

Effect of Cecectomy on Nitrogen Utilization Rate and Uric Acid Excretion in Growing Chicks

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성장중인 닭에 있어서 맹장절제수술이 질소의 이용률과 요산의 배설량에 미치는 영향

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ABSTRACT : A 2×2 factorial experiment was conducted to determine the effect of cecectomy and urea supplementation on nitrogen utilization in growing chicks. Birds were either cecectomized or shamoperated and fed a 19% protein diet with or without 1% urea supplementation. All chicks were provided *ad libitum* access to feed and water throughout the six-day experimental period. In the cecectomized chicks, feed efficiency was significantly decreased when fed a 19% protein diet supplemented with 1% urea ($P<0.05$). When chicks were fed a 19% protein diet, cecectomy significantly shortened gastrointestinal passage time (GPT) of food ($P<0.05$). However, the GPT was significantly lengthened in chicks fed a 19% protein diet supplemented with urea ($P<0.05$). Regardless of diets, cecectomized chicks increased the moisture contents of the excreta ($P<0.05$) and feeding a 1% dietary urea also significantly increased ($P<0.05$). Cecectomy significantly decreased uric acid N excretion by about 30 mg per 100 g body weight per day ($P<0.05$) and uric acid N/ total N excretion when fed both diets ($P<0.05$). The present study suggests that cecectomy improves nitrogen utilization rate by decreasing uric acid excretion in growing chicks. These results are in good agreement with those obtained previously in a cecectomy study of adult chickens.

(Key words : growing chick, nitrogen utilization, cecectomy, uric acid excretion)

INTRODUCTION

The gastrointestinal tract in the domestic fowl normally includes a pair ceca, protruding from the ileo-colonic junction (Clark, 1978). Although the ceca form the habitat of numerous micro-organisms (Barnes et al., 1972) and various species of protozoa and helminth (Crompton and Nesheim, 1976), cecal functions are not fully understood yet. Still, the possibility that the ceca play a roll in the recycling of excretory nitrogen in birds has been discussed (Mattock, 1971).

Lee and Blair (1972), Miller (1973), and Okumura et al. (1978) found that conventional chicks could utilize dietary urea as a source of nitrogen for the synthesis of amino acids. They

concluded that the capacity of utilizing dietary urea might be mediated through the gut flora, by bacterial ureolysis and liberation of ammonia which, if absorbed would provide the necessary nitrogen. On the other hand, Chavez and Thomas (1969), Kagan and Balloun (1976), and Kobayashi et al. (1981) reported that there were no beneficial results when domestic fowl diet were supplied with urea.

It has been reported that ligation of ceca and cecectomy (removal of ceca) improved nitrogen utilization and decreased urinary uric acid excretion in chickens due to possible changes in fermentation and no modification of ceca fermentation (Son et al., 1996a, b; Karasawa et al., 1997; Son et al., 1997).

The present experiment was carried out to investigate the

responses of nitrogen utilization and nitrogen excretion in cecectomized growing chicks compared to the result to obtained by Son et al. (1997) who studied with adult chickens.

MATERIALS AND METHODS

Ten-day-old layer type male chicks (Isa Brown 980731; Kangnam Hatchery Co., Korea) were housed in electrically heated battery brooders with raised wire floors. The chicks used in this study were either sham operated (control) or cecectomized and fed 19% protein diet with or without urea in a 2×2 factorial experiment. In the basal diet, methionine was added to maintain a constant proportion of methionine+ cystine to total protein. The calculated crude protein level and metabolizable energy level were 19.1% and 2,850 kcal/kg diet, respectively.

Surgery for the cecectomy was made according to the method of Son et al. (1997). Prior to surgery chicks were fasted for 6 h. The ceca were cut as near its origin as possible and removed under anaesthesia with sodium pentobarbital (2.5 mg/100 g BW). Powdered sulfisomidinum¹⁾ was put in the abdominal cavity of chicks, and the abdominal muscular layer and skin were sutured. Control group chicks were sham-operated in the same manner as in the cecectomized chicks except for that ceca were not excised. Ten days after the operation, the chicks were used for experiments. Post mortem inspections were done on all the cecectomized chicks to ascertain the absence of ceca.

Sixteen chicks had free access to a diet and water, and then chicks were divided into 12 equal groups: six were the control group (three were fed a basal diet and three were fed a basal diet supplemented with 1% urea) and six were the cecectomized group (three were fed a basal diet and three were fed a basal diet supplemented with 1% urea). Each group included five chicks. All chicks were housed in individual wire-bottom cage (20 cm H \times 20 cm W \times 20 cm D) in a light-controlled room (14 L and 10 D). The 60 chicks were used in a 6 day experiment during which food, water intake, and output of excreta were monitored.

A mixture of feces and urine was collected for the last 2 d

of the experimental period. The collected excreta were immediately sprayed with 5% hydrochloric acid and dried in forced-air oven at 55°C. Total nitrogen in excreta was determined by the Kjeldahl method. Uric acid in excreta was determined by an enzymatic spectrophotometric method (Pudelkiewicz et al., 1968).

The gastrointestinal passage time of food was measured as follows: the chicks had no access to a diet during 12 h after the 6 day experimental period and then fed a each diet supplemented with 1% chromic oxide, and chromium excretion time was documented (Hillerman et al., 1953).

Data on various parameters were subjected to statistical analysis, using analysis of variance technique in completely randomized design with 2×2 factorial arrangement; Duncan's Multiple Range Test was used to compare among the treatment means (Steel and Torrie, 1981).

RESULTS AND DISCUSSION

Table 1 shows changes in body weight gain, amount of moisture in excreta, gastrointestinal passage time (GPT) of food and feed efficiency in control and cecectomized chicks fed a 19% protein diet or 19% protein diet supplemented urea. Body weight gain and feed efficiency tended to increase and decrease by cecectomy in chicks fed a 19% protein diet and 19% protein diet plus urea, respectively. It has been reported that the ceca play a useful role in nitrogen economy of the protein-depleted adult chickens (Karasawa and Maeda, 1994). The present result also suggests that ceca play a role in recovery of urea nitrogen in growing chicks. In the cecectomy, feed efficiency was significantly decreased by supplement of urea ($P < 0.05$). The amount of moisture in excreta was increased about by 20% by cecectomy ($P < 0.05$) and further increased by supplement of urea ($P < 0.05$). When fed a 19% protein diet, cecectomy significantly shortened GPT of food ($P < 0.05$), but when fed urea, cecectomy significantly lengthened GPT of feed ($P < 0.05$).

The function of ceca in avian nutrition is well documented (McNab, 1973; Thompson et al., 1975; Skadhauge, 1981) and, in particular, water absorption and the mechanism associated

¹⁾ Iwaki Pharmaceutical Co., Tokyo

Table 1. Effects of cecectomy on body weight gain, amount of water excretion and gastrointestinal passing time (GPT) of food in growing chicks

	19% protein diet		19% protein diet plus 1% urea		SEM	ANOVA		
	Con ¹	Cec ²	Con ¹	Cec ²		+Urea	+Cec ²	Urea × Cec ²
Body wt. gain (g/6d)	66.6	77.7	62.2	58.6	6.3	NS	NS	NS
Moisture in excreta (%)	66.4 ^a	73.6 ^b	72.8 ^b	81.9 ^c	3.1	<0.05	<0.05	<0.05
GPT (mins)	130.1 ^b	111.1 ^a	145.6 ^c	153.4 ^d	6.1	<0.05	<0.05	<0.05
Feed efficiency	0.33 ^b	0.35 ^b	0.31 ^{ab}	0.30 ^a	0.04	ND	ND	ND

Values are means of 15 birds.

¹Shamoperated chicks (Control), ²Cececctomized chicks.

^{a-d}Values with different letter within a row are significantly different at P<0.05.

with these flux. In many avian species ureteral urine flows from the uredeum into the ceca, where water absorption may occur (Skadhauge, 1968). Akester et al (1967) and Koike and McFarland (1966) observed the movement of dyes from the cloaca into the ceca and radiographic evidence in domestic fowl. Few estimates of the fraction of ureteral urine that enters the ceca are available: in turkeys 20~30% of urine flow enters the ceca (Björnag and Sperber, 1977) and concomitant with retrograde filling of the ceca there is an approximately equal flux from the small intestine (Clemens et al., 1975 and Son et al., 2002). In this study, therefore, cececctomized chicks with

significantly increased content of moisture in excreta (P<0.05) may have resulted from the absence of recovery of urine and water in the ceca.

It has been reported that when 2% urea was fed in the chicks, water consumption was increased by about 20% (March and Biely, 1971) but in spite of increase water consumption, water balance was not changed (Son and Karasaw, 2001), therefore, water excretion was increased by the dietary urea. These results are in good agreement with those obtained previously in March and Biely (1971).

As shown in Table 2, the nitrogen balance and utilization rate tended to be increased by the cececctomy in both diets. And

Table 2. Effects of cececctomy on nitrogen excretion, utilization rate and uric acid (UA) excretion in growing chicks

Item	19% protein diet		19% protein diet plus 1% urea		SEM	ANOVA		
	Con ¹	Cec ²	Con ¹	Cec ²		+Urea	+Cec ²	Urea × Cec ²
Nitrogen (mg/ 100g BW/day)								
Intake	417.1	447.9	527.2	526.2	38.0	NS	NS	NS
Excretion	201.9	180.1	237.9	228.8	26.8	NS	NS	NS
Balance	215.2	267.8	289.3	297.7	26.3	NS	NS	NS
Utilization (%)	51.6	59.8	54.9	56.5	5.7	NS	NS	NS
UA excretion (N mg/100g BW/d)	80.7 ^{bc}	50.5 ^a	89.3 ^c	63.9 ^b	7.8	ND	<0.05	ND
UA-N/ Total N excretion(%)	40.0 ^b	28.0 ^a	37.5 ^b	27.9 ^a	3.7	ND	<0.05	ND

Values are means of 15 birds.

^{a-c}Values with different letters within a row are significantly different at P<0.05.

¹Shamoperated chicks (Control), ²Cececctomized chicks.

Nitrogen balance: (nitrogen intake)–(nitrogen excretion).

Nitrogen utilization: (nitrogen balance)/(nitrogen intake)×100.

the cecectomy significantly decreased uric acid N excretion by about 30 mg (per 100 g body weight every day) and uric acid N/ total N excretion in chicks fed both diets ($P < 0.05$), which contributed to a increase in nitrogen balance and utilization rate. This response agrees well with our previous results which were observed in ceca-ligated chickens, and cecectomized chickens (Son et al., 1996a; Karasawa et al., 1997; Son et al., 1997). March and Biely (1971) have shown that in the chicks, the feeding of urea significantly increased the levels of uric acid in the serum. In this study, therefore, the high contents of excretory uric acid N in the both types of chick fed a 19% protein diet supplemented 1% urea ($P < 0.05$ in the cecectomised chicks) compared to chicks fed a 19% protein diet may result from the urea feeding. Previous studies have indicated the nitrogen metabolism in chick and chicken are affected by possible changes in cecal fermentation produced by preventing substances from urine and digesta from entering the ceca (Son and Karasawa, 2000; Son et al., 2000).

The present study suggests that cecectomy improves nitrogen utilization by decreasing uric acid excretion in growing chicks, and these results are in good agreement with those obtained previously in cecectomy studies of adult chickens.

적 요

본 연구는 성장중인 닭에 있어서 질소 이용에 미치는 맹장절제 및 요소사료 첨가의 영향을 조사하기 위해서 실시되었다. 시험 사료는 19% 단백질 사료와 여기에 1% 요소를 첨가한 사료를, 시험닭은 모의수술을 실시한 대조구와 맹장절제 수술을 실시한 처리구를 이용한 2×2 의 요인시험법으로 행해졌다. 6일 동안의 본 시험기간 동안 물과 사료는 자유 섭취시켰다. 맹장절제 수술닭의 사료효율은 요소의 급여에 의해서 유의하게 감소하였다($P < 0.05$). 19% 단백질사료 급여조건에서 맹장절제 수술닭은 소화관내 사료의 통과시간을 유의하게 감소시켰지만($P < 0.05$), 반대로 19% 단백질사료 + 1% 요소 급여조건에서는 유의하게 증가시켰다($P < 0.05$). 맹장절제 수술은 사료에 관계없이 수분 배설량을 유의하게 증가시켰으며($P < 0.05$), 요소의 급여는 맹장절제 수술과 관계없이 수분의 배설량을 유의하게 증가시켰다($P < 0.05$). 양 사료 급여조건에서 맹장절제 수술은 요산 질소의 배설량을 체중 100g당 약 30 mg 정도씩 감소시켜서($P <$

0.05), 총 질소 배설에 대한 요산 질소의 배설비를 유의하게 감소시켰다($P < 0.05$). 결론적으로 성장중인 닭에서의 맹장절제 수술은 요산의 배설량을 감소시켜서 질소의 이용률을 개선 시켰으며, 본 연구의 결과는 이전에 성계를 통해서 얻어진 결과와도 일치하였다.

(색인어: 성장중인 병아리, 질소이용효율, 맹장절제술, 요산분비)

REFERENCES

- Akester AR, Anderson RS, Hill KJ, Osbaldiston GW 1967 A radiographic study of urine flow in the domestic fowl. *Br Poul Sci* 8: 209-212.
- Barans EM, Medae GC, Barnum DA, Harry EG 1972 The intestinal flora of the chicken in the period 2 to 6 weeks of age, with particular reference to the anaerobic bacteria. *Br Poul Sci* 13: 311-326.
- Björnhag G, Sperber I 1977 Transport of various food components through the digestive tract of turkey, geese and guinea fowl. *Swed J Agri Re* 7: 57-66.
- Chavez R, Thomas JM 1969 The utilization of non-protein nitrogen by laying hens. *Poul Sci* 45: 547-553.
- Clark PL 1978 The structure of the ileo-caeco-colic junction of domestic fowl (*Gallus gallus* L.). *Br Poul Sci* 19: 595-600.
- Clemens ET, Stevens CE, Southworth E 1975 Sites of organic acid production and pattern of digesta movement in the gastrointestinal tract of geese. *J Nutr* 105: 1341-1350.
- Crompton DWT, Nesheim MC 1976 Host-parasite relationships in the alimentary tract of domestic birds. *Ad Parasi* 14: 95-194.
- Hillerman JP, Kratzer FH, Wilson WO 1953 Food passage through chickens and trukeys and some regulating factors. *Poul Sci* 35: 332-335.
- Kagan A., Balloun SL 1976 Urea and aspartic acid supplementation of low-protein broiler diets. *Br Poul Sci* 17: 403-413.
- Karasawa Y, Maeda M 1994 Role of caeca in the nitrogen nutrition of the chicken fed on a moderate protein diet or a low protein diet plus urea. *Br Poul Sci* 35: 383-391.
- Karasawa Y, Son JH, Koh K 1997 Ligation of caeca improves nitrogen utilisation and decreases urinary uric acid excretion

- in chickens fed a low protein diet plus urea. *Br Poul Sci* 38: 439-441.
- Kobayashi S, Koike H, Itoh H 1981 Effect of dietary urea on nitrogen excretion in cockers. *Jap Poul Sci* 18: 78-85.
- Koike TI, McFarland LD 1966 Urography in the unanaesthetized hydroponic chicken. *Am J Vet Re* 27: 1130-1133.
- Lee DJW, Blair R 1972 Effects on chick growth of adding various non-protein nitrogen source or dried autoclaved poultry manure to diets containing crystalline essential amino acids. *Br Poul Sci* 13: 243-249.
- March BE, Biely J 1971 Urea tolerance in growing and adult chickens. *Poul Sci* 50: 1077-1080.
- Mattock JGW 1971 Some aspects of the problems of cellulose digestion and caecal function in the domestic goose. M Sc Thesis Univ of Bath.
- McNab JM 1973 The avian caeca: a review. *Worlds Poul Sci J* 29: 251-263.
- Miller D 1973 Chick growth response from nitrogenous compounds fed with suboptimal level of protein. *Poul Sci* 52: 1059-1064.
- Okumura J, Tanaka H, Muramatsu T 1978 Utilization of dietary urea by chicks. *Jap Poul Sci* 15: 163-169.
- Pudelkiewicz WJ, Stutz WW, Matterson LD 1968 Determination of uric acid in Avian excreta by use of uricase and differential spectrophotometry. *Poul Sci* 47: 1274-1277.
- Skadhauge E 1968 Cloacal storage of urine in the rooster. *Comp Biochem Physiol* 24: 7-18.
- Skadhauge E 1981 Osmoregulation in birds. In: Farner DS (ed), *Zoophysiol* 12 Springer Berlin Heidelberg New York pp 1-203.
- Son JH, Karasawa Y, Koh K 1996a. Comparative effect of ligation of ceca on nitrogen utilization and nitrogen excretion in chickens fed a low protein diet or a low protein diet plus urea. *An Sci Tech* 67: 171-174.
- Son JH, Karasawa Y, Koh K 1996b Effects of ligation of ceca on nitrogen utilization and nitrogen excretion in chicken fed a moderate protein diet or a moderate protein diet plus urea. *Jap Poul Sci* 33: 193-197.
- Son JH, Karasawa Y, Nahm KH 1997 Effect of cecectomy on nitrogen utilization and nitrogen excretion in chickens fed a low protein diet supplied with urea. *Asian-Aus J Anim Sci* 10: 274-276.
- Son JH., Karasawa Y 2000 Effect of removal of cecal contents on nitrogen utilisation and nitrogen excretion in caecally ligated chickens fed on a low protein diet supplemented with urea. *Br Poul Sci* 41: 69-71.
- Son JH, Karasawa Y, Nahm KH 2000 Effect of caeectomy on growth, moisture in excreta, gastrointestinal passage time and uric acid excretion in growing chicks. *Br Poul Sci* 41: 72-74.
- Son JH, Karasawa Y 2001 Effects of caecum ligated and colostomisd on water intake and excretion. *Br Poul Sci* 42: 130-133.
- Son JH, Ragland D, Adeola, O 2002 Quantification of digesta flow into the ceca. *Br Poul Sci* 43: 322-324.
- Steel RGD, Torrie JH 1986 Principles and Procedures of statistics. Int Student Ed, McGraw Hill, Tokyo.
- Thompson DC, Boag DA 1975 Role of the caeca in Japanese quail energetics. *Canad J Zooltech* 53: 166-170.