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Feed intake, performance and nutrient utilization of West African Dwarf (WAD) sheep fed *Panicum maximum* and cassava peels supplemented with *Moringa oleifera, Gmelina arborea* and *Tithonia diversifolia*-based multinutrient blocks

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Abstract: Sixteen (16) yearly West African Dwarf (WAD) sheep were assigned randomly to four (4) dietary treatments viz: *Moringa oleifera* multi-nutrient blocks (MMNB), *Gmelina arborea* multinutrient blocks (GMNB), *Tithonia diversifolia* multi-nutrient blocks (TMNB) and the control (Panicum+Cassava peels). The weight gains were 3.5±0.04kg, 3.4±0.03kg, 3.4±0.02kg and 2.1±0.04kg for GMNB, MMNB, TMNB and control fed sheep respectively. The digestibility coefficient of sheep fed *Gmelina arborea*-based multinutrient blocks were 64.52%, 34.57%, 19.98%, 44.03% and 35.00% for DM, CP, EE, CF and NFE respectively. The digestibility coefficient of sheep fed *Moringa oleifera*-based multinutrient blocks were 64.86%, 35.89%, 17.13%, 47.12% and 33.75% for DM, CP, EE, CF and NFE respectively. The digestibility coefficient of sheep fed *Tithonia* –based multinutrient blocks were 65.65%, 32.64%, 16.51%, 55.23% and 31.17% for DM, CP, EE, CF and NFE respectively while the digestibility coefficient of sheep fed the control diets were 54.89%, 8.74%, 4.74, 35.08% and 29.25% for DM, CP, EE, CF and NFE respectively. The feed intake were 1.8±0.02kg, 1.7±0.05kg and 1.6±0.03kg for TMNB, MMNB and GMNB respectively compared to 1.5±0.03kg control. The nitrogen balance were 4.81±0.04g day^{-1}, 5.02±0.05g day^{-1} and 5.35±0.05g day^{-1} for GMNB. MMNB and TMNB respectively compared to 1.04±0.03g day^{-1} for the control. This indicated that multinutrient blocks enhance better performance than the control treatment. Nitrogen retention were 52.38±0.22g day^{-1}, 52.34±0.02g day^{-1} and 46.92±0.10g day^{-1} for TMNB, MMNB and GMNB respectively compared to 40.52±2.42g day^{-1} for the control. This shows that the amount of nitrogen retained in the animal body is significantly higher than the control (*Panicum maximum* and cassava peels) when fed GMNB, MMNB and TMNB based multinutrient blocks. This shows that the nutrient utilization were significantly higher in the feed block treatments compared to that of the control. The study revealed that WAD sheep fed multinutrient blocks performed better than those fed control diet of *Panicum maximum*-cassava peels only. Of the entire multinutrient blocks WAD sheep on *Moringa oleifera* – based multinutrient blocks had the best performance, thus providing a better nutrients balance to WAD sheep.

Keywords: Performance, Supplements, Feed blocks, Nutrient utilization, Conversion ratio

INTRODUCTION

The soaring prices of conventional feedstuffs is continually slashing off the potential profits that should have accrued to livestock farmers in Nigeria and other less developed countries of the world and this has discouraged potential farmers from engaging in large scale production of ruminant animals[1].

West African Dwarf (WAD)sheep, a native breed of sheep reared in the humid zone of Nigeria are fed with grasses and agricultural by-products which affect the growth rate, physiological responses and performance of the WAD sheep[2]. The end result is the persistence shortage in the supply of animal protein in people's diet which is inimical to growth, performance, intelligence and defence against avoidable diseases[3]. WAD sheep are adjudged to be vigorous, fertile, resistance to climatic stress and are tolerant of irregular supply of feeds[4]. WAD sheep are mainly kept as a minor farm enterprise by most small holder farmers in South- Western Nigeria. They play important socio-economic and cultural roles in the lives of these farmers due to their use as means of storing wealth in times of agricultural plenty; provision of cash reserves for emergencies; and the guarantee of a degree of food security in times of crop failure[5].

In spite of the importance of sheep in Nigeria, their current contributions to the economy fall short of their full productivity potentials due to poor investment in feed, health and housing. It has been reported that farmers should feed small ruminants diet containing up to 14% crude protein as part of the ways to improve the productivity and efficiency of production [6-7]. To meet this protein need, supplementation of sheep basal diet with protein rich fodders or feed blocks has been advocated[8].

Better results of using browses from tree over other supplementation strategies have been reported in literature [3,8,9]. Fodder trees as browses are important components of food and feeds, as a source of protein, fibre and a balance of other nutrients needed for maintenance, growth and reproduction [6,11,12].

Multinutrient blocks, which are of no dietary importance to man could be utilized as supplements for sheep production. Multinutrient blocks represent a vast reservoir of cheap nutrients, particularly for ruminants [13]. Feeding *Moringa, Gmelina* and *Tithonia* - based multinutrient blocks would result in reduced feed cost, lowered price of animal products and contribute to self-sufficiency in protein, calcium, phosphorus and expensive nutrients in ruminant production.

Protein supplements like oil seed cakes [14] and leguminous browse plants such as *Gliricidia* and *Leucaena* [15] have been put to good use in boosting the productivity of sheep and goats. Feed blocks have been advocated as a panacea to protein and energy deficiencies in ruminants especially during the extended dry season [16-17]. It has been demonstrated to improve dry matter intake and turn a Live-weight loss of –53g day^{-1} to a gain of +10gday^{-1} in lambs on a basal diet of wheat straw [18].

In the wet season, grasses grow luxuriantly and contain adequate protein needed for maintenance and production. However, as the rainy season progresses, the grasses become fibrous leading to reduction in nutritional qualities. Thus, multinutrient blocks supplementation will also be useful in the wet season. Further, during the cropping season in many communities in South Western Nigeria, small ruminants are restricted or tied in the homestead to prevent damage to crops. Thus, the owners of animals cut grass for them, which may not represent the best feed selection to ensure adequate growth. Therefore, multinutrient blocks supplementation is also necessary in the wet season as a form of supplementary nutrients.

The present study is designed to validate the nutritional potentials of *Moringa, Gmelina* and *Tithonia* - based multinutrient blocks using performance and nutrients utilization of control and test diets in West African Dwarf Sheep.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at the Small Ruminant Unit of the Teaching and Research Farm of Ekiti State University, Ado-Ekiti. Ado-Ekiti is in the Humid Zone of West Africa (HZWA), with a tropical climate and bimodal rainfall distribution between April and October with a break in August. The site is located on Latitude 07^{0} 37^{1} 15^{11} N and Longitude 05^{0} 13^{1} 17^{11} E, with a temperature range 21^{0}C to 28^{0}C and high humidity [19]. The experiment was conducted for twelve weeks. Individual pens were washed and disinfected with izal disinfectant, cleaning of the surroundings, cleaning of feeding troughs and drinking troughs were carried out before the arrival of the animals.

Procurement of West African Dwarf (WAD) sheep

Sixteen yearling West African Dwarf sheep weighing 12.20±0.36 kg were purchased from the open market in Otun-Ekiti, Ekiti State, Nigeria. They were quarantined for four weeks during which routine treatment developed at NAPRI [20] and modified by Aye [21] was applied. Prior to the commencement of the experiment, the WAD sheep were dewormed with Levadex injection(Pantex Holland B.V) at a dose of 1cm^{3} 50kg^{-1} and coccidiostat treatments were administered for 3 days. They were treated against trypanosomiasis with Dimiazine aceturate (Nozomil Kepro, Holland B.V) at the dose of 3.5mg kg^{-1} by intramuscular injection. Oxytetracyclin 200LA was administered at the rate of 1cm^{3} 10kg^{-1} against bacterial infection. Ivomec was also administered against mange at1cm^{3}50kg^{-1}. The animals were vaccinated against Peste des Petites Ruminants (PPR) using Tissue Cultures Rinderpest Vaccine

Experimental layout and animal management

The sheep were weighed into their experimental unit. Efforts were made to ensure that all the treatments were balanced in body weight and age. The design of the experiment was a completely randomised design (CRD). The animals were randomly assigned to four treatments and each treatment had four WAD sheep (replicate) assigned to it in a separate experimental unit. The sheep in treatment 1 were fed control diet consisting of *Panicum maximum* and cassava peels. The sheep on treatments 2, 3 and 4 were fed *Panicum maximum* + cassava peels ration supplemented with *Moringa oleifera*-based multinutrient blocks (MMB), *Gmelina arborea*-based multinutrient blocks (GMNB) and *Tithonia diversifolia*-based multinutrient blocks (TMNBs) respectively.

Feed Preparation

Fresh cassava peels were obtained from garri processing factory in Ado-Ekiti, the fresh cassava peels were sundried for about 4-6 days. *Panicum maximum* was harvested about 10cm from the base of the plant with sickle. The stems and the leaves were then chopped into smaller pieces with the cutlass so as to prevent wastage by the animals. The grass was wilted for about 2-3 days to avoid scouring of the animals. Leaves of *Moringa oleifera*, *Gmelina arborea* and *Tithonia diversifolia* were harvested in fresh condition on campus of Ekiti State University. The harvested leaves were air-dried to aid proper grinding using fabricated grinding machine.

Production of multinutrient blocks

The cement was mixed first with water at the rate of 50 parts of cement to 100 parts of water. *Moringa oleifera*, molasses, urea, NaCl (salt) was also added in that order and cement mixture was added last. The same procedure was also adopted for *Gmelina arborea* and *Tithonia diversifolia*-based feed blocks. The mixture was poured into a cellophane lined plastic mould measuring 14cm by 10cm by 5cm. The cellophane paper was used to facilitate the removal of the multinutrient blocks when formed. The moulded multinutrient blocks were dried under shade (not exposed to direct sunlight) for about seven days.

Table 1: Ingredient composition (%) of different multinutrient blocks

Ingredient	MMNB	GMNB	TMNB
Molasses	40	40	40
Moringa leaf meal	30	-	-
Gmelina leaf meal	-	30	-
Tithonia leaf meal	-	-	30
Urea	10	10	10
Salt	5	5	5
Cement	15	15	15
Total	100	100	100

MMNB = Moringa-based multinutrient blocks, GMNB = Gmelina-based multinutrient blocks, TMNB = Tithonia-based multinutrient blocks.

Feeding trial

The preliminary feeding period lasted for 7days during which the animals were allowed to adjust to the experimental diets. The feeding trial period of 12 weeks, when animals were fed basal diets containing dried cassava peels and wilted *Panicum maximum* supplemented with *Moringa oleifera*, *Gmelina arborea* and *Tithonia diversifolia* –based multinutrient blocks were tagged treatments 2, 3 and 4 respectively. Clean and fresh water was provided *ad libitum*. During the twelve weeks of feeding trial, the sheep were fed weighed amount of feed and left over were collected and weighed to determine amount of feed consumed by the sheep.

After the feeding trial period, WAD sheep were weighed into the metabolic units randomly. Each sheep was individually confined in wooden metabolic cage where the animal had free access to feed, fresh water and multinutrient blocks as the case may be. The first two weeks (14 days) was used as the adjustment period designed to allow the sheep adjust to the feed and the environment. Thereafter daily feed intake was measured by offering about 3kg of feed to each animal and left over was weighed. Each animal was weighed before the commencement and the end of the digestibility trial. During the last seven days, after 14 days of adjustment to the cages, the total feed refused, faeces and urine were collected and measured. The total faeces voided were collected and weighed and 10% aliquot samples were taken and oven-dried for 48 hours. Urine samples were frozen while the faecal samples were dried at 65^0C to a constant weight, milled using the laboratory hammer mill, so as to pass through 2mm sieve prior to chemical analysis and stored in air tight polythene bag till required for laboratory analysis.

Data collection

Linear body measurement

The body length which is an average of left and right side measurements of the distance between the head of humeri and the distal end of the pine bone were taken using a centimetre graduated tape with the animal standing on a flat surface. The height at wither which is the distance between the most cranial palpable spinesus and the ground was determined on the animal standing vertically straight. A centimetre graduated tape was used for the measurement. The heart girth is the measurement of the body circumferences just behind the fore legs was measured. Scrotum circumference which is the distance round the largest point of the scrotum was determined.

Weight gain

All the WAD sheep were weighed at the beginning of the trial and subsequently every week for an assessment of the growth rate using a mobile metallic weighing scale. A standard 100 kg salter scale was mounted on the weighing crate. The average daily gains were calculated from the weekly weight in individual WAD sheep over the entire period of the trial.

Analytical Procedure (feed, faeces and urine)

2 grams of milled samples of grasses, cassava peels, multinutrient blocks and faeces were further dried at 105^0C to a constant weight for residual moisture determination before analysis. The milled samples were subjected to proximate analysis for dry matter (DM) crude protein (CP), ether extract (EE), crude fibre (CF), nitrogen free extract (NFE) as described by AOAC [22]. The milled faeces and aliquots of urine samples were then analysed for nitrogen according to AOAC [23] methods. The results obtained were used to determine the nitrogen balance, nitrogen retention and the digestibility co-efficient.

Statistical analysis

The data were analysed using one way analysis of variance (ANOVA) to test the effect of the treatments on the WAD sheep performance [24]. Treatment means were separated using Duncan's Multiple Range Test[25].

RESULTS

Experimental diets composition

Table 2 shows the proximate analysis of the multinutrient blocks and basal diets (*Panicum maximum* and cassava peels). Guinea grass (*Panicum maximum*) contained 84.35g100g^{-1} dry matter (DM), 8.14g100g^{-1} crude protein (CP), 32,12g100g^{-1} crude fibre (CF), 3.52g100g^{-1} ether extract (EE), 13.26g100g^{-1} ash, 42.78g100g^{-1}nitrogen free extract (NFE) and 22.03MJ Kg^{-1} gross energy. Cassava peels contained 94.54g100g^{-1} DM, 10.94g100g^{-1} CP, 7.12g100g^{-1} CF, 6.90g100g^{-1} EE, 6.89g100g^{-1} ash, 62.67g100g^{-1} NFE and 15.99MJ Kg^{-1} gross energy.

Moringa-based multinutrient blocks (MMNB) contained 71.59g100g^{-1} DM, 21.36g100g^{-1} CP, 6.50g100g^{-1} CF, 8.7g100g^{-1} EE, 10.23g100g^{-1} ash, 53.20g100g^{-1} NFE and 16.640MJ Kg^{-1} gross energy. *Gmelina*-based multinutrient blocks (GMNB) had 71.57g100g^{-1} DM, 15.82g100g^{-1} CP, 6.39g100g^{-1} CF, 9.58g100g^{-1} EE, 11.20g100g^{-1} ash, 57.0g100g^{-1}NFE and 15.91MJ Kg^{-1}gross energy. *Tithonia*–based muiltinutrient blocks (TMNB) contained 74.64g100g^{-1} DM, 19.72g100g^{-1} CP, 6.39g100g^{-1} CF, 7.08g100g^{-1} EE, 19.92g100g^{-1} ash, 46.89g100g^{-1} NFE and 15.15MJ Kg^{-1} gross energy.

Table 3 shows the mineral composition of the experimental diet. For the macro-minerals, potassium (K) was the most abundant with the highest value in *Tithonia diversifolia* –based feed blocks (2135.56 mg Kg^{-1}), calcium (Ca) value was highest in *Gmelina arborea*-based feed blocks (1524.91 mg Kg^{-1}). *Gmelina arborea*-based feed blocks had the highest value of Fe (542.78 mgKg^{-1}) followed by *Moringa oleifera* (318.61 mgKg^{-1}) and least value was obtained in *Tithonia diversifolia*-based feed blocks(176.42 mgKg^{-1}).

Table 4 presents the anti-nutrient contents of the multinutrient blocks typified by tannin, phytin-phosphorus, phytic acid, oxalate, saponin, flavonoid and alkaloid. *Moringa oleifera*-based multi-nutrient blocks had the highest flavonoid, phytic acid and phytin-phosphorus values (0.90g 100g^{-1}, 11.40g100g^{-1} and 3.21g100g^{-1} respectively), *Gmelina arborea*-based multinutrient blocks had the highest alkaloid, Tannin and Polyphenol values (3.60g100g^{-1}, 11.04g100g^{-1} and 6.38g100g^{-1} respectively) while *Tithonia diversifolia*-based multinutrient blocks had the highest value of saponin (2.25g 100g^{-1}).

Performance of WAD sheep

Table 5 shows the effect of different feed supplements on the performance of West African dwarf (WAD) sheep. The average feed intakes of the experimental animals were 1.5±0.03kg, 1.6±0.00kg, 1.7±0.05kg and 1.8±0.02kg for the control, MMNB, GMNB, and TMNB respectively. The feed conversion ratios were 18.8, 11.6, 12.6 and 12.4 for the control, MMNB, GMNB, TMNB respectively. This indicates that supplemental multinutrient blocks fed to WAD sheep enhanced better performance than the control diets of *Panicum maximum* + cassava peels. The highest feed conversion ratio was in MMNB (11.6), followed by TMNB (12.4) while the least value was in the control diet (18.3). . The weight gains were 2.1±0.04g day^{-1}, 3.4±0.02g day^{-1}, 3.4±0.03g day^{-1} and 3.5±0.04g day^{-1} for the control, TMNB, GMNB and MMNB. The metabolic weight gain ($W^{0.75}$) were 0.9±0.02, 1.3±0.00, 1.3±0.03 and 1.4±0.01 for control, TMNB, GMNB and MMNB respectively.

Nutrient utilization of WAD sheep fed experimental diets

Table 6 shows the digestibility co-efficient of dry matter to be 65.65%, 64.86%, 64.52% and 54.89% for *Tithonia diversifolia* multinutrient blocks (TMNB), *Moringa oleifera* multinutrient blocks (MMNB), *Gmelina arborea* multinutrient blocks (GMNB) and the control respectively. The highest digestibility coefficient value was in TMNB with the least value recorded in the control. The digestibility co-efficient of the dry matter of the multinutrient blocks were significantly ($P<0.05$) higher than the control. Crude protein values were 32.64%, 34.57%, 35.89% and 8.74% for TMNB, GMNB, MMNB and the control respectively. The highest digestibility co-efficient value was in MMNB with the least value recorded in the control. Ether extract values were 19.98%, 17.13%, 16.51% and 4.74% for GMNB MMNB, TMNB and the control respectively. The highest digestibility co-efficient value was in GMNB with the least value in the control. Crude fibre digestibility co-efficient values were 35.08%, 44.03%, 47.12% and 55.23% for control treatment, GMNB, MMNB and TMNB respectively. The highest value was in TMNB with the least value in the control. Nitrogen free extract values were 35.00%, 33.75%, 31.17% and 29.25% for GMNB, MMNB, TMNB and the control respectively. The highest digestibility coefficient value was in GMNB with the least value obtained in the control. The digestibility coefficient of the crude protein, ether extract, crude fibre and nitrogen free extract of the multinutrient blocks were significantly ($P<0.05$) higher than the control treatment.

Nitrogen utilization

Table 7 presents the nitrogen utilization of the experimental animals. The highest nitrogen retention was in TMNB (52.38g day^{-1}), followed by MMNB (52.34g day^{-1}), GMNB (46.92g day^{-1}) and the least was in the control (40.52g day^{-1}). The highest nitrogen balance was also in TMNB (5.35g day^{-1}), followed by MMNB (5.02g day^{-1}), followed by GMNB (4.81g day^{-1}) and the least value was in the control (1.04g day^{-1}).

Nitrogen balance in TMNB and MMNB are not significant different but they are significantly ($P<0.05$) higher than GMNB and the control. Nitrogen retention in TMNB and MMNB are not significantly different but they are significantly (P<0.05) higher than the GMNB and the control.

Table 2: proximate composition of the experimental diets (g100g^{-1})

Diets	DM	ASH	CP	EE	CF	NFE	GE(MJKg^{-1})
Panicum maximum	84.35	13.26	8.14	3.52	35.12	42.78	22.03
Cassava peels	94.54	6.89	10.94	6.90	7.12	62.67	15.99
MMNB	71.59	10.23	21.36	8.70	6.50	53.20	16.64
GMNB	71.57	11.20	15.82	9.58	6.39	57.0	15.91
TMNB	74.64	19.92	19.72	7.08	6.39	46.89	15.15

Table 3:Mineral composition of experimental diets (mgkg^{-1})

	Na	K	Ca	Mg	Zn	Fe	Mn	Cu
Panicum maximum	188.74	519.68	512.88	148.74	102.49	95.23	ND	ND
Cassava peels	174.98	156.16	135.47	122.30	77.14	7.53	3.76	ND
MMNB	677.24	1939.36	2308.75	196.01	106.20	318.61	121.59	27.71
GMNB	568.62	1602.48	1524.94	330.83	367.02	542.78	237.79	18.09
TMNB	495.20	2135.56	1114.21	204.27	139.28	176.42	182.61	20.12

ND = Not detected

Table 4: Anti-nutrient of experimental nutrient blocks

	MMNB	GMNB	TMNB
Tannin (mg100g^{-1})	7.67	11.04	8.83
Flavonoid (mg100g^{-1})	0.90	0.84	0.81
Alkaloids (mg100g^{-1})	0.80	3.60	1.60
Phytic acid (mg100g^{-1})	11.40	5.10	8.10
Phytin-P (mg100g^{-1})	3.21	1.44	2.28
Saponin (mg100g^{-1})	1.85	1.74	2.25
Polyphenol (mg100g^{-1})	5.25	6.38	5.76

Table 5: Performance characteristics of West African Dwarf sheep (kg) fed multinutrient blocks

Parameters	Control	MMNB	GMNB	TMNB
Dry matter intake	38.4 ±0.1^{c}	40.6 ±0.0^{b}	42.8 ±0.02^{a}	42.3 ±0.1^{a}
Feed intake	1.5±0.0^{b}	1.6±0.0^{ab}	1.7±0.05^{ab}	1.80.02^{a}
Weight gain	2.1±0.04^{b}	3.5±0.04^{a}	3.4±0.03^{a}	3.4±0.02^{a}
Metabolic weight gain(W$^{0.75}$)	0.9±0.02^{b}	1.4±0.01^{a}	1.3±0.03^{a}	1.3±0.00^{a}
Feed conversion ratio	18.3^{c}	11.6^{a}	12.6^{b}	12.4^{b}

a,b,c means with different superscripts in the same row differs significantly (P<0.05)

Table 6: Nutrient utilization of West African Dwarf sheep (%) fed multinutrient block

Treatments	DM	CP	EE	CF	NFE
Control	54.89±0.67^{c}	8.74±0.08^{d}	4.74±0.00^{d}	35.08±0.66^{d}	29.25±0.58^{d}
GMNB	64.52±1.67^{b}	34.57±0.12^{b}	19.98±0.00^{a}	44.03±1.11^{c}	35.00±0.20^{a}
MMNB	64.86±0.78^{b}	32.64±0.32^{c}	17.13±0.01^{b}	47.12±0.58^{b}	33.75±0.17^{b}
TMNB	65.65±0.85^{a}	35.89±0.22^{a}	16.51±0.03^{c}	55.23±0.40^{a}	31.17±0.20^{c}

a,b,c means with different superscripts in the same row differs significantly (P<0.05)

Table 7: Nitrogen utilisation by West African Dwarf Sheep fed multinutrient blocks

Parameters	Control	GMNB	MMNB	TMNB
Mean live weight (Kg)	13.1±0.16	14.6±0.22	147±0.14	14.7±0.19
Mean live weight (W$^{0.75}$Kg)	6.9±0.06	7.52±0.09	7.5±0.05	7.5±0.07
Nitrogen intake (g day^{-1})	2.15±0.00	5.82±0.00	6.18±0.00	6.31±0.00
Faecal nitrogen (g day^{-1})	1.92±0.02	1.82±0.04	1.81±0.03	1.75±0.05
Digested nitrogen (g day^{-1})	0.23±0.02	4.00±0.04	4.37±0.03	4.47±0.02
Urinary nitrogen (g day^{-1})	0.8±0.02	0.82±0.01	0.65±0.02	0.79±0.02
Nitrogen balance (g day^{-1})	1.04±0.03^{b}	4.81±0.04	5.02±0.05	5.35±0.05
Nitrogen retention (g day^{-1})	40.52±2.42^{b}	46.92±0.10^{a}	52.34±0.02^{a}	52.38±0.22a

a,b,c means with different superscripts in the same row differs significantly (P<0.05)

DISCUSSION

The ash and crude protein contents of *Panicum maximum* obtained in this study (13.26g100g^{-1} and 8.14g100g^{-1}) were higher than 10.6g100g^{-1} and 5.9g100g^{-1} reported by Duke and Atchley [26]. The crude fibre obtained was 35.12g100g^{-1} which is lower than the value obtained by Purseglove [27] (39.44g100g^{-1}). The cassava peels had dry matter and ether extract of 94.54g100g^{-1} and 6.90g100g^{-1} respectively and these values were higher than 92.0g 100g^{-1} and 6.5g 100g^{-1} obtained in literature [28]. The ash content of 6.87g100g^{-1} was higher compared with the value of 3.8-4.4 g 100g^{-1} reported by Oyenuga [29]. Aduku [30] reported crude fibre content of cassava peels to be 9.5g100g^{-1} which was higher than 7.12g100g^{-1} obtained in this study, he also reported that cassava peels contained 72.5g100g^{-1} nitrogen free extract which was higher than 62,67g100g^{-1} obtained in this study.

The differences in the values obtained in this study and those of other researchers might be due to the stage of harvest of the crops, the amount of edible part and the head added to the wastes. It may also be due to processing methods such as; sun drying, the length of storage of the blocks, grinding and the browse plants used as residues.

The mineral composition of this experimental diets showed that the potassium (K) was the most abundant with the highest value in *Tithonia diversifolia* (2135.56mg kg^{-1}). Calcium (Ca) value was the highest in *Moringa oleifera* (2308.75mg kg^{-1}). *Gmelina arborea* had the highest Fe (542.78mg kg^{-1}) and the least value of Mn was in cassava peels (3.76mg kg^{-1}).

The values of anti-nutrients obtained in this study showed that the antinutrients evaluated did not pose any serious health hazard on the animals. This is because the animals have the ability to efficiently utilize these anti nutrients owning to their possession of fauna/flora in their rumen. Furthermore, tannin aids absorption in the small intestine via by-pass protein process.

The feed intake were 1.5±0.03, 1.6±0.04, 1.7±0.05, 1.8±0.02g and average dry matter intake were 38.4, 40.6, 42.8, 42.3 in control, MMNB, GMNB and TMNB respectively and this revealed that there was a higher intake values of MMNB, GMNB and TMNB which agrees with the results[31-32] that supplementation increases consumption of basal diets resulting from increased degradation of the basal diets and rate of passage of the digesta in the rumen due to increased activity of cellulolytic rumen microfloral.

The lower intake of rams fed with control diet compared to those fed with multinutrient blocks could be due to palatability and higher protein content of the diets and this conforms with the results obtained by M'hamed *et al.* [33] that diets with higher protein content increases intake. The increase in feed intake of animals fed supplemental diets conforms to the findings of other authors [31,34] which reported that supplementation increased consumption of basal diets of low nutritional value. This is because browsing of multipurpose trees provide rumen microbes with a source of nitrogen thereby boosting the rate of passage and digestibility of grasses with a corresponding increase in intake even at relatively small levels of supplementation [35]. The significantly lower intake in the *Moringa*- based feed blocks compared to those of *Gmelina* and *Tithonia* –based feed blocks could be due to palatability problem encountered by small ruminants when fed with *Moringa oleifera*[36].

In this study, it is shown that the multinutrient blocks (MMNB, GMNB and TMNB) enhanced better performance than the control diets (*Panicum maximum* and cassava peels). Molasses-urea multinutrient blocks contain available energy and nitrogen and are used in feeding[37]. This study demonstrates the usefulness of multinutrient blocks when introduced into livestock farming under a confined management to improve the growth rate of the animals and this agrees with Ricca and Cambellas [38] submission that the blocks have a positive effect on the growth of the animal when forage or grazing is sufficiently available.

The significant higher digestibility co-efficient reported in sheep fed multinutrient blocks was due to the non-protein nitrogen and molasses used in multinutrient blocks which appears to favour proper functioning of the rumen microorganism. The apparent lowest dry matter(DM) digestibility in the control diet could be due to the higher fibre content of the control died than others. Dry matter digestibility is dependent on the cell wall constituents of the diets with feedstuffs having higher fibre being less digestible than those with lower fibre [39]. The crude protein and the crude fibre digestibilities in this study(32.64-35.89 CP and 44.03-55.23 CF) were lower than the values of CP(75.56%) and CF(89.35%) obtained by Asaolu *et al.* [40] when sole *Moringa oleifera* and its mixtures with equal proportion of *Leucaena leucocephala* and *Gliricidia sepium* were fed to WAD goats. The result showed that the WAD sheep fed supplemented multinutrient blocks performed better than their counterpart fed only basal diet of *Panicum maximum* and cassava peels only.

Of all the multinutrient blocks used in this study, rams fed with supplements of TMNB had the highest nutrient digestibility of CP (35.89%) compared to the values of the other multinutrient blocks and this is comparable with the results reported by Aye and Adegun [13] when Moringa multinutrient block, Gliricidia multinutrient block and Leaucaena multinutrient blocks were fed to WAD rams.

The nitrogen intake, digested and retained by WAD sheep fed supplemental feed blocks obtained in this study were significantly higher than the control group and this agrees with the results obtained by Hendratno *et al.* [41] and Aye and Adegun [13]. The high nitrogen retention of animal fed multinutrient blocks (GMNB, MMNB and TMNB) could be due to the high crude protein in the supplements fed to the animals and this agrees with Fadiyimu *et al.* [42] that high nitrogen retention in WAD sheep could be as a result of high crude protein present in the fodder used as supplements in the diets. This conforms to the observations of McDonald *et al*. [43] and Mupangwa *et al*, [44] that dietary nitrogen intake in animals is directly related to the proportion of nitrogen in the diet. This is because MNBs made from browse plants and urea enhanced the performance of small ruminants by providing a better balance of nutrients, improvement in rumen fermentation and supply of by-pass protein [45].

Nitrogen intake, nitrogen balance and nitrogen retention increased with supplementation of the basal diet in this study. The higher nitrogen retention values obtained in diets supplemented with MNBs indicate a higher efficiency of protein utilization as a result of the supplementation.

CONCLUSION

This study demonstrates that WAD sheep fed *Panicum maximum*+cassava peels supplemented with multinutrient blocks had better performance and posed no health challenges to the animals. *Tithonia diversifolia*-based multinutrient blocks compared favourably with *Gliricidia sepium, Moringa oleifera, Leucaena leucocephala* – based multinutrient blocks nutritionally and thus enhanced performance of the sheep. Furthermore, multinutrient blocks should be used as supplement during the extended dry season so as to overcome dry season weight losses or poor performances.

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