Methionine and lysine requirement of Campbell Sheldrake ducks from forty-two to sixty-two days of age

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Abstract

An experiment was conducted to investigate dietary methionine and lysine levels on growth performance and yield carcass in Campbell Sheldrake ducks from 42 to 62 days. A total of 936 ducks with 42-day-old were randomly designed to 3 × 3 treatments with 4 replicates of 26 birds each. Ducks were fed with diets containing methionine(Met) at 0.28%, 0.38%, and 0.48% and lysine (Lys) at 0.58%, 0.73%, and 0.88%, respectively, for 21 days. No interaction between methionine and lysine was found on growth performance of ducks ($P > 0.05$), but had a significant effect on yield carcass ($P < 0.05$). Based on the yield carcass, the dietary methionine recommended for Campbell Sheldrake duck at the period of 42 - 62 days was 0.38% (0.69% of Met + Cystein (Cys)), and the Lysine recommended was 0.73% or 0.52 of Total Met : Lys ratio (0.945% of Total Met + Cys : Lys ratio) .

Key words: methionine; lysine; requirement; Campbell Sheldrake ducks

Introduction

Methionine and lysine are the first and second limiting amino acids, respectively, in practical poultry diets, which are mainly involved in protein synthesis in animals and have an important impact on the production performance and carcass quality of poultry. The study on methionine and lysine requirements for ducks is of great importance for healthy breeding and standardized production. Originated from the UK, Campbell Sheldrake ducks are derived from crossbreeding between domestic Sheldrake and wild Sheldrake ducks. Compared to the regular Sheldrake ducks, they are wilder and have better meat flavor. However, there are few studies on their dietary methionine and lysine requirements or its ratio. In this experiment, we investigated the methionine and lysine requirements or its ratio for Campbell Sheldrake ducks from 42 to 62 days of age.

Materials and methods

Experimental design

In a two-factor random grouping design, 936 healthy 42-day-old Campbell Sheldrake ducks with average body weight of 1264.44 ± 22.25 g were fed with the same diet from 0 to 42 days of age, and the nutrient level was set based on the NRC (2012). The ducks were randomly divided into 9 groups of 4 replicates each based on body weight, with 26 ducks in each replicate. The experiment was a 3 × 3 treatment design with methionine levels of 0.28%, 0.38% and 0.48%, and lysine levels of 0.58%, 0.73% and 0.88%, respectively. Except methionine and lysine, the other nutrient contents were basically the same among the treatment groups, with the metabolic energy level set at 11.46 $MJ \cdot kg^{-1}$ and the crude protein level set at 16.11%. The experimental diets (treatments) are shown in Table 1.

Table 1. Composition of experimental diets for the finishing ducks

Ingredients	Methionine levels, %								
	0.28	0.28	0.28	0.38	0.38	0.38	0.48	0.48	0.48
	Lysine levels, %								
	0.58	0.73	0.88	0.58	0.73	0.88	0.58	0.73	0.88
Corn, %	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00
Soybean meal, %	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30
Rapeseed meal, %	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Cottonseed meal, %	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
DDGS, %	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Wheat shorts, %	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
Miscella, %	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Limestone, %	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Dicalcium phosphate, %	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
L-Methionine, %	0.00	0.00	0.00	0.19	0.19	0.19	0.36	0.36	0.36
L-Lysine, %	0.00	0.19	0.38	0.00	0.19	0.38	0.00	0.19	0.38
Zeolite powder, %	3.00	2.81	2.62	2.81	2.62	2.43	2.64	2.45	2.26
Salt, %	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Choline chloride, %	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Vit-mineral premix, %	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Nutrient levels - Content									
Metabolizable energy ($MJ \cdot kg^{-1}$)	11.46	11.48	11.50	11.48	11.49	11.53	11.49	11.52	11.55
Crude protein, %	16.11	16.25	16.40	16.29	16.44	16.59	16.46	16.61	16.76
Lysine total, %	0.58	0.73	0.88	0.58	0.73	0.88	0.58	0.73	0.88
Methionine total, %	0.28	0.28	0.28	0.38	0.38	0.38	0.48	0.48	0.48
Cysteine total, %	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
Met + Cys, Total, %	0.59	0.59	0.59	0.69	0.69	0.69	0.79	0.79	0.79
Ca total, %,	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Available phosphorus, %	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32

Supplied per kilogram of diet: Fe 80 mg, Cu 8 mg, Mn 80 mg, I 0.35 mg, Se 0.3mg, vitamin A 1500 IU, vitamin D^3 200 IU, vitamin E 10 IU, vitamin K^3 0.5 mg, vitamin B^1 1.8 mg, vitamin B^2 3.6 mg, vitamin B^6 3.5 mg, vitamin B^{12} 0.01 mg, nicotinic acid 30 mg, calcium pantothenate 10 mg, folic acid 0.55 mg, biotin 0.15 mg

Feeding management

Fishponds were used for cage rearing, with consistent feeding management and environmental conditions for all groups. The ducks were fed and watered freely and were reared and immunized according to the conventional feeding operation protocols and immunization procedures. The test period was 21 d.

Sample collection and processing

At the end of the experiment, two healthy, near-average weight ducks from each replicate were asphyxiated and killed for slaughter examination.

Measurement indicators and methods

The experimental diets were suspended while water was still provided at 4:00 p.m. the day before the end of the experiment. On the next day (9:00 a.m), the ducks were accurately weighed in the each replicate, the leftover diet was recovered, and the average daily gain (ADG), average daily feed intake (ADFI) and feed-to-gain ratio (F/G) were determined.

At the end of the experiment, a duck with average weight within each replicate was selected and assessed for yield carcass determination. The Ducks were weighed before slaughter with 16 h fasting. They had free access to water. After slaughter, the yield carcass was determined considering the carcass weight, semi-eviscerated weight and eviscerated weight.

Statistical analysis

The data were analyzed using two-way ANOVA from the GLM program of SAS 9.0 for windows software. Duncan's multiple comparisons showed a significant level of $P < 0.05$, and the results were presented as mean ± standard error (mean ± S.E).

Results

The cross-talk between dietary methionine and lysine had no significant effect on the final body weight, average daily gain, average daily feed intake and feed-to-gain ratio of Campbell Sheldrake ducks at 42 - 62 days of age ($P > 0.05$, Table 2).

Table 2. Effect of interactions of dietary methionine and lysine on growth performance of Campbell Sheldrake ducks from 42 to 62 days of age

No.	Methionine levels (%)	Lysine levels (%)	Initial weight (g)	Final weight (g)	Average daily feed intake ($g \cdot d^{-1}$)	Average daily gain ($g \cdot d^{-1}$)	Feed/Gain ratio
1	0.28	0.58	1264.23±15.35	1552.03±16.27	124.45±4.70	14.39±1.80	9.05±1.09
2	0.28	0.73	1252.05±14.60	1509.65±18.36	110.49±7.83	12.88±2.71	9.46±1.39
3	0.28	0.88	1263.21±14.90	1485.81±20.04	109.50±5.44	11.13±2.63	11.66±2.62
4	0.38	0.58	1269.81±14.02	1452.61±12.63	103.54±5.39	9.14±1.94	12.68±2.14
5	0.38	0.73	1269.72±13.40	1469.72±17.82	106.46±8.14	10.00±2.79	13.16±3.16
6	0.38	0.88	1277.95±8.74	1492.95±26.77	104.16±7.65	10.75±3.10	12.15±2.89
7	0.48	0.58	1264.10±9.66	1491.9±15.23	105.57±4.73	11.39±2.27	10.27±1.66
8	0.48	0.73	1260.84±13.43	1506.44±24.36	108.76±6.50	12.28±2.26	8.93±1.00
9	0.48	0.88	1258.06±11.86	1475.26±23.45	105.31±5.40	10.86±2.66	11.52±2.61
Methionine							
	0.28			1515.83±19.70	114.34±3.95	12.80±1.32	10.06±0.06
	0.38			1471.76±22.63	104.72±3.76	9.96±1.40	12.66±0.12
	0.48			1491.20±20.74	106.35±2.85	10.92±1.30	10.36±0.06
Lysine							
		0.58		1503.09±13.85	108.09±2.33	11.64±1.24	10.66±0.10
		0.73		1495.27±20.36	110.11±2.15	11.13±1.44	10.66±0.08
		0.88		1484.67±23.70	105.95±1.45	10.91±1.47	11.78±0.05
P value							
Methionine				0.3763	0.2216	0.3867	0.312
Lysine				0.9231	0.7574	0.9371	0.7831
Methionine x Lysine				0.9015	0.9762	0.9114	0.9089

From Table 3, it is evident that variation in dietary methionine and lysine levels had no significant effect ($P > 0.05$) on semi-eviscerated versus eviscerated yield, while having a significant effect ($P < 0.05$) on carcass yield. From one-way analysis, methionine level of 0.38% had the best carcass and semi-eviscerated yields, but the difference was not significant ($P > 0.05$) compared to the other two levels. Lysine level of 0.88% had the best carcass yield and 0.73% had the best semi-eviscerated and eviscerated yield, but the difference was not significant ($P > 0.05$).

Table 3. Effect of interactions of dietary methionine and lysine on slaughter performance of 62-day-old Campbell Sheldrake ducks (%)

No.	Methionine levels (%)	Lysine levels (%)	Dressing percentage	Half-eviscerating percentage	Eviscerating percentage
1	0.28	0.58	88.07±0.57^{abc}	80.88±0.81	74.21±1.06
2	0.28	0.73	86.88±1.10^{c}	79.88±1.11	72.74±1.08
3	0.28	0.88	88.35±0.45^{abc}	80.24±0.67	73.28±0.70
4	0.38	0.58	88.62±0.69^{ab}	81.64±0.75	74.44±0.83
5	0.38	0.73	89.69±0.74^{ab}	82.19±1.22	75.42±1.28
6	0.38	0.88	88.36±0.77^{abc}	80.99±1.04	73.89±0.86
7	0.48	0.58	85.67±0.39^{c}	79.58±0.58	73.04±0.85
8	0.48	0.73	88.48±0.56^{abc}	82.11±1.36	75.23±1.12
9	0.48	0.88	90.30±1.37^{a}	82.74±1.17	76.10±1.21
Methionine					
	0.28		87.77±0.44	80.33±0.48	73.41±0.53
	0.38		88.89±0.42	81.61±0.55	74.58±0.56
	0.48		88.35±0.92	81.47±0.70	74.79±0.68
Lysine					
		0.58	87.62±0.49	80.70±0.45	73.89±0.52
		0.73	88.32±0.65	81.39±0.72	74.46±0.71
		0.88	89.00±0.56	81.32±0.60	74.42±0.61
P value					
Methionine			0.2611	0.2462	0.2179
Lysine			0.1495	0.6495	0.7488
Methionine x Lysine			0.0294	0.2329	0.1977

From Table 4, it is evident that variation in dietary methionine and lysine levels had a significant effect on both pectoral and leg muscle yield in large ducks. From one-way analysis, the pectoral muscle yield increased with the increasing methionine level with the highest at 0.38% of methionine level, which was significantly higher than that at 0.28% level ($P < 0.05$); while the difference in leg muscle yield was not significant ($P > 0.05$). Pectoral muscle yield increased with the increasing lysine levels with the highest at 0.88% of lysine level, but the difference was not significant compared with the other two levels ($P > 0.05$). The cross-talk between methionine and lysine had a significant effect on leg muscle yield ($P = 0.0403$).

Table 4. Effect of interactions of dietary methionine and lysine on percentage of breast muscle, leg muscle, and abdominal fat of 62-day-old Campbell Sheldrake ducks (%)

No.	Methionine levels (%)	Lysine levels (%)	Percentage of breast muscle	Percentage of leg muscle	Percentage of abdominal fat
1	0.28	0.58	8.72±0.60	8.63±0.24^{a}	1.11±0.10
2	0.28	0.73	8.78±0.73	8.17±0.36^{ab}	1.19±0.20
3	0.28	0.88	10.67±0.50	8.02±0.31^{ab}	1.27±0.16
4	0.38	0.58	10.70±0.87	8.67±0.24^{a}	0.95±0.16
5	0.38	0.73	10.94±0.54	7.49±0.18^{b}	1.28±0.24
6	0.38	0.88	11.33±0.50	8.29±0.29^{ab}	1.05±0.14
7	0.48	0.58	10.76±0.56	7.84±0.37^{ab}	1.38±0.33
8	0.48	0.73	10.74±0.53	8.67±0.46^{a}	1.10±0.21
9	0.48	0.88	10.70±0.73	8.06±0.22^{ab}	1.03±0.11
Methionine					
	0.28		9.52±0.44^{b}	8.24±0.18	1.19±0.08
	0.38		10.99±0.34^{a}	8.10±0.20	1.09±0.11
	0.48		10.73±0.32^{a}	8.19±0.22	1.16±0.12
Lysine					
		0.58	10.13±0.46	8.33±0.21	1.14±0.12
		0.73	10.21±0.44	8.11±0.23	1.19±0.11
		0.88	10.86±0.33	8.12±0.15	1.12±0.08
P value					
Methionine			0.0225	0.8651	0.828
Lysine			0.3022	0.6601	0.9002
Methionine x Lysine			0.3728	0.0403	0.4754

In the same column, values with the same letters mean no significant difference ($P > 0.05$), values with the different letters mean significant difference ($P < 0.05$). The same as below.

Discussion

Methionine and lysine, as the first and second limiting amino acids in poultry diets, respectively, affect not only the effective utilization of other essentials amino acids, but also the production performance of poultry. Many studies have shown that when the levels of these two amino acids in the diet are low, appropriate additions can improve the production performance of meat poultry [1 - 4]. However, overdosing does not further significantly improve their production performance, which instead may even lead to a decreased performance [5 - 8]. The changes in dietary methionine and lysine levels used in this experiment do not have any significant effect on feed intake, daily weight gain and feed-to-gain ratio of 42 - 62 day-old Campbell Sheldrake ducks, and there is no cross-talk between them. The good growth and health status of the ducks during the experiment period indicate that the dietary methionine and lysine levels were within the range required for normal growth of 42 - 62 day-old ducks. The lysine level change alone shows a better feed intake at 0.73% and a better daily weight gain at 0.58%, but the feed-to-gain ratio was the same (10.66) at both levels. Taking together the above production performance indicators, there is no significant effect on the production performance when the dietary lysine level 42 - 62 day-old Campbell Sheldrake ducks is 0.58% - 0.73% and the dietary methionine level is 0.28% - 0.48%.

Studies have shown that moderate amounts of methionine and lysine in diets can improve the carcass quality in poultry [9 - 11]. Feeding diets deficient in methionine reduces the protein deposition by broiler chicken tissues. Lysine deficiency significantly increases the rate of protein synthesis and degradation in muscle but decreases the net protein synthesis [12].

This study shows that changes in dietary methionine and lysine levels have a significant effect on the slaughter rate of 62-day-old Campbell Sheldrake ducks. The analysis of methionine levels alone shows a slight increase in slaughter, semi-eviscerated and eviscerated yields, but the difference is not significant. The analysis of lysine alone shows better results with lysine levels of 0.73% and 0.88%, but the difference is also not significant compared with 0.58% level. Changes in dietary methionine and lysine levels have a significant effect on the pectoral and leg muscle yields in Sheldrake ducks. When analysed from the methionine level alone, methionine level groups of 0.38% and 0.48% have a significantly higher pectoral muscle yield than 0.28% level group, while there are no significant changes in leg muscle and abdominal fat yields among the groups. The analysis of lysine levels alone shows no significant changes in pectoral, leg muscle and abdominal fat yields at lysine levels of 0.58% - 0.88%. However, methionine and lysine have a significant cross-talk effect on leg muscle rate. Based on the analysis of the above indicators, for the reference of slaughter performance, the recommended dietary lysine and methionine levels for 42 - 62 day-old Campbell Sheldrake duck were 0.73% and 0.38%, respectively.

Conclusions

The performance of 42 - 62 day-old Campbell Sheldrake ducks is not affected by the two limiting amino acids when the dietary methionine levels are 0.28 - 0.48% and the dietary lysine levels are 0.58 - 0.88%. However, slaughter performance is affected by them and there is a cross-talk effect. Therefore, appropriate ratios of methionine and lysine in the diets could improve the slaughter performance of ducks. At a metabolism energy level of 11.49 $MJ \cdot kg^{-1}$ and a crude protein level of 16.44%, the recommended total dietary methionine and lysine for Campbell Sheldrake ducks at 42 - 62 days of age are 0.38% (0.69% of Met + Cys), and 0.73% respectively, or 0.52 of Total Met : Lys ratio (0.945% of Total Met + Cys : Lys ratio).

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