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Relationship of Body Weight, Testes Biometry and Sperm Production in Broiler Breeder

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ABSTRACT The objective of this study was to elucidate the basis for the difference in sperm production of broiler breeders. Nine sexually mature Hubbard broiler breeder males, 35 weeks of age, were trained for two weeks for semen collection on alternate days by abdominal massage technique. Following the training, the breeder males were collected daily for five successive days. The males were then classified as low or high sperm producers. The mean body weights of individual males were also recorded on the basis of body weight at the start and end of the experiment. Immediately after last collection the males were slaughtered and testes biometry was determined. Daily sperm output of individual males varied from 0.21×10^9 to 2.64×10^9 sperm. The daily sperm production of low sperm producer males was lower (0.47 ± 0.13 vs. $2.06 \pm 0.20 \times 10^9$; $P < 0.05$) than high sperm producer males. Testes weight of low sperm producer males was lower (6.32 ± 1.6 vs. 20.33 ± 4.76 gm; $P < 0.05$) than high sperm producer males. Moreover the testis weight of high sperm producer males was 3.22 times higher than low sperm producer males. The average body weight of high sperm producer males was higher ($4,389 \pm 116.3$ vs. $3,960 \pm 131.77$ gm; $P > 0.05$) than low sperm producer males. The correlation coefficients indicate significantly positive correlation of body weight ($P < 0.05$) and testes weight ($P < 0.01$) on semen volume, sperm concentration and daily sperm production.

(Key words : body weight, broiler breeder male, correlation, sperm, testes)

INTRODUCTION

In poultry, reproductive efficiency of breeder flock is of great importance in exploiting the advanced genetic stocks. Selection pressure for economically important, heritable traits can be increased by increasing reproductive efficiency, thereby improving progeny performance. The reproductive efficiency of broiler breeder males in the artificial insemination program is synonymous with semen yield. Lake (1962) summarized the results from different authors and showed a wide variation in semen quality of different poultry breeds. Normally cock semen volume varies from 0.2 to 0.5 mL with concentration of 3×10^9 sperm/mL (Predoievic, 2001). According to Sexton (1983), semen production in cocks is affected by factors such as genotype, photoperiod and diet. In an environment where adequate feed and water are provided under a constant photoperiod, daily sperm production of the cock is constant (Etches, 1996). Furthermore, the ejaculate volume varies appreciably among males. Similar observations have also been reported for turkey semen (Cecil and Bakst, 1984 Froman and Engel, 1991). The disparity in semen quality is an enigma in that such males are generally of similar genotype and have been reared under identical conditions.

Within the reproductive system, the size or weight of testes is indicative of the gonad mass involved in the sperm production. Stenova et al. (1987) reported a positive correlation between testes weight and semen production in different lines of poultry. Various characteristics of semen quality i.e., volume, color and sperm concentration also correlate positively with body weights (Ramamurthy et al., 1986). The objectives of this study were to correlate semen quality, testes weight and body weight of males of the same line, in the same age group and under the same regimen; and also to evaluate whether variation in sperm production is due to testes size and body weights disparity or response of individual males to manual stimulation.

MATERIALS AND METHODS

1. Experimental Birds

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Nine sexually mature broiler breeder males (Hubbard Broiler Breeder) aged 35 weeks, reared as per breeders guidelines were randomly selected from a farm. The males were housed individually in deep littered, single floor pens measuring 3 × 4 ft. Each bird was kept in isolation and screened-out from the others. Each bird was given 125 gm commercial non-medicated broiler breeder feed per day containing CP and ME levels of 14% and 2,700 kcal/kg, respectively. All the birds were reared under identical management conditions, and were subjected to 16 hours light (16L: 8D), using controlled light. Room temperature was controlled between 18 and 21℃ using gas heaters. Proper ventilation and fresh clean water was provided in the room round the clock throughout the experimental period.

2. Semen Collection and Evaluation

Ten days following their selection, the males were trained for semen collection by the abdominal massage technique (Burrows and Quinn, 1937). Semen was collected on alternate days during the training period. After the training period, the live body weight and daily sperm output of individual birds was recorded. Then, semen of each bird was collected daily into a separate plastic tube for five consecutive days. Semen volume was measured in micro liters (μL) by micropipette and the concentration was determined using Neubauer haemocytometer with 1:500 distilled water dilution rate. Daily sperm yield was calculated as semen volume x concentration. On an average, the broiler breeder males which produced less than one billion sperm daily (over a period of five days) were classified as low sperm producer males (n = 4) and those which produced more than one billion sperm daily were classified as high sperm producer males (n = 5). After five successive readings of daily sperm production the live weight of each bird was once again recorded and average live weight of each bird was calculated.

At the end of the experiment, the birds were slaughtered; their testes were removed and weighed on an electrical balance. The length (distance from cranial border to caudal border), width (from attached portion to free border) and thickness (from medial surface to the lateral surface) of each testis were measured in cm with a vernier caliper. The volume of each testes was calculated as length × width × thickness.

3. Statistical Analysis

The data were subjected to ANOVA using the computer based programme "Statistical Package for Social Sciences (SPSS) version 10.0." The differences among means were tested by Fisher's protected Least Significant Difference (Steel and Torrie, 1982). The correlations among testis weight, testis volume, body weight, daily sperm output, semen volume and sperm concentration were evaluated by applying the Pearson correlation test. The Paired Student's *T*-test was applied to evaluate the difference between right and left testis biometry. The data of high sperm producer males and low sperm producer males were subjected to the Unpaired Student's *T*-test to evaluate difference between them. Data are presented as mean ± SEM, $P < 0.05$ was considered as significant and $P < 0.01$ as highly significant.

RESULT AND DISCUSSION

Semen volume, sperm concentration and daily sperm production of individual males varied from 112 ± 15.30 to 420 ± 51.48 μL, 1.91 ± 0.20 to 6.21 ± 0.61 × 10^9 sperm/mL and 0.21 ± 0.03 to 2.64 ± 0.65 × 10^9 sperm, respectively (Table 1).

Table 1. Characteristics of ejaculates collected from individual broiler breeder males[1]

Bird #	Semen volume (μL)	Sperm concentration (× 10^9/mL)	Daily sperm production (× 10^9 sperm)
1	350 ± 78.68^{a}	6.21 ± 0.61^{a}	2.13 ± 0.52^{ac}
2	308 ± 16.55^{ac}	5.28 ± 1.21^{a}	1.59 ± 0.32^{ad}
3	136 ± 19.39^{b}	2.32 ± 0.31^{bc}	0.30 ± 0.04^{b}
4	390 ± 48.48^{a}	5.65 ± 0.62^{a}	2.28 ± 0.49^{ac}
5	314 ± 27.31^{ac}	5.43 ± 1.08^{a}	1.66 ± 0.28^{acd}
6	420 ± 51.48^{a}	6.05 ± 1.11^{a}	2.64 ± 0.65^{c}
7	216 ± 29.26^{bc}	2.96 ± 0.60^{bc}	0.71 ± 0.23^{bd}
8	154 ± 16.00^{b}	4.38 ± 0.53^{ac}	0.66 ± 0.08^{bd}
9	112 ± 15.30^{b}	1.91 ± 0.20^{b}	0.21 ± 0.03^{b}
Mean	266 ± 20.20	4.47 ± 0.33	1.35 ± 0.17

[1] Data shown are mean ± SEM(n = 5).

[a~d] Denote difference($P < 0.05$) within columns.

These results in cocks partly confirm the findings of previous studies in turkeys that the ejaculate volumes, sperm concentration/ml and daily sperm production varied within a flock among individuals (Cecil and Bakst, 1984; Froman and Engel, 1991).

The average values for testicular length, width and thickness were 3.65 ± 0.16, 2.00 ± 0.13 and 1.53 ± 0.12cm, respectively (Table 2). These results are in agreement with those reported by Suchy et al. (1988). In seven out of nine males, the right testes weighed less than the left testes thus making the average right testis weight (6.66 ± 1.64 gm) less ($P < 0.05$) than left testis weight (7.45 ± 1.94 gm). The volume of paired testes was 26.28 ± 6.43 cm^3. The difference in average values of left and right tsetse's volume was 0.8 cm^3($P > 0.05$).

Table 2. Testicular biometry of broiler breeder males at 40 weeks of age[1]

Character	Right testis	Left testis	Both testis
Weight(gm)	6.66 ± 1.64[a]	7.45 ± 1.94[b]	14.11 ± 3.58[*]
Length(cm)	3.73 ± 0.20[a]	3.58 ± 0.25[b]	3.65 ± 0.16[**]
Width(cm)	1.93 ± 0.18[a]	2.07 ± 0.18[b]	2.00 ± 0.13[**]
Thickness(cm)	1.52 ± 0.17[a]	1.55 ± 0.17[a]	1.53 ± 0.12[**]
Volume(cm^3)	12.74 ± 2.97[a]	13.54 ± 3.49[a]	26.28 ± 6.43[*]

[1] Data shown are mean ± SEM (n = 9).
[*] Aggregate values.
[**] Average values.
[a,b] Denote difference ($P < 0.05$) within rows.

Table 3. Correlation coefficients (r) among testes weight (TWT), testes volume (TVL), daily sperm production (DSP), semen volume (SVL) and sperm concentration (Conc).

Parameters	*r* value
TWT and TVL	0.999**
TWT and DSP	0.821**
TWT and SVL	0.794*
TWT and Conc	0.710*
TVL and SVL	0.798**
TVL and Conc	0.707*
SVL and Conc	0.902**

* $P < 0.05$, ** $P < 0.01$.

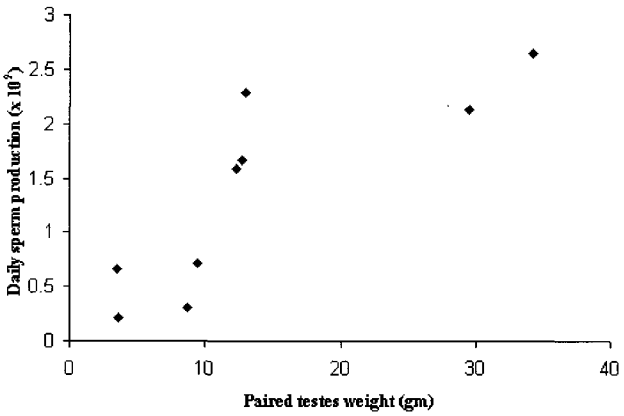

Fig. 1. The relationship between testes weight and daily sperm production in nine breeder males.

Table 3 shows a significantly positive correlation ($P < 0.01$) between testis weight, testis volume ($r = 0.999$) and daily sperm output ($r = 0.821$). In Fig. 1, a positive relationship of testes weight with daily sperm output is shown. Comparable results on these parameters were reported in broiler males by Moller (1988) and Wilson et al. (1988), who observed that sperm number per ejaculate increased with testis weight. Semen volume and concentration showed a significantly positive correlation ($P < 0.05$) with testis weight and testis volume (Table 3). Similar findings have been reported by Konopleva (1987), Stenova et al. (1987) and Moller (1988). Fig. 2 and Table 3 shows significant positive correlation ($r = 0.902$; $P < 0.01$) between semen volume and sperm concentration of individual birds.

Table 4 shows that the testis weight of low sperm producer

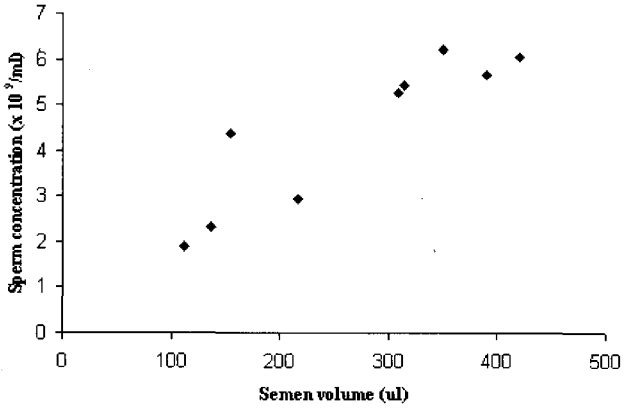

Fig. 2. The relationship between semen volume and sperm concentration in nine breeder males.

Table 4. *Body weight, testis weight and daily sperm production* of broiler breeder males characterized as low or high sperm producers[1]

	High sperm producer males(n = 5)	Low sperm producer males(n = 4)
Body weight(gm)	4,389.70 ± 116.30[a]	3,960.67 ± 131.77[a]
Testes weight[2](gm)	20.33 ± 4.76[a]	6.32 ± 1.60[b]
Daily sperm production($\times 10^9$)	2.06 ± 0.20[a]	0.47 ± 0.13[b]

[1] Data shown are mean ± SEM.
[2] Left and right testis.
[a,b] Denote differences within rows($P<0.05$).

males was lower than high sperm producer males (6.32 ± 1.6 vs. 20.33 ± 4.76 gm; $P < 0.05$). Moreover the testis weight of high sperm producer males was 3.22 times higher than low sperm producer males (Table 4). However, when same values were calculated for daily sperm production, it was found that high sperm producer males ($2.06 \pm 0.20 \times 10^9$) have 4.38 times higher values than low sperm producer males ($0.47 \pm 0.13 \times 10^9$). Therefore, the difference in testicular weight alone does not seem to account for the difference in sperm production.

It has been reported (Ramamurthy et al., 1986; Wilson et al., 1988; Omeje and Ude, 1998; Zhang et al., 1999) that body weight gain is necessary to optimize semen production in broiler males. The results in Table 5 represent a significantly positive correlation of body weight with daily sperm production, semen volume and sperm concentration ($P < 0.05$). The correlation of body weight and testes weight was also positive but non significant ($r = 0.565$; $P > 0.05$). However, these results are not in agreement with those of Wilson et al. (1988), who reported a highly significant positive ($P < 0.01$) correlation of body weight with testes weight.

Table 5. Correlation coefficients (r) among body weight (BWT), testes weight (TWT), daily sperm production (DSP), semen volume (SVL) and sperm concentration (Conc)

Parameters	r value
BWT and TWT	0.565
BWT and DSP	0.787*
BWT and SVL	0.786*
BWT and Conc	0.721*

*$P < 0.05$.

In our study, high sperm producer cocks had healthy looks and their combs (visible) and wattles were more reddish and shiny in color than poor sperm producer males. The combs of the experimental birds had been burned for administrative purposes at the farm. So the correlation of the combs could not be properly determined. In relation to wattles it was also observed that high sperm producer cocks had larger wattles than low sperm producer males. These observations are supported by the findings of Suchy et al. (1997), who reported that hematological parameters (hemoglobin concentration, erythrocyte count and haematocrit) were positively correlated with gonad weight, measurements and sperm concentration.

In conclusion, the correlation coefficients indicate a significantly positive correlation of body weight ($P < 0.05$) and testes weight ($P < 0.01$) on semen volume, sperm concentration and daily sperm output. However, the relationship between body weight and testes weight is not significant ($P > 0.05$). Thus, testes weight has a significant influence on daily sperm production.

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