

## トウモロコシ・大豆粕主体低タンパク質飼料への酵素添加がブロイラーヒナの飼養成績および窒素排泄に及ぼす影響

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# Effect of Enzyme Supplementation on Performance and Nitrogen Excretion of Broiler Chick Fed Low-Protein Diets Based on Corn and Soybean Meal

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## Abstract

The effects of dietary multi-enzyme complex supplementation on the performance and nitrogen excretion of broiler chicks were investigated. Low crude protein diets (19% CP) based on corn and soybean meal with commercial enzyme complex at the inclusion level of 0, 150 and 300 mg/kg diet, and a control diet (21% CP) were fed to 6-day-old male broiler chicks for 14 days. The commercial enzyme complex had cellulase (800 U), protease (10000 U) and pectinase (300 U) activities per gram of crude product. As a result, body weight gain, feed consumption and feed efficiency were not affected by the dietary treatments. Apparent metabolizable energy (AMEn) content was significantly increased with enzyme supplementation. Excreted nitrogen was lower for chicks fed low-protein diets compared to the control diet, however, no significant effect of enzyme supplementation was observed.

It can be concluded that dietary CP content can reduce from 21% to 19% without affecting performance of chick, and supplementation of the enzyme complex to the 19% CP diet increases the AMEn level of the diet.

**Key words :** enzyme supplementation, nitrogen excretion, metabolizable energy, broilers

## Introduction

In order to reduce the environmental impact of the livestock and poultry production, it is important to reduce the concentration of certain elements, such as phosphorus, nitrogen in the excreta. It has been reported that dietary CP levels in broiler chicks are able to be reduced by supplementing synthetic amino acids without affecting body weight gain<sup>1)</sup>, and feeding low-CP diet could reduce nitrogen excretion by about 15%<sup>2)</sup>. Yamazaki *et al.*,<sup>3)</sup> also suggested that nitrogen retention of chicks fed the higher ratio of essential to non-essential amino acids diets tend to be better than chicks fed the lower ratio diet.

The beneficial effect of xylanase-based enzyme sup-

plementation to wheat-based diet for improving nutrient availability and bird performance is well-established<sup>4)</sup>. Zanella *et al.*,<sup>5)</sup> also reported that the total protein digestibility of the corn and soybean meal diet was improved by the use of xylanase, protease and amylase mixture. Thus, the supplementation of enzyme mixture to the low-CP diet will increase the available amino acid content of the diet, and may improve nitrogen retention and further reduce its excretion.

The aim of this study was to determine the effects of a mixture of enzymes, cellulase, protease and pectinase supplementation on the performance and nitrogen excretion in broiler chicks fed a low-protein diet.

## Materials and Methods

Day-old male broiler chicks (Cobb) obtained from a local hatchery were used. The chicks were housed in electrically-heated battery cages and had free access to water and a commercial starter diet for 6 days. They were then divided into four groups, each of which contained five replicates of two chicks. Experimental diets were fed from 6 to 20 days of age.

The CP contents of experimental diets were 21 and 19%. Both diets consisted mainly of corn and soybean meal, and other nutrients were formulated to meet or exceed the Japanese Feeding Standard<sup>6)</sup> requirements for broiler chicks (Table 1). Synthetic amino acids were supplemented to meet the essential amino acid requirements. The crude enzyme preparation used in this study was a commercial multi-enzyme complex originated from *Irpex lacteus* (Driselase: DRS-20; Donated from Kyowa Hakko

Kogyo Co., Ltd., Tokyo, Japan) with the following enzyme activities: cellulase, 800 U (pH 4.5); protease, 10000 U (pH 3.5); pectinase, 300 U (pH 5.0) per gram of crude product, and the recommended level of supplementation ranged from 50 to 250 mg per kg diet. The four dietary treatments consisted of the 19% CP diet supplemented with 0, 150 or 300 mg enzyme per kg diet, and control diet containing 21% CP.

Lighting was provided 24 hours a day, and room temperature was maintained between 25 and 28°C. The birds and feed remaining in each tray were weighed at 20 days of age to determine body weight gain and feed consumption during the experimental period. From 13 to 17 days of age, a nitrogen balance trial was conducted, and amount of excreta was calculated from the concentration of chromic oxide (Cr) in the diets and that in the excreta, and the apparent metabolizable energy (AMEn) was also estimated. Nitrogen content in diets and excreta was measured by the macro Kjeldahl method. Cr content of diets and excreta were analyzed using the method described by Takemasa<sup>7)</sup>. Gross energy in diets and excreta was analyzed using an adiabatic, oxygen-bomb calorimeter (Yoshida Seisakusho Co., Ltd., Tokyo, Japan).

Data were analyzed using the General Linear Models procedure of SAS with Tukey's multiple range test<sup>8)</sup>.

## Results and Discussion

The growth performance of chickens fed the control and low-CP diets supplemented with enzymes is shown in Table 2. Body weight gain and feed efficiency of chicks fed the low-CP diet without enzyme supplementation were equal to those of chicks fed the control diet. Several workers have reported that performance of chicks fed a diet with a low protein, amino acid-fortified diet was good that fed a diet containing a conventional protein level<sup>1,2)</sup>. Hence, although differences due to supplementation of

Table 1. Composition of experimental diets

Dietary CP (%)	21 (Control)	19
Corn	59.59	63.78
Dehulled soybean meal (51% CP)	29.27	23.23
White fish meal	6.00	6.00
Soybean oil	2.80	2.80
CaHPO <sub>4</sub> ·2H <sub>2</sub> O	0.78	0.84
CaCO <sub>3</sub>	0.76	0.77
Sodium chloride	0.33	0.33
Cellulose	-	1.46
DL-Methionine	0.22	0.33
L-Lysine-HCl	-	0.13
L-Threonine	-	0.07
L-Arginine	-	0.01
Vitamin-Mineral mixture <sup>1)</sup>	0.15	0.15
Cr <sub>2</sub> O <sub>3</sub>	0.10	0.10
Calculated composition		
ME(kcal/g)	3.10	3.10
CP(%)	21.0	19.0

<sup>1)</sup>: See Yamazaki *et al.*<sup>2)</sup>

Table 2. Effect of dietary enzyme supplementation on performance of male broiler chicks from 6 to 20 days of age<sup>1)</sup>

Dietary CP (%)	Enzyme supplementation (mg/kg diet)				Pooled SEM
	21	0	150	300	
Body weight gain (g/14days)	613	591	594	618	21.4
Feed intake (g/14days)	824	815	811	834	23.1
Feed efficiency (%)	74.4	72.6	73.2	73.9	1.14

<sup>1)</sup>: Each treatment consists of 5 replicates of 2 birds per pen.

Means within the same rows with no common superscript are significantly different (p<.05).

Table 3. Effect of dietary enzyme supplementation on AMEn content and metabolizability on male broiler chicks <sup>1)</sup>

Dietary CP (%)	21		19		Pooled SEM
Enzyme supplementation (mg/kg diet)	0	0	150	300	
AMEn (cal/g)	3.26 <sup>a</sup>	3.21 <sup>b</sup>	3.30 <sup>a</sup>	3.25 <sup>a</sup>	0.009
Metabolizability (%)	81.2	80.7	81.4	81.5	0.27

<sup>1)</sup> :Each treatment consists of 5 replicates of 2 birds per pen.

<sup>a,b)</sup> :Means within the same rows with no common superscript are significantly different (p<.05).

Table 4. Effect of dietary enzyme supplementation on nitrogen balance of male broiler chicks from 13 to 17 days of age <sup>1)</sup>

Dietary CP (%)	21		19		Pooled SEM
Enzyme supplementation (mg/kg diet)	0	0	150	300	
Nitrogen intake (g/4 days/bird)	10.12 <sup>a</sup>	8.68 <sup>b</sup>	8.50 <sup>b</sup>	9.08 <sup>ab</sup>	0.352
Nitrogen retained (g/4 days/bird)	6.94 <sup>a</sup>	6.14 <sup>b</sup>	6.02 <sup>b</sup>	6.60 <sup>ab</sup>	0.246
Nitrogen excreted (g/4 days/bird)	3.18 <sup>a</sup>	2.54 <sup>b</sup>	2.48 <sup>b</sup>	2.47 <sup>b</sup>	0.132
Nitrogen excreted (%) <sup>2)</sup>	31.4 <sup>a</sup>	29.3 <sup>ab</sup>	29.2 <sup>ab</sup>	27.4 <sup>b</sup>	0.70

<sup>1)</sup> :Mean of 5 replicates. Means within the same rows with no common superscript are significantly different (p<.05).

<sup>2)</sup> :Nitrogen excreted as a percentage of nitrogen intake.

enzyme were not significant in any case, it seemed that the performance of chicks fed the low protein diet unsupplemented with enzymes was almost optimum.

In the present study, although AMEn content of the low-CP diet was lower than the control diet, it significantly increased (P<.05) with supplementation of enzyme (Table 3). The addition of multi-enzyme complex to feed ingredients resulted in an increased apparent metabolizable energy (AMEn)<sup>9)</sup> content, and moreover, according to the results of Zanella *et al.*<sup>3)</sup>, supplementation of enzyme mixture containing amylase, protease and xylanase to the corn and soybean meal-based diet improved the AMEn content by about 2%. These results suggest that the AMEn content of corn and soybean meal diet would increase with enzyme supplementation.

The results of the nitrogen balance trial are shown in Table 4. The amounts of nitrogen intake and retention of chicks fed the 21% CP diet were higher (P<.05) than those of chicks fed low-protein diets supplemented with enzyme at 0 or 150 mg/kg. In agreement with previous studies<sup>2,3)</sup>, chicks fed the low-CP diets excreted about 20% less nitrogen (P<.05) than those fed 21% CP diet. However, no further reduction was observed with enzyme supplementation. Excreted nitrogen expressed as a percentage of nitrogen intake of chicks fed the 300 mg/kg enzyme supplemented diet were significantly lower (P<.05) than those of chicks fed the control diet. It seems that the

response to the enzyme supplementation to the corn and soybean meal-based diet in terms of nitrogen excretion was small. However, since improvement of apparent nitrogen retention of corn and soybean meal<sup>9)</sup>, and ileal amino acid digestibility of corn and soybean meal based-diet<sup>5)</sup> were reported, enzyme supplementation would be beneficial when a diet containing below the requirement level of protein.

It can be concluded that supplementation of the enzyme complex to the corn and soybean meal-based diet improve the AMEn level of the diet.

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### 要 約

飼料への複合酵素添加がブロイラーヒナの成長および窒素排泄量に及ぼす影響を検討した。トウモロコシ・大豆粕主体の低タンパク質（CP19%）飼料に市販の複合酵素剤を0、150および300mg/kg添加した飼料、CP21%の対照飼料を6日齢の雄ブロイラーヒナに14日間給与した。供試した複合酵素剤は、セルラーゼ、プロテアーゼ、ペクチナーゼ活性を、それぞれ800、10000、300単位/gもつものであった。増体重、飼料摂取量および飼料効率は飼料間に差は認められなかった。飼料の見かけの代謝エネルギー含量は、酵素添加により有意に増加した。窒素排泄量は、低タンパク質飼料給与により減少したが、酵素添加の影響は認められなかった。

これらの結果から、飼料中のCP含量をヒナの生産能に影響を与えることなくCP21%から19%に減少させることが可能であり、CP19%飼料への複合酵素の添加は、飼料の見かけの代謝エネルギー含量を上昇させることが示された。

キーワード：酵素添加、窒素排泄、代謝エネルギー、ブロイラー