Utilization of Energy and Protein in Local Indian Crossbred Gilts Fed Diets Containing Different Levels of Rice Bran

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ABSTRACT : Fifty four crossbred gilts of 26.38±0.85 kg body weight and 25 weeks of age were randomly divided into three groups, having six replicates of three animals each and were assigned to one of the three dietary treatments containing corn, wheat bran and rice bran (RB) at 35, 47 and 0% in R_1; 17.5, 23.5 and 41% in R_2 and 0, 0 and 82% in R_3. Soybean meal and fishmeal were used as source of protein at 10 and 6%, respectively, in all the rations. Average daily CP, DCP, DE and ME intake per kg $W^{0.75}$ and body weight gains were lowest ($p<0.01$) in gilts fed 82% RB (R_3), followed by R_2 and R_1. Utilization of protein with respect to nitrogen balance and DCP conversion efficiency did not differ ($p>0.05$) between the treatment groups. All the gilts were in positive nitrogen balance. However, the excretion of dietary nitrogen and energy through faeces was higher ($p<0.01$) in gilts fed RB. However, the DE and ME conversion efficiency were higher ($p<0.01$) in gilts fed RB. Therefore, it can be concluded that the digestibility of energy and protein in diets containing rice bran goes on decreasing with the increasing level of fat and fibre, but the metabolizability of the energy and protein was better in pigs fed RB in the diet. ***(Asian-Aust. J. Anim. Sci. 2004. Vol 17, No. 5 : 688-692)***

Key Words : Gilts, Rice Bran, Protein, Energy, Utilization

INTRODUCTION

The productive performances of the local Indian pigs are comparatively lower than that of developed breed due to genetic make up. The nutrient requirements and conversion efficiencies are markedly different in these breeds in comparison to exotic one. Therefore, there is a need to study the utilization of dietary energy and protein containing variable level of energy as specified by Bureau of Indian Standards (BIS, 1987). However, in practice the BIS recommended level of protein and energy in the diet of the gilts are almost similar to that of NRC (1988) recommendation which can support ADG of 500 to 800 g. Thus, the utilization of major nutrients namely protein and energy with variable fibrous diets may help in the incorporation of high fibre feeds like rice bran judiciously in the process of developing low cost feeds for swine under Indian condition. Such type of ration may be suitable for 300 to 400 g gain of Indian crossbred pigs. As the fresh rice bran contains sufficient oil due to which it is one of the easily available and palatable source of energy in the pig diets. Addition of rice bran at higher level increases the fibre content of the diets to the extent to reduce nitrogen balance (Yadav and Gupta, 1995) due to higher faecal nitrogen loss. Moreover, the utilization of dietary energy decreases with the increased level of rice bran, particularly solvent extracted, in diet (Bhar et al., 2001). Thus, the objective of the research was to study the utilization of energy and protein in pig diets with graded levels of rice bran.

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MATERIALS AND METHODS

Fifty-four crossbred gilts (Landrace×Local Indian) of 26.38±0.85 kg body weight and 25 weeks of age were randomly divided into three groups in completely randomized design (CRD) having 6 pens (replicates) of 3 animals each. The gilts in each group were offered one of the three diets namely, R_1, R_2 and R_3 containing rice bran as a major source of energy at 0, 41 and 82%, respectively (Table 1). The protein content of the diets was kept almost similar by assigning soybean meal and fishmeal at uniform level. The experiment was conducted on the gilts under standard hygienic and uniform managemental conditions throughout the experimental period at the Swine Production Farm of the Indian Veterinary Research Institute as a part of an All India Coordinated Research Project on pigs. The animals were housed in well-ventilated cement-floored pen of 2. 95×4.65 m size with a run of 7.15×4.65 m. The average temperature during the experimental period was 20±2°C. All the animals were vaccinated and dewormed as per the normal schedule of the farm.

Feed was offered once daily in the morning and the gilts were allowed to have *ad libitum* intake in groups, with free access to drinking water through out the day. Feeding trail was conducted for 112 days and daily records of feed intake

Table 1. Dietary ingredients, chemical compositions (%) and calorific value of the experimental diets

Ingredients	R_1	R_2	R_3
Corn	35	17.5	0
Wheat bran	47	23.5	0
Rice bran	0	41	82
Soybean meal	10	10	10
Fish meal	6	6	6
Mineral mixture*	1.5	1.5	1.5
Salt	0.5	0.5	0.5
Vitablend AD_3 (g/100 kg)	15	15	15
Attributes			
Organic matter	92.02	88.90	86.20
Crude protein	18.76	18.09	17.07
Ether extract	2.83	7.11	9.29
Crude fibre	6.38	11.6	15.94
Nitrogen free extract	64.05	52.54	43.90
Total ash	7.98	11.10	13.80
Acid insoluble ash	1.17	4.17	6.35
Gross energy (kcal/kg)	4,680	4,630	4,620
Digestible energy (kcal/kg)	3,386	2,713	2,366

* Composition of mineral mixture, Calcium-28%, Phosphorus-12%, Iodine (as Potassium iodide)-0.1%, Copper-0.13%. Dietary treatments R_1, R_2 and R_3 contain 0, 41 and 82% of rice bran, respectively.

were maintained. Body weight changes of the gilts were recorded at fortnightly intervals in the mornings before offering feed. Toward the end of the experimental feeding at 51.39±0.71 kg body weights, a metabolism trial of 6 days duration was carried out on eight representative gilts to study the nitrogen balance and dietary energy utilization. An adjustment period of six days duration was allowed for the gilts to adopt in the metabolism cages prior to collection of faeces and urine. Feed offered, residues left, faeces and urine excreted were recorded daily on 24 h basis. Feeds, residues and faecal samples were dried at 100±1°C for 24 h and stored for further analysis. Another aliquot of faeces was preserved with 1:4 sulphuric acid for nitrogen determination. Similarly, for the estimation of urinary nitrogen a suitable aliquot of urine was taken in the Kjeldahl flask containing 40 ml of commercial sulphuric acid. For the estimation of faecal energy an aliquot of faecal sample (1/60th) was dried at 37°C. A suitable aliquot of urine (1/200th part) was preserved in plastic bottles and kept in deep freeze for energy estimation of urine. Samples of feeds, residues and faeces were analyzed for proximate constituents and urine were analyzed for nitrogen (AOAC, 1995). Gross energy (GE) content of feeds, residues, faeces and urine samples was estimated by Gallenkamp Ballistic Bomb Calorimeter (CBB 330) manufactured by M/S Expotech USA., Inc. Houston, Texas. A measured quantity of dried feeds, residues and faeces was pelleted and measured volume (10 ml) of urine sample (pH adjusted, slightly acidic) after drying in hot air oven at 37°C in a pre-weighed butter paper disc of known energy value was burnt in bomb and deflection in the galvanometer was noted. The

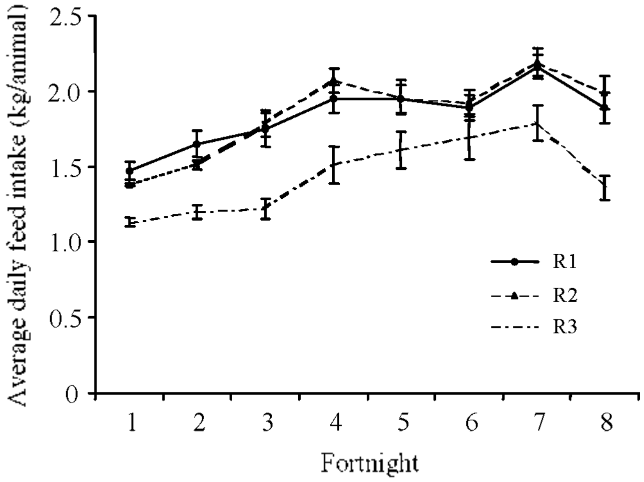

Figure 1. Average daily feed intake (kg/animal) of gilts fed on different diets. Dietary treatments R_1, R_2 and R_3 contain 0, 41 and 82% of rice bran, respectively.

energy values of the samples were calculated by comparing the deflection in the galvanometer with known amount of thermo chemical grade benzoic acid (calorific value 6.318 kcal/g) after ignition in bomb. The data obtained from the experiment were subjected to one way analysis of variance following completely randomized design for all the parameters to ascertain the effect of various treatments on nitrogen balance and dietary energy utilization as per the standard methods of statistical analysis (Snedecor and Cochran, 1989). Differences among the means were tested applying Duncan's multiple range test (Duncan, 1965).

RESULTS AND DISCUSSION

Chemical composition of the diets

The three experimental diets R_1, R_2 and R_3 contained almost similar CP, but the OM and NFE of the respective diets decreased with increase in the level of bran, which in turn increased the ash, and acid insoluble ash (AIS) contents of the diet R_2 and R_3 (Table 1). As the EE and CF contents of the rice bran are more than the corn and wheat bran, the relative proportion of fat and fibre also increased along with the RB in the diets R_2 and R_3, than that of R_1 (control diet). The GE values of the three diets were almost similar as the EE content increased along with the decrease of OM.

Feed consumption

The daily feed intake of the gilts in the respective groups increased with the advance of experimental feeding in the successive fortnight (Figure 1) due to increase in age and body weight of the gilts. The voluntary feed intake was affected in gilts fed grain-less rice bran based diets (R_3) which might be due to relatively unpalatable nature of the diets having higher CF and ash contents (Lindemann et al., 1986). Moreover, fibre content of the diet increased to an

Table 2. Nitrogen balance during the metabolism trial

Attributes	R_1	R_2	R_3	SEM
Nitrogen intake (g/d)	52.90	62.74	52.02	2.36
Faecal nitrogen (g/d)*	15.79^b	23.37^a	19.83^{ab}	1.15
Urinary nitrogen (g/d) ^{NS}	18.38	19.07	17.80	0.91
Nitrogen balance (g/d) ^{NS}	18.73	20.30	14.39	1.46
Nitrogen balance (as % of intake) ^{NS}	34.72	31.99	26.84	1.80
Nitrogen balance (as % of absorb) ^{NS}	49.59	50.81	43.82	2.62
Nitrogen balance (g/kg $W^{0.75}$/d) ^{NS}	0.97	1.05	0.75	0.08

Dietary treatments R_1, R_2 and R_3 contain 0. 41 and 82% of rice bran, respectively. SEM standard error of the means.
$^{a, b, c}$ means with different superscripts in a row differ significantly, * $p<0.05$. NS; non significant.

Table 3. Distribution of dietary energy during the metabolism trial

Attributes	R_1	R_2	R_3	SEM
Gross energy intake (Mcal/d) ^{NS}	8.24	10.03	8.91	0.38
Faecal energy (Mcal/d)**	2.25^b	4.17^a	4.35^a	0.28
Digestible energy intake (Mcal/d)**	5.99^a	5.86^a	4.57^b	0.25
Digestible energy (as % of gross energy)**	72.44^a	58.67^b	51.20^c	1.93
Urinary energy (Mcal/d) ^{NS}	0.29	0.31	0.29	0.18
Metabolizable energy intake (Mcal/d)*	5.70^a	5.54^a	4.29^b	0.25
Metabolizable energy (as % of gross energy)**	68.88^a	55.49^b	48.03^c	1.93
Metabolizable energy (as % of digestible energy) ^{NS}	95.15	94.64	93.76	0.39

Dietary treatments R_1, R_2 and R_3 contain 0. 41 and 82% of rice bran, respectively. SEM; standard error of the means.
$^{a, b, c}$ means with different superscripts in a row differ significantly, * $p<0.05$, ** $p<0.01$. NS; non significant.

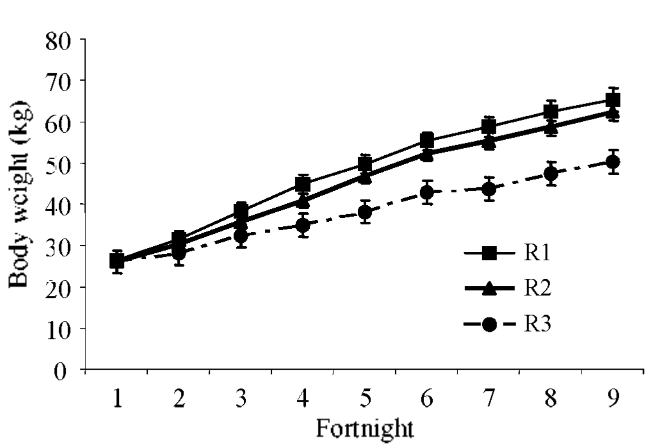

Figure 2. Fortnightly body weight changes of gilts fed on different diets. Dietary treatments R_1, R_2 and R_3 contain 0, 41 and 82% of rice bran, respectively.

extent that it became incompatible to the gut volume of the gilts. However, feed intake in group R_3 increased after 4th fortnight which might be an attempt to compensate energy intake through the DE deficient diets to meet the requirements for maintenance and growth (Bhar, 1998).

Body weight changes

Fortnightly pattern of body weight changes in groups R_1 and R_2 was comparable (Figure 2). The growth rate in R_3 group was much lower than that of control and R_2 group and the gilts fed 82% RB based diets failed to attain the target body weight even after eighth fortnight due to lower feed intake and lower plane of nutrition. Similar was the finding of Bhar et al. (2001), in cross bred barrows fed 82% de-oiled rice bran (DORB) in the diets.

Nitrogen balance

The mean daily intake of nitrogen was comparable among the treatment groups as the metabolism trial was conducted at uniform body weight i.e. 51.39±0.71 kg body weight (Table 2). Faecal nitrogen (FN) excretion was significantly ($p<0.05$) higher in rice bran fed groups (R_2 and R_3) than the control group (R_1). Higher FN excretion in R_2 and R_3 might be due to higher CF intake. Lower digestibility of high fibre diet was reported by Mosenthin and Henkel (1978), Bergner (1981) and Malmlof and Hakansson (1984). Higher CF level might have acted as a barrier for proteolytic enzyme and have increased the passage rate of feeds leading to less contact time for the proteolytic enzyme, resulting in lower protein digestibility. All animals were in positive nitrogen balance and this finding is in accordance with the reports of Robles and Ewan (1982) and Bhar (1998). However, a trend of lower values of nitrogen balance in pigs fed 82% RB based diets was similar to the finding of Bhar (1998) in crossbred barrows fed diets with 82% DORB, and similar was the finding of Yadav and Gupta (1995) in male pigs fed rice polish.

Utilization of dietary energy

The gilts on RB based diets had an increasing trend of GE intake (Mcal/d/animal) during the metabolism trial (Table 3) conducted on comparable body weight between the groups. However, the differences among the groups were non-significant. However, the excretion of faecal

Table 4. Plane of nutrition during the experimental period

Attributes	R_1	R_2	R_3	SEM
Crude protein intake (g/kg $W^{0.75}$/d)**	17.17^a	17.50^a	14.33^b	0.44
Digestible crude protein intake (g/kg $W^{0.75}$/d)**	11.83^a	11.17^a	8.83^b	0.36
Total digestible nutrients intake (g/kg $W^{0.75}$/d)**	65.50^a	60.00^b	44.50^c	2.31
Digestible energy intake (kcal/kg $W^{0.75}$/d)**	312.16^a	263.67^b	197.66^c	12.01
Metabolizable energy intake (kcal/kg $W^{0.75}$/d)**	297.50^a	249.50^b	185.66^c	11.68

Dietary treatments R_1, R_2 and R_3 contain 0, 41 and 82% of rice bran, respectively. SEM: standard error of the mean.
a, b, c means with different superscripts in a row differ significantly. ** p<0.01.

Table 5. Nutrients conversion efficiency (intake per kg gain) of the gilts during the experimental feeding

Attributes	R_1	R_2	R_3	SEM
Crude protein (kg)**	0.89^b	0.94^b	1.08^a	0.03
Digestible crude protein (kg) ^{NS}	0.62	0.59	0.64	0.01
Digestible energy (Mcal)*	15.90^a	14.08^b	14.32^b	0.32
Metabolizable energy (Mcal)*	15.12^a	13.32^b	13.44^b	0.31

Dietary treatments R_1, R_2 and R_3 contain 0, 41 and 82% of rice bran, respectively.
a, b, c means with different superscripts in a row differ significantly.
SEM; standard error of the mean. * p<0.05. ** p<0.01. NS; non significant.

energy in gilts fed RB was significantly higher (p<0.01) than that of control gilts fed non-RB. The higher (p<0.01) values of faecal energy (FE) loss in rice bran were reflected in lower (p<0.01) DE intake in R_3. Lower (p<0.01) ME intake in R_3 group was due to lower DE intake caused by higher FE loss. There was significant difference (p<0.01) among the groups when DE and ME intake was expressed as percent of GE, which is obviously due to increase in the level of bran, which concomitantly increased the CF, total ash and AIA contents of the diets .The above findings are in accordance with the reports of Bhar (1998). On calculation during formulation of ration the DE values calculated were 3,383, 3,427 and 3,460 kcal/kg DE in R_1, R_2 and R_3, respectively, based on the values by NRC (1988). However, the analyzed values were 3,386, 2,713 and 2,366 kcal/kg DE in different groups. It indicated that the DE value reported (NRC, 1988) for rice bran did not match when used at higher levels. The higher levels of fibre and oil have reduced the digestibility of OM, CP, CF, NFE and total carbohydrate (Soren et al., 2003).

Plane of nutrition

CP intake in group R_3 was lower (p<0.01) than that of group R_1 and R_2 (Table 4) which might be due to differences in feed intake. Significant difference (p<0.01) in digestible crude protein (DCP) intake in R_3 group was due to addition of higher level of fibrous RB containing higher ash and AIA in the diets. The EE content, inherent for the RB, might have also influenced the digestibility in R_3 as the level was beyond 8% (Soren, 2002). Significant reduction (p<0.01) in TDN intake of RB was due to lower digestibility of almost all the nutrients (Soren et al., 2003). Significant differences in the DE and ME intake among the three groups might be due to increased faecal energy loss. Present findings are in accordance with the reports of Bhar (1998).

Nutrient conversion efficiency

Overall protein and energy conversion efficiency of the gilts are presented in Table 5. The third group consumed more (p<0.01) CP per kg gain in comparison to the other two groups. High dietary fibres and EE in the 82% RB based diets might had adverse effect on protein utilization, which was clearly evident from the fact that protein digestibility reduced with increased level of rice bran (Soren, 2002). The gilts fed control diets (R_1) were significantly (p<0.01) less efficient in utilization DE and ME per kg gain than gilts fed rice bran, which might be due to higher fat deposition in the control group. Moreover, the energy intake was higher (p<0.01) in R_1, which probably led to higher fat deposition giving a higher value of energy intake per unit gain. Thus, these crossbred gilts might have consumed more energy and protein than that of its maintenance and production requirement with respect to their genetic growth potentiality, which was 288 to 434 g/d (Bhar et al., 2000; AICRP, 2001; Bhar et al., 2001; Soren, 2002).

CONCLUSION

It can be concluded that the nitrogen and energy balance decreased with increased level of rice bran. The metabolizable or digestible energy value of rice bran decreased at higher inclusion level. Indian crossbred gilts can be reared satisfactorily on 41% rice bran without adversely affecting the nitrogen balance and energy utilization even if the CF and AIA concentration of the diets exceeds the maximum (BIS, 1987) recommended level of 6 and 8%, respectively, along with the lower recommended level of DE value (3,300 kcal/kg) of the diet. RB at very high level in the diet of Indian crossbred gilts lower the conversion efficiency of various nutrients along with the palatability of the diets.

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