 24(7), 6840.

Ould-Ali, D., & Schulte-Drüggelte, R. (2013). Review of different day-old chick quality parameters in layer type breeds. *International Poultry Production, 23*(4), 15-19.

Pan, X., Su, X., Ding, P., Zhao, J., Cui, H., Yan, D., Teng, Q., Li, X., Beerens, N., Zhang, H., Liu, Q., de Jong, M. C. M., & Li, Z. (2022). Maternal-derived antibodies hinder the antibody response to H9N2 AIV inactivated vaccine in the field. *Animal Diseases 2*, 9

Petek, M., Orman, A., Dikmen, S., & Alpay, F. (2010). Physical chick parameters and effects on growth performance in broiler. *Archives Animal Breeding*, *53*(1), 108-115.

Proszkowiec-Weglarz, M., Miska, K. B., Ellestad, L. E., Schreier, L. L., Kahl, S., Darwish, N., Campos, P., & Shao, J. (2022). Delayed access to feed early post-hatch affects the development and maturation of gastrointestinal tract microbiota in broiler chickens. *BMC Microbiology*, *22*(1), 206.

Safari, A., Ahmadpanah, J., Jafaroghli, M., & Karimi, H. (2021). Comparative study of growth patterns for three Strains of broiler chickens using mathematical models. *Agriculturae Conspectus Scientificus*, *86*(1), 75-82.

Shane, S. M. (2005). Principles of immunization and vaccination. In *Poultry Health and Management* (pp. 123-145).

Tabler, G. T., Berry, I. L., & Mendenhall, A. M. (2004). Mortality patterns associated with commercial broiler production. *Avian Advice*, *6*(1), 1-3.

Tarro, L., Llauradó, E., Ulldemolins, G., Hermoso, P., & Solà, R. (2020). Effectiveness of workplace interventions for improving absenteeism, productivity, and workability of employees: A systematic review and meta-analysis of randomized controlled trials. *International Journal of Environmental Research and Public Health, 17*(6), 901.

Tona, K., Voemesse, K., N'nanlé, O., Oke, O. E., Kouamé, Y. A. E., Bilalissi, A., Meteyake, H., & Oso, O. M. (2022). Chicken incubation conditions: Role in embryo development, physiology, and adaptation to the post-hatch environment. Frontiers in Physiology, *13*, 895854.

Tzschentke, B., & Riedel, C. (2021). *The effect of light during incubation on embryonic development and post-hatch behaviour, health and performance of domestic chicken*. Lohmann Breeders.

Willemsen, H., Everaert, N., Witters, A., De Smit, L., Debonne, M., Verschuere, F., Garain, P., Berckmans, D., Decuypere, E., & Bruggeman, V. (2008). Critical assessment of chick quality measurements as an indicator of posthatch performance. *Poultry Science*, *87*(11), 2358-2366.