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Full Research Article

Effects of Different Levels of Dietary Crude Protein on Growth and Reproductive Performance of Broiler Breeder Birds

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Abstract

This study was conducted to evaluate the growth and reproductive quality of of male broiler breeder strain reared with diets having 8, 10, 12 and 14% CP. One hundred twenty male breeder chicks of color-synthetic male-line (CSML) strain were raised on common starter diet (20% CP, 2750 ME kcal kg^{-1} up to 5 weeks). On completion of 5 weeks, the birds were distributed in four treatment groups; each treatment groups comprised of 3 replicate groups and each replicate had 10 birds. The birds were restricted fed during 6th-20th week of age. Four isocaloric grower diets containing 8, 10, 12 and 14% CP were randomly allotted to each treatment group. Semen was collected at 25th, 30th, 35th, 45th and 50th week to measure semen volume, sperm concentration, sperm motility and sperm livability. The body weight of different supplemented group differed significantly ($p<0.05$). The semen volume of 8 and 10% CP diet groups at 25th and 30th weeks were lower than 0.50 ml and the values were significantly different than that of 12 and 14% CP diet groups. But by 35th week there were no significant difference between different CP % groups. The sperm concentration of 8% CP diet group was lower than the other treatment groups. The sperm individual motility of all the treatment groups at different weeks had no significant difference between them. The sperm livability of all the different treatment groups was not significantly different at any week.

1. Introduction

The plane of nutrition has significant effect on semen volume, quality, fertility, hatchability, and body weight of hatched chicks (Sterling et al., 2005). Nutrition plays an important role in activation of hormonal response and the supply of essential components or cofactors for reproductive function (Kamran et al., 2010). Restricted feeding is practiced universally in broiler breeder flocks during growing period in order to control body weight and excessive breast muscle development (De Beer, 2011). Excessive body weight has adverse effects on the reproductive performance of parent breeders (Nir et al., 1996). Body weight management of broiler breeder males during rearing may impact the reproductive efficiency of males throughout production period there by seriously affecting the economics of breeder farm. It has been accepted that broiler breeder males can be raised on low CP diets to maintain optimum semen quality and fertility. Breeder farms usually use diets with 15-18% CP for feeding cockerels as a margin of safety (Leeson and Summers, 2000). Adverse effects of high dietary CP intake due to elevated plasma uric acid concentration as a result of protein catabolism have been well documented (Hernandez et al., 2012). However excessive protein restriction can delay sexual maturity (Malomo et al., 2013). Feeding grower diets with 8% or less CP from 7 to 21 weeks resulted in delayed sexual maturity in white Leghorn cockerels (Bruggeman et al., 1998). CP restriction in young growing birds decrease the concentration of LH which is associated with decreased gonadal weight (Bruggeman et al., 1998). The requirement of CP varies with strain due to difference in their ability to utilize protein. Further, climatic condition has a significant effect on protein utilization (Behura et al., 2014). Therefore the present investigation was planned in broiler breeder parent line to determine the effect of four different CP levels (8, 10, 12 and 14%) during growing period (6 to 20 weeks) on body weight, body conformation traits, semen volume and semen quality parameters under hot and humid climatic conditions.

2. Materials and Methods

2.1. Experimental birds, feeding and management

One hundred and twenty male broiler breeder day-old chicks of CSML strain were raised on starter diet (20% CP and 2750 kcal ME kg^{-1} diet) fed ad libitum up to 5 weeks of age at Dept. of Poultry Science, College of Veterinary Science and Animal Husbandry, Orissa University of Agriculture and Technology, Bhubaneswar. On completion of 5 weeks, the birds were distributed in four treatment groups having 30 birds treatment^{-1} and each treatment group comprised of 3 replicate groups of 10 birds each. The experiment continue up-to 50 wk of age. Four iso-caloric grower diets containing 8, 10, 12 and 14% CP were prepared (Table 1). and randomly allotted to each treatment group. The birds were restricted fed following Sakumra (2003) energy model from 6th-20th week. From 21st-24th week a recovery diet was fed to the birds (17% CP, 2750 kcal ME kg^{-1} diet) @ 140 g bird^{-1} day^{-1} up to 25th week. From 26th week onwards the birds were fed a diet with 16% CP and 2750 kcal ME kg^{-1} @ 145 g bird^{-1} day^{-1} up to 42nd week and @ 150 g bird^{-1} day^{-1} up to 50th week. The birds were raised on litter floor from 0 to 20 weeks and there after shifted to individual cages. Standard vaccination and medication protocols were followed.

Table 1: Composition of the starter, grower and breeder diets

Ingredient	Type of feed						
	Starter	Grower				Pre-breeder	Breeder
Maize	60.00	61.00	63.00	61.00	58.50	62.50	60.00
Soya bean meal	30.00	--	5.25	11.50	17.50	22.50	19.50
DORB	7.00	29.00	28.75	24.50	21.00	07.00	12.50
Broken rice	--	7.00	--	--	--	--	--
Shell grit	--	--	--	--	--	5.00	5.00
Mineral mixture	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Common salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30
L Lysine (98.5%)	0.10	0.35	0.25	0.10	0.10	0.10	0.10
DL-Methionine (99%)	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Calculated values							
ME-(kcal Kg^{-1})	2850.56	2747.08	2750.00	2756.36	2753.58	2754.06	2752.00
Energy: Protein	142.70	342.90	273.90	227.90	195.00	163.73	172.22
Analyzed value (% DM Basis)							
Moisture	9.23	9.25	9.14	9.04	9.27	9.13	9.26
CP	19.98	08.01	10.04	12.09	14.12	17.08	16.11
Ether extract	4.14	5.26	5.12	4.98	4.55	4.36	4.40
Crude fibre	4.22	5.33	5.03	4.94	4.91	4.73	4.65
Total ash	9.43	10.54	9.98	10.06	10.17	9.90	9.77
Acid insoluble ash	2.60	2.48	2.72	2.54	2.63	2.72	2.79
Nitrogen free extract	62.23	70.86	69.83	67.93	66.25	63.93	65.07
Calcium	0.90	0.90	0.92	0.92	0.93	0.96	0.97
Av. Phosphorus	0.45	0.46	0.48	0.48	0.45	0.43	0.44

2.2. Body measurements

Body weight was recorded at weekly intervals up to 20th week after which it was recorded at monthly intervals. The uniformity of body weight was calculated from the recorded weekly body weight of all the replicate groups expressed in terms of coefficient of variation (CV%) (Anonymous, 2009). Shank and keel lengths of sample birds were measured using a tailor's tape rule (Amao et al., 2010) at 20th week and expressed in cm. Shank (tarso-metatatsus) length was measured as the distance from the hock joint to the middle of the foot pad on the left leg and keel length was measured from the point of fusion in the clavicle to the ventral portion of the sternum (McGovern, 2002) by using a tailor's tape and expressed in cm.

2.3. Semen parameters

Semen was collected at 25th, 30th, 35th, 45th and 50th week in a plastic funnel with blocked stem by abdominal massage method (Burrows and Quinn, 1937). Volume of semen was measured in 1 cc plastic syringes graduated in increments of 0.01 cc and expressed in ml (Vaughters et al., 1987).

Individual motility was measured by diluting a drop of fresh semen sample with 2.9% Sodium citrate solution and is then examined under phase contrast microscope (400X magnification) with a cover slip. The individual motility was recorded between 0-100 depending upon the percentage progressively motile spermatozoa (Chemineau et al., 1991). The concentration of spermatozoa was determined by Haemocytometer (Neubaeur) method (Taneja and Gowe, 1961).

Measurement of sperm livability was done by using Eosin-Nigrosin stain under phase contrast microscope with oil immersion (100X) as described by Lake and Stewart (1978).

The semen collected during 32nd week was used for fertility trial. The semen collected from the birds of a treatment group was pooled and was used for inseminating the hens @ 0.1 ml of processed semen per hen. The same practice was repeated at three days interval during 32nd week for fertility trial. The eggs from inseminated hens were collected in the succeeding week of insemination and kept separately for incubation to find out fertility rate.

2.4. *Statistical procedures*

Data were analyzed as a randomized block design using the General Linear Model procedure of SPSS (IBM SPSS, version 20.0, 2011), based on the statistical model. Means were tested using Snedecor and Cochran (1994). Probability values of $p<0.05$ were declared as significant.

3. Results and Discussion

3.1. *Body measurements*

The weekly body weight from 6th to 50th week of the treatment groups have been illustrated in Table 2. The body weight gain in 8% CP group during growing period from 6 to 20 weeks was low and during subsequent period it was high as compared to other groups. In 14% CP group the body weight gain during 6th to 20th weeks was high and low during 30th to 50th weeks. In both 8 and 14% groups the body weight gain was inconsistent as compared to 10 and 12% CP groups where the body weight gain during the entire experimental period (6 to 50 weeks) was more consistent. The 20th week body weight of the treatment groups increased with increase in dietary CP level. The 8% CP group had the significantly ($p\leq0.05$) lower body weight (1843.9 g) among all treatment groups. The 20th week body weight of 14% CP group was (2647.2 g) significantly higher ($p\leq0.05$) than 8 and 10% CP groups but similar ($p>0.05$) to 12% CP group (2618.8 g).

The 20th week CV %, shank length and keel length of the different treatment groups have been presented in Table 3. The 20th week CV % of the treatment groups ranged between 10.96 and 13.19, and did not differ significantly ($p>0.05$) among treatment groups. The 20th week shank length increased with increase in dietary CP level, but the difference was not statistically significant ($p>0.05$). Similarly, the 20th week keel length of different dietary CP groups did not differ significantly ($p>0.05$).

It has been observed that males consistently gaining BW exhibited better reproductive performance than those that were more erratic in their BW gain (Romero-Sanchez et al., 2008). In the present experiment the males on 8 and 10% CP diets gained low body weight during growing period (6-20 weeks) and the body weight gain during next 10 weeks was very high after providing the compensatory diet. This erratic body weight gain in these groups could have resulted in low semen volume, poor semen quality and lower fertility as compared to 12 and 14% CP groups. The effects of dietary CP level on growth performance of broiler breeders during growing period have been reported by several workers (Romero-Sanchez et al., 2007). By feeding diets with CP range as low as 12% of the diet, no significant difference in 20th week body weight was observed in birds. However, they

Table 2: Body weight (g) and nutrient intake (g) of male broiler breeder growers under different dietary treatments

Age (weeks)	CP (%) 8	10	12	14	SEm±	P value
5	885.1	883.2	883.6	883.7	18.3	0.82
8	933.6^{a}	1074.5^{c}	1051.2^{bc}	1059.2^{bc}	23.7	0.04
12	1157.3^{a}	1402.5^{bc}	1459.8^{bc}	1611.2^{d}	35.8	0.02
16	1535.7^{a}	1813.5^{bc}	1904.7^{cd}	2081.8^{e}	43.7	0.03
20	1843.9^{a}	2451.9^{bc}	2618.8^{cd}	2647.2^{d}	41.3	0.01
*Dietary regime						
25	3104.50^{a}	3024.80^{a}	3438.30^{b}	3484.20^{b}	86.65	0.05
30	3477.20^{a}	3576.70^{a}	3641.20^{ab}	3791.50^{b}	103.35	0.03
35	3738.20^{a}	3734.70^{a}	3900.80^{ab}	3856.50^{ab}	84.73	0.04
40	4765.50^{b}	4489.60^{ab}	4429.20^{ab}	4240.00^{a}	131.11	0.03
45	4815.00^{b}	4571.30^{ab}	4552.20^{ab}	4347.25^{a}	135.33	0.04
50	4865.00^{b}	4653.00^{ab}	4675.20^{ab}	4454.50^{a}	120.39	0.02

abcdMeans with in a row without common superscript differ significantly ($p<0.05$).*From 21st-25th week a recovery diet (17% CP), From 26th week onwards diet with 16% CP

Table 3: CV percent, shank length and keel length of broiler breeder males under different dietary treatments at 20th week of age

Attributes	CP (%) 8	10	12	14	SEm±	P value
CV (%)	13.19	12.78	11.59	10.96	0.32	0.62
Shank length (cm)	12.70	13.10	13.10	13.20	0.10	0.75
Keel length (cm)	14.60	14.90	15.70	15.90	0.20	0.09

reported a decrease in body weight with decrease in CP level below 12% of the diet. Pesti (2009) reported that CP level is a significant contributor to body weight. Waldroup et al. (2005) reported that body weight gain declined as the CP level was reduced in the diet.

In the present experiment though feed allocation was decided following an energy requirement model, the offered feed was not consumed completely by the low CP diet groups (8 and 10%) during different periods. This low feed and consequently low CP intake during growing phase might have adversely affected skeletal growth and body weight gain in these groups. The CV% was not influenced by CP level of the diet. The findings of the present experiment agrees with the findings of Zhang et al. (1999), who reported that the body weight uniformity was not affected by dietary CP level. During the growing period, as the birds were under restricted feeding, the wide range of CV% obtained could be due to severe competition among the males during feeding (McGovern, 2002).

Lilburn et al. (1989) reported that the frame size or skeletal growth in broiler breeder is primarily a function of body weight gain. Difference in dietary protein and energy can influence the rate of gain and in this way indirectly influence skeletal growth. Amao et al. (2010); Yahaya et al. (2012) reported that the correlation between body weight and shank and keel length are high, positive and significant. The findings of the present experiment are in agreement with the earlier findings.

3.2. Semen parameters

The semen volume of 8 and 10% CP diets groups at 25th and 30th weeks were lower than 0.50 ml and the values were significantly ($p\leq0.05$) lower than those of 12 and 14% CP diet groups for the corresponding periods (Table 4) . There was significant difference in semen volume between different treatment groups up to 30th week of age. Sturkie and Opel (1976) reported that those treatment groups were considered to be sexually matured, whose mean semen volume were ≥0.5 ml and ≥80% males were in semen production. From the present study it was found that in treatment groups with 8 and 10% CP levels, sexual maturity was delayed by 10 weeks as compared to 12 and 14% CP diet groups where sexual maturity was attained by 25th week. Delay in sexual maturity by 4 and 8 weeks were recorded when broiler breeder males were fed diets with 5.1 and 8.9% CP diet during growing period (Wilson et al. 1971). Similarly Hocking and Bernard (1997) reported a quadratic effect of CP intake on semen volume. In the present investigation a synthetic colour broiler strain was under hot and humid climatic condition. The CP requirement is influenced by the ambient temperature.

Table 4: Semen volume and semen quality of treatment groups

Attributes	Age (weeks)	CP (%) 8	10	12	14	SEm±	p value
Semen volume (ml)	25	0.3[a]	0.30[a]	0.63[b]	0.74[c]	0.02	0.03
	30	0.43[a]	0.43[a]	0.84[b]	0.58[ab]	0.10	0.02
	35	0.80	0.76	0.83	0.77	0.09	0.15
	45	0.89	0.98	0.81	0.85	0.08	0.21
	50	0.79	0.70	0.78	0.76	0.20	0.37
Sperm concentration (million ml^{-1})	25	2.98[a]	3.78[ab]	4.38[b]	5.38[c]	0.20	0.03
	30	2.94[a]	3.74[b]	4.50[b]	5.44[c]	0.24	0.02
	35	2.85[a]	3.72[ab]	4.44[bc]	5.06[c]	0.36	0.03
	45	2.70[a]	3.47[a]	3.44[a]	4.83[b]	0.33	0.04
	50	2.82[a]	3.70[b]	3.76[b]	5.22[c]	0.27	0.02
Sperm Individual motility (%)	25	68.60	68.00	69.60	67.20	1.66	0.24
	30	67.00	68.00	67.50	69.00	2.40	0.17
	35	70.00	70.00	73.00	72.50	2.33	0.17
	45	67.50	67.50	70.00	73.75	2.47	0.09
	50	68.75	72.50	67.50	70.75	2.19	0.11
Sperm livability (%)	25	79.20	78.40	82.00	82.6	2.32	0.43
	30	78.00	78.70	77.00	82.00	8.87	0.18
	35	74.80	77.22	75.32	76.25	2.16	0.09
	45	61.20	65.40	64.70	66.00	6.19	0.13
	50	62.80	65.16	64.60	65.80	6.26	0.29
Fertility (%)	32	72.96[a]	76.85[a]	90.74[b]	86.11[b]	2.18	0.01

[abc]Means with in a row without common superscript differ significantly ($p<0.05$)

Sakomura (2004) reported that with increase in ambient temperature, the efficiency of ME utilization for protein decreases. As the investigation was carried out in a hot and humid climate in open sided poultry houses and the growing period (6-20 weeks) coincided with the summer season (March to June), when the ambient temperature was above 400C during this period, the protein utilization might have been adversely affected. This could have lead to low semen volume in the 8 and 10% CP groups.

The sperm concentration of 14% CP diet group for all the periods were significantly ($p\leq0.05$) higher than all the treatment groups (Table 4). The sperm concentration decreased with decrease in dietary CP levels. However, the sperm concentration of 10 and, 12% groups did not differ significantly ($p>0.05$). The sperm concentration of 8% CP diet group was lower than the other treatment groups throughout the experimental period. Similar findings have been reported by Wilson et al. (1965) who reported that at the start of semen production, the sperm concentration was low but after the recovery diet was fed at 28 weeks of age for 5 weeks the sperm concentration varied directly with the protein level. Borges et al. (2006) reported a quadratic effect of CP intake on sperm concentration. In the present experiment even after feeding the recovery diet for 4 weeks, the sperm concentration remained low in 8% CP diet group. It seems that the very low body weight at the recommended age of sexual maturity (20 weeks) in 8% CP groups had lasting adverse effect on sperm concentration during the rest part of the reproductive period and compensatory growth during latter part did not help improve the situation.

The sperm individual motility of the treatment groups varied from 67.50 to 73.75. The values did not differ significantly (p>0.05) among the treatment groups (Table 4). It could be due to the fact that up to 25th week of age 8 and 10% CP diet groups had lower body weight than all other treatment groups. Selvan (2007) reported that a high CP diet adversely affected sperm motility. Borges et al. (2006) reported a quadratic effect of CP intake on sperm motility. They further reported that at extreme levels (deficiency or excess) of dietary CP intake reproductive performance of broiler breeder males declined. The sperm livability of the treatment groups at different ages were not influenced by the dietary treatment (Table 4). Similarly, Tyler and Bekker (2012) observed that different dietary crude protein (10.5%, 12.6% and 15%) had no effect on semen quality of male broiler breeder birds.

The fertility of the treatment groups at 32nd week have been presented in Table 4. The fertility of the treatment groups ranged between 72.96 and 90.74%. The fertility of 14 and 12% CP groups were similar (p>0.05) and significantly (p<0.05) higher than 8 and 10% CP groups which did not differ significantly. The 12% CP groups had numerically higher (90.7%) fertility than 14% group (86.1%). Similar findings have been reported by Romero-Sanchez et al. (2007) who reported a decline in early and late fertility in broiler breeder males while increasing dietary CP level from 12 to 17%. Hocking (1990) found a negative correlation between high dietary CP level on fertility. Tyler and Bekker (2012) studied the influence of dietary crude protein (10.5%, 12.6% and 15%) on male broiler breeder fertility. They reported that sperm obtained from males that received 12.6% CP diets than males that received 10.5% and 15% CP diets had better fertility. The findings of the present experiment corroborates with the earlier reports showing that low CP levels such as 8 and 10% as well as high CP level of 14% exhibited lower fertility as compared to 12% CP levels.

4. Conclusion

12% CP diet was optimum for the strain to attain maximum fertility and with increase or decrease in CP level the fertility declined in the broiler breeder strain under study

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