



Evaluation of rice gluten meal as a potential alternate feed source for poultry

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ABSTRACT

A biological experiment was conducted in a factorial design (3×2×2) involving two substitution levels (20 and 40%) of basal diet with rice gluten meal (RGM) with and without enzymes (protease and multi-enzyme) in cockerels following practical diet replacement method. Birds (72) were divided into nine groups containing eight cockerel birds each. The conventional grower ration was provided to the birds for an adaptation period of 10 days followed by feeding of experimental diets for 14 days with final four days as collection period. A metabolic trial lasting for four days was done in which weighed quantity of feed was offered to birds and faeces voided were collected, weighed and dried. Both feed and faeces were analysed for gross energy value to calculate the apparent metabolizable energy for all diets and then apparent metabolizable energy (AME) of test ingredient, i.e. rice gluten meal. The AME value of RGM was 3035 and 3028 kcal/kg at 20 and 40% replacement levels of basal diet with a mean value of 3031 kcal/kg. However, with protease and multi-enzyme supplementation, a numerical increase of 37 and 35 kcal/kg of AME was observed, which was 1.22 and 1.15% more upon supplementation of protease and multi-enzyme, respectively. The proximate analysis revealed that rice gluten meal contains 92.30% dry matter which consists of 50% crude protein, 6.92% ether extract, 9.47% crude fibre, 21.54% nitrogen free extract and 4.37% ash. *In vitro* pepsin-pancreatin digestibility (IVPPD) of RGM was 81.50%. The total phosphorus content in the RGM was 0.78%, in which phytate content was 0.43% and non-phytate phosphorous was 0.35%, which is 44.87% of total phosphorous content. Hence, it can be concluded that RGM containing AME of 3031 kcal/kg, 50% crude protein with IVPP of 81.50% can prove to be a possible alternate feed source in the diet of poultry.

Keywords: Apparent metabolizable energy, Digestibility, *In vitro* pepsin pancreatin, Proximate analysis, Rice gluten meal

Poultry industry has emerged as the most dynamic and fastest growing sector in Indian agriculture. It is a healthy, palatable and economical source of food protein (Maheshwar *et al.* 2010). The major constituent in the poultry production is feed, accounting 65-70% of broiler and 75-80% of layer production cost. Feed supplied to birds must be of good quality, free from bacterial and fungal toxins. The quality and safe food can only be prepared from quality and safe raw materials. The quality control of animal feeds is commonly based on chemical analysis for determining the composition of the nutrients e.g. energy, protein, fibre, etc. Among the parameters of feed quality, most important are its energy and protein, as these are needed for execution of metabolic processes and animal activity. The animal is not able to utilize all energy of the feed (gross energy) but, only a bio-available portion called metabolizable energy (ME) and from protein (crude protein), only digestible portion (digestible crude protein) are utilized. These parameters serve as an accurate indicator of feed quality, and are crucial for diet formulation (Farrell

1999). The constant evaluation of the nutritional value and energy of feedstuff to be used in feed formulation is important in order to meet the nutritional needs of animals adequately (Morata *et al.* 2008).

The formulation of poultry feed is known to be based on corn and soybean meal, but their availability is variable, depending on region and time of year, leading to variations in their costs. This variation directly affects the profitability of poultry production. The variation and rising cost of production can be overcome by the use of energy and protein rich alternative feed ingredients, which might even be economical. Incorporation of de-corticoid cotton seed meal, as alternate protein source up to 15% level in basal diet replacing soybean meal by 61%, was found beneficial for economical egg production in laying hens (Wani *et al.* 2014). Similarly, in another study, decorticated cotton seed meal was safely and effectively included up to 20% level without enzyme supplementation in maize-soybean based diets of broiler chickens, for profitable broiler production (Sajad *et al.* 2016). In India, there is production of huge quantity of raw materials for livestock feeding, but only a narrow range of raw materials are used for poultry feed formulation due to lack of reliable data on their nutrient composition, presence of toxic/anti-nutritional factors, feeding value and their safe and effective level of inclusion.

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India is one of the largest producers of rice in the world producing approximately 116 million tonnes of rice in 2018-2019 (Annual Report 2019-2020). Therefore, a lot of by-products are available from rice processing industries. Rice gluten meal (RGM), a by-product of wet milling of rice, is available in appreciable amounts and at a lower cost. Thus, the present study was conducted to estimate the metabolizable energy, protein content and *in vitro* protein digestibility of rice gluten meal, to evaluate its feasibility in the diet of poultry.

MATERIALS AND METHODS

This study was conducted at Avian Nutrition and Feed Technology Division, ICAR-Central Avian Research Institute, Izatnagar, India. The experimental procedures carried out on the birds were approved by the Institutional Animal Ethics Committee of Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh, India.

The proximate analysis of rice gluten meal for moisture, crude proteins (CP), ether extract (EE), crude fibre (CF) and ash was done by recommended methods (AOAC 2000), calcium (Talpatra 1940) and fibre fractions (Van Soest and Wine 1967). All analysis was done in triplicate, mean value was calculated and reported. Mycotoxin (Aflatoxin B1 and Ochratoxin) screening of RGM was done by thin layer chromatography (AOAC 2000).

For the determination of available phosphorus, the total phosphorus content in the RGM samples were analysed following standard techniques (AOAC 2000). The phytate phosphorus content was analysed as per Haugh and Lantzsich (1983). Samples weighing 0.02 g were extracted with 10 ml 0.2 N HCl. An aliquot of 0.5 ml extract was pipetted into a test tube fitted with a glass stopper. One ml of ferric solution was added into the tubes and tubes were covered with a stopper fixed with a clip. The tubes were heated in a boiling water bath for 30 min, care was taken that tubes remained well stoppered for the first 5 min. After cooling in ice water for 15 min, tubes were allowed to adjust at room temperature. The contents of the tubes were mixed and centrifuged for 30 min at 3000 rpm. One ml of 2, 2-bipyridine solution was transferred to another test tube and 1.5 ml of ferric solution was added. The contents were mixed and absorbance was measured after a defined time (0.5-1 min is recommended) at 519 nm against distilled water.

In vitro pepsin-pancreatin digestibility of RGM samples (triplicate) and soybean meal was measured as per the method of Gopalkrishnan and Jamuna (2000). One gram

Table 1. Ingredient composition of the Basal diet (T1) for ME bioassay of RGM

Ingredient	Parts/100 parts
<i>Basal mixture</i>	
Maize	84.00
Soybean meal	10.00
Fish meal	5.00
Total	99.00
<i>Supplement</i>	
Limestone powder	0.48
Di-calcium phosphate	0.25
Sodium chloride	0.20
Trace elements*	0.05
Vitamin premix*	0.01
B-complex	0.01
Total	1.00

*Vitamin A, 6000 IU; Vitamin D₃, 1200 ICU; Vitamin E, 10 IU; Riboflavin, 5 mg; Nicotinamide, 12 mg; Calcium pantothenate, 3 mg; Cyanacobalamin, 10 ug; Choline chloride, 180 mg; Mn, 30 mg; Fe, 10 mg; I, 1.5 mg; Co, 0.5 mg.

of finely ground RGM was suspended in 15 ml of 0.1 N HCl, containing 1.5 mg pepsin in a 100 ml conical flask and heated over a water bath with 5 ml of water for 10 min. The mixture was incubated at 37°C for 3 h. The suspension was then neutralized with 0.5 N NaOH and treated with 4 mg pancreatin in 7.5 ml of 0.2 M phosphate buffer (pH 8.0), containing 0.005 M sodium azide. After that, the mixture was incubated for different time intervals (30-50 min). Ten millilitres of 10% tri-chloroacetic acid (TCA) was added to the mixture to stop the reaction. The mixture was then centrifuged at 3000 rpm for 20 min at 27°C. The supernatant was estimated for nitrogen by micro-Kjeldahl method. A blank was also prepared in the same manner without the sample and the value was subtracted from total digestibility of each sample (Akeson and Stahmann 1964).

Crude protein (CP) was determined by the macro-Kjeldahl technique (%N × 6.25).

IVPPD was calculated with the formula:

IVPPD (%) = (CP supernatant - CP blank) / (CP Rice gluten meal) × 100.

A metabolic trial was conducted involving two substitution levels (20 and 40%) of basal diet with rice gluten meal (RGM) in cockerels following practical diet replacement method (Sibbald and Slinger 1963). Experiment was conducted in a factorial design (3×2×2)

Table 2. Composition (%) of experimental diet for ME bioassay of RGM

Group	T1	T2	T3	T4	T5	T6	T7	T8	T9
Reference [#]	99.0	99.0	99.0	79.0	79.0	79.0	59.0	59.0	59.0
Supplement	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
RGM	0.00	0.00	0.00	20.00	20.00	20.00	40.00	40.00	40.00
Enzyme	-	P	M	-	P	M	-	P	M
Total	100	100	100	100	100	100	100	100	100

[#]Reference includes maize, soybean meal and fish meal. RGM, Rice gluten meal; P, protease; M, multienzyme.

in a well-ventilated open shed with ceiling fans. The birds were provided natural light for about 12 h with no artificial light. There were nine groups containing eight cockerel birds each. Each cockerel was kept individually in raised wire floor metabolism/layer cage, with separate feeding, watering and excreta collection facility. The dimensions of the cages used for rearing cockerels were 45 cm long × 30 cm wide × 46 cm depth. During the preliminary feeding period of 10 days, the birds were fed on conventional basal diet. Thereafter, basal diet and test diets (Tables 1, 2) were offered at two substitution levels (20 and 40%) with and without enzyme to each group for a 10 days adaptation period. The birds were given free access to water, basal and test diets, feed intake during adaptation period was recorded to ascertain the intake capacity of birds. This was followed by a collection period of four days. During this period, a weighed quantity of feed was offered to match the previous mean feed intake of the birds. Precautions were taken to avoid spillage of feed using properly designed feeders measuring 16 cm long × 9.5 cm wide × 13.5 cm deep for cockerels. The total excreta collection method was employed. The excreta samples were dried at 60°C in a forced hot-air oven. The feed and excreta samples were ground and assayed for gross energy using an adiabatic bomb calorimeter (Toshniwal Technologies Pvt. Ltd.). Apparent metabolizable energy of basal diet and test diets were calculated.

The information gathered in the balance study and knowledge of the GE contents of diets and excreta samples was utilized for calculating the ME value of a particular diet (Hill and Anderson 1958). The calculation was made in the following manner:

$$\text{AME of diet (kcal/kg)} = (\text{FI} \times \text{GE}) - (\text{EW} \times \text{GE}) / \text{FI}$$

where AME, Apparent metabolizable energy (kcal/kg); FI, Feed intake (g/bird); GE, Gross energy (kcal/kg); EW, Weight of dried excreta (g/bird).

Having derived the AME value for the various diets, the AME value of the test material employed at a particular level was worked out as follows:

AME of the test ingredient (kcal/kg)

$$= \frac{\text{AME of test diet} - [\text{AME of reference diet} \times (\% \text{ of basal in test diet} / \% \text{ of basal in reference diet})] \times 100}{\% \text{ of test material in test diet}}$$

The data obtained in the experiment was statistically analysed for mean, standard errors and analysis of variance by Snedecor and Cochran (1989) using statistical package for social sciences (SPSS) 16th version and comparison of mean was tested using Duncan's multiple range tests (Duncan 1955).

RESULTS AND DISCUSSION

The proximate analysis (Table 3) revealed that rice gluten meal contains 92.30% dry matter which consists of 50% crude protein, 6.92% ether extract, 9.47% crude fibre, 21.54% nitrogen free extract, 4.37% ash, and 36.7% neutral detergent fibre. Metwally and Farhat (2015) reported higher value of RGM in terms of protein (57.60%), but lower values of RGM in terms of EE (3.16%) and CF (1.45%) as compared to our results. Similarly, Kumar *et al.* (2016) reported lower values of RGM in terms of protein (46.40%) and ether extract (3.40%) as compared to our results. Dinani *et al.* (2020) reported similar value of RGM in terms of protein (49.90%) but lower values of RGM in terms of EE (5.7%) and CF (7.4%) and higher value in terms of nitrogen free extract (33.50%). Rice gluten meal used in our study contained 4.37% TA, which is close to the value (5%), reported by Kumar *et al.* (2016) but higher than the value 1.24% and 3.30%, reported by Metwally and Farhat (2015) and Dinani *et al.* (2020), respectively. The value of neutral detergent fibre (NDF) obtained in our analysis was 36.70%, which is lower than the value (40.40%) reported by Kumar *et al.* (2016). The variation in composition of RGM may be due to many factors such as base grain used, milling process and the preparation of the final product especially drying and packaging. Furthermore, the drying process can have crucial influence not only on variability of nutrients but also on concentration and availability of amino acids in different samples (Bandegan *et al.* 2009). No detectable aflatoxin B1 and ochratoxin was found in RGM.

The total phosphorus content (Table 4) in the RGM samples analysed in our experiment was 0.78%. The phytate phosphorus content was 0.43% and non-phytate phosphorous (available phosphorous) was found 0.35%, which is 44.87% of total phosphorous. In contrast to our results, Metwally and Farhat (2015) reported lower value (0.40%), whereas Dinani *et al.* (2020) reported higher

Table 3. Chemical composition of RGM (%) on dry matter (DM) basis

Chemical composition	(%) on DM basis	Chemical composition	(%) on DM basis
Moisture	7.70	Neutral detergent fibre (NDF)	36.70
Dry matter (DM)	92.30	Acid detergent soluble (ADS)	22.40
Crude protein (CP)	50.00	Acid detergent fibre (ADF)	14.30
Ether extract (EE)	6.92	Acid detergent lignin (ADL)	3.18
Crude fibre (CF)	9.47	Total phosphorous (TP)	0.78
Total ash (TA)	4.37	Non-phytate phosphorous (NPP)	0.35 (44.87% TP)
Acid insoluble ash (AIA)	1.32	Phytate phosphorous (PP)	0.43
Nitrogen free extract (NFE)	29.24	IVPPD (%)	81.50
Calcium (Ca)	0.62	Gross energy (Kcal/kg)	4537

Table 4. Effect of feeding RGM on feed intake (FI), excreta DM (%), dry matter metabolizability (DMM %), apparent metabolizable energy (AME kcal/ kg) and gross energy metabolizability (GEM %) of diets fed to cockerels

Treatment	RGM (%)	Enzyme	FI (g/b/d)	Excreta DM (%)	DMM (%)	AME (kcal/ kg)	GEM (%)
Control-1	-	-	88.80	21.42	75.86 ^c	3167	80.80 ^d
Control-2	-	Protease	93.60	22.33	76.06 ^c	3274	82.30 ^c
Control-3	-	Multi-enzyme	92.40	20.92	76.63 ^c	3251	82.03 ^{de}
T1	20	-	91.58	25.17	72.56 ^b	3134	77.95 ^c
T2	20	Protease	92.33	22.08	75.91 ^c	3226	81.70 ^{de}
T3	20	Multi-enzyme	81.38	20.00	75.30 ^c	3210	81.03 ^{de}
T4	40	-	97.20	29.75	69.44 ^a	3096	74.74 ^a
T5	40	Protease	88.95	27.50	69.15 ^a	3176	75.93 ^{ab}
T6	40	Multi-enzyme	80.78	23.92	70.49 ^a	3157	76.38 ^b
Pooled SEM			3.39	0.88	0.38	8.55	0.36
<i>RGM (%)</i>							
0			91.60	21.56 ^a	76.18 ^c	3231 ^c	81.71 ^c
20			88.43	22.42 ^a	74.59 ^b	3190 ^b	80.22 ^b
40			88.98	27.06 ^b	69.69 ^a	3143 ^a	75.68 ^a
<i>Enzyme</i>							
-			92.53	25.44	72.62 ^a	3132 ^a	77.83 ^a
Protease			91.63	23.97	73.71 ^b	3225 ^b	79.97 ^b
Multi- enzyme			84.85	21.61	74.14 ^b	3206 ^b	79.81 ^b
<i>Significance</i>							
RGM			NS	P<0.05	P<0.01	P<0.01	P<0.01
Enzyme			NS	NS	P<0.01	P<0.01	P<0.01
Interaction			NS	NS	P<0.01	NS	P<0.05

value (0.98%) of total phosphorous in RGM. Phytic acid represents 50-85% of total phosphorous in plants (Reddy *et al.* 1982). The major storage form of phosphorous in cereals, legumes, oil seeds and nuts is phytic acid, known as a food inhibitor which chelates micronutrients and restricts its bioavailability for mono-gastric animals, including humans. Phytic acid is myoinositol 1,2,3,4,5,6-hexakis di-hydrogen phosphate, a major storage form of phosphorous comprising 1-5% by weight in cereals, legumes, oil seeds and nuts (Van Soest and Wine 1967). In cereal grains, rice and wheat, it is found in bran fraction such as aleurone layer and pericarp, and in corn, it is seen in endosperm (O'Dell *et al.* 1972). Mono-gastric animals including poultry and humans are unable to metabolize phytic acid due to the lack of sufficient level of phytate degrading enzyme activity in their digestive tract (Schroder *et al.* 1996, Wodzinski *et al.* 1996, Singh *et al.* 2011) and is largely excreted in their manure. Hence, efforts are made to either eliminate or reduce phytic acid content in plant feed-stuffs through chemical methods, solid state fermentation technology and autolysis or by the use of phytase enzyme in diet.

The mean value of *in vitro* pepsin pancreatin digestibility (IVPPD) of RGM samples was 81.50%, whereas that of soybean meal was 88.20%. The IVPPD of RGM was slightly lower than that of soybean meal. Our results for RGM were close to the value (81.90%) reported by Dinani *et al.* (2018). Measurement of *in vitro* dry matter digestibility (DMD) and protein digestibility (PD)

have been extensively used to analyse feeds due to their correlation with *in vivo* digestibility (Martens 2005). The two-step pepsin pancreatin system simulates the digestion in the stomach and the small intestine, and appears to be an effective system to predict organic matter digestibility in pigs (Pujol and Torralardona 2007), although, it doesn't take into account some aspects of *in vivo* digestion such as endogenous secretions, absorption, and transit (Wodzinski *et al.* 1996, Noblet and Jaguelin-Peyraud 2007). The cereal grains contain only limited quantities of crude protein and amino acids, but the grain by-products contain crude protein and amino acids in appreciable amounts. The reason for this difference is that grain by-products are produced after processing, that primarily removes the nitrogen free extract from the grains. This increases the concentration of proteins and amino acids in the grain by-products. Rice gluten meal (RGM), employed in our study is a protein by-product of wet-milling of rice containing 50% crude protein, having protein digestibility of 81.20%.

The commercial multi-enzyme preparation (ROSSCOMP) was analyzed for different enzyme activities following standard methods compiled by Sastry *et al.* (1999). The preparation contained amylase (EC 3.2.1.1) 2000±51 mIU/g, glucanase (EC 3.2.1.21) 150±25 mIU/g, xylanase (EC 3.2.1.8) 3000±48 mIU/g, carboxymethyl 63 cellulase (EC 3.2.1.4) 40±12.5 mIU/g, pectinase 150±48 mIU/g, proteinase 600±52 mIU/g, galactosidase 250±38 mIU/g, galactosidase (EC 3.2.1.37) 200±21 mIU/g, lipase 400±45

mIU/g and phytase 50 ± 4.8 mIU/g. Cibenza (Novus) was used as a source of protease enzyme having activity 6 lacs U/g @ 50 g/100 kg supplemented in the diet.

The data pertaining to feed intake (FI), excreta dry matter, apparent metabolizability (AME) [kcal/kg], dry matter metabolizability (DMM) and gross energy metabolizability (GEM) of diets with and without enzyme supplementation is given in Table 4. FI of cockerels did not differ significantly ($P > 0.05$); however, excreta DM, DMM%, GEM% and AME (kcal/kg) of diets fed to cockerels differed significantly ($P < 0.05$) on replacement of basal diet with 20 and 40% RGM. The excreta DM was lowest in control and 20% RGM replacement groups and highest in 40% RGM replacement groups; while the DMM%, GEM% and AME (kcal/kg) were highest in control and 20% RGM replacement groups and lowest in 40% RGM replacement groups. There was no significant ($P > 0.05$) difference in feed intake and excreta DM on protease and multi-enzyme supplementation, but the DMM (%), GEM (%) and AME (kcal/kg) differed significantly ($P < 0.01$), being lowest in control and highest in protease and multi-enzyme supplemented groups. No significant ($P > 0.05$) difference was observed in feed intake, excreta DM and AME of diets fed to cockerels due to interaction of RGM and protease or multi-enzyme supplementation. However, DMM% and GEM% of diets differed significantly ($P < 0.05$) on interaction of RGM and protease or multi-enzyme supplementation. The lowest values of DMM% was found in T4, T5 and T6 groups, where basal diet was replaced with RGM at 40% level and higher value was

found in control and 20% RGM replacement groups. The GEM% of diets followed the same trend, but in protease and multi-enzyme supplemented groups, the GEM% was observed significantly ($P < 0.05$) higher as compared to non-enzyme supplemented groups. From the results, it can be concluded that as the percentage of RGM in the basal diet increases from 20 to 40%, DMM%, GEM% and AME of the diet decreased, indicating lower availability of nutrients in the diet. This shows that the birds are not able to utilize the nutrients of the diet on inclusion of RGM at a level higher than 20%. Also, supplementation of protease and multi-enzyme significantly increased the available nutrients to the bird in the diet. Enzyme supplementation of poultry diets is nutritionally, environmentally and economically justified. Enzymes are used to increase the energy value of feed ingredients and enhance the utilisation of protein, fats, carbohydrates and phytin phosphorus from plant materials, leading to a lower excretion rate of undigested nutrients into the environment and, hence, reduced environmental pollution. Ghazi *et al.* (2003) observed an improvement in broiler live performance as well as energy and nitrogen utilization when proteases were added to diets. Similarly, Peek *et al.* (2009) found that protease addition affects the mucous layer thickness in the gastrointestinal tract, apparently alleviating the effect of a coccidial infection, resulting in higher weights.

The data pertaining to apparent metabolizability (AME) [kcal/kg], gross energy metabolizability (GEM) and dry matter metabolizability (DMM) of RGM with and without protease and multi-enzyme supplementation

Table 5. Dry matter metabolizability (DMM %), apparent metabolizable energy (AME kcal/ kg) and gross energy metabolizability (GEM %) of RGM fed to cockerels

Treatment	RGM (%)	Enzyme	AME (kcal/ kg)	GEM (%)	DMM (%)
Control-1	-	-	-	-	-
Control-2	-	Protease	-	-	-
Control-3	-	Multi-enzyme	-	-	-
T1	20	-	3035	73.35	82.19 ^b
T2	20	Protease	3067	74.15	82.41 ^b
T3	20	Multi-enzyme	3076	74.36	83.03 ^b
T4	40	-	3028	73.19	78.61 ^a
T5	40	Protease	3070	74.2	82.25 ^b
T6	40	Multi-enzyme	3056	73.87	81.58 ^b
Pooled SEM			18.97	0.46	0.3
<i>RGM (%)</i>					
20			3059	73.95	82.54 ^b
40			3051	73.75	80.81 ^a
<i>Enzyme</i>					
-			3031	73.27	80.40 ^a
Protease			3069	74.17	82.33 ^b
Multi-enzyme			3066	74.11	82.31 ^b
<i>Probability</i>					
RGM			NS	NS	$P < 0.01$
Enzyme			NS	NS	$P < 0.01$
Interaction			NS	NS	$P < 0.05$

are given in Table 5. The GEM% and AME (kcal/kg) were found non-significant ($P>0.05$) at different levels of RGM, whereas DMM% differed significantly ($P<0.01$) at different levels of RGM and was highest in 20% RGM replacement groups and lowest in 40% RGM replacement groups. The DMM% showed a significant ($P<0.01$) difference on enzyme supplementation, being lowest in the non-enzyme supplemented group and highest in the enzyme supplemented groups. The AME (kcal/kg) and GEM% did not differ significantly ($P>0.05$), but DMM% differed significantly ($P<0.05$) on interaction of RGM with protease or multi-enzyme supplementation. The DMM% values were highest in enzyme supplemented groups as compared to non-enzyme supplemented groups. The estimated AME value of RGM was 3035 and 3028 kcal/kg at 20 and 40% replacement with a mean value of 3031 kcal/kg. However, with protease and multi-enzyme supplementation, the values estimated were 3067, 3070 and 3076, 3056 kcal/kg, respectively at 20 and 40% replacement, with a mean value of 3068 and 3066 kcal/kg, respectively. Therefore, a numerical increase of 37 and 35 kcal/kg of AME was observed, which is 1.22 and 1.15% more upon supplementation of protease and multi-enzyme, respectively. There are only few references available on the estimation of apparent metabolizable energy (AME) value of RGM in poultry. In the present investigation, the estimated mean value of AME of RGM was 3031 kcal/kg, which is close to the value of 3152 kcal/kg reported by Kumar *et al.* (2016) but lower than the value of 3330 kcal/kg reported by Metwally and Farhat (2015). The metabolizable energy content of cereals like maize, jawar, bajra are 3300, 3000, 2640 kcal/kg respectively, whereas that of pulses like soybean meal, groundnut meal are 2250, 2400 kcal/kg, respectively (BIS 2007). The AME value of RGM, i.e. 3031 kcal/kg reported in our study indicates that it is a good source of energy, hence can be included in the diet of poultry.

In conclusion, chemical analysis on dry matter basis indicated that rice gluten meal is a high protein (CP 50%) source with *in vitro* pepsin-pancreatic digestibility of 81.50%. The gross energy value of rice gluten meal was 4537 kcal/kg with a metabolizable energy value of 3031 kcal/kg. Thus, it can be concluded that rice gluten meal is a high protein and a good source of energy, hence can prove to be a good alternate feed source for poultry.

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