

Original Research Article

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Growth Performance of Large White Yorkshire Pigs Fed with Concentrate Diet Incorporated with Brewer's Spent Grains, *Moringa oleifera* and Rice Gluten Meal

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ABSTRACT

Performance of Large White Yorkshire piglets fed with alternate protein sources on growth rate were studied using 24 weaned Large White Yorkshire piglets available at Instructional Livestock Farm Complex, Veterinary College and Research Institute, Namakkal for 120 days period. They were randomly allotted into 4 treatments with 6 animals in each group to study the effect of inclusion of wet brewer's spent grains (T₁), *Moringa oleifera* leaves (T₂) and rice gluten meal (T₃) at 10, 10 and 5% level, respectively and conventional concentrate diet kept as control (T₄). The mean body weight (kg) of pigs fed with alternate protein sources were 76.58 ± 0.79, 72.17 ± 0.96, 82.00 ± 1.28 and 79.20 ± 1.01 for T₁, T₂, T₃ and T₄ groups, respectively and showed highly significant (P < 0.01) difference between the treatment groups. The overall ADG of pigs were 434 ± 0.02, 431 ± 0.03, 487 ± 0.02 and 465 ± 0.03 g, respectively for 10% wet brewer's spent grains (T₁), 10% *Moringa oleifera* leaves (T₂), 5% rice gluten meal (T₃) and conventional concentrate control diet (T₄). The pigs fed with 5% rice gluten meal (T₃) had significantly (P < 0.01) higher ADG during the finisher period compared to all other groups and the lowest ADG was observed in pigs fed with 10% *Moringa oleifera* leaves (T₂). The pigs fed with 5% rice gluten meal had recorded better FCR (2.87 ± 0.03) followed by conventional concentrate control diet (2.97 ± 0.02) and 10% wet brewer's spent grains (3.11 ± 0.03) and poor FCR (3.20 ± 0.02) was recorded in 10% *Moringa oleifera* group. In general, the pigs fed with 5% rice gluten meal recorded significantly (P < 0.01) better FCR compared to all other treatments during grower cum finisher period.

Keywords

Large White Yorkshire pigs, Body weight, Average daily gain, Feed conversion ratio

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Introduction

Pigs are competing with humans and other livestock for the conventional cereals. Moreover, conventional feed resources (cereals, legumes *etc.*) for pig production are scarce and highly expensive in many parts of

the world. Thus, searching for an alternative unconventional feed source that may have valuable components of animal diets is indispensable. For instance, feeding by-products from agricultural and food processing industries to pigs can be one of the alternate viable solutions.

Spent grain is the most abundant brewery by-product, corresponding to around 85 per cent of the total by-product generated. When grain is fermented to produce ethanol, the starch is utilized leaving behind a protein rich residue generally used as livestock feed. Brewer's spent grains (BSG) are available at low or no cost throughout the year and are produced in large quantities not only by large but also small breweries. Brewer's spent grain was found to be a satisfactory source of energy in finishing pigs and poultry rations (Yeong, 2000; Truinin, 2001 and Madubuike *et al.*, 2004). Spent grain has often been used for duck, guinea fowl and pig production by small-holder farmers (Ahaotu *et al.*, 2013 and Chukwu *et al.*, 2013).

Foliage from drought tolerant multipurpose trees could be used as alternative protein and energy resources during drought periods of tropical countries. Among multipurpose tree foliage, Moringa tree parts are known for better biomass yield, ecologically well-established on marginal soils and do not compete for arable lands; better nutrient composition and drought tolerant in tropical and sub-tropical climate. It has negligible amount of tannins and other anti-nutritional compounds and offers an alternative protein sources (Makkar and Becker, 1996; Sanchez *et al.*, 2006; Melesse *et al.*, 2009; and Melesse *et al.*, 2011). Inclusion of *Moringa oleifera* was used as a protein supplement in low quality diets to improve the dry matter intake and digestibility of the diet and increased milk production without affecting milk composition (Reyes *et al.*, 2006).

Rice gluten meal is the dried residue from rice after the removal of starch and separation of the bran by the process employed in wet milling manufacture of +rice starch or syrup or glucose. Rice gluten meal has an above average essential amino acid profile, added vitamins and high protein content. Thus it is

an excellent option for animal feeds for reducing ration cost by replacing portions of expensive soya bean meal, groundnut oilcake and is also ideal for livestock having corn and wheat allergies. Rice gluten meal has a higher biological value than wheat gluten and corn gluten because of its low cost and better results.

Feed cost alone accounts for about 70% of the cost of pig production in which protein represents the most expensive component of diet. The conventional protein sources such as fish meal, soya bean meal and groundnut oilcake are become too expensive. Taking into account the overall shortage of protein rich feeds and their relative costs, there is a need to explore economical and alternate protein sources which are locally available and easy to produce / purchase. Hence, the present study has been taken up to study the growth rate of Large White Yorkshire piglets fed with brewery waste, *Moringa oleifera* leaves and rice gluten meal.

Materials and Methods

A biological experiment was conducted to evaluate the growth performance of Large White Yorkshire piglets fed with conventional concentrate diet incorporated with wet brewer's spent grains (WBSG), dried *Moringa oleifera* leaves (MOL) and rice gluten meal (RGM). The weaner piglets available in the Instructional Livestock Farm Complex, Veterinary College and Research Institute, Namakkal were utilized for the study. A total of 24LWY piglets at the age of three and half months old were selected and grouped into 4, each treatment comprised of 6 animals. Wet Brewer's spent grains and rice gluten meal were purchased from the market and incorporated in the conventional concentrate diet at 10% and 5% inclusion level, respectively. *Moringa oleifera* leaves were collected and shade dried and the dried leaves

were incorporated in the feed at 10% inclusion level. Known quantities of diets (restricted feeding) were offered twice daily in the morning and evening and the left over feed was collected and weighed daily before each feeding. *Ad libitum* potable water supply was made available. Body weight, Average daily gain (ADG), and feed conversion ratio (FCR) were recorded at fortnightly interval to study the growth performance.

Results and Discussion

Body weight

In this study, the fortnightly mean body weight of LWY pigs fed with 10% WBSG (T₁), 10% *Moringa oleifera* leaves (T₂), 5% rice gluten meal (T₃) and conventional concentrate control diet (T₄) showed non-significant difference between the treatment groups during the grower period (Table 1).

But, the mean body weight of the finisher pigs recorded significant ($P < 0.05$) difference during 5th fortnight and highly significant difference ($P < 0.01$) from 6th fortnight to 8th fortnight period between the treatment groups.

Among the treatment groups, the final body weight of the pigs fed with 10% WBSG (T₁) showed numerically lower value (76.58 kg) as compared to conventional concentrate control diet (79.20 kg) but they did not differ significantly.

This is in accordance with the findings of Margaret Salomi (2015) who observed that there was non-significant difference between the average growth rate of pigs received upto 30% and Young and Ingram (1967) upto 50% inclusion of dried brewer's spent grains in pigs. Contrary to the above findings, Aguilera-Soto *et al.*, (2008) reported that the inclusion of wet brewer's spent grains at incremental

levels (0, 15, 30 and 45 per cent level) linearly reduced the growth rate of pigs during grower period.

At the end of the trial period, the piglets fed with 10% *Moringa oleifera* leaves (T₂) recorded significantly ($P < 0.01$) lower body weight (72.17 kg) compared to conventional concentrate control diet (79.20 kg). In close accordance with the above findings, reduced body weight was also reported by Mukumbo *et al.*, (2014) who studied the performance of Large White Yorkshire x Landrace pigs fed with *Moringa oleifera* leaves at 0, 2.5, 5 and 7.5 per cent inclusion level, but the difference was non-significant.

Among the treatment groups, the pigs fed with 5% rice gluten meal (T₃) produced significantly ($P < 0.01$) higher body weight (82.00 kg) at the end of the trial followed by conventional concentrate control diet (79.20 kg) and 10% WBSG (76.58 kg).

On perusal of available literatures, reports on inclusion of rice gluten meal in livestock are very limited. Similar positive trend in body weight was also reported by Rohit Kumar *et al.*, (2016) while replacing groundnut oilcake with rice gluten meal at 0, 50 and 75 per cent level in growing dairy calves. But, Metwally and Farahat (2015) reported non-significant difference in body weight of broiler chicken fed with inclusion of rice gluten meal at 0, 2.5, 5, 7.5, 10 and 12.5%. The higher body weight recorded in 5% RGM (T₃) fed pigs might be due to good balance of essential amino acids as amino acids are crucial for growth, development and cellular metabolism in animals (Wu, 2014).

The lower body weight observed in the 10% WBSG pigs (T₁) could be attributed to high fibre content as reported by Enwerem *et al.*, (2013) while comparing brewer's spent grains with fish meal; Madubuike (1994) and

Ngodigha *et al.*, (1994) also reported that increasing level of brewer's spent grains replacing maize and soya bean meal produced lower body weight compared to control.

The lowest body weight (72.17 kg) registered in 10% MO leaves (T_2) pigs which might be due to high fibre content and bulkiness (Oduro-Owusu *et al.*, 2015) and may also be attributed to a decrease in nutrient availability owing to the presence of phyto-chemicals or anti-nutrient factors (Afuang *et al.*, 2003).

Average daily gain

The average daily gain of pigs fed with 10% WBSG (T_1) was significantly lower during the grower period (Table 2) but there was non-significant difference observed during finisher period as compared to conventional concentrate control group.

In line with the above findings, Aguilera-Soto *et al.*, (2008) also observed lower mean average daily gain (617 g) in pigs fed with WBSG group (15, 30 and 45% inclusion) during the grower period compared to control (690 g) whereas, the ADG was similar during the finisher period in all WBSG included groups. Similarly, reduced body weight gain was also reported by Yaakugh *et al.*, (1994) in growing pigs.

In contrast, Imonikebe and Kperegbe (2014) who included brewer's spent grains at 0, 10, 20 and 30 per cent level in grower pigs and found non-significant difference in ADG among the treatments. But, Chawla and Sikka (1985) who included brewer's spent grains at 0, 10, 15 and 20% level in pigs and observed that the average daily gain of pigs fed rations containing 10 to 15% brewer's spent grains as comparable to control diet. However, there was significant depression in growth rate at 20% level. In contrary, Ngodigha *et al.*, (1994) observed no adverse effect in average daily

gain upto 20% inclusion of dried brewer's grains in grower pigs but the ADG was significantly ($P < 0.05$) lowered in 25 per cent dried brewer's grains incorporated diet.

The overall mean ADG of pigs fed with 10% MOL (T_2) during grower period showed non-significant difference with the conventional concentrate control diet. Similarly, Mukumbo *et al.*, (2014) observed non-significant difference in the average daily gain between the treatment groups while including *Moringa oleifera* leaves at 0, 2.5, 5.0 and 7.5% level in grower diet.

Likewise, Acda *et al.*, (2010) studied the potential of *Moringa oleifera* leaves as partial substitute for commercial pre-starter and starter diets of weaned pigs at 2, 3, 4% and 5 and 10% level, respectively under backyard conditions and found significant difference in the ADG of pigs between the treatment groups. Contrary to the above findings, Oliver *et al.*, (2015) observed significantly higher weight gain at early ages of the piglets while feeding fermented extract of *Moringa oleifera* leaves at a dilution of 1/250 in the drinking water beginning at 21 days old pigs.

During the grower period the piglets fed with 5% RGM (T_3) had similar overall average daily gain as compared to conventional concentrate control diet.

This result was supported by the findings of Rohit Kumar *et al.*, (2016) who fed rice gluten meal as an alternate protein source for groundnut cake in calves at 0, 50 and 75% level and found non-significant difference between the treatment groups.

Similarly, Metwally and Farahat (2015) included rice gluten meal at 0, 2.5, 5.0, 7.5, 10 and 12.5% level in broiler chicken and observed non-significant difference in mean ADG between the treatments.

Table.1 The fortnightly mean (\pm SE) of progressive body weight (kg) of Large White Yorkshire pigs fed with Alternate protein sources

| Treatment groups | Initial body weight at start of trial | Grower period | | | | Finisher period | | | |
|------------------|---------------------------------------|---------------------|---------------------|---------------------|---------------------|--------------------------------|--------------------------------|-------------------------------|--------------------------------|
| | | Fortnights | | | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| T ₁ | 24.80 \pm 0.46 | 28.51 \pm 0.69 | 33.46 \pm 0.63 | 40.31 \pm 0.66 | 47.87 \pm 0.63 | 55.25 \pm 0.82 ^a | 62.87 \pm 0.77 ^{ab} | 70.12 \pm 0.81 ^b | 76.58 \pm 0.79 ^b |
| T ₂ | 24.43 \pm 0.31 | 29.50 \pm 0.38 | 34.93 \pm 0.60 | 41.99 \pm 0.57 | 47.83 \pm 0.61 | 55.08 \pm 0.82 ^a | 60.25 \pm 0.75 ^a | 66.62 \pm 0.82 ^a | 72.17 \pm 0.96 ^a |
| T ₃ | 24.00 \pm 0.25 | 28.00 \pm 0.52 | 34.58 \pm 0.89 | 42.16 \pm 1.05 | 50.33 \pm 1.02 | 59.00 \pm 0.91 ^b | 67.58 \pm 1.06 ^c | 75.45 \pm 1.18 ^c | 82.00 \pm 1.28 ^c |
| T ₄ | 24.50 \pm 1.19 | 28.74 \pm 1.26 | 34.70 \pm 1.34 | 41.75 \pm 1.41 | 49.41 \pm 1.44 | 57.29 \pm 1.32 ^{ab} | 65.01 \pm 1.28 ^{bc} | 72.41 \pm 1.22 ^b | 79.20 \pm 1.01 ^{bc} |
| F value | 0.243 ^{NS} | 0.239 ^{NS} | 0.505 ^{NS} | 1.131 ^{NS} | 1.536 ^{NS} | 3.933* | 9.835** | 13.111** | 16.525** |

NS – Non-significant

* Significant (P < 0.05)

** Highly significant (P < 0.01)

Means bearing the same superscript in a column do not differ significantly.

Table.2 The fortnightly mean (\pm SE) of average daily gain (g) of Large White Yorkshire pigs fed with alternate protein sources

| Treatment groups | Grower period | | | | | Finisher period | | | | | Overall trial period |
|------------------|---------------------|---------------------|---------------------|------------------------------|------------------------------|------------------------------|------------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| | Fortnights | | | | | | | | | | |
| | 1 | 2 | 3 | 4 | Overall | 5 | 6 | 7 | 8 | Overall | |
| T ₁ | 352 \pm 0.08 | 431 \pm 0.01 | 433 \pm 0.01 | 467 \pm 0.01 ^{ab} | 425 \pm 0.03 ^a | 482 \pm 0.05 ^a | 508 \pm 0.02 ^{ab} | 507 \pm 0.02 ^b | 509 \pm 0.09 ^b | 492 \pm 0.02 ^b | 434 \pm 0.02 ^a |
| T ₂ | 393 \pm 0.02 | 453 \pm 0.05 | 456 \pm 0.01 | 458 \pm 0.07 ^a | 435 \pm 0.02 ^{ab} | 476 \pm 0.02 ^a | 455 \pm 0.02 ^a | 458 \pm 0.01 ^a | 457 \pm 0.07 ^a | 463 \pm 0.03 ^a | 431 \pm 0.03 ^a |
| T ₃ | 390 \pm 0.01 | 452 \pm 0.08 | 455 \pm 0.01 | 503 \pm 0.08 ^c | 452 \pm 0.02 ^b | 523 \pm 0.02 ^b | 556 \pm 0.01 ^b | 575 \pm 0.03 ^c | 588 \pm 0.01 ^c | 559 \pm 0.03 ^c | 487 \pm 0.02 ^c |
| T ₄ | 391 \pm 0.09 | 445 \pm 0.01 | 454 \pm 0.03 | 498 \pm 0.01 ^{bc} | 451 \pm 0.03 ^b | 514 \pm 0.04 ^{ab} | 523 \pm 0.01 ^b | 528 \pm 0.01 ^b | 527 \pm 0.01 ^b | 524 \pm 0.01 ^b | 465 \pm 0.03 ^b |
| F value | 2.144 ^{NS} | 1.445 ^{NS} | 1.724 ^{NS} | 8.108** | 5.426** | 3.301* | 5.137** | 13.024** | 24.840** | 27.06** | 27.298** |

NS – Non-significant

* Significant (P < 0.05); ** Highly significant (P < 0.01)

Means bearing the same superscript in a column do not differ significantly.

Table.3 The fortnightly mean (\pm SE) of feed conversion ratio of LWY pigs fed with alternate protein sources

| Treatment groups | Grower period | | | | | Finisher period | | | | | Overall trial period |
|----------------------|-------------------------|---------------------|---------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|
| | Fortnights | | | | | | | | | | |
| | 1 | 2 | 3 | 4 | Overall | 5 | 6 | 7 | 8 | Overall | |
| T₁ | 2.05 \pm 0.03 | 2.64 \pm 0.03 | 2.80 \pm 0.02 | 3.54 \pm 0.03 ^{bc} | 2.79 \pm 0.02 ^c | 3.63 \pm 0.04 ^{ab} | 3.52 \pm 0.18 ^{ab} | 3.45 \pm 0.08 ^b | 3.47 \pm 0.06 ^b | 3.51 \pm 0.05 ^c | 3.11 \pm 0.03 ^c |
| T₂ | 1.92 \pm 0.04 | 2.53 \pm 0.01 | 2.76 \pm 0.06 | 3.65 \pm 0.08 ^c | 2.73 \pm 0.03 ^{bc} | 3.70 \pm 0.05 ^b | 3.84 \pm 0.08 ^b | 3.82 \pm 0.09 ^c | 3.87 \pm 0.06 ^c | 3.81 \pm 0.04 ^d | 3.20 \pm 0.02 ^d |
| T₃ | 1.94 \pm 0.04 | 2.58 \pm 0.05 | 2.71 \pm 0.04 | 3.29 \pm 0.05 ^a | 2.63 \pm 0.03 ^a | 3.37 \pm 0.15 ^a | 3.21 \pm 0.06 ^a | 3.05 \pm 0.06 ^a | 3.02 \pm 0.05 ^a | 3.16 \pm 0.03 ^a | 2.87 \pm 0.03 ^a |
| T₄ | 1.94 \pm 0.04 | 2.58 \pm 0.05 | 2.78 \pm 0.09 | 3.36 \pm 0.08 ^{ab} | 2.66 \pm 0.02 ^{ab} | 3.40 \pm 0.04 ^a | 3.36 \pm 0.10 ^a | 3.33 \pm 0.10 ^b | 3.34 \pm 0.08 ^b | 3.36 \pm 0.05 ^b | 2.97 \pm 0.02 ^b |
| F value | 0.841 ^N s | 1.332 ^{NS} | 1.878 ^{NS} | 6.471 [*] | 5.484 ^{**} | 3.529 [*] | 5.167 ^{**} | 13.233 [*] | 27.320 [*] | 31.494 [*] | 28.855 [*] |

NS – Non-significant

* Significant (P < 0.05)

** Highly significant (P < 0.01)

Means bearing the same superscript in a column do not differ significantly.

Table.4 Proximate analysis of feed and fodder samples

| Experimental feed | Proximate principles (per cent) | | | | | | Gross energy (Kcal/kg) |
|--------------------------------------|---------------------------------|---------------|-------------|---------------|-----------|-----------------------|------------------------|
| | Dry matter | Crude protein | Crude fibre | Ether extract | Total ash | Nitrogen Free Extract | |
| Wet brewer's spent grains | 33.43 | 32.06 | 14.27 | 7.23 | 3.71 | 42.73 | 4774.15 |
| Dried <i>Moringa oleifera</i> leaves | 92.67 | 25.24 | 6.22 | 8.70 | 9.06 | 50.78 | 4528.97 |
| Rice gluten meal | 88.71 | 45.32 | 2.18 | 4.94 | 5.80 | 41.76 | 4785.25 |
| Concentrate feed | 91.15 | 24.21 | 5.21 | 2.40 | 7.03 | 61.15 | 4253.43 |

Table.5 Feed formulation for swine grower diet

| Sl. No | Ingredients | T ₁ | T ₂ | T ₃ | T ₄ |
|--------|----------------------|----------------|----------------|----------------|----------------|
| | | Quantity in kg | | | |
| 1. | Maize | 520.25 | 592.09 | 634.91 | 536.05 |
| 2. | (DORB) | 169.01 | 129.18 | 18.40 | 211.88 |
| 3. | Soya bean meal | 183.41 | 139.09 | 260.41 | 219.27 |
| 4. | Salt | 3.62 | 2.84 | 3.25 | 3.48 |
| 5. | Calcite | 17.32 | 21.22 | 18.60 | 25.24 |
| 6. | Di-calcium phosphate | 2.05 | 7.23 | 9.92 | 0.00 |
| 7. | Phytase 2500 | 0.30 | 0.30 | 0.30 | 0.30 |
| 8. | Methionine | 1.43 | 1.48 | 1.14 | 1.21 |
| 9. | Lysine | 2.61 | 4.94 | 2.27 | 2.57 |
| 10. | Sodium bicarbonate | 0.00 | 1.63 | 0.8 | 0.00 |
| 11. | WBSG | 100 | 0.00 | 0.00 | 0.00 |
| 12. | MOL | 0.00 | 100 | 0.00 | 0.00 |
| 13. | RGM | 0.00 | 0.00 | 50 | 0.00 |
| | Total | 1000.00 | 1000.00 | 1000.00 | 1000.00 |

Table.6 Feed formulation for swine finisher diet

| Sl. No | Ingredients | T ₁ | T ₂ | T ₃ | T ₄ |
|--------|----------------------|----------------|----------------|----------------|----------------|
| | | Quantity in kg | | | |
| 1. | Maize | 568.35 | 618.24 | 679.74 | 584.29 |
| 2. | (DORB) | 179.99 | 160.29 | 32.06 | 223.18 |
| 3. | Soya bean meal | 120.82 | 74.65 | 197.64 | 156.54 |
| 4. | Salt | 3.53 | 2.31 | 2.28 | 3.54 |
| 5. | Calcite | 17.32 | 21.86 | 18.68 | 25.65 |
| 6. | Di-calcium phosphate | 2.76 | 6.96 | 10.51 | 0.09 |
| 7. | Phytase 2500 | 0.30 | 0.30 | 0.30 | 0.30 |
| 8. | Methionine | 1.90 | 1.98 | 1.62 | 1.69 |
| 9. | Lysine | 4.75 | 7.06 | 4.41 | 4.71 |
| 10. | Sodium bicarbonate | 0.28 | 3.00 | 2.77 | 0.00 |
| 11. | Oil/Fat | 0.00 | 3.35 | 0.00 | 0.00 |
| 12. | WBSG | 100.00 | 0.00 | 0.00 | 0.00 |
| 13. | MOL | 0.00 | 100.00 | 0.00 | 0.00 |
| 14. | RGM | 0.00 | 0.00 | 50.00 | 0.00 |
| | Total | 1000.00 | 1000.00 | 1000.00 | 1000.00 |

Among the treatment groups the pigs fed with 10% wet brewer’s spent grains (T₁) during the finisher period had recorded comparable ADG (492 g) with the conventional concentrate control diet (524 g) and did not differ significantly. But, it differed significantly (P < 0.01) with ten per cent *Moringa oleifera* leaves (463 g) and five per cent rice gluten meal (559 g). The pigs fed with 5% rice gluten meal (T₃) during the entire trial period recorded the highest mean ADG (487 g) followed by conventional concentrate control diet (465 g) and ten per cent wet brewer’s spent grains (434 g) and 10% *Moringa oleifera* leaves (431 g) and they differ significantly (P < 0.01) between the treatments. The highest average daily gain recorded in pigs fed with 5% rice gluten meal (T₃) may be attributable to the differences in palatability and higher content of methionine, phenyl alanine, valine and alanine (Rohit Kumar *et al.*, 2016).

The overall lower ADG (431 g) observed in pigs fed with 10% wet brewer’s spent grains (T₁) during the growing period may be attributable to the bulkiness and high fibre

content of the diet (Imonikebe and Kperegbe, 2014). But, there was a compensatory gain observed during the finisher period.

The overall lower ADG (431 g) observed in the pigs fed with 10% *Moringa oleifera* leaves (T₂) during the overall trial period is ascribed to a decrease in nutrient availability (Mukumbo *et al.*, 2014) owing to the presence of phytochemicals and anti-nutrient factors (Afuang *et al.*, 2003) and high tannin content 32 g per kg and 12 g per kg, reported by Moyo *et al.*, (2011) and Makkar and Becker (1997), respectively.

Feed conversion ratio

The observations recorded in the study revealed that there was a highly significant (P < 0.01) difference between the groups in feed conversion ratio during the grower and finisher period (Table 3).

In close agreement with the above findings, Margaret Salomi (2015) reported non-significant difference in FCR of pigs fed with brewer’s dried grains at 0, 15 and 30% inclusion

between the treatment groups during the growing period, but during the finishing period (10th fortnight) there was a significant difference.

Many researchers (Ngodigha *et al.*, 1994; Aregheore and Ting, 2002; Imonikebe and Kperegbe, 2014) also reported that non-significant difference in feed conversion ratio between the pigs fed with brewer's dried grains at different inclusion levels.

But, Enwerem *et al.*, (2013) while replacing the fish meal with brewer's spent grains at 0, 30, 60 and 100% level in growing pigs recorded better FCR during the growing period but poorer feed conversion in the finishing phase.

The overall mean FCR of the pigs fed with 10% wet brewer's spent grains (3.11) during grower cum finisher period showed non-significant difference compared to conventional concentrate control diet (2.97) and this results was in agreement with the findings of Imonikebe and Kperegbe (2014); and Ngodigha *et al.*, (1994).

Contrasting results were observed by Aguilera-Soto *et al.*, (2008) and Albuquerque *et al.*, (2012) when pigs fed control diet had lower feed conversion ratio as compared to the pigs fed with brewer's dried grains.

The pigs fed with 10% *Moringa oleifera* leaves had numerically better FCR during 1st and 2nd fortnight of the grower period compared to conventional concentrate control diet but, numerically poor FCR (3.81) was observed when compared to conventional concentrate control diet (3.36) during the finisher period.

This better FCR observed during growing period in 10% *Moringa oleifera* leaves group may be attributable to the lower quantity of *Moringa oleifera* leaves consumption. But, in finisher pigs the total quantity of *Moringa oleifera* leaves consumption is increased as age advances which could have increased the feed conversion ratio value.

This result was supported by the findings of Oduro-Owusu *et al.*, (2015) who observed better feed conversion ratio ($P < 0.05$) when pigs fed with *Moringa oleifera* leaves at 2.5 and 5% level of inclusion, but did not show any significant difference at 1 and 3.5% level of inclusion. But, Mukumbo *et al.*, (2014) observed non-significant difference in FCR of pigs fed with 0, 2.5 and 5% inclusion level of *Moringa oleifera* leaves whereas, significantly poorer feed conversion ratio was observed at 7.5% level and concluded that *Moringa oleifera* leaves did not show negative effect on feed conversion ratio upto 5% level of inclusion. The *Moringa oleifera* leaves reported to contain 80 g per kg of saponins (Mukumbo *et al.*, 2014) which has been described as a substantial amount (Makkar and Becker, 1997). Saponins are reportedly characterized by bitter taste and have been known to reduce the palatability of feeds.

Among all the treatment groups, the pigs fed with 5% rice gluten meal recorded better ($P < 0.01$) overall FCR (2.87) followed by conventional concentrate control diet (2.97) and 10% wet brewer's spent grains (3.11). The better FCR observed in 5% rice gluten meal may be attributable to palatability, low fibre content and good balance of essential amino acids (Rohit Kumar *et al.*, 2016).

In line with the above findings, better feed efficiency of rice gluten meal inclusion in calves was observed by Rohit Kumar *et al.*, (2016). On the contrary, Metwally and Farhat (2015) found non-significant difference in feed conversion ratio of broiler chicken fed with rice gluten meal at 0, 2.5, 5, 7.5, 10 and 12.5% inclusion levels.

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