

Original Research Article

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## Replacement of Maize by Wheat Bran on Growth, Feed Efficiency and Nutrient Digestibility in Pigs

N. Elanchezian<sup>1\*</sup> and K. Ally<sup>2</sup>

<sup>1</sup>Department of Animal Nutrition, Rajiv Gandhi Institute of Veterinary Education and Research, Puducherry- 605 009, India

<sup>2</sup>Department of Animal Nutrition, College of Veterinary and Animal Sciences, Mannuthy, Thrissur, Kerala, India-680651

\*Corresponding author

### ABSTRACT

#### Keywords

Pig, wheat bran, Growth, Feed conversion, Digestibility

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The aim was to study the effect of replacement of maize by wheat bran on growth and nutrient utilization of growing Large White Yorkshire pigs. Thirty weaned female Large White Yorkshire piglets were divided into three groups with five replicates in each group and were maintained under identical management conditions for the period of 70 days. The three dietary treatments were randomly allotted, T1-control ration as per NRC (1998), T2 -50 per cent of maize of control ration replaced by wheat bran and T3-100 per cent of maize of control ration replaced by wheat bran. The average daily gain and feed conversion efficiency were 813.00, 769.86, 678.43g and 2.80, 2.88, 3.08, respectively for three dietary treatments. The pigs of T1 and T2 had similar and higher ( $P<0.05$ ) average body weight gain and feed conversion efficiency than that of T3 treatment. The crude fibre digestibility was higher ( $P<0.05$ ) for T1 and T2 rations than that of T3. The digestibility of dry matter, organic matter, crude protein, DE and NFE was higher for T1 ration and lower for T3 ration than the other groups, but no difference in ether extract digestibility. Availability of calcium, magnesium and manganese was lowered ( $P<0.01$ ) in T3 group compared to other groups, but no difference in other minerals availability. It can be concluded that partial (50 per cent) replacement of the maize in the feed for pigs by wheat bran did not affect the weight gain, feed intake, feed conversion efficiency and nutrient utilization, whereas 100 per cent replacement of maize by wheat bran affected the growth performance and nutrient digestibility.

### Introduction

Cereal grain forms the major source of energy in the swine feed. Even though India produces more than 20 million MT of maize per year, it could meet only 60 per cent of the requirement in the country. The lower availability and increasing price of maize,

necessitate an alternative energy source for incorporation in the swine feed. Wheat bran, a byproduct of wheat milling industry, available in huge quantity is one of the choices as energy ingredient in pig feed. Though it has more amount of crude fibre, it improves the palatability and feed intake. The present work aims to study the effect of replacement of

maize by wheat bran on growth and nutrient utilization of growing Large White Yorkshire pigs.

### **Materials and Methods**

Thirty Large White Yorkshire piglets were randomly divided into three groups with five replicates in each group. Each replicates were allotted with two piglets and housed in a single pen. All piglets were maintained under identical management conditions throughout the experimental period of 70 days.

### **Experimental rations**

The animals were fed with standard grower ration containing 18 per cent of crude protein (CP) and 3265 kcal of metabolizable energy (ME)/kg of feed up to 50 kg body weight and finisher ration with 16 per cent CP and 3265 kcal of ME /kg of feed from 50 kg body weight as per NRC (1998).

The three groups of piglets were randomly allotted to the three dietary treatments, T1-control ration as per NRC (1998), T2 -50 per cent of maize of control ration replaced by wheat bran and T3-100 per cent of maize of control ration replaced by wheat bran. Ingredient composition of pig grower and finisher ration were given in the Table 1. The ration used in this study had similar nutrients as per NRC (1998; 2012) recommendations.

### **Feed intake, body weight and feed efficiency**

Weighed quantities of feed were offered twice a day at 9.00 am and 3.00 pm. The feed intake was measured daily after collecting the left over feed if any and body weight of the individual animals were taken fortnightly in the morning hours before feeding. Then average daily gain and feed conversion efficiency was calculated.

### **Nutrient digestibility**

Digestibility trial was conducted towards the end of the experiment following total collection method. The feed and faecal samples were analyzed for proximate principles (AOAC, 1990) and minerals such as calcium, magnesium, zinc, copper and manganese were analyzed using Atomic Absorption Spectrophotometer (Perkin Elmer 3110, USA) after wet ashing using nitric acid and perchloric acid (2:1). Phosphorus contents of both feed and faecal samples were analyzed by colorimetry (Vanado-molybdate method, AOAC, 1990) using spectronic 20D

### **Statistical analysis**

Data collected on various parameters were statistically analyzed by Completely Randomized Design (CRD) method and means were compared by Duncan Multiple Range Test (DMRT) using Statistical Package for Social Studies (SPSS. 17.0.1v, 2008) software.

### **Results and Discussion**

#### **Feed intake**

Data on weekly average feed intake of pigs given the three experimental rations T1, T2 and T3 are presented in Table 2. The total feed intake recorded were 159.28, 154.98 and 145.98 kg, respectively and statistically T1 and T2 had similar feed intake but higher than that of T3 treatment. There was no difference in the feed intake between treatments in first three weeks, whereas from fourth to tenth week except for week eighth, there was no difference in the feed intake of pigs among T1 and T2 but was higher ( $P<0.05$ ) than that of T3 treatment. In the eighth week, there was no difference between T2 and T3, but had lower ( $P<0.05$ ) feed intake than T1 treatment. From the results on weekly feed intake it

could be seen that replacement of maize at 100 per cent level by wheat bran lowered the feed intake, but there was no significant difference between control and 50 per cent maize replacement group except in eighth week. This is in agreement with Bhar *et al.* (2000) who observed similar feed intake in crossbred pigs fed diet with 0 and 50 per cent replacement of maize by wheat bran. Brouns *et al.* (1995) observed that decreased feed intake when the fibre level in the ration increases due to addition of fibrous materials like wheat bran.

### **Body weight**

The data on the body weight and weight gain of pigs are presented in Table 3. The average initial and final body weight of piglets belonging to three groups were 23.94, 23.96 and 24.01 kg and 80.85, 77.85 and 71.50 kg, respectively. The statistical analysis of the data revealed no significant difference in the average body weight among treatments during the first two fortnights. During the third to fifth fortnight there was no difference in the average body weight between T1 and T2 but had higher ( $P < 0.05$ ) average body weight than T3 group.

### **Feed conversion efficiency**

The data on the fortnightly feed conversion efficiency and their cumulative values of pigs under three treatment groups are presented in Table 4. The overall feed conversion efficiency recorded was 2.80, 2.88 and 3.08, respectively. There was no significant difference between T1 and T2 for feed conversion efficiency during any fortnight and cumulative period, but had better result than that of T3 treatment. The result observed in T3 treatment may be due to the higher level of crude fibre (9.40 per cent) and acid insoluble ash (6.52 per cent) content in the ration.

### **Daily gain and feed conversion efficiency of growing pigs**

To reach body weight of 50 kg, T1 and T2 treatment took 4 weeks whereas T3 treatment took 5 weeks period. Average daily gain and feed conversion efficiency of growing pigs maintained on the three experimental grower rations T1, T2 and T3 are presented in Table 5. The average weight gain of these pigs during growing stage was 27.10, 25.49 and 26.86 kg, respectively. On statistical analysis there was no difference in the average weight gain among the three treatments. The average daily gain in the three groups was 774.29, 728.29 and 639.52 g, respectively. There was no difference in the average daily gain between T1 and T2 treatments. However, pigs on these treatments had higher ( $P < 0.05$ ) daily gain than that of T3 treatment. Pigs under T3 group took longer period (42 days) to reach 50 kg body weight than other groups (35 days). The total feed intake of grower ration was 64.45, 62.48 and 73.82 kg and the feed conversion efficiency was 2.37, 2.45 and 2.75, respectively for three treatments. The treatment T1 and T2 recorded similar values but had significantly lesser feed intake and better feed conversion efficiency than that of T3 treatment.

The result in this study indicates that the average daily gain in growing pure breed of Large White Yorkshire pigs were not affected by 50 per cent of maize replacement by animal fat. The lower performance values recorded in T3 groups may be because of higher level of crude fibre due to 100 per cent replacement of maize by wheat bran.

### **Daily gain and feed conversion efficiency of finisher pigs**

The pigs were maintained till the T3 group reaches 70 kg body weight. Average daily gain and feed conversion efficiency of

finisher pigs maintained on the three experimental finisher rations are presented in Table 5. The average weight gain of these pigs during finisher stage was 29.81, 28.40 and 20.63kg and average daily gain was 851.71, 811.43 and 736.78 g, respectively for three treatments.

Statistical analysis revealed no difference in weight gain and average daily gain between T1 and T2, however these treatments had higher ( $P<0.05$ ) values than T3 treatment. The feed intake and feed conversion efficiency in the three groups was 94.83, 92.50, 72.16 and 3.18, 3.26 and 3.50, respectively. The treatment T1 and T2 recorded similar values but had significantly better feed conversion efficiency than that of T3 treatment.

#### **Overall daily gain and feed conversion efficiency of experimental pigs**

The overall average daily gain and feed conversion efficiency of pigs maintained on the three experimental rations are presented in Table 5. The average final weight and weight gain of these pigs for overall period were 80.85, 77.85 and 71.50 kg and 56.91, 53.89 and 47.49 kg, respectively. The overall average daily gain was 813.00, 769.86 and 678.43g, respectively for three treatments. There was no difference in final body weight, weight gain and average daily gain between T1 and T2, but had higher values than that of T3 treatment. The total feed intake and overall feed conversion efficiency for three treatment groups was 159.28, 154.98, 145.98 and 2.80, 2.88, 3.08, respectively. There was no significant difference for these parameters between T1 and T2, but had better feed conversion efficiency than that of T3 treatment.

In the present study T3 treatment recorded significantly lower average daily gain and feed efficiency compared to other groups.

This may be due to high crude fibre (9.40 per cent) and acid insoluble ash (6.52 per cent) content in the ration which might have affected the digestion and utilization of the nutrients. This is in agreement with Kyriazakis and Emmans (1995) who reported decreased weight gain and feed conversion efficiency in growing purebred pigs fed on a high level (more than 60 per cent) of wheat bran in their diet. Growth rate and feed efficiency of pigs were depressed as fiber level in the diet increased (Cline and Richert, 2000; Grieshop, 2000). But Bhar *et al.* (2000) observed similar average daily gain and feed to gain ratio in crossbred pigs fed diet with 0, 50 and 100 per cent replacement of maize by wheat bran. Sikka (2007) found that replacement of maize and rice bran with paddy grain in growing and finishing pigs led to significant decrease in the growth rate. Sheikh (2011) observed significant reduction in weight gain in crossbred pigs fed diet containing paddy grain instead of maize.

#### **Nutrient digestibility**

Data on apparent digestibility of nutrients are presented in Table 6. The percentage digestibility of the three dietary rations T1, T2 and T3 were 85.73, 72.18 and 59.07 for dry matter, 87.95, 76.14 and 64.00 for organic matter, 84.48, 77.59 and 67.94 for crude protein, 67.60, 62.83 and 58.62 for ether extract, 55.36, 49.63 and 38.84 for crude fibre and 91.49, 80.48 and 69.21 for NFE, respectively.

Ether extract digestibility was similar in all the three treatments. The digestibility of all the other nutrients in the control group was higher than the other groups. Pigs fed ration with 50 per cent of maize replaced with wheat bran had higher ( $P<0.05$ ) digestibility of nutrients than T3. The crude fibre digestibility was higher ( $P<0.05$ ) in T1 and T2 compared to T3, in which it was the lowest.

**Table.1** Ingredient composition of pig grower and finisher rations, %

Ingredients	Grower rations <sup>1</sup>			Finisher rations <sup>1</sup>		
	T1	T2	T3	T1	T2	T3
<b>Yellow maize</b>	<b>70</b>	<b>35</b>	<b>0</b>	74	37	0
<b>Wheat bran</b>	<b>1.5</b>	<b>31</b>	<b>59.8</b>	3.6	34.7	64.9
<b>Soyabean meal</b>	26.25	25.5	25.0	<b>20.5</b>	<b>19.7</b>	<b>19.2</b>
<b>Animal fat</b>	0	6.5	13	<b>0</b>	<b>7</b>	<b>14</b>
<b>Salt</b>	0.5	0.5	0.5	<b>0.5</b>	<b>0.5</b>	<b>0.5</b>
<b>Dicalcium phosphate</b>	0.9	0.4	0	<b>0.65</b>	<b>0.10</b>	<b>0</b>
<b>Calcite</b>	0.85	1.1	1.7	<b>0.75</b>	<b>1.0</b>	<b>1.4</b>
<b>Total</b>	100	100	100	<b>100</b>	<b>100</b>	<b>100</b>
<b>Nicomix AB<sub>2</sub>D<sub>3</sub>K<sup>1</sup>, g</b>	25	25	25	25	25	25
<b>Nicomix BE<sup>2</sup>, g</b>	25	25	25	25	25	25
<b>Zinc Oxide<sup>3</sup>, g</b>	45	13	0	30	0	0
<b>Oxylock antioxidant<sup>4</sup>, g</b>	10	10	10	10	10	10

<sup>1</sup>Nicomix A, B<sub>2</sub>, D<sub>3</sub>, K (Nicholas Piramal India Ltd, Mumbai) containing Vitamin A- 82,500 IU, Vitamin B<sub>2</sub>-50 mg, Vitamin D<sub>3</sub>-12,000 IU and Vitamin K-10 mg per gram.

<sup>2</sup>Nicomix BE (Nicholas Piramal India Ltd, Mumbai) containing Vitamin B<sub>1</sub>-4 mg, Vitamin B<sub>6</sub>-8 mg, Vitamin B<sub>12</sub>-40 mg, Niacin-60 mg, Calcium pantothenate- 40 mg and Vitamin E-40 mg per gram.

<sup>3</sup>Zinc oxide (Nice Chemicals Pvt. Ltd., Kochi) containing 81.38% of Zn.

<sup>4</sup>Oxylock antioxidant (Vetline Ltd., Indore) contains Ethoxyquin, Butylated HydroxyToluene (BHT), Chelators and Surfactantant.

**Table.2** Average feed intake of LWY pigs maintained on the three experimental rations, kg

Week	Feed intake <sup>1</sup>			Cumulative feed intake <sup>1</sup>		
	T1	T2	T3	T1	T2	T3
<b>1</b>	9.83±0.51	9.59±0.24	9.25±0.07	9.83±0.51	9.59±0.24	9.25±0.07
<b>2</b>	10.92±0.77	10.30±0.30	10.06±0.06	20.75±1.28	19.89±0.54	19.31±0.11
<b>3</b>	12.58±0.68	12.60±0.39	12.22±0.17	33.33±1.93	32.49±0.92	31.53±0.26
<b>4</b>	13.98±0.84 <sup>b</sup>	13.29±0.53 <sup>b</sup>	11.36±0.31 <sup>a</sup>	47.31±2.7 <sup>b</sup>	45.78±1.40 <sup>b</sup>	42.89±0.57 <sup>a</sup>
<b>5</b>	17.14±0.81 <sup>b</sup>	16.70±0.66 <sup>b</sup>	15.58±0.42 <sup>a</sup>	64.45±3.50 <sup>b</sup>	62.48±2.01 <sup>b</sup>	58.47±0.98 <sup>a</sup>
<b>6</b>	17.52±0.75 <sup>b</sup>	17.38±0.66 <sup>b</sup>	15.65±0.71 <sup>a</sup>	81.97±4.19 <sup>b</sup>	79.86±2.64 <sup>b</sup>	74.12±1.58 <sup>a</sup>
<b>7</b>	18.22±0.69 <sup>b</sup>	17.74±0.39 <sup>b</sup>	16.81±0.67 <sup>a</sup>	100.19±4.81 <sup>b</sup>	97.60±3.01 <sup>b</sup>	90.93±2.22 <sup>a</sup>
<b>8</b>	19.18±0.75 <sup>b</sup>	16.72±0.36 <sup>b</sup>	17.43±0.51 <sup>a</sup>	119.37±5.51 <sup>b</sup>	114.32±3.32 <sup>b</sup>	108.36±2.72 <sup>a</sup>
<b>9</b>	18.86±0.57 <sup>b</sup>	19.05±0.66 <sup>b</sup>	17.73±0.28 <sup>a</sup>	138.23±6.04 <sup>b</sup>	133.37±3.94 <sup>b</sup>	126.09±2.99 <sup>a</sup>
<b>10</b>	21.05±0.53 <sup>b</sup>	21.61±0.49 <sup>b</sup>	19.89±0.32 <sup>a</sup>	159.28±6.54 <sup>b</sup>	154.98±4.42 <sup>b</sup>	145.98±3.30 <sup>a</sup>
<b>Total</b>	159.28±6.54 <sup>b</sup>	154.98±4.42 <sup>b</sup>	145.98±3.30 <sup>a</sup>	159.28±6.54 <sup>b</sup>	154.98±4.42 <sup>b</sup>	145.98±3.30 <sup>a</sup>

<sup>1</sup>Mean of 5 observations

a, b - Means of different superscripts within the same row differ significantly Significant (P<0.05)

**Table.3** Average body weight gain of LWY pigs maintained on the three experimental rations

Fortnight	Weight gain <sup>1</sup>			Cumulative weight gain <sup>1</sup>		
	T1	T2	T3	T1	T2	T3
1	10.25±0.50 <sup>b</sup>	10.13±0.27 <sup>b</sup>	8.94±0.25 <sup>a</sup>	10.25±0.50 <sup>b</sup>	10.13±0.27 <sup>b</sup>	8.94±0.25 <sup>a</sup>
2	10.35±0.63 <sup>b</sup>	9.53±0.46 <sup>b</sup>	7.97±0.34 <sup>a</sup>	20.60±0.81 <sup>b</sup>	19.66±0.70 <sup>b</sup>	16.91±0.34 <sup>a</sup>
3	12.33±0.39 <sup>b</sup>	11.53±0.49 <sup>b</sup>	9.95±0.51 <sup>a</sup>	32.93±1.09 <sup>b</sup>	31.19±1.04 <sup>b</sup>	26.82±0.80 <sup>a</sup>
4	11.13±0.39 <sup>b</sup>	9.9±0.27 <sup>b</sup>	9.39±0.26 <sup>a</sup>	44.06±1.15 <sup>b</sup>	41.09±1.06 <sup>b</sup>	36.25±0.88 <sup>a</sup>
5	12.85±0.73 <sup>b</sup>	12.80±0.41 <sup>b</sup>	11.24±0.45 <sup>a</sup>	56.91±1.48 <sup>b</sup>	53.89±0.85 <sup>b</sup>	47.49±1.26 <sup>a</sup>

<sup>1</sup>Mean of 5 observations

a, b - Means of different superscripts within the same row differ significantly

Significant (P<0.05)

**Table.4** Average feed conversion efficiency of LWY pigs maintained on the three experimental rations

Fortnight	Feed conversion efficiency <sup>1</sup>			Cumulative feed conversion efficiency <sup>1</sup>		
	T1	T2	T3	T3	T2	T3
1	2.03±0.12 <sup>a</sup>	1.97±0.06 <sup>a</sup>	2.17±0.06 <sup>b</sup>	2.03±0.12 <sup>a</sup>	1.97±0.06 <sup>a</sup>	2.17±0.06 <sup>b</sup>
2	2.58±0.13 <sup>a</sup>	2.73±0.07 <sup>a</sup>	2.97±0.08 <sup>b</sup>	2.29±0.07 <sup>a</sup>	2.33±0.05 <sup>b</sup>	2.54±0.04 <sup>b</sup>
3	2.82±0.11 <sup>a</sup>	2.97±0.12 <sup>a</sup>	3.15±0.08 <sup>b</sup>	2.48±0.06 <sup>a</sup>	2.56±0.05 <sup>a</sup>	2.76±0.05 <sup>b</sup>
4	3.38±0.18 <sup>a</sup>	3.49±0.11 <sup>a</sup>	3.66±0.16 <sup>b</sup>	2.71±0.08 <sup>a</sup>	2.78±0.05 <sup>a</sup>	2.99±0.05 <sup>b</sup>
5	3.13±0.13 <sup>a</sup>	3.19±0.16 <sup>a</sup>	3.36±0.10 <sup>b</sup>	2.80±0.05 <sup>a</sup>	2.88±0.05 <sup>a</sup>	3.08±0.06 <sup>b</sup>

<sup>1</sup>Mean of 5 observations

a, b - Means of different superscripts within the same row differ significantly

Significant (P<0.05)

In T3 (100 per cent maize replacement) group the level of wheat bran was 64.9 per cent, compared to 34.7 per cent in T2. The level of crude fibre and acid insoluble ash in the three rations were 3.73 and 1.04; 6.54 and 4.29 and 9.4 and 6.52, respectively for T1, T2 and T3.

The higher levels of crude fibre and acid insoluble ash might have contributed to the lowered digestibility of all nutrients except ether extract. Bhar *et al.* (2000) also observed decreased digestibility of dry matter, organic matter, crude fibre, total carbohydrate, nitrogen free extract and energy with increased level of wheat bran (0, 50 and 100

per cent maize replacement) in the diet of crossbred pigs. The digestive tract enlarges to accommodate a larger volume of feed rich in crude fibre and the rate of passage of ingesta increases, resulting in reduction in digestibility of nutrients (Ewan, 2000; Lentle, 2008). Sikka (2007) found that replacement of maize and rice bran with paddy in growing and finishing pigs led to a significant decrease in the digestibility of organic matter and crude fibre. Sheikh (2011) observed a significant reduction in digestibility of dry matter, ether extract, crude fibre and NFE in crossbred pigs fed diet containing paddy grain instead of maize.

**Table.5** Average daily gain and feed conversion efficiency of LWY pigs maintained on the three experimental rations

Parameters	Growing stage <sup>1</sup>			Finishing stage <sup>1</sup>			Overall period <sup>1</sup>		
	T1	T2	T3	T1	T2	T3	T1	T2	T3
<b>Average initial body weight, kg</b>	23.94 ±1.30	23.96 ±1.55	24.01 ±1.19	51.04 ±2.13	49.45 ±2.41	50.87 ±1.76	23.94 ±1.30	23.96 ±1.55	24.01 ±1.19
<b>Average final body weight, kg</b>	51.04 ±2.13	49.45 ±2.41	50.87 ±1.76	80.85 ±2.76 <sup>b</sup>	77.85 ±2.35 <sup>b</sup>	71.50 ±2.00 <sup>a</sup>	80.85 ±2.76 <sup>b</sup>	77.85 ±2.35 <sup>b</sup>	71.50 ±2.00 <sup>a</sup>
<b>Total weight gain, kg</b>	27.10 ±0.89	25.49 ±0.92	26.86 ±0.80	29.81 ±0.72 <sup>b</sup>	28.40 ±0.29 <sup>b</sup>	20.63 ±0.53 <sup>a</sup>	56.91 ±1.48 <sup>b</sup>	53.89 ±0.85 <sup>b</sup>	47.49 ±1.26 <sup>a</sup>
<b>Average daily weight gain, g</b>	774.29 ±25.57 <sup>b</sup>	728.29 ±26.28 <sup>b</sup>	639.52 ±19.08 <sup>a</sup>	851.71 ±20.48 <sup>b</sup>	811.43 ±8.37 <sup>b</sup>	736.78 ±18.79 <sup>a</sup>	813.00 ±21.20 <sup>b</sup>	769.86 ±12.16 <sup>b</sup>	678.43 ±18.06 <sup>a</sup>
<b>Total feed intake, kg</b>	64.45 ±3.50 <sup>a</sup>	62.48 ±2.01 <sup>a</sup>	73.82 ±1.70 <sup>b</sup>	94.83 ±3.27 <sup>b</sup>	92.50 ±2.50 <sup>b</sup>	72.16 ±1.64 <sup>a</sup>	159.28 ±6.54 <sup>b</sup>	154.98 ±4.42 <sup>b</sup>	145.98 ±3.30 <sup>a</sup>
<b>Feed conversion efficiency</b>	2.37 ±0.06 <sup>a</sup>	2.45 ±0.03 <sup>a</sup>	2.75 ±0.05 <sup>b</sup>	3.18 ±0.06 <sup>a</sup>	3.26 ±0.10 <sup>a</sup>	3.50 ±0.09 <sup>b</sup>	2.80 ±0.05 <sup>a</sup>	2.88 ±0.05 <sup>a</sup>	3.08 ±0.06 <sup>b</sup>

<sup>1</sup>Mean of 5 observations with SE

a, b- Means with different superscripts within the same row differ significantly (P<0.05)

**Table.6** Apparent digestibility of nutrients and availability of minerals of the three experimental rations

Parameters	Treatments		
	T1	T2	T3
Dry matter, %	85.73±0.36 <sup>c</sup>	72.18±1.57 <sup>b</sup>	59.07±1.77 <sup>a</sup>
Organic matter, %	87.95±0.40 <sup>c</sup>	76.14±1.28 <sup>b</sup>	64.00±1.48 <sup>a</sup>
Crude protein, %	84.48±0.68 <sup>c</sup>	77.59±1.03 <sup>b</sup>	67.94±2.39 <sup>a</sup>
Ether extract, %	67.60±2.07	62.83±3.47	58.62±4.15
Crude fibre, %	55.36±1.49 <sup>b</sup>	49.63±1.70 <sup>b</sup>	38.84±3.05 <sup>a</sup>
Nitrogen free extract, %	91.49±0.54 <sup>c</sup>	80.48±1.23 <sup>b</sup>	69.21±1.75 <sup>a</sup>
DE, kcal/kg	3558.12±31.47 <sup>c</sup>	3104.22±76.15 <sup>b</sup>	2837.96±61.48 <sup>a</sup>
Calcium, %	60.34±1.77 <sup>b</sup>	55.28±2.11 <sup>ab</sup>	47.53±2.27 <sup>a</sup>
Phosphorus, %	54.53±2.74	51.38±3.23	46.22±2.36
Magnesium, %	66.29±2.29 <sup>b</sup>	58.82±2.53 <sup>ab</sup>	52.95±2.40 <sup>a</sup>
Manganese, %	71.38±1.38 <sup>b</sup>	64.13±2.06 <sup>b</sup>	54.92±2.23 <sup>a</sup>
Copper, %	62.02±1.74	57.41±3.70	53.08±2.22
Zinc, %	63.40±1.94	61.48±2.80	56.65±2.76

<sup>1</sup>Mean of 5 observations with SE

a, b, c- Means with different superscripts within the same row differ significantly. (P<0.01)

The digestible energy values of the three experimental rations were 3558, 3104 and 2837 kcal/kg, respectively. The control group (T1) had higher (P<0.01) DE than T2 and T3 and the lowest DE was recorded in T3.

### Mineral availability

From the Table (No.6) it can be observed that there was no difference in the availability of phosphorus, copper and zinc between the three rations, whereas the availability of calcium, magnesium and manganese were lowered (P<0.01) in T3 group. The comparatively higher levels of phosphorus (0.83 per cent) in T3 might have caused an imbalance between calcium and phosphorus resulting in lowered absorption of calcium. The high level of wheat bran (64.7 per cent) in 100 per cent maize replacement (T3) group might have led to a decrease in availability of minerals like magnesium and manganese.

Fibrous feedstuffs such as peanut hulls, oat hulls, wheat bran, and soyabean hulls have been shown to decrease mineral absorption in pigs (Kornegay and Moore, 1986).

An evaluation of the results obtained in the experiment indicates that partial (50 per cent) replacement of the maize in the feed for pigs by wheat bran did not affect the weight gain, feed intake, feed conversion efficiency and nutrient utilization. Full (100 per cent) replacement of maize in the feed by wheat bran resulted in lowered weight gain and feed conversion efficiency and poor nutrient utilization.

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