Effects of Methionine on Growth Performance and Serum Biochemical Indices in Sika Deer Fawns: Postprint

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Abstract

This experiment aimed to investigate the effects of methionine supplementation in low-protein diets on growth performance and serum biochemical indices of sika deer fawns. Twenty-four healthy sika deer fawns were selected and randomly allocated to three groups (Groups I, II, and III), with eight replicates per group and one fawn per replicate. Group I received a diet containing 14.16% protein, Group II received a low-protein diet containing 12.46% protein supplemented with 0.16% methionine, and Group III received a low-protein diet containing 12.46% protein supplemented with 0.12% methionine. The feeding trial was conducted from October 2, 2015, to October 24, 2015. To determine growth performance, fawns were weighed at the beginning and end of the trial; to determine serum biochemical indices, blood samples were collected at the end of the trial. The results showed that weight gain, average daily gain, and feed conversion ratio did not differ significantly among groups ($P>0.05$); serum total protein (TP), globulin (GLOB), urea nitrogen (UN), and glucose (GLU) contents, as well as alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (AKP) activities, did not differ significantly among groups ($P>0.05$); serum albumin (ALB) content in Group III was significantly higher than that in Group I ($P<0.05$). It was concluded that, compared with the diet containing 14.16% protein, supplementation of 0.16% methionine in a low-protein diet containing 12.46% protein had no significant effects on growth performance and serum biochemical indices of sika deer fawns, indicating that within the scope of this experiment, using methionine-supplemented low-protein diets as a substitute for high-protein diets is feasible.

Full Text

Effects of Methionine on Growth Performance and Serum Biochemical Indices of Sika Deer Fawns

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Abstract

This study investigated the effects of dietary methionine supplementation in low-protein diets on growth performance and serum biochemical indices of sika deer fawns. Twenty-four healthy sika deer fawns were randomly allocated into three groups (Groups I, II, and III) with eight replicates per group and one deer per replicate. Group I received a diet containing 14.16% crude protein, Group II received a low-protein diet (12.46% crude protein) supplemented with 0.16% methionine, and Group III received a low-protein diet (12.46% crude protein) supplemented with 0.12% methionine. The feeding trial was conducted from October 2, 2015, to October 24, 2015. Body weight was measured at the start and end of the experiment to assess growth performance, and blood samples were collected at the conclusion of the trial for serum biochemical analysis. The results indicated no significant differences in weight gain, average daily gain, or feed-to-gain ratio among the three groups ($P>0.05$). Similarly, no significant differences were observed in serum total protein (TP), globulin (GLOB), urea nitrogen (UN), glucose (GLU) concentrations, or alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (AKP) activities ($P>0.05$). However, serum albumin (ALB) content in Group III was significantly higher than that in Group I ($P<0.05$). These findings suggest that compared with a 14.16% protein diet, supplementation of a low-protein diet (12.46% crude protein) with 0.16% methionine had no significant effects on growth performance or serum biochemical indices of sika deer fawns, indicating that using methionine-supplemented low-protein diets as a replacement for high-protein diets is feasible within the parameters of this study.

Keywords: sika deer; growth performance; serum biochemical indices; feed-to-gain ratio

Introduction

The sika deer, a protected species in China, is primarily distributed in northeastern China and parts of Sichuan. Sika deer possess significant economic value, as their antlers, fetuses, penises, blood, and meat are all highly prized medicinal and nutritional products. However, sika deer production requires high-quality dietary protein, and China faces a relative scarcity of protein feed resources. The increasing livestock population in recent years has further escalated protein feed

demand, exacerbating the shortage. Moreover, environmental pollution and greenhouse effects have intensified, with livestock waste becoming a major pollution source following industrial and domestic contamination [1]. Since amino acids are the fundamental building blocks of protein, research on amino acid nutrition is crucial for enhancing sika deer productivity, reducing dietary protein levels, decreasing nitrogen excretion, and mitigating environmental pollution.

Since the mid-20th century, researchers have investigated amino acid nutrition in animals, with numerous studies identifying methionine and lysine as limiting amino acids in livestock diets [2-3]. Previous research has demonstrated that varying methionine levels affect nutrient digestibility and serum biochemical indices in mink implanted with melatonin [4], that amino acid-balanced diets influence dairy cow performance, serum biochemistry, and economic returns [5], and that essential amino acid supplementation in low-protein diets impacts growth performance, serum biochemistry, and meat quality in growing-finishing pigs [6]. Studies have also shown that coated methionine supplementation improves broiler growth performance and ileal amino acid digestibility in a dose-dependent manner [7], that 0.52% methionine supplementation in a 29.31% protein diet optimizes nutrient digestibility and serum biochemistry in female blue foxes during pre-mating [8], and that 0.3% dietary methionine maximizes average daily gain and crude protein digestibility while minimizing feed-to-gain ratio in piglets [9]. While extensive research on methionine supplementation has been conducted in monogastric animals with considerable success, studies in ruminants, particularly sika deer, remain limited. Therefore, investigating whether methionine supplementation can produce similar beneficial effects in sika deer warrants further investigation. This experiment examined the effects of different methionine supplementation levels in low-protein diets on growth performance and serum biochemical indices of sika deer fawns to explore the feasibility of using methionine-supplemented low-protein diets as alternatives to high-protein diets.

Materials and Methods

Experimental Animals

Twenty-four newly weaned sika deer fawns from the deer farm at Jilin Agricultural University were selected and randomly divided into three groups (Groups I, II, and III) with eight replicates per group and one fawn per replicate.

Experimental Design

Group I received a diet with 14.16% crude protein (the baseline protein level used at the Jilin Agricultural University deer farm). Groups II and III received low-protein diets (12.46% crude protein, representing a 1.7% reduction from Group I) supplemented with 0.16% and 0.12% methionine, respectively. The methionine supplementation levels were based on previous research by Huang et al. [1] indicating that 0.12% methionine supplementation in low-protein diets

approaches the optimal threshold.

Diet Formulation

The basal diet was formulated based on the conventional feed formula used at the Jilin Agricultural University deer farm. Dietary nutrient levels were calculated based on the average ratio of concentrate to forage intake. Oak leaves served as the forage source, and the composition of the concentrate and dietary nutrient levels are presented in Table 1 .

Table 1 Composition of concentrates and nutrient levels of diets (DM basis) %

Note: 1) Each kilogram of minerals contained: Fe 60 mg, Zn 35 mg, Mo 6 mg, Mn 35 mg, S 0.3 mg, Co 0.1 mg, Se 0.2 mg. 2) Nutrient levels of diets are calculated values.

Feeding Management

The feeding trial was conducted from October 2, 2015, to October 24, 2015. Concentrate was fed precisely according to body weight changes, with actual intake recorded daily. Roughage was provided at approximately 3 kg per animal daily, and water was available ad libitum.

Sample Collection and Processing

On October 24, 2015, before morning feeding, blood samples were collected via jugular venipuncture. Blood was placed in tubes without anticoagulant, centrifuged at 4,000 r/min for 10 minutes, and serum was collected in 1.5 mL EP tubes and stored at -20°C until analysis.

Measurements

Growth Performance Body weight was measured at the beginning and end of the feeding trial to calculate weight gain and average daily gain. Daily feed intake was recorded to determine average daily feed intake. Feed-to-gain ratio was calculated as the ratio of total standard feed consumed to weight gain during the feeding period:
Feed-to-gain ratio = Total standard feed consumed (kg) / Weight gain (kg).

Serum Biochemical Indices Serum total protein (TP) was determined by the biuret method, albumin (ALB) by the bromocresol green method, and globulin (GLOB) was calculated as the difference between TP and ALB. Urea nitrogen (UN) was measured by the enzyme two-point kinetic method, aspartate aminotransferase (AST) activity by continuous monitoring, alanine aminotransferase (ALT) activity by the rate method, glucose (GLU) by the glucose oxidase method, and alkaline phosphatase (AKP) activity by the rate method.

Statistical Analysis

Results are expressed as "mean ± standard deviation." All data were analyzed using SPSS 22.0 software, with ANOVA used for significance testing. Excel 2010 was used for graph preparation. $P>0.05$ was considered not significant, and $P<0.05$ was considered significant.

Results

Growth Performance of Sika Deer Fawns

The growth performance results are presented in Table 2 . Although numerical differences were observed in weight gain, average daily gain, and feed-to-gain ratio among groups, no significant differences were detected ($P>0.05$). Similarly, no significant differences were found in average daily concentrate intake among groups ($P>0.05$). The data indicated that Group II exhibited the best weight gain and lowest feed-to-gain ratio, though these differences were not statistically significant.

Table 2 Growth performance of sika deer fawns

Note: In the same row, values with different small letter superscripts indicate significant difference ($P<0.05$), while values with the same or no letter superscripts indicate no significant difference ($P>0.05$). The same applies below.

Serum Biochemical Indices of Sika Deer Fawns

Serum biochemical indices are presented in Table 3 . No significant differences were observed among groups in serum TP, GLOB, UN, GLU concentrations, or ALT, AST, and AKP activities ($P>0.05$). Group II showed the highest GLOB and GLU concentrations and ALT and AKP activities, while Group III exhibited the highest TP concentration and ALB and AST activities, with ALB content being significantly higher than that in Group I ($P<0.05$).

Table 3 Serum biochemical indices of sika deer fawns

Yang Weiren [10] reported that rumen-protected methionine coated with animal fat significantly improved average daily gain in beef cattle. Hussein et al. [11] and Yang Kui [12] demonstrated that rumen-protected methionine and lysine supplementation increased average daily gain in ruminants. Qin Yinghe et al. [13] found that increasing dietary methionine levels significantly improved average daily gain and feed intake while markedly reducing feed-to-gain ratio in rex rabbits. Other studies have shown that 0.6% methionine supplementation produced the highest weight gain in 6-week-old New Zealand rabbits [14], and that methionine supplementation improved average daily gain in 1-21 day-old broilers [15]. El Boushy et al. [16] observed higher average daily gain in broilers fed 19% protein diets supplemented with methionine and lysine compared to those fed 23% protein diets. However, some studies found no significant effects of methionine supplementation on average daily gain, feed intake, or

feed-to-gain ratio in 3-month-old meat rabbits [17] or in sheep receiving 6 g of rumen-protected methionine daily [18]. These inconsistent results align with our findings, where the 0.16% methionine group showed the highest average daily gain and lowest feed-to-gain ratio, though differences were not significant. This may be attributed to the fact that, despite being domesticated, sika deer retain some wild characteristics, and although efforts were made to minimize external stressors during the trial, complete elimination of such influences cannot be guaranteed. Alternatively, the methionine supplementation levels used in this study may have been insufficient to produce significant effects.

Huang et al. [19] and Yu Hongxin et al. [20] reported that serum ALB and TP concentrations increase with dietary protein levels. Our results contradict these findings, as reducing dietary protein from 14.16% to 12.46% while supplementing with methionine (Groups II and III) resulted in higher serum ALB concentrations than the control group (Group I). Serum GLOB, a major component of immunoproteins, partially reflects immune function [21]. Although no significant differences in serum GLOB were observed among groups in this study, concentrations tended to increase with methionine supplementation. Yi Xuejing [22] found that dietary methionine levels had no significant effect on serum GLU in goats, suggesting that limiting amino acids have minimal impact on GLU metabolism. Xia Ke et al. [23] reported that amino acid supplementation had no significant effects on serum GLU or UN in dairy cows, though UN tended to decrease. Bi Xiaohua et al. [24] similarly observed no significant effects of rumen-protected methionine on plasma triglycerides or GLU in dairy cows. Other studies have shown that amino acid supplementation reduces serum UN in dairy cows [5]. Our findings are consistent with these results, showing no significant effects of methionine supplementation on serum GLU or UN in sika deer fawns, though UN tended to decrease with increasing methionine levels. AKP, ALT, and AST are important enzymes involved in amino acid metabolism. The lack of significant differences in these enzyme activities among groups in our study suggests that methionine supplementation in low-protein diets did not significantly affect these metabolic parameters within the experimental range.

Conclusion

Compared with a 14.16% protein diet, supplementation of a low-protein diet (12.46% crude protein) with 0.16% methionine had no significant effects on growth performance or serum biochemical indices of sika deer fawns. The improved weight gain and reduced feed-to-gain ratio observed in the methionine-supplemented groups suggest that using methionine-supplemented low-protein diets as alternatives to high-protein diets is feasible within the parameters of this study.

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Note: Figure translations are in progress. See original paper for figures.