

Silage quality, growth performance and haematology of West African dwarf goats fed *Moringa oleifera* leaves ensiled with cassava peels

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Abstract

Forage scarcity in the dry season is challenging for ruminant production in the tropics. The utilization of browse species, particularly as silage can bridge this gap. In this study, the potentials of *Moringa oleifera* leaves ensiled with varying levels of cassava peels as dry season feed for West African dwarf (WAD) goats were assessed. Different mixtures of *Moringa oleifera* leaves and cassava peels were ensiled and designated as follows: T1= 100% *Moringa*, T2= 60% *Moringa* + 40% Cassava peels, T3= 40% *Moringa* + 60% Cassava peels, T4= 50% *Moringa* + 50% Cassava peels, T5= 100% Cassava peels. Chemical composition and silage characteristics were investigated. Twenty five WAD goats with average body weights of 6.02 ± 0.71 kg were used in the growth study that lasted 12 weeks. Blood samples were collected from the goats through the jugular vein for haematological status at the beginning and end of the experiment. Chemical composition of the silage diets showed that it contained 27.79 – 36.26 % dry matter (DM), 7.45 – 22.25 % crude protein (CP), 8.92 – 16.45 % crude fibre (CF), 2.55 – 7.01 % ether extract (EE), 6.10 – 10.08 % ash content, 42.40 - 68.14 % Nitrogen Free Extract (NFE). Appearance, odour and texture of the silage had acceptable physical attributes with pH values ranging from 3.53 – 5.80. Average daily feed intake (ADFI) and Feed conversion ratio (FCR) were not significantly ($P < 0.05$) affected by diets while Average daily weight gain (ADWG) was significantly improved in T3 (40% *M. oleifera* + 60% cassava peels) than in others. White blood cells (WBC) ranged from $5.88 \times 10^9/L$ in T2 to $13.77 \times 10^9/L$ in T4. Red blood Cells (RBC) and Packed Cell Volume (PCV%) were not significantly ($P < 0.05$) affected by diets. It was concluded that *Moringa oleifera* leaves and cassava peels silage with 40% *Moringa oleifera* as additive elicited the best performance indices in WAD goats fed diets consisting of mixtures of *Moringa oleifera* leaves and cassava peels ensiled together in graded levels or alone and did not affect animals negatively in terms of their haematological components.

Keywords: Cassava peels, feed intake, growth, *moringa oleifera*, silage, WAD goats

La Qualité de l'ensilage, la performance de croissance et l'hématologie des chèvres naines d'Afrique de l'Ouest nourries avec des feuilles de *moringa oleifera* mélangés avec des pelures de manioc



Résumé

La rareté des fourrages pendant la saison sèche est difficile pour la production de ruminants sous les tropiques. L'utilisation des espèces de broutage, en particulier comme ensilage peut combler ce défi. Dans cette étude, les potentiels des feuilles de *Moringaoleifera* ensilées avec différents niveaux de pelures de manioc comme aliment de saison sèche pour les chèvres naines d'Afrique de l'Ouest (le 'WAD') ont été évalués. Des différents mélanges de feuilles de *Moringaoleifera* et de pelures de manioc ont été ensilés et désignés comme suit : T1= 100%

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Moringa, T2= 60% *Moringa* + 40% Pelures de manioc, T3= 40% *Moringa* + 60% Pelures de manioc, T4= 50% *Moringa* + 50% Pelures de manioc, T5= 100% Pelures de manioc. Des caractéristiques chimiques de composition et d'ensilage ont été étudiées. Vingt-cinq chèvres 'WAD' avec un poids corporel moyen de 6,02±0,71 kg ont été utilisées dans l'étude de croissance qui a duré 12 semaines. Des échantillons de sang ont été prélevés sur les chèvres par la veine jugulaire pour le statut hématologique au début et à la fin de l'expérience. La composition chimique des régimes d'ensilage a montré qu'elle contenait 27,79 – 36,26 % de matière sèche (DM), 7,45 à 22,25 % de protéines brutes (CP), 8,45 à 22,25 % de protéines brutes (le 'CP'), 8,45 – 16,45 % de fibres brutes (le 'CF'), 2,55 à 7,01 % d'extrait d'éther (le 'EE'), 6,10 à 10,08 % de cendres, 42.40 - 68.14 % Extrait sans azote (le 'NFE'). L'apparence, l'odeur et la texture de l'ensilage avaient des attributs physiques acceptables avec des valeurs de pH allant de 3,53 à 5,80. L'apport quotidien moyen en aliments (le 'ADFI') et le ratio de conversion des aliments pour animaux (le 'FCR') n'ont pas été significativement ($P<0,05$) affectés par les régimes alimentaires, tandis que le gain quotidien moyen de poids (le 'ADWG') a été sensiblement amélioré en T3 (40 % *M. oleifera* + 60 % de pelures de manioc) que dans d'autres. Les globules blancs (le 'WBC') allaient de 5,88 x10⁹/L en T2 à 13,77 x10⁹/L en T4. Les globules rouges (le 'RBC') et volume de cellules emballées (le 'PCV' %) n'ont pas été significativement ($P<0,05$) affectés par les régimes. On a conclu que les feuilles de *Moringaoleifera* et l'ensilage des pelures de manioc avec 40 % de *Moringaoleifera* comme additif ont obtenu les meilleurs indices de performance chez les chèvres WAD nourries à des régimes composés de mélanges de feuilles de *Moringaoleifera* et de pelures de manioc ensilées ensemble ou seuls et n'affectaient pas négativement les animaux en termes de composantes hématologiques.

Mots-clés: Pelures de manioc, Apport alimentaire, Croissance, *Moringaoleifera*, Ensilage, Chèvres WAD

Introduction

Livestock productivity in the tropics has suffered major setback due to inadequate quantity and quality of feeds for animals especially during dry season (Peters, 1998). Tree fodders maintain higher protein and mineral contents during growth than do grasses, which decline rapidly in quality with progress to maturity (Aganga and Tshwenyane, 2003). Due to the deciduous nature and leaves-shattering of some of these tree fodders, silage making which has great potential to solve shortage of feed for small ruminants by preserving excess forage produced during the wet season for use at the dry period could be adopted. *Moringa oleifera* L. (*moringa*) is known as one of the most useful multipurpose plants of significant economic importance with industrial and medicinal uses (Odeyinka,

2007; Odeyinka, 2020). Protein content of *Moringa oleifera* leaves is high. They also contain high mineral value and high yield potential (Aregheore, 2002) and can be exploited for feeding animals during the dry season when forage is scarce. One of the solutions to problem of tropical livestock production as pertaining to insufficient feed during the dry season is forage conservation. Forage conservation is an option to overcome periods of feed shortage. Across the world, ensiling is a growing practice for preserving forages (Wilkinson *et al.*, 2003).

Low levels of fermentable carbohydrates in *Moringa oleifera* limit its use as a silage material, hence there is a need to mix with highly fermentable carbohydrate to enhance its silage value. Cassava peels contains readily fermentable carbohydrates and have

been used as additive (Olorunnisomo, 2011) in grass silage fed to red Sokoto goats. Ensiling moringa together with cassava peels presents an opportunity to preserve their nutrients and enhance their feeding value for small ruminants during the dry season. *Moringa oleifera* contains antinutritional factors like tannin and phytate which can possibly lead to poor palatability and precipitation of anaemia and thus compromise the health status of the animal (Jiwuba *et al.*, 2016). Blood parameters are important in assessing the suitability and quality of feed ingredients in farm animals (Maxwell *et al.*, 1990), as they provide a good understanding of the nutritional and antinutritional effects of diets (Yusuf *et al.*, 2018). Blood analysis is the fastest means of ascertaining toxicity of ingested feed in animals (Olafadehan, 2011). In view of the above, there is a strong justification for carrying out feed intake, body weight changes and haematological evaluation of WAD goats fed diets of *M. oleifera*. This study was therefore designed to assess the silage quality, growth performance and haematological profile of WAD goats fed *Moringa oleifera* leaves ensiled with different levels of cassava peels.

Materials and methods

Experimental station and duration

The experiment was carried out at the Sheep and Goat Unit, Obafemi Awolowo University (OAU) Teaching and Research Farm, Ile – Ife located approximately between latitude 7° 31'N and 7° 33'N; and longitudes 4° 33'E and 4° 34'E (Amujoyegbe *et al.*, 2008). The experiment lasted Twelve (12) weeks.

Silage production and experimental diets

Moringa oleifera leaves were collected from plots within the Obafemi Awolowo University Teaching and Research Farm, Ile – Ife, Osun State. Fresh cassava peels were

also collected from a cassava processing Unit within the OAU Teaching and Research Farm. They were chopped into bits using a forage chopping machine and then included in the silage mixture in levels as designated:

T1= 100% *Moringa oleifera*; T2= 60% *Moringa* + 40% Cassava peels; T3= 40% *Moringa* + 60% Cassava peels; T4= 50% *Moringa* + 50% Cassava peels; T5= 100% Cassava peels.

Mixture was packed, compacted and sealed in thick polythene bags to create an anaerobic condition for proper fermentation. The silage was ensiled for 21 days after which they were opened.

Experimental animals and their management

Twenty-five growing WAD goats with average weights of 6.02±0.71kg were randomly assigned to the five experimental diets in a completely randomized design. There were five goats per treatment with each animal serving as a replicate. The goats were housed in open sided, well-lighted and adequately ventilated building with slated floor. The house was disinfected before the animals arrived. The animals were vaccinated against *Pestes des Petite Ruminantes*, quarantined and observed for any disease symptom for seven days. The goats were also dewormed and treated against ectoparasites using ivomec ® prior to the commencement of the experiment. Animals were feed at 5% of their body weight. Water was supplied *ad libitum*.

Growth performance determination

Growth trial lasted twelve weeks. Each animal was weighed using hanging scale and weighing sack before the commencement of the study and subsequently weekly throughout the experimental period. Parameters measured included; feed refusal, feed intake and weight gain.

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Determination of silage quality

After 21 days, the fermentation was terminated by opening the silage bags and silage quality characteristics (colour, aroma and texture) were assessed using the method of Babayemi (2009). Silage pH was determined according to the methods described by Falola *et al.* (2013). Colour assessment was carried out through visual assessment with the aid of a colour chart. Aroma of the silage was assessed by five different people. Sub-samples from the treatments and at different depths were taken and mixed together for dry matter determination by oven drying at 65°C until a constant weight was achieved. The samples were later milled and stored in triplicates in cellophane bags until needed for chemical analysis.

Haematological analysis

Three goats were randomly selected from each treatment. They were bled through the jugular vein and blood collected for haematological determination. The blood samples were collected into labelled sterile universal bottle containing 1.0mg/ml ethyldiamine tetracetic acid (EDTA) and used for haematological analysis. Red blood cells (RBC), White blood cells (WBC) and Packed cell volume (PCV) were determined with the Neubauer haemocytometer after appropriate dilution (Lamb, 1981).

Chemical analysis

Crude protein, crude fibre, ether extract and ash of the silages were determined according to the methods of AOAC (1990). Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF) and Acid Detergent Lignin (ADL) were determined using the procedure of Van Soest *et al.* (1991).

Statistical analysis

All data were subjected to a one-way

analysis of variance (ANOVA) of SAS (1999) in a completely randomized design and treatment means, where significant, were separated using Duncan's Multiple Range Tests of the same package.

Results and discussion

The chemical composition of *Moringa oleifera* and cassava peels-based silage diets are presented in Table 1. The Dry matter content and Nitrogen Free Extract (NFE) of silage increased as the proportion of the cassava peels in the silage increased while the crude protein, fibre fraction and ash reduced. The increased level of NFE and reduced crude protein in the silage mixture with increasing proportion of cassava peels indicate that the addition of cassava peels to *Moringa* based silage diets improved the energy at the expense of the protein. This is similar to the result obtained by Olorunnisomo and Adesina (2013) who assessed the preference of Zebu cows for *Moringa* leaves ensiled with different levels of cassava peels. The feed mixtures except T5 (sole cassava peels silage) with a CP level of 7.45% met the requirement for protein (10-12%) recommended for ruminants (ARC, 1980). This implied that animals fed high percentage of cassava peels would need protein supplementation to meet their requirement for maintenance and production.

Table 2 shows the silage characteristics of *Moringa oleifera* and cassava peels-based silage diets. Appearance, odour and texture of the silage had acceptable physical attributes with pH values ranging from 3.53 – 5.80. Good silage usually preserves well the original colour of the pasture or any forage (t'Mannetje, 1999). The greenish and dark spots colour of the silages showed that the original colours of the moringa silage constituents were well preserved.

Table 1: Proximate composition of *Moringa oleifera* and cassava peels based silage diets fed to WAD goats

Parameters	T1	T2	T3	T4	T5
Dry matter	27.83	30.40	27.79	28.06	36.26
Crude fibre	16.45	12.75	11.94	15.70	8.92
Crude protein	22.25	16.50	12.75	14.38	7.45
Ash	10.08	9.40	7.95	8.66	6.10
Ether Extract	2.55	6.81	6.45	6.64	7.01
NFE	42.40	50.79	57.17	49.62	68.14
<i>Fibre fractions</i>					
NDF	53.17	36.60	45.43	48.69	32.78
ADF	40.04	25.88	30.30	36.55	17.92
LIGNIN	12.02	10.78	11.90	17.82	5.98

T1= 100% Moringa, T2= 60% Moringa + 40% Cassava peels, T3= 40% Moringa + 60% Cassava peels
T4= 50% Moringa + 50% Cassava peels, T5= 100% Cassava peels;

Table 2: Silage characteristics of *Moringa oleifera* and cassava peels based silage diets

Parameters	T1	T2	T3	T4	T5
Appearance	Greenish + dark spots	Greenish brown + dark spots	Greenish brown + dark spots	Greenish brown + dark spots	Brown
Odour	Pleasant with faint acidic smell	Pleasant with fruity smell	Pleasant with fruity smell	Pleasant with fruity smell	Pleasant with fruity smell
Texture	Firm and moist	Firm and moist	Firm and moist	Firm and moist	Firm and moist
pH	4.80	3.95	3.82	3.86	3.53
Temp (°C)	29.20	28.60	28.80	28.70	29.30

T1= 100% Moringa, T2= 60% Moringa + 40% Cassava peels, T3= 40% Moringa + 60% Cassava peels; T4= 50% Moringa + 50% Cassava peels, T5= 100% Cassava peels.

Table 3 shows the growth performance of WAD goats fed *Moringa oleifera* and cassava peels silage diets fed to WAD goats. Average daily feed intake ADFI (g) of diets were not significantly ($P < 0.05$) affected by silage diets. Final weight of goats in T2 was significantly higher in T2 than in T5, but similar in T1, T3 and T4. The Average Daily Gain (ADG) obtained in this study (12.30 - 19.05 g/day) is similar to values of 10.60 - 24.60 g/day reported by Okolo *et al.* (2012) for WAD goats fed graded levels of cashew nut shell with some other non-conventional feed stuff. The values were also similar to the range of 14.88-21.43 g/day reported by Asaolu *et al.* (2012) for WAD goats offered dried leaves of *Moringa*, *Gliricidia* and *Leucaena* as supplement to a basal diet of

cassava peels. Animals fed silage diets consisting of a mixture of 40% Moringa and 60% cassava peels elicited the highest ($P < 0.05$) weight gain (19.05) compared to others. Result appears to suggest an associative effect of the combination of Moringa and cassava at this level which gave the best ADG beyond which values were observed to decline. Feed Conversion Ratio (FCR) were similar in diets.

Table 4 shows the Hematological parameters of WAD goats fed *Moringa oleifera* ensiled with cassava peels. White blood cells (WBC) ranged from $5.88 \times 10^9/L$ in T2 to $13.77 \times 10^9/L$ in T4. The values of WBC in T4 was significantly ($P < 0.05$) higher than in others. The higher values observed in T4 is confounding. However,

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values of WBC observed in this study were lower than those (13.4 – 17.0 x10³/L) reported by Yusuf *et al.* (2018) when they included *M. oleifera* in graded levels to diets of goats. Jiwuba *et al.* (2016) reported

values (10.38 - 14.70 x10⁹/L) similar to the values observed in this study. Daramola *et al.* (2005) reported a normal range of 6.8 – 20.1 x10³/µl for WAD goats which agree with the findings of this study

Table 3: Growth performance of WAD goat fed *Moringa oleifera* based silage diets

Parameter	T1	T2	T3	T4	T5	SEM	P-value
ADFI (g)	138.64	143.05	138.33	138.34	130.86	0.3624	0.520
Initial weight (kg)	6.13	6.90	6.07	6.17	4.83	0.3560	0.533
Final weight (kg)	7.50 ^{ab}	8.17 ^a	7.67 ^{ab}	7.23 ^{ab}	5.87 ^b	0.3397	0.284
TWG (kg)	1.37	1.27	1.33	1.10	1.03	0.108	0.880
ADG (g/day)	14.70 ^b	15.07 ^b	19.05 ^a	12.70 ^c	12.30 ^c	0.0013	0.340
FCR	9.43	9.49	7.26	10.89	10.64	0.3624	0.520

^{a,b,c}; Means within rows with different superscript are significantly different (P<0.05); T1= 100% Moringa, T2= 60% Moringa + 40% Cassava peels, T3= 40% Moringa + 60% Cassava peels T4= 50% Moringa + 50% Cassava peels, T5= 100% Cassava peels; ADFI - Average Daily Feed Intake; ADG - Average Daily Gain; TWG - Total weight gain; FCR - Feed Conversion Ratio

Table 4: Haematological parameters of WAD goats fed *Moringa oleifera* ensiled with cassava peels

Parameters	T1	T2	T3	T4	T5	SEM	P value
WBC (x10 ⁹ /L)	7.87 ^b	5.88 ^b	5.96 ^b	13.77 ^a	6.65 ^b	0.878	0.164
RBC (x10 ¹² /L)	9.03	7.83	13.00	12.80	13.63	1.305	0.576
PCV (%)	25.33	28.67	32.67	33.33	27.00	1.533	0.425

. T1= 100% Moringa, T2= 60% Moringa + 40% Cassava peels, T3= 40% Moringa + 60% Cassava peels T4= 50% Moringa + 50% Cassava peels, T5= 100% Cassava peels; WBC: White Blood Cell; RBC: Red Blood Cell; PCV: Parked Cell Volume

The normal values of WBC obtained in this study suggested well developed immune system of the goats in different dietary groups (Jiwuba *et al.*, 2016). Red blood Cells (RBC) and Packed Cell Volume (PCV %) were not significantly (P<0.05) affected by diets. The values observed however fell within the normal physiological range 9.2 – 13.5 x 10⁶/µl for RBC (Daramola *et al.*, 2005) and 22 – 38% for PCV (Krammer *et al.*, 2000). Findings in this study were also similar to report by Fadiyimu *et al.* (2010), that haematological parameters of WAD sheep fed *M. oleifera* as a supplement to *P. maximum* did not differ. The use of *M. oleifera* and cassava peels as a silage diet did not negatively affect blood parameters

in this study indicating the adequacy of this diet for small ruminant nutrition.

Conclusion

The study showed that 40% *Moringa Oleifera* leaves ensiled with 60% cassava peels elicited the best performance indices in WAD goats fed *Moringa oleifera* and cassava peels based silage diets.

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