Annals of Agric. Sci., Moshtohor **ISSN 1110-0419**
Vol. 57(1) (2019), 59 – 66 **http://aasj.bu.edu.eg/index.php**

Effect of Dietary Phytase Enzyme Supplementation on Growth Performance and Some Blood Parameters of Japanese Quails

Maha M. Arafa[1] , Gaafar M. El- Gendi[2], Osama. H. El-Garhy[3]*
[1,2,3] *Animal Production Department, Faculty of Agriculture, Benha University, Egypt*
*** Corresponding author:** osama.alsayed@fagr.bu.edu.eg

Abstract

This study was conducted to investigate the effect of dietary supplementation of phytase enzyme on growth performance and some blood parameters of Japanese quails. A total number of 200 one day old Japanese quail chicks with nearly similar initial average weight were used in this study. Chicks were randomly distributed into four experimental groups each of 50 birds. Chicks of the 1st experimental group were fed basal diet and considered as control group. Chicks of the 2nd, 3rd and 4th experimental groups were fed the basal diets supplemented with PHE at a levels of 25, 50 and 75 g/ton diet, respectively. Results obtained showed significant variations ($p<0.05$) in averages live body weight (LBW), body weight gain (BWG), growth rate (GR), feed intake (FI) and conversion (FC), mortality rate (MO), performance index (PI), absolute weight of carcass and giblets due to dietary phytase applied. The highest significant improvement in LBW, BWG, GR, FC, PI, carcass traits, REE and lower mortality rate were showed by quail chicks fed diet supplemented with phytase enzyme at a level of 50 and 75 g/ton diet, respectively, followed by those fed diet supplemented with 25 g phytase enzyme /ton when compared with control group. Chicks fed diet supplemented with 50 and 75 g phytase/ton diet , respectively significantly increased plasma total protein, globulin, calcium and inorganic phosphorus and decreased plasma ALT, creatinine, uric acid and plasma cholesterol compared with the other level of phytase and control group. It could be recommended to use phytase enzyme at a level of 50 and 75 g/ ton diet, respectively to improve the productive, metabolic performance and economical efficiency of Japanese quail.

Key words: quails, phytase enzyme, productive traits, plasma

Introduction

Japanese quail (***Coturinx coturnix japanica***) is the smallest avian species raised for meat and egg production (**Panda and Singh, 1990**). It has worldwide importance as a laboratory animal (**Bauagartner, 1990**). Rapid growth enables quail to be marketed for consumption at 5th -6th week of age. Early sexual maturity resulting in a short generation interval, high rate of lay and much lower feed and space requirements are considered distinct characteristics of Japanese quail. Thus, the meat type quail rearing is common practice to bridge a gap between present demand and supply of animal protein. The efficiency of broiler quails to convert the feed into meat, play a key role in economics of broiler industry. Therefore, it is highly essential to improve feed efficiency of quails to produce meat economically.

The extent to which dietary phytate influences performance and nutrient utilization of intensively farmed livestock has received considerable attention in the scientific literature in recent years. Initially, phytate was considered to be a nutritional diluent, exerting its effects via a reduction in the solubility, and thus availability, of phosphorus (p) and, to a lesser extent, calcium (Ca^{++}) **(Simons *et al*., 1990)**. Recent evidence suggests that the ingestion of phytate can have a substantial effect on digestive physiology, modifying secretion and absorption dynamics **(Liu *et al*., 2008)**.

El-Deek *et al*. (2009) study the effect of feeding different levels of corn gluten meal (CGM) with or without phytase supplementation at 500 FTU/kg for 7 to 42 days of age of broiler. The result obtained revealed that dietary phytase significantly increased ($p<0.01$) the body weight.

Rajpoot (2009) noted that increase in body weight in treated group by phytase as compared to control group. **Amin and Hamidi (2013**) concluded that the level of phytase enzyme did not affect ($P<0.05$) body weight of hens.

Johnson *et al*. (2014) revealed that the average weekly gain of the broiler was improved by increasing levels of dietary microbial phytase content at 7-14 days, in which chicks fed with respectively activity levels of 0, 500, 1500, and 4500 FTU phytase unit, supplemented through feed.

Aureli *et al*. (2011) reported that increased phytase supplementation from 500 to 2000 u/kg resulted in a significant improvement of the feed conversion ratio compared to negative control diet. **Santos *et al*. (2013)** revealed that, 500 ftu/kg inclusion of phytase in an available p adequate diet and 1,000 and 5,000 ftu/kg inclusion of phytase in a Marginally deficient diet improved FCR of birds compared with birds fed a diet meeting the available p and ca requirement.

The aim of this study was to evaluate the effect of dietary supplementation of phytase enzyme as feed additives on growth performance and some blood parameters of Japanese quail (*Coturinx coturnix japanica*).

Materials and Methods

This study was carried out at private farm at Moshtohor, El-Qalubia Governorate, Egypt during the period from 25 September to 5 November 2017. The chemical analyses were conducted at the laboratories of animal production department, faculty of Agriculture, Benha University.

Birds and their management:

A total number of 200 one day old Japanese quail chicks of a nearly similar live body weight were (8.69g) used in this study. Chicks were kept under similar standard hygienic and environmental conditions in separate pens with 80 birds/m^2 stocking density until the end of the experiment. Wood shaving was used at 10 cm depth as a litter. Floor brooder with gas heaters were used for brooding chicks. Brooding temperature was maintained at 37ºC during the first 5 days of chick's age then decreased by 2ºC weekly until the end of the brooding period (4 weeks) thereafter, normal temperature with natural ventilation was applied up to 42 days of age. Feed and water were offered ad-libitum, chicks were fed basal diet as shown in (Table, 1) was formulated according to the recommended requirement of **NRC (1994).**

Table 1. Composition and calculated analysis of basal diet,

Ingredients	%
Yellow corn	56.00
Soybeans meal (44%)	27.00
Corn gluten (60%)	12.00
di-calcium phosphate	1.70
Calcium carbonate	1.35
Salt	0.25
Broiler premix*	0.30
DL. methionine	0.20
Lysine	0.30
Total	100.00
Calculated analysis	
Me(kcal/kg)	2948.3
Cp (%)	24.39
Calcium	0.97
Available phosphorus (%)	0.45

* Eash 3.0 kg of broiler premix manufactured by Agri-Vet company, Egypt Contains: Vit. A, 12000000 IU; Vit. D3 2000000 IU; Vit. E, 10 g; Vit. K3, 2.0 g; Vit. B1, 1.0 g; Vit. B2, 5 g; Vit, B6, 1.5 g; Vit, B12, 10 mg; choline chloride, 250 g; biotin, 50 g; folic acid, 1 nicotinic acid, 30 g; pantothenate, 10g; Zn, 50 g; Cu, 10 g; Fe, 30 g; Co, 100 mg; Sem, 100 mg; I, 1 g; Mn, 60 g and anti – oxidant, 10 g, and complete to 3.0 kg by calcium carbonate.

Grouping birds and experimental design:

Chicks were randomly distributed into four experimental groups each of 50 birds. Chicks of the 1st experimental group were fed on the basal diet and considered as the control group. Chicks of the 2nd, 3rd and 4th experimental groups were fed the basal diet supplemented with PHE (Natuphos which considered as phytase enzyme in form of powder and contains 10000 FTU (3 phytase)/kg, at a levels of 25, 50 and 75 g/ton diet, respectively.

Data collection and estimated traits.

Live Body Weight, Body Weight Gain and Growth Rate:

Live body weight (LBW) was obtained by weighing the birds individually to the nearest gram at the beginning and at the end OF the experimental period. Weight gains and growth rate were calculated according to **Broody (1949).** Feed intake was measured weekly and feed conversation ratio was calculated during the studied period. Performance index was calculated according to **North (1981)**, mortality rate and economical efficiency were also calculated

Slaughter and carcass traits

At the end of the experimental period (6 weeks) five birds from each experimental treatment were randomly taben . The assigned birds were deprived of feed for 16 hours prior to slaughter. Eviscerated weight, giblets (liver, gizzard and heart), total edible parts (carcass and giblets). Proportional weights to live body weight were then calculated.

Blood parameters:

At slaughtering heparinzed blood samples were collected and centrifuged at 3500 rpm for 15 minutes. Separated Plasma produced was transferred and stored in the deep freezer at approximately -20ºC till the time of chemical analysis of plasma total protein, albumin, globulin, triglycerides, cholesterol, creatinine, uric acid, calcium, inorganic phosphorus, asparatate aminotransferase (AST) and alanine aminotransferase (ALT).

Statistical analysis

Analysis of variance was calculated on all data obtained using the general Linear Models Procedures **(SAS, 2004).** Significant differences between treatments means were determined using Duncan New Multiple-Rang test **(Duncan, 1955).**

The statistical analysis for studied traits was carried out according to the following linear model:

$X_{ij} = \mu + T_i + e_{ij}$

Whereas:

X_{ij} = the Nth observations

μ = the overall mean

T_i = the effect of the ith treatments

e_{ij} = random error assumed to be independently and randomly distributed

Results and Discussion

Live body weight (LBW), body weight gain (BWG) and growth rate (GR):

The results obtained in Table (2) showed significant effect on averages of LBW, BWG and GR of quail birds at the end of the experiment (6th week of age) due to feeding on diets supplemented with different levels of phytase enzyme compared to control. The highest improvement in LBW, BWG and GR were found in chicks fed diet supplemented with phytase enzyme at a level of 50 g/ton diet than those fed diets supplemented with phytase enzyme at a level of 75 and 25 g/ton diet, respectively. While, the lowest averages of LBW, BWG and GR were showed by birds fed diet without additive (control). The improvement of body weight due to phytase supplementation may be due to involved phytase in strengthening of the immune system by enhancing immunocyte activity and inhibiting pathological calcification. The results obtained disagree with those reported by **Amin and Hamidi (2013) . they** concluded that the level of phytase enzyme did not affect (p<0.05) body weight of hens. The results obtained agree with those of **Lelis *et al.* (2012)** who revealed that improvement in the body weight gain in the broiler birds with supplementation of phytase enzyme added in the basal diet of the broiler. Moreover, **Baker *et al.* (2007)** who showed that the phytase supplementation to LPC based diet had a positive impact on growth performance of broiler chicken.

Table 2. Least–square means and standard error (X±S.E) of LBW, BWG and GR of Japanese quail as affected by dietary phytase levels

Phytase level (g/ton diet)	Live body weight (g)		Body weight gain (g) during 0-6 wks	Growth rate (%) during 0-6 wks
	at hatch	at 6 wks		
0	8.71±0.13	232.5±0.11^d	223.8±0.004^d	185.4±0.19^c
25	8.34±0.13	279.0±0.10^c	270.7±0.004^c	188.3±0.19^a
50	8.68±0.13	293.0±0.10^a	284.3±0.004^a	188.4±0.19^a
75	9.06±0.13	281.0±0.10^b	271.9±0.004^b	187.5±0.19^b

Mean having similar letters in each column are not significantly different (P<0.05).
A,b,c means with different letter in the same column are significantly different . (P<0.05)

Feed intake (FI) and conversion (FC)

Significant variations (P<0.05) were found in FI and FC due to feeding diets supplemented with different levels of phytase enzyme. (Table, 3). Quail birds fed diet supplemented with different levels of phytase enzyme showed lower averages of FI and higher improve in FC compared to control. Moreover, quail chicks fed on diets supplemented with phytase enzyme at a level of 50 g/ton diet showed lower average of FI (17.0 g/bird /day) and higher improve in FC (2.50 g feed/g gain) during the whole period of the experiment (0-6 wks) compared with the other levels of phytase and control group. However, the higher FI and lower FC was observed by chicks of control group (21.0 g/bird/day and 4.0 g feed /g gain, respectively). This may be due to improving intestinal digesion and absorption mucosal immunity by enhancing nutrient uptake for the intestinal immune cells and improving mucin integrity**.** These results were agree with those reported by **Adeola (2005)** who stated revealed that the phytase enzyme had significant (p<0.05) effect on feed intake as compared to control group.

Table 3. Least–square means and standard error (X±S.E) of feed intake and feed conversion of Japanese quail as affected by dietary phytase levels.

Phytase level (g/ton diet)	Feed intake (g/bird/day) during 0-6 WKs	Feed conversion (g feed/ g gain) during 0-6 WKs
0	21.0±0.7^a	4.0±0.29^a
25	18.0±0.7^b	2.8±0.29^b
50	17.0±0.7^b	2.5±0.29^b
75	18.0±0.7^b	2.8±0.29^b

Mean having similar letters in each column are not significantly different (P<0.05).
A,b,c means with different letter in the same column are significantly different . (P<0.05)

Mortality rate (MR) and performance index (PI):

Data presented in table (4) showed that chicks fed on diets supplemented with phytase enzyme had significantly decreased average mortality rate (MR) compared to control group. The lowest MR (2.0%) was observed by quail chicks fed diet supplemented with phytase enzyme at a level of 75 g/ton diet, followed by those fed diet supplemented with 25 and 50 g/ton diet (4.0 and 4.0 %, respectively), compared with control group (21.0 %). Concerning to the effect of phytase enzyme on performance index (PI), it is clearly observed that quail chicks that fed diet supplemented with 50 g/ton showed the higher average of PI mounted 11.72 %, followed by those fed diet supplemented with 75 g/ton diet (10.04 %), then by those fed diet supplemented with phytase enzyme at a level of 25 g/ton diet (9.96 %) compared with control group (5.81 %). Mortality in the current study was low; the relatively poor immune parameters for birds fed diets without phytase addition, or for birds receiving the diet with a low concentration of phytase, may be a consequence of the sub-nutritional status of those birds. The results obtained disagree with those reported by **Walk *et al.* (2012)** who found that broiler chicken fed on diet supplemented with 5000 FTU/kg of phytase had significantly increased (P≤ 0.05) mortality percent compared with those fed diet without phytase supplementation.

Table 4. Least–square means and standard error (X±S.E) of mortality rate and performance index of Japanese quail as affected by dietary phytase levels

Phytase level (g/ton diet)	Mortality (%) during 0-6 WKs	Performance index (%) during 0-6WKs
0	8.0 ± 0.57^{a}	5.81 ± 1.7^{d}
25	4.0 ± 0.57^{b}	9.96 ± 1.8^{c}
50	4.0 ± 0.57^{b}	11.72 ± 1.84^{a}
75	2.0 ± 0.57^{c}	10.04 ± 1.8^{b}

Mean having similar letters in each column are not significantly different (P<0.05).
A,b,c means with different letter in the same column are significantly different . (P<0.05)

Carcass traits:

Significant variations were found in absolute carcass weight, absolute and relative giblets weight due to phytase enzyme levels supplementation. Chicks fed diet supplemented with phytase enzyme at a level of 50 g/ton diet showed the highest absolute weights of carcass (213.5 g), giblets (14.6 g) and total edible parts (228.1 g) compared to the other levels and control group(Table, 5). The results obtained disagree with those reported by **Bharathidasan and Chandrasekaran (2000)** they showed that the commercial multi-enzyme preparations (cellulose-145.84 IU/g, xylanase-241.35 IU/g and phytase – 32.95 IU/g), when given to broilers in feed (500 g/ton) had no effect on carcass yield, weight of visceral organs, dressing percentage and intestinal length.

Table 5. Least–square means and standard error (X±S.E) of carcass traits of Japanese quail as affected by dietary phytase levels

Phytase level (g/ton diet)	Live body weight	Carcass		Giblets		Total edible parts	
	(g)	(g)	(%)	(g)	(%)	(g)	(%)
0	242.2 ± 15.4^{b}	181.5 ± 9.6^{b}	74.7±3.2	12.6 ± 1.3^{b}	5.1 ± 0.46^{a}	194.1±10.4	79.9±3.4
25	279.0±15.4	205.5 ± 9.6^{ab}	73.9±3.2	12.0 ± 1.3^{b}	4.3 ± 0.46^{b}	217.5±10.4	78.3±3.4
50	293.2±15.4	213.5 ± 9.6^{a}	73.3±3.2	14.6 ± 1.3^{a}	5.0 ± 0.46^{a}	228.1±10.4	78.4±3.4
75	281.0±15.4	203.2 ± 9.6^{ab}	72.6±3.2	10.9 ± 1.3^{c}	3.8 ± 0.46^{c}	214.1±10.4	76.5±3.4

Mean having similar letters in each column are not significantly different (P<0.05).
A,b,c means with different letter in the same column are significantly different . (P<0.05)

Plasma total protein, albumin (A), globulin (G) and A/G ratio:

Data presented in Table (6) showed insignificant differences (p<0.05) in averages of plasma total protein, albumin and A/G ratio. While significant difference was found in plasma globulin only due to applying of phytase enzyme levels. Birds fed diet supplemented with phytase at a level of 50 g/ton diet showed the highest levels of plasma total protein (3.67 g/dl) and globulin (2.11 g/dl), while birds of control group showed the highest values of plasma albumin (1.56 g/dl) and A/G ratio (1.09) followed by those fed diet supplemented with 25 g phytase/kg diet compared with different treatments applied.

Table 6. Least–square means and standard error (X±S.E) for protein fractions in quails as affected by dietary phytase levels

Treatments	Level (/kg diet)	Total protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	A/G Ratio
Control	0	3.56±0.34	1.75±0.24	1.80±0.26[b]	1.09±0.20
Phytase (g)	25	3.24±0.34	1.56±0.24	1.68±0.26[c]	1.07±0.20
	50	3.67±0.34	1.55±0.24	2.11±0.26[a]	0.75±0.20
	75	3.02±0.34	1.30±0.24	1.72±0.26[bc]	0.83±0.20

Mean having similar letters in each column are not significantly different (P<0.05).
A,b,c means with different letter in the same column are significantly different . (P<0.05)

Plasma aspartate aminotransfers (AST), alanine aminotransfers (ALT), creatinine and uric acid:

Data presented in table (7) showed significant differences (p<0.05) in plasma (AST) and (ALT) enzymes due to applying phytase enzyme levels. Birds of control group and those fed diet supplemented with phytase at a level of 50 g/ton diet showed significant the lowest levels of plasma (AST) 203.0 and ALT 26.7 U/L, compared with birds fed diet supplemented with different levels of phytase. However, birds fed diet with 75g phytase/ton diet and those of control group significantly decreased plasma ALT, respectively, compared with different levels applied. Results obtained go in agreement with those reported by **Viveros *et al.* (2002)** who noted that microbial phytase supplementation to broiler chicke fed low P-diets, increased aspartate aminotransferase (AST) activity, reduced plasma serum alanine aminotransferase (ALT).In addition, significant differences (p<0.05) were found in plasma creatinine and uric acid due to feeding diets supplemented with phytase enzyme levels. Quail chicks fed diet supplemented with phytase at a level of 50 and 25 g/ton diet showed the lowest levels of plasma creatinine (0.19 mg/dl) and uric acid (5.40 mg/dl), followed by those fed diet with phytase at a level of 25 and 50 g/ton diet for plasma creatinine and uric acid, respectively when compared with different treatments applied.

Table 7. Least–square means and standard error (X±S.E) for plasma AST and ALT in quail as affected by dietary phytase level.

Phytase enzyme g/ton diet	AST (U/L)	ALT (U/L)	Creatinine (mg/dl)	Uric acid (mg/dl)
0	203.0±33.4[c]	27.0±5.2[c]	0.27±0.07[a]	6.05±0.76[b]
25	298.0±33.4[a]	40.7±5.2[b]	0.25±0.07[a]	5.40±0.76
50	232.7±33.4[b]	46.2±5.2[a]	0.19±0.07[b]	5.57±0.76
75	283.2±33.4[a]	26.7±0.42[c]	0.27±0.07[a]	6.32±0.76

Mean having similar letters in each column are not significantly different (P<0.05).
A,b,c means with different letter in the same column are significantly different . (P<0.05)

Plasma cholesterol, triglycerides, calcium and inorganic phosphorus:

Data presented in table (8) showed that birds of control group and those fed diet supplemented with phytase at a level of 75/ton diet showed significantly the lowest levels of cholesterol 2.08 and 213.2 mg/dl, respectively while birds of control group and those fed diet with phytase at a level of 25 g/kg diet showed the lowest value of plasma triglycerides (293 and 352 mg/dl), respectively compared with different treatments applied. On other hand, birds received 50 g phytase/kg diet showed significantly the highest values of plasma cholesterol and triglycerides. The results obtained disagree with those reported by **El-Deek et al. (2009)** who revealed that dietary phytase positively increased (p<0.05) total plasma protein without showing any significant effect on plasma total lipids or cholesterol.

Highly significant effect (p<0.05) was found in plasma calcium level only due to feeding on phytase enzyme levels. Quail chicks fed diet supplemented with phytase at a level of 50/ton diet showed the highest averages of plasma calcium (11.5) and inorganic phosphorus (5.4 mg/dl), followed by those fed 75 g phytase/ton diet (9.5 mg/dl) and (4.8 mg/dl) for plasma calcium and inorganic phosphorus, respectively, when compared with birds received 25 g phytase/ton and control group. The results obtained go in harmony with those stated by **Kanagaraju et al. (2000)** who reported a significant increase in serum calcium, Phosphorus and alkaline phosphatase after phytase (750 U/kg) supplementation in broilers. Also, **Jain (2008)** noted that the serum calcium, phosphorus, level increased significantly in treatment groups with deferent levels of phytase as compared to control.

Table 8. Least–square means and standard error (X±S.E) for plasma cholesterol, triglycerides, calcium and inorganic phosphorus in quail of as affected by dietary phytase level.

Treatments	Level (/kg diet)	Cholesterol (mg/dl)	Triglycerides (mg/dl)	Calcium	Inorganic Phosphorous
Control	0	208.2±27.4^{b}	293.0±13^{c}	9.3±1.2^{b}	4.4±0.5
Phytase (g)	25	223.2±27.4^{b}	352.0±13^{bc}	8.2±1.2^{b}	4.0±0.5
	50	242.2±27.4^{a}	665.0±13^{a}	11.5±1.2^{a}	5.4±0.5
	75	213.2±27.4^{b}	402.8±13^{b}	9.5±1.2^{b}	4.8±0.5

Mean having similar letters in each column are not significantly different (P<0.05).
A,b,c means with different letter in the same column are significantly different . (P<0.05)

Economical efficiency:

The result obtained in (Table, 9) revealed that quail chicks fed diet supplement with different levels of phytase showed higher economical efficiency (EE) and relative economical efficiency (REE) than control group. the highest (REE) were recorded by quails fed diet supplemented with phytase at a level of 50 and 25 g/ton diet mounted 262.36 and 216.39%, respectively compared with the other treatment applied and control group which considered (100.0%). From these result, it could be concluded that the improving in REE of birds which fed diets supplemented with different levels of phytase may be attributed to the beneficial effects as a growth promoters on the productive performance of quails which consequently reflected on the increasing values of EE and REE. These results were agreed with those stated by **Ponnuvel *et al.* (2013)** who reported that increased net profit was recorded among various phytase supplemented dietary treatment when compared with standard layer diet.

Table 9. Effect of dietary phytase levels on economical efficiency of Japanese quail.

Phytase Levels (g/ton diet)	Economical efficiency							
	Total feed intake (g/bird)	Total feed costs L.E	Other costs 30% L.E	Total cost L.E	Price of one bird L.E	Net revenue L.E	Economical efficiency (EE)	Relative economical efficiency (REE)
0	0.882	6.62	1.98	8.60	10.00	1.40	0.16	100.00
25	0.756	5.69	1.71	7.39	10.00	2.61	0.35	216.39
50	0.714	5.39	1.62	7.00	10.00	3.00	0.43	262.36
75	0.756	5.72	1.72	7.44	10.00	2.65	0.34	211.59

Net revenue/chick (pt.) = total revenue/g gain (pt.) – total feed cost/chick (pt.)
EEf = net revenue/chick (pt.)/total feed cost/chick (pt.)
Price of 1kg phytase = 500 L.E
Price of 1kg probiotic = 210 L.E
Price of 1kg Chamomile powder = 40L.E
Price of 1kg feed = 7.5 L.E
Price of one bird = 10 L.E

References

Adeola R.G and Adebayo O.O (2005). Socio-Economics Factors Affecting Poultry Farmers in Ejigbo Local Government Area of Osum State. J. Hum. Ecol., 18(1): 39-41.

Amin, M.D.R and Elliyana, N.B.T.H. (2013). Effect of phytase supplemntatin on the performance of babcock – 308 layer hens. Journal of Tropical Resources and Sustainable Science, 1(1): 36-41.

Aureli, R.; Umar Faruk, M.; cechova, I.; Pedersen, P.B.; Elvig– Jergensen, S.G.; Fru, F. and Broz, J. (2011). International Journal of Poultry Science, 10(2): 160-168.

Baker, N.J.; Parson, A.S. and Mortiz, J.S. (2007). Effect of various phytase concentrations in diet with low-phytase corn on broiler chicks performance and performance and nutrient use. International Journal of Poultry Science, 6(2): 77-84.

Bauagartner, J. (1990). Japanese quail as laboratory animal (in Slovak). Publishing House of Slovak Academy of Science, Bratislava.

Bharathidasan, A. and Chandrasekaran, D. (2000). Enzyme supplementation on performance of broiler. In:XX Annual Conference and Symposium of Indian Poultry Science Association, 12-14, Oct. 2000. Chennai. pp. 127.

Broody, S. (1949). Biomergetic and growth. Reinhold publication ctop. New York, NY.

Duncan, D.B. (1955). Multiple ranges and multiple tests. Biometric, 11: 14.

El-Deek, A.A.; Osman, M.; Yakot, H.M. and Yahya, E. (2009). Response of broilers to microbial phytase supplementation as influenced by dietary corn gluten meal levels. Egypt. Poult. Sci., 29(1): 77-97. http:/www.google.com.

Jain, A. (2008). Biochemical and haematological parameters in broilers. Indian J. Anim. Nutr., 25(3): 285-287.

Johnson, L.A.; Deep, A. and Classen, H. (2014). Digestability and performance responses of broiler chickens fed a pea-based diet with different levels of dietary microbial phytase. University of Saskatchewan Undergraduate Research Journal, 1(1): 39-44.

Kanagarju, P.A.; Jalaludeen, A. and Anitha, P. (2000). Effect of microbial phytase on retention of calcium and phosphorus in broilers. XX Annual conference and symposium of India Poultry Science Association, 12-14 Oct. 2000. Chennai. Pp. 115.

Lelis, G.R.; Albino, L.F.T. and Calderano, A.A. (2012). Diet supplementation with phytase on performance of broiler chicken. Brazilian Journal of Animal Science. 41: 929-933.

Liu, N.; Ru, Y.J.; Li, F.D. and Cowieson, A.J. (2008). Effect of diet containing phytase and phytase on the activity and messenger ribonucleic acid expression of carbohydrase and transporter in chickens. J. Anim. Sci 86: 3432-3439.

North, M.O. (1981). Commercial chicken production manual. Avi publishing company. INC, West port. Connecticut, USA.

NRC (1994). National Research Council. Nutrient Requirements of Poultry. National Research Council, National Academy Press, Washington, D.C., 9th Revised Editionز

Panda, B. and Singh, P.P. (1990). Development in processing quail meat and egg. Worlds Poultry Sci. J., 46: 219-234.

Ponnuvel, P.; Narayanankutty, K.; Jalaludeen, A. and Anitha, P. (2013). Economics of phytase enzyme supplementation in low energy-protein layer chicken diet. Academic Journal, 5(7): 113-116.

Rajpoot, J.S. (2009). Comparative studies on use of multi-enzymes through drinking water and feed in broilers. M.V.Sc and A.H. Thesis, JNKVV, Jabalpur, (M.P.).

Santos T.T.dos; Srinongkote, S.; Bedford; M.R. and Walk, C.L. (2013). Effect of high phytase inclusion rates on performance of broiler fed diets severely limited in available phosphorus, Asian-Aust. J. Anim. Sci., 26(2): 227-232.

SAS Institute (2004): SAS User's Guide. Release 8.2. Ed. SAS Institute Inc. Cary. NC.

Simons, P.C.M.; Versteegh, H.A.J.; Jongbloed, A.W. Kemme, P.A.; Slump, P.; Bos, K.D.; Wolters, M.G.E.; Beudeker, R.F. and Verschoor, G.J. (1990). Improvement of phosphorus availability of microbial phytase in broilers and pigs. British Journal of Nutrition, 64 (2): 525-540.

Viveros, A.; Brenes, A.; Arija, I. and Centeno, C. (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.

Walk C.L.; Bedford M.R. and McElroy (2012). Influence of limestone and phytase on broler performance, gastrointestinal ph, and apparent ileal nutrient digestibilit.