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Effect of dietary energy level on body weight, testicular development and semen quality of local barred chicken of the western highlands of Cameroon

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ABSTRACT

This study was designed to examine the effects of dietary energy levels on some growth and reproductive parameters of local barred chickens in Cameroon. For this purpose, One hundred and forty four day-old barred male chicks, weighing 28.33 g in average were randomly divided into 12 groups of 12 chicks each. Three feeding programs (FP) comprising each a starter diet from day old to 12 weeks (S0: 2800 Kcal/Kg; S1: 2900 Kcal/Kg; S2: 3000 Kcal/Kg) and grower diet from 13 to 20 weeks (G0: 2900 Kcal/Kg; G1: 3000 Kcal/Kg; G2: 3100 Kcal/Kg) were used and designated FP1, FP2 and FP3 respectively. Each of the FP was randomly allotted of 4 groups of 12 birds in a completely randomized design. Throughout experiment (1 day old to 20 weeks), body weight was recovered every 2 weeks. At 20 weeks of age, roosters were sacrificed; semen characteristic was analyzed and testes were characterized. Between 2 to 10 weeks old, body weight of cocks fed with FP3 was significantly higher ($P < 0.05$) as compared to others FP. Inversely, from 12 to 20 weeks, body weight of cocks receiving FP1 was significantly higher ($P < 0.05$) than that of cocks receiving feeding programs 2 and 3. At 20 weeks, 100% of cocks fed on FP3 produced semen versus 66.66% and 16.66% respectively for those on FP1 and FP2. Semen volume and mass motility of cocks fed on FP3 or FP1 were significantly ($P < 0.05$) higher than FP2. It was concluded that FP1 had more suitable dietary energy levels for growth and reproduction of local barred cocks.

Keywords: Energy; Body Weight; Testes; Semen; Puberty; Local Barred Chicken

1. INTRODUCTION

Local chickens are characterized by good adaptability to the hard tropical environment, slower growth rate, poor laying ability and smaller egg size compared to the exotic breed; In addition, they possess good mothering ability and resistance to diseases [1]. In developing countries, many studies attempted to evaluate the genetic potential of the indigenous birds under improved management conditions [2-7]. Most of works tended to overlook behavioral and reproductive traits, which are important under village production environment [1]. However, one of the most important objectives of poultry breeding in village condition is the production of chicks since they are highly demanded in the market. Chick's production highly depends on flock fertility. As it has been reported, semen quality can impact egg fertility and subsequently egg hatchability [8]. According to Sarah [9], fertility in a breeder flock can be improved by using males with high sperm quality. Upendra *et al*. [10] reported that semen quality is positively correlated with percentage of fertile eggs and hatchability. The semen quality in poultry gives an excellent indicator of their reproductive potential [11, 12]. Usually, assessing fertilizing potential of semen includes sperm morphology, motility, concentration, viability, ability of acrosome to penetrate oocytes, the specific conductivity of the ejaculate [13,14]. However, sperm viability, concentration and motility are the major components of routine quality assessment [12,14]. These components are under the control of many factors including feeding.

Dietary energy level has been reported by many authors to affect performance trait such as body weight, delayed sexual maturity, semen production and quality in the male bird [15-17]. It has been reported that hypoenergetic diet leads to excessive weight gain [17,18] and consequently induce early sexual maturity and reduce fertility in male broiler [17]. Kirby *et al.* [19] reported that increase in calorie intake may lead to an increase in testes weight with no apparent increase in spermatogenic efficiency. Adequate nutrition is therefore essential to maintain the breeding flock in good reproductive condition [17]. Age at sexual maturity has long been considered as an important factor that determines fecundity trait and affects subsequent performances [20-22]. In cock flock, Brière *et al.* [17] reported that sexual precocity is related to early testicular regression. Kirk *et al.* [23] and Walsh and Brake [24] revealed that one of the major problems encountered with commercial broiler breeder flocks has been the often dramatic decrease in fertility during the latter part of laying period, particularly after 50 weeks of age. This could be associated with decrease in semen quality. Several studies on semen characteristics of African local cocks have been published [25,26] but none of them reports on Cameroon chickens which constitutes approximately 56% of the chicken population in the country [27]. Moreover, there is no information on nutritional requirements of these birds. The aim of the present study was therefore to evaluate the effect of dietary energy level on body weight, testicular development and semen characteristic of local barred cocks of the Western Region of Cameroon.

2. MATERIALS AND METHODS

2.1. Study Area

The study was carried out between February and September 2012 at the Teaching and Research Farm of the University of Dschang (LN 5 to 7˚, LE 8 to 12˚). Dschang is located in the Western Sudanoguinean Savanna of Cameroon at 1500 m above sea level. Mean wind speed is 1.60 m/s; mean temperature is 20˚C and relative humidity generally exceeds 60%. Annual rainfall varies between 1910 and 2010 mm. The raining season goes from mid-March to mid-November and the dry season from mid-November to mid-March.

2.2. Experimental Animals

One hundred and forty four day-old barred male chicks, weighing 28.33 g in average were randomly divided into 12 groups of 12 chicks each. Chicks were housed in raphia bamboo made cages and kept under similar environmental and managerial conditions during experiment. Feed and water were given *ad libitum* in adapted equipments.

2.3. Experimental Diets and Design

Three feeding programs comprising each a starter diet from day old to 12 weeks (S) and grower diet from 13 to 20 weeks (G) were drawn as reported in **Table 1**.

Each of the feeding programs was randomly allotted of 4 groups of 12 birds in a completely randomized design.

2.4. Data Collection

Live body weight was recorded every two weeks.

At 20 weeks of age, 8 cocks per treatment were randomly chosen and sacrificed by decapitation. Semen was collected immediately after sacrifice by slight finger pressure on spermiductus from epididymalductus till the base of the phallus. The number of cocks producing semen was recorded together with volume and color of the

Table 1. Percentage composition and calculated chemical components of experimental diets.

Ingredients	Feeding program 1		Feeding program 2		Feeding program 3	
	S0	G0	S1	G1	S2	G2
	2800 Kcal	**2900 Kcal**	**2900 Kcal**	**3000 Kcal**	**3000 Kcal**	**3100 Kcal**
Corn meal	42.0	47.0	48.0	49.0	43.0	45.0
Wheat bran	22.5	22.0	16.5	22.0	20.0	22.0
Cotton seed cake	8.0	9.0	8.0	8.0	8.0	6.0
Soybean cake	15.0	11.0	15.0	7.0	15.0	13.0
Fish meal	6.0	3.0	6.0	6.5	6.0	3.0
Bone meal	0.0	2.0	0.0	1.5	0.0	1.5
Shellfish powder	1.5	5.0	1.5	5.0	1.5	5.0
Premix 5% (*)	5.0	0.0	5.0	1.0	5.0	3.5
Palm oil	0.0	1.0	0.0	0.0	1.5	1.0
Total	100.0	100.0	100.0	100.0	100.0	100.0
Crude protein (%)	23.66	20.78	23.27	20.70	23.43	20.34
ME (kcal/kg)	2803.9	2936.03	2913.73	3013.51	3006.17	3100.95
Calcium (%)	1.49	1.74	1.48	1.51	1.49	1.55
Phosphor (%)	0.76	0.74	0.69	0.73	0.71	0.74
Lysine (%)	1.31	1.06	1.29	1.10	1.49	1.06
Met (%)	0.43	0.40	0.43	0.40	0.43	0.46

***Premix 5%:** crude protein = 40%; Metabolizable energy = 2078 kcal/kg; Calcium = 8%; Phosphor = 2.05%; Lysine = 3.30%; Met (Methionine) = 2.40%; ME = Metabolizable energy.

sample. The collected semen was maintained at 38˚C - 40˚C using a water bath for sperm motility assessment and sperm density. The left and right testes were also removed, cleaned from adhesive tissue, and testes measurements were recorded. The left testis diameter and height were measured. The testicular shape index was obtained by dividing testicular diameter by testicular height.

The collected semen was analyzed as described by Ngoula *et al*. [28] and Hafez [29].

2.5. Statistical Analysis

Data collected were subjected to one way analysis of variance (ANOVA) at P < 0.05. When differences were significant between means, Duncan multiple range test were used to separate means. Pearson correlation coefficient for some parameters was also performed at P < 0.05. All statistical analyses were performed using SPSS 12.0.

3. RESULTS

3.1. Effect of Dietary Energy Level on Body Weight

Figure 1 presents the evolution of live body weight of cocks during the experiment. Between 2 and 10 weeks, body weight of cocks receiving feeding programs 3 (FP3) was significantly higher (P < 0.05) than that of animals

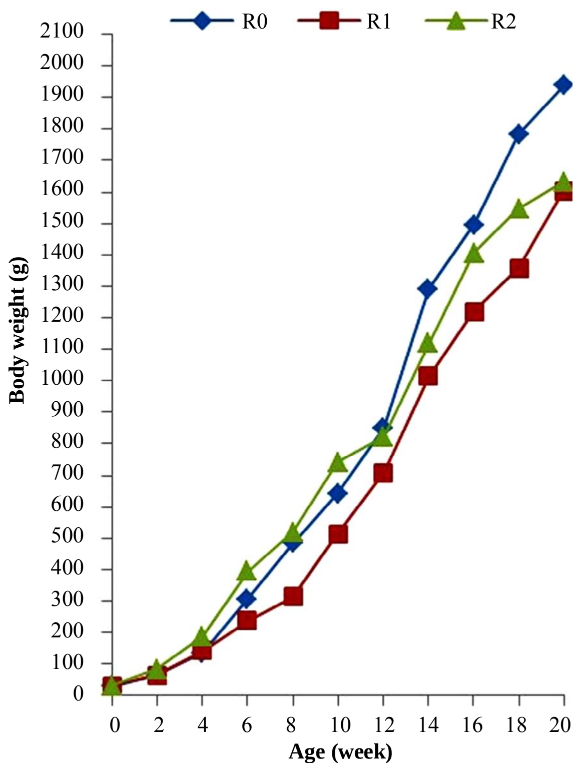

Figure 1. Growth curve of local barred cocks fed graded energy levels. Each point represents means ± ESM; n = 12.

fed with feeding programs 1 (FP1) and 2 (FP2). Inversely, from 12 to 20 weeks, body weight of cocks receiving FP1 was significantly higher than that of cocks receiving FP2 and FP3. The lowest body weight was recorded with FP2 from the beginning to the end of the experiment period.

3.2. Effect of Dietary Energy Level on Testicular Development

The summary of the analysis of variance as presented in **Table 2** indicated that dietary energy level had significant effect on testicular weight (P < 0.05). The left and right testes weights recorded on FP3 and 1 were significantly higher (P < 0.05) compared to testes weight of cocks fed on FP2. However, no significant difference was found between treatments neither for testicular shape index nor left-right testicular weight ratio. A highly positive and significant correlation was found between body weight at 4 weeks and testicular weight in cocks fed with FP3 (r = 0.896, P < 0.05). In addition, in cocks fed on FP1, a highly positive correlation was recorded between body weight at 8 weeks and testicular weight (r = 0.802).

3.3. Effect of Dietary Energy Level on Puberty and Semen Characteristics

Table 3 summarizes the effects of dietary energy level on percentage of cocks producing semen at 20 weeks, and semen characteristics. All the cocks (100%) receiving FP3 versus 66.66% and 16.66% respectively of cocks receiving FP2 and FP1 produced semen at 20 weeks. The semen volume and spermatozoa mass motility of cocks fed on FP3 and FP1 were significantly higher (P < 0.05) compared to cocks fed on FP2. The sperm density was not significantly affected by the dietary energy level (P > 0.05). However, cocks fed on FP1 had the relative highest value of sperm density. Semen color remained unchanged irrespective of treatment (P > 0.05).

Table 2. Effect of dietary energy level on testicular development.

Parameters	FP1 (n = 8)	FP2 (n = 8)	FP3 (n = 8)
Paired testis weight	12.04 ± 2.69^b	5.73 ± 1.41^a	15.35 ± 0.20^b
Left testicular weight	6.90 ± 1.69^b	3.01 ± 0.82^a	8.43 ± 0.1^b
Right testicular weight	5.48 ± 1.23b	2.54 ± 0.65^a	6.91 ± 0.27^b
Testicular shape index	0.582 ± 0.008^a	0.588 ± 0.014^a	0.574 ± 0.005^a
Left-right testicular weight ratio	1.188 ± 0.027^a	1.159 ± 0.018^a	1.232 ± 0.063^a

Means in the same line with different letters are significantly different (P < 0.05).

Table 3. Effect of dietary energy level on puberty and semen characteristics.

Parameters	FP1 (n = 8)	FP2 (n = 8)	FP3 (n = 8)
Cocks producing semen at 20 weeks (%)	66.66	16.66	100
Mass Motility	3.37 ± 0.185^b	2.00 ± 0.158^a	2.90 ± 0.187^b
Individual Motility	3.87 ± 0.243^a	2.33 ± 0.241^a	2.20 ± 0.200^b
Sperm density (10^9/mL)	6.59 ± 1.301^a	3.33 ± 0.064^a	5.42 ± 1.774^a
Volume (ml)	0.216 ± 0.047^b	0.08 ± 0.008^a	0.208 ± 0.045^b
Color	1^a	1^a	1^a

Means in the same line with different letters are significantly different ($P < 0.05$).

4. DISCUSSION

Body weight of cocks receiving the lowest energy level (FP1) at 20 weeks was significantly higher than that of cocks receiving respectively the intermediate (FP2) and highest (FP3) energy level. It is well established that hypo energetic diet leads to excessive weight gain [18,30, 31]. Birds fed with low metabolizable energy diet consume more nutrients than needed, particularly protein, vitamins and minerals. They then increase their caloric intake by using part of the diet protein as source of energy without affecting the protein quantity necessary for growth [10,11,30]. Hyper energetic diet doesn't cover quantitatively other nutritive needs such as protein, vitamins and minerals. The deficiency may negatively impact growth [18,30,31]. Body weight evolution between 2 and 10 weeks showed significantly higher values for cocks receiving feeding programs 3. This result is in agreement with the findings of Teteh *et al*. [32] who pointed out that the faster growth rate of chicks fed with high metabolizable energy diet may be due to the use of energy for efficient retention of protein; since protein is the building blocks needed for growth.

This study revealed that dietary energy level affected testicular development. In fact, testicular development was significantly higher with FP3 and FP1 compared with feeding programs 2. This may be attributed to growth dynamic within the first 10 weeks. The highest (FP3) and the lowest (FP1) dietary energy level lead to an increase of testes weight. In fact, it is well established that bird fed hypo-energetic diet uses a part of the diet protein as source of energy to compensate and then increase caloric intake [18,32], suggesting that high energy intake leads to precocious testicular development and testicular hypertrophy. The testicular development of roosters with high body weight at 8 weeks was significantly higher than that of other cocks. This result supported the findings of Brière *et al*. [17] and El-Dlebshany [23] who reported that high growth performance leads to early sexual maturation. High body weight gain during prepubertal period seems to involve an acceleration of the increase in testes size. This could be associated with the development of seminiferous tubules in testes. In fact, during prepubertal period, testicular development is highly correlated to the number and size of Sertoli cells while during pubertal period; it is rather correlated to the number of germinal cells. This is in agreement with Kirby *et al*. [19] who reported an increase of testis weight with no apparent increase in spermatozoa production. This work also revealed that 66.66% of cocks receiving the lowest (FP1) versus 100% of cocks receiving the highest (FP3) energy level started producing semen at 20 weeks. Testes produce both sperm and part of seminal plasma suggesting that testis development is not only associated with Sertoli cell proliferation but also with establishment of spermatogenesis activity [33]. This result also suggests that high energy intake accelerates prepubertal development, advance spermatogenesis and hence early puberty.

Semen characteristics of roosters fed with the highest dietary energy (FP3) were relatively lower when compared to those of cocks fed with the lowest dietary energy (FP1). In birds, Brière *et al*. [17] reported that intratesticular hyperthermia resulting from high dietary energy intake may lead to reduction of sperm production. Intratesticular hyperthermia acts by altering the functional state of spermatogonia stock [17]. High dietary energy can reduce sperm production by decreasing the ability of spermatogonia to develop into spermatocyte I and II. The sperm density of cocks receiving the lowest and the highest dietary energy level were higher than those reported by Peters *et al*. [34] in Nigerian indigenous, white leghorn and giriraja cocks. The differences in sperm density could be associated with dietary energy level since FP2 which produced similar results as reported by Peters *et al*. [34] is the standard diet used to feed white leghorn. The semen volumes recorded in this work are in agreement with Sauveur [35] who indicated that semen volume of light stump cock ranges between 0.1 to 0.8 ml.

5. CONCLUSION

The presented results suggested that testicular development and sexual maturity are affected by dietary energy level. This work generated first data of semen characteristic from Cameroonian local chicken. Feeding programs 1 seems to be more interesting for both growth and reproductive performances but further work is required for accurate conclusion.

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