



The apparent metabolisable energy requirement of Sansui ducks from hatch to 21 days of age

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SHORT COMMUNICATION
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Abstract

A dose-response experiment was conducted to estimate optimal dietary apparent metabolisable energy requirement (AME) in Sansui ducks (Sansui Sheldrake duck) from hatch to 21 days of age. Three hundred thirty-six one-day-old male Sansui ducks were randomly assigned to six experimental treatments, each consisting of seven replicate pens with eight birds per pen. Birds were fed diets containing either 10.92, 11.38, 11.8, 12.26, 12.68 and 13.14 MJ AME/kg, respectively. At 21 d of age, the body weight, weight gain, feed intake, protein intake, energy intake and feed conversion ratio of ducklings from each pen were measured. Increasing AME content from 10.92 MJ/kg to 13.14 MJ/kg significantly improved body weight, weight gain, feed intake, feed conversion ratio and crude protein intake ($P < 0.05$). No significant changes in energy intake were found among treatments ($P > 0.05$). Based on broken-line regression analysis, the AME requirement of male Sansui ducks from hatch to 21 d of age was 11.49 and 11.59 MJ/kg for maximum body weight and best feed conversion ratio, respectively.

Keywords: apparent metabolisable energy; growth performance; broken-line regression

1. Introduction

Energy-contributing feed ingredients are a major cost in poultry production, and include maize, wheat, barley and oils. Energy plays an important role in animal growth and the apparent metabolisable energy (AME) is the globally accepted system for describing the available energy for poultry (Abdollahi *et al.*, 2021). Optimal AME provision influences feed conversion ratio by lowering feed intake (Fan *et al.*, 2008; Xie *et al.*, 2010). In addition, a lower feed intake caused by high-energy diets certainly required higher amino acid requirements in ducks, such as lysine and methionine (Wen *et al.*, 2017; Wu *et al.*, 2019). Therefore, accurate estimation of AME is critical for precise poultry feed formulation and for reducing feed cost per unit of poultry product.

As the dietary energy is highly relevant for growth performance, a few studies associated with AME requirement for Pekin ducks have been conducted (Fan

et al., 2008; Xie *et al.*, 2010) and Korean native ducks (Wickramasuriya *et al.*, 2016). Sansui ducks (Sansui Sheldrake) are a local breed of Guizhou province, China (Li *et al.*, 2007). At present, the experimental data of AME requirements on Sansui ducks from hatch to 21 d of age are still lacking. In addition, previously published data on the AME requirement of other duck species may not be applicable to Sansui ducks because of genetic growth differences (Wickramasuriya *et al.*, 2016). Therefore, the purpose of this study was to assess the requirement of dietary AME of Sansui duck from hatch to 21 d of age in relation to growth performance.

2. Materials and methods

All practices and procedures of this experiment were reviewed and approved by the animal care and welfare committee of the Institute of Animal Husbandry and Veterinary Medicine, Guizhou Academy of Agricultural

Sciences and performed according to the guideline for animal experiments established by the National Institute of Animal Health.

A dose-response experiment with six dietary energy levels was conducted in a completely randomised design. The dietary treatments were formulated containing 10.92, 11.38, 11.8, 12.26, 12.68 and 13.14 MJ AME /kg, respectively, based on the AME values of feed ingredients for ducks (Table 1). A total of 336, one-day-old male Sansui ducklings from a commercial hatchery were randomly allocated into six experimental treatments, each containing seven replicate pens containing eight birds each. The ducklings were fed respective experimental diets and water provided *ad libitum* from d 1 to 21. During this period, these ducklings were reared in raised wire-floor pens and lighting was continuous for 24 h. The ambient temperature was maintained at 33 °C from 1 to 3 d of age and then gradually decreased to 25 °C until 21 d of age.

At 21 d of age, after overnight fasting, body weight, weight gain, feed intake, energy intake, crude protein intake and feed conversion ratio of ducklings from each

pen were measured or calculated. Feed conversion ratio was expressed as feed intake/weight gain after being all corrected for mortality.

Data were analysed as a completely randomised design by the GLM procedure in ANOVA using SAS software (SAS Institute, 2003). The variability in the data was expressed as the pooled standard error of means. The effects of dietary AME levels on growth performance were determined by using orthogonal polynomials for linear and quadratic effects. The broken-line regression analysis (Robbins *et al.*, 2006) was used to estimate the AME requirement of Sansui ducks based on feed conversion ratio and body weight using the NLIN procedure of SAS (SAS Institute, 2003), as regression was significant ($P < 0.05$). The broken-line model used was as follows:

$$y = l + u(r - x)$$

Where y = feed conversion ratio, or body weight; x = dietary energy level (kcal/kg), r = requirement of dietary energy, l = the response at $x = r$, u = the slope of the curve. In this model, $y = l$ when $x > r$.

Table 1. Composition and calculated composition of experimental diets (as feed).

Item	Energy level (AME, MJ/kg)					
	10.92	11.38	11.8	12.26	12.68	13.14
Ingredients, %, unless noted						
Maize	48.00	48.80	49.60	50.40	51.20	52.00
Wheat bran	19.00	16.14	13.28	10.42	7.56	4.70
Soybean meal	28.77	29.54	30.30	31.07	31.83	32.60
Sodium chloride	0.30	0.30	0.30	0.30	0.30	0.30
Dicalcium phosphate	1.39	1.43	1.47	1.50	1.54	1.58
Limestone	1.29	1.27	1.25	1.24	1.22	1.20
Vitamin and trace mineral premix ¹	1.00	1.00	1.00	1.00	1.00	1.00
DL-Met	0.15	0.15	0.16	0.16	0.17	0.17
Lysine	0.10	0.09	0.08	0.07	0.06	0.05
Soybean oil	0.00	1.28	2.56	3.84	5.12	6.40
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated composition, %, unless noted						
Metabolisable energy, MJ/kg ²	10.92	11.38	11.8	12.26	12.68	13.14
Crude protein	19.55	19.55	19.55	19.55	19.55	19.55
Calcium	0.91	0.91	0.91	0.91	0.91	0.91
Non-phytate phosphorus	0.40	0.40	0.40	0.40	0.40	0.40
Methionine	0.46	0.46	0.46	0.46	0.46	0.46
Cysteine	0.35	0.35	0.35	0.35	0.35	0.35
Lysine	1.06	1.06	1.06	1.06	1.06	1.06
Analysed composition, %						
Gross energy	15.94	16.35	16.82	17.22	17.68	18.1
Crude protein	20.05	19.62	19.94	20.07	19.57	19.7

¹ Supplied per kilogram of total diet: Cu (CuSO₄·5H₂O), 10 mg; Fe (FeSO₄·7H₂O), 60 mg; Zn (ZnO), 60 mg; Mn (MnSO₄·H₂O), 80 mg; Se (NaSeO₃), 0.2 mg; I (Wickramasuriya *et al.*), 0.2 mg; choline chloride, 1000 mg; vitamin A (retinol acetate), 10,000 IU; vitamin D₃ (cholecalciferol), 3,000 IU; vitamin E (DL- α -tocopheryl acetate), 20 IU; vitamin K₃ (menadione sodium bisulphate), 2 mg; thiamin (thiamin mononitrate), 2 mg; riboflavin, 8 mg; pyridoxine hydrochloride, 4 mg; cobalamin 0.06 mg; calcium-D-pantothenate, 20 mg; nicotinic acid, 50 mg; folic acid, 1 mg; biotin, 0.2 mg.

² Values were calculated according to the AME values of feedstuffs for ducks (Ministry of Agriculture of China, 2012).

3. Results and discussion

In this study, a maize-soybean meal diet was used and soybean oil and wheat bran were used to prepare experimental diets with different AME levels. The growth performance of ducks from hatch to 21 d of age are summarised in Table 2. Consistent with what was expected as dietary energy level increased from 10.92 to 13.14 MJ/kg, the body weight of ducks at 21 d of age and weight gain increased linearly and quadratically ($P < 0.05$), but the feed intake and feed conversion ratio decreased linearly ($P < 0.05$). Similar supporting results using Pekin ducks and Korean native ducks have been reported (Fan *et al.*, 2008; Wickramasuriya *et al.*, 2016; Xie *et al.*, 2010). However, no significant ($P > 0.05$) effect was seen for energy intake in this study, which was in line with results of Xie *et al.* (2010) who observed that there was no significant relationship between energy intake and dietary AME level in white Pekin ducklings. The improvement in feed conversion ratio in this study resulted from the reduced feed intake caused by high dietary energy concentration, because poultry are thought to maintain constant energy availability by regulating the intake (Leeson *et al.*, 1996). In contrast, Wickramasuriya *et al.* (2016) reported that increasing AME content from 10.89 to 13.82 MJ/kg significantly improved the energy intake in Korean native duck from hatch to 21 d of age. In the current study, as dietary energy content increased, the crude protein intake was reduced due to the decline in feed intake. This was supported by the findings of Wickramasuriya *et al.* (2016) and Xie *et al.* (2010) who both observed a similar response in ducks.

The accuracy of estimated nutrient requirements determines maximum growth performance. Therefore, maximum growth performance is the first consideration when choosing a statistical model to estimate optimal nutrient requirements. Many regression models have been used to determine nutritional requirements of poultry, including broken-line, quadratic and quadratic broken-line regression models (Fan *et al.*, 2008; Pesti *et al.*, 2009; Tang

et al., 2013; Wang *et al.*, 2013; Xie *et al.*, 2010). Broken-line regression analysis has been commonly used to estimate the AME requirement of poultry in terms of maximum weight gain or feed conversion ratio (Fan *et al.*, 2008; Xie *et al.*, 2010). As mentioned above, body weight improved linearly ($P < 0.05$) with increasing AME up to 11.38 MJ/kg, and reached a plateau. Feed conversion ratio ($P < 0.05$) decreased linearly and reached a plateau when dietary AME was above 11.8 MJ/kg. Both parameters fitted the broken-line pattern and, hence, the AME requirement for Sansui ducks from hatch to 21 d of age were estimated to be 11.49 MJ/kg for maximum body weight, according to the equation:

$$y = 594.6 - 153.3 \times (11.4901 - x)$$

with an $R^2 = 0.916$ (Figure 1)

Energy levels in feed was 11.59 MJ/kg for minimum feed conversion ratio, according to the equation (Figure 2; $R^2 = 0.942$):

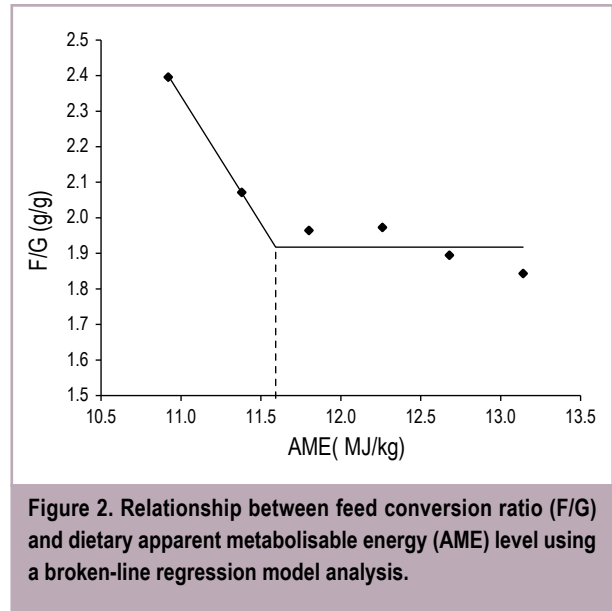
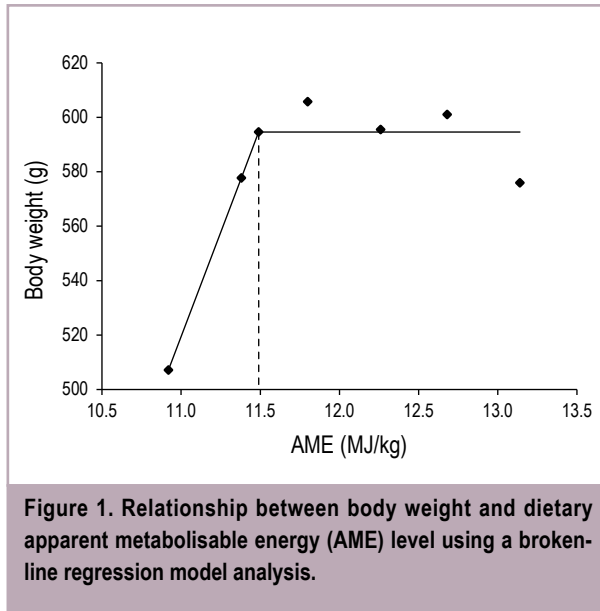
$$y = 1.9175 + 0.7174 \times (11.5926 - x)$$

Xie *et al.* (2010) and Wickramasuriya *et al.* (2016) reported that the minimum AME requirements of Korean native ducks and white Pekin duck from hatch to 21 d of age were 12.13 and 12.63 MJ/kg, respectively. This indicated that previously published data might not be applicable to Sansui ducks due to their high genetic diversity (Li *et al.*, 2007). However, one limitation of the current study was that the AME of experimental diets was calculated according to values for feedstuffs provided by the Ministry of Agriculture of China (2012), which were not derived from methods using the classical total excreta collection method.

Table 2. Effects of apparent metabolisable energy on growth performance of Sansui ducks from hatch to 21 days of age.¹

AME levels (MJ/Kg)	Body weight (g/bird)	Weight gain (g/bird/day)	Feed intake (g/bird/day)	Feed conversion ratio (g/g)	Energy intake (kJ AME/bird/day)	CP intake (g/bird/day)
10.92	507.2	22.1	52.8	2.40	576.18	10.32
11.38	577.7	25.4	52.4	2.07	596.96	10.25
11.8	605.7	26.8	52.5	1.96	619.15	10.26
12.26	595.6	26.3	51.7	1.97	634.27	10.12
12.68	601.1	26.6	49.5	1.90	627.85	9.68
13.14	575.9	25.3	45.4	1.84	596.76	8.88
Pooled SEM	8.8	0.4	0.8	0.04	8.00	0.15
P-value						
AME	0.0048	0.0048	0.0229	<0.0001	0.2712	0.0229
AME linear	0.0134	0.0134	0.0019	<0.0001	0.1997	0.0019
AME quadratic	0.0017	0.0017	0.0732	0.0036	0.0409	0.0732

¹ AME = apparent metabolisable energy; CP = crude protein; SEM = standard error of mean.



4. Conclusions

Dietary AME levels of 11.49 and 11.59 MJ/kg are recommended for maximum body weight and minimum feed conversion ratio, respectively, for Sansui ducks from hatch to 21 d of age, based on broken-line regression model.

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Conflict of interest

The authors declare no conflict of interest.

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