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Blood Profile and Reproductive Performance of Pregnant West African Dwarf Ewes Fed Rumen Epithelial Scrapings-Based Diets

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Abstract:

Twelve WAd ewes weighing 18.50 ± 4.00 kg 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 as supplement to a basal grass (*Panicum maximum*), together with fresh water ad-libitum daily. All experimental ewes were given prostaglandin F₂α for synchronization of oestrus and served with herd ram as soon as signs of heat were detected. Parameters measured and recorded were: Dry matter intake, Serum metabolites and Haematological indices. Before mating, after mating, as pregnancy advanced, and with increasing inclusion of RES, grass consumption (g/kgBW^{0.75}/day) increased; 34.08, 40.90 and 52.57 for diets A, B and C respectively in the early pregnancy, to 37.96, 40.30 and 55.06 in mid-pregnancy. There was a noticeable decline in these values to 29.35, 29.98 and 40.83 in late pregnancy with animals on diets A, B and C respectively. Treatment effect on PCV(%) values declined significantly ($p < 0.05$), from pre-mating period to early pregnancy, and with only animals on different levels of dietary RES inclusion, there was a significant ($p < 0.05$) but corresponding rise in PCV. RBC (10^6mm^{-3}) and Hb (g/100ml) followed the same trend as PCV. Macrocytic anaemia was observed in the animals during early pregnancy, {MCV (μ^3): A(85.10), B(80.80) and C(99.50)} and this was corrected by late pregnancy (42.70, 35.80 and 33.70) for all treatments, displaying normal values, although, treatment effect was significant ($p < 0.05$). The values of WBC ($\times 10^3 \text{mm}^{-3}$) were not consistent with increasing inclusion of RES. Serum minerals varied inconsistently with increasing inclusion of RES in the diet. Sera levels of both minerals varied similarly for other periods of pregnancy (mMol/l): (246.50, 311.50 & 290.50 of Na⁺ and 116.50, 119.50 & 117.50 of Cl⁻ for animals fed diets A, B and C respectively) in early pregnancy, and decreased to (148.80, 141.00 & 146.00 of Na⁺ and 108.00, 104.00 & 105.80 of Cl⁻ for animals fed diets A, B and C respectively) in late pregnancy. Variations in the sera levels of urea and creatinine were inconsistent with increasing inclusion of RES in the diet. Animals on diet C recorded the highest urea level (70.50mg/100ml) in early pregnancy and late pregnancy (39.50mg/100ml) but lowest level of urea in period prior to mating (30.00mg/100ml). Animals on diet C recorded a relatively stable protein profile and relatively higher sera protein in pre- pregnancy (6.53g/100ml), early pregnancy (7.90/100ml) and late pregnancy (6.50g/100ml), despite relatively low intake of dietary protein (10.84, 10.94 and 10.95g/kgBW^{0.75}/day for diets C, B and A respectively). The mean serum cholesterol, triglycerides and glucose values for sheep on diets A, B and C showed that trends obtained were inconsistent with the inclusion of RES in the diet. Serum transaminases were statistically similar at all stages of pregnancy and lack of dietary effect in values obtained for these transaminases is an indication of safety in feeding of RES to sheep. At the three stages of pregnancy, there were significant ($p < 0.05$) improvements in most of the measured parameters, while few were inconsistent, with increasing dietary level of RES.

Keywords: Rumen epithelial scrapings, graded gnc replacement, reproductive performance

1. Introduction

Shortage of feed especially during the dry season is considered as one of the major problems of livestock farmers in developing countries. In Nigeria, the Northern farmers are predominantly cattle rearers who need regular supplies of forages; it is the practice of the cattle herdsman to move towards the Southern part of the country where there is longer period of raining season with available pastures for their livestock. In the course of such movement of livestock, there are clashes between the herdsman and crop farmers. Such clashes has aggravated division in the country, so much that open grazing was banned in certain parts of Nigeria and Ghana. Restraint of such livestock in their natural environment with long period of drought with poor quality forages will further deplete their productivity. Tarawali *et al* (1983) reported that many animals died of starvation during the dry season due to limited availability of all year round feed resources and high cost of conventional feeds. Though grass and forage form greater proportions of ruminant feed

resources Bankole *et al* (2003), their use is limited due to seasonal availability and content of anti-nutritional factors (Bawala *et al*, 2006).

Feed scarcity, therefore, has made it necessary to search for substitutes for the conventional feed resource by harnessing available agro-industrial wastes (crop and animal residues) testing them both in the laboratory for chemical constituents and feed for efficiency of their utilization by the ruminants (Baawala *et al*, 2007). Previous reports (Akinfemi and Ogunwole, 2012; Akinfemi, 2012) exploited fungal treatment of agricultural wastes and also urea-molasses treatment of crop residues. In an attempt to further enlarge the availability of cheap feed resources to ruminants, the use of rumen epithelial scraping was considered. Rumen epithelial scrapings (RES) in an abattoir waste and environmental pollutant, being scrapped-off from the rumen linings, suggesting a high protein source (Alikwe *et al*, 2013).

Information on RES is scanty and yet to be exploited for livestock feed (Bawala *et al* 2006). Recent challenges in ruminant feedstuffs availability has propelled further research into the use of RES. Reports has shown that RES has similar constituents to that of meal (Isah, 2001; Bawala *et al* 2003; Fajemisi *et al* 2003). Research into the means of utilizing this erstwhile waste will perform triple roles of alleviating the rigour involved in its disposal, eliminate stench emanating from its putrescence and provide avenue for generating income for teaming poor women involved in the processing. In view of this, this experiment has considered the dry matter intake and reproductive performance of pregnant West African Dwarf ewes fed rumen epithelial scrapings based diets.

2. 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).

2.1. Source and Description of RES

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 collected fresh RES was immediately spread on a nylon sac, on a clean concrete platform and properly sundried until crisp. Groundnut cake was purchased from feed millers at Monatan, Ibadan. All samples were ground in a Wiley mill to pass through a 0.5mm sieve and little portions were then stored until required for 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.

Ingredients (%)	A	B	C
Groundnut Cake	20.00	10.00	0.00
RES	0.00	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	100	100

Table 1: Formulation of Rumen Epithelial Scrapings-Based (Experimental) Diets
Composition of the Vitamin/Mineral premix

0.2% Vitamin/Mineral Premix for Sheep and Goat (Vitadiz SG), each 2.5kg bag contains; Vitamin A 10,000,000 i.u.; Vitamin D 1,000,000 i.u.; Vitamin E 15,000 i.u.; Calcium 600mg; Phosphorus 400mg; Anti-Oxidant 15g; Manganese 50g; Zinc 100g; Iodine 1g; Iron 100 g; Selenium 0.2g; Cobalt 0.5g

2.2. 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 ectoparasites. Concentrate supplements were offered *ad libitum* at 09h and 16h. Voluntary feed intake was estimated as the difference between feed offered and feed refused.

2.3. Sample Collection and Preparation

Collection of rumen epithelial scrapings as earlier enumerated and 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.

2.4. Oestrus Synchronization

All experimental ewes were given prostaglandins F2 α 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.

2.5. Digestibility Trail

Estimation of digestibility was done in the last two weeks of the feeding trial with the first 7 days for acclimatization and adjustment of the experiment to the metabolic cages fitted in such a way that there is separate collection of the urine and faecal droppings, in the last 5 days, the faeces voided were collected and weighed daily and a 10% kept for analyses. To prevent nitrogen loss from the urine through volatilization, 10ml of 10% H₂SO₄ was added to each collected sample of urine (Chen and Gomez, 1992). Urine samples were collected in PVC containers with a lid and subsequently stored at 20°C in deep freezer until required for analysis. Faecal samples were dried at 65°C to constant weight, milled and stored in air tight bottle until analysed.

2.6. Collection of Blood

Blood samples were collected before morning feeding through jugular veinpuncture with a minimum excitation (Anosa *et al.*, 1978), before and at the end of feeding experiment and just before the commencement of metabolic procedure. An average of 10ml of blood was collected from each animal, about 2ml of each sample was contaminated with ethylene diamine tetraacetic acid (EDTA) for haematological studies, while the remaining 8ml was left in glass universal bottle from which serum was harvested.

2.7. Analytical Procedure

Samples of feed and faeces 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).

2.8. Statistical Analysis

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

3. Result and Discussion

Parameters	A	B	C	Grass
Dry Matter (%)	91.90	92.53	91.69	93.76
Chemical Composition (g/100gDM)				
Crude Protein	20.25	19.87	19.65	6.23
Crude Fibre	16.73	16.50	16.27	41.12
Ether Extract	4.38	4.27	3.51	2.34
Ash	17.67	11.85	16.34	11.13
Nitrogen-Free Extract (NFE)	40.97	47.51	44.23	39.28
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

Table 2: Chemical Composition (g/100g DM) of RES-Based Diets and Grass (*Panicum maximum*)

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

Table 3: Chemical Composition of Rumen Epithelial Scrapings (RES)
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) and 6.20 (Bawala *et al.*, 2007) 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).

The average crude protein value (g/100gDM) of air-dried sample was 44.19±1.68. Isah (2001) and Fajemisin (2002) and Bawala *et al.* (2007) obtained higher values and wider range of 41.38, 69.48, 62.0 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. Fanimu (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 4. 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 (2003). 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 Isa and Babayemi (2010); Ola and Adeogun, 2001; Isah, 2001).

Constituent	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	13.880	4.80
Crude Fibre	3.81	12.17	35.60	11.50
Ether Extract	9.20	5.56	5.30	7.00
Nitrogen-Free Extract	37.35	58.84	38.10	57.90
Crude Protein	44.75	17.13	7.20	18.80

Table 4: Chemical Composition of Other Ingredients Used in the Formulation of Experimental Diets
GNC= Groundnut Cake, PKC= Palm Kernel Cake

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 of their capacity to utilize feed voluntarily. Grass DM consumptions (g/kg BW^{0.75}/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.

	Trtmt. Concentration (g)	Daily DMI Grass (g)	Daily Total DMI (g)	Total DMI %BW	Av. Grass	Intake g/Day Conc.	BW ^{0.75} Total DMI	CI(%) TDMI
Pre-Preg.								
A	390.80	329.00	719.80	3.95	37.28	44.08	81.36	54.19
B	460.00	420.00	880.00	4.22	42.95	47.19	90.14	52.41
C	458.40	471.80	930.00	4.61	49.63	47.91	97.54	49.17
SE	11.40	31.73	62.89	0.10	2.02	1.52	2.38	1.30
Early-Preg								
A	512.00	310.00	822.00	4.34	34.08	56.67	90.75	62.44
B	570.00	407.90	977.90	4.58	40.90	57.40	98.30	58.67

	Trtmt. Concentration (g)	Daily DMI Grass (g)	Daily Total DMI (g)	Total DMI %BW	Av. Grass	Intake g/Day Conc.	BW ^{0.75} Total DMI	CI(%) TDMI
Pre-Preg.								
C	552.40	527.60	1080.0	5.00	52.57	55.14	107.71	51.19
SE	95.37	38.33	6.40	0.18	2.73	1.75	3.57	1.32
Mild-Preg								
A	546.00	368.30	932.30	4.52	37.96	58.46	96.42	60.60
B	664.00	443.50	1107.5	4.53	40.30	60.31	100.60	60.05
C	618.80	614.70	233.70	4.97	55.06	55.67	110.73	50.31
SE	33.88	38.70	66.08	0.13	2.02	1.61	2.40	1.42
Late-Preg								
A	458.50	301.00	759.30	3.44	29.35	45.01	74.36	60.51
B	546.30	357.50	903.80	3.32	29.98	45.69	75.67	60.51
C	508.70	493.30	1002.2	3.63	40.83	42.22	83.05	50.90
SE	27.52	31.02	53.63	0.92	1.89	1.79	3.97	1.36

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

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 (Isis et al; Mitimura et al., 2018; Rusdy, 2018; Nyambati et al, 2003) 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 ($p < 0.05$). Dry matter intake decreased generally in late pregnancy for animals on all diets as reported elsewhere (Linden et al 2015; Janovick et al, 2011; Janovick and Drackley (2010); Dann et al, 2005; Drackley and Cardoso, 2014; Litherland et al., 2011). 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. This is within normal range as animals are expected to consume 3.00 – 5.00% of their body weight as dry matter for proper performance (ARC, 1985; Steele, 1996).

4. Haematological Indices of Pregnant WAD Ewes Fed RES-Based Diets

Variations observed in values of haematological indices for pregnant WAd ewes are displayed in Table 6. Haemoglobin (Hb)(g/100ml) values obtained for experimental animals were not consistent with the inclusion of RES in the diet. Hb is indicative of oxygen-carrying capacity of the blood. Animals with high oxygen-carrying capacity do not succumb easily to respiratory diseases (Mmerede, 1996). Prior to mating, values obtained for Hb were 10.50, 10.20 and 10.30, for animals on diets A, B and C respectively and treatment effects were not significant. In early pregnancy, there were marked decline in Hb values for all diets and these values (6.90, 6.80 and 4.50, for diets A, B and C respectively), were lower than normal range recommended for ovine species (Radostits et al; 2000). Animals on diet C recorded a significantly ($p < 0.050$) lower Hb value, compared with values for A and B. However, in late pregnancy, animals on all diet their Hb values to levels normal for ewes. Animals on diet a recorded a significantly ($p < 0.05$) lower mean Hb value (7.70) compared with the values of B (11.08) and C (10.60).

Treatment effect on PCV (%) values at pre-mating period (30.50, 30.50 and 31.00 for treatments A, B and C respectively) was not significant. There was sharp decline in PCV (%) values in early pregnancy (21.00, 20.00 and 13.50 for treatments A, B and C respectively). The values improved tremendously for all diets in late pregnancy. Animals on diet a recorded a significantly ($p < 0.05$) lower PCV (24.50) in late pregnancy compared with B(31.80) and C(32.00). this observation is suggestive of a relatively lower ability of diet A to restore PCV in late pregnancy compared with diets B and C. RBC (10^6mm^{-3}) values for animals on diets A, B and C followed the same trend as PCV and Hb. Observed values for animals on diets A, B and C were 8.00, 7.80 and 8.00 in early pregnancy. RBC values declined in mid-pregnancy (2.50, 2.60 and 1.40), while the values also improved significantly ($p < 0.05$) in late pregnancy (5.70, 8.90 and 9.48).

In early pregnancy, MCV (μ^3) values obtained for A(85.10), B(80.80) and C(99.50) were beyond normal range. This shows that at this stage, the erythrocytes of ewes on all treatments were macrocytic, i.e. erythrocytes were larger than normal. MCV is in classifying anaemia morphologically. This classification has little reference to the cause of the anaemia. The estimation is for only normal erythrocyte size and haemoglobin concentration. Macrocytic anaemia is usually transitory – a common feature in convalescence or in recuperating animals (Zawn, 2018). Expectedly, the erythrocyte size in late pregnancy improved (42.70, 35.80 and 33.70 for animals on diets A, B and c respectively), but treatment effect was not significant.

WBC ($\times 10^3/\text{mm}^3$) obtained for all treatments in late pregnancy (i.e. 13.03, 12.73 and 17.80 for animals on diets A, B and C respectively), was highest for diet C – this is suggestive of reactions by animals, making them to produce antibodies, or WBC, to fight against infections as a result of feeding on RES-based concentrate. The WBC reported in this study indicates high immunity status of the animals to fight against infection (William, 1995) and this implies the animals were in sound health. The transmission of pathogenic bacteria and parasites is one of the major drawbacks of waste recycling for feeding animals (FAO, 1982). Nevertheless, neither health nor behavioural traits were affected by the experimental diets.

Haematological values for ewes must be interpreted with caution. The spleen of sheep has been reported to have the capability of storing 500 – 800ml of concentrated blood cells (Dooley et al., 1971) that could be released into circulation under stressful conditions, thus causing a variation in haematological values. Once feed is adequate, variations observed could therefore be due to external changes rather than direct response to feeding regime. The main constraint hindering the productivity of the livestock sector in most sub-Saharan countries are diseases, poor nutrition, poor breeding policies and poor management. (Kusiluka and Kambarage, 1996). For example, WAD sheep are trypanotolerant (Chukwuka et al, 2010). Thus, sheep have innate ability to contain to a great extent, the effects of trypanosomiasis sub-clinical infections (Ristic and McLyntre, 1981) and constant parasitic burden (Nfi, 1991). They grow and reproduce without therapy, but this challenge will reflect in the blood picture, as may be the case here.

	Treatment	PCV	Hb	RBC	MCV	MCHC	MCH	WBC
Early Preg.								
A	12.70 \pm 0.08	10.20 \pm 0.16	8.00 \pm 0.08	38.10 \pm 0.45	33.30 \pm 0.21	30.50 \pm 0.65	9700 ^a \pm 310.91	9.70
B	30.50 \pm 2.25	10.20 \pm 0.76	7.80 \pm 0.78	39.60 \pm 1.46	33.30 \pm 0.41	13.20 \pm 0.65	7500 ^b \pm 402.08	7.50
C	31.00 \pm 1.83	10.30 \pm 0.60	8.00 \pm 0.46	38.70 \pm 0.07	32.80 \pm 0.46	12.70 \pm 0.16	8850 ^a \pm 375.30	8.85
Mild-Preg.								
A	21.00 ^a \pm 0.91	6.90 ^a \pm 0.28	2.50 ^a \pm 0.23	85.10 \pm 4.60	33.10 \pm 1.13	28.30 \pm 2.23	10150 ^b \pm 232.74	10.15
B	20.50 ^a \pm 1.76	6.80 ^a \pm 0.50	2.60 ^a \pm 0.31	80.80 \pm 8.49	33.40 \pm 2.28	26.50 \pm 1.28	10550 ^{ba} \pm 292.30	10.55
C	13.50 ^b \pm 0.74	4.50 ^b \pm 0.29	1.40 ^b \pm 0.18	99.50 \pm 8.13	33.50 \pm 2.54	33.40 \pm 4.32	12350 ^a \pm 961.34	12.30
	1.22	0.37	0.30	7.29	2.07	2.90	595.47	
Late Preg.								
A	24.50 ^b \pm 1.71	7.70 ^b \pm 0.60	5.70 ^b \pm 0.30	42.70 ^a \pm 1.74	31.60 \pm 1.56	14.80 ^a \pm 1.32	13025 \pm 2875.60	13.02
B	31.80 ^a \pm 2.93	11.08 ^a \pm 1.01	8.90 ^{ba} \pm 0.96	35.80 ^b \pm 1.77	34.90 \pm 1.68	12.50 ^{ba} \pm 0.53	12725 \pm 306.80	12.72
C	32.00 ^a \pm 0.71	10.60 ^a \pm 0.24	9.48 ^a \pm 0.19	33.70 ^b \pm 0.10	33.20 \pm 0.03	11.20 ^b \pm 0.03	17800 \pm 195.1	17.80
	2.00	0.69	0.59	1.44	1.33	0.82	2675.58	

Table 6: Effects of Inclusion of RES on Haematology of Ewes during Pregnancy
Means along the Same Column with Identical Superscripts Are Not Significant

PCV= Packed Cell Volume; Hb= Haemoglobin; RBC= Red Blood Cells; MCV= Mean Corpuscular Volume
MCHC= Mean Corpuscular Haemoglobin Concentration; MCH= Mean Corpuscular Haemoglobin
WBC= White Blood Cell.

5. Reproductive Performance of WAD Ewes Fed RES-Based Diets

5.1. Live-Weight Changes during Pregnancy

Pattern of live-weight changes of pregnant ewes fed Res-based diets in the last six weeks of gestation is shown in Table 7. All animals on diets A, B and C gained weight during pregnancy indicating that dry matter intakes were sufficient both for maintenance and production. Weight changes during pregnancy were 6.08, 7.48 and 8.30kg for animals on diets A, B and C respectively, (highest for animals on diet C). This numerical increment in observed weight gain increasing with the inclusion of RES in the diets were however not statistically significant. Weight loss during parturition was highest for animals on diet A (4.75kg) and decreased numerically with the inclusion of RES in the diet (i.e. 4.43kg and 4.13kg for diets B and C respectively). The observed variation was however, not statistically significant. Ewes on diet B were heaviest at mating (20.90kg) while those on diet A had the least mean weight (18.43kg), although treatment effect was not significant. At parturition and weaning, mean weight of animals on diet C was highest (28.80kg and 23.90kg respectively). There was no significant correlation between live-weight at mating and lambs birth weight, and this agrees with the observation of Orji (1976) and Uwechue (2000) on Wad ewes.

5.2. Gestation Length

Estimation of gestation length commences from the day of mating till the day of lambing or parturition (Terril and Hazel, 1974). Values obtained for gestation length were 149.25, 148.50 and 154.30 days for ewes on diets A, B and C respectively. However, the observed variations were only numerical but statistically insignificant. The average gestation length in sheep varies from 142 to 152 days (Sheep 201). The average is 147 days. Individual pregnancies may vary from

138 to 159 days (201) Hill (1960) observed a range of 140 -169 for WAD sheep. Mean gestation length obtained for multiple births were higher than the corresponding gestation periods for single births. This observation is at variance with that reported by Uwechue (2000) that sheep with multiple births have shorter gestation periods.

5.3. Parturition

All births took place unassisted and most lambing were in the night. All foetal membranes were recovered with none consumed by the ewes. No mortality was recorded at birth.

5.4. Type of Birth and Sex Indication

Of the four ewes per treatment, all ewes on diet A had single births while animals on diets B and C had one ewe each with twin birth. Twinning rate vary greatly and ranges from 20% (Hill, 1960) to 87% (Ngere, 1975). Taiwo (1979) obtained 51.9% and Ademosun (1973) got 27% as twinning rates. Treatment effect was significant ($p < 0.05$) for sex of lambs from animals fed diets A, B and C. All lambs from animals fed diet A were male, while 80% and 50% of lambs obtained from diets B and C respectively were male. The proportion of male lambs thus decreased with inclusion of RES in the diet, but considering the fact that male animals determine the sex of the offspring, it is not certain that RES inclusion in the diet has anything to do with the sex ratios of the lambs, so further studies and observations are necessary on a larger number of ewes for certainty.

5.5. Lamb Birth Weight

The birth weight of lambs is significantly affected by nutritional status of ewes during pregnancy (Adu and Olaloku, 1979). The mean birth weights were 2.10kg, 2.93kg and 3.48kg for animals on diets A, B and C respectively. The numerical increase in these values with the increasing inclusion of RES was however not significant. 1.70 to 1.85kg reported for WAD (Djallonke) Baffour- Awuah et al., 2007, Odom, 2012) 2.34kg reported by Awuah (2009). Bosso et al 2007 and Yapi-Gnaore et al 1997 obtained 1.90 and 2.01kg for the same breed in Coted'ivore respectively. Among et al, 2019 noted that the variation in birth weight may be linked to nutritional status of the dam during pregnancy, age and pantry of dam during pregnancy and different management practices in production. For example, the limited availability and poor quality of forages for grazing dams especially during the dry season adversely influence their nutritional status, subsequently affecting the availability of nutrients for foetal development. This is because birth weight is a consequence of the net supply of nutrients reaching the foetus (Obese et al 2013). The correlation between the ewes live-weight closest to lambing and the lamb's birth weight was not significant.

Parameter	A	B	C	D
Weight at Mating (kg)	18.43	20.90	20.43	1.74
Weight before Parturition (kg)	24.50	28.38	28.80	1.94
Weight Loss During Parturition (kg)	4.75	4.43	4.13	0.91
Weight Gain During Pregnancy (kg)	6.08	7.48	8.30	1.04
Gestation Length (Days)	149.30	148.50	154.30	2.73
Lamb Birth Weight (kg)	2.10	2.33	2.57	0.20
Litter Weight (kg)	2.10	2.93	3.48	0.64
% Lamb Mortality at Birth	0	0	0	0
% Lamb Mortality till Weaning	0	20.00	0	0
Sex Indication % Male	100.0	80.0	50	0

Table 7: Data on Reproductive Performance of WAD Ewes Fed RES-Based Diets
Means along the same row with identical superscripts are not significant.

6. Conclusion

RES incorporation into the diets of sheep improved nutrients intake and digestibility. This is because the intake of more basal diet (grass) was stimulated. The net effect is the improved nutrient balance as shown by nitrogen and energy balance (Ogunwole, 2004), which improved with the increasing inclusion of RES. Haematological studies on the pregnant ewes fed RES-based diets showed that in early pregnancy, all ewes exhibited gross decline in their blood parameters which could necessary not be due to nutritional inadequacy but probably physiological adjustment in early pregnancy or disease of low morbidity – the blood picture could thus be subclinical manifestation of such. In late pregnancy, all animals tended to recover from their erstwhile declined blood condition showing that all diets were capable of restoring blood condition with animals on diet C followed by animals on diets A and B respectively in the order of their improvement in blood conditions.

There were improved overall performances of animals with increasing inclusion of RES. However, the improvement observed was only numerical but not statistically significant. All dietary treatments sustained pregnancy with no reported case of pregnancy toxemia, a common occurrence as a result of nutritional inadequacy during pregnancy. Therefore, RES could suitably replace GNC in the diets of pregnant ewes.

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