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Assessment of Broiler Breeder Cocks Under Selection for Semen Quality as Influenced by Age and Body weight Changes

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***Target Audience:** Animal Breeders/Researchers, Broiler Hatchery/Companies.*

Abstract

The study was conducted to assess the semen quality characteristics of broiler breeder cocks under selection at young (22 - 29weeks) and adult (30 - 40weeks) ages in a pedigreed population. Data were collected on a weekly interval for body weight and semen quality characteristics (sperm volume, semen colour, sperm motility, semen pH, sperm concentration and live cell) and semen morphological defects (detached head, coiled tail, bent tail and full head) and were analyzed using the SAS statistical package. Sequel to semen collection, body weights of each cock were taken and recorded. Results obtained for body weight at the two age groups showed a significant ($p < 0.05$) difference with the adult cocks been heavier as the age advanced. The semen quality showed a highly significantly ($p<0.01$) difference at all ages with the exception of live cells for the adult breeder cocks' group where the trait showed no significant ($p>0.05$) difference across weeks. The semen morphological defect of young breeder cocks showed a progressive significant ($p<0.01$) increase with the highest defect of 21.20% at 27 weeks, while for the adult cocks, the highest defect was recorded at 30 weeks with 23% defect. It can therefore be recommended that for optimum reproductive performance of the broiler breeder cocks under selection, cocks should be introduced into hen pens or used for artificial insemination at about 26weeks of age under favourable conditions that promote optimum quality semen, which can enhance fertility and hatchability for pedigree hatching.

***Keywords:** Age, Body weight, Broiler Breeder cock, Semen quality.*

Description of problem

It is of essence that the reproductive abilities of the broiler breeder cock and those of other poultry species be routinely monitored. This is so because in the poultry industry, there are no breeding soundness evaluations *per se* and also due to fertility challenges sometimes faced on breeder broiler flocks (1). The assessment of semen quality characteristics of poultry gives an excellent indicator of their reproductive potential and is a major determinant of fertility and subsequent hatchability of eggs (2). Also, the production of hatching eggs is the primary goal of a broiler breeding industry and so semen quality is vital to the industry due to its effect on fertility and eventual hatchability of the eggs (3).

Cocks are most times selected based on physical characteristics of comb and wattle size and colour as well as over-all body size and shank length (4), which are associated with reproduction. Males that are underweight or that have bad legs or any other form of deformities are culled and not used for breeding purposes. However, with the bad leg, some could be reproductively sound for artificial insemination programs. Nevertheless, (4) showed that physical characteristics are not strong and efficient

predictors of male fertility. (5) explained that for best results in artificial insemination in poultry, breeders need to ensure the highest quality of collected semen. This is achievable prior to or during hen-house placement as the semen characteristics of broiler breeders can be evaluated and cocks with possibly better semen quality be used. According to (6), semen evaluation tests can be a valuable tool in the management of roosters or toms. (7) is of the view that the main objective of evaluating semen quality should be to predict the fertility of an individual male.

The semen quality of chicken is influenced by a number of factors like age, strain, feed and ambient temperature (8) while (9) reported the influence of breed and age on the quality of fresh and stored semen in broiler breeder cocks. It was reported on age factor that the semen quality of indigenous roosters and broiler (10) and pedigreed lines (11) have high semen motility in younger chickens. However, in older turkey birds significantly lower motility, viability and mass movement have been reported (12). The report of (13) stated that broiler breeder cocks are placed on feed restriction so as to achieve body weights targeted at high and persistent semen quality and quantity resulting in high fertility. Also, restriction prevents incidence of cocks being overweight and are not able to mount the breeder hens. There is dearth of information on semen quality traits of young and adult pedigreed grandparents' broiler cocks under selection. This study was carried out with the objective of evaluating the semen quality characteristics of broiler breeder cocks under selection at young and adult age.

Materials and Methods

Experimental site

The research was conducted at the Poultry Breeding Unit of Poultry Research Programme, National Animal Production Research Institute (NAPRI) Shika, Zaria. Shika is located in the semi-arid, Northern Guinea savanna zone of Nigeria within latitude 11°8'N and 07°4'E with an elevation of 2178 feet (663.77 meters) above sea level (14). The average annual precipitation is 1,100mm, which spreads from late April or early May to mid- October, with a peak between June and September while the temperature varies from 27^{o}C to 35^{o}C depending on the season. Detailed description of Shika climate has been given elsewhere by (15).

Experimental birds and management

A total of thirty (30) pedigreed cocks were examined irrespective of the selection line on their semen quality characteristics for this experiment at a weekly interval for the study. The birds were on a feed restriction programme according to the breeders' guide as they would be the parents of the next generation. The cocks were on breeder diet with crude protein of 15-16% and metabolizable energy of between 2750-2800kcal/kg. They were housed in the open-sided type of housing system with a deep litter floor pen using wood shavings. Water was given *ad libitum*. The cocks were given preliminary training to produce semen prior to actual semen collection. This was considered essential for effective semen collection and to familiarize the cocks with the semen collector and process.

Semen collection and evaluation

A total of 570 semen ejaculate samples were collected from the 30 pedigreed cocks by the abdominal massage method as described by (16). The collections were done between the hours of 08:00am and 10:00am every collection day. The cocks responded to the massage by aversion of the cloaca, and semen was collected into a collection tube.

Individual ejaculate sample were collected into a 1.5ml graduated rubber tube to record the volume of the semen. During collection, all the semen tubes were maintained at about 37-40ºC in a warm water bath. The samples were subjected to microscopic examinations and physical evaluations in which the semen volume was recorded to the nearest 0.1ml while the colour was visually observed from the transparent tube and expressed as creamy, milky or consistency, and scored as 1, 2 or 3 respectively as described by (17). The sperm motility was expressed as the percentage of motile sperm with moderate to rapid progressive movement done immediately after each sample collection. The semen pH was obtained using the pH meter strip. Colour change on the strip was read using the pH meter (Chemo craft®) as indicated by the manufacturer and then recorded.

The sperm abnormalities were obtained using stained slides from each of the semen samples. The stained slides were prepared using the eosin-nigros stain technique as described by (18). The percentage dead sperm cell was calculated from the stained slides as described by (19). The slide was viewed under the light microscope at x400 magnification and 100 sperm cells were counted per slide for both live and dead spermatozoa. The dead sperm cells were stained with the eosin dye while the live cells repelled the stain. This was repeated to ensure accuracy and the average was taken. Sperm abnormalities were studied from the stained slides under the light microscope at x1000 magnification using the oil immersion. Concentration of the spermatozoa was determined as described by (20). The cells were counted using haemocytometer, diagonally from top left to right bottom in 5 large squares from the 25 large squares. The concentration of sperm per ml was found using the formula:

$$\mathbf{C = 50{,}000 \times N \times D}$$

Where: C = concentration of sperm per volume (ml), N= Number of spermatozoa counted,
D = Dilution rate.

Data collection and statistical analysis

Weekly data were collected from 22 – 40weeks of age on the body weight, semen quality characteristics (sperm volume, semen colour, sperm motility, semen pH, sperm concentration and live cell) and morphological defects (detached head, coiled tail, bent tail and full head) of the broiler breeder cocks. The body weight of individual cock was taken weekly using the Camry top loading sensitive scale with sensitivity of 0.1g. The semen output were analyzed to obtain the effect of body weight and age effect on the semen characteristics. The collected data were subjected to Analysis of Variance (ANOVA) of (21) while the differences between means were separated using the Duncan Multiple Range Test (22). Below is the linear statistical model used:

$$\mathbf{Y_{ij} = \mu + A_i + e_{ij}}$$

Where:
Y_{ij} = is the single observation on the i^{th} age on the j^{th} random residual error, μ = overall population mean, A_i = is the fixed effect of the i^{th} age of the cocks (i=22, 23, …., 40weeks), e_{ij} = random residual error.

Results and Discussions

The result on effect of age group on semen quality characteristics of broiler breeder cocks under selection is presented in Table 1. The body weight showed significant ($p<0.05$) difference across all ages. The semen quality traits had a highly significantly ($p<0.01$) difference at all ages with the exception of live cells for the adult age groups where no significant ($p>0.05$) difference was recorded. The highest sperm

volume between the two groups was recorded at 26weeks (0.60mls) and 38weeks (1.10mls), highest sperm motility was at 26weeks (90%) and 37weeks (85.10%) and highest sperm concentration was at 26weeks ($367.5x10^6$) and 36weeks ($246\ x10^6$). Observation showed that body weight progressively increased as age advanced and this was expected. This agrees with the report of (23) who reported a linear increment in body weight with increasing age in two strains of chicken. (3) reported body weight of 4.73kg which is similar to those of this study for the adult breeder cocks from 34weeks of age in the same breed of birds. Body weight affected the semen quality traits by improvement in the semen quality from 26weeks as age increased, implying that heavy poultry species like the broiler birds possess larger testes and produce more sperm cells during spermatogenesis (24) and resulting in higher sperm volume and sperm concentration (24; 25). This agrees with the report of (23) who reported a positive body weight influence on sperm volume, sperm concentration and sperm motility but not on sperm volume and semen pH in Norfa chickens and also with those of (26) who reported a significant effect of body weight on sperm concentration and sperm motility but not on semen pH in two local strains of chickens. It was also reported by (26) that the heavy weight had the advantage of high sperm concentration but sperm motility was to the advantage of the light weight group. This is in line with this report as sperm concentration and sperm motility where the heavier weight cocks were better in these traits.

Age difference had been reported to affect sperm concentration and sperm motility but not sperm volume and semen pH while season (hot or cold) affected sperm volume, sperm concentration, sperm motility and semen pH (26). The result on sperm volume found in this study (0.34 – 1.10mls) is higher than 0.55mls obtained by (3) in the same genetic birds and with the ranges of 0.34 - 0.59ml reported by (27) on broiler breeder cocks. However, in this study the sperm volume at the early ages was fluctuating but at later advanced ages, it increased above the initial quantity likened to body weight, age and other possible factors.

There is dearth of information on weekly age differences for semen colour in broiler breeder cocks under selection. However, from this study significant effect on semen colour which improved from milky to creamy as the age of the birds increased seems to agree with those of (28) who reported similar values of semen colour in three indigenous cock types in the semi-arid zone of Nigeria as affected by season but lower when genotype effect was considered. Age has been reported to have a deteriorative effect on semen colour in White Leghorn breeder cocks (29), naked neck and dwarf genetic lines (30) which is not in agreement with those of this current study as the semen colour was still improving till 40weeks of age. These differences are likened to a more advanced age, breed difference, season or presence of contaminants.

The range recorded for sperm motility (46.25 – 90%) in this study is similar with those of (3) who used similar genetic cocks and obtained 83.5%. Also, these results are comparable with those of (18) who reported a range of 70 - 87.35% in different strains of chickens. (32) reported 74.5 - 85.67% in Iranian broiler breeder chickens but higher than 73.9% reported by (33) in local breeder cocks while (24) reported a range of 68.97 – 75.21% in White layer sire lines. The result of this study shows a similarity with those of (29) at 32weeks with sperm motility of 84.28% although this study did not consider

a further age as those of (29) with 58.97% sperm motility at 64weeks. The semen pH recorded in this result is slightly alkaline and similar to the report of (3), (34) and (33) who reported semen pH of 7.40, 7.54 and 7.80 in Hubbard breeder cocks, Denizli cocks and Nigerian local breeder cocks, respectively. The sperm concentration recorded in this study fell in the range of 3.40-9.70 billion/cc as reported by (27) and that of 4.3 billion sperm/ml obtained by (35) in broiler cocks but lower than the 6.6 billion sperm/ml reported by (10) on Ross broiler breeder. These differences in values for the cocks used in this study with those reported in other literatures can been attributed to their genetic background or origin, environment and their natural tendencies. The live cell ranges recorded in this study are lower than those of (36) who obtained livability of between 89.33 – 90.30% in similar ages (36 – 44weeks) in Bronze turkey toms and also with those of (29) who recorded live sperm range of 80.91 -83.49% at 32weeks, although their report at advanced age (64weeks) in the range of 64.56 – 69.63% is in comparative with that from this study. Also, this result agrees with the report of (37) who reported 69.61% in pigeons.

Table 1: Effect of age groups on semen quality characteristic of broiler breeder cocks under selection

				Young cocks Traits			
Age	**Bwt (g)**	**SV (ml)**	**SC**	**SM (%)**	**Semen pH**	**S.Conc** ($x10^6$)	**Live cells (%)**
22	2580.11^{d}	0.43^{b}	2.00^{b}	46.25^{c}	8.20^{b}	113.9^{c}	53.0^{b}
23	3037.50^{c}	0.35^{c}	2.16^{b}	50.00^{c}	8.33^{b}	139.1^{c}	50.83^{b}
24	3112.07^{c}	0.47^{b}	2.00^{b}	68.12^{b}	8.00^{b}	193.3^{b}	64.37^{b}
25	3197.40^{c}	0.44^{b}	1.70^{ab}	71.50^{ab}	7.48^{a}	185.0^{b}	66.0^{b}
26	3305.60^{b}	0.60^{a}	1.28^{a}	90.00^{a}	7.00^{a}	367.5^{a}	88.57^{a}
27	3841.00^{ab}	0.44^{b}	2.07^{b}	65.38^{b}	7.00^{a}	183.0^{b}	67.30^{b}
28	3936.29^{a}	0.40^{b}	2.00^{b}	61.36^{b}	7.90^{ab}	212.0^{b}	61.36^{b}
29	4056.09^{a}	0.49^{b}	1.96^{b}	70.40^{b}	7.51^{a}	201.7^{b}	65.10^{b}
SEM	54.80	0.38	0.02	10.96	0.44	14.30	14.12
P-value	0.04	0.01	0.001	0.001	0.01	0.01	0.05
				Adult cocks			
30	4220.32^{d}	0.39^{cd}	1.66^{b}	78.16^{ab}	7.08^{a}	179.3^{c}	77.91^{ns}
31	4430.60^{c}	0.50^{c}	1.23^{a}	75.38^{b}	6.84^{b}	221.6^{a}	75.38^{ns}
32	4597.12^{c}	0.46^{c}	1.08^{a}	84.16^{a}	7.08^{a}	220.1^{a}	84.16^{ns}
33	4658.54^{c}	0.38^{cd}	1.45^{b}	70.80^{b}	7.10^{ab}	230.5^{a}	73.50^{ns}
34	4721.09^{bc}	0.28^{d}	1.00^{a}	84.38^{a}	7.00^{a}	171.7^{c}	73.15^{ns}
35	4793.41^{b}	0.34^{d}	1.07^{a}	80.00^{a}	7.14^{ab}	202.6^{b}	77.50^{ns}
36	4863.57^{b}	0.34^{d}	1.08^{a}	70.83^{a}	7.33^{d}	246.0^{a}	73.50^{ns}
37	4823.41^{b}	0.57^{c}	1.20^{a}	85.10^{a}	6.97^{a}	234.5^{a}	75.10^{ns}
38	4885.22^{b}	1.10^{a}	1.74^{b}	82.50^{a}	7.11^{ab}	200.1^{b}	73.80^{ns}
39	5007.02^{a}	0.85^{b}	2.02^{c}	75.80^{b}	7.20^{c}	150.5^{cd}	73.01^{ns}
40	5090.91^{a}	0.90^{b}	1.98^{c}	74.20^{b}	7.18^{c}	155.7^{cd}	73.20^{ns}
SEM	58.24	0.15	0.16	3.50	0.03	16.50	5.50
P-value	0.05	0.01	0.001	0.011	0.001	0.001	0.11

^{abcd} = Means with different superscript within the same column differ significantly ($p<0.01$), Bwt = Body weight, SV = Sperm volume, SC = Semen colour, SM = Sperm motility, Sperm concentration, ns = non-significant, SEM = Standard error of mean

Table 2 shows the effect of age on semen morphology of broiler breeder cocks under selection. The semen morphological defect of young cocks showed a progressive significant ($p<0.01$) increase with the highest defect of 21.20% at 27week then with a drop at 28 and 29weeks respectively. In the adult cocks, significant ($p<0.01$) difference were recorded in the different ages with the highest defect recorded at 30weeks with 23% defects. There is dearth of literature on age effect and segments of the sperm on semen morphology of broiler breeder cocks. However, the report of (38) on semen defect in naked neck and feathered chicken was of 10.17 – 16.58% are in the range of the study however, (29) had a much lower abnormal sperm of 5.64 – 6.04% (32weeks) and 9.68 – 10.24% (64weeks) in two strains of White Leghorn cocks. Also, the overall defect from this study is higher than those of (36) who recorded lower deformity of 9.67 – 10.73% between 36-44weeks of age in Bronze turkey. The low value recorded for semen morphological defect of the broiler breeder cocks might be due to the environmental effect as at the time of the research or the rearing house of the cocks. (30) reported that when male breeder cocks are raised under open-sided houses, both age of birds and environmental factors either alone or in combination influence the semen quality characteristics and for this study it affected it positively by the birds having a low sperm defect.

Table 2: Effect of age groups on semen morphology of broiler breeder cocks under selection

Young cocks					
Age (weeks)	**Head segment**	**Tail segment**			
	Detached head	**Coiled tail**	**Bent tail**	**Full tail**	**Over-all**
22	6.3^{c}	1.5^{a}	4.0^{b}	1.7^{a}	13.50^{ab}
23	3.6^{a}	3.5^{b}	5.0^{c}	4.3^{b}	16.40^{b}
24	2.8^{a}	3.8^{b}	3.0^{a}	3.0^{ab}	12.60^{a}
25	3.0^{a}	3.5^{b}	3.1^{a}	3.2^{ab}	12.80^{a}
26	3.4^{a}	2.1^{a}	2.7^{a}	1.5^{a}	9.70^{a}
27	8.0^{c}	4.3^{c}	4.4^{b}	4.9^{b}	21.20^{c}
28	4.5^{b}	3.9^{b}	4.0^{b}	1.9^{a}	14.30^{b}
29	4.1^{b}	3.7^{b}	3.9^{b}	0.8^{a}	12.50^{a}
SEM	1.99	0.80	0.50	1.12	3.01
P-value	0.05	0.041	0.09	0.05	0.04
Adult cocks					
30	6.9^{c}	4.2^{c}	6.4^{c}	5.5^{ns}	23.0^{b}
31	4.3^{a}	2.0^{a}	3.3^{b}	3.3^{ns}	12.9^{a}
32	5.7^{b}	3.8^{b}	2.1^{a}	4.9^{ns}	16.5^{a}
33	6.4^{c}	3.2^{ab}	2.4^{a}	4.0^{ns}	16.0^{a}
34	7.0^{c}	2.46^{a}	3.2^{b}	4.2^{ns}	16.86^{a}
35	6.2^{c}	2.42^{a}	2.3^{a}	3.4^{ns}	14.30^{a}
36	4.1^{a}	2.41^{a}	2.8^{a}	3.8^{ns}	13.11^{a}
37	4.0^{a}	2.70^{a}	2.5^{a}	4.7^{ns}	13.90^{a}
38	4.5^{a}	3.0^{a}	1.7^{a}	4.3^{ns}	13.50^{a}
39	5.7^{b}	2.8^{a}	2.0^{a}	4.0^{ns}	14.50^{a}
40	6.2^{c}	1.5^{a}	2.1^{a}	4.4^{ns}	14.20^{a}
SEM	0.5	0.98	0.8	1.18	3.55
P-value	0.03	0.01	0.01	0.14	0.01

^{abc} = Means with different superscript within the same column differ significantly ($p<0.01$), ns = non- significant, SEM = Standard error of mean

Conclusions and Applications

1. The broiler breeder cocks used for this study reveals that at about 26weeks of age the semen quality traits were ideal for fertility under favourable conditions and it could be earlier. However, the study did not go beyond the 40weeks of age to ascertain the age at which the breeder cocks might not be good for breeding purposes.
2. The semen of the breeder cocks can be used for either natural mating or artificial insemination purposes with a view of the low semen defects at most ages.

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