Growth Performance, Nutrient Digestibility and Blood Indices of West African Dwarf Goats Fed Graded Levels of Broiler Litter

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ABSTRACT

Background: A study was conducted to investigate effects of broiler litter (BL) on growth performance, nutrient utilization, blood haematology and serum biochemistry of West Africa Dwarf (WAD) goats.

Methods: Five complete diets were formulated using BL to replace 40% composition of cottonseed cake at 0 (control), 25, 50, 75 and 100%. Thirty WAD bucks weighing 10.57±0.42 kg were randomly allotted to the five treatments in a randomized complete block design (RCBD).

Result: The results revealed that daily feed intake (g) and final weight gain (kg) were statistically similar (p>0.05), but daily feed intake cost (N) and feed cost per kg gain (N/kg) decreased (p<0.05) across the treatments. Dry matter and organic matter digestibility increased (p<0.05), while neutral detergent fibre and acid detergent fibre digestibility decreased (p<0.05) across the diets. There was no statistical difference (p>0.05) in N intake, faecal N, urine N and N retained (as % N intake). The serum biochemistry and haematological parameters were statistically similar (p>0.05). Therefore, replacing 100% of CSC with BL maintained body growth; reduced cost of feed; improved nutrient digestibility and maintained normal blood haematology and serum biochemistry.

Key words: Blood parameter, Digestibility, Feed cost, Goat, Growth performance, Poultry waste.

INTRODUCTION

One of the major challenges to ruminant production is the cost of feeding which may account for about 70 to 80 % of the total production cost (Amole et al. 2017). High cost of ruminant feed formulated with oilseed cakes can be reduced by incorporating poultry litter (Chavda et al. 2014). Faecal waste from broiler litter contains high energy value and high crude protein (20-37%) content with appreciable amount of minerals and vitamins (Jeon et al. 2013). Poultry litter is safe for feeding ruminants after a simple staking to eliminate harmful microbes (Owen et al. 2010).

However, some researches raised general fear of spreading potential pathogens from poultry wastes to ruminants as well as increasing the risk of antibiotic-resistant bacteria (Agyare et al. 2019). The present study was aimed to investigate effects of replacing cottonseed cake completely with broiler litter on growth performance, blood constituents and feed cost.

MATERIALS AND METHODS

The experiment was conducted between February to June, 2019 at Teaching and Research Farm, Faculty of Agriculture, Kaduna State University, Nigeria. The area is located at latitude rainfall, relative humidity and temperature are 1800 mm, 63 % and 34°C, respectively.

Maize (40%), cottonseed cake (40%), cowpea husk (10%), sorghum spikelet (9.3), bone meal (0.1%), limestone (0.3%) and common salt (0.3 %) were used to formulate control diet. The litter was then used to replace cottonseed cake at 0 (control), 25, 50, 75 and 100%, hence each replacement level served as a treatment.
Chemists (AOAC, 1990) methods of analysis. Cell wall fractions were determined according to the method of Van Soest et al. (1991). Gross energy (GE) was measured using bomb calorimeter (Brand IKA; model C2000).

Data collected on feeding trial, nutrient digestibility, N-balance and blood constituents were analysed using general linear model (GLM) of Statistical Analysis System (SAS, 2011). Means were separated using Duncan Multiple Range Test (DMRT) (Duncan, 1955).

RESULTS AND DISCUSSION

Feed intake, weight gain and feed cost

Feed intake, weight gain feed to gain ratio (Table 2) were statistically similar (p>0.05) across all the treatments. However, there was difference (p<0.05) in cost of daily feed intake and feed cost per kg gain. The daily weight gain (25.56 – 29.33g/d) observed in the present study was within the range reported for West African Dwarf goats (Ilori et al. 2013). The daily weight gain was higher than values reported by Ogunmoye (1995), but lower than average daily weight recorded for WAD goats in hot-humid zone of rain forest (Oni et al. 2010). The differences in DWG in this study and the previous reports could be related to the nature of the diets and ecological location (hot-humid vs hot-dry) of the experiments.

The feed cost per kg gain observed (₦664.24 – 1193.37) in this study was higher compared with ₦170.30 – 290.10 reported by Makun et al. (2013), but lower than ₦1590.12 – 1795.60 recorded for WAD goats fed brewers’ dried grain basal diet (Babale et al. 2018). The differences in feed cost/kg gain found between this study and the previous reports could be due to the different breeds (Red Sokoto and Sahelian goat vs West African Dwarf) used in the experiments and also the nutritional quality of the experimental diets.

Nutrient digestibility

The apparent digestibility (Table 3) of dry matter (DM), organic matter (OM), neutral detergent fibre (NDF), acid detergent fibre (ADF), crude protein (CP) and gross energy (GE) were altered (p<0.05) across the treatments. The trend of nutrient digestibility in this study shows that the apparent digestibility of NDF and ADF decreased across the treatments, while DM digestibility increased with level of cottonseed cake replacement with broiler litter. The trend could be explained in relation to nutrient composition of the experimental diets (Table 1) both NDF and ADF contents decreased with levels of CSC replacement with BL. Besides, NDF is known to correlate negatively with rate of feed digestion (Casler and Jung, 2006) while ADF indirectly correlates to gross energy. Hence, animals on treatments with lower NDF contents tended to empty their rumen contents at faster rates than animals on control or on lower levels of broiler litter inclusion. Similarly, increasing ADF concentration across the treatments reduced gross energy contents hence the low digestible energy and its apparent digestibility. The result of this study disagrees with Makun et al. (2013) who reported no difference (p>0.05) in DM, NDF and ADF digestibility of Red Sokoto and Sahelian goats fed CSC based diet. The finding was, however, similar to report by Ilori et al. (2013) who observed difference (p<0.05) in DM, CP and fibre digestibility of WAD goats supplemented with baobab fruit meal in a wheat offal concentrate diet. The differences observed in this study and other reports could be related to the different types of test and basal feeds fed to the experimental animals.

Nitrogen intake, nitrogen loss and nitrogen balance

Nitrogen balance (Table 4) was different (p<0.05) across the treatments; however, nitrogen intake, nitrogen losses and percentage nitrogen retained were similar (p>0.05). The absence of differences in nitrogen intake can be attributed to a nearly similar CP content between broiler litter and cottonseed cake used in formulating experimental diets. Though the trend of nitrogen balance in this result was not consistent to the replacement levels, animals on 100% replacement level showed higher nitrogen balance. This finding revealed that animals on treatment diets had similar

| Nutrient (%) | Level of replacing CSC with BL |
|--------------|-------------------------------|
|              | 0% | 25% | 50% | 75% | 100% |
| Dry matter   | 90.30 | 90.02 | 90.21 | 90.04 | 90.03 |
| Organic matter | 89.62 | 87.34 | 86.04 | 85.79 | 84.62 |
| Ash          | 10.38 | 12.66 | 13.96 | 14.21 | 15.38 |
| Neutral detergent fibre | 57.40 | 54.30 | 52.50 | 50.20 | 47.40 |
| Acid detergent fibre | 24.90 | 26.70 | 27.75 | 28.40 | 26.75 |
| Acid detergent lignin | 5.65 | 6.30 | 7.48 | 8.45 | 8.95 |
| Crude fibre | 16.67 | 15.33 | 14.00 | 11.33 | 10.00 |
| Hemi cellulose | 32.50 | 27.60 | 24.75 | 21.80 | 20.65 |
| Cellulose   | 19.25 | 20.40 | 20.27 | 19.95 | 17.8 |
| Ether extract | 4.67 | 4.33 | 4.13 | 3.84 | 3.25 |
| Crude protein | 13.88 | 13.96 | 13.65 | 13.56 | 13.76 |
| Gross energy (MJ/kg DM) | 16.138 | 15.895 | 15.285 | 14.870 | 14.510 |
**Table 2:** Effects of replacing Cottonseed cake with broiler litter on feed intake, weight gain and feed cost of WAD bucks fed complete diet.

| Nutrient               | 0%  | 25%  | 50%  | 75%  | 100% | SEM | P-value |
|------------------------|-----|------|------|------|------|-----|---------|
| DFI (g)                | 377.87 | 372.76 | 391.2 | 346.98 | 318.63 | 16.76 | 0.454  |
| TFI (kg)               | 31.74 | 31.31 | 32.86 | 29.15 | 26.77 | 1.41 | 0.454  |
| DWI (L)                | 0.66  | 0.78  | 0.77  | 0.70  | 0.72  | 0.03 | 0.307  |
| DWG (g)                | 29.33 | 26.22 | 27.78 | 27.78 | 25.56 | 0.14 | 0.968  |
| FWG (kg)               | 2.53  | 1.97  | 2.50  | 2.50  | 2.30  | 0.005 | 0.005  |
| FGR                    | 13.98 | 13.36 | 15.68 | 13.14 | 13.20 | 0.80 | 0.639  |
| FC/kg (N)              | 81.08 | 75.08 | 60.08 | 63.08 | 57.08 | 1.43 | 0.005  |
| DFIC (N)               | 30.64 | 27.99 | 27.02 | 21.89 | 18.19 | 1.43 | 0.005  |
| TFIC (N)               | 2573.56 | 2350.94 | 2270.08 | 1838.56 | 1527.75 | 120.49 | 0.005  |
| FC/Kg gain(N/kg)      | 1017.22 | 1193.37 | 908.03c | 735.42 | 664.24 | 61.87 | 0.002  |

DFI= daily feed intake, TFI= total feed intake, DWI= daily water intake, FWG= final weigh gain, FGR= feed to gain ratio, FC= feed cost ($= N 360), DFIC= daily intake cost, TFIC= total feed intake cost, FC/kg gain= feed cost per kg gain.

**Table 3:** Apparent nutrient digestibility (%) of WAD bucks fed cottonseed cake diet replaced with broiler litter.

| Nutrient               | 0%  | 25%  | 50%  | 75%  | 100% | SEM       | P-value |
|------------------------|-----|------|------|------|------|-----------|---------|
| Dry matter             | 41.11b | 44.35b | 54.70a | 52.54a | 53.69a | 1.26 | 0.0035  |
| Organic matter         | 43.16b | 50.90ab | 58.42a | 55.79a | 55.98a | 2.55 | 0.0492  |
| NDF                    | 50.12a | 43.50b | 35.07c | 33.08c | 25.67d | 1.74 | 0.0003  |
| ADF                    | 43.59a | 40.49b | 31.56c | 21.35c | 13.33d | <0.001 |        |
| Crude protein          | 44.62b | 51.48a | 44.78b | 44.95b | 51.07ab | 1.51 | 0.0461  |
| Ash                    | 30.54  | 34.34  | 34.40  | 35.19  | 42.56  | 4.36 | 0.4904  |
| Ether extract          | 76.4   | 99.02  | 99.20  | 98.65  | 98.55  | 4.81 | 0.5659  |
| DE                     | 27.33ab | 30.75a | 31.70a | 23.89b | 23.26b | 1.41 | 0.0079  |

NDF= neutral detergent fibre, ADF= acid detergent fibre, DE= digestible energy.

**Table 4:** Nitrogen balance (g/d) of WAD bucks fed cottonseed cake diet replaced with broiler litter.

| Parameter             | 0%  | 25%  | 50%  | 75%  | 100% | SEM | P-value |
|-----------------------|-----|------|------|------|------|-----|---------|
| N intake              | 9.54 | 9.65 | 9.44 | 9.35 | 9.56 | 0.092 | 0.0831  |
| Faecal N              | 1.71 | 1.55 | 1.70 | 1.69 | 1.52 | 0.048 | 0.0704  |
| urine N               | 0.14 | 0.12 | 0.11 | 0.11 | 0.12 | 0.019 | 0.7854  |
| N loss                | 1.83 | 1.67 | 1.82 | 1.75 | 1.64 | 0.056 | 0.1893  |
| N Balance             | 7.75bc | 7.99a | 7.76c | 7.63c | 7.88ab | 0.056 | 0.0069  |
| N retained (as % intake) | 80.74 | 82.74 | 80.78 | 81.31 | 82.76 | 0.584 | 0.1129  |

Nitrogen intake and nitrogen retention to animals on the control diet. The nitrogen retained (80.74 – 82.76%) in the present study was higher than previous report for WAD goats fed ensiled mixtures of elephant grass (*Pennisetum purpureum*) with legume beans (Ajayi, 2011), but similar result was recorded for WAD goats fed different browse plants (*Moringa oleifera, Leucaena leucocephala* and *Gliricidia sepium*) (Asaolu et al. 2011). The reason for different nitrogen balances between our results and previous reports could be associated with different nitrogen intake observed in the experiments.

**Haematology and serum biochemistry**

Blood haematology and serum biochemistry is presented as Table 5. The total red blood cells (TRBC) was slightly low but within a normal range (5 – 8 × 10^{12}/L); TRBC below the normal value is associated to an underlying haem parasitic infection or poor nutrition (Paul and Dey 2015). The total white blood cell counts (TWBC) were within the normal values of 4 – 13 × 10^{9}/L, hence the animals were healthy (Al-Bulushi et al. 2017). The observation on blood haematology in the present work was previously confirmed by Singh et al. (2002) that feeding poultry litter to crossbred calves did not cause any health threats.

Blood urea nitrogen (BUN) across treatments were within normal values (12-26 mg/dl) which suggested that the kidneys and liver were functioning well since BUN levels provide information to renal physiology (Ostfeld et al. 2010). The higher BUN concentration observed in treatment groups was an evidence that BL contains high nitrogen (N) content that was indicated in Table 5.
Table 5: Haematology and serum biochemistry of West African Dwarf bucks fed cottonseed cake diet replaced with broiler litter.

| Parameter          | Level of replacing CSC with BL | SEM  | p-value |
|--------------------|---------------------------------|------|---------|
|                    | 0%                              | 25%  | 50%     | 75%     | 100%   |       |
| PCV (%)            | 32.33                           | 36.00| 31.00   | 37.00   | 34.67  | 2.69  | 0.398 |
| Hb (g/L)           | 10.73                           | 11.97| 10.30   | 12.30   | 11.53  | 0.90  | 0.401 |
| TP (g/L)           | 6.67                            | 6.80 | 5.87    | 6.20    | 6.40   | 0.54  | 0.713 |
| TWBC (x 10^9/L)    | 11.13                           | 10.63| 10.67   | 6.60    | 8.00   | 1.04  | 0.136 |
| TRBC (x 10^9/L)    | 5.57                            | 6.03 | 4.93    | 6.07    | 5.90   | 0.46  | 0.399 |
| Neutrophils (%)    | 35.67                           | 37.67| 33.00   | 33.67   | 36.33  | 4.93  | 0.197 |
| Lymphocytes (%)    | 58.67                           | 59.33| 64.67   | 62.33   | 62.00  | 5.57  | 0.903 |
| Basophils (%)      | 1.33                            | 1.33 | 1.00    | 0.67    | 1.00   | 0.78  | 0.785 |
| BAND (%)           | 0.0                             | 0    | 0       | 0       | 0      |       |       |
| MCV (fL)           | 58.40                           | 59.53| 63.20   | 61.00   | 58.80  | 1.53  | 0.512 |
| MCH (pg)           | 19.37                           | 19.83| 21.03   | 20.27   | 19.57  | 0.49  | 0.473 |
| albumin (g/L)      | 21.00                           | 27.67| 31.33   | 28.00   | 32.33  | 4.57  | 0.485 |
| Ts protein (g/L)   | 63.33ab                         | 73.33| 64.00ab | 62.00b  | 66.33ab| 3.25  | 0.032 |
| BUN (mg/dl)        | 18.33                           | 20.08| 21.73   | 22.67   | 23.72  | 2.25  | 0.471 |
| Creatine (mg/dl)   | 1.63                            | 1.00 | 1.53    | 1.33    | 1.80   | 0.26  | 0.193 |
| Cholesterol (mg/dl)| 1.73                            | 1.77 | 1.17    | 1.70    | 1.67   | 0.32  | 0.791 |
| ALT (IU/L)         | 18.33                           | 19.67| 15.67   | 21.33   | 20.67  | 5.60  | 0.947 |
| AST (IU/L)         | 68.67                           | 70.00| 86.33   | 88.33   | 90.67  | 13.49 | 0.21  |
| ALP (IU/L)         | 17.00                           | 18.67| 16.00   | 20.33   | 25.00  | 6.32  | 0.894 |

PCV= packed cell volume, Hb= haemoglobin, TP= total protein, TWBC= total white blood cells, TRBC= total red blood cells, MCV= Mean corpuscular value, MCH= Mean corpuscular haemoglobin, MCHC= Mean corpuscular haemoglobin concentration. Ts protein= thymidylate synthase protein, BUN= blood urea nitrogen, ALT= Alanine Aminotransferase, AST=Aspartate Aminotransferase, ALP= alkaline phosphate level.

uric acid content (Liang et al. 2011), which is quickly degraded in the rumen to ammonia, thus excess ammonia that is not utilize by rumen microbes or absorbed via rumen walls is converted to urea by the liver (Jin et al. 2018). Urea is then either recycled via saliva or excreted in the urine; nonetheless, urea is secreted via milk (Gulinski et al. 2016).

The range of blood glucose (48.42-68.58 mg/dl) observed in the study was higher than values reported for WAD goats fed dried cassava leaves plus guinea grass as basal feed (Daramola et al. 2005). Nevertheless, the high blood glucose level recorded in this study contradicted glucose levels observed in WAD goats fed groundnut haulms and cowpea husk supplemented with brewers’ dried grain (Babale et al. 2019). The variation in blood glucose levels between the present study and the previous reports could be associated to carbohydrate intake and the energy content of the experimental diets.

**CONCLUSION**

Based on the findings of this study, it was concluded that replacing 100 % of cottonseed cake with broiler litter in the diet of goats maintained feed intake and weight gain; it reduced cost of feed and feed cost per kg gain; it improved nutrient digestibility and nitrogen balance and did not alter blood parameters from normal values.

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