Effects of dietary crude protein and metabolizable energy levels on the growth performance of White Roman Geese between 4 and 8 weeks of age [(1)]

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Abstract

The purpose of this study was to evaluate the effects of dietary crude protein (CP) and metabolizable energy (ME) levels on growth of White Roman geese from 4 to 8 weeks of age (WOA). Experiment was a 2 × 3 factorial arrangement with two CP levels (13 and 15%) and three ME levels (2, 400, 2, 700 and 3,000 kcal/kg). Results showed that there was no difference on feed intake or BW gain for the geese fed either the 13 or 15% crude protein diets. The feed conversion ratio (FCR) of geese providing the 13% CP diet was significantly (P < 0.05) better than that giving the 15% CP diet. Calculating the protein intake of geese, a 38.2 g/goose/day protein intake was sufficient for BW gain of geese from 4 to 8 WOA. The decrease of dietary ME significantly (P < 0.01) increased the feed intake and BW gain for geese fed 13% CP diet from 4 to 8 WOA. The FCR was improved by increasing dietary ME. In conclusion, the provision of 13% crude protein with 2,700 kcal/kg ME diet was sufficient for the geese growth from 4 to 8 WOA.

Key words: Goose, Crude protein, Metabolizable energy.

Introduction

White Roman goose is the most popular domestic goose in Taiwan (more than 95% of the market). Concerning goose meat production, geese are sold at 12 weeks of age (WOA) and slaughtered between 13 and 15 WOA. From 80 to 90% of marketable body weight of geese can be achieved at 8 WOA. In the UK, geese are marketed at 9 or 16 WOA when they have the first or second set of feathers, or when they are in the complement moult stage after 20 WOA (Stevenson, 1989). In two review papers, the CP requirement of domestic geese was found to be from 140 to 200 g/kg during growth period, (Saleyev, 1975; Allen, 1983). Allen (1983) suggested that dietary CP contents should be 160 and 140 g/kg for the periods from 5 to 6 and 7 to 9 WOA, respectively. Saleyev (1975) recommended that the dietary CP content should be 180 g/kg from 4 to 9 WOA. The higher CP concentration diet from 180 to 220 g/kg had no advantage in BW gain of Embden geese (Summer *et al.*, 1987).

The metabolizable energy (ME) content should be 2,916 kcal/kg from 4 to 9 WOA (Saleyev 1975). The range of grower diets ME concentration from 2,629 to 3,107 kcal/kg had no significant differences in the weight gain of Italian Legarth geese (Stevenson, 1985). A 15% CP and 2,900 ME kcal/kg diet was recommended for growing geese after 4 WOA (NRC, 1994). These studies show that the choice of dietary CP and energy had a broad range from 14 to 22% CP and from 2,629 to 3,170 ME kcal/kg. This implies that a low CP or ME diet may be useful for domestic White Roman geese.

In general, giving the same diet to domestic geese from 4 to 12 WOA is recommended. The BW of White Roman geese can achieve about from 80 to 90% marketable body weight at 8 WOA. This implies that the nutrition requirements of geese before and after 8 OWA are different. This study evaluates the effects of different CP and ME levels on the growth performance of White Roman geese from 4 to 8 WOA.

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Materials and methods

I. Geese and dietary treatments

The 1-day-old White Roman goslings were obtained from Changhua Animal Propagation Station, COA-LRI. The goslings were given starter feed (CP 20%，ME 2,900 kcal /kg) until 4 WOA. A total of 192 geese (4 WOA, 28-d-old) were randomly assigned to 6 dietary treatments, each dietary treatment with 4 replicated pens, each pen with 4 females and 4 males in a 2 × 3 factorial arrangement experimental design. Two dietary CP levels of 13 and 15% each containing 2,400, 2,700 and 3,000 kcal ME/kg (Table 1) were used from 4 to 8 WOA. Water and feed were provided ad libitum throughout the experimental period. Feed consumption and body weight were measured weekly. The FCR was calculated by feed consumption and BW gain.

Table 1. The composition of the experimental diets

CP, %	13			15		
ME, kcal/kg	2,400	2,700	3,000	2,400	2,700	3,000
Ingredients, %						
Yellow corn	53.10	60.10	67.10	50.30	56.40	62.50
Soybean meal	11.50	14.57	17.65	17.90	20.87	23.85
Wheat bran	25.25	13.73	2.20	21.65	10.83	0.00
Rice hulls	7.00	6.75	6.50	7.00	6.75	6.50
Limestone, pulverized	0.80	0.80	0.80	0.80	0.80	0.80
Dicalcium phosphate	1.60	1.60	1.60	1.60	1.60	1.60
Salt, iodized	0.30	0.30	0.30	0.30	0.30	0.30
Choline chloride, 50%	0.10	0.10	0.10	0.10	0.10	0.10
Soybean oil	0.00	1.70	3.40	0.00	2.00	4.00
Vitamin premix[1]	0.20	0.20	0.20	0.20	0.20	0.20
Mineral premix[2]	0.15	0.15	0.15	0.15	0.15	0.15
Calculated values						
CP, %	13.0	13.0	13.0	15.0	15.0	15.0
ME, kcal/kg	2401	2701	3002	2401	2703	3004
C fiber, %	8.00	6.9	6.0	8.0	7.0	6.1
Ca, %	0.78	0.77	0.77	0.79	0.79	0.78
Available P, %	0.41	0.39	0.38	0.41	0.40	0.39
Met, %	0.225	0.230	0.235	0.251	0.256	0.260
Met + Cystine, %	0.455	0.467	0.478	0.510	0.520	0.530
Lys, %	0.791	0.822	0.853	0.934	0.964	0.994
Analyzed values						
Crude protein (%)[*]	14.1 ± 0.08	13.8 ± 0.04	13.9 ± 0.57	15.6 ± 0.02	15.4 ± 0.02	15.1 ± 0.08
Ether extract (%)[*]	3.0 ± 0.03	4.9 ± 0.33	6.1 ± 0.53	3.4 ± 0.33	5.2 ± 0.74	6.9 ± 0.96

[1] Provided per kilogram of diet: Vitamin A (retinyl acetate), 20,000 IU; vitamin D_3 4,000 IU; vitamin E (DL-α-tocopheryl acetate), 40 IU; vitamin K_3, 6 mg; vitamin B_1 4 mg; vitamin B_2 10 mg; vitamin B_6 6 mg; vitamin B_{12}, 0.06 mg; nicotinic acid, 60 mg; pantothenic acid, 20 mg; folic acid, 4 mg; and biotin, 0.4 mg.

[2] Provided per kilogram of diet: Fe, 150 mg; Cu, 22.5 mg; Mn, 120 mg; Co 0.38 mg; Zn, 75 mg; I, 1.3mg; Se 0.23 mg.

[*] Mean ± SD.

II. Feed composition determination

The crude protein and ether extract of feed samples were determined by Livestock Research Institute Feed Analysis Center, which using CNS 2770-5 method and CNS 2770-4 method, respectively.

III. Statistical analyses

The data of experiment were analyzed with General Linear Model (GLM). The ANOVA option of GLM as a 2 × 3 factorial arrangement of dietary treatments with dietary CP and ME as main effects were used with SAS software (SAS Institute, 1996). The differences of growth performance between the 6 dietary treatments were compared by the Tukey's Studentized Range Test when probability values were significant (P < 0.05).

Results

The effects of dietary CP and ME levels on the growth performance of geese from 4 to 8 WOA are given in Table 2. There were no significant difference in feed intake or BW gain between 13 and 15% CP levels during this period. Whereas, the FCR (feed intake / BW gain, kg : kg) of geese fed with 13% CP diet was better (P < 0.05) than those fed with 15% CP diets.

Table 2. The effects of CP and ME levels on growth performance of White Roman geese from 4 to 8 weeks of age

Item	Feed intake (g/day/goose)	BW gain (kg)	Feed conversion ratio (feed intake / BW gain, kg : kg)
CP levels, %			
13	292	1.93	4.25^{b}
15	302	1.93	4.38^{a}
ME, kcal/kg of diet			
2,400	317^{a}	2.03^{a}	4.37^{a}
2,700	302^{a}	1.91^{b}	4.43^{a}
3,000	274^{b}	1.85^{b}	4.14^{b}
	----------	P-value	----------
CP	0.0826	0.8919	0.0372
ME	0.0001	0.0025	0.0028
CP × ME	0.0800	0.0781	0.3323

[a, b] Means within a column that without a common superscript were significantly different (P < 0.05).

The effects of dietary ME levels significantly influenced (P < 0.05) the feed intake, BW gain, and FCR in this growing period. Feed intake and BW gain were increased by decreasing the dietary ME levels (P < 0.01). The highest and lowest FCR was 4.43 and 4.14 from the diets containing 2,700 and 3,000 ME kcal /kg respectively, and the lowest FCR significantly (P < 0.01) better than others.

No significant interaction between CP and ME factors had been detected in feed intake, BW gain, and FCR. However, the P values of feed intake (P = 0.080) and BW gain (P = 0.078) were low. This indicated that CP and ME interaction factor to feed intake and BW gain tended to interact.

Discussion

I. The CP effects on the growth performance of geese

A low CP diet suppresses the appetite of chicken (Leeson *et al.*, 1993). The feed intake of geese fed with the 13 and 15% CP diets had no significant difference (P = 0.08) in this study (Table 2). Similar with chicken, a lower feed intake (292 g/day/goose) was obtained from the geese fed with the lower 13% CP diets. It seems that the effect of low CP diets was to suppress the appetite of geese. The 13% CP diets had lower feed consumption and the same BW gain of geese fed with the 15% CP diets. However, the FCR of geese fed with the 13% CP diets was significantly (P < 0.01) better than those fed with the 15% CP diets. We concluded that the 13% CP level diet was useful for the growth of geese from 4 to 8 WOA.

II. Higher energy diet resulting better FCR on geese

Higher energy diets had better FCR on the broilers at 6, 7, and 8 WOA (Holsheimer and Veerkamp, 1992). The most critical nutritional factor for Pekin ducks is dietary nutrient density. Giving higher dietary ME concentration had better

FCR was also found in Pekin duck (Zeng *et al.*, 2015). The same result was found in this study, the geese from 4 to 8 WOA given higher energy diets had better FCR (P < 0.01) (Table 2).

III. The relation between energy and feed intake of geese

Morris *et al.* (1968) indicated that the effect of changing dietary energy on growing birds is dependent on the capacity of birds to alter feed intake to meet demands. Veldkamp *et al.* (2005) reported that feed intake decreased linearly as dietary energy increased in turkeys. Increasing diet energy from 2,500 to 3,250 ME kcal/kg, showed a decreasing feed intake from 318 to 273 g/day/goose on White Roman geese from 4 to 8 WOA (Wang *et al.*, 2004). In this study, increasing dietary energy from 2,400 to 3,000 ME kcal/kg of diet could decrease the feed intake from 317.1 to 274.0 g/day/goose in the geese from 4 to 8 WOA of geese (Table 2). Changing the dietary energy from 2,500 to 3,250 ME kcal/kg, the geese had the ability to alter the feed intake to meet geese demands (Wang *et al.*, 2004). We concluded that geese have to adjust their feed intake with diet ranging from 2,400 to 3,000 ME kcal/kg.

IV. Protein and essential amino acid intake of geese

The 15% CP level of grower diet was recommended by NRC (1994). The White Roman geese giving 15% CP diets under relative high and low environmental temperature, we calculated protein intake of the geese were 44.3 and 50.6 g/day/goose, respectively (Wang *et al.*, 2004). In this study the BW gain of geese fed with 2,400, 2,700 and 3,000 ME kcal/kg under 15% CP diet had no significant difference (Table 3). The 3 groups giving 15% CP diet had similar calculated protein intakes (47.0, 46.7 and 42.6 g/goose/day) and BW gain (1.99, 1.91 and 1.91 kg/goose) from 4 to 8 WOA, respectively.

Table 3. The growth performance of White Roman geese between 4 and 8 weeks of age

CP, %	13			15		
ME, kcal/kg	2,400	2,700	3,000	2,400	2,700	3,000
ME/CP ratio	185	208	231	160	180	200
8 weeks body weight (kg/goose)*	4.6 ± 0.4	4.4 ± 0.4	4.3 ± 0.5	4.5 ± 0.5	4.4 ± 0.4	4.4 ± 0.6
Body weight gain (kg/goose)	2.08 ± 0.07^{a}	1.92 ± 0.09^{bc}	1.80 ± 0.10^{c}	1.99 ± 0.10^{ab}	1.91 ± 0.07^{bc}	1.91 ± 0.11^{bc}
Feed intake (g/goose/day)	321 ± 14^{a}	294 ± 11^{bd}	264 ± 11^{e}	313 ± 13^{ac}	311 ± 8^{ab}	284 ± 18^{d}
Feed conversion rate**	4.32 ± 0.20^{bc}	4.30 ± 0.10^{bc}	4.12 ± 0.17^{c}	4.42 ± 0.10^{ab}	4.57 ± 0.13^{a}	4.17 ± 0.17^{c}
Calculated intake						
Protein (g/day)	41.7	38.2	34.3	47.0	46.7	42.6
Met + Cystine (g/day)	1.46	1.37	1.26	1.60	1.62	1.51
Lys (g/day)	2.54	2.42	2.25	2.92	3.00	2.82
ME (kcal/day)	770.4	793.8	792.0	751.2	839.7	852.0

* Mean ± SD.

** Feed intake/body weight gain.

a-e Means within rows without a common superscript were significantly different (P < 0.05).

In 13% CP dietary treatments, the geese given the 3,000 ME kcal/kg diet showed the lowest protein intake (34.3 g/day/goose) and BW gain (1.80 ± 0.10 kg/goose). The geese fed with 2,700 ME kcal/kg diet had a 38.2 g/day/goose protein intake and had similar BW gain 1.92 kg/goose with the 15% CP dietary treatments, although lower than the calculated protein intake 44.3 g/day/goose from Wang et al. (2004). It means that the 38.2 g/goose/day protein intake was sufficient for the geese from 4 to 8 WOA.

Besides, we also calculated Methionine + Cystine and Lysine intake (protein intake × amino acid percentage of diet), which were 2.42 and 1.37 g/day/goose. It implied that diet with 2.42 g Methionine + Cystine and 1.37 g Lysine intake per day, was sufficient for the geese. We concluded that the 38.2 g/goose/day protein intake was sufficient for BW gain of White Roman geese from 4 to 8 WOA.

V. The ratio of energy to protein of diet influence the growth performance

Birds receiving higher energy diet had a lower feed intake and better FCR than birds receiving normal energy diet (Waldroup *et al.*, 1990; Lei and Van Beek 1997; Hu *et al.*, 2008). Our data revealed that geese from 4 to 8 WOA receiving the lowest ME diet (2,400 ME kcal/kg) had the highest feed intake (317 g/day) and BW gain (2.03 kg) (Table 2). It implied that the ratio of energy to protein of diet might be an affecting factor.

The BW gain of geese fed with the three different energy diets with 15% CP had no significant difference (Table 3). The geese receiving the 231 ME/CP ratio diet had the lowest BW gain 264 ± 11 (mean ± SD) g/goose/day. The result indicated that the 231 ME/CP ratio of diet is too high for geese from 4 to 8 WOA. The geese that fed with 208 ME/CP ratio diets (13% CP and 2,700 ME Kcal/kg) did not get a lower BW gain. We concluded that the ME/CP ratio for the geese was not more than 208, and the lower CP diet with suitable ME/CP ratio might be useful for the geese.

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飼糧粗蛋白與代謝能含量對 4 至 8 週齡白羅曼肉鵝生長表現的影響 (1)

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摘　要

本試驗目的在評估不同粗蛋白 (CP) 和代謝能 (ME) 含量對 4 至 8 週齡白羅曼肉鵝生長表現的影響。試驗以 192 隻 4 週齡白羅曼鵝為試驗動物。試驗採 2 × 3 複因子設計，即二種粗蛋白質含量 (13 及 15%) 與三代謝能含量 (2,400、2,700 及 3,000 kcal/kg)。結果顯示，試驗期間肉鵝給飼 13 或 15%粗蛋白質飼糧，對肉鵝的採食量或增重均無顯著影響。給予 13% CP 飼糧之肉鵝飼料轉換率 (FCR) 顯著 ($P < 0.05$) 優於 15% CP 飼糧者。計算鵝隻的蛋白質攝入量，顯示 4 到 8 週齡肉鵝攝取 38.2 克 / 天的蛋白質，足以使鵝隻有良好的生長表現。降低 13% CP 飼糧的 ME 含量，顯著 ($P < 0.01$) 增加 4 至 8 週齡鵝隻的採食量和增重，而增加飼糧 ME 含量可改善鵝隻的 FCR。綜上所述，13%粗蛋白質及 2,700 kcal/kg 代謝能含量飼糧，可滿足 4 到 8 週齡肉鵝生長所需。

關鍵詞：鵝、粗蛋白質、代謝能。

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