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Effect of Fermented Rice Bran, Bio-Converted Byproduct on Performance of Broiler Chickens

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Abstract: About 3 weeks feeding trial using 96 days old, male broiler chicks (Cobb) was conducted to evaluate the potential of fermented rice bran, residue from phytase production on performance of broiler chicken in comparison with untreated rice bran. There were eight birds per pen and four replicate pens per treatment. Feed and water were available *ad libitum* throughout the 21 days experiment. The experimental diets formulated were corn-soya bean meal based diet (control), corn-soya bean meal-untreated rice bran based diet and corn-soya bean meal-fermented rice bran based diet. The value of crude protein content and crude fat was significantly ($p<0.05$) improved in the fermented rice bran and phytate P content was reduced as compared to untreated rice bran. No significantly different body weight gain, feed intake and FCR ($p>0.05$) was shown by addition of 10% untreated rice bran and fermented rice bran in corn soya bean meal diet in comparison with corn soya bean meal based diet. The growth performance of chicken fed 10% fermented rice bran was not significantly different ($p>0.05$) from those fed 10% untreated rice bran. The addition of fermented rice bran, bio-converted byproduct in the diet produced better phosphorus content in tibia ash and P retention ($p<0.05$) in comparison with untreated rice bran. Inclusion of 10% untreated rice bran and fermented rice bran in corn soya bean meal based diet did not give adverse effect on any performances of broiler chicken except for total P retention and can reduce feed cost with the same production cost. The fermented rice bran, byproduct of phytase production can be applicable as chicken feed without giving detrimental effects.

Key words: Rice bran, fermented rice bran, performance, bone ash, phosphorus retention, Malaysia

INTRODUCTION

Rice bran, a byproduct of the rice industry is not available in abundances and at all time. Therefore, it is not used as a regular feed ingredient in poultry rations in Malaysia. Rice bran contains high levels of protein, lipids, vitamins B and E and trace minerals (Saunders, 1986; Warren and Farrell, 1990a). Amino acid composition in rice bran is favorably comparable with other cereal bran (Farrell, 1994). Rice bran may vary widely in the nutritional content because of differences in hull content, degree of polishing during milling and differences in variety of rice grown. Several studies were done the use of rice bran in feed for poultry.

Maust *et al*. (1972) and Zombade *et al*. (1982) indicated that chick fed high levels of rice bran gave reasonable growth rate. However, Kratzer *et al*. (1974) and Virlq *et al*. (1978) reported that the performance of broiler chicken declined as the level of rice bran in the diet increased. Agriculture residues including rice bran are used for phytase production through solid state fermentation and under submerged condition; Popanich *et al*. (2003) used rice bran and soya bean meal; Tuyet (2004) used wheat bran, rice bran, corn meal and Spier *et al*. (2008) used citric acid pulp. Hussin *et al*. (2010) reported the effects of different concentration of rice bran, incubation temperature and initial pH values of the media on phytase production.

Incorporation of 7.5% rice bran has the inducible effect on phytase production for all the phytase producing bacteria tested. The addition of 5% rice bran in the LB (Luria-Bertani) media showed significant difference ($p<0.05$) on the phytase production by all the bacterial strains tested showing the highest activity in ASUIA279 followed by ASUIA271 (Shobirin *et al*., 2009). Recently, ASUIA279 phytase was locally produced by addition of 10% rice bran in LB media under the project supported by Ministry of Science, Technology and Innovation,

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Malaysia (MOSTI). The cell free supernatant was separated using centrifuge and the solid portion containing rice bran (fermented rice bran) was retained as bio converted byproduct. Fermentation of agricultural residue improved their nutritive values and presence of phytase in the fermented rice bran and palm oil meal effluent was benefited through feed usage of animal (Purwaradia *et al*., 2003). It would be of great economic if rice bran bio converted byproduct of phytase production would be used as chicken feed ingredient. Therefore, this experiment was conducted to evaluate the efficacy of fermented rice bran, residue from phytase production on performance of broiler chicken in comparison with untreated rice bran.

MATERIALS AND METHODS

Fermented rice bran: The fermented rice bran used was bio converted byproduct from phytase production. Phytases were locally produced by addition of 10% rice bran in LB media under the project supported by MOSTI. The cell free supernatant containing phytase was separated using centrifuge. The byproduct of phytase production, the fermented rice bran was dried at 55°C. At this temperature, it is assumed that any phytase enzyme left in the rice bran will not be destroyed. The chemical compositions of fermented rice bran obtained from five batches of phytase production and untreated rice bran are shown in Table 1.

Experimental diet: The experimental diets were formulated to provide similar ME and CP levels according to the requirement of NRC (1994). The diets contained 4.5 g kg^{-1} available P and 9.3 kg^{-1} of Ca. About 1 g chromic oxide/kg was used as an indigestible marker. The experimental diets formulated were corn-soya bean meal based diet (control), corn-soya bean meal-untreated rice bran based diet corn-soya bean meal-fermented rice bran based diet. The ingredient composition and nutritive value of experimental diets were shown in Table 2 and 3.

Bird housing and management: A total of 96 days old, male broiler chicks (Cobb) were used in the 3 weeks of study. They were fed one of three diets in a completely randomized design. There were eight birds per pen and four replicate pens per treatment. Feed and water were available *ad libitum* throughout the 21 days experiment. Chicks were housed in wire netted battery cages with mesh grate floors above excreta collection trays in a thermostatically control room. Temperature was set at about 32°C for 1st week and gradually reduced to 27°C until 21 days of age (the end of experiment). Birds were vaccinated for Newcastle Disease-infectious Bronchitis (ND-IB) at 7 days and Infectious Bursal Disease (IBD) at 14th day of age.

Parameter measurements: For performance, weekly cumulative feed consumption, body weight gain, average daily gain and feed conversion ratio were calculated on a pen basis. Mortality rate was recorded daily. To determine total P, phytate P and Ca retention, clean excreta (free from feathers and feed) were collected for 2 consecutive days at the end of experiment. The pooled samples were then frozen. Prior to analysis, the samples were dried in a forced air oven at 55°C for 5 days followed by fine grinding for analysis. Feed consumption by the birds was

Table 1: Nutrient composition (%) of untreated rice bran and normal rice bran (DM basis)

Description	Untreated rice bran	Fermented rice bran	No. of samples
Ash	7.29[a]	6.56[a]	5
Crude protein	14.12[a]	17.27[b]	5
Crude fat	13.48[a]	16.42[b]	5
Crude fibre	13.31[a]	12.91[a]	5
Total phosphorus	1.87[a]	1.78[a]	5
Phytate phosphorus	1.39[a]	1.31[a]	5

Mean in each row with different superscripts are significantly different at $p<0.05$ by Student t-test

Table 2: Ingredient composition of diet

Ingredients	Diet 1	Diet 2	Diet 3
Corn	557.0	453.0	458.0
Soya bean meal	364.0	260.0	356.0
Untreated rice bran	-	100.0	-
Fermented rice bran	-	-	100.0
Oil	41.0	49.0	48.0
Dicalcium phosphate	17.0	15.0	15.0
Limestone	11.0	13.0	13.0
Table salt	4.0	4.0	4.0
Dl methionine	2.5	2.5	2.5
Chromic oxide	1.0	1.0	1.0
Vitamins[1]	1.5	1.5	1.5
Trace minerals[1]	1.0	1.0	1.0
Total	1000.0	1000.0	100.0

[1]Provided (per kg diet): Vitamin A, 2300 IU; vitamin D_3, 400 IU; vitamin E, 1.8 mg; vitamin B_{12}, 3.5 mg; Riboflavin, 1.4 mg; Panthotenic acid, 2 mg; Nicotinic acid, 7 mg; Pyridoxine, 0.25 mg; Folic acid, 0.15 mg; Menadione, 0.3 mg; Thiamin, 0.15 mg; Manganese oxide, 35 mg; Ferrous sulfate 35 mg; Zinc oxide, 30 mg; Copper sulfate, 60 mg; Cobalt carbonate, 5 mg; Potassium iodine, 0.6 mg; Selenium vanadate, 0.09 mg

Table 3: Nutrient content of experimental diets

Nutrients	Diet 1 (%)	Diet 2 (%)	Diet 3 (%)
Calculated value (90% DM basis)			
Crude protein	22.80	22.90	23.00
Non-phytate phosphorus	0.44	0.44	0.44
Calcium	0.93	0.93	0.93
Metabolisable energy (kcal kg^{-1})	3093.00	3095.00	3094.00
Analysed value (100% DM)			
Crude protein	23.20	23.60	23.50
Total phosphorus	0.63	0.62	0.61
Phytate phosphorus	0.19	0.20	0.20
Crude fibre	3.27	3.00	3.10
Crude fat	6.80	6.50	6.70
Ash	7.18	7.30	7.50

recorded on a pen basis for that day and diets were sampled for analysis. At the end of 3rd week, blood samples were randomly collected from 2 birds per pen. The serum samples were collected, pooled for replicates and kept at -20°C for serum inorganic phosphorus and calcium assay by Hitachi 902 Automatic analyser using Roche reagent containing R1 and R2 solution. For the determination of tibia ash and bone P, left tibia of three birds (selected at random) from each experimental unit (12 birds/diet) were collected after slaughtering the birds at the end of week 3.

Chemical analysis and calculation of digestibility coefficient: The proximate analysis of ingredients, experimental feed and excreta are measured by AOAC (1980) method. The crude protein content was measured by macrokjahdel digestion unit using Kjeltec 1030 Auto analyser. Total phosphorus (AOAC, 1980), phytate phosphorus (Latta and Eskin, 1980) and chromic oxide of feed and fecal sample were measured. Bone ash of left tibia on fat free dry basis was determined by the method of AOAC (1995).

The coefficient of total tract apparent digestibility for total P, phytate P and calcium was calculated according to the following equation:

$$\text{CTTAD} = 1 - \left[\frac{\text{Cr, diet}}{\text{Cr, out}} \times \frac{\text{Nut, out}}{\text{Nut, diet}}\right]$$

Where:

Cr, diet = The initial chromic oxide concentration in the diet

Nut, diet = The initial dietary concentration of the nutrient or the dietary component (i.e., dry matter, P, phytate P)

Cr, out and Nut out = The respective concentration of either chromic oxide or nutrient/dietary component in the excreta (Dilger and Adeola, 2006)

Statistical analysis: Statistical analysis for chemical composition of untreated and fermented rice bran was compared by Student t-test and experimental data were performed with one way analysis of variance using the General linear model program of SAS appropriate for CRD (SAS, 2004).

RESULTS

Nutrient contents of untreated and fermented rice bran: Nutrient contents (DM basis) of untreated and fermented rice bran are shown in Table 3. All nutrient contents of untreated and fermented rice bran were not significant from each other except for crude protein and crude fat. Crude protein and crude fat content of fermented rice bran were significantly higher ($p<0.5$) than those of untreated rice bran.

Growth performances: Effect of replacement of 10% fermented and normal rice bran in corn soya bean meal based diet on growth performance of broilers chickens at 0-7, 0-14 and 0-21 days of age are shown in Table 4. No significantly different body weight gains, feed intake and FCR ($p>0.05$) was shown by addition of 10% untreated rice bran and fermented rice bran in corn soya bean meal diet in comparison with corn soya bean meal based diet. The growth performances of chicken fed 10% fermented rice bran was not significantly different ($p>0.05$) from those fed 10% untreated rice bran ($p>0.05$) although, there were indication of numerical improvement in boy weight gain and FCR by supplementation 10% fermented rice bran in corn soy bean meal diet at 0-14 and 0-21 days.

Bone and serum mineralization: Table 5 shows the effect of replacement of 10% fermented and normal rice bran in corn soya bean meal based diet on mineralization of broiler chicken at 21st day of age). Tibia ash content of chickens fed 10% untreated rice bran was found to be lower than those fed 10% fermented rice bran supplemented diet and corn soya bean meal based diet although, there were no significant differences ($p>0.05$) among the diets. For tibia P content, chicks fed 10% fermented rice bran gave significant higher value ($p<0.05$)

Table 4: Effect of replacement of 10% fermented and normal rice bran in corn soya bean meal based diet on performance of broilers

Diets	Weight gain (g/bird)	Feed intake (g/bird)	Feed conversion ratio
0-7 days			
T1	100±5.23	128±4.58	1.29±0.03
T2	100±3.42	136±2.61	1.36±0.07
T3	101±3.94	132±1.22	1.31±0.05
0-14 days			
T1	336±7.07	512±8.34	1.53±0.02
T2	345±10.24	518±4.89	1.51±0.06
T3	358±6.37	513±2.49	1.43±0.03
0-21 days			
T1	701±11.80	1121±9.74	1.59±0.03
T2	693±7.31	1106±7.98	1.58±0.03
T3	714±5.53	1101±6.03	1.54±0.01

Table 5: Effect of replacement of 10% fermented and untreated rice bran in corn soya bean meal based diet on mineralization of broiler chicken at 21st day of age

Diets	Tibia ash (g/100 g)	P in tibia ash (g/100 g)	Serum P ($mg\ dL^{-1}$)	Serum Ca ($mg\ dL^{-1}$)
T1	47.05±0.53	15.79±0.97^{ab}	8.58±0.08	9.17±0.29
T2	45.3±0.39	15.75±0.45^{b}	8.4±0.22	9.65±0.19
T3	47.13±0.96	17.28±0.23^{a}	8.88±0.07	9.01±0.4
p-value	0.149	0.05	0.119	0.353

Means in each column with different superscript are significantly different at $p<0.05$

than those fed 10% untreated supplemented diet and corn soya bean meal diet. Supplementation of 10% untreated rice bran gave the same value ($p>0.05$) with corn soya bean meal based diet. Replacement of 10% untreated and 10% fermented rice bran in corn soya bean meal diet on serum mineralization (serum P and serum Ca) was not significantly different from corn soya bean meal based diet.

Nutrient retention and excretion: Effect of replacement of 10% fermented and normal rice bran in corn soya bean meal based diet on apparent phosphorus retention and excretion of broiler chicken are shown in Table 6. Replacement of 10% untreated and fermented rice bran in corn soya bean significantly ($p<0.05$) decreased total P retention coefficient and increased total P excretion than corn soya bean meal based diet. Replacement of 10% fermented rice bran in corn soya bean meal diet showed increase in total P retention and excretion ($p = 0.08$) than 10% untreated rice bran supplemented diet. There were no significant differences ($p = 0.085$) for phytate phosphorus retention and ($p = 0.635$) excretion among the diets. However, 10% untreated rice bran supplemented diet gave significantly decrease ($p<0.05$ and $p = 0.076$) in phytate P retention than 10% fermented rice bran supplemented diet and corn soya bean meal diet respectively. Effects of replacement of 10% fermented and normal rice bran in corn soya bean meal based diet on apparent calcium and crude protein retention and excretion of broiler chicken are shown in Table 7. There were no significantly different effect ($p>0.05$) on retention and excretion of Ca and crude protein between the 10% rice bran supplemented and corn soya bean meal based diet.

Table 6: Effect of replacement of 10% fermented and normal rice bran in corn soya bean meal based diet on apparent phosphorus retention and excretion of broiler chicken

	Phosphorus retention coefficient		Phosphorus excretion ($g\ kg^{-1}$ DMI)	
Diets	Total P	Phytate P	Total P	Phytate P
T1	0.63±0.03[a]	0.57±0.01[ab]	2.29±0.23[a]	0.77±0.02
T2	0.43±0.04[b]	0.52±0.02[b]	3.53±0.27[b]	0.75±0.05
T3	0.51±0.03[b]	0.59±0.01[a]	2.90±0.23[b]	0.72±0.03
p-value	0.01	0.05	0.01	0.635

Mean in each column with different superscripts were significantly different at $p<0.05$ by LSD

Table 7: Effect of replacement of 10% fermented and normal rice bran in corn soya bean meal based diet on apparent calcium and crude protein retention and excretion of broiler chicken

	Retention coefficient		Excretion ($g\ kg^{-1}$ DMI)	
Diets	Calcium	Crude protein	Calcium	Crude protein
T1	0.64±0.01	0.65±0.003	3.30±0.10	72.15±0.62
T2	0.56±0.04	0.64±0.02	3.7±0.33	76.24±4.97
T3	0.55±0.02	0.67±0.01	3.45±0.17	69.54±2.33
p-value	0.107	0.321	0.530	0.368

Mean in each column with different superscripts were significantly different at $p<0.05$ by LSD

DISCUSSION

Although, the crude protein and crude fat content of fermented rice bran were significantly higher than untreated rice bran, both were with the range of the studies reported by Oladunjoye and Ojebiyi (2010), IRRI (2009), Amissah *et al*. (2003) and IRRI (2009). However, fat content of rice bran in this study was lower than the report of Arosemena *et al*. (1995). They reported that rice bran is a high fat content with a range of 18.24-24.5%. The crude protein, crude fat and crude fibre content in the studies were higher in comparison with the average value of Malaysian rice bran reported by Ukil (1999). However, total ash and total phosphorus content were within the range of 1.26-1.79% reported by Ukil (1999) and 1.62-1.81% reported by Warren and Farrel (1990c). The variations in nutrient composition might be due to the sources from which the bran was obtained. Chemical composition of rice bran varies due to the variation in milling process and adulteration with hull (Warren and Farrel, 1990a).

The higher CP and crude fat content in fermented rice bran were possibility due to the presence of microbial biomass in the fermented rice bran after the centrifugation which separates the phytase in the liquid portion from the solid portion. Purwaradia *et al*. (2003) reported that fermentation of agricultural residue improved their nutritive values. In their research, the protein content of rice Bran and Palm Oil Mill effluent (POMB) were increased as the fermentation time increased due to the mycelium growth of *Aspergilus niger* and dry matter loss. In the studies, the total phosphorus content of untreated rice bran and fermented rice bran was not significant from each other although, the phytate content of fermented rice bran had tendency to decrease. Purwaradia *et al*. (2003) also indicated that the soluble P content and total P content of rice bran was increased during the fermentation as compared to unfermented rice bran due to the dry matter loss (organic matter) and phytase production. However in their study, the whole fermented rice bran was analysed without subjected to separate by centrifugation. No improvement of total P of fermented rice bran in the study might be due to a loss of soluble P into liquid portion by hydrolysis of phytate by phytase during fermentation.

The replacement of 10% fermented and untreated rice bran in corn soya bean meal based diet on growth performance of broilers chickens was not significant from corn soya bean meal based diet (control diet) through out the experiment. Chicken fed 10% fermented rice bran produced the same growth performance as those fed 10% untreated rice bran through out the experiment. In the study by Warren and Farrel (1990b), the substitution with DFRB (defatted rice bran) at 7-21% in a basal diet improved growth and FCR of broiler from 3-13 days of age. The researchers also reported that feed intake did not decline significantly until the DFRB content of the diet exceeded 20% diet. Rice bran should be included in broiler diets at a level between 10 and 20% if strategies for decreasing the antinutritive activity are not used (Gallinger *et al*., 2004). Significant depression was observed in Average Daily Gain (ADG) when rice bran was included in >20% in the diets. The adverse effect of rice bran was reversed by the application of enzyme (Oladunjoye and Ojebiyi, 2010). In layer, rice bran could be included up to 10% without any adverse affect on laying performance, egg quality and digestive organs (Samli *et al*., 2006). Any significant effect was observed in serum mineralization (serum Ca and serum P) among the diet. Tibia ash content of chickens fed 10% fermented rice bran supplemented diet and corn soya bean meal based diet had tendency to increase as compared to those fed untreated rice bran, although there were no significant differences among the diets. Significant improvement in tibia P content was seen in chickens fed 10% rice bran supplemented diet in comparison with 10% untreated rice bran. Oladunjoye and Ojebiyi (2010) reported that birds fed a 10% rice bran diet had mineralization similar to birds fed the control diet when different levels of rice bran was included in corn soya bean meal diet. Feed conversion and tibia ash were impaired with diet containing >10% of rice bran. They suggested that feed conversion ratio and tibia ash are more sensitive than weight gain for detecting antinutritive factors in RB (Gallinger *et al*., 2004). Addition of 10% untreated and fermented rice bran in corn soya bean diet produced significant decrease in total P retention coefficient and increased total P excretion as compared to corn soya bean meal based diet. This may be the presence of antinutrtional factors in rice bran. Warren and Farrell (1991) reported that phytate and fiber can interfere with mineral digestibility and retention in nonruminant animals. However, it is an ongoing debate for the relative importance of these 2 factors in the nutrition of non ruminant. When compared to two types of rice bran, replacement of 10% fermented rice bran in corn soya bean meal diet gave better improvement in total P retention and excretion 10% than untreated rice bran supplemented diet. Supplementation of 10% untreated rice bran in corn soya bean meal based diet showed lower phytate P retention than 10% fermented rice bran supplemented diet and corn soya bean meal diet, respectively. In this study, fermented rice bran is bio converted byproduct of phytase production with microbe, ASUIA279. In comparison with untreated rice bran, there were reduced antinutritional factors like phytate and fibre in the fermented rice bran which may affect on increased retention coefficient of phytate P retention and improve bone mineralization. Formulation of diets containing reduced levels of phytate is one approach to reduce the negative impact of phytate (Selle and Ravindran, 2007). Dephytinisation of feedstuffs is an alternative way to reduce the anti-nutritive properties of phytate. The antinutrition properties of rice bran in the diet can be reduced by addition of enzyme when the level of rice bran in the diet was >20% (Oladunjoye and Ojebiyi, 2010). The increase in bone mineralization and P retention could be the fact that the diet containing the fermented rice bran, bio-converted byproduct of phytase production may perhaps have increased phytase activity than untreated rice bran supplemented diet. Treated rice bran may contain residual phytase activity.

Effects of replacement of 10% fermented and normal rice bran in corn soya bean meal based diet on apparent calcium and crude protein retention and excretion of broiler chicken were no significantly different from corn soya bean meal based diet. The fermented rice bran gave the same effect with untreated rice bran on crude protein retention.

The fermentation of rice bran does not increase crude protein but increase diluted protein and nitrogen retention (Hardini, 2010). Purnomo and Adiono stated that fermentation caused protein, fat and carbohydrate of fermented product hydrolyzed easily and have a higher digestibility.

CONCLUSION

The value of crude protein content and crude fat was improved in the fermented rice bran and phytate P content was reduced as compared to untreated rice bran. Inclusion of 10% untreated rice bran and fermented rice bran in corn soya bean meal based diet did not give adverse effect on any performances of broiler chicken except for total P retention and can reduce feed cost with the same production cost. The addition of fermented rice bran, bio converted byproduct in the diet produced better bone mineralization and P retention in comparison with untreated rice bran. This may be due to some residual phytase enzyme may be present in the fermented product. The fermented rice bran, byproduct of phytase production can be applicable as chicken feed without giving detrimental effects.

REFERENCES

AOAC, 1980. Official Methods of Analysis. 13th Edn., Association of Official Analytical Chemist, Washington, DC., USA., pp: 56-132.

AOAC, 1995. Official Methods of Analysis. 16th Edn., Association of Official Analytical Chemists Inc., Arlington, Virginia, USA.

Amissah, J.G.N., W.O. Ellis, I. Oduro and J.T. Manful, 2003. Nutrient composition of bran from new rice varieties under study in Ghana. Food Control, 14: 21-24.

Arosemena, A., E.J. DePeters and J.G. Fadel, 1995. Extend of variability in nutrient composition with selected by-products feedstuffs. Anim. Feed Sci. Technol., 54: 103-120.

Dilger, R.N. and O. Adeola, 2006. Estimation of true phosphorus digestibility and endogenous phosphorus loss in growing chicks fed conventional and low-phytate soybean meals. Poult. Sci., 85: 661-668.

Farrell, D.J., 1994. Utilization of rice bran in diets for domestic fowl and duckling. World's Poult. Sci. J., 50: 115-131.

Gallinger, C.I., D.M. Suarez and A. Irazusta, 2004. Effects of rice bran inclusion on performance and bone mineralization in broiler chicks. J. Applied Poult. Res., 13: 183-190.

Hardini, D., 2010. The nutrient evaluation of fermented rice bran as poultry feed. Int. J. Poult. Sci., 9: 152-154.

Hussin, A.S.M., A.E.A. Farouk, A.M. Ali and R. Greiner, 2010. Production of Phytate-degrading enzyme from Malaysian soil bacteria using rice bran containing media. J. Agrobiotechnol., 1: 17-28.

IRRI, 2009. By products and their utilization. Rice Knowledge Bank.

Kratzer, F.H., L. Earl and C. Chiaravanont, 1974. Factors influencing the feeding value of rice bran for chickens. Poult. Sci., 53: 1795-1800.

Latta, M. and M. Eskin, 1980. A simple and rapid colorimetry method for phytate determination. J. Agric. Food Chem., 28: 1313-1315.

Maust, L.E., M.L. Scolt and W.C. Pond, 1972. The metabolizable energy of rice bran, cassava flour and blacke e cowpea for growing chickens. Poult. Sci., 51: 1391-1401.

NRC, 1994. Nutrient Requirements of Poultry. 8th Rev. Edn., Natl. Acad. Press, Washington, DC..

Oladunjoye, I.O. and O.O. Ojebiyi, 2010. Performance characteristics of broiler chicken (*Gallus gallus*). Fed rice (*Oriza sativa*) bran with or without roxazyme G2G. Int. J. Anim. Vet. Adv., 2: 135-140.

Popanich, S., C. Klomsiri and S. Dharmsthiti, 2003. Thermo-acido-tolerant phytase production from a soil bacterium in a medium containing rice bran and soybean meal extract. Bioresour. Technol., 87: 295-298.

Purwaradia, T., N. Nirwana, P.P. Ketaren, D.I. Pradono and Y. Widyastuti, 2003. Synergistic activity of enzymes produced by *Eupenicillin javanicum* and *Aspergillus niger* NRRL 337 on palm oil factory waste. Biotropia, 20: 1-10.

SAS, 2004. SAS/STAT User's Guide Statistics. Version 9.2, SAS Institute Inc., Cary, NC.

Samli, H.E., N. Senkoylu, H. Akyurek and A. Agma, 2006. Using rice bran in laying hen diets. J. Central Eur. Agric., 7: 135-140.

Saunders, R.M., 1986. Rice bran: Composition and potential food uses. Food Rev. Int., 1: 465-495.

Selle, P.H. and V. Ravindran, 2007. Microbial phytase in poultry nutrition. Anim. Feed Sci. Technol., 135: 1-41.

Shobirin, M.H.A., A. Farouk and R. Greiner, 2009. Potential phytate-degrading enzyme producing bacteria isolated from Malaysian maize plantation. Afr. J. Biotechnol., 8: 3540-3546.

Spier, M.R., R. Greiner, J.A. Rodriguez-Leon, A.L. Woiciechowski, A. Pandey, V.T. Soccol and C.R. Soccol, 2008. Phytase production using citric pulp and other residues of the agroindustry in SSF by fungal isolates. Food Technol. Biotechnol., 46: 178-182.

Ukil, M.A., 1999. Rice bran for broiler chicken (finisher) ration and utilization of phytate phosphorus. Ph.D. Thesis, Putra University, Malaysia

Virlq, R.S., G.N. Lodhi and J.S. Ichhponani, 1978. Influence of climatic conditions on protein and energy requirements of poultry: Energy requirements of broiler starter in winter and summer. Indian J. Anim. Sci., 48: 3641-3641.

Warren, B.E. and D.J. Farrell, 1990a. The nutritive value of full-fat Australian rice bran. I. Chemical composition. Anim. Feed Sci. Technol., 27: 219-228.

Warren, B.E. and D.J. Farrell, 1990b. The nutritive value of full fat and defatted Australian rice bran. II. Growth studies with chickens, rats and pigs. Anim. Feed Sci. Technol., 27: 229-246.

Warren, B.E. and D.J. Farrell, 1990c. The nutritive value of full fat and defatted rice bran. IV. Egg Production of hens on diets with defatted rice bran. Anim. Feed Sci. Technol., 27: 259-268.

Warren, B.E. and D.J. Farrell, 1991. The nutritive value of full-fat and defatted Australian rice bran. V. The apparent retention of minerals and apparent digestibility of amino acids in chickens and adult cockerels with ileal cannulae. Anim. Feed Sci. Technol., 34: 323-342.

Zombade, S.S., G.N. Lodhi and J.S. lchhponani, 1982. Evaluation of raw and parboiled rice bran. 11. Feeding value for broilers. Indian J. Anim. Sci., 52: 325-329.