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Performance characteristics, rumen fermentation parameters and nitrogen metabolism of West African dwarf sheep fed diets mixed with palm kernel oil and soyabean oil

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Target Audience: *Livestock Farmers, Ruminant Nutritionists.*

Abstract

Palm kernel oil (PKO) and Soyabean oil (SBO) contain high amounts of unsaturated fatty acids that would provide significant alteration in rumen fermentation and production of volatile fatty acids for better animal productivity. Therefore, this study was aimed to determine the efficacy of PKO and SBO in modulating fermentation patterns, improving growth and nitrogen utilization of West African Dwarf Sheep (WADS). Twenty (20) WADS weighing 12.50 ± 0.5kg were randomly allotted into four dietary treatments in a completely randomized design. Mixture of (PKO) and (SBO) were incorporated into the diets of sheep at 0.0g/day, 10.5g/day, 7.5:7.5g/day and 5:10g/day as treatments 1, 2, 3 and 4 respectively. Parameters determined were weight gain, feed conversion ratio, rumen fluid parameters and nitrogen balance. The results showed that weight gain (2.40 – 4.55kg) was significantly affected (P<0.05)by inclusion of PKO and SBO in the diets. The best daily weight gain (54.15g/day) and feed conversion ratio (10.20) were recorded at Treatment 4 which were significantly (P<0.05) different across the treatments. The rumen fluid pH ranged 5.60 - 6.50 Ammonia Nitrogen (NH_3-N) values (0.44-0.88), Propanoic acid (6.05-6.84), rumen fluid temperature (36.25-37.00^{0}C) and Valeric acids (6.08-7.56g/dL) were significantly influenced by addition of PKO:SBO in the diets of sheep. The nitrogen balance ranged from 0.05 - 0.56. The best nitrogen retention value (26.22%) was recorded with animals on Treatment 4 with 5:10g/day PKO:SBO. The study concluded that PKO:SBO can be incorporated into the diets of WAD sheep at 5:10g/day for effective feed utilization, improved growth performance and better nitrogen utilization.

Keywords: *Sheep, Performance, Palm Kernel, Nitrogen balance, rumen.*

Description of Problem

The emission of methane from the rumen represents a loss up to 15% of the digestible energy and enteric methane contributes approximately 30-40% of the total methane produced as greenhouse gases from agricultural sources (1). Oils extracted from plant sources, like Palm Kernel and Soyabean oils have high potentials of medium long fatty acids in the abatement of methane released in ruminants and increase the proportion of volatile fatty acids to improve energy status (2). Supplementing fats and oils to ruminant diets reduces methane emission (3). Organic acids and oils have attracted attention for their potentials as alternatives to feed antibiotics and growth promoters in livestock (4). Dietary

manipulations using these plants oils have been found to also result in methane reduction by decreasing fermentation of organic matters in the rumen by shifting the site of digestion from the rumen to the intestines, inhibiting methanogenesis or by optimizing the rumen fermentation in reducing methane emission per unit of organic matter digested (5). The objectives of this study were to evaluate the performance characteristics, rumen fermentation parameters and nitrogen utilization of WAD Sheep fed diets mixed with PKO and SBO.

Materials and Method

The experiment was carried out at the small ruminant unit, Institute of Agricultural Research and Training (IAR&T), Moor Plantation, Ibadan, Nigeria. The unit is located in south western part of Nigeria. The area lies within longitude and latitude 7.27^0N and 3.25^0E respectively. Altitude 200-300m above sea level with average rainfall of about 1250-1300mm, temperature and relative humidity ranges from 30-35^0C and 76-78% respectively. It lasted for sixteen (16) weeks.

Experimental animals and their management

Twenty (20) West African Dwarf sheep weighing 12.50 ± 0.5kg were used. Animals on arrival at the farm were given necessary prophylactic treatments. At the onset of the experiment, initial body weight of the animals were measured and recorded weekly. The animals were treated against endo and ectoparasites using Ivermectin at the rate of 1ml/50kg body weight. After the acclimatization period, the sheep were allotted into four treatments of five replicates each balanced for body weight. Animals were housed individually in well ventilated pens. The experimental design used was Completely Randomized Design (CRD).

Experimental Diet

The plant oils (PKO and SBO) were incorporated into the diets of sheep at varying levels of 0:0g/day, 10:5g/day, 7.5:7.5g/day and 10:5g/day as treatments 1, 2, 3 and 4 respectively as indicated in Table 1.

Data Collection

Performance Characteristics

Data were collected on average daily feed intake and average daily gain, feed to gain ratio was calculated from data collected on average daily gain and average daily feed intake.

Collection of Rumen Fluid

Rumen fluid was collected at the end of the experiment from sheep in each treatment for determination of rumen pH, ammonia nitrogen, volatile fatty acids with the suction tube inserted directly to the rumen through the oesophagus according to the procedure described by (6). After collection, the rumen fluids were stored in ice-packed container pending laboratory analysis.

Nitrogen Metabolism Trial

At the end of the feeding trials, the animals were allotted to individual metabolic cages designed for separate collection of faeces and urine. Digestibility and nitrogen metabolism trials were carried out after 14 days adjustment period. The quantity of feed offered and left over for each sheep was weighed daily. The weight difference between them was the feed intake. Daily faecal sub-samples were weighed, oven dried, bulked together. Representative aliquot (10%) was obtained from the samples and stored in air-tight container until needed for chemical analysis. Daily urine samples

(20ml) for each sheep were collected in sample bottles containing sulphuric acid and frozen until needed for chemical analysis. Nitrogen metabolism by the sheep was calculated as the difference between Nitrogen intake and Nitrogen excreted from faeces and urine while percentage Nitrogen retention was computed from Nitrogen balance expressed as a percentage of Nitrogen intakes.

Table 1: Gross composition of experimental diets (%)

Feed Ingredient	T_1(g/day) PKO:SBO 0:0	T_2(g/day) PKO:SBO 10:5	T_3(g/day) PKO:SBO 7.5:7.5	T_4(g/day) PKO:SBO 5:10
Dried cassava peel	37.00	37.00	37.00	37.00
Groundnut Haulms	20.00	20.00	20.00	20.00
Soyabean Husk	10.00	10.00	10.00	10.00
Cowpea Haulms	10.00	10.00	10.00	10.00
Corn bran	12.00	12.00	12.00	12.00
Palm Kernel Cake	10.00	10.00	10.00	10.00
Premix	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00
Calculated Analysis				
Crude Protein (%)	12.90	12.90	12.90	12.90
Crude Fibre (%)	17.50	17.50	17.50	17.50
Metabolizable energy (MJ/Kg)	12.05	12.45	12.45	12.46

Results and Discussion

The chemical compositions of the experimental diets are shown in the table 2. The crude protein values (13.87-13.89%) obtained in this study were higher than 10-12% crude protein moderate levels required by ruminants for optimum growth (7). Higher fibre fractions (Acid detergent fibre 24.14 – 30.53%, Neutral Detergent fibre 41.03-52.12%) obtained in this study might be high fibre content of agricultural by-products used in compounding the diets.

Table 2: Chemical compositions of the experimental diets containing varying levels of PKO and SBO

Parameters (%)	T1 0.0g/day PKO:SBO	T2 10.5g/day PKO:SBO	T3 7.5:7.5g/day PKO:SBO	T4 5:10g/day PKO:SBO
Dry Matter	95.20	93.90	93.10	92.20
Crude Protein	13.88	13.87	13.88	13.89
Ether Extract	9.48	10.04	10.48	10.54
Crude Fibre	21.45	21.56	21.48	21.55
Ash	15.50	15.45	15.55	15.60
NFE	33.19	31.20	30.64	30.39
Acid Detergent Fibre	24.14	25.34	27.42	30.53
Neutral Detergent Fibre	41.03	47.24	50.32	52.12
Acid Detergent Lignin	10.38	8.96	8.53	8.24
Hemicellulose	17.39	22.40	23.40	22.29
Cellulose	14.26	16.88	19.29	21.59

The performance characteristics of the West African dwarf sheep fed diets mixed with PKO and SBO are presented in Table 3. The results revealed the weight gain ranged from 2.27-4.55kg which was affected by the dietary inclusion of these plant oils was in line with (8) with values of 1.4-5.0kg fed palm kernel cake and poultry dropping concentrate on semi-intensively managed Maradi goats. The daily weight gain (28.57-54.15)g/day obtained in this study differed across the treatment ($P<0.05$) which was in agreement with (9) who reported (25.30-48.80)g/day for Red Sokoto bucks fed *Pilostima reticulum* pod. The daily feed intake observed in this feeding trial (501.82-552.23)g/day was within the range (473.38-553.19)g/day reported by (9). However, there was a short fall compared to the values (768.40-790.00g/day) reported by (10) for West African dwarf goats fed *Dichrostachineria* as supplements to Buffalo grass. The feed conversion ratios (FCR) observed in this study (10.20-17.56) were superior to the values reported by (11) for West African Dwarf sheep fed diets containing varying levels of sugarcane waste silage. It was within the range reported by (12) for WAD goats fed unripe plantain peels as replacement for maize. The FCR was also better than the values (13.17-22.40) reported by (13) for fattening beef cattle with cereal products. The better feed conversion ratio might due to the effects of Poly unsaturated fatty acids available in these plant oils that modulate better the rumen fermentation as reported by (14).

Table 3: Performance characteristics of WAD rams fed diets mixed PKO and SBO

Parameters	T_1	T_2	T_3	T_4	SEM±
Initial body weight (kg)	13.35	13.64	13.67	13.62	0.44
Final body weight (kg)	16.95^{ab}	16.04^{b}	16.38^{ab}	18.17^{a}	0.47
Weight gain (kg/d)	3.60^{ab}	2.40^{b}	3.72^{ab}	4.55^{a}	0.45
Daily weight gain (kg/d)	42.80^{ab}	28.57^{b}	32.35^{ab}	54.14^{a}	0.26
Metabolic weight gain ($w^{0.75}$g/day)	2.59^{ab}	1.93^{b}	2.01^{ab}	3.09^{a}	5.39
Total feed intake (kg)	45.83	42.15	44.80	46.39	2.22
Daily feed intake (kg/d)	545.63	501.82	533.30	552.23	26.44
Feed conversion ratio	12.73	17.56	16.47	10.20	5.15

^{ab} means along the same row with different superscripts and significantly different

Rumen fermentation parameters in this study increased by the supplementation of mixtures of PKO and SBO to the diets of sheep, this can be attributed to the rich amount of Lauric, myristic, capric and caprillic acids available in these plant oils (15)). The result revealed no significant ($P>0.05$) effect on the total volatile fatty acids was in line with (16) who reported that no effect on total volatile fatty acids but increased molar proportion of Propionate with the addition of capric and caprillic acids. A micro-organism yield in the rumen is an index or a function of the amount of microbial proteins made available to the ruminants (17). Marked significant ($P<0.05$) difference was observed in rumen protozoa for rams on diet 1 (control) of $7.55x10^6$cfu/ml, the significant increase in the protozoan count from $1.34x10^6$cfu/ml in treatment 4 to $7.55x10^6$ in the treatment 1 agreed with the findings of (18) who investigated the effects of Yucca Schidigers extracts on the pH and the concentration of Protozoa bacteria and fungi in the sheep rumen content at a level of 30g/head/day.

The total volatile fatty acid was not significantly affected (P>0.05) by the inclusion of these plant oils ranged between 18.70-19.40g/dl. Individual volatile fatty acids proportion are known to be responsible for methane production; Acetate and Butyrate promote its production while propionate formation is considered a competitive pathway for Hydrogen use in the rumen (19).

Table 4: Rumen fermentation parameters and microbial population of West African Dwarf Sheep fed diets mixed with PKO and SBO

Parameters	T1	T2	T3	T4	SEM
pH	6.20	6.05	5.60	6.50	0.34
NH_3-N (mg/dl)	0.78	0.55^{b}	0.88^{a}	0.44b	0.42
Temperature (^{0}C)	36.25^{ab}	36.40^{ab}	36.90^{a}	37.00^{a}	0.46
Acetic acid (g/dl)	6.06	6.27	6.25	6.80	0.55
Butyric acid (g/dl)	6.59	6.14	6.88	6.48	0.32
Propanoic acid (g/dl)	6.05^{b}	6.84^{a}	6.26^{ab}	6.20^{ab}	0.12
Valeric acid (g/dl)	6.77^{ab}	6.08^{b}	7.56^{a}	6.28^{b}	0.73
Total VFA (g/dl)	18.70	19.25	19.39	19.48	0.34
Coliform count (x10^6cfu/ml)	7.00	7.70	6.65	7.38	0.41
Bacillus count (x10^6cfu/ml)	8.65	8.15	8.25	9.00	0.50
Lactobacillus (x10^6)	2.00	3.00	3.12	3.50	0.21
Fungi count (x10^6)	6.65^{ab}	5.10^{ab}	8.13^{a}	4.05^{b}	0.61
Protozoan count (x10^6cfu/ml)	7.55^{a}	3.50^{b}	3.30^{b}	1.34^{c}	0.91

[a, b, c] means along the same row with different superscripts are significantly different

Conclusion and Applications

It could be concluded from the result of this study that:

1. Palm kernel oil and soyabean oil could be incorporated into the diets of West African dwarf sheep at 5:10g/day for effective feed utilization, improved growth performance and better nitrogen retention.
2. The palm kernel oil and soyabean oil can be mixed with diets of West African dwarf sheep at 5:10g/day for better feed conversion efficiency, effective rumen modulation and nitrogen utilization.

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