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Effect of dietary fibre on growth performance and digestive traits of geese

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Abstract

The aim of the present study was to evaluate the effect of dietary fibre level on growth performance and digestive traits of geese from 1 to 28 days of age. Forty one-day-old Jilin Nongan white geese were randomly divided into two groups of 20 and fed with different level of dietary fiber (*Leymus chinensis*). One group was fed with the diet containing 5% (control) CF (crude fibre), and the other with the diet containing 6% CF. The results showed that feeding with diet containing 6% CF not only significantly decreased average daily intake (ADI), average daily gain (ADG), total feed intake (TFI) and total weigh gain (TWG) of geese, but also decreased digestibility of crude fibre (CF) and hemicellulose (HC), and suppressed the development of gastrointestinal tract of gosling. It was concluded that the dietary fibre level could not be exceeded more than 5% in gosling when using *Leymus chinensis* as fibre source.

Introduction

The goose, an herbivorous poultry, is capable of utilizing more fibre than other avian species (Jamroz, 1992; Yu, 1998). Hollister et al. (1984) reported that the digestibility of crude fibre (CF) was 21.4% when the geese were fed a diet containing 40% lucerne meal. It has also been reported that the goose could digest 28% cellulose and 25% hemicellulose (HC) from plants (Buchsbaum et al., 1986). Shao (1991) found that the digestibility of HC, neutral detergent fibre (NDF) and acid detergent fibre (ADF) was 41.5%, 37.4% and 21.7% respectively. Our laboratory recently demonstrated that the digestibility of HC, NDF and ADF in geese feeding with lucerne diet was approximately 40%. These results demonstrated that the goose could utilize a great deal of crude fibre, although there were inconsistent in the digestibility of fibre fraction. It has been shown that the digestion and utilization of dietary fibre could be affected by difference in breed and age of the goose, fibre sources, and plant maturity and so on (Yu, 1998).

Although the digestion and utilization of dietary fibre in goose has been investigated in detail, little information is available on gosling. *Leymus chinensis*, a perennial species of Gramineae, is widely distributed in the Songnen plain and the eastern Inner Mongolian plateau in China (Li, 1988; Xiao et al., 1995). The digestion and utilization of *Leymus chinensis* in domestic livestock has been well documented, however, to our knowledge, there is no data in poultry. The aim of the present study was to investigate the effect of dietary fibre (*Leymus chinensis* as fiber source) level on growth performance and digestive traits of geese from 1 to 28 day of age.

Materials and Methods

Two diets containing either 5% (control) or 6% crude fibre were formulated according to the NRC (1994) by supplementing different level of *Leymus chinensis* meal. The two diets contained the same level of protein and energy. Formulation and nutrient compositions of the experiment diets are shown in Table 1. The crude protein (CP) and CF levels were determined according to standard AOAC (1990) procedures. The techniques described by Van Soest et al. (1991) were used to determine NDF and ADF concentrations, and HC was estimated by difference (NDF-ADF).

Forty one-day-old Jilin nongan white geese (native breed) roughly of the same weight were divided into two groups of 20 according to a completely randomized design. One group was fed with the diet containing 5%

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Table 1: Formulation and nutrient compositions of the experimental diet

Ingredient (%)	Diet containing 5% CF	Diet containing 6% CF	Nutrient composition	Diet containing 5% CF	Diet containing 6% CF
Maize meal	59	57	ME[2] (MJ/kg)	11.700	11.319
Soyabean meal	22	21	CP (g/kg DM)	20.25	19.704
Limestone	0.9	0.9	CF (g/kg DM)	5.073	5.997
Fish meal	7	7	NDF (g/kg DM)	50.77	51.04
Leymus chinensis	10	13	ADF (g/kg DM)	7.62	8.90
Salt	0.4	0.4	HC (g/kg DM)	43.15	42.14
Premix[1]	0.7	0.7			
Total	100	100			

[1] Premix composition (mg/kg of feed): 50 mg Fe/kg; 40 mg Zn/kg; 40 mg Mn/kg; 20 mg Cu/kg; 0.05 mg Se/kg; 0.05 mg Co/kg; 0.05 mg I/kg; 250 mg/kg of multiplex vitamins

[2] Calculated: ME was calculated based on analyzed values of feedstuffs (NRC, 1994). It is equal to the sum of the product of the metabolizable energy and the percentages of each ingredient in the diet

CF, and the other the diet with the diet containing 6% CF. The geese were housed at the farming base of Jilin Agricultural University. The birds had free access to feed and water throughout the trial. Room temperature was kept at 27-28°C during the first 5 d of life and then it was reduced gradually according to age until reaching 18-22°C at 16 d. Ethical approval for the study was obtained from the Ethical Committee of the Jilin Agricultural University, China.

The ADI was recorded. Body weigh (BW) were determined at 1, 2, 3, and 4 weeks of age to calculate the ADG and the feed to gain (F/G) ratio. TFI and TWG were also calculated.

Eight healthy geese were selected for metabolic experiment at the fourth week. The geese were housed in 16 metal cages and fed with the two diets respectively. Excreta were collected from the trays twice daily and immediately placed in a freezer at -20°C for 4 days. The digestibility of CP, CF, NDF, ADF, HC and energy was determined by using the method described above. In order to determine development of the gastrointestinal tract of geese, eight healthy geese in each group were sacrificed by cervical dislocation and glandular stomach, gizzard, duodenum, jejunum, ileum and rectum were collected for weighing and making tissue section. Three sections were selected from each digestive tract of the goose and photographed in six views, and then height of intestinal villus and caecum plica was determined by using Image-Pro Plus image analysis system software.

Statistical Analysis

Data was analyzed using the SPSS 13.0 for windows statistical software (SPSS, 2004). Differences in performance and digestive traits were tested for statistical significance using student t-test.

Results

The results of effect of dietary fibre on growth performance of the geese are presented in Table 2. High level of dietary fibre significantly decreased ADG, ADI, TFI and TWG of geese during these four weeks. Compared to control group, F/G of geese was significantly increased in group of high level of dietary fibre. Effects of dietary fibre level on metabolic rate of dietary nutrients in gosling are shown in Table 3. Increasing dietary fibre level decreased the digestibility of CF and HC ($p<0.05$), however, digestibility of NDF, ADF, CP and energy did not change. Effects of dietary fibre level on weight, length and digesta weight of gastrointestinal tract of goose are shown in Table 4. Compared to control group, high level of dietary fiber significantly decreased weight of gizzard ($p<0.05$), duodenum and jejunum($p<0.01$) but increased weight of glandular stomach ($p<0.01$) and caecum digesta ($p<0.05$). As shown in Table 5, high level of dietary fibre significantly decreased the height of duodenum villus ($p<0.05$) and increased height of caecum plica ($p<0.05$).

Discussion

Results of the present study showed that growth performance of gosling was significantly decreased with increasing crude fibre levels from 5% to 6% by supplementing with *Leymus chinensis* as fibre source. Hsu et al. (2000) reported that ADG significantly increased with increasing crude fibre levels, but F/G of gosling in high level of fibre diet increased. The difference in ADG may be caused by different fibre source. It has been well established that digestion and utilization of dietary fibre could be affected by dietary fibre source (Yu et al., 1998). To our knowledge, *Leymus chinensis*, as the main feed resource of domestic animal, has never been investigated in poultry. In the present study, the decreased growth performance of gosling in high level of dietary fibre group may be caused at least by decreasing food intake. The results of the present study also demonstrated that although the gosling could digest dietary fibre, the level of dietary fibre should not exceed 5% when *Leymus chinensis* was as the main fiber source.

Table 2: Effect of dietary fibre on growth performance of geese from 1 to 28 d of age

Item	Diet containing 5% CF	Diet containing 6% CF
ADG at 1 week (g)	22.13±0.43 ^{A}	9.82±0.56^{B}
ADG at 2 week (g)	38.62±0.91 ^{A}	24.82±0.83^{B}
ADG at 3 week (g)	56.61±1.74^{A}	39.75±2.85^{B}
ADG at 4 week (g)	96.80±2.21^{A}	68.00±2.42^{B}
ADI (g)	90.31±2.78^{A}	76.73±9.56^{B}
TFI (g)	2528.68	2148.44
TWG (g)	1499.08	960.07
F/G	1.69	2.24

Note: Values in the same line with different superscript letters (A, B) indicate significant differences at P<0.01

Table 3: Effect of dietary fibre level on metabolic rate of dietary nutrients in gosling

Item	Diet containing 5% CF	Diet containing 6% CF
Metabolic rate of CP (%)	65.48±8.21	63.67±6.14
Digestibility of CF (%)	20.04±11.30^{a}	17.89±7.28^{b}
Digestibility of NDF (%)	36.98±5.64	33.70±4.31
Digestibility of ADF (%)	13.14±5.46	12.41±8.74
Digestibility of HC (%)	47.74±3.12^{a}	46.69±1.47^{b}
Metabolic rate of energy (%)	70.28±5.14	69.87±6.21

Note: Values in the same line with different superscript letters (a, b) indicate significant differences at P<0.05

Table 4: Effect of dietary fibre level on weight, length and digesta weight of gastrointestinal tract of goose at 28 d of age

Item	Diet containing 5% CF	Diet containing 6% CF
Gizzard weight (g)	87.5±8.46^{a}	76.63±6.50^{b}
Glandular stomach weight (g)	7.83±0.41^{A}	10.04±2.45^{B}
Duodenum weight (g)	17.50±6.25^{A}	14.75±4.03^{B}
Duodenum length (cm)	45.50±4.32	41.07±8.93
Duodenum digesta weight (g)	3.30±1.86	2.88±2.03
Jejunum weight(g)	33.00±6.2^{A}	20.50±2.93^{B}
Jejunum length (cm)	91.08±14.10	78.44±14.40
Jejunum digesta weight (g)	14.30±7.97	15.29±7.61
Ileum weight (g)	3.50±1.05	2.25±1.16
Ileum length (g)	12.17±1.03	14.19±0.58
Ileum digesta weight (g)	1.25±0.50	2.14±2.19
Caecum weight (g)	3.50±1.05	3.00±1.31
Caecum length (cm)	33.17±8.14	29.38±9.78
Caecum digesta weight (g)	1.80±0.29^{a}	2.58±1.63^{b}
Rectum weight (g)	3.67±0.81	2.50±1.60
Rectum length (cm)	7.10±0.85	8.19±3.72
Rectum digesta weight (g)	0.75±0.35	1.14±0.38

Note: Values in the same line with different lower case indicate significant differences at P<0.05, and Values in the same line with different capital letter indicate significant differences at P<0.01

The present study firstly determined digestibility of dietary nutrients in gosling feeding with diet in which *Leymus chinensis* was as unique fibre source. The results showed that *Leymus chinensis* could be supplemented in diet of gosling. The present study also showed that higher level of dietary fibre significantly decreased the weight of gizzard, duodenum and jejunum. However, previous study has shown that dietary fibre source level did not significantly influenced the weight and length of the small intestine in geese (Chen, 1995). The reason may be due to that in this study, high level of dietary fibre significantly decreased the food intake and the low food intake affected the development of gastrointestinal tract in gosling.

Table 5: Effect of dietary fiber level on intestinal development of goose at 28 d of age

Item	Diet containing 5% CF	Diet containing 6% CF
Height of duodenum villus	9.40^{a}	6.00^{b}
Height of jejunum villus	11.70	8.30
Height of ileum villus	8.00	8.20
Height of caecum plica	11.75^{a}	15.10^{b}
Height of rectum villus	2.80	2.20

Note: Values in the same line with different superscript letters (a, b) indicate significant differences at P<0.05

In conclusion, the present study showed that the fibre level could not be exceeded more than 5% by adding *Leymus chinensis* to diet, which may lead to depressed performance.

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