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Nitrogen balance of lactating West African dwarf ewe fed Mexican sunflower leaf meal based diets

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A B S T R A C T

Fifteen days prior to weaning, sixteen West African dwarf (WAD) ewes (Initial BW 19.13±1.53kg) on a basal diet of *Panicum maximum* were allotted into 4 treatment groups A, B, C and D of 4 replicates each. The mexican sunflower leaf (MSL) replaced wheat bran (WB) gravimetrically at 0, 15, 30 and 45%. Treatment A served as control. The experiment lasted for one week. Digestibility was determined using a 6-d total fecal collection. The 16 ewes were previously lambed 10 weeks before the commencement of this study and tagged to their respective treatments. Parameters measured were nitrogen intake, nitrogen balance, nitrogen apparent digestibility and nitrogen retention. Data were analyzed using descriptive statistics and ANOVA. Animals on treatment B had the highest N-intake (18.1g/d), N faecal (1.7 g/d), N absorbed (16.4 g/d) and N balance (16.3 g/d) and this was significant (*P<0.05*). Urinary nitrogen g/d was significantly higher (*P<0.05*) with increasing inclusion of MSLM in the ration while protein retention increased from treatment A (0% MSLM) to treatment B (15% MSLM) (89.8 – 90.3%) and subsequently decreased from treatment B (15%MSLM) to D (45% MSLM) (90.3 - 84.4%). Nitrogen balance was positively related to DM intake and N intake. The overall regression were nitrogen balance (NB) =2.50+0.067 DMI; R^2 = 0.9372, (P=0.3937) and NB= 0.75+0.9066 NI; R^2 = 0.9957, (P=0.1401). Inclusion of up to 30% MSLM in the diets of lactating ewe appeared most beneficial to sheep as it had no negative effects on nitrogen intake.

1. Introduction

Tithonia diversifolia, often called Wild sunflower and Mexican sunflower, grows as annual, biennial or perennial plant depending on the habitat. It reproduces from seeds and vegetative re-growth of the basal stem when the plant is slashed. *Tithonia diversifolia* produces higher number of capitula and seeds per plant (Muoghalu and Chuba, 2005). *Tithonia* leaf meal was considered to be a valuable supplement in diets for laying hens and a cheap means of enhancing egg yolk coloration (Odunsi *et al.,* 1996). Akinola *et al.* (1999) reported that in south – western Nigeria, *T. diversifolia* is browsed by nomadic and village cattle and goats, and that farmer fed the harvested forage to these animals as well as to rabbits. A similar report from Katto and Salazar (1995) described its use as forage for sheep and guinea pigs. However little documented information exists on its nutritive value as a live stock feed for lactating ewes despite high chemical composition profile that displays its potential as a protein supplement. The present study was however, undertaken to determine the nitrogen balance of lactating West African Dwarf (WAD) ewe fed Mexican sunflower leaf meal based diets.

2. Materials and methods

2.1. Plant materials (Mexican sunflower)

Mexican sunflower "*Tithonia diversifolia*" leaf obtained at the Teaching and research farm, University of Ibadan was harvested at approximately 4 weeks by slashing and carrying after the onset of rains. The stems were cut 50 cm above the ground and sorted into leaves (Tarawali *et al*., 1995). The stems were sun-dried on a clean cemented platform until crisp. The leaves were partially ground and packed into sacks, weighed and stored in a silo. The samples were bulked together and manually mixed to obtain as uniform a product as possible. A representative sample was collected from it for proximate analysis. The MSLM sample was oven dried at 105^0C for 24 hours (to constant weight), milled and stored in air tight, sealed polythene bags prior to chemical analysis. The Mexican sunflower leaf meal used in this study contained (%) crude protein, 16.3; crude fiber, 21.8; ether extract, 2.8; ash, 14.7; and nitrogen free extract, 44.4.

2.2. Pen management

The pen and metabolic cages were swept and dusted. They were later fumigated with Izal (Saponated cresol) at the ratio of 1:200 water and also with diazintol (diazinon) at the rate of 2ml/liter of water (diazintol a strong and broad spectrum insecticide, acaricide and larvicide). Wood shavings were later spread on the floor of individual pens including the adaptation and spare pens; the wood shaving was changed fortnightly till the end of the trial.

2.3. Experimental design and treatments

Sixteen WAD sheep aged 16 - 17 months were divided into four groups of four animals each. Each group was randomly assigned to one of 4 treatments and individual animals were completely randomized within the experimental pens in the unit.

The statistical model was: $\gamma_{ij} = \mu + \alpha_i + e_{ij}$

where γ_{ij} = individual observation

μ = general mean of population

α_i = treatment effect due to diets

e_{ij} = error effect

2.4. Animal feeding

The WAD sheep were fed Mexican sunflower wheat bran blended ration (Table 1). *Panicum maximum* leaves were harvested from pasture and range management unit of Animal Science Department at the Teaching and Research farm of the University of Ibadan. Leaves were allowed to wilt over-night before feeding and this was chopped manually with cutlass into 3 – 5 cm pieces just before feeding.

Panicum maximum was given to all the treatments as basal diets. Concentrate supplements were formulated so that 0% (A), 15% (B), 30% (C), and 45% (D) of wheat bran were replaced by weight with Mexican Sunflower Leaf Meal (MSLM). Feeding was done daily at 08:00 and 16:00 hrs (GMT). Fresh water was provided for each animal *ad libitum* daily. The animals were fed at 5% of body weight on dry matter basis. Proximate composition (DM, CP, CF, EE, NFE, and ash) of the forage was also determined. Thus, nitrogen free extract (NFE) = 100 – (CP +CF + EE + ash). The diet formulation and nutrient composition are shown in Tables 1 and 3.

Table 1
Ingredient composition of experimental diet.

Ingredients %	Rations			
	A	B	C	D
MSLM[1]	0.00	15.00	30.00	45.00
Wheat bran	45.00	30.00	15.00	0.00
Cassava peel	33.20	33.20	33.20	33.20
Palm kernel meal	10.00	10.00	10.00	10.00
Ground nut cake	10.00	10.00	10.00	10.00
Oyster shell	0.50	0.50	0.50	0.50
Bone meal	0.50	0.50	0.50	0.50
Mineral/Vit. Premix	0.30	0.30	0.30	0.30
Common salt	0.50	0.50	0.50	0.50

MSLM=Mexican Sunflower Leaf Meal, A = 0%MSLM, B =15% MSLM, C = 30% MSLM, D = 45% MSLM

Table 2
Proximate composition of experimental diet.

	Rations			
Constituents %	A	B	C	D
Dry matter	92.00	91.00	90.00	89.00
Crude protein	17.10	16.90	16.50	16.20
Crude fiber	15.70	16.40	17.00	17.50
Ether extract	3.47	3.63	3.70	3.75
Ash	8.60	9.40	10.10	11.30
NFE[1]	55.13	53.67	52.70	51.25
ADF[2]	22.54	26.70	30.85	35.01
NDF[3]	43.15	44.50	45.85	47.20
ADL[4]	7.92	8.41	9.03	9.85
Gross energy(kcal/kg)	3829.5	3805.5	3781.0	3735.5

[1]Nitrogen Free Extract
[2]Acid Detergent Fiber
[3]Neutral Detergent Fiber
[4]Acid Detergent Lignin

2.5. Digestibility study

Digestibility was carried out by the total faecal and urine collection method (McDonald *et al*., 1995). Animals were weighed and each animal was penned in an individual cage for 14 d, with a 7 d adjustment and another 7d collection period. Faeces and urine voided were collected. Individual total urine was collected and a 10% aliquot were kept in a refrigerator (0-4 ^{0}C) for analysis. Faecal samples were dried at 65 ^{0}C for 48 hrs to a constant weight wrapped in aluminium foil, milled and stored in air-tight bottles until analyzed. Apparent Digestibilities (AD) of dry matter (DM), organic matter (OM), Energy, crude protein (CP), crude fiber (CF), ether extract (EE), ash, nitrogen free extract (NFE), neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) of experimental diets (Treatments) were calculated using the formula:

$$\frac{\text{Nutrient consumed (as feed)} - \text{Nutrient in feaces}}{\text{Nutrient consume}} \times 100$$

OR

$$\frac{\text{Nutrient [Input} - \text{Output]}}{\text{Input}} \times 100$$

2.6. Chemical analysis

Samples of dried MSLM and *Panicum maximum* were oven dried at 105 ^{0}C to constant weight, milled and stored in air tight, sealed polythene bags prior to chemical analysis. The nutrient composition of dried milled sample of MSLM, *Panicum maximum* leaves or branchlets and faeces were determined according to the procedure of AOAC (1990). Nitrogen content of feeds, faeces and urine were determined by the micro-kjeldahl technique using the Markham's distillation apparatus. Results obtained were used for the calculation of DM, nutrient digestibilities and nitrogen utilization by the WAD sheep. NDF was determined by the Van Soest and McQueen (1973) methods as the residue after the reflux with 0.5m H_2SO_4 (TetraoxosulphateVI acid) and acety/trimethy/ammonium bromide. ADF was determined by the Van Soest (1963) method as the residue after extraction with boiling neutral solutions of sodium lauryl sulphate and EDTA. The percentage hemicellulose was obtained by deducting the ADF from the NDF. The percentage cellulose was obtained by deducting the percentage lignin from the ADF. ADF residue is primarily lignocellulose. The cellulose is dissolved by using 72% H_2SO_4 (TetraoxosulphateVI acid) solution. The remaining residue consists of lignin and acid soluble ash.

2.7. Statistical analysis

The experimental design was completely randomized and the Data obtained were subjected to analysis of variance (ANOVA) using the General Linear Model (GLM) of SAS software (SAS, 1999). Treatment means were compared by Duncan test of the software.

Table 3
Chemical Composition of Dried Mexican Sunflower Leaf Meal (MSLM), Wheat bran and *Panicum maximum.*

Components	**MSLM**	**Wheat bran**	***Panicum maximum***
Dry matter	89.00	89.00	26.00
Crude protein (CP)	16.33	17.00	7.95
Crude fiber (CF)	21.80	8.50	31.00
Ether extract (EE)	2.81	3.50	4.00
Ash	14.68	13.01	8.90
NFE	44.38	57.99	48.15
ADF	42.63	25.00	42.70
NDF	60.00	51.00	74.30
Hemi cellulose	17.37	26.00	31.60
ADL	9.96	8.60	13.87

Table 4
Anti Nutritional Factors in MSLM.

Component	**Quantity (mg/100g)**
Total Alkaloid	6.32
Saponin	1.05
Oxalate	5.25
Phytate	8.81
Tannin	5.19
Glycosides	0.42
Phenol	0.53

Source: Ekeocha (2009)

3. Results and discussion

Treatment effects on observed values of N were significant (*P<0.05*) for N intake, faecal, absorbed, balance and urinary N excretion (Table 5). Animals on treatment B (1.70 g/d) had the highest faecal N and this was numerically higher (*P>0.05*) than for animals on treatment C (1.29 g/d) but significantly (*P<0.05*) higher than observed values for animals on treatments D (1.19 g/day) and A (1.10 g/d). Animals on treatment B (18.09g/d) had the highest nitrogen intake (NI) and this was significantly (*P<0.05*) higher than animals on treatment D (8.09 g/d) but numerically higher than animals on treatments A (11.29 g/d) and C (11.20 g/d). Higher N intake might lead to higher faecal N. The same trend follows for absorbed nitrogen (AB) and nitrogen balance (NB). The NI (8.09 – 18.09 gd^{-1}) and NB (6.83 – 16.33 gd^{-1}) obtained for lactating ewes in this study were higher than the values (3.12 – 3.86 gd^{-1}) for NI and (0.69 – 1.45 gd^{-1}) for NB reported for West African Dwarf goats by Eniolorunda *et al.,* (2008). Nitrogen balance was positively related to DM intake and N-intake (Figs 1 and 2). The overall regression were NB = 2.50+0.067 DMI; R^2 =0.9372, (P = 0.3937) and NB = 0.75+0.9066 NI; R^2 = 0.9957, (P = 0.1401). It shows that a higher level of nitrogen intake and DM intake significantly (*P<0.05*) improved N-balance.

Table 5
Nitrogen balance of lactating wad ewes fed MSLM based diets during lactation.

Parameters	Treatment				
	A	B	C	D	SEM
Conc. Dry Matter Intake (g/d)	346.18^{ab}	587.60^{a}	310.20^{ab}	199.00^{b}	157.82
Grass Dry Matter Intake (g/d)	143.02^{b}	173.25^{b}	236.41^{a}	230.43^{a}	34.76
Total Dry Matter Intake (g/d)	489.20	760.90	546.60	429.40	169.83
N intake (g/d)	11.29^{ab}	18.09^{a}	11.20^{ab}	8.09^{b}	5.68
N faecal (g/d)	1.10^{b}	1.70^{a}	1.29^{ab}	1.19^{b}	0.29
N absorbed (g/d)	10.19^{ab}	16.39^{a}	9.91^{ab}	6.90^{b}	5.44
N Apparent Digestibility (%)	90.26	90.60	88.48	85.29	3.44
Urinary N (g/d)	0.05^{b}	0.06^{a}	0.06^{a}	0.07^{a}	0.004
N balance (g/d)	10.14^{ab}	16.33^{a}	9.85^{ab}	6.83^{b}	5.09
N retention (%)	89.81	90.27	87.95	84.43	3.43
$g/d/kgW^{0.75}$					
N intake	6.16^{ab}	8.77^{a}	6.12^{ab}	4.80^{b}	3.10
N faecal	1.07^{b}	1.49^{a}	1.21^{ab}	1.14^{b}	0.28
N absorbed	5.09^{ab}	7.28^{a}	4.91^{ab}	3.66^{b}	2.72
N Apparent Digestibility (%)	82.63	83.01	80.23	76.25	3.15
Urinary N	0.11^{b}	0.12^{a}	0.12^{a}	0.14^{a}	0.009
N balance	4.98^{ab}	7.16^{a}	4.79^{ab}	3.52^{b}	2.50
N retention (%)	80.84	81.64	78.27	73.33	3.43

^{ab}Means on the same row with different superscripts differ significantly (*P<0.05*) ; S.E.M: Standard error of mean

For urinary excretion of N, animals on treatment D (0.07 g/d) had the highest and this was numerically higher than observed values for animals on treatments C (0.06 g/d) and B (0.06 g/d) but significantly (*P<0.05*) higher than animals on treatment A (0.05 g/d). The high increase in N retained observed in animals on treatment A with respect to intake could be due to efficient use of relative amount of N due to high absorptive rate in intestine in order to meet its physiological needs (Jarrige, 1999). Animals on treatment B (16.33 g/d) was distinctly superior (*P<0.05*) in nitrogen balance than animals on treatment D (6.83 g/d) and this might have been due to a better balance of nutrient particularly N from MSLM and soluble carbohydrates from the wheat bran. However, the N balance of animals on treatment B was not different (*P>0.05*) from those animals on treatments A (10.14 g/d) or C (9.85 g/d). The levels of N faecal and urinary excretion observed in this experiment were low compared with values of earlier reports (Bonsi *et al.*, 1995; Osuji and Dever's, 1979). The presence of some alkaloids like tannin can also bind enzymes responsible for protein digestion (Mangan, 1988). Also the presence of oestrogenic substance in the diet can lead to increased demand and utilization of nutrients (Hufstedler and Greene, 1995). No clinical signs were observed.

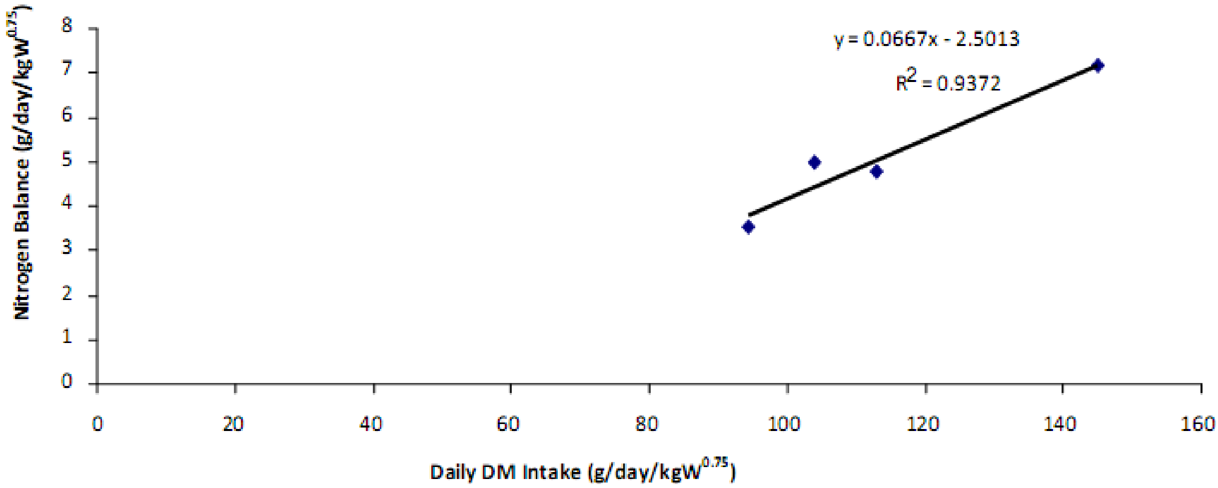

Fig. 1. Relationship between Nitrogen Balance and Dry Matter Intake of Lactating Ewes fed MSLM-based Diets.

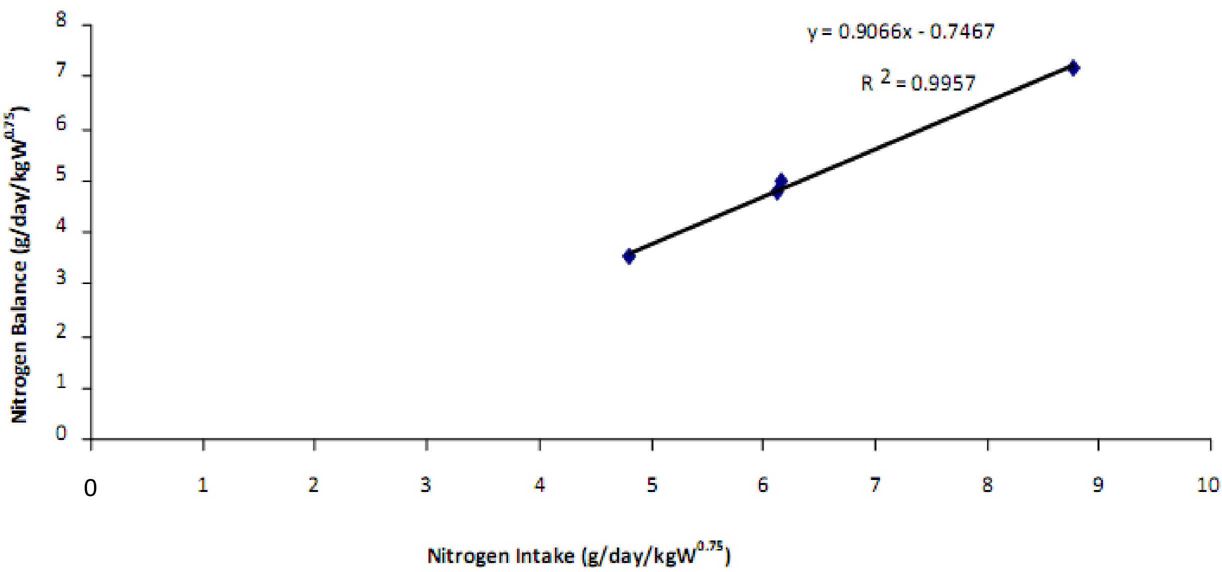

Fig. 2. Relationship between Nitrogen Balance and Nitrogen Intake of Lactating Ewes fed MSLM-based Diets.

4. Conclusion

Gross chemical analysis indicated that MSLM contained appreciable level of nutrients that could be utilized in the diets of lactating WAD ewes. The net effect is the improved nitrogen balance, which improved with MSLM inclusion. Nitrogen balance was related to DM intake and N-intake. It showed that a higher level of nitrogen intake and DM intake significantly (*P<0.05*) improved N-balance. The Mexican sunflower leaf meal inclusion enhanced productivity and can be fed to increase the efficiency of utilization of basal diets for livestock which in the tropics generally comprises of low nitrogen pastures and poor quality grass and could also replace wheat bran which is not sustainable all year round. Supplementing 30% Wheat bran with MSLM appeared most beneficial to lactating ewes.

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