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Nutrients Intake by Pregnant West African Dwarf Ewes Fed Rumen Epithelial Scrapings Based-Diets

[1]Akinfemi, A., [2]Ogunwole, A.O. and [3]Osineye, O.M.
1. Dept. of Agricultural Science, Yaba College of Technology, Lagos State, Nigeria.
2. Dept. of Animal Science, University of Ibadan, Oyo State, Nigeria.
3. Federal College of Fisheries and Marine Technology, Victoria Island, Lagos State, Nigeria.
Corresponding Author: akinfemiabayomi@gmail.com

Abstracts
Twelve WAD ewes weighing 18.00±4.00kg were blocked by weight into three groups of four animals each, in a randomized complete block design. They were kept in individual pens and fed formulated diets with Rumen Epithelial Scrappings (RES) as supplement to a basal grass (Panicum maximum), together with fresh water ad libitum daily. Each experimental ewe oestrus was synchronised with prostaglandins $F_2\alpha$ *and subsequently served with herd ram as soon as signs of oestrus were detected. Parameters measured and recorded were weight gain, dry matter intake, energy intake and crude protein intake. Grass consumption increased with advancing pregnancy from 34.08, 40.90 and 52.57g/day/kgBW*$^{0.75}$ *for diets A, B and C respectively in the early pregnancy to 37.96, 40.30 and 55.06 g/day/kgBW*$^{0.75}$ *in the mid pregnancy. There was a noticeable decline in these values to 29.35, 29.98 and 40.83 g/day/kgBW*$^{0.75}$ *in the late pregnancy, with animals on diets A, B and C respectively. At the three stages of pregnancy, dry matter intake of both grass and supplement increased with increasing inclusion of RES in the diets. Rumen Epithelial Scrapings increased the intake of supplements and digestibility efficiency of the pregnant ewes.*

Keywords*: Rumen Epithelial Scrapings, Dry matter intake, Sheep, Pregnant ewes*.

Introduction

The need for conservation and re-use of products, which would have been allowed to rot without a second thought cannot be over-emphasized. It also stemmed from the stark reality of the ever-diminishing World's available raw materials as population is growing exponentially. Also, as total population increases and demand for food rises, it is inevitable that most of the fertile land, now utilized as range will be cropped. In addition, by drainage of swamps, the irrigation of semi-arid areas and the improvement of less fertile soils by the increasing use of fertilizers, even large areas now considered only economic for use as rough grazing, will also be cultivated. It may be predicted that with competitive use of land for different purposes such as building, roads, etc., the available land for grazing will reduce considerably, therefore the likely preference for alternative feed resources. Cattle rumen epithelial scraping is the by-product of processing cattle rumen into edible meat which is highly relished in most African countries. It is the thin layer of the rumen that is scrapped of during the cleaning of the organ for food by man (Akinsonyinu, 2006, Bawala *et al.*, 2007; Ogunwole, 2011). Additionally, rumen epithelial scrapping dooes not constitute health risk to livestock's and man, the reason being that its microbial load is reported to be within the acceptable range of total plate limit of dry ready to eat food (Alikwe *et al.*, 2005). Abubakar (1980) reported cases where slaughterhouse by-products such as rumen contents, blood, meatscraps, bones, hair, feather, hooves and horns have been used as livestock feed ingredients for increased growth rate of cockerels, broilers, dairy calves and sheep in Nigeria. The preservation of slaughter offal consisting of rumen wastes, intestines, etc. used as feed for animals, was reported by Polonen, *et al*. (1998). Other researchers examined the effect of processing methods on nutritive value of shrimp waste meal (Oduguwa, *et al.* 1999: Osineye, *et al.* 2009), Osineye and Ashade (2012) replaced maize with cocoa pod husk in the nutrition of tilapia, Akinfemi *et al.* (2008a and b) enhanced the nutritive value of maize leaf by treating it with white rot fungus, while Fanimo

(1998), evaluated chicken offal meal compared with full fat soybean and fish meal in the ration of pigs. Their collective individual findings underscored the potentialities and promises that wastes from animal processing hold for livestock feeding. Despite its obvious availability and proven potentials as animal feed and their potentials in ameliorating the hitherto dearth of proven feedstuff, their neglect is evident in erstwhile improper disposal and sheer abandonment as in Bodija market, Ibadan, or burial, thereby constituting environmental nuisance due to serious stench from its perpetual putrescence. Feedstuff purchase and ration formulation should give primary consideration to least cost and maximum biological returns. With appropriate processing methods, it may be a worthwhile endeavour to evaluate such feedstuffs for examination of their suitability in livestock ration. Therefore, the present experiment seeks to determine the nutrient composition of RES and also evaluate the nutritional quality of feeding RES diets to pregnant WAD ewes.

Materials and Methods

The study was conducted at the Department of Animal Science, University of Ibadan and the International Livestock Research Institute (ILRI), IITA, Ibadan, Nigeria. Ibadan is located within 6° and 9°North of the equator and 4° – 6° East of Greenwich meridian, within the South-Western region of Nigeria. The climate is characterized by fairly high temperature of 36.00±4.00°C, Relative humidity ranging from an average of 60% in January, to 94% in August, with a yearly average of about 82%, as a result of moderately heavy average rainfall of about 2,000mm, being a typical tropical rainforest zone (BATC, 2005).

Samples collection and formulation of experimental diet

Samples of RES were collected at the main abattoir in Bodija market, Ibadan. The normal processing here involved initial elimination of the rumen content. This was then followed by washing and boiling of the empty rumen in hot water for about 5minutes. The inner epithelial layer was then scrapped off with a knife and this scrapped layer formed the wet RES. The air-dried samples were milled at the feed depot of the Teaching and Research Farm, University of Ibadan. The dried ground sample was then packed into sacks, weighed and stored in a silo pending its incorporation into diets or used in chemical analyses. Concentrate supplements were formulated such that 0%(A), 50%(B) and 100%(C) of the groundnut cake (GNC) were replaced weight by weight with RES in a concentrate diet containing 20% GNC. The formulated diets were then used for the experiment. The compositions and nutrient contents of test diets are shown in Tables 1 and 2 respectively.

Table 1: Formulation of Rumen Epithelial Scrapings-Based (Experimental) Diets

Ingredients (%)	A	B	C
Groundnut Cake	20.00	10.00	00.00
RES	00.00	10.00	20.00
Cassava Peel	30.00	30.00	30.00
Wheat offal	34.00	34.00	34.00
Palm kernel cake	10.00	10.00	10.00
Oyster shell	2.00	2.00	2.00
Bone meal	3.25	3.25	3.25
Vitamin/Mineral Premix	0.25	0.25	0.25
Common salt	0.50	0.50	0.50
Total	**100.00**	**100.00**	**100.00**

Key: A=0% RES; B=10% RES, C=20% RES

Table 2: Chemical Composition of RES-Based Diets and Grass (*Panicum maximum*)

	A	B	C	Grass	RES
Dry Matter (%)	91.90	92.53	91.69	93.76	80.95±8.45
Chemical Composition (g/100gDM)					
Crude Protein	20.25	19.87	19.65	6.23	44.19
Crude Fibre	16.73	16.50	16.27	41.12	1.52
Ether Extract	4.38	4.27	3.51	2.34	2.06
Ash	17.67	11.85	16.34	11.13	3.04
Nitrogen-Free Extract	40.97	47.51	44.23	39.28	49.19
Organic Matter					96.96
Calcium (%)	1.00	1.06	1.05	0.32	
Phosphorus (%)	0.76	0.87	0.80	0.42	
Gross Energy (Kcal/g)	2.77	2.74	2.75	3.56	3.93

Animals and their Management

Twelve (12) pregnant ewes, aged 2-4 years, weighing 18.50±4.00kg were blocked by weight into three groups of four animals each. They were kept in individual pens where each had a free access to food and fresh water daily. They were certified free of ecto-parasites. Concentrate supplements were offered *ad libitum* at 09h and 16h. Voluntary feed intake was estimated as the difference between feed offered and feed refused.

Oestrus Synchronization

All experimental ewes were given prostaglandins F2α intramuscularly in two doses of 1ml to synchronize their oestrus artificially. They were served with herd ram once signs of heat were detected. All ewes were weighed at mating.

Nutrient Digestibility and Utilization

Estimation of nutrient digestibility was carried out by total faecal collection method (McDonald, *et al.,* 1987) two weeks prior to mating. The animals were weighed and each animal penned in individual metabolic cage (Oyenuga, 1961) as modified for female animals to facilitate separate collection of urine and feaces (Akinsoyinu, 1974). In the last 5 days, the feaces voided were collected and weighed daily and a 10% kept for analyses. Feacal samples were dried at 65^{o}C to constant weight, milled and stored in air tight bottle until analyzed.

Analytical Procedure

Samples of feed and feaces were analyzed for crude protein (CP), ether extracts (EE), crude fibre (CF) and ash, as described by AOAC (1990). Gross Energy content was determined, using adiabatic bomb calorimeter, as described by Harris (1970).

Statistical Analysis

All data obtained were subjected to analysis of variance (Gomez and Gomez, 1986) while means were separated using Duncan Multiple Range Test (Duncan, 1955).

Results and Discussions

The values in Table 3 are in agreement with those obtained by Fajemisin (2002).

The ether extract value (g/100gDM), obtained was 2.06±0.15. This is lower than the value of 7.23 (Isah, 2001) for the same ingredient. However, this (2.06) value is much higher than 1.50 and 1.20 reported for fish meal and animal blood respectively (Fetuga and Tewe, 1985).

Table 3: Chemical Composition of Rumen Epithelial Scrapings (RES)

Dry Matter (%)	80.95±8.45
Chemical Composition (g/100gDM)	
Crude Protein	44.19
Crude Fibre	1.52
Ether Extract	2.06
Ash	3.04
Nitrogen-Free Extract (NFE)	49.19
Organic Matter	96.96
Calcium (%)	3.29
Phosphorus (%)	0.82
Magnesium (%)	0.57
Potassium (%)	0.61
Sodium (%)	0.46
Manganese (ppm)	748.00
Zinc (ppm)	48.19
Copper (ppm)	6.43
Iron (ppm)	135.00
Gross Energy (Kcal/g)	3.93

The average crude protein value (g/100gDM) of air-dried sample was 44.19±1.68. Isah (2001) and Fajemisin (2002), obtained higher values and wider range of 41.38 to 69.48 for the same ingredient. The most probable reason for such a wide range of variability in crude protein value of RES could be attributed to varied dietary components of the diet fed to the animals, being responsible for varied types and population densities of rumen microflora and fauna, as well as their metabolites (Osineye, 2009). Varied level of contamination of the sample during scraping and drying could also be a contributory factor to this wide range of variability in crude protein value. Hair, one of the notable contaminants of RES contains very high level of nitrogen. Hairs and sand from the platform during drying of the sample are also notable contaminants. RES is an attractant to flies and microorganisms, thus the level of various contaminants could influence the crude protein value. Fanimo (1998) obtained similar crude protein value (g/100gDM) of 43.71 for shrimp waste. Skrede and Nes (1988) reported crude protein values of 43.40, 34.00 and 32.10 for raw cattle tripe, raw mixed cattle waste and raw mixed hog waste respectively. These values were however lower when compared with values obtained for different samples of meat meal (Gonzalez *et al.*, 1998), which were (g/100gDM) 56.90, 58.80, 66.70, 57.90 and 52.30. There is therefore high variability in crude protein values in literature for animal products. The major mineral profile of RES is shown in Table 3. Result showed that RES could be a good source of minerals in the ration of livestock. It is particularly rich in sodium and iron. The values here compare favourably with what was obtained by Fajemisin (2002). Method of processing and rate of contamination could also alter the mineral profile. Other factors that could lead to variation in the mineral profile could be the sampling method. Chemical composition of ingredients used for compounding the experimental diets compare favourably with those reported in literature (Oyenuga, 1968; Gonzalez and Pocheco, 1970; Adetoro, 1997; Ola and Adeogun, 2001; Isah, 2001).

Table 4: Chemical Composition of other Ingredients used in the Formulation of Experimental Diets

Constituents	GNC	Wheat Offal	Cassava Peel	PKC
Dry Matter (%)	96.80	90.00	91.30	92.50
Chemical Composition (g/100gDM)				
Ash	4.89	6.30	13.80	4.80
Crude Fibre	3.81	12.17	35.60	11.50
Ether Extracts	9.20	5.56	5.30	7.00
Nitrogen-Free Extracts	37.35	58.84	38.10	57.90
Crude Protein	44.75	17.13	7.20	18.80

The values obtained for chemical compositions in Tables 2 and 4 are similar to those obtained by Osineye (2015); Fajemisin *et al.* (2015); Isah *et al.* (2015). Table 5 summarizes the feed intake of ewes during pregnancy. Dry Matter Intake is an indication is an indication of their capacity to utilize feed voluntarily. Thus it is a critical determinant of energy intake and performance of animal on a particular diet (Davendra and Mcleroy, 1982). Grass DM consumptions (g/kg $BW0^{.75}$/day) were 37.28, 42.95 and 49.63 in pregnant ewes on diets A, B and C respectively. Grass consumption increased with advancing pregnancy from 34.08, 40.90 and 52.57 for diets A, B and C respectively in early pregnancy to 37.96, 40.30 and 55.06 in mid pregnancy. These values declined in late pregnancy to 29.35, 29.98 and 40.83 for animals on diets A, B and C respectively.

Table 5: Dry Matter Intake of Pregnant Ewes Fed RES-Based Diets

Treatments	Daily DMI		Daily Total DMI (g)	Total DMI %BW	Av. Intake(g/day)		$BW^{0.75}$ Total DMI	CI (%) TDMI
	Concen.(g)	Grass(g)			Concen	Grass		
Pre Pregnancy								
A	390.8	329	719.8	3.95	37.28	44.08	81.36	54.19
B	460	420	880	4.22	42.95	47.19	90.14	52.41
C	458.4	471.8	930	4.61	49.63	47.91	97.54	49.17
SE	11.4	31.73	62.89	0.1	2.02	1.52	2.38	1.3
Early Pregnancy								
A	512	310	822	4.34	34.08	56.67	90.75	62.44
B	570	407.9	977.9	4.58	40.9	57.4	98.3	58.67
C	552.4	527.6	1080	5	52.57	55.14	107.71	51.19
SE	95.37	38.33	6.4	0.18	2.73	1.75	3.57	1.32
Mid Pregnancy								
A	546	368.3	932.3	4.52	37.96	58.46	96.42	60.6
B	664	443.5	1107.5	4.53	40.3	60.31	100.6	60.05
C	618.8	614.7	233.7	4.97	55.06	55.67	110.73	50.31
SE	33.88	38.7	66.08	0.13	2.02	1.61	2.4	1.42
Late Pregnancy								
A	458.5	301	759.3	3.44	29.35	45.01	74.36	60.51
B	546.3	357.5	903.8	3.32	29.98	45.69	75.67	60.51
C	508.7	493.3	1002.2	3.63	40.83	42.22	83.05	50.9
SE	27.52	31.02	53.63	0.92	1.89	1.79	3.97	1.36

Means along the same column with identical superscripts are not significant.
BW= Body Weight; TDMI= Total Dry Matter Intake; CI= Concentrate Intake; Int.= Intake

Grass consumption increased ($p<0.05$) with the inclusion of RES at all stages of pregnancy. Ewes on diet C recorded a consistently higher intake of grass ($p<0.05$) compared with those on diets A and B. This might probably be due to better quality of diet C. Studies (Putman and Loosli, 1959; Egan, 1965; Adu,1975; Nelson, *et al.*, 1984 Ndlovu and Smith, 1987) have shown that voluntary intake of low quality forage was greatly improved by the quality of supplementary concentrate given. Variations in concentrate supplement consumed were not significant. These observations suggest that the diets were equally acceptable to the animals. Generally total dry matter intake of animals fed various diets improved significantly ($p<0.05$) with increasing inclusion of RES except in late pregnancy where observed variation was not significant. Total dry matter intake as a percentage of body weight increased up to mid pregnancy in all treatments and decreased in late pregnancy. The observed values in the pre pregnant period were 3.95, 4.22 and 4.61 for animals on diets A, B and C respectively and treatment effect was significant ($p>0.05$). The leaves size (Barre *et al* 2006), stem physical properties, can stimulate limit in inhibit animal foraging behaviour (Provenza 2003). This can be further enhance by addition of digestible materials. In the present study, the quality under grazing, there is close relationship between leaf proportion (Parga *et al.,* 2002; O'Donovan *et al.,* 2005), green leaf mass (sward density (Prache *et al.,* 1997) and dry matter intake. This could be responsible for the variation observed in grass intake. A reduction in the volume of abdominal cavity due to compression of rumen by enlarging gravid uterus is implicated. The observed range for these indices was between 3.32 and 5.00. As a practical rule, sheep and goats will consume 2-4% of their body weight on dry matter basis in feed. The observed range is consistent with report elsewhere.
Table 6 summarizes the observed energy intake (Mcal/kgBW$^{0.75}$/day) by animals fed diets A, B and C. Energy intake improved significantly ($p<0.05$) with the inclusion of RES in the period prior to pregnancy, early and mid pregnancy. The trend observed in energy intake of animals on different treatments is similar to that of DMI at all stages of pregnancy. Observed trend is highly correlated with energy contents of the various concentrate diets and this conformed to the observations of McDonald *et al.,*(1987); INRA, (1989) that animals eat to satisfy their energy needs. Animals on diet C recorded the highest ($p<0.05$) energy intake, despite lower energy content whereas animals on diet A recorded the lowest energy intake despite its highest energy content. Energy intake (Mcal/kgBW$^{0.75}$/day) rose steadily for all animals in early pregnancy and increased till mid pregnancy. In late pregnancy, energy intake declined. The trend observed is similar to that obtained by Olatunji (1974) and Adu (1975) in WAD sheep.

Table 7 shows variations in mean intake of crude protein with stage of pregnancy. Animals on diet C consumed higher ($p<0.05$) CP (g/kgBW$^{0.75}$/day) from grass at all pregnancy stages. Obviously, CP intake from concentrate contributed a larger percentage of the total CP intake of all animals. The trend observed in CP contents of the various concentrate diets. This is in agreement with the observations of Cowan *et al.* (1981) and Vipond *et al.* (1982). Improvement in protein status of feed enhances rumen microorganism proliferation and also encourages a more rapid and thorough digestion of ingesta, leading to grass intake stimulation (Egan, 1965). In this study, sources of nitrogen in the diets (GNC or RES) did not influence the concentrate intake per unit metabolic weight (g/BWkg$^{0.75}$/day) and this conforms to earlier findings (Steen, 1989) that the effect of ruminal degradation rates on this factor was independent of feed intake level.

Table 6: Energy Intake (Mcal/kgBW$^{0.75}$/day)

Parameters	A	B	C	SE
Pre Pregnancy				
Grass	132.71^{b}	152.91b	176.67^{b}	7.18
Concentrate	122.15	129.32	131.75	4.19
Total Intake	254.86^{c}	282.23^{b}	308.41^{a}	7.9
Concentrate (%)Total Intake	47.94	45.88	42.8	1.28
Early Pregnancy				
Grass	121.32^{b}	145.62^{b}	187.14^{a}	9.72
Concentrate	156.98	157.27	184.97	14.26
Total Intake	278.30^{b}	302.89^{b}	372.11^{a}	19.28
Concentrate (%)Total Intake	56.4	52.25	49.06	2.16
Mid Pregnancy				
Grass	135.14^{b}	143.46^{b}	196.02^{a}	7.2
Concentrate	140.2	169.18	153.09	10.02
Total Intake	275.41^{b}	312.63^{ab}	349.10^{a}	12.1
Concentrate (%) Total Intake	50.43	54.22	43.9	2.21
Late Pregnancy				
Grass	104.50^{b}	106.72b	145.37^{a}	6.73
Concentrate	124.67	125.18	116.1	4.95
Total Intake	229.17	231.9	261.47	9.9
Concentrate (%) Total Intake	54.39	54.13	44.49	1.37

Means along the same row with identical superscripts are not significant.

Table 7: Crude Protein Intake (g/kgBW$^{0.75}$/day)

Parameters	A	B	C	SE
Pre Pregnancy				
Grass	2.32^{b}	2.68^{b}	3.09^{a}	0.13
Concentrate	9.81	9.38	9.41	0.32
Total Intake	12.13	12.06	12.5	0.33
Concentrate (%)Total Intake	80.86	77.79	75.23	0.92
Early Pregnancy				
Grass	2.13^{b}	2.55^{b}	3.28^{a}	0.17
Concentrate	11.48	11.41	10.83	0.35
Total Intake	13.61	13.96	14.11	0.44
Concentrate (%)Total Intake	84.36	81.82	76.76	0.85
Mid Pregnancy				
Grass	2.37^{b}	2.52^{b}	3.43a	0.13
Concentrate	11.92	11.99	10.94	0.36
Total Intake	14.29^{b}	14.51^{a}	14.37a	0.37
Concentrate (%) Total Intake	83.4	82.68	76.09	0.96
Late Pregnancy				
Grass	1.83^{b}	1.87^{b}	2.54^{a}	0.12
Concentrate	9.11	9.08	8.3	0.36
Total Intake	10.94	10.95	10.84	0.42
Concentrate (%) Total Intake	83.28	82.99	76.53	0.89

Means along the same row with identical superscripts are not significant.

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