2010 International Conference on Biology, Environment and Chemistry
IPCBEE vol.1 (2011) © (2011) IACSIT Press, Singapore

Phytase supplementation of low phosphorous diets included graded levels of rice bran on productive performance of laying hens

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***Abstract*—Rice bran, a low-price agricultural by-product which tremendously produces in North part of Iran, can be partly replaced in expensive ingredients of poultry diets to reduce production cost. In addition, an alternative method to minimize phosphorous waste via poultry feces could be using low phosphorous-phytase supplemented diets. To investigate effects of phytase supplementation of low phosphorous diets included graded levels of rice bran on productive performance of laying hens and egg quality characteristics, 288 Lohmann LSL-Lite hens after production peak were randomly divided in 48 cages (n=6). Twelve iso-energetic and iso-nitrogenous experimental diets (ME=2720 Kcal/ Kg and CP =154.2 g / Kg) including three levels (0, 75 and 150 g/kg) of rice bran with or without phytase (0 and 0.3 g/kg) and two levels of dietary non-phytate phosphorus (0.33 and 0.29 g/kg diet) fed to hens with 4 replicates per diet during 7-week trial period (58-64 weeks of age). In weeks 3 and 7, all produced eggs per each dietary group during three frequent days were collected to measure egg quality traits. During the experiment, feed intake (FI), feed conversion ratio (FCR) and egg production (EP) were measured. Collected data of FI, EP and calculated FCR in a 3×2×2 factorial arrangement were analyzed based on completely randomized design using GLM procedure of SAS. The results indicated that dietary inclusion of rice bran decreased. Phytase supplementation increased EP. Dietary inclusion of rice bran increased FI and FCR comparing with control diet. Phytase did not affect on FI; however improved FCR. Dietary non-phytate phosphorus level did not affect on FI, EP and FCR. From the results of this study, it can be concluded that rice bran can be included in laying hens' diets up to 7.5% with no adverse effects on performance. Decreasing non-phytate phosphorus level of Lohmann LSL-Lite hens' diet up to 0.029% would be beneficial way to minimize environmental pollution and decrease dietary phosphorous expenses with no adverse effect on productive performance and egg quality characteristics.**

Keywords-Rice bran; non-phytate phosphorous; phytase; performance; laying hens

I. INTRODUCTION

Rice bran is a powdery fine, downy material that consists seeds or kernels, in addition to particles of pericarp, seed coat, aleurone, germ and fine starchy endosperm. This agricultural by-product is rich in B-vitamins and its nutrient density and profiles of amino acids, including 74% of unsaturated fatty acids, are superior to cereal grains (Ersin Samli *et al.,* 2006).

The major portion of phosphorus (P) in plant feed ingredients is found in the form of phytate which is largely unavailable to monogastric animals. The interest in the use of microbial feed enzymes such as phytase arises from the need to improve the availability of phytate bound P and reduce the P levels in effluent from intensive livestock operations. The effectiveness of microbial phytase in releasing a significant portion of bound P and improving P bioavailability in poultry diets is now well documented (Kornegay, 1996). A number of studies have indicated that supplementing laying diets with microbial phytase results in improved performance (Van der Klis *et al.,* 1996), particularly when dietary levels of non phytate P (NPP) are low (Gordon and Roland, 1997). The results of a number of research studies with laying hens have shown that a diet with 0.1-0.13% available phosphorus (AP) in the presence of 100 to 300 units phytase can result in comparable performance to the control group which were fed a normal level of 0.4-0.45% AP.

Much of the 16 to 18 g phosphorus (P) per kg rice bran occurs as phytic acid P. Not only is the availability of P very low (< 18%) in rice bran (Corley *et al.,* 1980; Belyea *et al.,* 1992) but some other minerals can be complexed with phytate and their availability reduced (Ravindran, 1995). Farrell *et al.* (1993) reported significant beneficial responses when a microbial food phytase is added to chicken and duckling diets based on sorghum and soyabean meal. They reported increased availability of dietary P (reduced P excretion). In addition, the apparent metabolisable energy of the diet and in nitrogen retention increased. Although it appears that poultry can utilize plant P in a bound form to a limited extent, this is unlikely to be of significance in the young bird (Ravindran, 1995). The objectives of the present study are to investigate effects of phytase supplementation of low phosphorous diets included graded levels of rice bran on productive performance of laying hens.

II. MATERIALS AND METHODS

A total number of 288 Lohmann LSL-Lite hens after production peak were randomly divided in 48 cages (n=6). Twelve iso-energetic and iso-nitrogenous experimental diets (ME=2720 Kcal/ Kg and CP =154.2 g / Kg) including three levels (0, 75 and 150 g/kg) of rice bran with or without phytase (0 and 0.3 g/kg) and two levels of dietary non-phytate phosphorus (0.33 and 0.29 g/kg diet) fed to hens with 4 replicates per diet during 7-week trial period (58-64 weeks of age). In weeks 3 and 7, all produced eggs per each dietary group during three frequent days were collected to measure egg quality traits. During the experiment, feed intake (FI), feed conversion ratio (FCR) and egg production (EP) and were measured. Collected data of FI, EP and calculated FCR in a 3×2×2 factorial arrangement were analyzed based on completely randomized design using GLM procedure of SAS.

III. RESULTS AND DISCUSSION

Effects of dietary RB inclusion, P levels and phytase supplementation on FI, FCR and EP during weeks 1 to 7 of experiment are presented in Tables 1-3. There was no interaction between RB, P and E on FI except for wk 1 (p=0.02). Reducing dietary P level and E supplementation did not have significant effect on FI. There was no significant effect of dietary RB inclusion on FI during wk 1 to 3; however, the higher FI was observed in hens fed on diet included 150 g/kg RB ($P \leq 0.05$). There was no interaction between RB, P and E on FCR. Reducing dietary P levels and E supplementation did not significantly affect on FCR except for wk 6-7 (p=0.01). There was no significant effect of dietary RB inclusion on FCR during wk 1, the higher FCR was observed in hens fed on diet included 150 g/kg RB ($P \leq 0.05$). There was no interaction between RB, P and E on EP. Reducing dietary P levels and E supplementation did not significantly affect on EP except for wk 2-3, 4-5, 6-7 and 1-7. There was significant effect of dietary RB inclusion on EP during wk 2-3. The higher EP was observed in hens fed on diet control and diet with 75 g/kg RB ($P \leq 0.05$).

Keshavarz (2000) found that NPP levels of 0.25, 0.20, and 0.15% in a phase-feeding program were adequate, although Keshavarz (2003) suggested that there were differences between strains. In the poultry industry, however, inclusion of much greater levels of NPP in layer feeds is recommended. Coon (2002) suggested including 0.42% NPP in laying hens' diets. In our study, Lohmann LSL-Lite recommends 0.34 to 0.39% of NPP, depending on the strain and age of the hens. Ersin Samli *et al.* (2006) reported that the fiber level in laying hens diets increased to 4.29% by inclusion 15% of rice bran. Also Haghnazar and Rezaei (2004) reported that in most paddy grinding works in Iran, outer layer (rice hull) and inner rice bran are mined, thus the levels of crude fiber of the rice bran is increased and adding hulls back to rice bran can significantly change its nutrient composition particularly for poultry. Whereas; Ersin Samli *et al.* (2006) reported that inclusion 15% of rice bran in laying hens diets can significantly reduce egg mass. Ersin Samli *et al.* (2006), with inclusion 15% and Haghnazar and Rezaei (2004) with inclusion 25% of rice bran did not observe any adverse effect in FCR. Hagnazar and Rezaei (2004) reported that there was no significant difference in egg quality with inclusion up to 25% of RB in laying hens diets. In contrast Ersin Samli *et al*. (2006) reported that inclusion RB up to 15% in laying hens' diets can improve Haugh unit. Mouundras *et al.* (1997) reported that the plasma cholesterol lowering effect of crude fiber may be due to its ability to enhance fecal excretion of cholesterol and bile acids. Burr *et al.* (1985) reported a negative correlation between dietary fiber content and serum cholesterol.

Panda *et al.* (2005) reported that the addition of phytase to com and soybean diets containing 0.12% NPP improved the egg production and eggshell quality of layers to the level of those fed diets containing 0.18 to 0.30% NPP. However, Rao *et al.* (2003) reported that adding phytase to a diet with 3.25% Ca and 0.28% NPP did not improve the performance and retention of Ca and P in the bone and serum of White Leghorn layers, suggesting that 0.28% NPP is adequate for laying hens. The comparison of egg production among phytase treatments and with the positive control group in the current study also revealed that phytase numerically improved egg production. Simons *et al.* (1992) found that adding 200 FTU/kg to diets without added inorganic P sources improved FCR. In contrast, Van der Klis *et al.* (1997), and Um and Paik (1999) found no significant effects of phytase supplementation on feed conversion in laying hens. Most of the improvement in feed conversion in this trial was due to an increase in the denominator part of the equation— egg mass—as phytase was supplemented to low P diets. Carlos and Edwards (1998) also reported no effect of phytase addition to the diet on egg weight. Gordan and Roland (1997, 1998) reported improved egg specific gravity and shell weight at very low levels of NPP with phytase supplementation. Gordon and Roland (1997), however, reported in a study employing a factorial arrangement of NPP levels and phytase that feeding a 0.1%NPP without supplemental phytase decreased egg production, but 0.1% NPP diet supplemented with phytase completely corrected the adverse effect. Boling *et al.* (2000) obtained similar results in a study involving 0.15% NPP with phytase. Keshavarz (2000) reported increased egg specific gravity in low NPP diet. Nahashon *et al.* (1994) also reported that egg specific gravity was higher in hens fed 0.25% than those on 0.45% NPP diet. Panda *et al.* (2005) reported that the addition of phytase to corn and soybean diets containing 0.12% NPP improved the egg production and eggshell quality of layers to the level of those fed diets containing 0.18 to 0.30% NPP. However, Rao *et al.* (2003) reported that adding phytase to a diet with 3.25% Ca and 0.28% NPP did not improve the performance and retention of Ca and P in the bone and serum of White Leghorn layers, suggesting that 0.28% NPP is adequate for laying hens.

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TABLE 1. EFFECT OF DIETARY RICE BRAN INCLUSION (0, 75 AND 150 G/KG), PHOSPHOROUS LEVELS (3.3 AND 2.9 G/KG) AND PHYTASE (0 AND 0.3 G/KG) SUPPLEMENTATION ON FEED INTAKE (FI, G/HEN/DAY) IN LAYING HENS (WEEKS 58-65 OF AGE)

	Feed intake (g/hen/day)				
Week	1	2-3	4-5	6-7	1-7
Treatments					
Rice bran (RB)					
0.0 (g/kg diet	117.02±3.96	114.88±4.85	108.81±7.17[b]	112.01±8.17[b]	112.63±5.60[b]
75 (g/kg diet)	118.70±2.88	116.23±4.39	112.42±5.33[ab]	114.97±4.19[ab]	115.13±3.86[ab]
150 (g/kg diet)	118.89±2.02	116.98±3.25	115.48±2.96[a]	117.63±3.02[a]	117.01±2.14[a]
Phosphorus (P)					
3.3 (g/kg diet)	117.85±2.98	115.48±4.29	112.77±5.61	114.66±6.16	114.81±4.31
2.9 (g/kg diet)	118.55±3.27	116.58±4.17	111.70±6.42	115.08±5.82	115.04±4.61
Phytase (E)					
0.0 (g/kg diet)	117.58±3.51	115.44±4.51	111.42±5.89	114.09±6.55	114.21±4.59
0.3 (g/kg diet)	118.82±2.59	116.62±3.92	113.06±6.10	115.64±5.27	115.64±4.21
SEM	0.449	0.609	0.857	0.864	0.637
CV	2.38	3.60	5.14	5.27	3.83

[ab]Means within column with different superscripts are significantly different (P < 0.05).

TABLE 2. EFFECT OF DIETARY RICE BRAN INCLUSION (0, 75 AND 150 G/KG), PHOSPHOROUS LEVELS (3.3 AND 2.9 G/KG) AND PHYTASE (0 AND 0.3 G/KG) SUPPLEMENTATION ON FEED CONVERSION RATIO (FCR, G FEED: G EGG) IN LAYING HENS (WEEKS 58-65 OF AGE)

	Feed conversion ratio (g feed : g egg)				
Week	1	2-3	4-5	6-7	1-7
Treatments					
Rice bran (RB)					
0.0 (g/kg diet	2.39±0.44	1.99±0.15[b]	1.93±0.23[b]	1.92±0.16[b]	2.01±0.18[b]
75 (g/kg diet)	2.30±0.12	2.06±0.11[b]	2.00±0.14[b]	1.98±0.11[b]	2.05±0.11[b]
150 (g/kg diet)	2.39±0.29	2.19±0.13[a]	2.15±0.18[a]	2.11±0.12[a]	2.19±0.13[a]
Phosphorus (P)					
3.3 (g/kg diet)	2.39±0.34	2.10±0.12	2.07±0.21	2.02±0.14	2.11±0.15
2.9 (g/kg diet)	2.33±0.27	2.07±0.18	1.99±0.19	1.99±0.17	2.06±0.16
Phytase (E)					
0.0 (g/kg diet)	2.343±0.27	2.11±0.15	2.07±0.21	2.05±0.17[a]	2.12±0.17
0.3 (g/kg diet)	2.37±0.34	2.05±0.16	1.98±0.19	1.96±0.12[b]	2.05±0.14
SEM	0.044	0.022	0.029	0.022	0.023
CV	13.93	6.68	9.19	6.43	7.29

[ab]Means within column with different superscripts are significantly different (P < 0.05).

TABLE 3. EFFECT OF DIETARY RICE BRAN INCLUSION (0, 75 AND 150 G/KG), PHOSPHOROUS LEVELS (3.3 AND 2.9 G/KG) AND PHYTASE (0 AND 0.3 G/KG) SUPPLEMENTATION ON HEN-DAY EGG PRODUCTION (EP, %) IN LAYING HENS (WEEKS 58-65 OF AGE)

	Hen-day egg production (%)				
Week	1	2-3	4-5	6-7	1-7
Treatments					
Rice bran (RB)					
0.0 (g/kg diet	82.89±11.34	93.45±5.12[a]	91.22±7.51	92.64±5.98	91.07±5.70
75 (g/kg diet)	86.61±4.91	92.34±5.97[a]	91.13±6.93	92.44±6.23	91.20±5.64
150 (g/kg diet)	83.63±9.91	87.99±6.17[b]	88.18±7.73	89.66±6.66	87.90±6.333
Phosphorus (P)					
3.3 (g/kg diet)	83.03±10.03	89.96±6.09	88.85±8.39	90.72±6.65	88.87±6.58
2.9 (g/kg diet)	85.71±8.03	92.56±6.01	91.51±6.10	92.43±5.97	91.24±5.17
Phytase (E)					
0.0 (g/kg diet)	84.23±8.85	89.38±6.44[b]	87.98±7.65[b]	89.11±7.13[b]	88.17±6.63[b]
0.3 (g/kg diet)	84.52±9.52	93.13±5.29[a]	92.37±6.53[a]	94.05±4.23[a]	91.95±4.64[a]
SEM	1.313	0.885	1.065	0.911	0.862
CV	11.27	5.92	7.28	6.50	6.27

[ab]Means within column with different superscripts are significantly different (P < 0.05).