Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2018; 6(2): 2943-2945

Received: 15-01-2018
Accepted: 16-02-2018

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In vitro evaluation of rice gluten meal as a ruminant feed

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Abstract
This experiment aimed at studying the nutritional characteristics of rice gluten meal (RGM) along with conventional protein source groundnut cake (GNC). RGM contained 464 g/kg of crude protein with 821 and 196 g/kg nitrogen as borate-buffer insoluble nitrogen and acid detergent insoluble nitrogen, respectively, which were higher (P<0.05) when compared to GNC. *In vitro* gas production (183 and 192 mL/g), organic matter digestibility (737 and 751 g/kg), metabolisable energy (13.15 and 13.56 MJ/kg), net energy for maintenance and gain were comparable between RGM and GNC, respectively. Furthermore, the concentration of critical amino acids like lysine was almost comparable between the two feeds, whilst methionine level was slightly higher in RGM.

Keywords: Amino acids, groundnut cake, insoluble nitrogen, *in vitro* evaluation, rice gluten meal

Introduction

Locally available by-product feeds has been explored many times for sustainable livestock production throughout the world (Eisler *et al*. 2014) [3]. In this context, rice gluten meal (RGM) which is a by-product of wet-milling of rice, is relatively a newer feedstuff with brown coarse powdery texture and is available in appreciable amounts in northern part of India. Commercial traders categories RGM as a high crude protein (CP) (40–55%) and high-energy (75% total digestible nutrients, TDN) ingredient, which is currently priced equivalent to GNC and is recommended for feeding ruminants and poultry (www.innovativesoch.com/rice-gluten-meal/). Rice gluten meal is the dried residue from rice after the removal of starch, and separation of the bran by the process employed in the wet milling manufacture of rice starch or syrup or glucose. In India, the broken rice is increasingly being used in the rice starch or glucose production industry. So in future, a large amount of rice gluten meal is likely to be available in the country. Rice gluten meal has a fairly good amino acid profile, plenty of vitamins and high protein content. Thus, it can be an excellent animal feed resource for reducing ration cost, replacing portions of expensive protein meals such as soybean meal and maize gluten meal and hence reducing the feed cost for farmers and feed manufacturers. It is a rich source of phosphorous also. Phosphorous is present as phytates form. Rice gluten meal is being fed to poultry and aquatic animals as a protein source. It may provide livestock with high protein content having rich amino acids profile as compared to that of soy meal, groundnut extracted cake, maize gluten meal etc. It can prove to be a popular animal feed source and excellent alternate for soy meal and maize gluten meal which may reduce the production cost of animal feed by 10 to 20%. A huge gap between availability and requirements of concentrate feeds to the tune of 47% (NIANP, 2015) [9] calls for exploring newly available feed ingredients to reduce competition between human and livestock for feed. Although, such alternative feeds could offer an opportunity to enhance national feed balance, many of them are poorly studied in terms of nutrient composition, energy and protein content, palatability as well as nutrient utilisation. In this context, rice gluten meal (RGM), a co-product of wet-milling manufacture of starch from rice is considered in the present experiment with an objective of assessing *in vitro* gas production, digestibility, energy and protein value as well as amino acid composition, in comparison with conventional protein source groundnut cake (GNC).

Materials and Methods

Chemical composition and fibre fractionation was done as per AOAC (2005) [1]. Nitrogen fractions of feedstuffs were estimated as delineated by Licitra *et al.* (1996) [7]. For *in vitro* gas production ($GP_{24\ h}$), prediction of organic matter digestibility and metabolisable energy, methods of Menke and Steingass (1988) [8] involving Hohenheim gas test were followed. Net energy for maintenance and gain were calculated from the equations, as exemplified in NRC (2001) [10].

a. NE for maintenance (MJ/Kg) = $1.37ME-0.138ME^2+0.0105ME^3-1.12$
b. NE for growth (MJ/Kg) = $1.42ME-0.174ME^2+0.0122ME^3-1.65$

Metabolisable energy was calculated from IVGPT (Krishnamoorthy *et al*., 1995) [6] by using following formulas:

a) For cereals and byproducts: ME (MJ/Kg) = 1.06+0.1570GP+0.0084CP+0.022EE-0.0081TA
b) For roughages: ME (MJ/Kg) = 2.2+0.1357GP+0.0057CP+0.0002859EE2

In vitro organic matter digestibility was calculated by using following formula

a) For cereals and by products - IVOMD = 9+0.9991GP+0.0595CP+0.0181TA
b) For roughages - IVOMD = 16.49+0.9042GP+0.0492CP+0.0387TA

Amino acid analysis was completed at a wavelength of 254 nm using high performance liquid chromatography (HPLC, Waters India Pvt. Ltd., New Delhi) equipped with Picotag® assembly (tunable absorbance detector) and Millennium® software.

Statistical analysis

The data were expressed as mean± standard error and subjected to one-way analysis of variance using Statistical Analysis System (SAS Inst. Inc., Cary, NC, USA) software, fitting the following linear model: Yi = ¼ µ + þ Ti + þ εi

Results and Discussion

Chemical analysis of Rice gluten meal and Groundnut cakes is shown in Table 1 with organic matter (950 vs 901), crude protein (464 vs 446), ether extract (34.4 vs 68.9), total ash (50 vs 99) neutral detergent fibre (404, 286), acid detergent fibre (173, 167), hemicellulose (231vs 119) and acid detergent lignin (38.4 vs 49.8). RGM contained 464 g/kg of crude protein with 821 and 196 g/kg nitrogen as borate-phosphate insoluble nitrogen and acid detergent insoluble nitrogen, respectively, which were higher ($P<0.05$) when compared to GNC (Table 1). *In vitro* gas production (183 and 192 mL/g), organic matter digestibility (737 and 751 g/kg), metabolisable energy (13.15 and 13.56 MJ/kg), net energy for maintenance and gain were comparable between RGM and GNC, respectively. Furthermore, the concentration of critical amino acids like lysine was almost comparable between the two feeds, whilst methionine level was slightly higher in RGM (Table 1).

A low N solubility of RGM in borate- phosphate buffer reflects its resistance to degradation in. Concurrently, high rumen escape potential of gluten proteins have been already documented for CGM by Heuzé *et al*. 2015 [4] and Wadhwa *et al*. 2012 [11] accounted it for the presence of cereal prolamins and glutelins proteins in gluten meals that strongly resist ruminal proteolysis. Higher ADIN found in RGM could be due to heat treatment applied during processing has been reported for similar feed CGM (NRC 2001) [10]. Although ADIN has been generally believed to be completely indigestible, some researchers observed a considerable proportion of N that is available from heat-treated feedstuffs irrespective of ADIN level (Klopfenstein 1996; NRC 2001; Cabrita *et al*. 2011) [5, 10, 2]. GP24 h, OMD and ME found in the present study for GNC agree closely with the previous estimates of Krishnamoorthy *et al*. (1995) [6], and the similar values obtained for the test ingredient RGM surmises that it compares favourably with GNC. Furthermore, the present results substantiated that the GP24 h reflects good OMD and in turn energetic feed value for ruminants (Krishnamoorthy *et al*. 1995) [6].

Table 1: Comparison of chemical composition, energy and protein values of test feeds

Parameter	RGM	GNC
Organic matter	950	901
Crude protein	464	446
Ether extract	34.4	68.9
Ash	50	99
Neutral detergent fibre	404	286
Acid detergent fibre	173	167
Hemicellulose	231	119
Acid detergent lignin	38.4	49.8
Borate-phosphate insoluble N	821 ± 2.5[a]	368 ± 3.3[b]
Acid detergent insoluble N	196 ± 3.9[a]	27.7 ± 3.0[b]
Non-protein N[†]	115 ± 1.9	102 ± 2.1
$GP_{24\ h}$ (mL/g)	183 ± 0.95	192 ± 1.05
Organic matter digestibility (g/kg)	737 ± 1.9	751 ± 2.1
Metabolisable energy (MJ/kg)	13.15 ± 0.03	13.56 ± 0.03
Net energy for maintenance (MJ/kg)	8.98 ± 0.02	9.32 ± 0.02
Net energy for gain (MJ/kg)	6.16 ± 0.01	6.44 ± 0.01
Lysine (% crude protein)	3.19	3.29
Methionine (% crude protein)	2.08	1.17
NEAA	46.8	46.9
BCAA	17.0	13.8
Total AA	86.4	85.9

Means bearing different superscripts (a, b) in a same row differs ($P<0.05$); $GP_{24\ h}$ net gas production after 24 h of incubation in buffered rumen fluid; [†] Estimated as 1000-Trichloroacetic acid precipitable nitrogen (g/kg N)

Conclusions

It was concluded that RGM and GNC differed greatly with respect to nitrogen solubility. Moreover, *in vitro* gas production, organic matter digestibility and energy values of RGM were comparable with those of GNC. This preliminary study proves potential of RGM to be used as a protein source for ruminant diets.

Acknowledgments

We thank the Director, ICAR-National Dairy Research Institute for providing necessary research facilities for this study and first author acknowledges ICAR, New Delhi for providing Junior Research Fellowship during this research.

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