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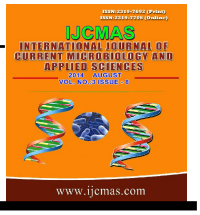

Original Research Article

Growth performance and nutrient digestibility of West African Dwarf goats fed graded levels of *Moringa oleifera* leaf meal

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A B S T R A C T

Keywords

Moringa oleifera leaf-meal, *Panicum maximum*, nutrient utilization, WAD goats

A sixty one days feeding trial was conducted to determine the total feed intake, live weight gain and digestibility coefficients of WAD goats (bucks) fed basal diet of *Panicum maximum* (guinea grass) and concentrate diet containing *Moringa oleifera* leaf meal (MOL) at 0%, 5%, 10% and 15% levels. The animals were allocated to four dietary treatments of three goats per treatment in a completely randomized design experiment. Feed intake, live weight gain and digestibility coefficients were determined. The results showed that the WAD goats fed the concentrate diet with 15% level of inclusion of *Moringa oleifera* leaf meal had significantly higher ($P<0.05$) rate of growth and digestibility coefficients than those on the 5% and 10% inclusion levels.

Introduction

The West African Dwarf goat is prevalent in South-western Nigeria and they are hardy, resistant to trypanosomiasis, known to have multiple births and are usually raised for meat production (Belewu, 2006). Livestock farmers in developing countries are faced with various challenges that led to a considerable fall in the production of certain livestock species like goats, cattle, swine and poultry. The major problem was the high cost of production due to increased prices of locally available feed ingredients. The effects of these challenges resulted in poor productivity of livestock and lower quantity of animal protein available for human consumption in the third world. One of the major factors limiting the productivity of small ruminants in developing countries is the over-dependence on low digestible feedstuffs which at certain periods of the year may not meet even the maintenance requirements of these animals. Jayasuriya (2002) categorized these feed resources as high fibre, low protein feeds having organic matter digestibility between 30 and 45 % and they include native grasses, crop residues and fibrous agro-industrial waste products. These also formed the bulk of the feed consumed by small ruminants in tropical countries since they are produced in

large quantities and are relatively cheap, also, they are not competed for by man or monogastric animals. The dry season result in a rapid decline in the quantity and quality of forage leading to low forage intake and digestibility with resultant low animal performance. It has been reported by (Adegbola, 2002) that poor quality roughages fed to ruminants without supplementation, especially during the dry season caused considerable weight losses and sometimes resulted in the death of the animals. The price of conventional sources of protein in livestock ration has risen exorbitantly (Akinmutimi, 2004) and this has necessitated the search for cheaper alternative feed resources that can meet the nutritional requirements of farm animals. These alternative feedstuffs should not be in high demand by humans and should be cheap (Ahamefule, 2002).

Also, Preston and Leng (1987) stated that the poor condition of livestock in the tropics is more likely as a result of inefficient digestion in the rumen and inefficient utilization of the nutrients absorbed from low quality feeds. However, in recent years there has been a growing interest in many tropical countries to identify potentially important feed sources among shrubs and trees for inclusion in the ruminant diet to provide green fodder that is high in protein to supplement the available low protein forage. This has been recognized as one of the most effective means of improving animal performance in smallholder livestock production (Blair, 1989). Ranjbar (2007) also mentioned that forages have important role in ruminant nutrition in terms of providing energy, protein and minerals as well as fibre for chewing and rumination.

Moringa oleifera is a well-known tree in West Africa and is often cultivated as a living fence around people's gardens and consumed in various forms as food. Leaves of the tree are noted for high content of crude protein, essential vitamins, minerals and amino acids (Makkar and Becker, 1997; Gidamis et al, 2003). However, according to Akinbamijo et al (2006), the value of the tree and its benefits as a high-quality supplement to low-quality roughages in ruminant feeding systems have not been fully known nor widely exploited.

This study was thus designed to determine the dry matter intake, weight gain and apparent digestibility coefficients in WAD goats when fed graded of *Moringa oleifera* leaf meal during the dry season.

Materials and Methods

Study area

The experiment was carried out at the Goat Unit of the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. The site is located within the derived Savannah ecological zones, within the Latitude 8^{o} 15´N and Longitude 4^{o} 15´E (Oguntoyinbo, 1978). The annual rainfall is about 1500 mm and occurs from April to November with the dry season between December and March.

Experimental animals and their management

Twelve intact growing WAD bucks with average weight of 7.5 kg were used. A completely randomized design (CRD) with 4 treatments and 3 animals per treatment was used. The experimental animals were routinely given Ivomec injection against endo and ecto-parasites and vaccinated against Peste des Petits Ruminant (PPR) disease. The animals were purchased from a reputable farm and quarantined for two weeks before the start of the experiment.

Experimental diets and feeding

The chemical composition of *Panicum maximum* and *Moringa oleifera* leaf meal (MOL) used in the feeding trial is presented in Table 1. Also, the ingredients composition of concentrate diets is presented in Table 2. The diets were made up of pre-wilted guinea grass (*Panicum maximum*) and concentrate diets at four levels of *Moringa oleifera* leaf-meal (MOL) as follows: D1 (0% MOL), D2 (5% MOL), D3 (10% MOL) and D4 (15% MOL). The experimental animals were served with the grass at 8.00 am daily, while the concentrate diets D1 – D4 were served at 12 noon. The animals were balanced for weight at the beginning of the experiment. Salt licks and fresh water were provided *ad libitum*.

Data collection

Fresh *Panicum maximum* were chopped, weighed and offered to the experimental WAD goats. Also, weighed quantities of the concentrate diets were given. Daily total feed intake was determined as feed offered minus feed refusal. The animals were given basal diet of *Panicum maximum* grass (10% of body weight) and also offered the concentrate diets at 4% of their body weight. Weekly body weights of the animals were measured. Other parameters calculated included the following: Total weight gain (final live weight minus initial live weight); Daily weight gain (total weight gain divided by 61 days experimental period); Daily metabolic weight gain (Daily weight gain $^{0.75}$); Feed conversion ratio (daily dry matter intake divided by daily weight gain).

Digestibility experiment

The digestibility trial was carried out using four goats, one animal was selected from each of the four treatments. The animals were transferred into separate metabolic cages provided with facilities for collection of faeces. The animals were fed weighed amounts of *Panicum maximum* grass and concentrate diets D1- D4, and water provided *ad libitum*. There were 7 days adaptation period and 7 days excreta (faeces) collection. Daily feed intake (feed offered minus refusal), faecal output were collected, well labelled, weighed and recorded for each animal.

Chemical analysis

Sub samples of the diets D1- D4 (offered and refusals), and faecal samples were oven dried at 105^{o}C until constant weight was attained for dry matter determination (AOAC, 2005). Another set of same samples of the diets and faecal samples were oven dried at 65^{o}C to a constant weight, milled through a Thomas Willey laboratory mill (1mm screen) for analysis. These samples were analysed for crude protein, crude fibre, ether extract, ash (AOAC, 2005). Neutral detergent fibre, acid detergent fibre and acid detergent lignin were determined according to the methods of Van Soest et al (1991). Data collected were used to compute the apparent nutrient digestibility coefficients (nutrient in feed - nutrient in faeces/nutrient in feed x 100).

Statistical analysis

Data collected were subjected to one way analysis of variance (ANOVA) procedure of SAS (2002). Significant means were ranked using the Duncan's multiple range test option of the same software package.

Results and Discussion

Chemical composition

The chemical composition of concentrate

diets at various levels of inclusions of *Moringa oleifera* leaf meal is shown in Table 3. The CP content of 7.26% for D1 (0% MOL) was lowest, followed by CP content of 7.88% in both D2 and D4, then 9.63% CP in D3. The CP content of 7.26% for D1 (0% MOL) was slightly below the minimum level for maintenance of 7.7% for goats (NRC, 1981). However, in D2-D4, CP content range of 7.88 to 9.63% was within this minimum level. The inclusions of MOL in D2 to D4 (5% to 15% MOL) could be responsible for the increases in the CP contents of the diets D2- D4. These CP contents of between 7.88 and 9.63% were just within minimum of 7- 8% necessary to provide the minimum ammonia levels required by rumen micro-organisms to support optimum rumen activity (Norton, 2003). The CF, NDF, ADF and ADL levels of the experimental diets ranged from 10.14-14.03%; 26.27-34.12%; 15.38-24.11% and 7.98-9.48% respectively. These values were lower than the ranges of 16.67-21.50% CF; 48.63-52.49% NDF; 20.88-42.51% ADF; and 9.73-11.26% ADL reported for similar diets inclusion of *Zizphus mauritiana* browse plant fed to goats of mixed breed (Bornu white and Sokoto red) (Njidda et al, 2010).

Nouala et al (2006) outlined that the environmental conditions of the rumen are normally in favour of the fibrolytic micro-organisms which aid the degradation of high fibre diets in contrast to the negative effects of concentrates high or sole concentrate diets which were very high in carbohydrates. The hemi-cellulose and cellulose contents were 9.47-18.74% and 7.03-14.63% respectively, and these were utilizable by the digestive system of ruminants. Also, these values were within the ranges of 4.45 and 22.23% hemi-cellulose and 12.16 and 28.75% cellulose obtained by Omoniyi et al (2013) in some forage plants.

Performance characteristics

Table.4 shows the performance characteristics of the WAD goats fed the different concentrate diets D1- D4. All the parameters were significantly ($P<0.05$) different for the dietary treatments. All the experimental animals had adequate total dry matter intake (DMI) which ranged from 336.39 to 392.46 g/animal/day. These values were comparable to values ranging from 288.48 to 354.49 g/animal/day for WAD goats fed *M. oleifera, Gliricidia sepium* and *Leucaea leucocephala* dried leaves as supplements to cassava peels (Asaolu et al, 2012). These values met the minimum daily DMI of 3% of body weight recommended for small ruminants (NRC, 1985). The DMI of the concentrate diets containing MOL were observed to increase in the order D2 (5% MOL) < D3 (10% MOL) < D4 (15% MOL). This intake pattern could be a reflection of the relative acceptability and palatability of these diets as was also observed by Asaolu et al (2012). The increased total DMI in this study might also be attributed to the corresponding increase in the CP and Ash (mineral) levels (3.58 to 7.64% Ash) in the concentrate diets D2 to D4.

Daily weight gain/goat were better ($P<0.05$) for animals on diets D1 (0% MOL) (21.15 g/day) and D4 (15% MOL) (22.79 g/day) than that obtained in D2 (5% MOL) (16.07 g/day) and D3 (10% MOL) (16.72 g/day) as shown in Table 2. The significantly ($P<0.05$) higher values of feed conversion ratios (FCR) of 20.94 and 22.29 recorded for animals on diets D2 (5% MOL) and D3 (10% MOL) respectively, implied that the animals utilized those feed with lesser efficiency as compared to the FCR values of 16.78 and 17.22 in D1 (0% MOL) and D4 (15% MOL) respectively.

Table.1 Chemical composition of *Panicum maximum* and *Moringa oleifera* leaf meal (MOL)

Parameters (%)	*Panicum maximum* (basal diet)	*Moringa oleifera* leaf-meal (test ingredient)
Dry Matter	75.75	90.46
Crude Protein	6.11	18.38
Crude Fibre	33.05	14.04
Ether Extract	3.65	14.58
Ash	9.34	8.38
Organic Matter	90.66	91.62
Nitrogen Free Extract	23.60	44.71
Neutral Detergent Fibre	62.50	25.68
Acid Detergent Fibre	42.10	14.78
Acid Detergent Lignin	16.33	8.11
Hemicellulose	20.40	10.90
Cellulose	25.77	6.67

Table.2 Ingredients composition of concentrate diets at various levels of inclusions of *Moringa oleifera* leaf meal (MOL)

Ingredients (%)	D1 (0% MOL)	D2 (5% MOL)	D3 (10% MOL)	D4 (15% MOL)
Dried cassava peels	35.00	35.00	35.00	35.00
MOL	-	5.00	10.00	15.00
Palm kernel cake	61.00	56.00	51.00	46.00
Bone meal	3.00	3.00	3.00	3.00
Salt	1.00	1.00	1.00	1.00
Total	100.00	100.00	100.00	100.00

Table.3 Chemical composition of concentrate diets at various levels of inclusions of *Moringa oleifera* leaf meal (MOL)

Parameters (%)	D1 (0% MOL)	D2 (5% MOL)	D3 (10% MOL)	D4 (15% MOL)
Dry Matter	92.47	92.42	86.76	90.38
Crude Protein	7.26	7.88	9.63	7.88
Crude Fibre	14.03	13.68	10.14	13.73
Ether Extract	15.85	16.23	13.07	14.23
Ash	5.89	3.58	4.64	7.64
Organic Matter	94.11	96.42	95.36	92.36
Nitrogen Free Extract	56.97	58.63	62.52	56.52
Neutral Detergent Fibre	33.58	34.12	26.27	26.27
Acid Detergent Fibre	24.11	15.38	15.42	16.59
Acid Detergent Lignin	9.48	8.35	8.11	7.98
Hemicellulose	9.47	18.74	10.85	9.68
Cellulose	14.63	7.03	7.31	8.61

Table.4 Performance characteristics of growing (WAD) goats fed concentrate diets at various levels of inclusions of *Moringa oleifera* leaf meal (MOL)

Parameters	D1 (0% MOL)	D2 (5% MOL)	D3 (10% MOL)	D4 (15% MOL)	SEM
Dry matter intake					
Panicum maximum (g/day)	214.37[a]	203.09[b]	213.59[a]	198.36[b]	6.63
Concentrate (g/day)	140.55[c]	133.30[c]	159.20[b]	194.10[a]	19.80
Total dry matter intake/goat (g/day)	354.92[c]	336.39[c]	372.79[b]	392.46[a]	19.74
Growth performance					
Initial live weight/goat (kg)	6.26[b]	6.54[b]	7.32[a]	6.25[b]	0.70
Final live weight/goat (kg)	7.55[b]	7.52[b]	8.34[a]	7.64[b]	0.72
Total weight gain/goat (kg)	1.29[a]	0.98[b]	1.02[b]	1.39[a]	0.21
Daily weight gain/goat(g/day)	21.15[a]	16.07[b]	16.72[b]	22.79[a]	1.69
Daily metabolic weight gain/goat (g $W^{0.75}$/day)	9.86[a]	8.03[b]	8.27[b]	10.43[a]	1.60
Daily dry matter intake/goat (g/day)	354.92[c]	336.39[c]	372.79[b]	392.46[a]	19.74
Feed conversion ratio (FCR)	16.78[b]	20.94[a]	22.29[a]	17.22[b]	1.38

[a,b,c.] Means on the same row with different superscript differ significantly (P<0.05)

Table.5 Apparent digestibility coefficients (%) of nutrients by WAD goats fed graded levels of inclusions of *Moringa oleifera* leaf meal (MOL)

Digestibility coefficient (%)	D1 (0% MOL)	D2 (5% MOL)	D3 (10% MOL)	D4 (15% MOL)	SEM
Dry Matter	81.67[a]	77.80[b]	77.47[b]	79.53[ab]	0.87
Crude Protein	37.20[ab]	27.03[b]	41.00[a]	39.97[a]	3.40
Crude Fibre	74.80[a]	66.63[c]	66.13[c]	71.23[b]	1.60
Ether Extract	93.63[a]	82.40[b]	78.20[c]	78.50[c]	0.88
Organic Matter	80.47	78.07	78.97	79.50	1.08
Ash	89.33[a]	79.53[b]	81.83[b]	90.80[a]	0.83
Nitrogen Free Extract	82.90[b]	87.87[a]	87.03[a]	87.27[a]	0.79
Neutral Detergent Fibre	76.30[a]	70.13[b]	61.23[c]	62.73[c]	1.66
Acid Detergent Fibre	71.33[a]	44.30[b]	45.43[b]	43.03[b]	2.45
Acid Detergent Lignin	77.63	75.77	76.73	78.40	3.20

[a,b,c.] Means on the same row with different superscript differ significantly (P<0.05)

This is because the higher the value of the feed conversion ratio (FCR), the less desirable is the diet, as the animal consumes more feed to produce a unit weight gain. This probably showed that the feed was better utilized at the higher level of inclusion in D4 (15% MOL). Various researchers, Manh et al (2005) and Asaolu et al (2012) reported that *Moringa oleifera* leaf-meal contained high

protein, essential vitamins, minerals, amino acids and low anti-nutritional factors like tannins, which could help the animals to better utilize the feed.

Apparent nutrient digestibility

The results obtained in Table 5 showed that apparent nutrient digestibility coefficient values were significantly different ($P<0.05$) across all the treatments, except those for organic matter and acid detergent lignin which were not significantly different ($P>0.05$). The digestibility coefficients of DM in this study were high and ranged from 77.47 to 81.67%, suggesting that the diets were highly digested. Similarly, Manh et al (2005) reported the apparent DM digestibility values of between 78.2 and 82.6% in the evaluation of *Moringa oleifera* leaves as sole feed for goats. The diets D1 (0% MOL) and D4 (15% MOL) both had highest CP, and Ash digestibility values. The apparent digestibility coefficients of CP, CF, EE, OM, Ash, NFE, NDF and ADL followed to a high extent, a similar trend as the apparent DM digestibilities. A similar observation was reported by Arigbede et al (2005) who found that the digestibility coefficients of OM, CP, NDF, ADF and ADL followed the same trend as the DM digestibility coefficients in diets containing graded levels of combinations of *Grewia pubescens* and *Panicum maximum*.

It can be concluded from this study that the WAD goats fed the concentrate diet with 15% level of inclusion of *Moringa oleifera* leaf meal had significantly higher rate of growth and digestibility coefficients than those on the 5% and 10% inclusion levels.

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