フィターゼ添加飼料を給与したブロイラーの成績に及ぼすグアガムの効果

誌名	日本家禽学会誌
ISSN	00290254
著者	古瀬, 充宏 中嶋, 真一 中川, 二郎
巻/号	34巻2号
掲載ページ	p. 103-109
発行年月	1997年3月

Effects of Dietary Guar Gum on the Performance of Growing Broilers Given Diets Containing Phytase

Mitsuhiro FURUSE[1], Shin-ichi NAKAJIMA[2], Jiro NAKAGAWA[2], Misao OKUMURA[3] and Jun-ichi OKUMURA[1]

[1] Laboratory of Animal Nutrition, School of Agricultural Sciences, Nagoya University, Nagoya 464-01
[2] Toyohashi Feed Mills Co. Ltd., Toyohashi 440
[3] Tokai Gakuen Women's College, Nagoya 468

The present study was done to investigate whether dietary guar gum (GG), which is known to delay the food passage from the crop, improves the performance of growing broiler chicks given diets containing phytase. Several combinations of dietary GG and partially hydrolysed GG at 40 g per kg diets and two levels of phytase (0 or 500 units per kg diets) were prepared and the experimental diets were given for two weeks. Body weight gain was significantly improved by dietary phytase, but was decreased in a dose-dependent fashion as dietary GG increased. Weight and Ca content in the tibia were not influenced by dietary phytase, whereas significantly decreased by increasing dietary GG. Ash and P concentrations in the tibia were significantly improved by phytase treatment.

The results obtained here suggested that dietary phytase was available for the performance of growing broilers. However, dietary GG was not effective for the improvement of efficacy of dietary phytase, because dietary GG suppressed the utilization of food in the chicken.

*(Jpn. Poult. Sci., **34** : 103-109, 1997)*

Key words : phytase, guar gum, growth, bone mineral, broiler

Introduction

The principal storage form of P in seeds is phytate P. The reports for chicken intestinal phytase are conflicting. Some reserachers reported that endogenous phytase was absent in chicken alimentary tract (TAYLER, 1965 ; NELSON, 1967). MADDAIAH *et al.* (1964) indicated that both young and mature chickens had intestinal phytase activity. Anyway, the utilization of phytate P is generally considered poor in chickens. Therefore, high levels of phytate P present in chicken feeds usually lead to high levels of P in the excreta. Supplementation of inorganic P in the diet improves the performance of the chicken, but phytate P is still excreted. Consequently, chicken droppings may create an environmental contaminant in terms of excess P when they are applied to land.

The optimal pH of the phytase (KR-2014, Kyowa Hakko Kogyo Co. Ltd.) was about

Received July 29, 1996 Accepted September 4, 1996
Correspondences should be addressed : Dr. M. FURUSE Laboratory of Animal Nutrition, School of Agricultural Sciences, Nagoya University, Nagoya 464-01 Tel : 052-789-4077 Fax : 052-789-4012

5.5 ; however, the gastric pH of the chicken is very low to obtain maximal activity of phytase except for the crop (FORD, 1974). Therefore, to delay the food passage from the crop may enhance the utillization of phytate. Guar meal from the guar bean (*Cyamopsis tetragonolobus*) has been used in poultry rations (BORCHER and ACKERSON, 1950 ; VOHRA and KRATZER, 1964), and component of guar meal is considered to be guar gum (GG) which is a galactomannan (McCLEARY, 1979 ; WHITE *et al.*, 1978). The high viscosity of GG has shown to slow crop emptying rate of diets in the chicken (FURUSE and MABAYO, 1996).

Thus, the present study was done to clarify whether or not dietary GG improves the efficacy of phytase in the performance of broilers.

Materials and Methods

One-day-old male broiler chicks (Chunky) were given a standard diet (Table 1) for 7 days. On day 8, chicks were individually weighed and then selected and distributed into 10 groups of 4 birds each and given experimental diets for 2 weeks. The experimental diets contained several partially hydrolyzed GG (PHGG)/GG combina-

Table 1. Composition (%) of a standard diet

Ingredient	
Yellow corn	45.372
Milo	10.0
Soybean meal (CP 44%)	25.5
Corn gluten meal	0.5
Canola meal	3.0
Fish meal (CP 60%)	5.0
Feather meal	0.5
Chicken meal	4.0
Rice bran	1.5
Blend fat	3.2
Limestone	0.8
Sodium chrolide	0.2
Vitamin and mineral premix*	0.1
DL-Methionine	0.210
L-Lysine	0.020
Avoparcin	0.010
Bicozamycin	0.005
Salinomycin	0.050
Choline chloride (60%)	0.033

Calculated values : ME 12.8 kJ/g and CP 23%.
*Contained (/kg) : Vitamin A, 8,000,000 IU ; Vitamin D_3, 1,800,000 IU ; Vitamin E, 8,000 mg ; Vitamin K_3, 2,000 mg ; Vitamin B_1, 1,215 mg ; Vitamin B_2, 5,000 mg ; Pantothenic acid, 9,201 mg ; Niacine, 30,241 mg ; Vitamin B_6, 500 mg ; Biotine, 40 mg ; Folic acid, 500 mg ; Vitamin B_{12}, 10 mg ; Mn, 60 g ; Zn, 45 g ; Fe, 50 g ; Cu, 8 g ; Co, 100 mg and I, 350 mg.

tions in 5 different proportions, namely 0 : 40, 10 : 30, 20 : 20, 30 : 10 or 40 : 0 g PHGG : GG to 1 kg of the standard diet, with (500 units/kg) or without phytase (KR-2014, Kyowa Hakko Kogyo Co. Ltd.). Ca, total P and nonphytate P levels in the standard diet were 1.00, 0.69 and 0.47% respectively, to meet the requirement (Japanese Feeding Standard, 1992). At the termination of feeding trials, birds were killed by cervical dislocation, and the right and left tibiae were saved for the determination of bone Ca and P. According to the method by KESHAVARZ and NAKAJIMA (1993), the Ca contents of tibiae were determined by atomic absorption spectrophotometry, after ashing the samples in a muffle furnace over night at 600℃. The P contents of tibiae were determined by spectrophotometry according to the method by AOAC (1990).

To compare the significance of differences between means, two way analysis of variance was used by considering dietary GG and phytase concentrations as the main effects. When main effects and interaction were statistically significant, comparison of mean was performed by the Duncan's multiple range test. Differences were considered significant at $P<0.05$. Values in the text are means±SEM. Statistical procedures were done using a commercially available statistical package (SAS, 1985).

Results

Table 2 shows the body weight gain of chicks given diets containing different levels of dietary GG with or without dietary phytase. During the first week of feeding, dietary phytase significantly improved body weight gain, but no significant effect was observed in the second week. Overall body weight gain (over 2 weeks) was also significantly improved by dietary phytase. Dietary GG significantly decreased body weight gain, in a dose dependent fashion, in any periods. No significant interactions in body weight gain were found in any three periods.

Table 2. Effects of dietary guar gum on body weight gain (g) of growing broilers given diets containing phytase

Periods	Phytase (units/kg)	Dietary guar gum levels (g added to 1 kg diet)					Mean
		0	10	20	30	40	
1 to 2 weeks of age							
	0	211±19	204±16	185±23	138± 7	150±17	178±10
	500	234± 1	226±12	208± 7	192±14	156±26	203± 9*
	Mean	222±10^{A}	215±10^{A}	197±12^{AB}	165±13^{BC}	153±14^{C}	
2 to 3 weeks of age							
	0	365±23	375±11	341±27	269±14	241±17	318±14
	500	372±15	361±32	318±18	310±16	294±11	331±10
	Mean	368±13^{A}	368±16^{A}	329±15^{AB}	290±12^{BC}	268±14^{C}	
1 to 3 weeks of age							
	0	576±30	579±26	526±42	407±17	391±15	496±22
	500	605±15	587±42	526±17	502±29	450±31	534±17*
	Mean	591±17^{A}	583±23^{AB}	526±21^{B}	455±24^{C}	420±19^{C}	

*Significantly different from the phytase unsupplemented group at $P<0.05$.
$^{A-C}$Means without the same superscript were significantly different at $P<0.05$.

Food intake of chicks given diets containing different levels of dietary GG with or without dietary phytase is given in Table 3. There were no significant main effect and interaction in food intake except for the effect of phytase in the first week. Dietary phytase significantly enhanced food intake of chickens in the first week.

Food efficiency decreased as dietary GG levels increased in any periods, but was

Table 3. Effects of dietary guar gum on food intake (g) of growing broilers given diets containing phytase

Periods	Phytase (units/kg)	Dietary guar gum levels (g added to 1 kg diet)					Mean
		0	10	20	30	40	
1 to 2 weeks of age							
	0	239±13	225±10	216± 6	224± 9	234±14	227± 5
	500	251± 8	252±24	270±11	235±10	239±11	249± 6*
	Mean	245± 7	239±13	243±12	229± 6	237± 8	
2 to 3 weeks of age							
	0	954±22	939±33	897±63	958±43	990±10	947±17
	500	924±24	929±25	951±30	964±30	944±28	942±11
	Mean	939±16	934±19	924±34	961±24	967±16	
1 to 3 weeks of age							
	0	1,193±28	1,164±26	1,112±64	1,182±46	1,224±18	1,175±18
	500	1,174±24	1,181±31	1,220±27	1,198±20	1,183±31	1,191±11
	Mean	1,184±18	1,172±19	1,166±38	1,190±24	1,203±18	

*Significantly different from the phytase unsupplemented group at $P<0.05$.

Table 4. Effects of dietary guar gum on bone weights and mineral contents of growing broilers given diets containing phytase

Parameters	Phytase (units/kg)	Dietary guar gum levels (g added to 1 kg diet)					Mean
		0	10	20	30	40	
Bone weight (g/a pair of tibiae)							
	0	3.25±0.19	3.44±0.17	3.11±0.21	2.58±0.09	2.44±0.08	2.97±0.11
	500	3.39±0.14	3.31±0.14	3.05±0.11	2.90±0.25	2.72±0.15	3.07±0.09
	Mean	3.32 ± 0.11^{A}	3.38 ± 0.10^{A}	3.08 ± 0.11^{A}	2.74 ± 0.14^{B}	2.58 ± 0.09^{B}	
Ash content (%)							
	0	39.5±0.6	39.4±0.2	38.1±0.6	38.3±1.0	36.5±1.7	38.4±0.5
	500	39.5±0.8	40.5±0.4	39.7±0.7	38.3±0.7	38.7±0.5	39.3±0.3*
	Mean	39.5±0.4	40.0±0.3	38.9±1.7	38.3±0.6	37.6±0.9	
Ca content (%)							
	0	14.1±0.1	14.4±0.1	13.4±0.1	13.5±0.3	13.1±0.6	13.7±0.2
	500	14.4±0.3	14.5±0.2	14.0±0.4	13.5±0.5	13.8±0.2	14.0±0.2
	Mean	14.3 ± 0.1^{AB}	14.4 ± 0.1^{A}	13.7 ± 0.2^{BC}	13.5 ± 0.3^{C}	13.5 ± 0.3^{C}	
P content (%)							
	0	6.33±0.09	6.36±0.06	6.10±0.07	6.18±0.20	5.99±0.31	6.19±0.08
	500	6.43±0.18	6.62±0.12	6.43±0.11	6.32±0.10	6.17±0.09	6.40±0.06*
	Mean	6.38±0.09	6.49±0.08	6.27±0.09	6.25±0.11	6.08±0.15	

*Significantly different from the phytase unsupplemented group at $P<0.05$.
$^{A-C}$Means without the same superscript were significantly different at $P<0.05$.

not influenced by dietary phytase (data not shown).

Table 4 indicates effects of dietary GG on bone weights and mineral contents of growing broilers given diets containing phytase. Ash and P contents of the bone were significantly enhanced by dietary phytase, though bone weight and Ca content were not influenced. Dietary GG significantly decreased bone weight and Ca content, in a dose dependent manner, but ash and P contents were hardly affected.

Discussion

Body weight gain was significantly increased by the supplementation of dietary phytase, but was significantly decreased in a dose dependent fashion with the increase of dietary GG. In the present study, dietary phytase did not alter food intake over 2 weeks, but chicks ate significantly more food during the first week of the experiment (Table 3). Thus, the growth promotion effect of dietary phytase may be associated with the enhanced food intake at early stages of phytase applied. In fact, food efficiency was not altered by dietary phytase at this stage. However, the mechanism by which phytase improves food intake has been unclear.

According to FURUSE and MABAYO (1996), as dietary GG increased food intake of chicks was suppressed in a short time period (over 3 hours). In the present study, however, food intake was not suppressed by dietary GG, which implying that the adaptation for GG might be occurred during 2 weeks.

It has been reported that GG decreases utilization efficacy of protein (POKSAY and SCHNEEMAN, 1983) and lipid (SIMONS *et al.*, 1982 ; VAHOUNY *et al.*, 1987). One of the reasons for this effect may be the high viscosity of GG, resulting to slow gastric emptying (JENKINS *et al.*, 1978 ; SHAH *et al.*, 1986) and crop emptying (FURUSE and MABAYO, 1996). The present study was aimed to delay the food passage from the crop by using this nutritional and physiological characteristic of GG, because the crop has a favorable environment for phytase activity as a standpoint of pH. However, a detrimental effect of GG in body weight gain was dominant rather than a beneficial effect.

In addition to body weight gain, bone weight and its mineral contents have been considered to be the most sensitive indicators in this experiment. Bone weight was linearly ($R^2=0.821$, $P<0.0001$) related to the body weight and significantly decreased as dietary GG increased. The similar tendency was observed in Ca content of bone. Both bone weight and Ca content were not influenced by dietary phytase. However, P concentration in the bone was significantly improved by phytase treatment and this result suggested that dietary P utilization may be improved by phytase.

The present study clearly indicated that dietary phytase (KR-2014) was available for the performance of growing broilers. However, dietary GG was not effective for the improvement of efficacy of phytase, because dietary GG suppressed the utilization of food in the chicken.

Acknowledgement

This study was supported by Kyowa Hakko Kogyo Co. Ltd., Tokyo.

References

BORCHER, R. and C.W. ACKERSON (1950) The nutritive value of legume seeds. X. Effect of autoclaving and trypsin inhibitor test for 17 species. Journal of Nutrition, **41** : 339-345.

FORD, D.J. (1974) The effect of the gut microflora on gastrointestinal pH in the chick. British Poultry Science, **15** : 131-140.

FURUSE, M. and R.T. MABAYO (1996) Effects of partially hydrolysed guar gum on feeding behaviour and crop emptying rate in chicks. British Poultry Science, **37** : 223-227.

Japanese Feeding Standard for Poultry (1992) Edited by Agriculture, Forestry and Fisheries Research Council Secretariat Ministry of Agriculture, Forestry and Fisheries. Central Association of Livestock Industry.

JENKINS, D.J.A., T.M.S. WOLEVER, A.R. LEEDS, M.A. GASSULL, P. HAISMAN, J. DILAWARI, D.V. GOFF, G. L. METZ and K.G.M.M. ALBERTI (1978) Dietary fibers, fiber analogues and glucose tolerance : importance of viscosity. British Medical Journal, **1** : 1392-1394.

KESHAVARZ, K. and S. NAKAJIMA (1993) Re-evaluation of calcium and phosphorus requirement of laying hens for optimum performance and eggshell quality. Poultry Science, **72** : 144-153.

MADDAIAH, V.T., A.A. KURNICK, B.J. HULETT and B.L. REID (1964) Nature of intestinal phytase activity. Proceedings of the Society for Experimental Biology and Medicine, **115** : 1054-1057.

McCLEARY, B.V. (1979) Enzymic hydrolysis, fine structure, and gelling interaction of legume-seed *D*-galacto-*D*-mannans. Carbohydrate Research, **71** : 205-230.

NELSON, T.S. (1967) The utilization of phytase P by poultry—A review. Poultry Science, **46** : 862-871.

Official methods of analysis of the association of official analytical chemists. (1990) Fifteenth edition, volume 2. Association of Official Analytical Chemists, Arlington, p. 88.

POKSAY, K.S. and B.O. SCHNEEMAN (1983) Pancreatic and intestinal response to dietary guar gum in rats. Journal of Nutrition, **113** : 1544-1549.

SAS Institute Inc. (1985) SAS User's Guide : Statistics, 5 th ed. Cary, NC, U.S.A.

SHAH, N., R.R. MAHONEY and P.L. PELLETT (1986) Effect of guar gum, lignin and pectin on proteolytic enzyme levels in the gastrointestinal tract of the rat : a time-based study. Journal of Nutrition, **116** : 786-794.

SIMONS, L.A., S. GAYST, S. BALASUBRAMANIAM and J. RUYS (1982) Long-term treatment of hypercholesterolaemia with a new palatable formulation of guar gum. Atherosclerosis, **45** : 101-108.

TAYLOR, T.G. (1965) The availability of the calcium and P of plant materials for animals. Proceedings of Nutrition Society, **24** : 105-112.

VAHOUNY, G.V., R. KHALAFI, S. SATCHITHANANDAM, D.W. WATKINS, J.A. STORY, M.M. CASSIDY and D. KRITCHEVSKY (1987) Dietary fiber supplementation and fecal bile acids, neutral steroids and divalent cations in rats. Journal of Nutrition, **117** : 2009-2015.

VOHRA, P. and F.H. KRATZER (1964) The use of guar-meal in chicken rations. Poultry Science, **43** : 502-503.

WHITE, W.B., H.R. BIRD, M.L. SUNDE, N. PRENTICE and W.C. BURGER (1978) Effects of gums and grit on barley and corn based diets. Poultry Science, **57** : 1170-1171.

フィターゼ添加飼料を給与したブロイラーの成績に及ぼすグアガムの効果

古瀬充宏[1)]・中嶋真一[2)]・中川二郎[2)]・奥村ミサヲ[3)]・奥村純市[1)]

[1)] 名古屋大学農学部，名古屋市千種区 464-01
[2)] 豊橋飼料，豊橋市 440
[3)] 東海学園女子短期大学，名古屋市天白区 468

そ嚢からの飼料の流出を遅延させることが知られているグアガムが，フィターゼ添加飼料を給与したブロイラーの成績を改善するかどうかについて検討した。グアガムとその加水分解物を様々な組み合わせで飼料 1 kg に対し 40 g 添加した。フィターゼは飼料 1 kg 当たり 500 単位添加，あるいは無添加とし，ブロイラーヒナに 2 週間給与した。飼料中の Ca，全 P および非フィチン態 P 含量は，それぞれ 1.00，0.69 および 0.47% であった。増体重はフィターゼ添加により有意に増加したが，グアガムの量に比例して低下した。脛骨重量とその Ca 含量にフィターゼは有意な効果をもたらさなかったが，グアガムはそれらを減少させた。脛骨中の灰分および P 含量はフィターゼ添加により有意に高くなった。

これらの結果より，フィターゼはブロイラーの成績を有意に改善するが，グアガムはその効果を改善することなくむしろ飼料の利用性を低下させることが判明した。

（家禽会誌，***34*** : *103-109*, *1997*）

キーワード：フィターゼ，グアガム，成長，骨灰分，ブロイラー