ISSN 1682-8356
ansinet.org/ijps

INTERNATIONAL JOURNAL OF

POULTRY SCIENCE

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International Journal of Poultry Science 7 (3): 207-210, 2008
ISSN 1682-8356
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Effects of Early Maturation on Growth, Fertility and Testosterone Levels in Broiler Breeder Males

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Abstract: A study was conducted determine the feasibility of rearing broiler breeder males to an earlier age of sexual maturation. Three hundred Ross males were divided at 3 weeks of age into three treatments and four reps. Control birds (CD) were fed a normal 15% grower diet and an increased photoperiod began at 22 weeks of age. The fast growth (FG) birds were divided into 2 treatments; high protein (HP) birds were fed a 20% grower diet and normal protein (NP) birds were fed the control diet. FG males were raised to the breeder guideline recommend 22 wk target body weight by the age of 16 weeks, at which time photoperiod was increased to promote sexual maturity. CD males were photostimulated (PS) at 22 weeks. The second part of the trial was a fertility study. Following PS, 16 cockerels from each treatment were divided into 2 replicates and placed with 80 hens/ replicate. Eggs were collected and set weekly to determine fertility. Results indicated no differences between the NP and CD birds in performance. NP males performed better with respect to uniformity and growth. The HP males had the lowest fertility but the highest uniformity. It was concluded that early maturation is feasible in male broiler breeders and extra protein is unnecessary for an accelerated growth program.

Key words: Broiler breeder, males, feeding, maturation and testosterone

Introduction

In the broiler industry, breeder females are feed restricted to delay age at maturation in order to increase initial egg size, decrease mature BW and to increase total egg production (Wilson *et al*., 1987). Separate sex rearing is common, although males are still kept to the same management schedule as females, including use of the same diets, similar feeding regimens and photo schedule. In males, feed restriction at the levels used in pullet management may cause detrimental effects to reproductive performance. Parker and McSpadden (1943) found that limitation of feed intake in roosters decreased semen volume, sperm density and fertilizing capacity of semen. When the calorie level of diets fed to males decreased, significant reduction in testes size and fertility were detected (Parker and Arscott, 1965). More recently, Duncan *et al*. (1990) have shown a decrease in libido and fertility at later stages of semen production in more severely restricted males.

McCartney (1977) demonstrated the presence of fully mature spermatozoa in the male reproductive tract as early as 11 weeks of age. In breeder male flocks, the heavier males generally mature first (Vaughters *et al*., 1987). In a sex separate rearing situation, early sexual maturation in males may provide an advantage by reducing maintenance costs and allowing for faster production of replacement males. However, these males may need a higher protein grower diet. Walsh and Brake (1997, 1999) calculated a minimum protein requirement needed prior to photo stimulation for optimal fertility. This study was conducted to determine the feasibility of rearing males to an early age of maturation and to determine whether a higher-than-normal grower protein level is required by males on an accelerated growth program.

Materials and Methods

Rearing phase: One hundred Ross male chicks were placed in each of three litter floored pens with *ad libitum* access to a control corn-soy starter diet (Table 1) and water. A photo schedule of 23 h light (L) to 1 h dark (D) was set for the first 3 weeks. After three weeks, lighting was decreased to 8L:16D and the birds were divided into three treatments with four replicates each containing 25 males. The control birds (CD) were switched to a 15% crude protein (CP) control developer diet and reared according to Ross breeder recommended guidelines. The fast growth (FG) birds included the other two treatments and were put on an accelerated growth program. Of the FG birds, the normal protein diet (NP) cockerels were fed the 15% CP control developer diet and the high protein (HP) cockerels were placed on a 20% CP developer diet (Table 1). For the FG males, a growth curve was made projecting a target body weight (BW) for 16 weeks that was the same as the breeder guideline recommended BW for 22 weeks of age. Goal weights fell along a linear graph with the equation:

$Y = 0.216x - 0.140.$

where X was the age of birds (wk) and Y represented the body weight at that age (kg).

Table 1: Ingredients of diets used during trial

Ingredients (%)	Starter (all)	NP, CD Grower	HP Grower	Breeder (all)
Corn	63.47	66.98	57.88	67.81
Soybean meal	28.34	17.49	30.77	21.92
Rice mill feed	3.98	11.69	7.42	-
Blended fat	-	-	-	0.33
Dicalcium phosphate	1.76	1.31	1.21	1.29
Limestone	1.41	1.55	1.56	7.13
Salt	0.40	0.40	0.39	0.43
Mineral premix	0.25	0.25	0.25	0.50
Vitamin premix	0.25	0.25	0.25	0.50
DL methionine	0.13	0.08	0.27	0.09
Nutrients*				
CP (%)	19.00	14.51	19.99	15.99
ME (kcal/kg)	2853.34	2746.27	2738.17	2857.67
Fat (%)	2.75	3.22	2.73	3.02
Met + Cys (%)	0.75	0.56	0.90	0.63
Methionine (%)	0.46	0.34	0.59	0.38
Lysine (%)	1.01	0.71	1.08	0.82

*Calculated values

Body weights (BW) were measured weekly to determine the amount of feed needed. From 3 - 16 wk birds were fed on a 4/3 skip-a-day program. Mortality was recorded daily. Blood samples were collected as well as organ weights (heart, liver, testes) and growth parameters (shank and keel length).

FG birds were switched to a control breeder diet, fed every day at 16 weeks of age. Lighting was increased to 14L:10D to induce photo stimulation (PS); light intensity also increased. Photoperiod changed by an increment of 0.5 h/wk until the birds received 16L:8D by 20 wk. Control birds were switched to the breeder diet at 22 weeks and PS was induced using the same ratio of L:D and incremental increase in photo schedule over 4 weeks to 26 wk.

Breeder phase: The second part of the trial began at 20 wk for FG and 26 wk for CD. From each treatment, 16 males were selected. Birds were divided into 2 reps with 8 males and placed in litter floored breeder pens with 80 hens. Eggs were collected and saved weekly beginning the following week. From each pen, 90 eggs from the weekly production were incubated for 3 days and then opened to determine fertility. Fertility was defined as the % of fertile eggs.

Statistics: Data that was determined as a percentage (e.g. % uniformity) was analyzed after arcsine transformation to control for variance. Comparisons were made based on Tukey's HSD (α = 0.05) after performing one-way ANOVA.

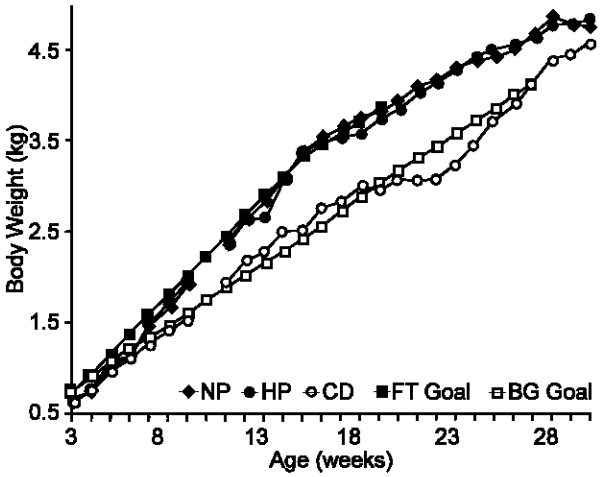

Fig. 1: Mean body weights of treatments from 3 – 30 weeks. The goal body weights for FG birds (NP and HP) for various ages are labeled "FT Goal." The breeder guideline recommended BWs for various ages are labeled "BG Goal."

Results

BW at PS differed statistically between the FG and the CD males. However, when compared 4 weeks post-PS and at the same chronological age (30 wk), there were no detectable differences (Table 2). Fig. 1 shows the progression of body weights compared to target weights for all groups. Uniformity was defined as the % of birds within ± 15% of the mean BW. All treatments differed statistically with HP (91.4%^{a} ± 9.4%) > NP (85.5%^{b} ± 13.4%) > CD (77.8%^{c} ± 14.3%) (Fig. 2).

Heart and liver weights, evaluated as a % of BW, did not differ among treatments. Testes weights varied at 4 weeks post-PS but not at 30 wk for all birds (Table 2). For shank length (cm), there was no difference at 4 weeks post-PS. However, at 30 wk for all, NP (13.0^{a}±0.4) > CD (12.1^{b}±0.7), although neither differed from HP (12.6^{ab} ± 0.5). Keel length (cm) at 4 wk post-PS indicated statistical differences between HP (21.2^{b}±0.6) and CD (23.4^{a}±1.1), with no difference by either from NP (21.3^{ab}±0.5).

Table 2: Mean body weights and testes weights as a % BW (± standard deviation) compared at the same development stage and the same chronological age

	BW (kg)			Testes* (% BW)		
Age (wk)	CD	NP	HP	CD	NP	HP
FG 16, CD 22 (PS)	3.10^{b}±0.07	3.52^{a}±0.16	3.49^{a}±0.15			
FG 20, CD 26 (PS+4)	3.92±0.20	3.94±0.06	3.85±0.19	0.94^{a}±0.19	0.73^{b}±0.19	0.66^{b}±0.88
All-30	4.60±0.23	4.77±0.21	4.83±0.09	1.04±0.14	0.90±0.23	1.01±0.32

$^{a-b}$ Means without a common superscript on the same row differ significantly (P<0.05). *Testes data analyzed after arcsine transformation to control for variance.

Table 4: Comparison of fertility (% fertile eggs) for treatments (± standard deviation) at the same developmental stage and at the same chronological age. Data was analyzed after arcsine transformation to control for variance

Age (wk)	CD	NP	HP
FG 21-24, CD 27-30 (same developmental stage)	80.7[a]±7.1	81.5[a]± 6.6	60.3[b]±13.8
All 27-30 (same chronological age)	80.7[a]±7.1	87.5[a]±2.9	39.5[b]±12.0

[a-b]Means without a common superscript in the same row differ significantly (P<0.05)

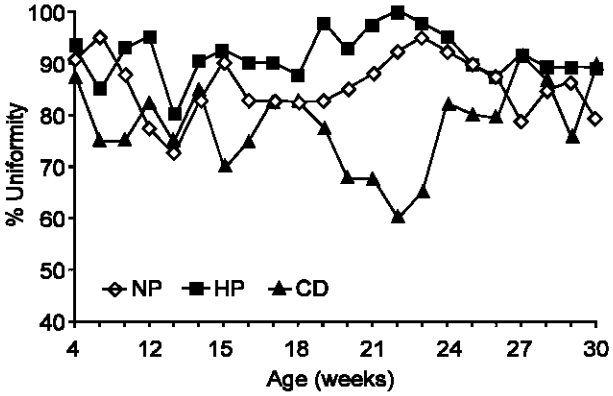

Fig. 2: Percent body weight uniformity (within ± 15% mean body weight) from 4-30 weeks.

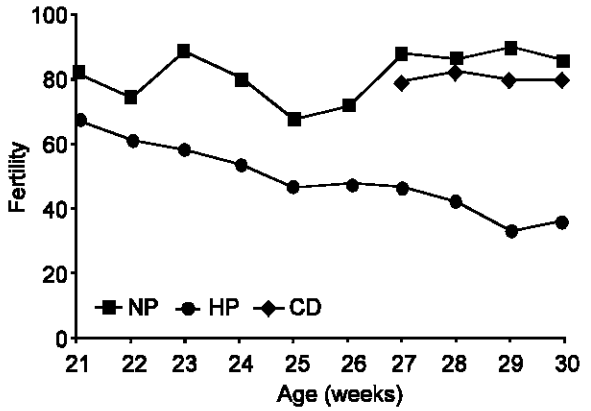

Fig. 3: Fertility (% fertile eggs) from 21 – 30 weeks for fast growth treatments (NP, HP) and from 27 – 30 weeks for control treatment (CD).

Results of testosterone assays have been summarized in Table 3. At PS, CD males had higher testosterone levels (0.38[a] ng/ml ± 0.16) than NP (0.04[b] ng/ml ± 0.07) or HP (0.12[b] ng/ml ± 0.15) males. However, by four weeks post-PS there were no detectable differences. All males had similar levels of plasma testosterone compared at the same chronological age (30 wk).

Fertility data (Fig. 3) was compared for the first four weeks after placement with hens (FG 21 - 24 wk, CD 27 - 30 wk) and also for the same ages over a four-week period (27 - 30 wk). Results (shown in Table 4) indicated that CD and NP > HP significantly for both time period comparisons. NP birds had a higher % fertility than CD for both comparisons, although not statistically.

Discussion

In this preliminary study the results indicate that it may be possible to reduce the age of breeder males at onset of sexual maturity. A higher protein level is not required to allow for faster growth and development and, in fact, proved detrimental to reproductive performance. These results agree with earlier findings (Wilson *et al.*, 1987; Hocking, 1990; Hocking and Bernard, 1997) that higher protein levels in the diet reduce overall male fertility.

Managers might have concern about the possibility of reduced growth due to the effects of testosterone (Fennell and Scanes, 1992; Fennell *et al.*, 1996) and an increase in the occurrence of leg problems resulting from a heavier weight at a younger age. In our study, there were no observed leg problems and fast growth did not appear to stunt the total growth of the breeder males in spite of elevated testosterone levels at a younger age. The observed difference in testosterone level at PS may have been due to the additive effects of naturally rising levels of testosterone in the chronologically older birds (CD).

Further research would indicate the ideal age for photo stimulation of breeder males and an ideal photo schedule that would allow for reduced concern about the incidence of photo refractoriness at a younger age in the FG males.

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