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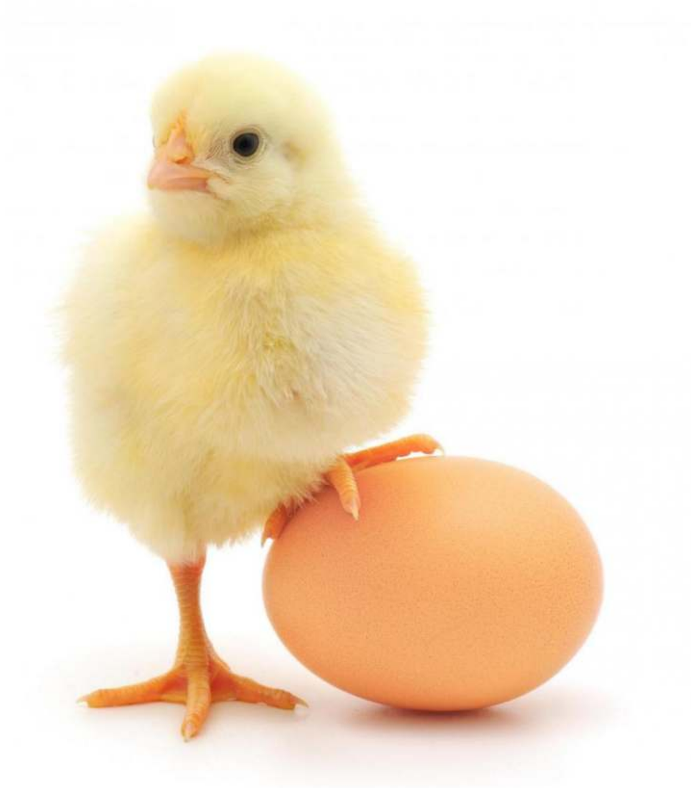

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Effects of Low-protein or High Energy Levels Diets on Layer-type Chick Juvenile Performance

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Abstract: Effects of feed nutritive values on broiler performance are widely investigated. But, relationship between feed macronutrients' levels and layer-type chicks (male and female) retains little attention. However, as for all developmental stages, starter diet composition may affect layer-type chick juvenile growth as well as physiological parameters. A total of 684 Hisex Brown layer-type chicks were studied. Chicks were divided, at random, into 3 groups with equal number of males and females: control, Low-Protein Diet (LP) and High Metabolisable Energy Diet (HME). During rearing period, feed intakes were recorded and chicks were weighed individually at the end of each week. Also, sample of chicks were used to weigh liver, at hatch and at 7, 14 and 56 day-old and to collect blood for glucose, total protein and triglyceride levels determination. Results indicate that layer-type chick growth rate, liver weight and feed efficiency were in following order HME > control > LP. With regard to chick sex, male chicks of HME and control diets grew better than female chicks from d 7 onward. But, in LP group, the weights of male and female chicks were comparable up to 49 d-old. At 7 d post-hatch, serum total protein and triglyceride levels of control chicks were higher than those of chicks of LP group while the levels of HME group were comparable to those of the two other groups. For total protein levels this trend lasted until 56 d of age. It can be concluded that low protein level of starter diet affects negatively feed efficiency and layer-type chick juvenile growth while high level of metabolisable energy improve feed efficiency and growth rate.

Key words: Layer-type chick, starter diets, growth rate, feed efficiency, blood metabolites

INTRODUCTION

Energy and protein levels of diet, feed composition and feed intake influences chicken production performances (Buyse *et al*., 1992; Nieto *et al*., 1997; Collin *et al*., 2003; Camacho *et al*., 2004; Parsons *et al*., 1993; Keshavarz and Nakajima, 1995; Schutte and De Jong, 1994; Swennen *et al*., 2007) and plasma metabolites (Gonzalez-Barranco and Rios-Torres 2004; Collin *et al*., 2003; Swennen *et al*., 2005, 2006; Caldera *et al*., 2007). It was reported that an increase in dietary crude protein increases body weight, weight again and improves feed conversion rate (Gokceyrek and Ciftci, 2005). In addition, Noy and Sklan (2002) started that chicks show a bell-shaped response to increasing dietary crude protein with maximum performance values at about 230 g/kg crude protein. In experiments with crude protein ranging from 160-280 g/kg with constant ratios of essential amino acid to crude protein, performance was much enhanced with high crude protein diets. In diets with increased energy levels, feed intake is only slightly decreased. Chicks do not increase feed intake when low energy diets are given during the first week post-hatch. It is assumed that when diets with isoenergetic substitutions between protein, fat or carbohydrates were given, chicks appeared to be more susceptible to low levels of dietary protein than to the levels of carbohydrates and lipids (Careghi, unpublished). Although effects of feed nutritive values on broiler performance are widely investigated, relationship between feed macronutrients' levels and layer-type chicks (male and female) retains little attention. However, layer-type chick juvenile performance may be related to egg production performance. It can be hypothesized that, as broiler chick, starter diet composition may affect layer-type chick juvenile growth and physiological parameters. Also, the effects of diets macronutrient composition may different according to the chick sex because of their different growth trajectory. In sub-Saharan Africa countries, feed nutritive values retained very little attention. Oftenly, each poultry farmer formulates its own feed ration without valuable background or enough knowledge of feed ingredients. As consequence, feed provided to animals do not fit well with the needs of chickens in matter of crude protein and energy levels. However, it is generally recommended to increase dietary energy levels in hot climatic zone of about 10% above standards. Therefore, the aim of this study was to investigate the effect of low-protein or high-

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energy diets compared to standard diet on layer-type chick juvenile performance and blood parameters in relation to chick sex.

MATERIALS AND METHODS

Experimental design: A total of 684 Hisex Brown layer-type chicks (342 males and 342 females) produced by Laboratory of Poultry Sciences, University of Lome were studied. Chicks were divided, at random, into 3 groups of 228 chicks with equal number of males and females: control, Low-Protein Diet (LP) and High Metabolisable Energy Diet (HME). Table 1 shows levels of ME and crude protein of each diet. Within each group, chicks were divided into two replications of 57 males and 57 females each. During rearing period, feed intakes were recorded and chicks were weighed individually at the end of each week. Also, sample of chicks were used to collect blood and to weigh liver, at hatch and at 7, 14 and 56 day post-hatch. Data collected are used to determine daily feed intake, body weigh gain, feed conversion ratio and liver weigh/body ratio. Blood samples were centrifuged and serum was collected for measurement of glucose, total protein and triglycerides levels.

Table 1: Metabolisable energy and crude protein levels of different diets

Diet	ME (kcal/kg)	Protein (%)
Control	2830	20
Low-Protein (LP)	2800	16
High ME (HME)	2950	20

Glucose, triglyceride and total proteins levels determination: For glucose, triglyceride and total protein concentration measurements, blood samples were collected from day-old chicks and at 7, 14 and 56 d of age. Within each pen, blood samples were collected from 8 chicks at each stage. Triglyceride, glucose and total protein were measured in serum samples by colorimetric analysis. Total protein liquicolor, glucose liquicolor and triglycerides liquicolor provided by Human Gmbh (65205 Wiesbaden-Germany) were used for, respectively, total proteins, glucose and triglyceride concentration determinations. All samples were run in the same assay in order to avoid inter-assay variability.

Statistical analysis: The data were processed with a statistical software package of SYSTAT 11. The effects of diets and chick on chick or liver weight, feed intake, concentrations of triglyceride, total protein or glucose were analyzed using a two-way, fixed effects ANOVA model (Neter *et al.*, 1996). A probability value of 0.05 was retained as the degree of significance. The model was as follows:

$$\text{Yijk} = \mu + \alpha\text{i} + \beta\text{j} + \alpha\beta\text{ij} = \text{eijk}$$

Where, Yijk = Chick or liver weight, feed intake, concentrations of triglyceride, total protein or glucose of chick k of sex i and fed with diet j, μ = overall mean, αi = main effect of chick sex i, βj = main effect of diet j, $\alpha\beta$ij = interaction between sex of chick and diet and eijk = random error term.

RESULTS

Body weight: Table 2 indicates that day-old chick weights were similar between sex and feed treatments. Irrespective of chick sex and in all feed treatment groups, chick weight increased with increasing age. Overall, male chicks of HME and control diets grew better than female chicks from d 7 onward ($p<0.05$). But, in LP group, the weights of male and female chicks were comparable up to 49 d-old. From d 14 onward, HME group chick weights increased more rapidly than those of the two other diets groups ($p<0.05$). Although male chicks weights of control diet were higher than those of LP diet group from d 7 until d 56 of age, female chick weights did not follow the same trend.

Feed intake and feed conversion ratio: Figure 1 shows daily feed intake according to feed treatment and the sex of chick. In all diet groups, female chicks consumed more feed than male chicks ($p<0.05$). Overall, feed intake of LP chicks was lower than that of chicks from HME and control groups ($p<0.05$). With regard to chick sex, feed intakes were in following order: LP < HME = Control and HME < LP = Control; respectively for male and female chicks ($p<0.05$).

Table 2: Chick weights according to developmental stage, feed treatment and chick sex

Developmental stage	Low-protein diet		High energy diet		Control	
	Male	Female	Male	Female	Male	Female
d-old	41.54±0.29[a]	41.31±0.30[a]	41.82±0.30[a]	41.57±0.57[a]	41.17±0.43[a]	41.87±0.42[a]
7d-old	63.00±1.02[c]	61.81±0.99[c]	73.15±0.97[a]	68.56±1.28[b]	72.72±1.14[a]	67.84±1.42[b]
14d-old	102.85±2.21[d]	103.23±1.94[d]	131.00±2.38[a]	121.53±2.65[b]	124.04±2.46[b]	111.03±3.30[c]
21d-old	152.50±3.30[d]	152.86±3.58[d]	196.63±4.35[a]	178.70±4.60[c]	188.21±4.53[b]	152.72±5.59[d]
28d-old	190.31±4.84[c]	191.86±5.56[c]	245.26±5.25[a]	211.73±6.02[b]	216.37±5.31[b]	177.00±6.78[d]
35d-old	231.27±7.09[c]	232.27±7.70[c]	290.62±5.93[a]	258.50±5.97[b]	280.68±6.90[a]	236.82±9.74[c]
42d-old	261.60±8.88[e]	265.55±9.40[e]	360.88±6.82[a]	313.06±8.75[c]	338.30±8.56[b]	287.00±12.75[d]
49d-old	340.41±10.36[c]	327.68±11.94[c]	470.00±9.12[a]	412.90±12.48[b]	434.51±11.78[b]	352.26±15.86[c]
56d-old	402.20±12.23[d]	363.10±13.24[e]	557.00±9.96[a]	483.00±14.86[b]	512.86±15.27[b]	440.61±16.74[c]

[a, b, c, d, e] Within lines, data sharing no common letter are different

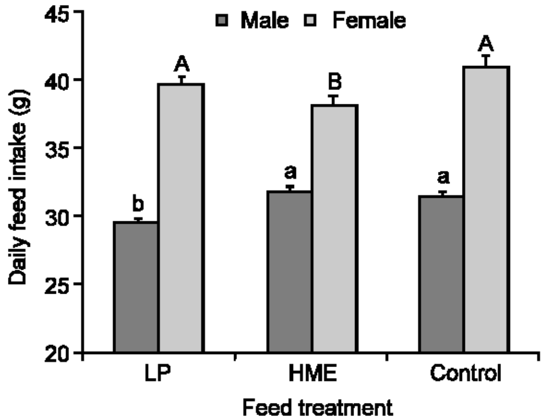

Fig. 1: Daily feed intake according to feed treatment and the sex of chick. [A,B,C]Data sharing no common letter are different between feed treatments for female chicks. [a,b,c]Data sharing no common letter are different between feed treatments for male chicks

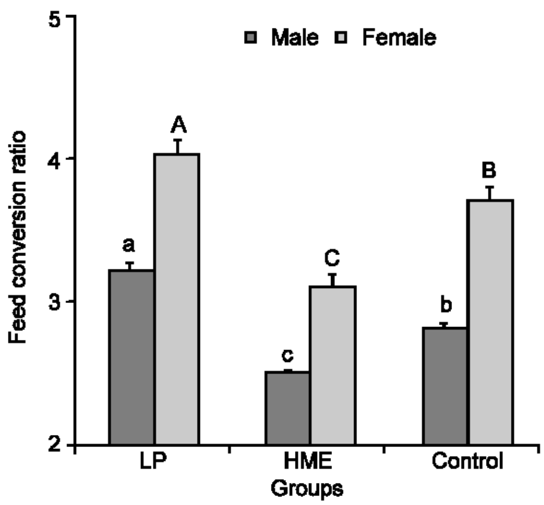

Fig. 2: Feed conversion ratio according to feed treatment and the chick sex. [A,B,C]Data sharing no common letter are different between feed treatments for female chicks. [a,b,c]Data sharing no common letter are different between feed treatments for male chicks

Figure 2 indicates that feed conversion ratio was in the following order for both female and male chicks: LP > Control > HME ($p<0.01$).

Liver weight: Figure 3 shows liver weights at 56 d of age according to feed treatment groups and chick sex. Chicks fed with LP diet had lower liver weight compared to those of HME and control groups ($p<0.05$). With regard to chick sex, liver weights were similar between male and female chicks of LP group while, in HME and control diet groups, liver of male chicks were heavier than those of female chicks ($p<0.05$).

Serum parameters: Serum concentrations in of glucose, triglyceride and total protein are shown in Table 3. At each developmental stage, glucose levels were not affected by feed treatment. With regard to developmental stage, serum total protein levels were higher at 7 d compared to 14 d and 56 d of age. From d 7 onward, serum total protein levels of control chicks were higher than those of chicks of LP group ($p<0.05$) while the levels of HME group were comparable to those of the

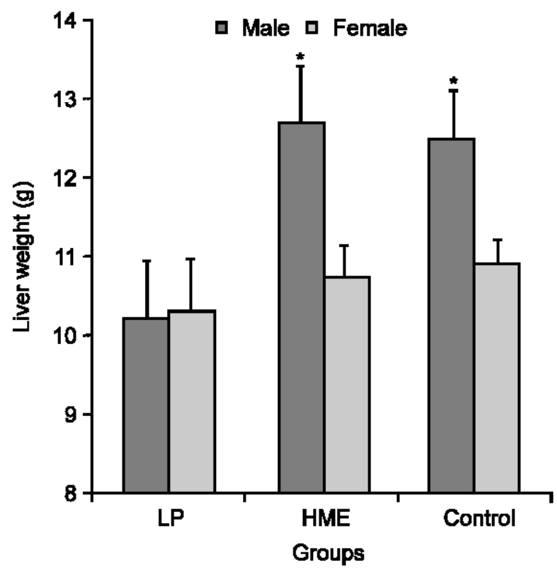

Fig. 3: Liver weight according to feed treatment and chick sex. *Indicates difference between male and female chicks ($p<0.05$)

Table 3: Serum concentrations of glucose, triglyceride and total protein according to developmental stage and feed treatment

Serum parameter	Developmental stage (d)	Low-protein	High energy	Control
Glucose	7	165.32±11.47	153.10±7.05	136.12±18.00
	14	134.69±13.25	115.50±8.86	112.75±20.03
	56	165.65±6.09	159.20±5.54	153.30±5.67
Totalprotein	7	3.78±0.26[b]	4.17±0.39[ab]	4.83±0.29[a]
	14	2.23±0.21[b]	2.79±0.27[ab]	3.18±0.36[a]
	56	3.12±0.22[b]	3.56±0.21[ab]	3.69±0.26[a]
Triglyceride	7	248.25±34.89[b]	353.64±46.80[a]	355.92±53.32[a]
	14	71.16±10.21[a]	85.03±27.37[a]	98.68±12.56[a]
	56	80.12±29.89[a]	91.66±20.59[a]	52.24±9.54[b]

[a,b]Within lines, data sharing no common letter are different ($p<0.05$)

two other groups. Triglyceride concentrations were significantly higher at d 7 compared to those of d 14 and d 56 which were similar. At d 7 post-hatch, triglyceride levels were lower in chick of LP group compared to those of HME and control groups which were similar. At d 14 and d 56, feed treatments did not affect triglyceride levels.

DISCUSSION

This study examined the effects of low protein and high energy levels in the starter diet on performance of layer-type chicks until 8 wk of age. Body and liver weights, feed intake and feed conversion were influenced differently by diet protein or energy levels as well as chick sex. Also, serum levels of triglyceride and total protein were affected by the dietary protein or energy levels.

Surprisingly, daily feed intake of chicks from LP group was lower compared to that of chicks fed with control and HME diets. This low feed intake of chicks from LP group is contrary to report of Smith and Pesti (1998), Sklan and Plavnik (2002) who pointed out that low nutritive value leads to hyperphagia. Lake of hyperphagia of chicks of LP group may be partly due to low appetite of the diets which may be pronounced by climatic conditions of rearing (temperature 28-37°C and relative humidity about 40-60%) (Tur and Rial, 1985). High feed consumption of control group compared to HME group may be explained by low energy level in control diet compared to HME. But, in term of energy intake, HME chicks consumed more energy than those of the two other groups indicating that because of limited feed ingestion level of chick, dietary energy level should be increased when climatic conditions do not favour appetite. Interestingly, dietary low-protein or high energy levels affected negatively or positively body weight, respectively. Irrespective of feed treatments, increasing chick weights during rearing period followed the same trend. However, growth rates as well as feed intakes were not similar between feed treatments. Chicks fed with HME diet grew better than those of control group which had better growth rate than those of LP group. This difference between growth rate with regard to diet protein or energy levels indicates that diet level of macronutrients influences layer-type chick growth rate during starter period. Lower body weights of chicks fed with LP diet suggests that chicks are more susceptible, irrespective to sex of layer-type chick, to low levels of dietary protein, since protein is the building blocks needed for growth. These results are the line of reports of Alster and Carew (1984) who pointed out that low protein diet affects negatively body weight of growing chicken. Also, Nieto *et al.* (1997) and Collin *et al.* (2003) reported that broiler chick fed with low protein diet retained less energy as protein than can be translated into protein retention. The slower growth rate of chicks fed with LP diet is most likely the consequence of their reduced cumulative protein consumption (Suthama *et al.*, 1991; Malheiros *et al.*, 2003).

The faster growth rate of chicks of HME diet than this of chicks of control group may be due to the use of energy for efficient retention of protein for growth. This result is in line with a report of Stubbs (1995) who pointed out that increasing energy intake leads to decreased protein oxidation. Also, Rama Rao *et al.* (2006) reported that higher metabisable diet improve broiler performance up to slaughter age.

With regard to chick sex, it is well known that anabolisant effect of testosterone leads to faster growth rate in male chicks compare to female chicks. Also, this study revealed that although male chicks consumed less than female, they grew better than female chicks. However, lake of difference in weights of male and female chicks fed with LP diet suggests that their unknown factors which favour fast growth rate of male chicks. This lake of difference of weights between chick sexes, at least up to 7 wk of age, requires more investigations.

Spectacular decrease of triglycerides concentrations from 7 d to 14 d of age may be due to the fact that triglycerides are important energetic products particularly used by chicks for growth performance (Swennen *et al.*, 2007; Zhan *et al.*, 2007; Caldera *et al.*, 2007). Lake in differences of glucose concentrations with regard to feed treatment may be explained by the strict regulation of the carbohydrate metabolism in the chicken (Belo *et al.*, 1976; Simon, 1989; Reisenfeld *et al.*, 1982; Gonzalez-Barranco and Rios-Torres, 2004).

It is concluded that low protein level of starter diet affects negatively feed efficiency and layer-type chick juvenile growth while high level of metabolisable energy improve feed efficiency and growth rate. With regard to chick sex, male chick growth better with less feed intake and this is more pronounced with increasing dietary macronutrients levels. It is recommended to increase dietary levels of protein and energy when environmental conditions do not favor feed intake.

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