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Effects of Different Protein Levels on Growth Performance, Carcass Characteristics and Blood Parameters of Cherry Valley Ducks

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Abstract: The 480, 1 day old male Cherry Valley ducks were randomly allocated into three groups for a 42 days feeding trial including 1-21 and 22-42 days period. Dietary CP percentage in experimental diets (g/kg) were 21, 20 and 19% for groups I, II, III, respectively. Results showed that 1-21 days: the feed intake and body weight gain in group II and III was higher ($p<0.01$) than group I the feed conversion ratio of group II was lower ($p<0.05$) than group I; the serum total protein in group I was higher ($p<0.05$) than group III, 0.22-42 days: the feed conversion ratio of group III was lower ($p<0.05$) than group II; the breast muscle ratio of the group II was increased ($p<0.05$) by 7.53% than group I; the leg muscle ratio of the group I was increased ($p<0.05$) by 7.57% than group III; the GSH-PX of group II and III was higher ($p<0.05$) than group I by increased 16.50 and 17.21%, respectively. In conclusion, a dietary CP level of 20% was optimal in terms of growth performance and reduced nitrogen excretion.

Key words: Different protein level, Cherry Valley duck, growth performance, feed conversion, reduced nitrogen

INTRODUCTION

Poultry industry is growing rapidly throughout the developing countries. A major concern for the modern poultry industry is to reduce feed cost for optimal economic return because feed represents the main component of total production cost and Crude Protein (CP) is one of the major cost components of poultry diets (Kamran *et al*., 2004). Dietary protein is a crucial regulator of poultry growth and reproductive performance but also of the development of the gastrointestinal tract (Laudadio *et al*., 2012). Meanwhile, the excretion of N originating from dietary protein is largely responsible for the environmental issues arisen from intensive livestock production (Morse, 1995). Jacob reported that the amount of N emitted in poultry manure can be reduced by up to 21% providing that CP content of the diet is lowered by 2.5%.

A considerable amount of research has been done to evaluate the effects of low-protein, Amino Acid (AA) supplemented diets with broiler chickens (Edmonds *et al*., 1985; Fancher and Jensen, 1989a, b; Holsheimer and Jenson, 1991; Bregendahl *et al*., 2002; Kamran *et al*., 2008; Namroud *et al*., 2008; Berres *et al*., 2010). The results have shown that growth performance and carcass composition become inferior to those of broiler chicks fed standard high-CP diets when the dietary CP content is lowered by >3% points. Whereas, others have reported no effect on performance when low-protein diets are fed (Parr and Summers, 1991; Deschepper and de Groote, 1995; Moran and Stilborn, 1996; Yamazaki *et al*., 1996; Aletor *et al*., 2000; Widyaratne and Drew, 2011). Thus, conflicting results from these studies prevent a clear conclusion on the effects of these diets in practical broiler production.

Being an essential constituent of all tissues, protein is very impotent nutrient for ducks like other living creatures. However, to the knowledge, little information is available on nutrient requirements of Cherry Valley ducks. Therefore, the present study was conducted to examine the changes of growth performance of Cherry Valley ducks exposure to a different protein levels and assess the optimum protein level leading to optimum growth of the ducks.

MATERIALS AND METHODS

Experimental animal and feeding: The experiment was carried out in accordance with the Chinese Guidelines for Animal Welfare and the procedures were supervised by

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Table 1: Composition and nutrients levels of basal diet

	1-21 days			22-42 days		
Ingredient (g kg^{-1})	I	II	III	I	II	III
Maize	517.00	548.00	577.00	587.50	618.00	650.00
Wheat-middlings	55.00	55.00	55.00	60.00	60.00	60.00
Soybean oil	15.00	12.00	10.00	15.00	12.00	9.00
Rice bran	19.85	20.36	20.91	19.85	20.78	20.23
L-lysine	0.89	2.30	3.67	0.36	1.36	2.35
DL-methionine	1.68	1.82	1.97	1.35	1.49	1.59
L-threonine	0.20	0.64	1.07	0.56	1.00	1.45
Phytase[a]	0.12	0.12	0.12	0.12	0.12	0.12
Zinc bacitracin	0.20	0.20	0.20	0.20	0.20	0.20
Colistin sulfate	0.06	0.06	0.06	0.06	0.06	0.06
SBM[b]	350.00	319.50	290.00	280.00	250.00	220.00
Mineral and vitamin premix[c]	40.00	40.00	40.00	35.00	35.00	35.00
Total	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
Nutrient levels (%)						
Metabolizable energy (MJ kg^{-1})	2.84	2.84	2.84	2.89	2.89	2.89
Crude protein	21.20	20.19	19.21	18.55	17.56	16.58
Crude fat	3.95	3.72	3.58	4.09	3.85	3.63
Crude fiber	3.12	3.09	3.06	3.00	2.99	2.92
Ash	5.95	5.85	5.76	5.77	5.68	5.57
Calcium	0.92	0.91	0.90	0.89	0.88	0.87
Total phosphorus	0.56	0.55	0.54	0.50	0.49	0.48
Available phosphorus	0.40	0.40	0.40	0.36	0.36	0.36
Sodium chloride	0.32	0.32	0.32	0.31	0.35	0.38
L-lysine	1.21	1.21	1.21	1.01	1.01	1.01
DL-methionine	0.49	0.49	0.49	0.42	0.42	0.42
DL-methionine+L-cystine	0.84	0.82	0.81	0.73	0.72	0.70
L-threonine	0.82	0.82	0.82	0.76	0.76	0.76
Linoleic acid	2.22	2.12	2.06	2.34	2.24	2.13

[a]Phytase 5000I U g^{-1}, [b]SBM = Soybean Meal, [c]Mineral and vitamin premix (content per kg diet): 1-21 days period; Fe: 200 mg; Cu: 20 mg; Mn: 134 mg; Zn: 99 mg; I: 0.4 mg; Se: 0.2 mg; vitamin A: 14,000 IU; vitamin D3: 1750 IU; vitamin E: 31 mg; vitamin K: 1.12 mg; vitamin B1: 10 mg; vitamin B2: 9 mg; vitamin B6: 13 mg; vitamin B12: 0.04 mg; Niacin: 95 mg; d-pantothenic acid: 22 mg; Folic acid: 1 mg; Biotin: 0.2 mg; Choline: 1820 mg; 22-42 days period; Fe: 200 mg; Cu: 18 mg; Mn: 132 mg; Zn: 97 mg; I: 0.4 mg; Se: 0.45 mg; vitamin A: 10,000 IU; vitamin D3: 1250 IU; vitamin E: 28 mg; vitamin K: 0.80 mg; vitamin B1: 8 mg; vitamin B2: 7 mg; vitamin B6: 12 mg; vitamin B12: 0.03 mg; Niacin: 75 mg; d-pantothenic acid: 17 mg; Folic acid: 0.82 mg; Biotin: 0.18 mg; Choline: 1570 mg

the Animal Care and Use Committee of Fujian Agricultural and Forestry University. The 480, 1 day old male Cherry Valley ducks were randomly allocated into three groups (4 replications per group, 40 ducks per replication). The ducks were placed in floor pens for a 1-42 days feeding trial including 1-21 and 22-42 days period. The ducks were allowed free access to water and experimental diets. Average body weight was measured at the initial and at the end of each feeding trial. Growth performance results as feed intake, body weight gain, feed conversion ratio, survival rate were calculated. The basal diet was supplemented with minerals and vitamins to meet the requirements for ducks. Dietary CP percentage in experimental diets (g/kg) were 21, 20 and 19% for treatments I, II, III, respectively. Synthetic lysine, methionine and threonine were modified to achieve balance (Table 1). The experimental diets were provided in mash form (5 mm screen).

Sample collected: Blood collection was carried out in the experimental ducks at two time intervals. One set (n = 24) was slaughtered at the age of 21 days and other set (n = 24) was killed at 42 days of age. Blood samples were collected from the wing vein of the birds at the age of 21 and 42 days, samples were centrifuged at 1600×g for 15 min and collected the serum, the resulting serum was stocked at -20°C until use. Plasma samples were evaluated for: serum Total Protein (TP), Albumin (ALB), Uric Acid (UA), Urea Nitrogen (UN), Total Superoxide Dismutase (T-SOD), Glutathione Peroxidase (GSH-PX) and Malondialdelyde (MDA) were meseaured. Dressing ratio, semi-eviscerated ratio, eviscerated ratio, breast muscle ratio, leg muscle ratio were meseaured and calculated at the age of 42 days.

Statistical analysis: Data were analyzed by one-way ANOVA using the General Linear Models Procedure in SAS (SAS Institute, 1998). Pens were used as the experimental unit for all data. Significant effects were further analyzed and individual mean differences were determined by Duncan's multiple-range test. A significance level of 0.05 was used.

RESULTS

The growth performance of Cherry Valley ducks: The effects of dietary CP on growth performance are presented in Table 2.

Table 2: Effect of different protein levels on growth performance of Cherry Valley ducks

Treatment groups	Feed intake/g	Body weight gain/g	Feed conversion ratio (g kg^{-1})	Survival rate (%)
1-21 days				
I	1474.79±30.330[B]	927.71±17.86[B]	1.59±0.01[b]	99.38±1.250
II	1543.67±30.080[A]	994.34±5.150[A]	1.55±0.03[a]	99.38±1.250
II	1581.54±40.200[A]	1005.72±29.88[A]	1.58±0.01[ab]	96.88±2.390
22-42 days				
I	6545.91±212.04	3047.81±70.12	2.12±0.03[AB]	98.13±3.75
II	6752.09±85.890	3154.21±41.05	2.14±0.02[B]	98.13±2.39
II	6597.87±119.61	3150.65±38.34	2.08±0.03[A]	96.25±2.50

[a, b]Mean within columns having different superscripts are significant different (p<0.05), [A, B]Mean within columns having different superscripts are significant different (p<0.01)

Table 3: Influence of different protein concentration on slaughter performance of Cherry Valley ducks

Treatment groups	Dressing ratio (%)	Semi-eviscerated ratio (%)	Eviscerated ratio (%)	Breast muscle ratio (%)	Leg muscle ratio (%)
I	86.37±1.16	80.27±1.43	73.01±1.44	13.14±0.66[b]	14.49±0.840[a]
II	87.12±1.09	80.84±1.75	73.83±2.03	14.13±0.91[a]	13.82±0.340[ab]
II	86.87±1.18	80.94±1.20	74.07±1.46	13.50±0.29[ab]	13.47±0.67[b]

[a, b]Mean within columns having different superscripts are significant different (p<0.05)

1-21 days: The feed intake and body weight gain of Cherry Valley ducks in group II and III was higher (p<0.01) than group I. The feed conversion ratio of group II was lower (p<0.05) than group I.

22-42 days: The group II has the highest body weight gain by 3.49% higher than group I and 0.11% higher than group III. The feed conversion ratio of group III was lower (p<0.01) than group II. Compare to the survival rate of treatment groups, group I and II were increased by 1.95% than group II.

The slaughter performance of Cherry Valley ducks: The effects of dietary CP on slaughter performance of Cherry Valley ducks are presented in Table 3. Dressing ratio, semi-eviscerated ratio, eviscerated ratio, breast muscle ratio and leg muscle ratio were not affected by CP treatments.

The breast muscle ratio of the group II was increased (p<0.05) by 7.53% than group I and increased by 4.67% than group III. The leg muscle ratio of the group I was increased by 4.85% than group II and increased (p<0.05) by 7.57% than group III.

Effect of different protein levels on blood serum biochemical parameters and anti-oxidation parameters of Cherry Valley ducks: The effects of dietary CP levels on blood serum biochemical parameter of Cherry Valley ducks are presented in Table 4.

The results showed that on the 21 days, the serum total protein of Cherry Valley ducks in group I was higher (p<0.05) than group III. On the 42 days: the blood urea nitrogen of group I was higher (p<0.05) than group II.

The effects of dietary CP levels on antioxidation parameters of Cherry Valley ducks are presented in Table 5.

Table 4: Effect of different protein levels on serum biochemical parameters of Cherry Valley ducks

Treatment groups	Total protein (g L^{-1})	Albuming (L^{-1})	Uric acid (mmol L^{-1})	Urea nitrogen (umol L^{-1})
21 days				
I	37.71±3.900[a]	22.7±5.090	335.20±20.04	0.19±0.08
II	34.71±1.380[ab]	20.57±4.96	310.67±43.11	0.15±0.05
III	33.75±4.530[b]	19.38±2.07	312.33±42.00	0.14±0.05
42 days				
I	45.33±8.500	20.75±3.96	356.40±41.33[a]	0.29±0.02
II	46.00±11.36	19.75±4.59	272.50±50.52[b]	0.29±0.02
III	43.00±6.930	20.88±4.76	322.50±53.16[ab]	0.29±0.01

Table 5: Influence of different protein concentration on antioxidation parameters of Cherry Valley ducks

Treatment groups	T-SOD (μ mL^{-1})	GSH-PX (umol L^{-1})	MDA (nmol mL^{-1})
21 days			
I	369.42±74.75	131.52±29.34	5.03±0.70[ab]
II	379.54±71.51	151.23±22.12	5.17±0.94[b]
III	328.62±31.87	144.55±34.28	4.15±0.98[a]
42 days			
I	369.23±44.31	208.89±31.25[b]	5.14±1.37[ab]
II	350.92±24.65	243.35±22.29[a]	6.15±1.63[b]
III	346.00±41.27	244.85±25.80[a]	4.15±0.74[a]

[a, b]Mean within columns having different superscripts are significant different (p<0.05)

21 days: The T-SOD and GSH-PX of group II was higher than group I and group III. The MDA of group III was lower (p<0.05) than group II.

42 days: The GSH-PX of group II and III was higher (p<0.05) than group I by increased 16.50 and 17.21%, respectively. The MDA of group III was lower (p<0.05) than group II.

DISCUSSION

Protein is an essential constituent of all tissues of animal body and having major effect on growth performance of the poultry. Meanwhile, protein is one of the major cost components of poultry diets. The trial had been conducted to assess effects of protein levels, amino acid-supplemented diets on the growth and blood serum biochemical parameters of Cherry Valley ducks.

For the 1-21 days: the difference in feed intake and body weight of the three groups were significant, group II had the lowest feed conversion ratio and better body gain weight. For the 22-42 days: the group III had the best feed conversion ratio. Actually, high protein level is less efficiently utilized for growth than low protein diets because the surplus protein is used particularly in efficiently as an energy source, this may explain in part, the lower feed conversion ratio on the diets with the higher protein contents. Guangbing *et al.* (2007) also observed that hens fed a 16% CP diet consumed less feed and surprisingly, egg mass was similar between different CP levels groups. The results were in accordance with the recent findings of Berres *et al.* (2010) who observed that broilers fed low-CP diets with synthetic amino acids had the same cumulative body weight gain, feed conversion compared with birds fed diets with a higher protein level. The level of CP (20%) in the diet could be considered optimal to obtain the same or better productive performance in ducks fed conventional feed formulations as the feed efficiency values among groups were similar and this concurs with Laudadio.

It is well-documented that varying the protein level in diets for broilers can influence performance (Kerr and Kidd, 1999). For all the dietary programs decreasing the CP content of the diet had no effect on survival rate. The finding concurs with some researches demonstrated that the reduction in the crude protein levels in the diet does not affect survival rate of broiler chickens. So, the lower protein performance better on the growth of the Cherry Valley ducks.

All the serum proteins are synthesized in liver, so liver is the primary source of serum proteins. The serum total protein content was considered as an indication of total protein reserves in an animal and may reflect the hepatic protein metabolic status in response to dietary treatments in cherry valley ducks. Albumin serves as the major amino acid pool; the catabolism of albumin provides protein precursors needed for growth or other physiological needs. Higher protein intake has been reported to increase serum albumin by Hallford. Total protein and albumin thus reflect availability of protein and their concentration decline in the face of protein deficiency.

In 21 and 42 days of age, the total plasma protein and serum albumin concentration were no difference between the three groups and the dietary protein did not affect total plasma protein. This observation in Cherry Valley ducks do agree with Farhat (2009) in Pekin ducks and is in accordance with Ardekani indicated that the effects of different levels of dietary protein supplemented had no difference in serum albumin concentration. Likewise, Hallford found no difference in serum total protein between ewes receiving protein deficient or adequate diets. However, it does not agree with the reported in growing chickens where increasing dietary protein resulted in an increase in plasma protein.

Accurate definition of protein requirement for duck is vital to ensure an appropriate supply of the assortments of amino acids while at the same time minimizing cost and more importantly, reducing wasteful excretion of excess nitrogen by circumventing protein over feeding. The overall findings of the study suggests that low protein diets supplemented with amino acids had no adverse effect on Cherry Valley ducks performance in 1-42 days of age.

In poultry, excess proteins are metabolized to uric acid which is then transported into the kidney where it is excreted. Serum uric acid levels will increase when one or several amino acids are deficient or in excess. In some studies, the serum uric acid and urea nitrogen concentration were positively correlated with protein deposition. Serum uric acid is considered an indication of the protein quality in the feed and its utilization and responds readily to different dietary protein levels. The high uric acid and low urea nitrogen demonstrated further that protein metabolism was improved.

In the trials, at the 21 day, the group II had the lowest uric acid and better urea nitrogen figure which means the lower protein level had a good utilization. This was agreement with some studies. Hallford had observed that high protein diets seldom cause increase in blood urea nitrogen in clinically healthy animals (Duncan and Prasse, 1986). However, Moss and Murray (1992) found higher plasma urea concentration due to supplementary protein intake on dairy calves. In Ardekani *et al.* (2011) study, it indicated that, serum uric acid concentration is lower for the chicks fed by low CP amino acid supplemented diets.

CONCLUSION

The overall findings of this study suggest that the use of low-protein diets did not show negative effects on the growth performance and led to superior N retention of ducks. These results explain the lack of consensus in the literature on the effects of low-protein diets on the growth performance of broiler chickens. However, the relationship between lowered protein and improved growth performance requires further investigation to elucidate the mode of action and these data need to be confirmed, the final choice of dietary protein contents must also include economic considerations.

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