ISSN 1682-8356
ansinet.org/ijps

INTERNATIONAL JOURNAL OF

POULTRY SCIENCE

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

International Journal of Poultry Science 8 (7): 692-695, 2009
ISSN 1682-8356

Effect of Varying Ratios of Dietary Calcium and Phosphorus on Performance, Phytate P and Mineral Retention in Japanese Quail (*Coturnix cotnurnix Japonica*)

Atefeh Sheikhlar[1], Azhar Bin Kasim[1], Loh Teck Chwen[1] and Mohd Hair Bejo[2]
[1]Department of Animal Science, Faculty of Agriculture, University of Putra Malaysia, 43400, Selangor, Malaysia
[2]Faculty of Veterinary Medicine, University of Putra Malaysia, Serdang 43400, Selangor, Malaysia

Abstract: The effect of different ratios of dietary calcium (Ca) to total phosphorus (tP) on the performances and retention of minerals and phytate phosphorus (pP) by quails were studied using 600 unsexed broiler quails from 1 to 21 days of age. Treatments consist of five corn and soybean meal (CSM) based diets with variable ratios of Ca:tP (1.96, 1.81, 1.66, 1.53 and 1.39) with four replicate of 30 birds each. Diets contained 3g chromium oxide (Cr_2O_3)/kg as marker. All ratios of Ca and P had no significant effect on feed consumption of birds. There were pronounced differences ($P < 0.05$) in body weight gain of chicks among treatments at second and third week of age. Improved ($P < 0.05$) feed conversion ratio was observed at 3 wk of age. Higher ratios of Ca:tP (1.96 and 1.81) increased ($P < 0.05$) the retention of P compared to other treatments while ratio of 1.96 decreased ($P < 0.05$) the retention of Ca and phytate. In conclusion, Ca:tP ratio of 1.81 showed positive effect on most of parameters measured in this study.

Key words: Calcium, total phosphorus, phytate P, broiler quail

INTRODUCTION

Calcium (Ca) and phosphorus (P) are two important minerals in the body that coexist in many biological functions. Hence, the dietary needs for these minerals are interdependent (Rama Rao *et al*., 2006). Besides Ca and P levels, their ratio in feed will optimize growth and skeletal mineralization in poultry. Dietary Ca and P have been reported to affect consumption of phytate P by chickens (Mohammad *et al*., 1991) and phytate P can be made available to chicken by reducing the level of Ca and P in the diet (Simons *et al*., 1990).

It is known that some nutrients in feed ingredients are not entirely available to monogastric animals such as poultry due to chelation by phytate. Phytate bind to cations such as Ca, P, Cu, Fe, Zn and other micro minerals (Oberleas and Harland, 1996). This strong anti-nutritional characteristic of phytate limits the absorption of these important nutrients in the body. Therefore, phytate-nutrients complex remains undigested by poultry and are excreted in the feces. Among the bound minerals, P is most disruptive in polluting water. Animal droppings added to soil, increases P capacity of the soil, and the extra P leaches into rivers, lakes, and reservoirs causing eutrophication (Correll, 1999; Sharpley, 1999), odors, sedimentation and other problems that impose various health risks, not only to humans but also to livestock and aquatic life.

The influence of Ca and P ratios on growth and phytate P utilization in chicken are widely reported but studies on their effect on broiler quail's growth, mineral and phytate P digestibility are scarce. Thus, present study was conducted to determine the optimum ratio of Ca and tP on growth performance, Ca, P and phytate P retention in broiler quail over 3 week of age.

MATERIALS AND METHODS

A total of 600 day-old unsexed broiler quail chicks *(Coturnix Cotnurnix Japonica)* were obtained from a commercial hatchery. Birds were placed in stainless steel starter battery brooders and randomly placed to 20 pens of 30 birds each. Four pens were assigned to each of five dietary treatments. Diets were based on corn and soybean meal. The dietary treatments included diets 1, 2, 3, 4, and 5 with Ca and total P ratios of 1.96 (Ca and tP levels are 0.64 and 0.3), 1.81 (Ca and tP levels are 0.71 and 0.37), 1.66 (based on NRC, 1994 recommendation) (Ca and tP levels are 0.8 and 0.44), 1.53 (Ca and tP levels are 0.89 and 0.54) and 1.39 (Ca and tP levels are 1 and 0.66) (Table 1). All diets were in mash form and fed *ad libitum* with free access to drinking water. The environmental temperature was initially 37°C and gradually reduced by 3°C per week to 28°C in week 3. The experiment lasted 21 days.

Daily feed intake and weekly body weights were recorded throughout the experiment. Feed efficiency was determined from the body weight gain and feed intake data. Excreta were collected at 19 d of age. Chromic oxide (3gr/Kg) which was added to determine the retention of minerals (Ca and P) and phytate P were measured in diets and excreta based on AOAC (1990).

Table 1: Composition of experimental diets

Ingredients (g/kg)	Diet1 Ca:tP = 1.96	Diet 2 Ca:tP = 1.81	Diet 3 Ca:tP = 1.66	Diet 4 Ca:tP = 1.53	Diet 5 Ca:tP = 1.39
Corn	490	487	472	478	468
Soybean meal	440.2	440	451	440.2	445.2
Palm oil	40	40	40	40	40
Limestone	13.5	13.5	13.5	13.5	13.5
Dicalcium phosphate (DCP) (DCP)	0	3.2	7.2	12	17
Salt	4	4	4	4	4
Mineral premix[1]	5	5	5	5	5
Vitamin premix[2]	5	5	5	5	5
Lys	1	1	1	1	1
DL Met	1	1	1	1	1
Cr_2O_3	0.3	0.3	0.3	0.3	0.3
Chemical composition					
ME (kcal/kg)	2970	2960	2944	2930	2910
Crude protein%	24.02	23.99	24.33	23.92	24.06
Ca%	0.64	0.71	0.8	0.89	1
Available P%	0.14	0.21	0.3	0.4	0.51
Na%	0.17	0.17	0.17	0.17	0.17
Met+cys%	0.91	0.91	0.91	0.91	0.91
Lys%	1.59	1.59	1.42	1.58	1.6
Threonin%	1.03	1.03	1.04	1.02	1.03
Arg%	1.86	1.86	1.89	1.85	1.87

[1]Mineral premix supplied /kg diet: Cu, < 15 mg; Fe, 70 mg; Zn, < 100 mg; Mn, 80 mg; Se,0.15 mg; Co, 0.50 mg; Pb, 50 ppm; Cd,10 ppm; Hg,0.5 ppm; I < 20 mg. [2]Vitamin premix supplied /kg diet: vitamin A, 15.00 MIU; vitamin D3 (cholecalciferol), 2.50 MIU; vitamin E, 40 mg; vitamin B_1 (thiamine), 3 mg, vitamin B_2 (riboflavin), 6 mg; vitamin B_6 (pyridoxine), 4 mg; vitamin B_{12}, 0.04 mg; vitamin PP (niacin), 30 mg; pantothenic acid, 16 mg; vitamin H (biotin), 0.12 mg; vitamin M (folic acid), 1 mg

The bird management was based on the guidelines of the Consortium Guide (1988). Feed samples were dried at 60°C to a constant weight, ground through a 1-mm sieve and wet-ashed with mixture of HNO_3, H_2SO_4 and $HClO_4$ (3:1:1, vol/vol/vol). The concentrations of Ca , P and phytate P in feed and excreta samples were determined in duplicate according to AOAC (1990); Ca was measured at 422nm by an atomic absorption spectrophotometer (Z-5000 polarized Zeeman, Hitachi Instruments, Inc., USA) P at 400nm by a spectrophotometer (U-2001, Hitachi instruments, Inc., USA) and phytate P is determined according to Latta and Eskin (1980).The experimental data were subjected to analysis of variance by the GLM procedure of SAS (SAS Institute, 1991) in a completely randomized design. Pen means were used as the experimental unit. Duncan's multiple range test (Duncan, 1995) was used to determine significance of differences among means at $P< 0.05$.

RESULTS AND DISCUSSION

Feed consumption, body weight gain and feed conversion ratio of broiler quails at 1, 2 or 3 wk of age are presented in Table 2. Different ratios of Ca and P had no significant effect of feed consumption of birds at any stage of experimental period. Furthermore, these ratios did not show any significant influence on body weight gain at first week of rearing period. However, there is pronounced differences ($P< 0.05$) in body weight gain of chicks among treatments at second and third week of age and Ca:tP ratio of 1.96 showed lowest weight gain compared to other groups of experiment at 2 and 3 week of age, but between Ca:tP ratios of 1.81 and 1.66 (NRC recommendation ratio) there was no significant differences in weight gain. Similar to this result, body weight gain of broiler chicken decreased significantly at high ratio of Ca and aP (Edwards, 1982; Qian *et al*., 1997).Some possible reasons for reduction of body weight gain are assumed: 1) insufficient supply of phosphorus in the ration to meet P requirement. 2) Decreasing in solubility of minerals complexes as a result of increased ileal pH by the relatively high concentration of calcium as mentioned by Shafey *et al*. (1999). Improved ($P< 0.05$) feed conversion ratio was only observed at 3 wk of age. This result agrees with the finding of Vandepopuliere *et al*. (1961) who reported better performance from chicken provided on a diet with a Ca:tP ratio of 1:1 compared to those fed with 2:1 ratio. Retention of Ca, P and phytate P at 3 week of age are presented in Table 3. Ratios of Ca:tP (1.96 and 1.81) increased ($P< 0.05$) the retention of P compare to other treatments while ratio of 1.96 decreased ($P< 0.05$) the retention of Ca and phytate P. These results were similar to those obtained by Um and Paik (1999) in laying hens and Keshavarz (2000), Ravindran *et al*. (2000) and Viveros *et al*. (2002) in broiler chickens. Higher retention of P in wide Ca:tP ratio could be depend on greater ability of birds to retain P from diet with lower rather than higher aP. For Ca, a possible explanation could be that the higher content of Ca relative to P caused an increase of intestinal pH and reduced the soluble fraction of minerals in the chicken (Shafey, 1993)

Table 2: Effect of treatment diets on Feed Intake (FI), Body Weight Gain (BWG) and Feed Conversion Ratio (FCR) of broiler quails over three weeks of age

Parameters	Diet 1 Ca:tP = 1.96	Diet 2 Ca:tP = 1.81	Diet 3 Ca:tP = 1.66	Diet 4 Ca:tP = 1.53	Diet 5 Ca:tP = 1.39	S.E.M	P
FI (g)							
Wk 1	27.09	26.27	26.76	27.3	27.43	1.5	0<001
Wk 2	96.37	92.63	103.34	100.65	100.81	11.6	0<001
Wk 3	146.3	148.89	148.77	152.04	152.2	12.1	0<001
BWG (g)							
Wk 1	18.62	19.00	19.20	19.28	19.32	1.7	0<001
Wk 2	44.14^{b}	46.27^{a}	47.09^{a}	46.79^{a}	48.20^{a}	2	0<001
Wk 3	54.31^{c}	57.66^{b}	57.60^{b}	59.02^{b}	63.26^{a}	3.2	0<001
FCR							
Wk 1	1.45	1.38	1.39	1.41	1.42	0.1	0<001
Wk 2	2.18	2.00	2.08	2.15	2.09	0.19	0<001
Wk 3	2.69^{a}	2.61^{a}	2.58^{a}	2.61^{a}	2.40^{b}	0.2	0<001

^{a,b,c} Means with different superscripts in the same row differ significantly, p<0.05, S.E.M: Pooled standard error of mean. P: possibility

Table 3: Effect of treatment diets on Ca, P and phytate P retention of broiler quail at 21 d of age

Parameters	Diet 1 Ca:tP = 1.96	Diet 2 Ca:tP = 1.81	Diet 3 Ca:tP = 1.66	Diet 4 Ca:tP = 1.53	Diet 5 Ca:tP = 1.39	S.E.M	P
Phosphorus Retention (%)	60.2^{a}	57.07^{a}	51.09^{b}	49.16^{b}	48.38^{b}	5.5	0<001
Calcium Retention (%)	47.24^{c}	49.73^{b}	52.41^{b}	54.77^{ab}	55.83^{a}	2.8	0<001
Retention of phytate P (%)	32.03^{c}	36.71^{b}	37.17^{b}	37.94^{b}	40.00^{a}	1.3	0<001

^{a,b,c,d}Means with different superscripts in the same row differ significantly, p<0.05, S.E.M: Pooled standard error of mean, P: possibility

or that the decreased retention of minerals was related to bone mobilization to maintain serum P and excretion of excess Ca and other minerals (Viveros *et al*., 2002). Also other reason might be that the higher content of Ca relative to P in corn soy bean diet which contain over 65% phytate P induce formation of Ca phytate and increased excretion of this mineral by this way.

In conclusion, among all Ca:tP ratios applied in present investigation, ratio of 1.81 (with Ca and tP levels of 0.71 and 0.37) improved some important criteria such as retention of P and phytate P that shows this ratio which also is low in Ca and P by 10% and 30% could be selected as the appropriate one in broiler quails over 3 week of age to improve retention of P and phytate P and reduce the excretion of P (total of phytate) to the environment.

REFERENCES

AOAC, 1990. Official Methods of Analysis. 15th ed. Washington, D.C. USA.

Consortium, 1988. Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching. Division of Agriculture, NASULGC (National Association of State University and Land-Grant Colleges Consortium) Publication. Champaign. IL.USA.

Correll, D.L., 1999. Phosphorus: a rate limiting nutrient in surface waters. Poult. Sci., 78: 674-682.

Duncan, D. B., 1995. Multiple range and multiple F-test. Biomet., 11: 1-42.

Edwards, H.M. Jr., 1982. Phosphorus and calcium for broilers. Proceeding of Georgia Nutrition Conference. 161-167.

Keshavarz, K., 2000. Reevaluation of nonphytate phosphorus requirement of growing pullets with and without phytase. Poult. Sci., 8: 1143-1153.

Latta, M. and M. Eskin, 1980. A Simple and Rapid Colorimetric Method for Phytate Determination. J. Agric. Food Chem., 28: 1313-1315.

Mohammed, A., M.J. Gibney and T.G. Taylor, 1991. The effects of dietary levels of inorganic phosphorus, calcium and cholecalciferol on the digestibility of phytate-P by the chick. Br. J. Nutr., 66: 251.

National Research Council, 1994. Nutrient Requirements of Domestic Animals. Nutrient Requirements of Poultry, 9th revised edition. National Academy of press, Washington, D.C.

Oberleas, D. and F. Harland, 1996. Impact of phytic acid on nutrient availability. In Phytase in animal nutrition and waste management (ed. M. B. Coelho and E. T. Kornegay), pp. 77-84. BASF, Mount Olive, NJ.

Qian, H., E.T. Kornegay and D.M. Denbow, 1997. Utilization of phytate phosphorus and calcium as influenced by microbial phytase, cholecalciferol and the calcium:total phosphorus ratio in broiler diets. Poult. Sci., 76: 37-46.

Rama Rao, S.V., M.V.L.N. Raju, M.R. Reddy and P. Pavani, 2006. Interaction between dietary calcium and non-phytate phosphorus levels on growth, bone mineralization and mineral excretion in commercial broilers. Anim. Feed Sci. and Tech., 131: 133-148.

Ravindran, V., S. Cabahug, G. Ravindran, P.H. Selle and W.L. Bryden, 2000. Response of broiler chickens to microbial phytase supplementation as influenced by dietary phytic acid and non-phytate phosphorus levels. II. Effects on apparent metabolisable energy, nutrient digestibility and nutrient retention. Br. Poult. Sci., 41: 193-200.

SAS Institute, 1991. SAS Stat User's Guide Release 6.08. SAS Institute Inc., Cary. NC.

Shafey, T.M., 1993. Calcium tolerance of growing chickens: Effect of ratio of dietary calcium to nonphytate phosphorus. Worlds Poult. Sci. J., 49: 5-18.

Shafey, T. M., J. G. Dingle and K. Kostner, 1999. Effect of dietary "-tocopherol and corn oil on the performance and on the lipoproteins, lipids, cholesterol and tocopherol concentrations of the plasma and eggs of laying hens. J. Appl. Anim. Res., 16: 185-194.

Sharpley, A., 1999. Agricultural phosphorus, water quality and poultry production: are they compatible. Poult. Sci., 78: 660-673.

Simons, P.C.M., H.A.J. Versteegh, A.W. Jongbloed, P.A. Kemme, P. Stump, K.D. Bos, M.G.E. Wolters, R.F. Beudeker and G.J. Verschoor, 1990. Improvement of phosphorus availability by microbial phytase in broilers and pigs. Br. J. Nutr., 64: 525-540.

Um, J.S. and I.K. Paik, 1999. Effects of microbial phytase supplementation on egg production, eggshell quality, and mineral retention of laying hens fed different levels of phosphorus. Poult. Sci., 78: 75-79.

Vandepopuliere, J.M., C.B. Ammerman and R. M. Harms, 1961. The relationship of calcium phosphorus ratios to the utilization of plant and inorganic phosphorus by the chick. Poult. Sci., 40: 951-957.

Viveros, A., Brenes, A., I. Arija and C. Centeno, 2002. Effects of microbial phytase supplementation on mineral utilization and serum enzyme activities in broiler chicks fed different levels of phosphorus. Poult. Sci., 81: 1172-1183.