Effects of supplementation of diets containing high levels of rice bran with microbial phytase on the performance of broiler chicken

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Abstract
*An experiment was conducted to determine whether the adverse effects of high rice bran (RB) levels in broiler diets could be overcome by supplementing the diets with microbial phytase. Twenty days old broiler chicks (n=300) were randomly allocated into 12 deep-litter cages. Four dietary treatments were randomly allocated into 12 cages in 2 * 2 factorial arrangements. Dietary treatments were two dietary non-phytate phosphorus (NPP) levels (2.5 and 3.5 g/kg) with or without 1000 FTU of microbial phytase. All the diets had 40% RB. Experimental diets were fed for 19 days from day 21-39. Cage-wise feed intake and weekly weight gains were measured. On day 40, birds were weighed and killed. Six carcasses from each treatment were randomly selected, eviscerated and the weights of the internal organs such as intestinal tract, pancreas, liver, gizzard and proventriculus were measured. In general growth performances were inferior. Dietary NPP levels or phytase supplementation did not significantly affect the growth performance indices such as weight on day 28, 35 and 40 and weight gains. The highest live weight on day 40 (2211 g) was reported when 3.5 NPP (which contained the standard nutrient requirements) diet was given without phytase. Feed intake was also not significantly affected by the dietary NPP levels and phytase supplementation. The feed intake values, particularly from day 35-40 were substantially low compared to standard values. Feed conversion ratio was also not affected by the treatment. Carcass parameters such as the weight of the pancreas, liver, digestive tract and gizzard were also not affected by the dietary treatments. It was concluded that adverse effects of high levels of rice bran inclusions in broiler diets could not be mitigated by supplementing the diets with microbial phytase.*
Key words: rice bran, broiler, phytase, performance

Introduction

Profitability of the poultry industry to the producers and the affordability of poultry products to the consumers are very much dependent on the efficient and effective utilization of cheap and locally available feed resources. Under local conditions, rice bran is probably the cheapest feed resource for a unit of many nutrients and energy for poultry and, thus the feeding cost can substantially be reduced by increasing the nutritive value and the level of RB in poultry diets. RB is a major by product from the milling of raw paddy (rough rice) into rice and is mainly composed of pericarp, aleuronic layer, starchy endosperm, tegmen and some parts of the germ. However, inclusion of more than 20 % RB in broiler diets and 40% in layer diets has been found to reduce the performance (Farrell, 1994). It has been shown that high phytate and, fibre levels (Warren and Ferrell, 1990abcd), and the presence of antiproteolytic factors (Deolanker and Singh, 1979; Desphande and Damodaran, 1989) of RB reduced the in vivo nutritive value and in turn the performance. RB contains as high as 1.6% phosphorus but the availability of P in RB is greatly reduced due to its high phytate level (Leske and Coon, 1999). Additionally, phytate reduces the availability of other cations (Kornegey, 2001), amino acids (Selle et al., 2000) and metabolizable energy value (BASF Technical Report, 2000). Increased *in-vivo* nutritive value of poultry diets containing RB by supplemental microbial phytase have been reported by several authors (Farrell and Martin, 1998; Ribeiro et al., 2003). However, no attempt has been made to increase the dietary RB inclusion levels by supplementing the diets with microbial phytase.

The objective of the present study was to determine whether adverse effects of high RB inclusion levels in broiler diets could be mitigated by supplementing the diets with microbial phytase.

Materials and methods

Day old broiler chicks were purchased from a local hatchery. The chicks were raised on an electrical brooder for two weeks. The temperature was 32^0 C during the first week and then gradually decreased to room temperature by the end of the second week. Chicks were fed a broiler starter diet in mash from. The starter diet contained 25% RB and met or exceeded the standard nutrient requirements set out by NRC (1994). On day 20, chicks were weighed and 300 chicks were randomly allocated to 12 deep litter cages so that between cage weight variation was minimum.

Table 1. Composition of the starter diet, experimental diets and the calculated nutrient composition.

Ingredient (%)	NC -/+	C -/+
Yellow maize meal	24.96	24.24
Rice bran	40	40
Soybean oil meal	21.8	22
Coconut oil	6.24	6.5
Fish meal	5	5
Dicalcium phosphate	0.1	0.8
Shell powder	1.4	1
Salt	0.25	0.25
Vitamin mixture	0.25	0.25
Phytase	-/+	-/+
ME (Kcal/kg)	3202	3202
CP	20	20
Ca	9	9
Non phytase P	2.5	3.5
Lysine	1.1	1.1
Methionine + Cystine	0.72	0.72
Crude fibre	6.6	6.6
Phytase activity (FTU/kg)	1000	1000

Each cage had a feeder and a drinker. Cages were randomly assigned to four dietary treatments of 2*2 factorial arrangements. The dietary treatments were two dietary non phytate phosphorus (NPP) levels (2.5; NC or 3.5 g/kg; C) with (1000 FTU/kg; +) or without (0 FTU/kg; -). Natuphos was used as the source of microbial phytase. All the four diets had 40% RB. All the diets met or exceeded the standard nutrient requirements except for NPP levels, set out by NRC (1994). Chicks were fed daily *ad libitum* for nineteen days from day 21 to 39. Chicks were weighed every week. On day 40, chicks were killed and six carcasses were randomly selected from each cage and dissected. The weights of liver, heart, intestine, gizzard and crop and dressed carcass were measured. Data were analyzed using GLM procedure of SAS (1989). The cage means were taken as replicates in the analysis of performance data. Selected individual birds served as replicates in the analysis of carcass data.

Results and discussion

Performances of the broiler chicks from day 21-40 as affected by the dietary NPP level and the phytase supplementation are summarized in Table 2. In general, the growth performances were inferior. Performance parameters such as weight on day 28, 35 and 40 and weight gain from day 21 to 40 were not significantly (p>0.05) affected by the dietary NPP level or by the microbial phytase supplementation. Even though the birds who received C- diet gave higher live weight on day 40, it must be noted that they were heavier than the birds in other groups at the beginning of the experiment. The highest live weight on day 40 (2211g) was recorded when standard control diet (3.5g NPP/kg) was fed without microbial phytase. The highest live weight gain was reported when 2.5 NPP diet was fed without phytase. Supplementation of a diet with 2.5 NPP resulted in 7.5% increase in weight gain whereas similar supplementation of a diet having 3.5 NPP resulted in only 0.5% increase in weight gain.

Table 2. Growth performance and feed intake of broiler chicks fed diets containing 40% RB, as influenced by the dietary NPP level and phytase supplementation.

NPP level	2.5 g/kg NPP		3.5 g/NPP/kg		Level of significance		
Phytase	-	+	-	+	NPP	phytase	NPP* phy
Live weight (g)							
21 d	693±56	850±10	894±193	831±296	NS	NS	NS
28 d	1234±135	1169±76	1303±211	1122±134	NS	NS	NS
35 d	1664±244	1538±245	1799±195	1651±63	NS	NS	NS
40 d	1866±314	1828±154	2211±28	1959±343	NS	NS	NS
Feed intake (g/bird/day)							
21-28 d	120±3	108±6	124±1.6	110.6	NS	NS	NS
28-35 d	137±18	115±5	139±17	118±6	NS	NS	NS
35-40 d	127±1	109±2	123±7	122±0.8	NS	NS	NS
21-40 d	129±8	109±6	128±7	115±1	NS	NS	NS
Weight gain (g)							
21-40 d	1265±456	1360±278	991±269	996±161	NS	NS	NS
FCR	2.0±0.7	1.8±0.16	2.1±0.2	2.2±0.6	NS	NS	NS

NS (p>0.05)

The feed intake was also not significantly affected by the dietary treatments. Irrespective of the dietary treatment the feed intake increased from day 21 to 35 and reduced by day 40. The feed intake pattern of this experiment is quite different from that of modern broilers fed standard commercial diets. The normal feed intake values of broiler chicks at week 4, 5 and 6 were 100, 137 and 163 g./bird/day, respectively (NRC 1994). The feed intake values of all the treatments during the fourth week (day 21-28) were found to be higher than the values reported by NRC (1994). However, feed intake values during the sixth week were lower than the typical values reported by (NRC (1994). Reduced feed intake may be the primary reason for poor performances we observed. Farrell and Martin (1998) reported that there was a significant decline in feed intake and growth rate of chicks with increasing dietary RB levels (0, 20, and 40%). Farrell and Martin, (1998) found that supplementation of the diets of ducklings containing RB with microbial phytase increased the feed intake and performance. However, in this experiment birds fed with diets containing microbial phytase also did not eat as expected. Therefore, the results of our findings suggest that reduced feed intake in broilers fed high RB containing diets are attributed not only to phytates but also to other factors.

The starter diet was nutritionally balanced and contained a relatively low RB level; 20%. Inclusion of 40% RB in finisher diets increased the dietary crude fibre level from 5.4% to 6.6%. One possible reason for reduced feed intake could be high dietary fibre levels in the finisher diets. Warren and Farrell (1990abcd, Farrell, 1994) found that RB contained high levels of fibre that is rich in hemicelluloses containing highly branched arabinoxylans; a non-starchy polysaccharide (Shibuya and Iwasaki, 1985 and Ebiringerova et al. 1994). Increased dietary NSPs such as arabinoxylans have been found to evoke a range of adverse effects including poor performance in broilers (Choct 2001). Consequently, it is hypothesized that high dietary fibre levels in finisher diets could be the major reason for reduced feed intakes and subsequent poor performances.

FCR was also not significantly affected by the dietary NPP level and phytase supplementation. However, the FCR was not particularly low and ranged from 1.8 in NC+ to 2.2 in C+ diet. This suggests that adverse effects of high RB on performance are triggered primarily by the reduced feed intake.

Carcass parameters

Effects of dietary NPP level and the microbial phytase supplementation on the carcass parameters are given in Table 3. All the carcass parameters, except hepato-somatic index were not significantly affected by the treatments. Hepato-somatic index of the birds fed control diet was significantly higher than that of the birds fed NC diet. We have no explanation for this observation. Several authors have found that RB contains a range of anti-proteolytic substances such as anti-trypsin factor and anti-pepsin like factors (Deolanker and Sing, 1979; Desphande and Damodaran 1989). It is also suggested that pancreas become more active to compensate for the adverse effects of those anti-proteolytic substances and, as a result the pancreas weight is increased when high RB based diets are fed to poultry. Phytase supplementation did not affect the weight or the relative weight of the pancreas.

Wang et al., (1997) found that high levels of RB in poultry diets increased the relative weight of the digestive tract and the effect was diminished when diets were supplemented with fibre digesting enzymes. The relative weight of the digestive tract in the present experiment (13%) was similar to the value reported by Wang et al. (1997) for broilers given 50% dietary RB. Our results support the argument that the higher digestive tract weight in broilers fed diets containing high levels of RB is mainly attributed to the high fibre levels.

Several studies have shown that microbial phytase increased performance of poultry given low dietary phosphorus levels and thus are contradictory to our results. However, the major difference between the reported studies and the present study is that we used higher levels of RB. Several studies (Warren and Farrell, 1990abcd; Farrell 1994; Madrigal et al., 1995) have shown that there was a significant decline in performance with increasing inclusion of RB in broiler diets. It was expected that microbial phytase would mitigate the problems associated with phytate and birds given NC+ diet would give similar performance to the birds fed C- diet. However, performances were poor across all the treatments. Major reasons for the poor performances in broilers fed diets containing high levels of RB are attributed to high dietary phytate and fibre levels and high rancidity (Farrell, 1994). Our results suggest that dietary microbial phytase could not be used as a means to increase the dietary inclusion level of RB in broiler finisher diets.

Tablc 3 Effects of dietary NPP level and phytase supplementation on the visceral organ parameters of broiler chicks from day 21-40

NPP level	2.5 g/kg NPP		3.5 g/NPP/kg				
Phytase	-	+	-	+	NPP	phytase	NPP* phy
Pancreas weight (g)	5.1±0.7	4.2±0.7	4.6±1	4.7±2	NS	NS	NS
% of pancreas	0.24±0.03	0.21±0.04	0.24±0.05	0.23±0.1	NS	NS	NS
Liver weight	39±7.8	33.7±8.5	38.5±3.6	42.3±7.9	NS	NS	NS
Liver wgt %	1.8±0.2	1.7±0.4	2.0±2.2	2.1±0.2	*	NS	NS
Digestive tract (g)	280±31	259±36	255±34	269±45	NS	NS	NS
Digestive tract %	13.5±1.7	13.2±2.7	13.4±0.95	13.6±1.4	NS	NS	NS
Gizzard weight	42±8.3	37.7±6.4	41.6±6.9	44.6±6.6	NS	NS	NS
Gizzard %	2.0±0.48	1.9±0.42	2.2±0.32	2.2±0.45	NS	NS	NS

*** p<0.05**

References

BASF Technical Symposium. (2000). Natuphos phytase: Validation of phosphorus, amino acids and energy matrix values in poultry and swine.

Choct, M. (2001). Enzyme supplementation of poultry diets based on viscous cereals. In: Bedford, M.R. and G.G. Patridge (eds). *Enzymes in Farm Animal Nutrition.* CABI Publishing. Oxon, UK. 145-160

Deolanker, R P and Singh, K S. (1979). Trypsin inhibitor, mineral availability, and performance of broiler chickens fed on diets based in rice bran. *Animal Feed Science and Technology.* 4(2): 133-141.

Desphande, S S and Demoderan, S. (1989). Effects of phytate on solubility, activity and conformation of trypsin and chymotrypsin. *Journal of Food Science.* 54:695-699.

Ebingerovo, A, Hromadkva, I and Berth, G. (1994). Structural and molecular properties of a water soluble arabinoxylans-protein complex isolated from rice bran. *Carbohydrate Research.* 264:97-109.

Farrell, D J. (1994). Utilization of rice bran in diets for domestic fowl and ducklings.*World's Poultry Science Journal.* 50:115-131.

Farrell, D J and Martin, E A. (1998). Strategies to improve the nutritive value of rice bran in poultry diets. 1. The addition of food enzymes to target the non-starchy polysaccharide fraction in the diets of chicken and ducks gave no response. *British Poultry Science.* 39:549-554.

Farrell. D J and Martin, E A. (1998). Strategies to improve the nutritive value of rice bran in poultry diets. III. The addition of inorganic phosphorous and a phytase to duck diets. *British Poultry Science.* 39:601-611.

Kornegay, E.T. (2001). Digestion of phosphorus and other nutrients: The role of phytase and factors influencing their activity. In: Bedford, M.R. and Partridge, G.G (2001). Enzymes in Farm Animal Nutrition. CAB Publishing. UK. 237-272.

Leske, K. and Coon, C N. (1999). A Bioassay to determine the effects of phytase on phytate hydrolysis and total phosphors retention of feed ingredients as determined with broilers and layers. *Poultry Science.* 87:1151-1157.

Madrigal, S A, Watkins, S E, Adams, M H and Waldroup, P W. (1995). Defatted rice bran to restrict growth rate in broiler chickens. *Journal of Applied Poultry Research.* 4:170-181.

NRC, (1994). Nutrient Requirements of Poultry. National Research Council. National Academy of Science, Washington, DC.

Ribeiro, A M L, Mireles, A J and Klasing, K C. (2003). Interaction between dietary phosphorus level, phytase supplementation and pelleting on performance and bone parameters of broilers fed high levels of rice bran. *Animal Feed Science and Technology*. 103:155-161.

SAS (1989). Statistical Analysis System. SAS Institute Inc, Cary, NC.

Selle, P H, Ravindran, V, Caldwell, R A and Bryden, W L (2000). Phytate and Phytase: Consequences for protein utilisation. *Nutrition Research Review*. 13: 255-278.

Shibayu, N and Iwasaki, T. (1985). Structural features of rice bran hemicelluloses. *Phytochemistry*. 24:285-289.

Wang, G J, Marquardt, R R and Guenter, W. (1997). Effects of irradiation and enzyme supplementation of rice bran on the performance of leghorn chickens. *Poultry Science*. 74(Suppl). 126.

Warren, B E and Ferrell, D J. (1990a). The nutritive value of full-fat and defatted Australian rice bran. 1. Chemical composition. *Animal Feed Science and Technology*. 27: 219-228.

Warren, B E and Ferrell, D J. (1990b) The nutritive value of full-fat and defatted Australian rice bran. II. Growth studies with chicken, rats and pigs. 27: 229-246.

Warren, B E and Ferrell, D J. (1990c) iv. Egg production of hens on diets with defatted rice bran. *Animal Feed Science and Technology*. 27: 259-268.

Warren, B E and Ferrell, D J. (1990d). Strategies to improve the nutritive value of rice bran. V. The apparent retention of minerals and apparent digestibility of amino acids in chickens and adult cockerels fitted with cannulae. *Animal Feed Science and Technology*. 27: 323-342.