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Effects of diets containing different concentrations of energy on growth performance and carcass traits of geese from 28 to 70 days of age

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Increasing dietary energy level improves weight gain, and feed utilization efficiency, while high dietary energy causes excess abdominal fat or carcass fat in broiler chickens (Dozier *et al.* 2006) and ducks (Zeng *et al.* 2015). Additionally, energy contributing ingredients are the major cost in poultry feeds. Therefore, dietary energy density is regarded as the most critical nutritional factor in poultry production.

Goose meat is rich in content of unsaturated and essential fatty acids, and low in cholesterol content (Schmid 2010), which has a strong health benefit for human. There is growing interest in goose production, nearly 6.8 billion geese were slaughtered all over the world in 2013 as per FAO. However, there were few studies on energy requirements in geese. At present, although goose response to dietary energy was reported (Roberson and Francis 1963 a, b, Stevenson 1985, Min *et al.* 2007), these experiments were conducted decades ago, and the experimental data on modern strain of growing goose is still lacking. The objective of this study was to estimate the optimal dietary energy concentration for growing goose.

Male, 28-day old, Sichuan White geese (270) were randomly allocated to 10 dietary treatments with 6 replicate pens of 10 birds/pen. Birds in each group were fed experimental diet (Table 1) containing 11.29, 12.10, 12.87, 13.67 and 14.49 MJ of apparent metabolic energy (AME)/ kg dry matter (DM), respectively. The energy values were calculated according to the AME of feed ingredient in geese (Chen 2005, Min *et al.* 2004, Wang 2012). Except for the dietary energy concentrations, all other nutritive values were the same across the 5 treatments (Table 1). At 70 days of age, the growth performance and carcasses traits of geese from each pen were measured, the data were subjected to one-way ANOVA using the GLM procedure of SAS software (Version 9.0) for analysis. Optimal dietary energy concentration were estimated using a broken line regression model (Robbins *et al.* 2006) by the NLIN procedure of SAS software (Version 9.0).

Dietary energy concentration (Table 2) did not significantly affect average daily gain (ADG) ($P>0.05$), but

Table 1. Ingredients and chemical composition of the experimental diets (% as fed)

Particular	Experimental diet				
	1	2	3	4	5
Ingredients (%)					
Corn	39.90	43.76	46.20	48.30	50.60
Soybean meal	12.74	12.20	9.52	7.00	4.41
Fish meal	0.00	1.50	4.00	6.50	8.95
Wheat bran	35.44	26.77	20.43	13.79	7.15
Alfalfa meal	7.78	10.00	12.30	14.70	17.10
Soybean oil	0.00	2.00	4.26	6.74	9.22
Lysine·HCl	0.28	0.24	0.20	0.14	0.09
Dl-Methionine	0.28	0.25	0.22	0.19	0.16
L-Tryptophan	0.09	0.09	0.09	0.09	0.09
L-Threonine	0.02	0.00	0.00	0.00	0.00
L-Arginine·HCl	0.52	0.45	0.38	0.35	0.30
Salt	0.30	0.30	0.30	0.30	0.30
Limestone	1.85	1.64	1.30	1.10	0.83
Hydrophosphate	0.40	0.40	0.40	0.40	0.40
Choline chloride	0.10	0.10	0.10	0.10	0.10
Mineral and vitamin premix	0.3	0.3	0.3	0.3	0.3
Total	100.00	100.00	100.00	100.00	100.00
Chemical composition (%)					
AME (MJ/kg)[§]	10.00 (11.29)	10.80 (12.10)	11.60 (12.87)	12.40 (13.67)	13.20 (14.49)
Crude protein	16.00	16.00	16.00	16.00	16.00
Crude fiber	5.45	5.45	5.45	5.45	5.45
Calcium	1.00	1.00	1.00	1.00	1.00
Total phosphorus	0.60	0.60	0.60	0.60	0.60
Lysine	0.87	0.87	0.87	0.87	0.87
Methionine	0.47	0.47	0.47	0.47	0.47
Threonine	0.54	0.54	0.55	0.55	0.55
Tryptophan	0.27	0.27	0.27	0.27	0.27
Arginine	1.00	1.00	1.00	1.00	1.00

[§]The bracketed values were expressed on dry matter basis.

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Table 2. Effect of dietary energy concentration on performance of Sichuan White geese from 28 to 70 days of age§

Attribute	Energy concentration (MJ/kg DM)					SEM
	11.29	12.1	12.87	13.67	14.49	
ADG (g)	53.21	52.42	53.62	52.7	54.21	0.65
ADFI (g)	230.33[a]	214.36[b]	208.28[b]	203.01[b]	204.77[b]	2.61
FGR (g:g)	4.34[a]	4.10[ab]	3.89[cb]	3.86[cb]	3.79[c]	0.05

§Each value is the mean of 6 replicates of 9 geese; different superscripts in a row differ significantly (P<0.05).

the average daily feed intake (ADFI) and feed/gain ratio (FGR) decreased significantly with increased dietary energy concentration (P<0.05). This was in agreement with the previous studies in geese (Roberson and Francis 1963a, Stevenson 1985, Min *et al.* 2007). Dietary energy concentration did not significantly affect percentage of breast and leg meat to live body weight (P>0.05) (Table 3), which is consistent with other studies on geese (Stevenson 1985), ducks (Fan *et al.* 2008) and chicken (Leeson *et al.* 1996). High dietary energy would cause excess abdominal fat or carcass fat in geese (Min *et al.* 2007), broiler chickens (Dozier *et al.* 2006) and ducks (Zeng *et al.* 2015), this was in accordance with the results in the present study, which revealed that percentage of subcutaneous fat and skin, and intramuscular fat content in breast meat was increased as dietary energy increased (P<0.05). However, no such increase was found in abdominal fat (P > 0.05) (Table 3). The increased fat deposit may be due to increased energy retention and caloric conversion caused by high dietary energy concentration (Zeng *et al.* 2015). In the present experiment, ADFI and FGR of geese were all improved significantly as dietary energy concentration increased (P<0.05) and these 2 response criteria reached a plateau when dietary energy concentration was above 12.10 MJ/kg (Table 3).

Therefore broken-line regression analyses were adopted, and ADFI and FGR were used as criteria for optimal concentrations estimation. According to this regression, the optimal concentration of dietary AME for geese from 28 to 70 days was 12.56 MJ/kg DM for ADFI (Fig. 1) and 13.09 MJ/kg DM for FGR (Fig. 2). The results were different from those of Leeson and Summers (2005), who recommended 12.34 MJ/kg diet (as fed basis) for heavy weight goose from 4 weeks to market. In addition, Min *et al.* (2007) reported that the optimal dietary AME requirement of goslings from hatch to 28 days was 11.87 MJ/kg (as-fed basis). Sichuan White Geese is a typical light weight goose (average live body weight is about 3.5 kg for males and 3.1 kg for females at 10 weeks), thus the results can also be used in feed formula in other light goose practice.

Table 3. Effect of dietary energy on carcass traits and intramuscular fat content of Sichuan White geese at 70 days of age§

Attribute	Energy concentration (MJ/kg DM)					SEM
	11.29	12.1	12.87	13.67	14.49	
Breast meat (%)	5.27	5.63	5.49	5.16	5.15	0.08
Leg meat (%)	9.86	10.14	10.07	9.96	9.67	0.22
Abdominal fat (%)	2.27	2.55	2.39	2.7	2.68	0.07
Subcutaneous fat and skin (%)	13.48[b]	15.22[a]	15.10[a]	15.73[a]	15.758[a]	0.28
Intramuscular fat (% as fresh sample)	1.47[b]	1.70[b]	1.72[ab]	1.69[ab]	1.88[a]	0

§Each value is the mean of 6 replicates of 2 geese; yield of breast meat, leg meat, abdominal fat, subcutaneous fat and skin were expressed as percentage to live body weight; different superscripts in a row differ significantly (P<0.05).

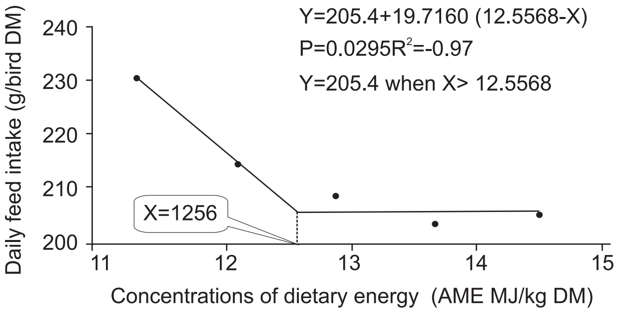

Fig. 1. Relationship between ADFI and dietary energy concentration in geese from 28 to 70 days using a broken-line regression model analysis.

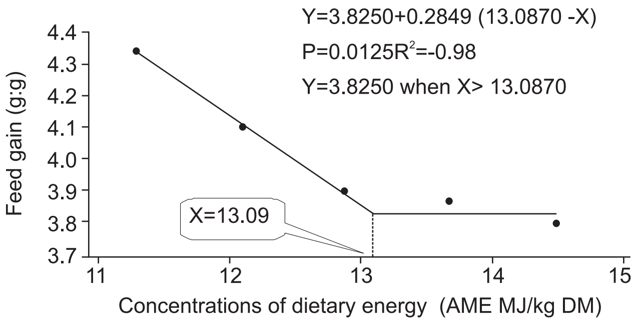

Fig. 2. Relationship between FGR and dietary energy concentration in geese from 28 to 70 days using a broken-line regression model analysis.

Our experiment is the first to estimate the optimal dietary energy concentration of grower light-weight geese, which would be helpful to guide formulating of geese feed.

SUMMARY

Supplementation of dietary energy could reduce daily feed intake, decrease the feed/gain ratio, and increase intramuscular fat content. Based on broken-line regression analysis, the optimal concentrations of dietary energy for Sichuan White geese from 28 to 70 d was 12.56 MJ AME/kg DM for minimum ADFI and 13.09 MJ AME/kg DM for optimum FGR, respectively.

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