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Dry Matter Intake and Milk Yield of Lactating West African Dwarf Ewes Fed RES-Based Diets

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Abstract:
Twelve WAD ewes weighing 18.50±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 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. Milk samples were collected on days 1 – 5 (colostrums) and from week 2 to week 13. Milk samples were collected and stored without preservative in a freezing cabinet until required for analyses. Parameters measured and recorded were: Dry matter intake, Intake performance, Weight changes, Milk yield, Estimated weekly yield and milk yield per stage of lactation.
Treatment effects on DMI (g/BWkg$^{0.75}$/day) in late lactation (88.77, 90.58 and 99.10 for ewes on treatment A, B and C respectively) were significant ($p<0.05$). Mean milk yield (kg) for the entire lactation period of 13 weeks (29.60±1.70, 34.50±4.70 and 41.60±10.90 for ewes on treatment A, B and C respectively) did not show a significant treatment effect. Colostrums were characterized by higher values in their contents of milk protein, energy and butter fat than mature milk. There were positive correlations ($p<0.05$) between total solids with milk energy (r=0.82, 0.95 and 0.88 for diets A, B and C respectively) and milk proteins with butterfat (r=0.44, 0.67 and 0.63 for diets A, B and C respectively) for ewes fed all diets. Variations observed for the efficiency of energy utilization for milk production (%) (20.88±0.46, 19.01±1.92 and 23.51±4.98) and efficiency of protein utilization for milk production (%) (17.48±0.27, 17.77±2.08 and 19.82±4.70) for animals on treatments A, B and C, were not significant.
RES incorporation in the diets of sheep supported pregnancy and lactation without any obvious adverse effect. Therefore, RES could suitably replace such expensive conventional feedstuff like GNC in the diets of WAd sheep and its use as livestock feedstuff will reduce health hazard and stench associated with it as an environmental pollutant.

Keywords: *Rumen epithelial scrapings, groundnut cake, replacement, diet, lactation*

1. Introduction

Growth in human population coupled with the scarcity of resources to meet the demands of the population has been the major challenge in developing countries. Increasing demand for animal protein and the ever-increasing competition for land resources calls for major structural changes in the agricultural sector, which is the major occupation, subsistence and income in the tropics (Chukwuka *et al.,* 2005). Opara *et al.,* (2005) noted that the threat of land degradation, rising demand in animal products should be met by an increase in animal productivity and by further increase in animal numbers, which means increase in production per animal through changes in animal genotypes, better feeding and management.

Furthermore, it is expected that as the human population continues to increase, the demand for food will also increase. Therefore, most of the fertile land presently used as range will be cropped. At present, there is a considerable under-utilization of a vast amount of non-conventional feed resources, including the waste materials generated from animal production and processing of food for human consumption (Manhadevan, 1981). Adegbola (1976) had earlier drawn attention to a general lack of awareness of the possible uses of crop residues and other agro-industrial by-products for animal feeding. Wilson and Brigstocke (1981) suggested that the cause of this situation was due to lack of information on their compositions and nutritive values, possible variations in composition, logistics, problems of availability, seasonality of supply and need for transport and processing. Prevention of environmental pollution is a global phenomenon at present (Falaye, 1988). This is particularly relevant for the perpetual sustenance of man and other living stock on earth. The rapid rate of urbanization, coupled with intensive food production and processing of wastes, are believed to be parts of the main contributors to environmental depletion. Within the European Economic Community (EEC) for example, farm animals' effluents have been identified as a major source of nitrate pollution of water systems, necessitating the issuance of Council Directive 91/670 EEC (1991).

Given this situation, rations could be made or supplemented with suitable concentrates developed from crop residues, animal wastes or other wastes from human agricultural activities, to avoid costly losses in animal production. One of the most limiting factors in feeding crop residues and by-products however, is their generally low protein contents (FAO, 1980). However, by-products from abattoirs could be profitably used to supply non-protein nitrogen and/or crude protein in such by-products-based feeds. There have been considerable interests in recent years, in feeding slaughterhouse by-products (SHBP), which is also an animal waste, to livestock as a protein substitute to replace other expensive protein sources. SHBP are materials from abbatoirs that are not sold directly as food (Gracey, 1986). SHBP abound in all major abattoirs in cities and towns. Wastes from such slaughterhouses like rumen contents, blood, meatscraps, bones, hairs, feathers, hooves, among others constitute serious environmental menace where such abattoirs are located.

Rumen epithelial scrapings (RES) is obtained from processing of the fore-stomach offal of slaughtered ruminants. Available report (Fajemisin, 2002) indicated that an average of 600g of properly dried RES could be obtained from adult cattle when slaughtered and processed for meat. In the year 2004, 82,612 metric tonnes of RES was produced from 137,687 heads of cattle slaughtered in Oyo State alone. Presently, no use has been found for this particular bi-product, if it left to rot and therefore, constitute environmental pollutant. One of the ways of ensuring sustainability in livestock production is to make valuable use of this bi-product. More so, those animals are slaughtered daily all year round and such wastes from slaughtering when found suitable could be used for feeding animals throughout the year.

Research into the means of utilising 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 teeming poor women involved in its processing. The development of a practical urban waste-based feeds and supplements that could either be marketed as a commercial ruminant ration, cheap enough even for the peasant farmer to buy and useful enough to encourage "new comers" to venture into livestock endeavour. Apart from the above, it will also help to solve the perennial seasonal availability of forage consequent upon increasing alternative uses of land, predicated by unbridled population and urban growth. Isah (2001) and Fajemisin (2002) already evaluated the use of RES and RES-based diet in goat production. However, no other known work has so far been done on its utilisation in other livestock especially, in supporting growth, pregnancy and lactation in small ruminants.

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^o and 9^o North of the equator and 4^o – 6^o East of Greenwich meridian, within the South-Western region of Nigeria. The climate is characterized by fairly high temperature of 36.00±4.00^{o}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 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	100.00	100.00	100.00

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 feed 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.

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 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.

2.5. Nutrient Digestibility and Utilization

In the last five day of feeding trial, the experimental animals were transferred into individual metabolic cages to facilitate collection of urine and faeces following 7 days of physiological adjustment to the cages. 10% of the faecal droppings was collected per day and preserved for further analysis by oven drying at 65^{o}C for 3- 5 days.

2.6. Collection of Milk

Milk samples were collected on days 1 – 5 (Colostrum) and from week 2 to week 13 of lactation. The milk samples were separately stored without preservative in labelled plastic bottles with lids and kept in a freezing cabinet until required for analyses.

2.7. Analytical Procedure

Milk samples were analysed for their contents of total solids, butterfat, crude protein, lactose, calcium and phosphorus. Milk fat was estimated by Gerber method (British Standard Institution, 1955). Total solid was determined by drying a known weight of milk at 105^{o}C for 24hours. Lactose was estimated by Barnett and Tawab's method (1957) as modified by Marrier and Boulet (1959). SNF was determined as the difference between total solids and butterfat, while milk energy Y (MJ/kg) was computed using the multiple regression equation:

$$Y = 0.386F + 0.205SNF - 0.236 \quad \text{(MAFF, 1975)}$$

Where F and SNF represent percentages of fat and Solid Non-Fat respectively.

Elemental concentrations were determined after wet digestion of samples with a mixture of perchloric acid and nitric acid (Ratio 1:4). Calcium was estimated with a Perkin-Elmer atomic absorption spectrometer model 250. Phosphorus was estimated as phosphovanadomolybdate (AOAC, 1980) and the yellow colour so developed was measured spectrophotometrically at 425nm.

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. Estimation of Milk Yield

Assessment of milk yield started 48hours after lactation to enable lambs suckle colostrums. Lambs were kept separately from ewes and were only allowed together at periods of suckling. Milk production of the ewes were estimated by the indirect method of weighing lambs before and after suckling, using a sensitive weighing balance thrice daily.

2.9. 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. Results and Discussions

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 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
Zinc (ppm)	48.19
Copper (ppm)	6.43
Iron (ppm)	135
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) 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 and Babayemi, (2010), Bawala *et al.,* (2007) 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 shrimpwaste. 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. Ola and Adeogun 2001; Isah, 2001; Isah and Babayemi 2010; Bawala *et al* 2007, Ogunwole *et al* 2011a, Ogunwole *et al* 2011b

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

Table 4: Chemical Composition of Other Ingredients Used in the Formulation of Experimental Diets

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 $BW^{0.75}$/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.

Treatments	Daily DMI		Daily Total DMI (g)	Total DMI	Av. Intake (g/day)		$BW^{0.75}$	CI(%)
	Conc(g)	Grass(g)		% BW	Conc(g)	Grass(g)	Total DMI	TDMI
	Pre-Pregnancy							
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 Pregnancy							
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
C	552.40	527.60	1080.00	5.00	52.57	55.14	107.71	51.19
SE	95.37	38.33	6.40	0.18	2.37	1.75	3.57	1.32
	Mid Pregnancy							
A	546.00	368.30	932.30	4.52	37.96	58.46	96.42	60.60
B	664.00	443.50	1107.50	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 Pregnancy							
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	1002.20	3.63	40.83	42.22	83.05	50.90

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 Furthermore, higher intake of grass could also be the result of stimulating effect associated with the level of RES supplementation in the diet which might induce higher levels of grass intake observed in diet C (Bawala *et al*., 2007). 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 ($p<0.05$). EL-Toum (2005), Rafiq *et al* (2006), Idris *et al* 2011, Uweche, 2000. 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).

3.1. Intake Performance

The proximate composition of grass (*Panicum maximum*) and the concentrate supplements are already presented on Table 2. Dry matter intake (DMI) at early and late lactation are as presented on Table 7. Average Total DMI (g/day) increased gradually from average values of 788.75, 946.25 and 1027.00 in early lactation to 802.00, 938.25 and 1042.67 in late lactation for animals on diets A, B and C respectively. Dietary effects on Total DMI were significant ($p<0.05$) in late lactation. At both stages of lactation, RES inclusion enhanced ($p<0.05$) intake of grass while concentrate intake only varied. DMI, when expressed on the basis of metabolic weight improved significantly ($p<0.05$) with increasing inclusion of RES in late lactation. DMI as a percentage of animal live weight varied between 4.03 and 4.46. The DMI of animals on various dietary treatment seemed to have been satisfied as the voluntary DMI were within range 3 – 5% live-weight specified to be adequate for maintenance and production in sheep (ARC, 1985; Steele, 1996).

Treatments	**A**	**B**	**C**	**SE**
Early Lactation				
Grass	305.50b	381.25b	494.00a	33.54
Concentrate	483.25	565	533	30.17
Total Dry Matter Intake	788.75	946.25	1027	58.52
DMI (g/dayBWkg0.75)	84.82	88.7	95.9	4.12
DM/LW (%)	4.05	4.03	4.36	0.21
Late Lactation				
Grass	320.00b	381.50b	511.33a	38.63
Concentrate	482.5	558.75	531.33	29.76
Total Dry Matter Intake	802.50b	940.25ba	1042.66a	62.21
DMI (g/daykgBW0.75)	88.77b	90.58ba	99.10a	2.93
DM/LW (%)	4.28	4.16	4.46	0.12

Table 6: Dry Matter Intake of Ewes during Lactation (g/day)
Means along the Same Row with Identical Superscripts Are Not Significant

3.2. Weights Changes of Animals during Lactation

Report (Table 6) suggested that during lactation, mutation deserves more attention because the female encounters different nutritional needs. In the first week, post-partum, the ewe has a negative energy balance because milk production is increasing and intake has not yet reached its potential, thus usually mobilizing the body reserves. Whereas, in the second situation the energy balance is zero as the milk production is already declining and females have reached the peak dry matter intake. In the third situation, the energy balance is positive and the body reserves are replenished.

Resende *et al* 2008, Tedeschi *et al*, 2010, (others) affirmed that weight loss in early lactation is a normal event during the first above mentioned situation when a negative balance energy occurs, mobilizing adipose tissue and even muscle tissue reserves. However, special attention should be paid to the negative energy balance as it can adversely affect milk production, lamb growth and subsequent reproductive performance, especially when working with reproductive programme aiming at more than one calving year. (NRC, 2007)

3.3. Milk Yield of WAD Ewes Fed RES-Based Diets

Estimated daily yield of milk in weeks of lactation for animals on treatment A, B and C is shown on Table 8. The yields reduced gradually with weeks of lactation. Yields varied between 155g/day in week 13 to 791g/day in week 2 of lactation. Treatments effects on the variation in obtained yields (g/day) for each week of lactation were not significantly different.

Weeks of Lactation	**A**	**B**	**C**	**SE**
Early Lactation				
Week 1	542.00	489.00	677.00	49.82
Week 2	639.00	720.00	791.00	50.44
Week 3	563.00	541.00	580.00	62.04
Week 4	408.00	532.00	541.00	63.85
Mid Lactation				
Week 5	417.00	456.00	395.00	51.29
Week 6	260.00	417.00	599.00	59.51
Week 7	242.00	372.00	517.00	67.21

Weeks of Lactation	A	B	C	SE
Week 8	286.00	286.00	341.00	40.07
Late Lactation				
Week 9	191.00	295.00	380.00	43.90
Week 10	196.00	253.00	312.00	25.60
Week 11	151.00	224.00	295.00	25.51
Week 12	180.00	193.00	258.00	16.78
Week 13	155.00	161.00	233.00	17.40

Table 7: Estimated Weekly Yields of Milk of Ewes Fed RES-Based Diets (G/Day)
Mean along the Same Row with Identical Superscripts Are Not Significant

Overall total mean milk yield (kg) for the entire lactation period of 13 weeks were 29.60±1.70, 34.50±4.70 and 41.60±10.90 for treatments A, B and C respectively and variations observed were not significant. Maximum daily milk production was attained in the second week (for about 14 days) of lactation for animals on all treatments. This implies a characteristic rapid increase in milk yield from parturition to attain a peak of production. Adu (1975) obtain similar pattern for WAd ewes. In Cameroon Blackbelly dwarf, daily peak milk production of 0.50kg was attained at week 4 of lactation (Njwe and Manjeli, 1990). However, Coombe *et al*., (1960) reported that milk output reached peak at 10 to 20 days while Ricodeau and Denamur (1962) reported that Prealpes sheep attained milk production peak at day 25. The daily peak milk production range of 0.639 to 0.791kg attained by WAd ewes in this study compare favourably with 0.7kg peak production obtained for Merino sheep (Bonsma, 1929) and about 0.6kg for WAd ewes (Adu, 1975) but higher than 0.5kg peak production value obtained for Cameroon Blackbelly (Njwe and Manjeli, 1990). This value is however low compared to 1.25 litres production per day with Prealpes sheep (Ricordeau and Denamur, 1962).

The total milk yield (i.e. 29.60 41.60kg) in lactation period of 91 days here compare favourably with the yield of 28 – 42kg by Cameroon Blackbelly sheep during a lactation period of 96 days. However, this value is low compared with production of Ossimi and Rahmani sheep (48-53kg) (Shera-feldin and Mostager, 1961) in a lactation period of 84 days and 100 – 150kg by Awassi sheep in a period of 160 days (Koseoglu and Aytug, 1961). This observation underscores the earlier assertion by other workers (Adu, 1975; Adeleye, 1980; Owens, 1981) that WAD ewes are not milk sheep.

Observed numerical increase in the yield of milk agrees with observation in dairy cow (Santo *et al*.,1998) that when a high quality RUP source, such as fish meal replaced a low quality RUP source in a diet, there was often an increase in milk yield, confirming that dietary protein quality is the major factor determining whether RUP improves lactation performance. Lack of significant increment here could also be due to effects of RUP from other ingredients used in the formulation of the concentrate diets, which could have contributed varying levels of RUP. There was a positive but non-significant correlation between birth weights of the lambs (r=0.489) and milk production of ewes. Also correlation between ewes live-weight closest to lambing and total milk yield in the first six weeks was positive (r= 0.75, 0.66 and 0.48 for diets A, B and C respectively) but not significant for all dietary treatments.

Stage of Lactation	A	B	C
Early	538.00±43.00a	571.00±82.00a	6652.00±143.00a
Mid	301.00±07.00b	383.00±72.00ab	463.00±16.00ab
Late	175.00±14.00c	225.00±15.00b	296.00±69.00b

Table 8: Milk Yield of Wad Ewes Fed RES-Based Diets in Stages of Lactation (G/Day).
Means Along The Same Column With Identical Superscripts Are Not Significant.

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