七面鳥の血中成長ホルモン,増体重,飼料摂取量および体成分組成に対するシステアミン投与の影響(131号)

誌名	明治大学農学部研究報告 = Bulletin of the Faculty of Agriculture, Meiji University
ISSN	04656083
著者名	丸山,公明 Solomon,M.B. Proudman,J.A.
発行元	明治大学農学部
巻/号	131号
掲載ページ	p. 37-46
発行年月	2002年9月

明治大学農学部研究報告　第131号（2002）　37～46

論　文

七面鳥の血中成長ホルモン，増体重，飼料摂取量および体成分組成に対するシステアミン投与の影響（131号）

丸山公明，M. B. ソロモン，J. A. プラウドマン

2002年6月13日受理

CYSTEAMINE ON TURKEY GROWTH AND BODY COMPOSITION

Effects of Cysteamine on Growth Hormone, Weight Gain, Feed Consumption, and Body Composition of Turkeys

KIMIAKI MARUYAMA[1], M. B. SOLOMON[2], AND J. A. PROUDMAN[3]

U.S. Department of Agriculture, Agricultural Research Service, Beltsville, Maryland 20705

要　旨

ソマトスタチンの分泌阻害剤であるシステアミンをラージホワイト種♂七面鳥に投与した場合の血漿中成長ホルモン濃度，成長速度，体組成に及ぼす影響を探索した。システアミンの成長ホルモン分泌への影響を調べるために，システアミン塩酸塩を 300mg/kg の用量にて，嗉嚢にストマックチューブを用いて投与したが，投与後 24 時間では血漿成長ホルモン濃度には変化が見られなかった。食餌中のシステアミンの成長速度と体組成への影響を調べるために，8 週令でシステアミン塩酸塩を基礎飼料中に 0%，0.12%，0.24%の割合で添加し，16 週令まで体重と飼料摂取量を各週測定した。血漿中成長ホルモンは 8 週令，12 週令，16 週令で測定し，16 週令で七面鳥を屠殺し，体全体，胸，腿，脛の化学組成を決定した。食餌中のシステアミンは 16 週令で血漿中の成長ホルモンを増加させ（$P<0.05$），飼料摂取量を減少させた（$P<0.05$）。体組成では，脂肪は減少し（$P<0.05$），水分が増加したが（$P<0.05$），タンパク質には変化がなかった。胸，腿，脛の化学組成には変化は認められなかった。

（キーワード：システアミン，ソマトスタチン，成長ホルモン，増体重，飼料摂取量，体組成，化学組成）

[1] Gene Evaluation and Mapping Laboratory, Livestock and Poultry Sciences Institute.
Present Address: Department of Life Science, College of Agriculture, Meiji University
[2] Meat Science Research Laboratory, Product Quality and Development Institute.
[3] Germplasm and Gamete Physiology Laboratory, Livestock and Poultry Sciences Institute.

ABSTRACT

Effects of cysteamine, an inhibitor of somatostatin secretion, on plasma growth hormone concentrations, growth and body composition of male Large White hybrid turkeys were investigated. To determine the effect of cysteamine on growth hormone secretion, turkeys were given cysteamine·HCl at the dose of 300 mg/kg body weight through a stomach tube into the crop. No changes in plasma growth hormone concentrations were observed during the following 24-hour period. To determine the effect of dietary cysteamine on turkey growth and carcass composition, cysteamine·HCl was added to the stock diet at the levels of 0%, 0.12%, and 0.24% at 8 weeks of age. Body weights and feed consumption were determined weekly from 8 to16 weeks of age. Plasma growth hormone concentrations were measured at 8, 12, and16 weeks. At 16 weeks of age, turkeys were killed to determine the chemical composition of the whole-body, and breast, thigh, and drumstick parts. Dietary cysteamine increased ($P<0.05$) plasma growth hormone concentrations at 16 weeks of age and decreased ($P<0.05$) feed consumption throughout the experiment. When turkeys were fed cysteamine, body fat was reduced ($P<0.05$), body moisture was increased ($P<0.05$), and body protein was unchanged. The chemical composition of breast, thigh and drumstick parts was not affected.

(*Key words*: cysteamine, somatostatin, growth hormone, weight gain, feed consumption, body composition)

INTRODUCTION

Immunoneutralization of somatostatin has been shown to increase the growth hormone level in rats (Arimura and Schally, 1976) and to increase growth rates of sheep (Spencer and Garssen, 1983). Therefore, it is considered one way to potentially modify poultry growth. In chickens, passive immunization with antiserum to sheep-somatostatin had no effect on either growth hormone levels or growth rates (Spencer *et al.*, 1986). However, the injection of antiserum to rabbit somatostatin was reported to increase the amplitude of growth hormone peaks (Harvey and Hall, 1987). When chickens were actively immunized at 8 days of age, immunoneutralization of somatostatin was effective in increasing 9-week body weights, despite a lack of an increase in the plasma growth hormone levels (Spencer *et al.*, 1986), suggesting that the depletion of somatostatin led to growth promotion in chickens.

Cysteamine (2-aminoethanethiol) has been shown to deplete immunoreactive somatostatin in blood, hypothalamus, gastric mucosa, and duodenal mucosa when a single dose was administered to rats by stomach tube. The concentrations of somatostatin in the plasma and hypothalamus reached the minimum values in four hours after intubation (Szabo and Reichlin, 1981). When administered subcutaneously, cysteamine caused an elevation of the baseline level of growth hormone and a loss of secretory bursts in the blood of rats (Millard *et al.*, 1983).

When cysteamine was given to chickens in the diet, there was no increase in the rate of weight gain, but an increase in feed efficiency, attributable to a decrease in feed consumption (Zany and Lindsey, 1988). In the present study, effects of dietary cysteamine on circulating growth hormone concentrations, growth rates, feed consumption, chemical compositions of the whole-body, breast, thigh and drumstick were determined using growing turkeys.

MATERIALS AND METHODS

Male Large White hybrid turkeys were used for the experiment. Two hundred forty day-old poults were purchased from a commercial hatchery and brooded in floor pens as described previously (Maruyama and Kanemaki, 1991). The feeding program was designed to exceed the nutrient requirements of turkeys set by National Research Council (NAS, 1984). A starter, two grower diets and one finisher diet composed of corn, soybean meal and meat meal were fed to turkeys beginning at 0, 4, 8, and 14 weeks of age, respectively. The crude protein and metabolizable energy contents were 30% and 2.85 Mcal/kg for the starter, 26% and 2.84 Mcal/kg for the first grower, 22% and 3.05 Mcal/kg for the second grower, and 19% and 3.05 Mcal/kg for the finisher. The lighting was provided for 24 hours a day until 2 weeks of age, and then the lighting period was reduced to 14 hours a day. The 14-hour light a day schedule was maintained until 10 weeks of age. Henceforth, the lighting was provided for 12 hours a day.

At 33 days of age, 120 poults weighing within the range of one standard deviation from the mean weight were selected for the experiment. Ten poults were randomly assigned to a pen and four pens were assigned to each treatment and acclimatized for four weeks.

At 52 days of age, 16 poults, two poults from each pen, were randomly selected and given either cysteamine or vehicle only to determine the effect of cysteamine on plasma growth hormone. Cysteamine was dissolved in phosphate buffered saline and pumped in the crop at the dose of 300 mg/kg body weight. Blood samples were collected at 0, 1, 3, 6 and 24 hours after the intubation and plasma concentrations of growth hormone were determined by radioimmunoassay (Proudman and Wentworth, 1978). All samples were processed in a single assay with an intra-assay CV of 3.85%.

When turkeys reached 8 weeks of age, dietary treatment was started by replacing the stock diet with experimental diets containing cysteamine·HCl at the levels of 0%, 0.12%, and 0.24%. Experimental diets were buffered by the mixture of 0.1% sodium bicarbonate, 0.075% talc, and 0.25%

aluminum hydroxide. Feed and water were provided ad libitum. Body weights and feed consumption was measured weekly throughout the experiment. Blood samples from eight turkeys from each treatment group were collected at 8, 12, and 16 weeks of age and assayed for growth hormone. At 16 weeks of age, turkeys were killed by an overdose of sodium pentobarbital. Feathers were removed from carcasses and a half carcass was ground for the determination of body composition. Breast, thigh, and drumstick parts were excised from the other half, deboned, and ground for the determination of chemical composition. The moisture content was determined by drying samples in an oven at 105 ℃ for 24 hours, the crude protein (N x 6.25) content was calculated from the total nitrogen content by measuring thermal conductivity after samples were combusted in a nitrogen analyzer (Leco Corp., St. Joseph, MI 49085-2396), and the fat content by extracting fat from samples in ether according to AOAC-Soxhlet method, in duplicate.

Data were analyzed using the GLM procedure (SAS Institute,1989). The experimental design was a complete random design with pens nested within treatments and mean squares for the nested pen effect were used as an error term for ANOVA. In addition, plasma growth hormone concentrations after the cysteamine intubation were analyzed by repeated measures analysis. The criterion for statistical significance was set at .05 level of probability; however, *P*-values are also provided in ANOVA summaries of tables as a reference.

RESULTS

Cysteamine and Plasma Growth Hormone Concentrations

Plasma growth hormone concentrations were not affected by the single dose of cysteamine that was administered to turkeys by intubation. When compared at 1, 3, 6, and 24 hours after intubation, plasma growth hormone concentrations in cysteamine-treated turkeys were not different from the control (Table 1). Repeated measures analysis also showed no differences between treatments ($P=0.89$), among time points ($P=0.19$), and among treatments by time point interaction ($P=0.35$).

When cysteamine·HCl was included in the diet, plasma growth hormone concentrations were elevated ($P<0.05$) at 16 weeks of age, but not elevated ($P=0.26$) at 12 weeks of age, as compared to the control (Table 2).

Table 1. Plasma growth hormone concentrations after intubation of cysteamine[1]

Treatment	Growth hormone concentrations[2]				
	before	1 hour	3 hours	6 hours	24 hours
			(ng/ml)		
Control[3]	16.6±14.1	14.7±16.5	18.6±11.0	23.9±16.0	26.5±22.7
Cysteamine[4]	15.4±11.7	20.9±16.9	26.4±12.1	13.0±11.8	27.6±10.3
P Value	0.85	0.49	0.22	0.15	0.9

[1] Average body weights of eight poults were 2.62 kg for the control and 2.94 kg for the treatment. Single blood samples were collected at a given time point from individual turkeys.

[2] Mean±SEM.

[3] Phosphate buffered saline only.

[4] Cysteamine·HCl at 300 mg/kg body weight in phosphate buffered saline.

Table 2. Effect of dietary cysteamine on plasma concentrations of growth hormone in growing turkeys[1]

Cysteamine·HCl		Growth hormone concentrations[2]		
		8 weeks	12 weeks	16 weeks
			(ng/ml)	
Control		16.6±14.1	2.4±2.2	2.3±0.2
0.12%		---	6.7±1.8	2.1±0.2
0.24%		---	9.6±1.7	3.4±0.2
		------ ANOVA Summary[3] -----		
Source	df		*P value*	
Treatment	2		0.26	0.05
Linear	1		0.15	0.08
Quadratic	1		0.2	0.2

[1] Cysteamine·HCl was added to the diet from 8 to 16 weeks of age. At 8, 12, and 16 weeks of age, single blood samples were collected from 8 individual turkeys from each treatment.

[2] Mean±SEM.

[3] Mean squares for nested pen effect were used as an error term for ANOVA.

Effects of Dietary Cysteamine on Turkey Growth and Feed Consumption

The effect of dietary cysteamine on the growth rate is summarized in Table 3. The starting weight at 8 weeks was 2.71±0.08 (SEM) kg for the control group, 2.73±0.07 (SEM) kg for the 0.12% cysteamine group, and 2.69±0.07 (SEM) kg for the 0.24% cysteamine group. The end weight at 16 weeks was 9.03±0.15 (SEM) kg for the control group, 8.87±0.13 (SEM) kg for the 0.12% cysteamine group, and 7.30±0.13 (SEM) kg for the 0.24% cysteamine group. The growth rate of turkeys were reduced ($P<0.05$) by dietary cysteamine during the period of 12 to 14 weeks and the response was quadratic. However, the overall avarage daily gain from 8 to 16 weeks was not affected. When the level of cysteamine·HCl in the diet was 0.12%, the average daily weight gain was about 97% of the control. But, when the level of cysteamine·HCl was increased to 0.24%, the average daily weight gain was about 73% of the control.

The effect of dietary cysteamine·HCl on feed consumption is summarized in Table 4. Average daily feed consumption was reduced ($P<0.05$) when cysteamine·HCl was included in the diet. The effect of dietary cysteamine on feed consumption was linear. Average daily feed consumption was reduced by 9% at the level of 0.12% and by 22% at the level of 0.24%.

Effects of Cysteamine on the Chemical Composition of the Whole-body and Breast, Thigh, and Drumstick Parts

When turkeys were fed cysteamine·HCl in the diet from 8 to 16 weeks of age, body composition of 16-week-old turkeys was drastically altered (Table 5). Body moisture was increased ($P<0.05$) and body fat was decreased ($P<0.05$) in turkeys receiving cysteamine·HCl. These responses were linearly related to the level of dietary cysteamine. The body protein content was not affected by dietary cysteamine.

Effects of dietary cysteamine on the chemical composition of breast, thigh, and drumstick parts were not significant (Table 6). The fat content was not reduced by dietary cysteamine in the breast part ($P=0.08$), the thigh part ($P=0.35$), and the drumstick part ($P=0.89$) with 8 replicates per treatment.

Table 3. Effect of dietary cysteamine on growth rates of growing turkeys[1]

Cysteamine·HCl			Average daily weight gain[2]			
		8-10 weeks	10-12 weeks	12-14 weeks	14-16 weeks	8-16 weeks
				(g/day)		
Control		100.2±9.3	114.1±3.2	109.2±2.8	127.8±3.6	112.8±2.9
0.12%		92.3±8.2	108.8±2.8	119.6±2.4	118.2±3.2	109.7±2.5
0.24%		66.9±8.8	78.4±2.7	87.4±2.3	97.6±3.1	82.4±2.4
				------ ANOVA Summary[3] ------		
Source	*df*			*P Value*		
Treatment	2	0.55	0.08	0.03	0.07	0.06
Linear	1	0.42	0.05	0.37	0.04	0.05
Quadratic	1	0.80	0.91	0.03	0.85	0.32

[1] Cysteamine·HCl was added to the diet from 8 to 16 weeks of age

[2] Mean±SEM.

[3] Mean squares for nested pen effect were used as an error term for ANOVA.

Table 4. Effect of dietary cysteamine on feed consumption of growing turkeys[1]

Cysteamine·HCl		Average Daily Feed Consumption (g/d)[2]				
		8-10 weeks	10-12 weeks	12-14 weeks	14-16 weeks	8-16 weeks
				(g/day)		
Control		188±4	318±7	338±6	419±7	316±3
0.12%		178±4	256±6	325±6	387±6	287±3
0.24%		135±4	222±6	292±5	338±±6	247±3
			------ ANOVA Summary[3] ------			
Source	*df*			*P Value*		
Treatment	2	0.04	0.09	0.11	0.03	0.01
Linear	1	0.05	0.04	0.06	0.02	0.006
Quadratic	1	0.20	0.15	0.86	0.61	0.46

[1] Cysteamine·HCl was added to the diet from 8 to 16 weeks of age.

[2] Mean±SEM.

[3] Mean squares for nested pen effect were used as an error term for ANOVA.

Table 5. Effect of dietary cysteamine on the whole-body chemical composition of growing turkeys[1]

Cysteamine·HCl		Body composition[2]		
		Moisture	Fat	Protein
			(%/wet weight)	
Control		66.5±0.2	10.1±0.4	20.8±0.4
0.12%		67.4±0.2	9.1±0.4	20.5±0.3
0.24%		70.9±0.2	4.9±0.3	21.3±0.3
		------- ANOVA Summary[3] -----		
Source	*df*		*P value*	
Treatment	2	0.02	0.04	0.97
Linear	1	0.02	0.03	0.94
Quadratic	1	0.22	0.82	0.88

[1] Cysteamine·HCl was added to the diet from 8 to 16 weeks of age. Eight turkeys from each treatment were killed at 16 weeks of age to determine body composition..

[2] Mean±SEM.

[3] Mean squares for nested pen effect were used as an error term for ANOVA.

Table 6. Effect of dietary cysteamine on chemical compositions of breast, thigh and drumstick parts[1]

Cysteamine·HCl		Chemical Composition[2]								
		Breast			Thigh			Drumstick		
		Moisture	Fat	Protein	Moisture	Fat	Protein	Moisture	Fat	Protein
		(%/wet weight)			(%/wet weight)			(%/wet weight)		
Control		73.3±0.1	0.9±0.1	25.9±0.2	73.7±0.2	5.7±0.4	21.1±0.1	75.5±0.2	2.8±0.3	21.6±0.4
0.12%		73.5±0.1	0.5±0.1	25.8±0.2	74.2±0.2	5.0±0.4	21.1±0.1	75.9±0.2	2.6±0.3	19.8±0.4
0.24%		74.0±0.1	0.1±0.1	25.8±0.2	75.3±0.2	3.2±0.3	21.5±0.1	76.2±0.2	1.8±0.3	22.0±0.4
		----- ANOVA Summary[3] -----								
Source	*df*	*P Value*								
Treatment	2	0.19	0.08	0.58	0.08	0.35	0.80	0.44	0.89	0.32
Linear	1	0.09	0.04	0.38	0.05	0.19	0.88	0.24	0.98	0.39
Quadratic	1	0.46	0.79	0.97	0.89	0.78	0.54	0.42	0.71	0.16

[1] Cysteamine·HCl was added to the diet from 8 to 16 weeks of age. Eight turkeys from each treatment were killed at 16 weeks of age to determine the chemical composition of breast, thigh and drumstick parts.

[2] Mean±SEM.

[3] Mean squares for nested pen effect were used as an error term for ANOVA.

DISCUSSION

The addition of cysteamine·HCl to the diet resulted in the increase in circulating growth hormone concentrations at 16 weeks of age, and no change in growth rates and the decrease in feed consumption from 8 to 16 weeks of age. Effects of dietary cysteamine were linearly proportional to the dose in the diet. It was reported that when cysteamine·HCl was added to the diet at the level of 0.12%, only the feed consumption was reduced, resulting in improved feed utilization in chickens (Zavy and Lindsey, 1988). In the present study, the feed:gain ratio for turkeys receiving cysteamineAHCl g at 0.12% was not better (P=0.08) than the control (2.8±0.04 for the control and 2.6±0.03 for the treatment, data not shown). Since cysteamine was provided as a HCl salt which was reported to increase gastric acid secretion in rats (Ishii *et al.*, 1976), sodium bicarbonate and the antiacid mixture were added in the stock diet to remove a possible loss of appetite due to HCl. Yet, feed consumption was decreased linearly as the level of dietary cysteamine was increased.

The body fat content increases with age in turkeys (Bacon *et al.*, 1986). In the present experiment, the body fat content was 3.3±1.3% at 8 weeks of age and 10.1±0.4% at 16 weeks of age (data not shown). When cysteamine·HCl was added to the diet at the level of 0.24%, the body fat content at 16 weeks of age was 4.9%, indicating a very small amount of fat was accumulated between 8 and16 weeks of age. There was a trend that the moisture content was increased and the fat content was decreased as the level of cysteamine was increased. The fat content was reduced to nearly zero in the breast part, by 44% in the thigh part, and by 36% in the drumstick part when the dietary level of cysteamine·HCl was 0.24%.

When broiler chickens were subjected to the skip-a-day feeding, very little fat was accumulated, and in fact, body fat was reduced about a half as much as in the full-fed control (Yu *et al.*, 1990). Therefore, reduced fat accumulation in the whole-body, and breast, thigh and drumstick parts was largely attributable to reduced feed consumption in the present study.

It is also probable that cysteamine reduced body fat via the anti-somatostatin action, in addition to its appetite-depressant action. When cysteamine was injected to chickens, plasma glucose, nonesterified fatty acids, and insulin were increased (Rideau *et al.*, 1990). A similar response was reported in chickens that were immunized against somatostatin (Cheung *et al.*, 1988). When somatostatin was infused to turkeys, circulating nonesterified fatty acids were decreased, suggesting that lipolysis was inhibited (Kurima *et al.*, 1994).

In conclusion, dietary cysteamine reduced feed consumption, and as a consequence, decreased fat accumulation in the carcass of turkeys. When an optimum dose is chosen, cysteamine can be a promising feed additive to improve the carcass quality and the efficiency of feed utilization

REFERENCES

Arimura, A., and A. V. Schally, 1976. Increase in basal and thyrotropin-releasing hormone (TRH)-stimulated secretion of thyrotropin (TSH) by passive immunization with antiserum to somatostatin in rats. Endocrinology 98: 1069-1072.

Bacon, W. L., K. E. Nestor, and P. A. Renner, 1986. The influence of genetic increases in body weight and shank width on the abdominal fat pad and carcass composition of turkeys. Poultry Sci.: 391-397.

Cheung, A., S. Harvey, T. R. hall, S. K. Lam, and G. S. G. Spencer, 1988. Effects of passive immunization with antisomatostatin serum on plasma corticosterone concentrations in young doemstic chickens. J. Endocrinol. 116: 179-183.

Havey, S., and T. R. Hall, 1987. Somatostatin-28(1-14) immunoneutralization stimulates growth hormone secretion in fowl. Gen. Comp. Endocrinol. 65: 111-116.

Ishii, Y., Y. Fujii, and M. Homma, 1976. Gastric acid stimulating action of cysteamine in the rat. Eur. J. Pharmacol. 36: 331-336.

Kurima, K, W. L. Bacon, and R. Vasilatos-Younken, 1994. Effects of somatostatin on plasma growth hormone and metabolite concentrations in fed and feed-deprived young female turkeys. Poultr Sci. 73: 714-723.

Maruyama, K., and N. Kanemaki, 1991. Myosin isoform expression in skeletal muscles of turkeys at various ages. Poultry Sci. 70: 1748-1757.

Millard, W. J., S. M. Sagar, T. M. Badger, and J. B. Martin, 1983. Cysteamine effects on growth hormone secretion in the male rat. Endocrinology 112: 509-517.

Proudman, J. A., and B. C. Wentworth, 1978. Radioimmunoassay of turkey growth hormone. Gen. Comp. Endocrinol. 36: 194-200.

Rideau, N., H. Karmann, and J. Simon, 1990. Effects of cysteamine administration on plasma concentration of metabolites, pancreatic glucagon and insulin in the chicken. Comp. Biochem. Physiol. 96A: 327-331.

SAS Institute, 1989. *SAS/STAT Users's Guide*, Version 6, Fourth Edition, Volume 1, SAS Institute, Inc., Cary, NC.

Spencer, G. S. G., and G. J. Garssen, 1983. A novel approache to growth promotion using auto-immunisation against somatostatin. I. Effects on growth and hormone levels in lambs. Livest. Prod.Sci. 10: 25-37.

Spencer, G. S. G., S. Havey, A. R. S. Audsley, K. G. Hallett, and S. Kestin, 1986. The effect of immunization against somatostatin on growth rates and growth hormone secretion in the chicken. Comp. Biochem.Physiol. 85A: 553-556.

Szabo, S., and S. Reichlin, 1981. Somatostatin in rat tissues is depleted by cysteamine administration. Endocrinology 109: 2255-2257.

Yu, M. W., F. E. Robinson, M. T. Clandinin, and L. Bodnar, 1990. Growth and body composition of broiler chickens in response to different regimens of feed restriction. Poultry Sci. 69: 2074-2081.

Zany, M. T., and T. O. Lindsey, 1988. Effect of cysteamine administration on growth and efficiency of food utilisation in chicks. Br. Poult. Sci. 29: 409-417.