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Effects of Dietary Protein Level on Protein Deposition in Broilers: 2. Body Composition, Plasma Metabolic Profile and Litter Composition

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Abstract. The aim of the present study was to assess the effects of three dietary protein levels on body composition, plasma metabolic profile and litter composition of broilers at 42 days of age. One-day-old unsexed Cobb 500 broilers (n=600) were randomly assigned in 3 groups with 4 replications per treatment. Three diets were formulated for each growth phases, to contain 3 levels of protein: high protein (HP), medium protein (MP) and low protein (LP). The diets were isocaloric, with similar content of digestible sulphur amino acids, lysine, calcium and available phosphorus. The empty body weight (BW) of broilers was influenced by the dietary treatments (+ 8% in HP, respectively - 7.7% in LP *vs.* MP; P<0.001). The carcass fraction in the HP diet represented 86.97% of BW and in the LP diet 85.47% of BW vs. MP (85.79% of BW; P<0.028). Also, the organ fraction was influenced by the dietary protein level in HP diet represented 10.52% of BW and in the LP 11.73% of BW vs. MP (11.42%; P<0.041). The chemical composition of carcass, organ and feathers fraction was not affected by the dietary treatments (P>0.05). In general, plasma biochemical parameters were not influenced by the dietary protein levels (P>0.05). In conclusion, low protein diets can support similar quality performance that high or medium diets when the quality ingredients are used. The lower dietary protein level resulted in reduced nitrogen excretion, which is an important advantage for environmental safety.

Keywords: protein level, body composition, plasma profile, *Cobb 500* broilers, litter composition

INTRODUCTION

Dietary protein is used in broilers for many functions, the most important being accretion as broiler meat (Aftab *et al.*, 2006). Manipulation of the dietary protein level has a major effect on performance and body composition of chickens (Buyse *et al.*, 1992; Collin *et al.*, 2003; Nieto *et al.*, 1997), muscle protein mass (Grizard *et al.*, 1995) and by inference, protein metabolism and muscle growth (Urdaneta-Rincon and Leeson, 2004). However, maximum protein deposition is associated with an optimum requirement of crude protein (CP) and amino acids (AA), where AA levels above those needed for growth does not improve protein deposition likely due to increased rate of protein catabolism (Urdaneta-Rincon and Leeson, 2004). It is known that a decrease in dietary protein level causes a decrease in carcass protein and an increase in carcass fat content (Si *et al.*, 2001). However, the use of low CP diets with AA supplementation is an effective way to reduce the nitrogen (N) excretion by broilers (Donsbough *et al.*, 2010) because 60 to 65% of the ingested dietary N is excreted via excreta (Aletor *et al.*, 2000). Nitrogen pollution is one of the greatest concerns for the public, for excesses excreted by animals can pollute not only water, but also air (Nahm, 2007).

Improved meat quality attracts more attention from consumers, and excessive fat deposition is one of the most important factors of poor meat quality of broilers (Zhan *et al.*,

2007). Also, the changes in protein metabolism and body composition of broilers due to the dietary protein level are reflected in blood plasma levels of intermediary metabolites. Several biochemical variables are strongly influenced by the nutritional status and nutritional deficiencies and can serve as bioindicators for more complex processes, such as AA degradation and N excretion (Friendship, 1984; Swennen *et al.*, 2005).

The findings regarding the effect of different dietary protein levels in isocaloric diets on broiler metabolism and body composition are controversied and still more research is needed in order to understand broilers' response. Therefore, the aim of present study was to evaluate the effects of three dietary protein levels on body composition, plasma metabolic profile and litter composition of broilers at 42 days of age.

MATERIALS AND METHODS

***Birds, housing and diets*.** The trial was performed on the experimental farm of INCDBNA-Balotesti, in an environmentally controlled house. Birds were treated in accordance with Romanian law no. 305/2006 (M.O. no. 685/2006) regarding handling and protection of animals used for experimental purposes. All experimental procedures used in this experiment were approved by the Animal Care Committee of the INCDBNA, Balotesti.

Six hundred *Cobb 500* one-day-old unsexed broiler chicks were randomly assigned in three treatments groups with 4 replications per treatment and 50 broilers per replication. Each group and replicate was kept in pens (2.5 m x 0.8 m) with wood shavings. The initial temperature was 33°C and it was weekly reduced by 3°C, according to breeding standards. The birds were exposed to a lighting schedule of 23 h light: 1 h darkness during the entire study. Chicken vaccination was carried out according to the usual schedule. Feed and water were provided *ad libitum*, except during 12 h prior slaughter when feed was withdrawn.

Three experimental diets were formulated for each growth phases: starter (1-10 days), grower (11-22 days) and finisher (23-42 days), respectively to contain three levels of protein (*Tab. 1*). The high protein (HP) diets contain 24, 22 and 20% CP, the medium protein (MP) diets contain 22, 20 and 18% CP and the low protein (LP) diets contain 20, 18 and 16% CP. All diets were based on corn, wheat, soybean meal, *camelina* meal, corn gluten and synthetic methionine and lysine. The diets were isocaloric (3000, 3100 and 3200 kcal metabolisable energy within grower phases), with similar content of digestible sulphur amino acids, lysine, calcium and available phosphorus according to Cobb-Vantress (2008) nutrition recommendations. Diets were provided in mash form.

***Sampling*.** At 42 d of age, 5 broilers from each replicate were randomly selected for blood sampling and body analyses. The blood samples were collected in heparinized tubes from wing vein (Vacutest®, Arzergrande, Italy). Samples were transport on ice immediately and processed within 1 h of collection. After blood centrifugation, plasma was frozen at -80°C for later analysis.

The broilers were successively weighed, killed by cervical dislocation (not bled) plunged into water of 60^{o}C for 1 min, de-feathered, dried and weighed again for calculation of the weight of feathers by difference. Afterwards, the oesophagus, trachea, proventriculus, gizzard, intestines, heart, liver, gall bladder, kidneys, lungs, spleen and Bursa of Fabricius were removed from the body. These organs were defined as the *"organ fraction"*. The remaining body, including the abdominal fat pad, formed the *"carcass fraction"*. The gastrointestinal tract was stripped of its contents. The carcass and organ fractions were weighed, grounded (TC-121 electric grinder, Maxigel, Italy), manual homogenized and frozen for at –20°C for later chemical analyses. The feathers were dried and ground for chemical analyses.

At the end of experiment five samples of litter were taken from each replicate (from different place of each pen), homogenized in plastic bags and were refrigerated until the chemical analysis.

***Chemical analyses*.** The carcass and organ fractions samples were analyzed for dry matter (DM), crude protein (CP), fat and ash contents. The DM was determined by gravimetric method (SR ISO 1442:2010). The CP was determined using a semiautomatic classical Kjeldahl method (SR ISO 937:2007). The fat was extracted using an improved version of the classical method by continuous extraction in solvent (SR ISO 1444:2008) and the ash by gravimetric method (SR ISO 936:2009). Also, the feathers and litter samples were analyzed for dry matter (DM), crude protein (CP) and ash contents. The standard analytical methods were used according to working protocols in agreement with the similar international protocols. BS-130 Chemistry analyzer (Bio-Medical Electronics Co., LTD, China) was used to determine the plasma metabolic profile: energetic (glucose, cholesterol, triglycerides, HDL, LDL), protein (total protein, albumin, total bilirubin, creatinine), mineral (calcium-Ca, phosphorus-P and magnesium-Mg), enzymatic (alanine aminotransferase-ALT, aspartate aminotransferase-AST, gammaglutamil transferase-GGT).

***Statistical analysis*.** All data were analyzed using GLM procedure of SPSS (IBM SPSS Statistics version 20.0). One-way analysis of variance (ANOVA) with the post hoc Tukey's multiple comparison test was used to evaluate statistical significance of differences between the treatment groups. The results are given as means with standard error of the mean (SEM) and was considered statistically different at $P<0.05$. Replication was considered as the experiment unit for determined parameters.

RESULTS AND DISCUSSIONS

***Body composition*.** The effects of protein level on *body composition* of broilers at 42 days of age are shown in *Table 2*. The empty body weight (BW) of broilers (without the gastrointestinal tract content) was influenced by the dietary treatments (higher by 8% in HP and lower by 7.7% in LP *vs.* MP; P<0.001). The results are according to previous results presented (unpublished) when we reported that dietary protein level influences the body weight gain. Also, many available researches from the literature point to compromised weight gain in broilers when fed on low CP diets compared to high and medium CP diets (Bregendahl *et al*., 2002; Hussein *et al.*, 2001; Jiang *et al.*, 2005; Kamran *et al.,* 2008; Kerr and Kidd, 1999a; Namroud *et al.*, 2008; Si *et al.*, 2004; Waldroup *et al.*, 2005).

The carcass fraction in the HP diet represented 86.97% of BW and in the LP diet 85.47% of BW compared to MP (85.79% of BW); the differences between treatments was significant (P<0.028). Also, the organ fraction was influenced by the dietary protein level in HP diet represented 10.52% of BW and in the LP 11.73% of BW vs. MP (11.42% of BW; P<0.041). There was no significant difference (P>0.05) among dietary treatments for feathers. The experimental results showed that the BW gain was represented mainly due to carcass gain, and organ and feather fractions consist in only a minor part of BW gain (10-12% and 2.5-2.8%, respectively). Similar results reported Rivera-Torres *et al*. (2011) in a turkey trial at 5 week of age.

The *chemical composition* of carcass, organ and feathers fraction was not affected by the dietary treatments (P>0.05). The protein content of carcass fraction increase in HP (17.48 g protein/100g) and decrease in LP (15.81 g protein/100g) *vs.* MP (17.06 g protein/100g), but no significant difference was noticed between treatments (P>0.05). Conversely, the fat content decrease in HP (10.92 g fat/100g) and increase in LP (11.53 g fat/100g) *vs.* MP (10.97 g fat/100g), but no significant difference was noticed between treatments (P>0.05).

Tab. 1

Ingredient and nutrient composition of broiler diets
for grower phases (%)

Ingredients	Starter (0-10 d)			Grower (11-22 d)			Finisher (23-42 d)		
	HP[1]	MP[2]	LP[3]	HP	MP	LP	HP	MP	LP
Corn	40.50	44.07	47.46	46.25	49.55	54.30	49.80	56.78	62.06
Wheat	10.00	10.00	9.00	6.00	7.00	8.70	7.00	5.00	6.00
Soybean meal	29.80	30.00	30.40	26.14	25.69	21.40	21.00	18.83	14.40
Camelina meal	4.00	4.00	4.00	6.00	6.00	6.00	8.00	8.00	8.00
Corn gluten meal	8.00	4.00	1.00	7.00	3.00	1.40	5.00	2.50	1.20
Sunflower oil	2.70	2.80	2.90	3.65	3.65	2.90	4.38	3.90	3.10
Monocalcium phosphate	1.70	1.70	1.70	1.80	1.80	1.80	1.64	1.65	1.67
Calcium carbonate	1.71	1.71	1.71	1.60	1.60	1.60	1.49	1.49	1.51
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Vitamin-mineral premix[4]	1.00	1.00	1.00	1.00	1.00	1.00	-	-	-
Vitamin-mineral premix[5]	-	-	-	-	-	-	1.00	1.00	1.00
DL- methionine	0.06	0.15	0.23	0.05	0.15	0.21	0.10	0.17	0.24
L- lysine HCl	0.17	0.21	0.24	0.15	0.20	0.33	0.23	0.32	0.46
Choline HCl	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
TOTAL	100	100	100	100	100	100	100	100	100
Calculated composition[6] (%)									
ME (Kcal/kg)	3000	3000	3000	3100	3100	3100	3200	3200	3200
CP	24.00	22.00	20.00	22.00	20.00	18.00	20.00	18.00	16.00
ME:CP ratio	125	136	150	140	154	172	160	178	200
Lysine, total	1.23	1.23	1.23	1.13	1.13	1.13	1.06	1.06	1.05
Lysine, digestible	1.08	1.09	1.09	0.99	0.99	0.99	0.95	0.95	0.95
Met + cys, total	0.89	0.89	0.89	0.84	0.84	0.84	0.82	0.82	0.82
Met + cys, digestible	0.81	0.81	0.81	0.77	0.77	0.77	0.75	0.75	0.75
Calcium	1.00	1.00	1.00	0.96	0.96	0.96	0.90	0.90	0.90
Available phosphorus	0.50	0.50	0.50	0.48	0.48	0.48	0.45	0.45	0.45
Crude fiber	3.83	3.86	3.89	3.80	3.80	3.59	3.70	3.58	3.36
Ether extract	6.12	6.24	6.39	7.47	7.56	6.95	8.70	8.39	7.74
Analysed composition (%)									
CP	24.04	22.21	19.82	22.26	20.18	18.17	20.07	18.16	16.21
Lysine, total	1.231	1.229	1.227	1.132	1.128	1.129	1.057	1.054	1.056
Met + cys, total	0.900	0.888	0.887	0.842	0.838	0.839	0.818	0.816	0.819
Calcium	0.99	0.99	0.99	0.95	0.94	0.95	0.87	0.88	0.89
Phosphorus, total	0.90	0.95	0.90	0.88	0.86	0.84	0.85	0.83	0.83
Crude fiber	3.75	4.03	3.45	3.76	4.06	4.43	3.78	3.80	3.91
Ether extract	4.78	4.98	5.52	6.76	6.76	5.42	7.02	6.28	6.03

Note: [1]HP- high protein; [2]MP – medium protein; [3]LP- low protein

[4] Supplied per kg diet: retinyl acetate, 4.47 mg; cholecalciferol, 0.12 mg; DL-α-tocopheryl acetate, 80 mg; menadione sodium bisulphite, 4 mg; thiamine mononitrate, 4 mg; riboflavin, 9 mg; pyridoxine-HCl, 4 mg; cyanocobalamin, 0.020 mg; Ca-panthotenate, 15 mg; niacin, 60 mg; folic acid, 2 mg; Mn, 100 mg; Zn, 100 mg; Fe, 40 mg; Cu, 15 mg; I, 1.0 mg; Se, 0.30 mg; Co, 0.25 mg, lasalocid sodium, 60 mg.

[5] Supplied per kg diet: retinyl acetate, 2.90 mg; cholecalciferol, 0.12 mg; DL-α-tocopheryl acetate, 50 mg; menadione sodium bisulphite, 3 mg; thiamine mononitrate, 2 mg; riboflavin, 8 mg; pyridoxine-HCl, 3 mg; cyanocobalamin, 0.015 mg; Ca-panthotenate, 12 mg; niacin, 50 mg; folic acid, 1.5 mg; Mn, 100 mg; Zn, 100 mg; Fe, 40 mg; Cu, 15 mg; I, 1.0 mg; Se, 0.30 mg; Co, 0.25 mg.

[6] based on feed composition

Also, the same trend was observed in the protein content of organs fraction (16.29 in HP and 15.29 g protein/100g in LP *vs.* 15.94 g protein/100g in MP) and fat content (9.14 in HP and 11.14 g fat/100 g in LP *vs.* 10.31 in MP), with no significant difference (P>0.05).The results obtained in our study are in agreement with other researches. Si *et al*. (2001) found

that the CP and amino acids status of a diet influenced the carcass composition of broilers, and decrease in dietary CP level causes a decrease in carcass protein and an increase in carcass fat content. Also, Hai and Blaha (2000) concluded that the decrease in dietary CP level had no adverse effect on carcass protein. Bregendahl *et al.* (2002) did not find any significant difference in the whole body CP content of chicks fed low CP diets as compared to the control. Gous *et al.* (2012) related that was differences in the carcass water contents at the end of experiment between broilers on the various dietary treatments and of different initial fatnesses, but the carcass ash and protein showed no consistent differences between treatments.

Tab. 2

Effects of protein level on body composition of broilers at 42 days of age[1]

Item	Dietary treatments				
	HP	MP	LP	SEM	P-value
Empty body weight (g/bird)	2174.00[a]	2010.00[b]	1855.00[c]	42.35	0.001
Empty body (% of BW)					
Carcass fraction	86.97[a]	85.79[ab]	85.47[b]	0.26	0.028
Organs fraction	10.52[b]	11.42[ab]	11.73[a]	0.22	0.041
Feathers	2.51	2.79	2.80	0.06	0.068
Chemical composition of carcass fraction (g/100g)					
Water	69.18	68.21	66.66	1.04	0.650
Protein	17.48	17.06	15.81	0.41	0.243
Fat	10.92	10.97	11.53	0.63	0.922
Ash	2.78	3.09	3.11	0.14	0.619
Chemical composition of organs fraction (g/100g)					
Water	70.92	69.89	66.96	1.16	0.392
Protein	16.29	15.94	15.29	0.22	0.051
Fat	9.14	10.31	11.14	0.86	0.683
Ash	1.71	2.32	2.52	0.19	0.207
Chemical composition of feathers (g/100g)					
Water	6.72	6.70	6.68	0.04	0.931
Protein	88.29	87.20	86.57	0.38	0.195
Ash	1.21	1.22	1.25	0.01	0.662

Note: [abc]Means within row with no common superscripts differ significantly (ANOVA GLM; Tukey's test, $P < 0.05$); [1] Means of 4 replicates with 5 broilers from each replicate

On the other hand, Namroud *et al.* (2008) did not observe significant difference in percentage of whole body CP, but dietary CP affected the whole body fat conversely. Also, the same authors suggested that one of the mechanisms involved in decreasing carcass fatness by feeding higher protein level diets is the associated increased heat increment involved in deamination and transamination of surplus amino acids to other metabolites and finally uric acid.

As expected, the composition of carcass and organ fraction mostly consisted of water, and contained 15-17% protein, 9-11% fat and 2-3% ash, while the feathers composition mostly consisted of protein (86-88%).

Plasma metabolic profile. The effects of protein level on plasma metabolic profile of broilers at 42 days of age are presented in *Table 3*. In general, plasma biochemical parameters were not significantly affected by the dietary protein levels.

The results showed that the dietary protein content did not affect the plasma glucose concentration (273.22 in HP and 264.85 mg/dL in LP vs. 275.13 in MP; $P>0.05$) the obtained values being in normal range (Clinical Diagnostic Division, 1990). Also, indicated that carbohydrate metabolism was not affected by the diet (Gonzalez-Barranco and Rios-Torres,

2004; Malheiros *et al.*, 2003; Swennen *et al.*, 2005). It is known that triglycerides are important energetic products particularly used by chicks for growth performance (Swennen *et al.*, 2007; Zhan *et al.*, 2007). In our study, the plasma level of triglycerides was increased (46.00 mg/dL) in LP diet compared to HP (43.25 mg/dL) or MP (41.50 mg/dL), but the difference were not significant (P>0.05). It was expected that the plasma triglycerides concentration of the broilers fed LP diet increased because the increase ME:CP ratio that accelerated the process of lipogenesis in the body (Rosebrough and Steele, 1985; Swennen *et al.*, 2005). Contrary to our study, Teteh *et al.* (2010) reported that plasma levels of triglyceride and total protein were affected by the dietary protein or energy levels in layer type chicks until 8 week of age.

Tab. 3

Effects of protein level on plasma metabolic profile of broilers at 42 days of age*

Item		Dietary treatments				
Plasma profile	Reference	HP	MP	LP	SEM	P-value
Energetic						
Glucose (mg/dL)	197-299[2]	273.22	275.13	264.85	3.07	0.384
Cholesterol (mg/dL)	86-211[1]	97.18	87.10	108.73	4.11	0.087
Tryglicerides (mg/dL)	59.04[3]	43.25	41.50	46.00	2.14	0.728
HDL (mg/dL)	76.38[3]	77.25	63.75	69.50	3.03	0.198
LDL (mg/dL)	-	25.28	23.95	24.50	0.67	0.763
Protein						
Total protein (g/dL)	3.0-5.5[1]	3.49	3.11	3.40	0.08	0.121
Albumin (g/dL)	1.3-2.8[1]	1.53	1.43	1.55	0.03	0.327
Total bilirubin (mg/dL)	0.41[6]	0.26	0.27	0.44	0.05	0.235
Creatinine (mg/dL)	0.31-1.8[1]	0.33	0.34	0.37	0.03	0.852
Mineral						
Ca (mg/dL)	8.1-12[2]	10.48	10.33	9.96	0.11	0.156
P (mg/dL)	6.2-7.9[1]	8.21	7.28	7.25	0.18	0.063
Mg (mg/dL)	1.64-2.15[4]	1.54	1.65	1.56	0.03	0.369
Enzymatic						
ALT (U/L)	7.9-10.20[4]	8.80	11.10	7.85	1.62	0.740
AST (U/L)	35.97-198[3]	44.07	37.22	34.07	3.67	0.571
GGT (U/L)	19-22[5]	15.02	17.98	16.65	0.95	0.488

Note: [*]Means of 4 replicates with 5 broilers from each replicate; [1]Ritchie *et al.*, (1994); [2]Clinical Diagnostic Division (1990); [3]Kudair and Hussary, (2010); [4]Abdi-Hachesoo *et al.*, (2011); [5]Bilgili *et al.* (2006); [6]Silva *et al.* (2007)

The plasma cholesterol concentration of dietary treatments was similar (P>0.05), but a wide variation is possible due to the effect of diet because lowering the protein intake results in a higher level of serum cholesterol (Palomeque *et al.*, 1991). The plasma levels of HDL and LDL was not affected by dietary protein level (P>0.05) and was found in normal ranges (Kudair and Hussary, 2010; Ritchie *et al.*, 1994).

Total plasma proteins are a common parameter utilized to estimate the avian body condition. Moreover, albumin, one of the main serum proteins, serves as the most favorable source of amino acids for synthesis of tissue proteins (Yaman *et al.*, 2000). Total plasma protein concentration was not influenced by the dietary treatments (3.49 in HP and 3.40 g/dL in LP vs. 3.11 g/dL in MP; P>0.05). Similarly, Corzo *et al.* (2005) observed that total plasma protein was not affected by feeding low protein diet supplemented with essential amino acids and non-essential amino acids, while plasma uric acid was substantially (P<0.05) decreased.

Creatinine is another important indicator of protein metabolism, a by-product of phosphocreatine breakdown in skeletal muscle. Its concentration is directly proportional to

muscle mass, related to age, physical activity and like the majority of blood chemistry constituents, is influenced by diet (Szabo *et al.*, 2005). In our study, the plasma levels of albumin, total bilirubin, creatinine was not affected by dietary protein level (P>0.05) and were found within physiological normal values (Ritchie *et al.*, 1994; Silva *et al.*, 2007).

Minerals are essential for broiler growth and they are involved in many digestive, physiological and biosynthetic processes within the body. In the present study the plasma Ca, P and Mg concentration was in normal range (Abdi-Hachesoo *et al.*, 2011; Clinical Diagnostic Division, 1990; Ritchie *et al.*, 1994) and not affected by the dietary protein level (P>0.05).

Enzyme activities in birds are variable and originate from different organs. In poultry, aspartate aminotransferase (AST), alanine aminotransferase (ALT) and gammaglutamil transferase (GGT) are synthesized in muscle, skeletal and cardiac, and in second order in the liver (Brugere-Picoux *et al.*, 1987). No significant differences between the dietary treatments were noticed for ALT, AST and GGT enzymes (P>0.05), the plasma concentration of these parameters was within physiological normal values (Abdi-Hachesoo *et al.*, 2011; Bilgili *et al.*, 2006; Kudair and Hussary, 2010).

Litter composition. The results regarding the effect of protein level on litter composition of broilers at 42 days of age (*Tab. 4*) showed that the nitrogen content of litter was significant influenced by the dietary treatments (P<0.008), in HP increase with 6.29% and in LP diet decrease with 8.76% *vs.* MP.

Tab. 4

Effects of protein level on litter composition of broilers at 42 days of age[1]

Item	Dietary treatments				
	HP	MP	LP	SEM	P-value
Chemical composition					
Moisture (%)	77.34	76.24	76.25	0.540	0.738
Nitrogen (% DM)	4.73[a]	4.45[ab]	4.06[b]	0.100	0.008
Ash (% DM)	12.73	13.01	13.68	0.296	0.535

Note: [ab]Means within row with no common superscripts differ significantly (ANOVA GLM; Tukey's test, P < 0.05); [1] Means of 4 replicates with 5 broilers from each replicate.

Also, Kerr (1995) reported that amino acid supplementation of LP diets for both poultry and swine on average reduced N excretion by 8.5% per one % unit reduction in CP, regardless of body weight. Litter moisture was increased in HP (1.44%) *vs.* MP, but no significant difference was observed between treatments (P>0.05). Also, the ash content was not affected by the dietary treatments (P>0.05). These results are similar with those found by Moran *et al.*, (1992) and Khajali and Moghaddam (2006), who reported a significant decrease in N content but recorded no change in the associated moisture and ash contents.

CONCLUSION

The results of present study indicate that the quantity of body composition (the proportion of carcass and organs fraction) of broilers was significantly influenced by the dietary protein level, but the quality of body composition (chemical composition) was similar. This demonstrated that low protein diets allow for similar transformation of protein and energy intake into tissue synthesis and accretion. Also, the results are sustaining with the plasma metabolic profile that reflected the broilers health condition.

In conclusion, low protein diets can support similar quality performance that high or medium diets when the quality ingredients are used. The lower dietary protein level resulted in reduced nitrogen excretion, which is an important advantage for environmental safety.

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REFERENCES

1. Abdi-Hachesoo, B., Alireza Talebi and Siamak Asri-Rezaei (2011). Comparative study on blood profiles of indigenous and Ross-308 broiler breeders. Global Veterinaria 7 (3): 238-241.

2. Aftab, U., M. Ashraf and Z. Jiang (2006). Low protein diets for broilers. World's Poult. Sci. J. 62: 688-698.

3. Aletor, V.A., I.I. Hamid, E. Nieb and E. Pfeffer (2000). Low protein amino acid-supplemented diets in broiler chickens: Effects on performance, carcass characteristics, whole body composition and efficiencies of nutrient utilization. J. Sci. Food Agric. 80: 547–554.

4. Bilgili, S.F., E.T. Moran, Jr. and J.S. Spano (2006). Pre-slaughter alterations in blood chemistry of broiler chickens. Proceedings of the "XVI European Symposium on the Quality of Poultry Meat" and the "X European Symposium on the Quality of Eggs and Egg Products", Saint-Brieuc Ploufragan, France.

5. Bregendahl, K., J.L. Sell and D.R. Zimmerman (2002). Effect of low protein diets on growth performance and body composition of broiler chicks. Poult. Sci. 81: 1156–1167.

6. Brugere-Picoux, J., Brugere, H., Basset, I., Sayad, N., Vaast, J. and Michaux, J.M. (1987). Biochimie clinique en pathologie aviaire. Intérêt et limites des dosages enzymatiques chez la poule. Recuel Médicine Vétérinari, 163: 1091-1099.

7. Buyse, J., Decuypere, E., Berghman, L., Kühn, E.R. and Vandesande, F. (1992). Effect of dietary protein content on episodic growth hormone secretion and on heat production of male broiler chickens. Br. Poult. Sci. 33, 1101-1109.

8. Cobb-Vantress (2008). COBB 500 Broiler Performance and Nutrition.

9. Collin, A., R.D. Malheiros, V.M.B. Moraes, P. Van As, V.M. Darras, M. Taouis, E. Decuypere and J. Buyse (2003). Effects of dietary macronutrient content onenergy metabolism and uncoupling protein mRNA expression in broiler chickens. Br. J. Nutr. 90: 261-269.

10. Corzo, A.C., Fritts, A., Kidd, M.T. and Kerr, B.J. (2005). Response of broiler chicks to essential and non-essential amino acid supplementation of low crude protein diets. Anim. Feed Sci. Tech., 118: 319-327.

11. Clinical Diagnostic Division. (1990). Veterinary Reference Guide. Eastman Kodak Company, Rochester, New York.

12. Donsbough , A.L., S. Powell , A. Waguespack , T.D. Bidner , and L.L. Southern (2010). Uric acid, urea, and ammonia concentrations in serum and uric acid concentration in excreta as indicators of amino acid utilization in diets for broilers. Poult. Sci. 89: 287–294.

13. Friendship R.M.. J.H. Lumsden. I. McMillan and M.R. Wilson (1984). Hematology and Biochemistry Reference Values for Ontario Swine. Can. J. Comp. Med., 48: 390-393.

14. Gonzalez-Barranco, J. and J.M. Rios-Torres (2004). Early malnutrition and metabolic abnormalities later in dietary protein levels on growth and muscle protein life. Nutr. Rev., 62: S134-S139.

15. Gous, R.M., G.C. Emmans and C. Fisher (2012). The performance of broilers on a feed depends on the feed protein content given previously. South African Journal of Animal Science. 42 (1): 63-73.

16. Grizard, J., D. Dardevet, I. Papet, L. Mosoni, P. Patureau-Mirand, D. Attaix, I. Tauveron, D. Bonin and M. Arnal (1995). Nutrient regulation of skeletal muscle protein metabolism in animals. The involvement of hormones and substrates. Nutr. Res. Rev. 8: 67-91.

17.Hai, D.T. and J. Blaha. (2000). Effect of low-protein diets adequate in levels of essential amino acids on broiler chicken performance. Czech. J. Anim. Sci. 45:429-436.

18.Hussein, A.S., A.H. Cantor, A.J. Pescatore, R.S. Gates, D. Burnham, M.J. Ford and N.D. Paton (2001). Effect of low protein diets with amino acid supplementation on broiler growth. J. Appl. Poult. Res. 10: 354-362.

19.Jiang, Q., P.W. Waldroup and C.A. Fritts (2005). Improving the utilization of diets low in crude protein for broiler chickens. 1. Evaluation of special amino acid supplementation to diets low in crude protein. Int. J. Poult. Sci., 4: 115-122.

20.Kamran, Z., M. Sarwar, M. Nisa, M.A. Nadeem, S. Mahmood, M.E. Babar and S. Ahmed (2008). Effect of low-protein diets having constant energy-to-protein ratio on performance and carcass characteristics of broiler chickens from one to thirty-five days of age. Poult. Sci. 87: 468–474.

21.Kerr, B.J. (1995). Nutritional strategies for waste reduction management. In: Longenecker, J.B., Spears, I.W. (Eds.), Nitrogen. New Horizons in Animal Nutrition and Health. The Institution of Nutrition of the University of North Carolina, Chapel Hill, NC, USA, 47-68.

22.Kerr, B.J. and M.T. Kidd (1999a). Amino acid supplementation of low-protein broiler diets: 1. Glutamic acid and indispensable amino acid supplementation. J. Appl. Poult. Res. 8: 298-309.

23.Khajali, F. and H.N. Moghaddam (2006). Methionine of low protein broiler diets: Influence upon growth performance and efficiency of protein utilization. Int. J. Poult. Sci. 5: 569-573.

24.Kudair, I.M. and N.A.J. Al-Hussary (2010). Effect of vaccination on some biochemical parameters in broiler chickens. Iraqi Journal of Veterinary Sciences, Vol. 24(2): 59-64.

25.Malheiros, R.D., V.M.B. Moraes, A. Collin, G.P.J. Janssens, E. Decuypere and J. Buyse (2003). Dietary macronutrients, endocrine functioning and intermediary metabolism in broiler chickens. Pair wise substitutions between protein, fat and carbohydrate. Nutr. Res. 23: 567-578.

26.Monitorul Oficial nr. 685. (2006). Legea nr. 305/2006 privind ratificarea Convenției europene pentru protecția animalelor vertebrate utilizate în experimente şi alte scopuri ştiințifice.

27.Moran, E.T., Jr., R.D. Bushong and S.F. Bilgili (1992). Reducing dietary crude protein for broilers while satisfying amino acids requirements by least cost formulations: Live performance, litter composition and yield of fast food carcass cuts at six weeks. Poult. Sci. 71: 1687-1694.

28.Nahm, K.H. (2007). Feed formulations to reduce N excretion and ammonia emission from poultry manure. Bioresource Technology 98: 2282–2300.

29.Namroud, N.F., M. Shivazad and M. Zaghari (2008). Effects of fortifying low crude protein diet with crystalline amino acids on performance, blood ammonia level, and excreta characteristics of broiler chicks. Poult. Sci. 87: 2250-2258.

30.Nieto, R., J.F. Anguilera, I. Fernandez-Figares and C. Deecuypere and J. Buyse (1997). Effect of low-protein diet on the energy metabolism of growing chickens. Arch. Tierernahr., 50: 105-109.

31.Palomeque, J., D. Pinto and G. Viscor (1991). Hematologic and blood chemistry values of the Masai ostrich (*Struthio Camelus*). Journal of Wildlife Diseases. 27(1): 34-40.

32.Ritchie, B.W., G.J Harrison and L.R. Harrison (1994). Avian Medicine: Principles and application. Wingers Publishing, Inc., Florida, 1341.

33.Rivera-Torres, V., J. Noblet , and J. van Milgen. (2011). Changes in chemical composition in male turkeys during growth. Poult. Sci. 90:68-74.

34.Rosebrough, R. W., and N. C. Steele. (1985). Energy and protein relationships in the broiler. 1. Effect of protein levels and feeding regimens on growth, body composition, and in vitro lipogenesis of broiler chickens. Poult. Sci. 64:119-126.

35.Si, J., C. A. Fritts, D. J. Burnham, and P. W. Waldroup. (2001). Relationship of dietary lysine level to the concentration of all essential amino acids in broiler diets. Poult. Sci. 80:1472-1479.

36.Si, J., C. A. Fritts, D. J. Burnham, and P. W. Waldroup. (2004). Extent to wich crude protein may be reduced in corn-soybean meal broiler diets through amino acid suplimentation. Int. J. Poult. Sci. 3:46-50.

37.SPSS. (2011). Statistics version 20.0. IBM SPSS Inc, USA.

38.Swennen, Q., G.P.J. Janssens, S. Millet, G. Vansant, E. Decuypere and J. Buyse. (2005). Effects ofsubstitution between fat and protein on feed intake and its regulatory mechanisms in broiler chickens: Endocrine functioning and intermediary metabolism. Poult. Sci., 84: 1051-1057.

39.Swennen, Q., G. P. J. Janssens, A. Collin, E. L. Bihan-Duval, K. Verbeke, E. Decuypere, and J. Buyse. (2006). Diet-induced thermogenesis and glucose oxidation in broiler chickens: Influence of genotype and diet composition. Poult. Sci. 85:731-742.

40.Swennen, Q., C. Laroye, G.P.J. Janssens, K. Verbeke, E. Nieto, R., J.F. Anguilera, I. Fernandez-Figares and C. Deecuypere and J. Buyse. (2007). Rate of metabolic decarboxylation of leucine as assessed by a L [1^{13}- C1] leucine breath test combined with indirect calorimetry of broiler chickens fed isocaloric diets with different protein: fat ratio. J. Anim. Physiol. Anim. Nutr., 91: 347-354.

41.Szabó A., Mézes M., Horn P., Sütö Z., Bázár G. Y., Romvári R. (2005). Developmental dynamics of some blood biochemical parameters in the growing turkey (*Meleagris gallopavo*). Acta Vet. Hung. 53: 397-409.

42.Teteh, A., K. Tona, K. Aklikokou, M. Gbeassor, J. Buyse and E. Decuypere. (2010). Effects of low-protein or high energy levels diets on layer-type chick juvenile performance. Intr. J. of Poul. Sci. 9 (12): 1156-1160.

43.Urdaneta-Rincon, M., and S. Leeson. (2004). Muscle (Pectoralis Major) protein turnover in young broiler chickens fed graded levels of lysine and crude protein. Poult. Sci. 83:1897-1903.

44.Waldroup, P. W., Q. Jiang, and C. A. Fritts. (2005). Effect of supplementing broiler diets low in crude protein with essential and nonessential amino acids. Intr. J. Poult. Sci. 4:425-431.

45.Yaman M. A., Kita K., Okumura J. (2000). Different responses of protein synthesis to refeeding in various muscles of fasted chicks. Br. Poultry Sci. 41: 224-228.

46.Zhan, X.A., M. Wang, H. Ren, R.Q. Zhao, J.X. Li and Z.L. Tan. (2007). Effect of early feed restriction on metabolic programming and compensatory growth in broiler chickens. Poult. Sci., 86: 654-660.