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Effect of Dietary Supplementation of Rice Gluten Meal and Exogenous Enzyme on Nutrient Utilization and Growth Performance of Broilers

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ABSTRACT

This experiment was conducted to evaluate the effects of dietary supplementation of rice gluten meal (RGM) and enzyme on nutrient utilization and growth performance of broilers. Two-hundred-and-forty-day-old broiler chicks were randomly allocated to six groups with four replicates. isonitrogenous and isocaloric starter, grower and finisher rations were formulated with different levels of RGM and were fed to the birds. Birds of T_1 (control) did not receive any supplement of RGM or enzyme; diets of the birds of group T_2 contained no RGM, but was supplemented with cocktail enzyme at 100g/q feed; diets of the birds in group T_3 contained 10% RGM; that of group T_4 contained 10% RGM with cocktail of enzyme at100g/q feed; diet of group T_5 contained 15% RGM with no enzyme; whereas, the diets of group T_6 contained 15% RGM along with cocktail of enzyme at 100g/q feed. Growth performance parameters like body weight gain, feed intake, feed conversion ratio (FCR), protein efficiency ratio (PER) and calorie efficiency ratio (CER) were monitored weekly. The results showed that irrespective of enzyme supplementation inclusion of RGM at 10 and 15% of the diet improved ($P<0.05$) body weight gain and feed intake; but FCR, PER and CER were similar among the groups. Apparent metabolizability of N was significantly ($P<0.01$) higher in 10 and 15% RGM fed group as compared to control, whereas, apparent metabolizability of Ca and P were similar among the groups. Thus, it was concluded that RGM can be supplemented into broiler diets up to 15% in broiler diets without any negative effect on growth performance and nutrient utilization.

Keywords: Rice gluten meal, Broilers, Nutrient utilization, Performance, FCR

INTRODUCTION

Good nutrition management is one of the important basis for healthy and economical rearing of poultry as there is a positive relation between nutrition, health and growth performance. With the increasing human population and improvement in income the demand for animal products is increasing day by day. Poultry industry is one of the major industries that are supporting the vast population of the world. However, one of the major constraints faced by the sector is the ever-escalating price of feed ingredients. So, there is an urgent need to explore the various agro-industrial waste and other unconventional feed resources for an economically viable poultry production (Bhatt and Sharma, 2001). As there is scarcity of both maize and soybean at reasonable price, there is need to utilize locally available feed ingredients. India is one of the largest producers of rice in the world producing approximately 112.91 million tons of rice and Punjab produced 11.85 million tons of rice in 2017-18 (GOI, 2018). So, a lot of by-products are available from rice processing industry. Among the various by-products of rice, rice gluten meal (RGM) is a protein by-product that have the potential to be incorporated in livestock and poultry feed. RGM is the dried residue from rice after the removal of starch and separation of the bran by the wet milling process. Rice gluten meal is a high protein and high energy alternate feed resource that can be utilized for livestock and poultry feeding for economic production (Dinani *et al.,* 2020). Rice gluten meal contains 46% crude protein and has 3152 kcal/kg metabolizable energy (Kumar *et al.,* 2016). Based on feed cost, RGM could be an effective alternative feed ingredient in the diet of broilers. If diets can be formulated using this ingredient, farmers will be able to pay less for their feed, hence reducing their overhead cost. Very first research on RGM conducted by Sherazi *et al.* (1995) showed that RGM can be included up to 10% level in broiler chicken without affecting feed efficiency and dressing percentage. Metwally and Farahat (2015) found in their research that broiler fed with RGM at different inclusion rates up to 12.5% had

almost same growth performance, carcass traits and serological parameters. There is also some research that points out the beneficial effect of exogenous enzyme supplementation including increased nutrient digestibility, reduction in water content of the excreta, reduced viscosity of intestinal contents and accelerated rate of passage of digesta through the gastrointestinal tract (Metawaly and Farhat, 2015; Dinani *et al.,* 2020). Therefore, this study was carried out to evaluate the supplementary effects of different levels of RGM with or without enzyme on growth performance and nutrient metabolizability of broilers.

MATERIAL AND METHODS

The study was carried out at Department of Animal Nutrition, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, India. RGM was procured from Prodigy Foods, Zirakpur, Punjab. The product was then analyzed for dry matter, crude protein (CP), ether extract (EE), crude fibre (CF), total ash and phosphorous following AOAC methods (2000), and calcium as per the modified of Talapatra *et al.* (1940). A feeding trial of 42 days duration was conducted in meat type birds to determine the effect of feeding RGM on broiler performance. The feeding trial was divided into 3 phases i.e. starter (1-14 days), grower (15-21 days) and finisher (22-35 days) phase and all the birds were fed to meet their nutrient requirements as per the recommendation of ICAR (2013), detailed in Table 1. In this study, 240 sexed chicks of 1 day of age were distributed randomly into 6 treatments having total of 10 birds per treatment with 4 replicates.

The chicks of all experimental groups were weighed individually on day-1 and then at weekly intervals, average body weights and body weight gains during starter (1-14 days), grower (14-21 days), finisher phase (22-35 days) and for entire experimental periods (1-35 days) were then calculated. Feed conversion ratio (FCR) was calculated as a ratio of grams of average feed consumed per grams of average body weight gain per bird. Protein efficiency ratio (PER) was calculated as grams of body weight gain per gram of protein consumed. The efficiency of energy utilization is expressed as calorie efficiency ratio (CER) and was

Table 1. Nutrient composition of experimental diets

Nutrient composition	Pre starter						Starter						Finisher					
	T_1	T_2	T_3	T_4	T_5	T_6	T_1	T_2	T_3	T_4	T_5	T_6	T_1	T_2	T_3	T_4	T_5	T_6
DM	91.17	91.17	91.64	91.33	91.45	91.25	91.98	91.98	91.90	91.93	92.12	91.88	91.13	91.1	91.35	94.43	90.97	91.10
OM	89.46	89.46	88.98	87.83	86.73	86.53	89.78	89.78	90.73	90.63	90.98	90.20	89.85	89.85	70.51	89.21	82.95	87.45
CP	22.89	22.89	22.62	22.62	22.64	22.64	21.86	21.86	21.87	21.63	21.57	21.45	19.98	19.98	19.94	19.98	19.86	19.83
EE	3.13	3.13	3.23	2.76	2.78	2.75	2.47	2.47	3.65	3.67	3.91	4.08	4.3	4.3	3.54	2.89	4.70	4.98
*ME	2935	2935	2936	2943	2941	2939	3100	3100	3106	3108	3100	3104	3209	3209	3224	3212	3193	3202
CF	6.01	6.01	6.99	7.06	7.09	7.19	7.00	7.00	7.09	7.26	7.31	7.86	6.71	6.71	7.27	7.29	7.78	8.35
TA	10.54	10.54	11.02	12.17	13.27	13.47	10.22	10.22	9.27	9.37	9.02	9.80	10.15	10.15	9.49	10.79	11.35	12.55
AIA	2.23	2.23	2.16	2.44	2.62	2.34	2.65	2.65	2.60	2.34	2.38	2.37	2.39	2.39	2.07	2.19	2.06	2.12
NFE	57.43	57.43	56.14	55.39	54.22	53.95	58.45	58.45	57.86	58.07	58.19	56.81	58.86	58.86	59.76	59.05	56.31	54.29
Ca	1.5	1.5	1.23	1.27	1.30	1.65	1.5	1.5	1.18	1.42	1.59	1.85	1.00	0.97	1.06	1.28	1.37	1.40
P	0.70	0.70	0.73	0.70	0.70	0.69	0.87	0.87	0.84	0.87	0.90	0.87	1.28	1.28	1.54	1.29	1.17	1.21

*ME (kcal/kg) - calculated values

calculated as body weight gain per kilo calories consumed. A metabolic trial of 7 days with 4 days adaptation period and followed by 3 days of collection period was conducted after 35 days of growth trial. Excreta were collected for three consecutive days of each replicate and were mixed properly. The sample of feed, residues and excreta were grounded and analyzed for various proximate parameters and P following AOAC methods (2000), and calcium as per the modified of Talapatra *et al.* (1940). The collected data were subjected to statistical analysis using Statistical Analysis System Software (SAS, version 9.3) and One -way ANOVA in Software Package for Social Sciences (SPSS, version 24.0) to test the difference between various treatments.

RESULTS AND DISCUSSION

The data pertaining to the phase wise (starter phase, grower phase, finisher phase and overall period) growth performance in terms of average body weight gain, average feed intake FCR, PER and CER are presented in Tables 2 and 3. The data regarding nutrient utilization is presented in table 4.

RGM supplementation at 10% without enzyme (T_3) showed similar response to control during finisher phase, but had higher (P<0.01) weight gain during starter and overall phase. As compared to control, RGM supplementation at 10% with enzyme (T_4) showed higher weight gain during starter, grower and overall phase, but similar weight gain to control during finisher phase. Supplementation of RGM at 15% without enzyme (T_5) and with enzyme (T_6) showed higher (P<0.05) weight gain during starter, grower and overall phase, however, no added advantage of enzyme supplementation was noticed. Wani *et al.* (2018) reported that that there was no significant difference in weight gain during starter phase due to inclusion of RGM at 7.5% in the diet as compared to control. Metwally and Farahat (2015) observed no significant difference in weight gain due to RGM supplementation in broiler diet during various growth periods and overall period. Inclusion of corn gluten meal (CGM) at 12% in the diet resulted in better weight gain in broilers (Seyedi and Hosseinkhani, 2014) as compared to control. However, Sherazi *et al.* (1995) reported that inclusion of RGM at lower level (2.5%) improved body weight gain, however, weight gain was depressed when inclusion of RGM was increased to 10%. Agena *et al.* (2019) reported that RGM can be included in broiler diets at a level of up to 12% without any negative effects on body weight gain.

Wani *et al* (2018) reported that feed intake was lower during pre-starter phase when RGM was incorporated into diet at 15%. however, results of this experiment show that RGM supplementation at 15% without enzyme (T_5) had higher feed intake during grower, finisher and overall phase whereas RGM supplementation at 15% with enzyme (T_6) had higher feed intake during grower and highest during finisher and overall phase. RGM supplementation at 10%

Table 2. Effect of RGM supplementation on average body weight gain and average feed intake in broilers

Variables	Average body weight gain						S.E.M.	P value
	T_1	T_2	T_3	T_4	T_5	T_6		
Starter phase	313.03^{a}	317.52^{ab}	332.55^{c}	336.76^{c}	324.49^{abc}	328.24^{bc}	2.039	≤0.05
Grower phase	301.20^{a}	324.51^{b}	330.41^{ab}	331.49^{b}	324.93^{b}	329.21^{b}	2.331	≤0.05
Finisher phase	765.48	748.23	737.46	737.89	760.45	759.14	3.274	0.023
Overall phase	1379.72^{a}	1390.27^{ab}	1400.43^{bc}	1406.15^{bc}	1409.87^{bc}	1416.60^{c}	3.150	0.001
	Average feed intake							
Starter phase	647.83^{b}	627.17^{a}	641.33^{ab}	641.52^{ab}	635.78^{ab}	642.38^{ab}	1.989	0.036
Grower phase	623.06^{a}	647.12^{b}	642.20^{b}	642.78^{b}	642.67^{b}	648.32^{b}	2.083	≤0.05
Finisher phase	1463.35^{a}	1488.40^{bc}	1477.06^{ab}	1474.83^{ab}	1483.06^{bc}	1494.43^{c}	2.485	≤0.05
Overall phase	2734.25^{a}	2762.70^{b}	2760.60^{b}	2759.15^{b}	2761.52^{b}	2785.14^{c}	3.695	≤0.05

Table 3. Effect of RGM supplementation on feed conversion ratio in broilers

Variables	Feed conversion ratio						S.E.M.	P value
	T_1	T_2	T_3	T_4	T_5	T_6		
Starter phase	2.07^{b}	1.97^{a}	1.92^{a}	1.90^{a}	1.95^{a}	1.95^{a}	0.012	≤0.05
Grower phase	2.06^{b}	1.99^{a}	1.94^{a}	1.93^{a}	1.97^{a}	1.96^{a}	0.010	≤0.05
Finisher phase	1.91^{a}	1.98^{b}	2.00^{b}	1.99^{b}	1.95^{ab}	1.96^{ab}	0.008	0.004
Overall phase	1.98	1.98	1.97	1.96	1.95	1.96	0.003	0.084
Protein efficiency ratio								
Starter phase	2.19^{a}	2.30^{b}	2.35^{bc}	2.38^{c}	2.31^{bc}	2.32^{bc}	0.014	≤0.05
Grower phase	2.24^{a}	2.33^{b}	2.39^{b}	2.39^{b}	2.35^{b}	2.36^{b}	0.012	≤0.05
Finisher phase	2.68^{b}	2.57^{a}	2.56^{a}	2.56^{a}	2.62^{ab}	2.60^{ab}	0.011	0.004
Overall phase	2.45	2.45	2.46	2.48	2.48	2.47	0.004	0.096
Calorie efficiency ratio								
Starter phase	0.1611^{a}	0.1688^{b}	0.1728^{bc}	0.1750^{c}	0.1701^{bc}	0.1704^{bc}	0.0010	d”0.05
Grower phase	0.1585^{a}	0.1644^{b}	0.1687^{b}	0.1691^{b}	0.1658^{b}	0.1665^{b}	0.0008	d”0.05
Finisher phase	0.1687^{b}	0.1622^{a}	0.1611^{a}	0.1614^{a}	0.1654^{ab}	0.1639^{ab}	0.0007	0.004
Overall phase	0.1646	0.1642	0.1655	0.1663	0.1666	0.1659	0.0002	0.083

without enzyme (T_3) and with enzyme (T_4) had higher feed intake during grower and overall phase but similar to control during starter and finisher phase. Metwally and Farahat (2015) observed no influence of RGM supplementation in broiler diet on feed intake, whereas, Seyedi and Hosseinkhani (2014) reported that corn gluten meal can be included in broiler ration upto 12% without any adverse impact on feed intake. Sherazi *et al.* (1995) reported that group fed with 10% RGM had significantly lower feed intake as compared to control. Our findings are similar to that of Agena *et al.* (2019) reported that upto 12% level of inclusion RGM had no significant effect on total feed intake in broilers.

Irrespective of enzyme RGM supplementation at 10% had significantly lower FCR during starter and grower phase, however, FCR was significantly higher (P<0.05) during finisher phase, resulting in overall no change in FCR due to RGM feeding at 10%of the diet. Similarly, feeding of RGM though caused some reduction in FCR during earlier phases, overall FCR was unaffected by RGM supplementation. This in contradiction with the finding of Seyedi and Hosseinkhani (2014) who reported that inclusion of 12% corn gluten meal (CGM) had better FCR as compared to control. as compared to control. Wani *et al.* (2018) observed that FCR was similar to control in broilers fed in 5 and 7.5% RGM group. Similarly, Mentally and Farahat (2015) reported no significant effect on FCR when RGM was included at 5% in the diets of broilers. Further, Agena *et al.* (2019) reported that up to 12% level of inclusion RGM showed no adverse impact on FCR. without negative effects on FCR at grower and finisher rearing stages as well as cumulative period. Overall, Per and FCR was also unaffected by inclusion of RGM upto 15% in the diet of broilers. In brief, the results of the current study indicate theta RGM can be safely included in broiler diet upto 15%, which is pretty similar to the recommendation of Dinani *et al.* (2020).

Table 4. Effect of RGM supplementation on apparent nutrient metabolizability† (%) in broilers

Variables	T_1	T_2	T_3	T_4	T_5	T_6	S.E.M.	P value
N	61.16^{a}	62.02^{ab}	65.079^{c}	65.06^{c}	64.17^{bc}	63.80^{abc}	0.474	0.009
Calcium	50.05	51.61	51.38	51.43	52.55	51.93	0.317	0.378
Phosphorous	61.60	63.26	63.13	64.35	63.47	63.77	0.357	0.394

^{a,b,c} Values bearing a different superscript within a row differ significantly (P<0.01); † Calculated as (nutrient retained/ nutrient intake)*100

However, in the previous study a further increase in inclusion level was achieved by supplementation of exogenous enzymes. In this experiment, however, no such positive influence of exogenous enzyme supplementation on RGM utilization was observed. Our results corroborate well with those of Wani (2017) who reported that enzyme supplementation had shown no significant improvement in BWG and FCR. On the contrary, Giannenas *et al.* (2017) reported that supplementation of protease enzymes to broilers diet containing corn gluten meal up to 20.10% showed significantly (P>0.05) lower feed intake and weight gain. Thus, it seems that response of enzyme supplementation would depend upon many factors, the composition of basal diet, composition of the enzyme, level of gluten meal and level of enzymes being some.

Data pertaining to the effect of RGM supplementation on nutrient metabolizability in broilers are presented in Table 4. Apparent metabolizability of Ca and P was similar among the groups. Similarly, Metwally and Farahat (2015) reported that digestibility of dry matter, crude protein, ether extract and NDF was not affected by feeding different levels of RGM in broilers. In this experiment inclusion of RGM at 10 and 15% improved the apparent metabolizability of N. Results of this experiment indicate that protein of RGM is of high quality. This corresponds to the earlier finding of Metwally and Farahat (2015) who reported that amino acid profile of RGM is superior to corn gluten meal especially with respect essential amino acids (methionine, lysine, arginine, valine and isoleucine).

CONCLUSION

It was concluded that RGM can be effectively incorporated into broiler diets up to 15% without any negative effect on growth performance and nutrient utilization.

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