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Original article

Effect of breed differences on semen qualities in adult male chickens in Nigeria

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ABSTRACT

Efficient reproduction is paramount for the sustainability and profitability of poultry enterprises. This study examined the influence of breed on semen quality traits in four chicken breeds commonly found in Nigeria, namely White Yaffa, Noiler, Yoruba ecotype and Fulani ecotype. A total of 40-day-old male chicks were used in the experiment, with 10 birds per breed. The birds were raised to 26 weeks before semen was collected. Mature cocks from each breed were subjected to semen collection and evaluation, with emphasis on both qualitative and quantitative parameters such as semen volume, color, viscosity, odor, motility, viability, and morphological characteristics. The findings revealed significant differences among the breeds studied ($p < 0.05$). Noiler cocks recorded the highest semen volume (0.52 ± 0.04 mL) while the indigenous Yoruba ecotype produced the lowest semen volume (0.31 ± 0.01 mL). White Yaffa performed best with the highest fast progressive motility (80.33%), followed by Noiler, Fulani, and lastly Yoruba respectively at $p < 0.05$. The sperm counts showed that Fulani had the highest concentration (1.33×10^9/mL), followed by White Yaffa (1.23×10^9/mL) and Yoruba (1.11×10^9/mL). Noiler, in spite of its large semen volume, had the lowest sperm concentration (0.67×10^9/mL). Despite this variation, all breeds displayed normal semen color, viscosity, and odor, reflecting general semen viability across the groups. In conclusion, this study highlights the importance of breed as a determining factor in semen quality of male chickens. The findings from this study provides useful insight for poultry breeders, researchers and farmers in selecting suitable breeds for breeding programs.

Keywords: breed, male chicken, poultry reproduction, semen, sperm quality

INTRODUCTION

The poultry sector of agriculture plays a major role in both food security and economic development. Efficient reproduction is paramount for the sustainability and profitability of poultry enterprises, whether they are large-scale commercial operations or smaller holder farms prevalent across the nation (FAO, 2020). Successful reproduction in chickens depends heavily on semen quality. High-quality semen, characterized by adequate volume and high concentrations of viable, motile, morphologically normal sperm, supports optimal fertilization, hatchability, and offspring viability. In contrast, poor semen quality reduces fertility, increases the need for repeat inseminations in AI programs, and lowers overall productivity (Blesbois, 2007). Understanding the factors that influence semen quality in different chicken breeds is crucial for optimizing reproductive performance and maximizing the genetic potential of the national poultry stock. Reproductive efficiency

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is a key factor in livestock production, directly influencing genetic improvement, productivity and profitability. Semen quality is a major determinant of fertility in male breeding stock, affecting the success of artificial insemination (AI) and natural mating systems (Ogbu, 2021). Several factors influence semen quality, including genetics, nutrition, management, and environmental conditions. Among these, breed differences play a significant role in determining semen characteristics such as sperm motility, concentration, morphology, and viability (Tesfay *et al.,* 2020).

The White Yaffa, Fulani, Indigenous Yoruba and Noiler breeds are poultry breeds with distinct genetic backgrounds and reproductive traits (Ukwu *et al.,* 2024). Understanding breed effects on semen quality is essential for optimizing breeding programs, improving fertility, and enhancing poultry productivity. Although various studies have assessed reproductive performance in poultry, information on how breed influences semen quality, particularly in White Yaffa, Fulani, indigenous Yoruba, and Noiler chickens, remains limited.

The White Yaffa, a widely adopted commercial layer known for high egg production, is popular in both backyard and commercial systems. While the reproductive performance of females is well documented, semen quality data for White Yaffa males under Nigerian conditions are scarce (Nwajiaku *et al.,* 2021). Noiler is a relatively newer breed specifically developed for dual-purpose (meat and egg) production in smallholder systems in Nigeria. Noiler has been created through selective breeding. Noiler is believed to be a product of genetic selection between the broiler and the native chicken. The Noiler chicken are now popular breed because they are easy to raise and manage. Understanding the semen quality of Noiler males is essential for optimizing their use in breeding programs aimed at improving rural poultry productivity (Etuk *et al.,* 2018). Indigenous Yoruba chickens are locally adapted and genetically diverse, valued for their resilience in the Nigerian environment. Their reproductive physiology, including semen quality, remains understudied and shows considerable phenotypic variation. Yoruba ecotype chickens naturally incubate and hatch their eggs, brood their chicks, and exhibit strong resistance to many poultry diseases. They reach sexual maturity at 133-169 days under extensive systems but grow faster in cages. Egg production is low (40-50 eggs/year), likely due to inadequate balanced nutrition, disease, and social behaviour, making them unsuitable for commercial egg production. Nonetheless, they can still provide reasonable income when raised under intensive or semi-intensive management (Ajibike *et al.,* 2022).

The Fulani breed, commonly associated with nomadic pastoralist communities, is known for its hardiness and distinctive genetic makeup. They are referred to as heavy ecotypes, are found in the Sahel and Guinea savannah parts of Nigeria and the Montane regions of the north. The mature weights are between 0.9kg and 2.5kg (Fayeye *et al.*, 2005). Information on their reproductive characteristics, particularly semen quality is scarce. This gap in knowledge makes it difficult for poultry farmers and breeders to make informed decisions regarding breeding stock selection and management (Hinsemu *et al.,* 2018; Gbigbi and Adaigho, 2025). Therefore, this study investigated effects of breed differences on semen quality focusing on key parameters such as semen volume, sperm motility, sperm concentration and viability.

MATERIALS AND METHODS

Experimental site and duration

The study was conducted at the Poultry Unit of Teaching and Research Farm of Olusegun Agagu University of Science and Technology, located in Okitipupa, Ondo State, Nigeria. Okitipupa is situated within a tropical agro-ecological zone, characterized by average daily temperatures ranging from 70°C to 80°C and relative humidity levels of 60-80%. The study was conducted between January and May in the year 2025, during which environmental conditions was closely monitored to ensure consistency.

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Experimental animals and management

The study made use of 40-day-old male chicks, comprising four breeds Noiler, Yaffa, Fulani ecotype and Yoruba ecotype with 10 birds per breed. The birds were allocated to replicate pens in a completely randomized design. All chicks were sourced from reputable hatcheries and indigenous breeding stations, and only clinically healthy individuals were selected. They were brooded for the first two weeks using standard management practices, including temperature regulation, vaccination, and administration of coccidiostats. Feed and water were provided ad libitum. All birds were maintained under similar housing, lighting, and ventilation conditions throughout the study. At 24 weeks of age, all roosters were housed individually in separate cages under uniform management conditions for the remaining duration of the study. They were provided with adequate feed and clean drinking water.

Experimental diet

All birds were fed by a grower ration (17% crude protein and 3000 kcal/kg ME) from week 6 to 24. Feeds were formulated to meet NRC (2018) standards for indigenous-type chickens. The same diet was used across all treatment groups to minimize dietary variability.

Semen collection

At age 26 weeks, semen was collected from each rooster using the abdominal massage method, adapted from Burrows and Quinn, (1937). Prior to the day of collection, feed and water were withdrawn to prevent fecal and urinary contamination. During collection, care was taken to avoid fecal and urate contamination. Semen was collected into pre-weighed, calibrated sterile tubes to allow for immediate volume determination. Collections were performed at a consistent time of day in the morning between 8:00 and 10:00 AM to minimize diurnal variation.

Semen quality evaluation

Immediately after collection, semen samples were transported to the laboratory within 5-10 minutes and maintained at 25-30 °C to prevent cold shock. Each sample was examined for semen color, volume, pH, odor, viscosity, sperm morphology, motility, viability, and sperm concentration. Semen volume was measured using calibrated micropipettes (Eppendorf Research Plus, 0.1-2.5 mL) and recorded to the nearest 0.01 mL. Semen color was assessed using a standardized color chart (Munsell Soil Color Charts, UK) under consistent lighting conditions. Semen pH was measured with a microelectrode pH meter (Mettler Toledo SevenCompact, USA) that was calibrated daily with standard buffers. Sperm viability and morphology were evaluated using the Eosin–Nigrosin staining technique following the procedure described by Osunkeye *et al*. (2025). Smears were prepared with two drops of nigrosin mixed with one drop of semen and examined microscopically at ×400 magnification (LEICA, Germany). Morphological assessment using Diff-Quik stained smears included evaluation of head defects such as acrosomal loss and misshapen heads, midpiece defects such as bending, swelling, or retained cytoplasmic droplets, and tail defects such as coiling, breakage, or double tails. A total of 200 sperm were evaluated to determine the overall percentage of abnormalities. Sperm motility was assessed by examining fresh, diluted semen under oil immersion at ×1000 magnification. Semen was diluted by mixing 1 mL of semen with 10 mL of normal saline. Motility was classified into four categories, namely fast progressive, slow progressive, non-progressive but vibrating, and non-motile. Fast progressive sperm were those moving rapidly in a forward direction, slow progressive sperm displayed slower forward movement, non-progressive sperm vibrated in place, and non-motile sperm showed no movement despite being alive. Sperm concentration was determined using a hemocytometer and microscopy at × 400 magnification. The concentration was calculated using the formula C= 50,000 × N × D, where C represents the number of sperm per millilitre, N represents the number of sperm cells counted, and D represents the dilution factor.

All data were entered into Microsoft Excel and analyzed using the SAS software package.

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Descriptive statistics (means and standard deviations) were computed. Analysis of variance (ANOVA) was performed to test for significant differences among breed groups ($p < 0.05$), and means were separated using Tukey's test. The breed effect was treated as the main factor in the model:

$$Yij = \mu + Bi + \varepsilon ij$$

Where

Yij = observed value of semen quality parameter

μ = overall mean

Bi = effect of breed

εij = residual error.

All results were interpreted in relation to breed physiology, adaptive traits, and relevant literature benchmarks.

RESULTS

Descriptive statistics of semen quality parameters

Table 1 presents the descriptive statistics for the semen quality parameters of the experimental birds. For each parameter, the mean, standard deviation, sample size (N), minimum and maximum values, and the coefficient of variation (CV) are provided. The mean ejaculate volume was 0.41 mL with a standard deviation of 0.08, ranging from 0.30 to 0.60 mL. The CV was 2.67%, indicating very low variability. The mean semen pH was 7.81, which falls within the normal physiological range for poultry semen (7.0-8.0). The percentage of live sperm cells was high (89.33%), while dead sperm cells averaged 10.67%. Both parameters showed relatively low variation (CV: 2.88% for live, 4.07% for dead), suggesting good semen viability. Normal sperm accounted for an average of 81.92%, while abnormal spermatozoa were just 5.92%. Importantly, the CV for abnormal sperm was relatively high (16.84%). Fast progressive (FP) motility was relatively high (77.67%) with low variation (2.59%), indicating that most sperm were moving forward in a straight trajectory, which is favourable for fertility. Slow progressive (SP) sperm averaged 7.83% with a high CV (33.92%), suggesting considerable individual variation among birds. Non-progressive (NP) sperm averaged 4.58% (CV= 31.49%), while Non-motile (NM) sperm averaged 11.00% (CV= 28.22%). The average sperm count was 1.09 billion/mL, with a wide range (0.10-1.40 billion/mL) and a CV of 31.29%. This parameter appears to be the most breed-sensitive, as sperm output often varies across breeds and individual cocks. Overall, semen quality parameters such as volume, pH, live sperm percentage, normal morphology, and progressive motility showed low variation and consistent values across birds, indicating generally good semen quality.

Table 1 Summary statistics of semen quality parameters

	mean	standard deviation	n	minimum	maximum	coefficient of variation
volume (mL)	0.41	0.08	12	0.3	0.6	2.67
pH	7.81	0.24	12	7.5	8.0	3.08
alive (%)	89.33	2.57	12	85.0	92.0	2.88
dead (%)	10.67	2.57	12	8.0	15.0	4.07
normal (%)	81.92	4.46	12	75.0	86.0	5.44
abnormal (%)	7.41	0.99	12	6.0	10.0	12.84
FP ($\times 10^6$)	77.67	2.02	12	75.0	81.0	2.59
SP ($\times 10^6$)	7.83	2.66	12	5.0	11.0	33.92
NP ($\times 10^6$)	4.58	1.44	12	2.0	6.0	31.49
NM ($\times 10^6$)	11.00	3.10	12	7.0	17.0	28.22
count ($\times 10^9$)	1.09	0.34	12	0.1	1.4	31.29

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Breed effects on semen quantitative parameters

Table 2 shows the effect of breed on semen quality parameters in male chickens. Semen volume varied among breeds, with Noiler producing the highest volume (0.52 mL) and Yoruba ecotype the lowest (0.31 mL), while Fulani and White Yaffa showed intermediate values (0.41 mL each). Semen pH was slightly higher in Yoruba and White Yaffa (8.0) than in Fulani and Noiler (7.6–7.7). For sperm morphology, Fulani cocks recorded the highest proportion of live sperm (91.67%), whereas Noiler had the lowest (85.33%). Consistent with this, Noiler exhibited the highest percentage of dead sperm (14.67%), while Fulani had the lowest (8.33%). Regarding viability, Yoruba and Fulani had the highest normal sperm (85.33%), followed by Noiler (81.67%), and White Yaffa had the least (75.33%). Interestingly, Fulani also showed a slightly higher abnormal sperm compared to others, indicating that although sperm viability was high, some abnormalities were present.

Table 2 Breed effects on semen quantitative parameters

	Yoruba ecotype	Fulani ecotype	White Yaffa	Noiler
volume (mL)	0.31 ± 0.01 ^{c}	0.41 ± 0.01 ^{b}	0.41 ± 0.01 ^{b}	0.52 ± 0.04 ^{a}
pH	8.0 ± 0.00 ^{a}	7.67 ± 0.17 ^{b}	8.0 ± 0.00 ^{a}	7.60 ± 0.10 ^{b}
morphology (%)				
alive	90.33 ± 0.33 ^{b}	91.67 ± 0.33 ^{a}	90.00 ± 0.58 ^{b}	85.33 ± 0.33 ^{c}
dead	9.67 ± 0.33 ^{b}	8.33 ± 0.33 ^{c}	10.00 ± 0.58 ^{b}	14.67 ± 0.33 ^{a}
viability (%)				
normal	85.33 ± 0.33 ^{a}	85.33 ± 0.33 ^{a}	75.33 ± 0.33 ^{c}	81.67 ± 1.67 ^{b}
abnormal	5.33 ± 0.33 ^{b}	7.33 ± 0.33 ^{a}	5.67 ± 0.33 ^{b}	5.33 ± 0.33 ^{b}

Means with different superscripts differ significantly ($p < 0.05$).

Breed effects on sperm motility and count

Table 3 shows effect of breed on sperm motility and sperm concentration. White Yaffa exhibited the highest fast progressive motility (80.33%), followed by Noiler, Fulani, and Yoruba. This means White Yaffa sperm moved faster and more efficiently in the forward direction, which is important for fertilization. Yoruba and Fulani had more slow progressive sperm, while Noiler recorded the highest non-motile sperm (15.67%), which could affect fertility despite having higher semen volume. Lastly, for sperm count, Fulani had the highest concentration (1.33×10^{9}/mL), followed by White Yaffa (1.23×10^{9}/mL) and Yoruba (1.11×10^{9}/mL). The Noiler breed, despite its large semen volume, had the lowest sperm concentration (0.67×10^{9}/mL), which shows its semen was more diluted.

Table 3 Breed effects on sperm motility and count in male chickens

	Yoruba ecotype	Fulani ecotype	White Yaffa	Noiler
motility (%)				
fast progressive	75.33 ± 0.33 ^{d}	76.67 ± 0.33 ^{c}	80.33 ± 0.33 ^{a}	78.33 ± 0.33 ^{b}
slow progressive	10.33 ± 0.33 ^{a}	10.33 ± 0.33 ^{a}	5.33 ± 0.33 ^{b}	5.33 ± 0.33 ^{b}
non-progressive	5.33 ± 0.33 ^{a}	5.33 ± 0.33 ^{a}	5.33 ± 0.33 ^{a}	2.33 ± 0.33 ^{b}
non-motile	10.33 ± 0.33 ^{b}	7.67 ± 0.33 ^{c}	10.33 ± 0.33 ^{b}	15.67 ± 0.67 ^{a}
sperm count ($\times10^{9}$/mL)	1.11 ± 0.01 ^{a}	1.33 ± 0.03 ^{a}	1.23 ± 0.03 ^{a}	0.67 ± 0.23 ^{b}

Means with different superscripts differ significantly ($p < 0.05$).

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The breed effect on qualitative parameters of chicken semen is presented in Table 4. The traits considered here are odor, viscosity, and color, which are important in assessing semen quality before microscopic evaluation. All breeds produced semen with a normal odor. In poultry, semen is expected to have a characteristic but non-offensive odor. The viscosity of semen across all four breeds was normal. There were slight variations in color among the breeds. Yoruba ecotype and White Yaffa semen were milk white, Noiler was also milk white, while Fulani ecotype semen was observed as creamy white.

Table 4 Qualitative assessment of semen characteristics

	Yoruba ecotype	Fulani ecotype	White Yaffa	Noiler
odor	normal	normal	normal	normal
viscosity	normal	normal	normal	normal
color	milk white	creamy white	milk white	milk white

DISCUSSION

The present study demonstrated clear breed-related differences in semen quality among four chicken breeds: Yoruba ecotype, Fulani ecotype, White Yaffa, and Noiler. To our knowledge, this is the first study to simultaneously compare semen quality traits among exotic, hybrid and indigenous breeds within the Nigerian poultry industry. The results revealed that breed had a considerable influence on both the qualitative and quantitative semen parameters.

Semen volume

Noiler cocks produced significantly higher semen volumes (0.52 mL) than the other breeds, followed by Fulani and White Yaffa (0.41 mL each), while Yoruba ecotype had the lowest significant value (0.31 mL). This means Noiler generally produces more semen, probably because of its larger body size and hybrid vigor. This finding suggests that Noiler, being a crossbred (Hybrid) chicken with a larger body size, has a higher testicular capacity and semen output. Similar observations were reported by Adetunji and Ola (2020), who noted that exotic or crossbred chickens often exhibit larger ejaculate volumes than indigenous breeds. However, high semen volume does not necessarily indicate superior fertility, as semen concentration and viability are more critical in determining fertilizing ability.

Semen pH

The pH values ranged between 7.6 and 8.0 across breeds, with Yoruba ecotype and White Yaffa showing slightly higher values (8.0) compared to Fulani (7.67) and Noiler (7.60). Poultry semen is usually slightly alkaline (7.0-8.0), which supports sperm motility and survival (Li *et al*., 2025). Since all the values fell within this normal physiological range, it indicates that none of the breeds experienced pH-related fertility limitations.

Sperm morphology (alive and dead sperm)

Fulani ecotype exhibited the highest proportion of live sperm (91.67%), while Noiler had the lowest (85.33%). Conversely, Noiler had the highest dead sperm count (14.67%), while Fulani had the least (8.33%). This suggests that indigenous Fulani ecotype semen is more viable and of higher quality than that of the crossbred Noiler. Yahaya *et al*. (2025) similarly reported that indigenous chickens often show higher adaptability and reproductive resilience under tropical conditions compared to exotic and crossbred strains.

Sperm viability (normal and abnormal)

Normal sperm percentage was highest in Yoruba and Fulani ecotypes (85.33%), followed by Noiler (81.67%), while White Yaffa had the lowest (75.33%). Fulani ecotype also had slightly highest abnormal sperm (7.33%) compared to the other breeds. This finding aligns with the report of Salisu *et al*., (2018), who observed that some

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indigenous chickens, despite showing high sperm concentration and viability, may also have elevated sperm deformities because of genetic or inbreeding factors within local populations.

Sperm motility

Motility is a crucial parameter because only motile sperm cells can travel through the female reproductive tract to fertilize eggs. In this study, the exotic breed 'White Yaffa cocks' had the highest fast progressive motility (80.33%), followed by Noiler (78.33%), Fulani (76.67%) and Yoruba (75.33%). This indicates that White Yaffa semen has the highest potency for fertilization. Froman and Feltmann (2000) also stressed that sperm motility, particularly progressive motility, is one of the major predictors of fertility in poultry. Noiler showed the highest non-motile sperm percentage (15.67%), which could affect fertility negatively despite its high semen volume. Fulani, on the other hand, had the lowest non-motile sperm (7.67%), further supporting its semen quality advantage. This indicates that indigenous breeds are better adapted for successful fertilization in the tropical conditions.

Sperm count

The Fulani ecotype recorded the highest significant sperm concentration (1.33×10^9/mL), followed by White Yaffa (1.23×10^9), Yoruba (1.11×10^9), and lastly Noiler (0.67×10^9). These results highlight the tendencies of indigenous breeds in producing more concentrated sperm cells compared to crossbred Noiler. Sperm count is critical since it determines the number of viable sperm available for fertilization (Björndahl *et al*., 2016). The low sperm concentration in Noiler suggests diluted semen, which aligns with its higher semen volume but reduced sperm viability.

Qualitative parameters

Across all breeds, semen odor and viscosity were normal, indicating good physiological quality and absence of contamination or infection. Abnormal or foul odor could indicate contamination, infection, or poor semen quality. The fact that all breeds recorded a normal odor suggests that the cocks used for the study were healthy and free from infection or contamination. Breeds slightly affect color variation with Yoruba, White Yaffa and Noiler producing milk-white semen, while Fulani ecotype produced creamy-white semen. The semen colors fall within the normal range (creamy to pearly white) as described by Miranda (2018) which is in line with semen of good fertilizing ability. Normal viscosity is essential because overly thick semen can hinder sperm motility, while watery semen may suggest low sperm concentration. The uniformity across breeds indicates that viscosity was not adversely affected by breed differences.

Comparison and implications

The indigenous breeds (Fulani and Yoruba ecotypes) showed higher sperm concentration and viability, while White Yaffa excelled in motility. Noiler, despite having the highest semen volume, showed lowest semen concentration, higher sperm mortality, and reduced motility efficiency. These findings confirm that breed significantly affects semen quality traits, and the choice of breed should be carefully considered in poultry breeding and AI programs.

CONCLUSIONS

The results of this study show that breed strongly influences semen quality in adult male chickens in tropical environments. Noiler produced the highest semen volume but had reduced sperm concentration, viability and motility. Fulani ecotype exhibited the highest sperm viability and concentration, White Yaffa had the strongest motility, and Yoruba ecotype showed moderate performance with lower semen volume. These findings indicate that indigenous breeds, particularly Fulani and Yoruba ecotypes, are well suited for breeding programs in the tropics, while White Yaffa's strong motility supports its use in fertility improvement and AI. Noiler may require genetic or management interventions to enhance reproductive potency. Breeding programs should prioritize indigenous breeds to promote fertility and sustainable poultry production, and selective breeding in

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Noiler should target improved sperm concentration and motility. White Yaffa and Fulani cocks appear promising for semen collection and AI.

APPROVAL OF ETHICAL COMMISSION

This research project was approved for execution by the ethical committee of the Olusegun Agagu University of Science and Technology, Okitipupa, Ondo state, Nigeria before its commencement. All protocol used followed the ethical guidelines laid down by the University.

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AUTHOR CONTRIBUTIONS

Olubisi Oluseun Oyeleye (OOO), Adelani Abayomi Adeoye (AAA), Thomas Ayodele Fatoba (TAF).

OOO and TAF: management of the experimental animals, data collection and management, AAA: Data analysis and interpretation, OOO: Conceptualization, design of the experiment, writing of the manuscript, visualization, manuscript review and final approval. All authors read and approved the final manuscript.

CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

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