低あるいは高タンパク質飼料を摂取したニワトリにおけるアンモニアの吸収

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Ammonia Absorption from the Intestine in Chickens Fed Low and High Protein Diets

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Introduction

It has been reported for mice[1] and chickens[2] that ammonia concentration in the portal blood and the difference in ammonia concentration between portal blood and other are higher in high protein feeding than in low protein feeding. Two possible mechanisms are involved in the enhancement of portal blood ammonia by feeding a high protein diet to chickens. One of them is the ability of chickens to absorb ammonia and the other is ammonia production in the intestine. The ability of chickens to absorb L-methionine is a little inhibited[3-5] and the absorptive ability of amino acid in rats is increased[6,7] by an increase of dietary protein. However, the absorptive ability of ammonia is not reported in chickens yet. In the present experiment it was examined whether ammonia absorption from chicken intestine is affected by a dietary protein level.

Materials and Methods

Animals and diets Experimental animals used in this experiment were adult dwarf-type Single Comb White Leghorn chickens, weighing about 1.4kg, which were obtained from Nagano Animal Industry Experiment Station (Nagano-ken, Japan). The chickens were housed in individual cages in a light-controlled room (12 hours light:12 hours dark), were fed 35g of an experimental diet per kilogram of body weight once a day (9:00 a.m.) for five days and were allowed to drink water freely. Before the absorption study the birds were allowed only water during 30 hours.

The 5 and 20% protein diets used in this experiment contained egg albumen as the sole source of protein. The compositions are specified in the previous report[8].

Experimental procedure Cardiac catheterization was performed in the chickens anesthetized by the intravenous injection of sodium pentobarbital (25 mg/kg body weight), as previously reported[8]. This catheter was used for collecting cardiac blood samples. Then, an abdominal incision was made, the intestine was drawn

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out, and the small intestine with the mesenteric vein draining it and with Meckel's diverticulum in the middle part was cut off 12 cm long. After the lumen of the segment was washed out with 10 ml of warm distilled water (39°C) by glass pipette to exclude intestinal contents, both sides of the segment were ligated with silk to make a sack (10 cm long). The segment was kept warm throughout the experiment by saline packs. The mesenteric vein draining the sack was cannulated by a small polyethylene tubing (Hibiki no. 4) through which the blood was collected. After the preparation of the intestinal segment and the cannulation of its vein, resting blood samples were collected through cardiac catheter and mesenteric cannula and then 3 ml of 2 mM ammonium acetate solution (pH 6.3) or distilled water (control), warmed to 39°C, was introduced into the lumen with syringe. For analysis of initial lumen ammonia content one ml of the introduced lumen fluid was withdrawn just after finishing the introduction. Cardiac blood was collected at 10 and 30 minutes and mesenteric blood at 5, 10 and 30 minutes after the introduction of ammonia into the segment. At the end of experiment the introduced lumen fluid was recovered to determine remaining ammonia.

Chemical analysis On the cardiac and mesenteric blood, ammonia was analyzed by the colorimetric method[9].

Results and Discussion

Fig. 1 shows time course changes in blood ammonia concentration in the mese-

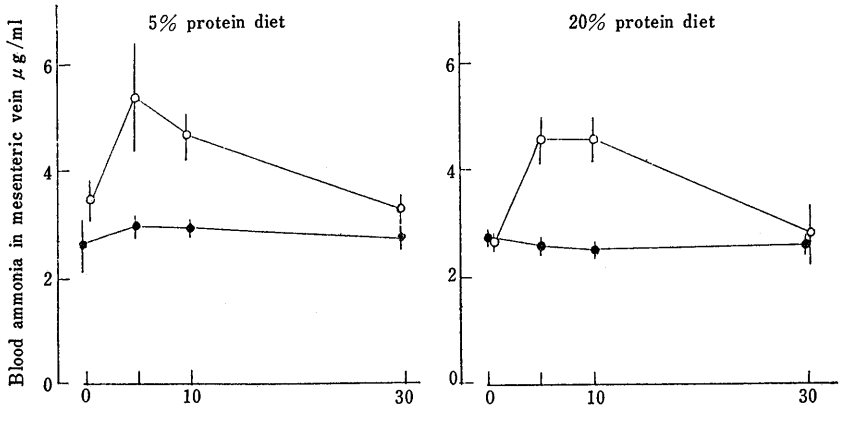

Fig. 1 Blood ammonia concentration in the mesenteric vein after introduction of ammonia into lumen of experimental portion of intestine. ○: ammonia introduced, ●: control. Each point with vertical line represents mean ±SEM of 3 chickens.

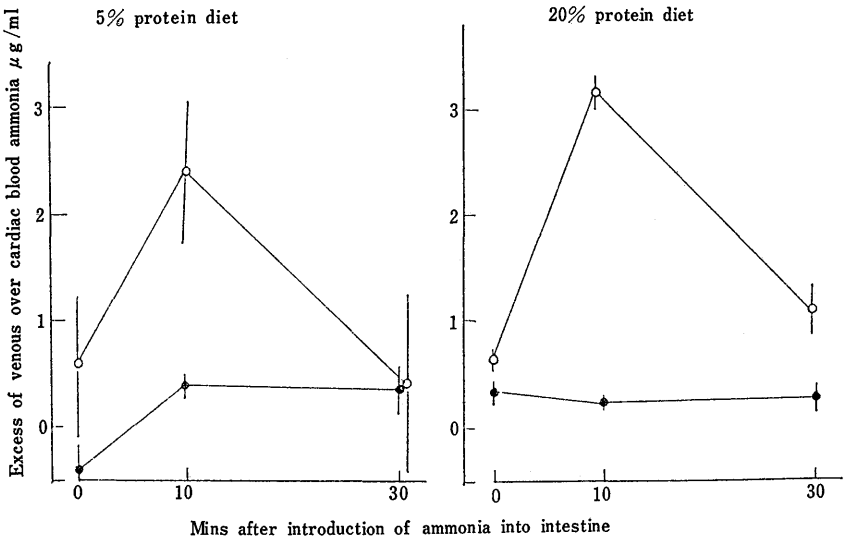

Fig. 2 Difference in blood ammonia concentration between mesenteric vein and heart after introduction of ammonia into lumen of experimental portion of intestine. ○ : ammonia introduced, ● : control. Each point with vertical line represnts mean ±SEM of 3 chickens.

nteric vein draining the intestinal sack into which ammonia was introduced in chickens fed 5 and 20% protein diets. The ammonia concentrations in both dietary groups similarly increased within 5 minutes and returned to the initial levels in 30 minutes. The difference in blood ammonia concentration between mesenteric vein and heart, an indication of net changes due to the introduction of ammonia into the intestinal lumen, showed a similar changing pattern to the ammonia concentration in the mesenteric venous blood in both the chickens fed 5 and 20% protein diets (Fig. 2). These results indicate that the appearance of ammonia in the portal blood after the introduction of ammonia into the intestinal lumen is similar in the chickens fed

Table 1. Disappearance of ammonia from intestinal lumen in 30 minutes after introduction of ammonia into the intestine of chickens fed 5 or 20% protein diet

Dietary protein	Introduced ammonia	Lumen ammonia		Disappearance of ammonia	
		Initial	Final		
%		μg/tested portion			% of introduced amount
5	−	2.25± 0.67	2.40±0.48	−0.21± 0.36	
	+	87.96± 5.96	3.03±1.32	84.94± 5.60	96.55±1.47
20	−	1.38± 0.09	1.88±0.21	−0.51± 0.13	
	+	73.65±13.30	4.59±0.99	69.06±11.58	92.93±1.91

Values are means ± SEM of 3 to 4 chickens.

5 and 20% protein diets. In addition the present experiment showed that 97 and 93% of ammonia introduced into the intestinal lumen disappeared in 30 minutes in the chickens fed 5 and 20% protein diets respectively (Table 1). Similar results were previously obtained in the chickens fed a conventional diet[10]. These findings suggest that ammonia absorption from chicken intestine is not affected by dietary protein intake and by a type of diet such as semi-purified diet or conventional diet.

It has been reported for mice[1] and chickens[2] that ammonia concentration in the portal blood and the difference in ammonia concentration between portal blood and other are higher in high protein feeding than in low protein feeding. Two possible mechanisms are involved in the enhancement of portal blood ammonia by feeding a high protein diet to chickens. One of them is the ability of chickens to absorb ammonia and the other is ammonia production in the intestine. The ability of chickens to absorb L-methionine is a little inhibited[3-5] and the absorptive ability of amino acid in rats is increased[6,7] by an increase of dietary protein. However, the present experiment offered the data supporting that the ability of ammonia absorption from chicken intestine is not affected by dietary protein intake. If so, the higher ammonia concentration of portal blood in the chicken fed a high protein diet than in that fed a low protein diet seems to mainly depend on the production of ammonia in the intestine rather than ammonia absorptive ability. The blood ammonia concentration in the portal vein, which is increased by feeding a high protein diet to conventional mice, is reported to be almost the same in germ-free mice fed low and high protein diets[1]. A further study on the absorptive ability of ammonia and ammonia production in the intestine is required.

Summary

In order to examine ammonia absorption from the intestine in chickens fed 5 and 20% protein diets, two ml of 2 mM ammonium acetate solution was introduced into 10 cm chicken intestinal sack having Meckel's diverticulum in the middle part.
1) After the introduction in both dietary groups blood ammonia concentration in the mesenteric vein draining the sack reached a maximal increase within 5 minutes and returned to the initial level in 30 minutes. The difference in ammonia concentration between cardiac and mesenteric venous blood also showed a similar time course change to mesenteric venous blood ammonia concentration in both dietary groups.
2) 97 and 93% of the ammonia introduced into the intestinal lumen disappeared in 30 minutes in the chickens fed 5 and 20% protein diets respectively.

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摘　　要

低あるいは高タンパク質飼料を摂取したニワトリにおけるアンモニアの吸収

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メッケル憩室を中央部に持つ長さ10cmの腸管サックに，2mMの酢酸アンモニウム液を2ml注人し，5％あるいは20％タンパク質飼料を摂取したニワトリにおけるアンモニアの吸収を比較した。アンモニア注入後，腸間膜静脈血のアンモニア濃度は両飼料区において増加し5分時にピークとなり，その後減少して30分時には元のレベルに戻った。った。また腸間膜静脈血と心臓血のアンモニア濃度差も，腸間膜静脈血のアンモニア濃度と同様の経時的変化を両飼料区で示した。一方腸管腔に注入したアンモニアは，5％および20％タンパク質飼料を給与したニワトリにおいて，それぞれ97％および93％が30分間に消失した。