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Effect of Different Levels of Dietary Crude Protein on Growth Performance, Body Composition of Broiler Chicken and Low Protein Diet in Broiler Chicken

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Abstract: The aim of this study was to provide level of dietary protein without causing any undesired effects on growth performance and carcass quality. In this study 150 one day-old commercial broiler chicks (Ross 308) were randomly subjected to 3 equal protein regiments groups. Weight gain, total feed consumption, feed conversion ratio (FCR), carcass compositions, water holding capacity (WHC), ash, pH, tensile strength, dripping loss after thawing and organoleptic characters in each groups were analyzed at the end of rearing period (42 days). The results showed that total feed consumption and weight gain of high protein group was higher than the low and medium protein group. In low protein group, abdominal fat, leg weights, pH content and excretion nitrogen were lower than medium and high protein groups; however feed efficiency, breast muscle percent, moisture and protein percents of the carcass were higher. The level of dietary protein did not affect tensile strength, dripping loss and organoleptic properties of chicken muscles. In female chickens, WHC was better in the medium and high protein groups. Therefore, dietary protein level of broilers could be reduced by 2%.

Key words: Crude protein, broiler chicken, performance, body composition

INTRODUCTION

Formulating broiler diets to maximize growth performance and economic returns are primary considerations of the broiler industry. Protein is a major component of chicken ration especially broilers diets. There are many controversial research results in the literature on the optimum levels of protein included in broiler chicken diets to obtain reasonable performance and product quality. A majority of the preliminary research in poultry nutrition was conducted to establish a minimum level of protein that would support the performance. In most of the previous studies weight gain was decreased, whereas feed intake and feed conversion ratio were increased as dietary protein decreased during experimental periods (Kamran *et al.*, 2008; Hernandez *et al.*, 2012).

On the other hand, growing public concerns on environmental issues dictate that poultry producers consider some environmental pollution parameters such as nitrogen and phosphorus excreta in poultry premises runoff in the environment. Nitrogen has been shown to have a negative effect on our fresh water supply and integrators will need to closely monitor and manage the nitrogen levels in their poultry waste (Morse, 1995). One way, to minimize nitrogen in the excreta is to formulate diets with reduced levels of crude protein (CP) and with inclusion of the commercially available amino acids. The other issue that supports this idea is the costs of protein. Protein is the most expensive nutrients in feeds/per unit weight. It has shown that reduction of 1% in dietary crude protein leads to 10% reduction in nitrogen losses in poultry waste. The only apprehension for reducing poultry dietary crude protein is diminishing bird growth and quality of carcass. However, reducing CP in broiler diets by inclusion of supplemental essential amino acids (EAA) has not been successful until recently (Dean *et al.*, 2006). Previously, decreasing CP content by more than 3% resulted in decreased weight gain and feed efficiency and increased abdominal fat. Dean *et al.* (2006) however, reported that maximum growth performance could be obtained in low CP, AA-supplemented diets if those diets were supplemented with crystalline Glycine. They used the diet that contained several supplemental AA which is not commercially available (Dean *et al.*, 2006). Responses of broilers to dietary amino acids have been extensively studied especially after synthetic forms became available allowing easier design of dose-response investigations. In this context, sulfur amino acids (SAA, methionine and cysteine) play a very important role in growing broilers because they are essential for optimum muscle growth and feather synthesis as well as for some biochemical processes (i.e., as methyl-group donators) (Vieira *et al.*, 2004). The addition of methionine to the birds' diet correlates with the tendency to have less total body fat (Rostagno *et al.*, 1995). Amino

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acid requirements can be influenced by a variety of dietary, environmental and genetic factors. Formulating a least-cost low-protein diet supplemented with synthetic amino acids to meet or exceed minimum standards suggested by NRC (1994) is the most important goal of nutritionist. Several data support the idea that young chicks respond well to a low protein diet supplemented with AAs as chicks fed positive control diet with 23% CP (Parr and Summers 1991; Han *et al.*, 1992; Moran *et al.*, 1992; Deschepper and DeGroote 1995), although other studies have reported impaired weight gain and feed efficiency when broilers were fed low protein amino acid-supplemented diets (Si *et al.*, 2004; Jiang *et al.*, 2005; Waldroup *et al.*, 2005). However the main reasons for this growth impairment are unknown, the role of the lysine and amino acid ratio under the ideal protein concept should not be ignored. This study was conducted to further illustrate the effect of graded low-protein lysine and methionine supplemented diet on production performance, body composition, meat flavors and leanness and excretal nitrogen runoff in mixed sex broiler chicken reared in conventional condition.

MATERIALS AND METHODS

Animals and diets: One hundred fifty one-day-old commercial broiler chicks (Ross 308) were obtained and randomly divided into 3 equal experimental groups and 5 replications in each groups with a chicken density of about 10/m^2. Their weights were 33.46±0.60 g ($p>0.05$). Diets were formulated encompassing the levels of protein. Chicks were fed separately to each experimental diet. Bird received water *ad libitum*. First group was fed with low protein diet (18% starter, 16% grower and 14% finisher diet), second was fed with medium protein diet (20% starter, 18% grower and 16% finisher diet) and third received high protein diet (22% starter, 20% grower and 18% finisher diet). Ingredients and nutrient composition of experimental diets were shown in Table 1 and 2. Experimental diets formulated according to NRC (NRC, 1994). The house had controlled ventilation and lighting. Lighting regime was constant lighting in first and second day and then 23 h of light and 1 h of darkness. The ambient temperature was gradually decreased from 32 to 24°C from first to 7th week of age. Before entrance of chicks to shed, experimental rooms were cleaned and disinfected.

Feed was analyzed for methionine, lysine and cystine. In this study actual amounts of methionine and lysine were about 80% of measured on the basis of amino acid analysis by atomic energy organization laboratory results (Table 3). The ratio of energy to sulfur amino acids and lysine and the total percent of methionine and lysine were the same in all trial groups. The amount of corn and soybean meal were adjusted to achieve the 3 protein levels and commercial DL-methionine was supplemented to provide additional quantities of total sulfur amino acids (TSAA). The amount of feed offered was weighed daily in the morning for each group. The feed leftover was collected and weighed prior to giving fresh feed for the day. Chicks were vaccinated against Newcastle, Influenza and Gumboro diseases based on standard protocols (Day 9: Newcastle type B1 vaccine, oral route; Day 10: Double Newcastle-Influenza vaccine, Merial, subcutaneous route at the back of the neck; Days 14 and 24: Gumboro vaccine, D78, Intervet Company of Dutchland). They were weighed individually at the beginning of the experiment and weekly till the end of the experiment and weekly weight gain and average of total weight gain in each group were calculated. Feed intake was also recorded for each group weekly. Mortality was monitored throughout the experiment.

At the end of experiment sexing was performed in each group and 10 birds (5 males and 5 females) were randomly selected and slaughtered to record the data on carcass yield. In these cases live bird weight/carcass, carcass characteristics, carcass pH, tensile strength, water holding capacity, dripping loss after thawing and organoleptic test were carried out to show the nutrition effects on these factors.

Proximate analysis: According to the AOCS methods; Moisture, protein (N x 6.25), fat and ash were determined to evaluate the carcass gross compositions (AOAC, 2010).

pH determination: For determining pH of the carcass; 20 g of ground meat was blended with 20 ml distilled water for 1 min using an Ultra Turrax T-25 (Janke and Kunkel IKA-Labortechnik, Staufen, Germany). A CG822 pH meter was used to determine the pH at 20°C.

Water holding capacity: The method of Hung and Zayas was used for determining water holding capacity (WHC) (Wang and Zayas, 1992). A Whatman No.2 filter paper was soaked in saturated KCl and then dried under vacuum. The meat (0.3 g) was placed on the paper and 2 plastic plates with dimensions of 6 x 6 x 0.8 inches were placed above and below the paper. A 1 kg weight was placed on the top plate. After 20 min, the area of the pressed meat and the total area of the moistened paper were measured using area measurement system (Delta-T Devices Ltd, London, England). WHC was calculated from the following equation:

$$WHC = [1-(B-A)/A] \times 100$$

where, B is the area of the moistened filter paper and A is the area of the pressed meat (Wang and Zayas, 1992).

Dripping loss: For dripping loss determination, meat samples were cut from the frozen muscles and immediately weighed. The samples weights were 40-50 g. The samples were placed within the container on the supporting mesh and sealed. After a storage period (usually 24 h) at chill temperatures (1 to 5°C), samples were again weighed. Drip loss is expressed as a percentage of the initial weight (Honikel, 1998).

Tensile strength: Tensile strength was calculated from the maximum load during a tension test carried out in order to rupture the specimen using an Instron Universal testing machine (Instron Co, Model 1140, California, USA). Breast muscles were cut perpendicular to the muscle fiber orientation to produce 0.3 cm thick slices. The slices were hooked to the testing machine and the resistance to tearing (tensile stress) was determined at a tensile velocity of 1 mm/sec (Honikel, 1998).

Feed efficiency and nitrogen excretion: Abdominal fat pad, heart, liver, gizzard, breast and thigh muscles of chickens were removed and weighed individually and breast percentage in both sex were measured. The performance characteristics which monitored were feed intake, body weight gain, feed conversion ratio (FCR). These were measured during the starter, grower and the finisher phases. The economics of all the rations was also calculated. Nitrogen excretion was measured by macro kjeldahl method on the fecal samples from day 37 to day 49 (AOAC, 2010).

Organoleptic test: A questionnaire was designed to evaluate the organoleptic and sensory characteristics of the various breast muscles of chicken samples in terms of apparent figure, color, texture, taste and odor intensity using a five-point descriptive Hedonic Scale (5-Like very much, 4-Like moderately, 3-Neither like nor dislike, 2-Dislike moderately, 1-Dislike very much). Chicken samples were steam cooked and a taste panel of 18 judges, consisting of randomly selected PhD students and members of the academic staff of food hygiene department, were used for the assessment.

The samples were coded and presented to the panelists blind so that each panelist did not know which sample they were evaluating.

Statistical analysis: Data were analyzed statistically by SPSS software (version 19). One-way analysis of Variance (ANOVA) and Duncan's multiple range test as a post hoc test were used for comparing means. Kruscal wallis test was used for non parametric variables. Comparing male and female was done by independent-sample Student's t-test. The level of significance was established at $p<0.05$.

RESULTS AND DISCUSSION

The present study was conducted to investigate the effects of dietary crude protein (CP) on performance

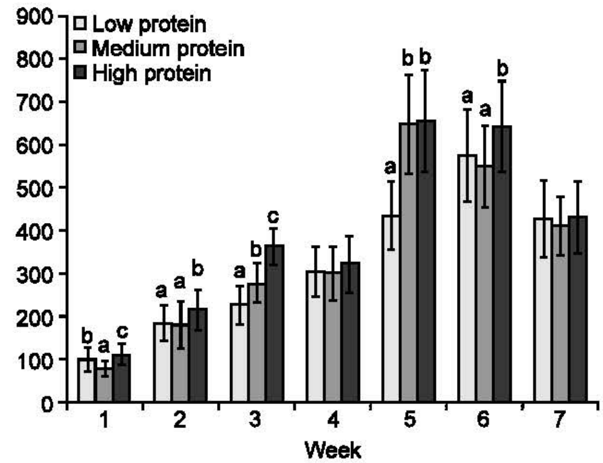

Fig. 1: Comparison of body weight gain in 3 experimental groups

(weight gain, feed conversion and feed efficiency ratio) and carcass compositions in broilers. The importance of utilizing the correct amount of balanced dietary protein and amino acids for poultry is a high priority issue. The reduction of protein level is an economic and metabolic advantage to broilers (Deschepper and DeGroote, 1995). Meeting the nutritional requirements for broiler chickens constitutes a large percentage of the cost of production. Reducing the level of crude protein (CP) in the diet may allow a reduction in feed costs, use of alternate feedstuffs and an improved ability to cope with heat stress (Kidd *et al.*, 1996).

In first, second and third groups 1 mortality occurred at days 14, 17 and 42 respectively. A significant ($p<0.05$) effect of dietary CP concentration on BWG and feed intake was observed. As shown in Fig. 1, the high protein group had the highest increase of body weight gain in first, second, third and sixth weeks and higher body weight and FCR at the end of the study (Table 4). Final FCR and body weight were significantly ($p<0.05$) lower in the group that received low protein diet. Some researches in broilers proposed that crude protein in diets can be reduced to a point without harming performance with the addition of synthetic amino acid supplementation (Lipstein and Bornstein, 1975; Waldroup *et al.*, 1976; Uzu, 1982; Han *et al.*, 1992; Kerr and Kidd, 1999; Aletor *et al.*, 2000; Dean *et al.*, 2006; Namroud *et al.*, 2008) or a combination of essential amino acids and a source of non-essential amino acids (as nitrogen) (Corzo *et al.*, 2005). Ciftci and Ceylan reported that a basal diet containing high CP (21.30%) resulted in poorer performance than a low CP (19.13 and 17.97%) during starter period when the low-CP basal diets were supplemented with synthetic amino acids to match amino acid content of the control diet (Ciftci and Ceylan, 2004). On the other hand, other studies have reported impaired weight gain and

Table 1: Composition of the broiler starter, grower and finisher diets

	Groups								
Diet (kg)	LP1	LP2	LP3	MP1	MP2	MP3	HP1	HP2	HP3
Yellow corn	671.6	730.12	802	611	669.63	739.12	516	605.57	679.04
Soybean meal	273	214	150	336.21	277.12	215	406	344	278.12
Vitamin supplement	3	3	2.7	3	3	2.7	3	3	2.7
Mineral supplement	3	3	2.7	3	3	2.7	3	3	2.7
DL-Methionine	3.01	2.9	3.3	2.28	2.2	2.56	1.93	1.43	1.85
L-Lysine	3.5	3.98	5	1.54	5.2	3.02	0	0	1.09
Conch	15	15	14	15	15	14	14.5	15	14
Dicalcium phosphate	15	15	13	15	15	13	14.5	15	12.5
NaCl	3	3	3	3	3	3	3	3	3
Oil	10	10	5	10	10	5	38.07	10	5

LP1, MP1 and HP1 are low, medium and high protein starter diet, respectively. LP2, MP2 and HP2 are low, medium and high protein grower diet, respectively. LP3, MP3 and HP3 are low, medium and high protein finisher diet, respectively

Table 2: Calculated nutrient content of starter, grower and finisher diets

Groups								
LP1	MP1	HP1	LP2	MP2	HP2	LP3	MP3	HP3
2970	2920	2996	3024	2974	2924	3067	3016	2968
18.01	19.98	21.99	16.02	17.99	20.07	14	16.03	18.00
0.59	0.55	0.54	0.56	0.52	0.47	0.57	0.53	0.48
1.27	1.25	1.28	1.16	1.14	1.12	1.08	1.07	1.05
0.23	0.26	0.30	0.20	0.23	0.27	0.17	0.20	0.23
164.91	146.15	136.26	188.72	165.33	145.55	219.08	188.16	164.88
5009.2	5336.33	5591.53	5413.62	5766.38	6247.23	5350.05	5716.34	6132.51
2341.14	2340.24	2340.09	2614.57	2612.52	2611.52	2828.32	2826.37	2828.90
3605.27	3695.22	3605.56	3978.99	3970.83	3976.99	4126.15	4128.76	4129.37
0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
0.97	1.11	1.26	0.84	0.98	1.13	0.70	0.84	0.98
0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22

1-12 numbers are energy (kcal/kg), crude protein (%), methionine (%), lysine (%), cystine (%), energy to protein ratio, energy to methionine ratio, energy to lysine, energy to TSAA (methionine + cystine), sodium (%), potassium (%) and chlor (%) respectively

LP1, MP1 and HP1 are low, medium and high protein starter diet, respectively. LP2, MP2 and HP2 are low, medium and high protein grower diet, respectively. LP3, MP3 and HP3 are low, medium and high protein finisher diet, respectively

Table 3: Calculated and analyzed composition in starter, grower and finisher diets in 3 experimental groups

	Calculated component				Analyzed component			
Groups	ME	CP	Methionine	Lysine	ME	CP	Methionine	Lysine
LP1	2970	18.01	0.59	1.27	2910	18.00	0.47	1.1
MP1	2920	19.98	0.55	1.25	2886	19.90	0.44	1.00
HP1	2996	21.99	0.54	1.28	2932	21.9	0.43	1.05
LP2	3024	16.02	0.56	1.16	2950	16.01	0.44	1
MP2	2974	17.99	0.52	1.14	2900	17.85	0.41	0.91
HP2	2921	20.07	0.47	1.12	2845	20.1	0.38	0.9
LP3	3067	14.00	0.57	1.08	3000	14.02	0.46	0.85
MP3	3016	16.03	0.53	1.07	2944	16.3	0.43	0.85
HP3	2968	18.00	0.48	1.05	2838	18.05	0.38	0.84

ME: Metabolizable energy, CP: Crude protein, LP, MP and HP are low, medium and high protein groups respectively and 1-3 numbers are starter, grower and finisher diets respectively

LP1, MP1 and HP1 are low, medium and high protein starter diet, respectively. LP2, MP2 and HP2 are low, medium and high protein grower diet, respectively. LP3, MP3 and HP3 are low, medium and high protein finisher diet, respectively

Table 4: Mean weight gain and FCR at the end of the study (mean±SD)

Groups	Mean final weight (gr)	FCR
Low protein (n = 49)	2292±320.21[c]	1.59±0.37
Medium protein (n = 49)	2534±310.84[b]	1.77±0.43
High protein (n = 49)	2785±314.51[a]	1.78±0.47

Values with differing letters are significantly (p<0.05) different

Table 5: Nitrogen excretion (NE) in 3 experimental groups (mean ±SD)

Groups	Nitrogen excretion (%)
Low protein (n = 49)	0.97±0.16[b]
Medium protein (n = 49)	1.13±0.17[a]
High protein (n = 49)	1.26±o.14[a]

Values with differing letters are significantly (p<0.05) different

feed efficiency when broilers were fed low protein amino acid supplemented diets (Parsons and Baker, 1982; Bregendahl *et al.*, 2002; Si *et al.*, 2004; Jiang *et al.*, 2005). Feffer *et al.* (2000) reported that broiler chicks

Table 6: pH, tensile strength, dripping loss and water holding capacity of each group (mean±SD)

Groups	pH	Tensile strength (grF)	Dripping loss (%)	Water holding capacity (%)
Male				
Low protein (n = 5)	5.10±0.40[b]	82.80±33.98	4.21±2.88	56.60±1.94
Medium protein (n = 5)	5.72±0.05[a]	88.80±44.22	4.18±2.49	55.60±2.40
High protein (n = 5)	5.90±0.15[a]	110.83±18.60	5.42±1.97	56.33±1.36
Female				
Low protein (n = 5)	5.28±0.32[b]	101.20±31.23	3.46±1.12	51.20±6.05[b]
Medium protein (n = 5)	5.62±0.11[a]	122.80±30.12	3.13±1.99	59.60±3.20[a]
High protein (n = 5)	5.83±0.11[a]	88.50±20.28	3.94±1.53	55.83±5.19[ab]

Values with different superscripts of each column in the same sex differ significantly ($p<0.05$)

Table 7: Carcass moisture, protein, fat and ash of each group (mean±SD)

Groups	Moisture (%)	Protein (%)	Crude fat (%)	Ash (%)
Male				
Low protein (n = 5)	71.80±0.83	25.44±1.34	27.00±0.70	96.8±0.44[a]
Medium protein (n = 5)	72.20±0.44	24.42±1.5	28.00±0.70	95.00±1.00[b]
High protein (n = 5)	72.33±0.51	24.15±0.96	27.00±1.2	95.50±1.37[ab]
Female				
Low protein (n = 5)	73.00±0.70	25.77±3.15[a]	28.20±0.83	95.60±0.89
Medium protein (n = 5)	72.00±0.70	24.02±0.74[a]	27.80±0.44	95.00±1.0
High protein (n = 5)	72.33±1.03	20.93±1.99[b]	27.66±0.51	95.33±0.81

Values with different superscripts of each column in the same sex differ significantly ($p<0.05$)

Table 8: Comparison of evaluated carcass composition factors of each group (mean±SD)

Groups	Carcass/live weight	Abdominal fat weight (gr)	Breast weight (gr)	Breast muscle (%)
Male				
Low protein (n = 5)	0.844±0.011	69.00±10.63	522.60±77.70[b]	87.60±0.54[ab]
Medium protein (n = 5)	0.848±0.014	58.40±26.06	628.60±119.30[ab]	85.20±6.30[b]
High protein (n = 5)	0.846±0.010	58.16±14.70	706.66±123.49[a]	91.33±1.21[a]
Female				
Low protein (n = 5)	0.862±0.016	69.40±14.22	440.40±71.59b	88.80±1.30[b]
Medium protein (n = 5)	0.858±0.010	56.60±27.53	517.80±79.51ab	82.00±3.60[c]
High protein (n = 5)	0.856±0.12	60.83±16.83	584.33±55.06a	92.66±1.03[a]

Values with different superscripts of each column in the same sex differ significantly ($p<0.05$)

Table 9: Comparison of thigh, liver, heart and gizzard weight of each group (mean±SD)

Groups	Thigh weight (gr)	Liver weight (gr)	Heart weight (gr)	Gizzard weight (gr)
Male				
Low protein (n = 5)	489.40±61.16[b]	64.00±2.34	12.40±2.07	43.20±4.43
Medium protein (n = 5)	593.00±76.16[a]	62.40±3.57	14.40±2.30	46.00±7.96
High protein (n = 5)	598.50±48.64[a]	60.00±7.69	15.33±2.16	48.33±5.24
Female				
Low protein (n = 5)	400.20±45.08[b]	56.60±10.06	10.80±0.83	38.80±3.56
Medium protein (n = 5)	472.80±35.56[a]	57.20±7.39	11.40±1.14	40.40±2.88
High protein (n = 5)	478.83±56.10[a]	67.16±7.25	10.66±1.86	42.83±3.06

Values with different superscripts of each column in the same sex differ significantly ($p<0.05$)

reared on diets containing various levels of CP prefer diets containing the lowest CP content (Feffer *et al.*, 2000). In present study feed consumption was higher in chicks with high protein diet, but chicks fed the lower protein diet had better FCR ($p<0.05$). Similar finding were reported by Urdaneta-Rincon and Leeson (Urdaneta-Rincon and Leeson, 2008). They reported that chicks fed on low CP diet (17%) had a significantly ($p<0.05$) reduced feed intake in comparison to the chicks reared on dietary CP ranging from 19 to 25% (Urdaneta-Rincon and Leeson, 2008). But our results is in contrast with those of Ferguson *et al.* (1998a) and Waldroup *et al.* (2005) reporting increased FCR due to decreasing CP levels and research of Ferguson *et al.* (1998b), Kidd *et al.* (2001) and Bregendahl *et al.* (2002) who found significant increase in feed intake by broiler chicks fed on diet with CP 20% and supplemented with amino acids as against those fed a 23% CP diet. Also the results of the present study on feed intake are not supported by the findings of some works that demonstrated that the reduction in the crude protein levels in the diet does not affect feed intake of broiler chickens (Han *et al.*, 1992; Bartov and Plavnik, 1998; Blair *et al.*, 1999; Hai and Blaha, 2000; Kidd *et al.*, 2001; Sabino, 2001).

Nitrogen excretion in high protein diet chicks was higher (Table 5), which indicates that chicks fed above 18% CP might have excreted excess nitrogen rather than utilizing

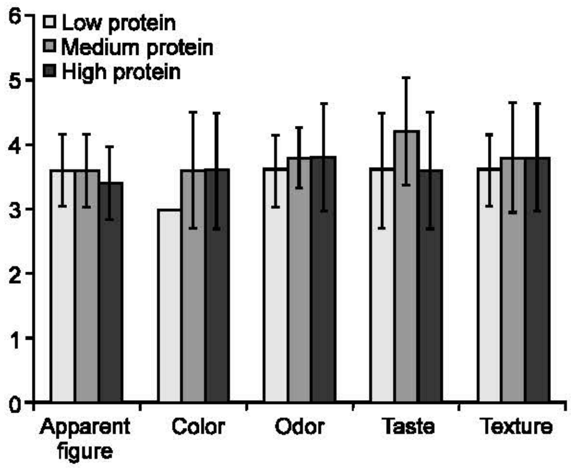

Fig. 2: Comparison of cooked thigh meat in 3 experimental groups with organoleptic test

it or the crude protein was metabolized and increased heat increment (Sabino, 2001). These findings are in agreement with those researches which revealed that high protein diets may lead to an increase in nitrogen excretion which has a negative environmental impact (Wolde *et al*., 2010; Aletor *et al*., 2000; Blair, 2008).

Some of the carcass characteristics of the broiler chicken were affected by the different dietary levels of protein. There was significant reduction in pH and water activity for birds on low CP diet compared with those on high CP diet in both sexes. Chicks fed on different levels of dietary CP were not significantly ($p \geq 0.05$) different in the tensile strength and dripping loss. In low protein group, water holding capacity was lower in female birds (Table 6).

Table 7 shows percentage of moisture, protein, fat and ash. Carcass ash in males was significantly higher in the group with low protein. Differences between treatments were non-significant for carcass moisture and fat. The percentage of protein in female carcasses was significantly ($p<0.05$) lower in chicks with high crude protein compared to the other treatment groups. Abdominal fat weight was unaffected by the different diets throughout the study. These results were not supported by the findings of some research demonstrating that low crude protein amino acid fortified diets result in increased abdominal fat (Bartov, 1985; Deschepper and DeGroote, 1995; Kerr and Kidd, 1999; Leeson and Summers, 2009). Breast muscle weight was higher in group that received high protein diet but percentage of breast muscle was higher in group that received low-protein diet (Table 8). Hai and Blaha (2000) and Kamran *et al*. (2008) also observed that decrease in dietary CP level had no negative effects on carcass proteins. Weight of thigh, heart, liver and gizzard were significantly ($p<0.05$) higher in birds fed diet containing high protein and there was not any significant difference between low and medium protein groups (Table 9).

To our knowledge there is little information about effects of dietary protein levels on meat quality. These results agree with Ferguson *et al*. (1998a) that reported meat pH reduces with decrease level of protein and Allen *et al*. (1997) who noted significant decrease in water activity. But our result is in contrast with those of Allen *et al*. (1997) who reported increase in dripping loss of chicks fed diets with lower protein diet.

Figure 2 shows results of organoleptic test of chicks fed the different treatment diets. We didn't see any significant differences between organoleptic properties of three studying groups. According to Fletcher (2002) the major poultry meat quality attributes are appearance, texture, juiciness, flavor and functionality. Meat color is a very important quality trait as it determines the appearance of meat and plays an important role in consumer acceptance of a product. Our results presented that reduction in dietary protein level has no negative effects on meat quality of broiler chickens. Economic evaluation of the trial revealed that decreasing CP resulted in reduced feed cost per kg of live weight gain (data not shown).

Conclusions and applications: The overall picture of the study suggests that (1) dietary protein level of broilers could be reduced by 2%, with beneficial effects on FCR, growth performance and carcass characteristics and increased economic impact. (2) The lowest level to which crude protein can be reduced with amino acid supplementation in broiler diets without reducing bird performance is still unknown and additional research is needed in order to discover the minimum levels of amino acids necessary to achieve maximum growth and efficiency.

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