

1 Variations in liveweight gains, milk yield and composition of Red Sokoto goats fed crop-
2 residue based supplements in the subhumid zone of Nigeria

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22 RUNNING TITLE: VARIATIONS IN WEIGHT GAIN, MILK YIELD AND COMPOSITION OF RED SOKOTO GOATS

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1 Abstract

2 Variations in weight gain, milk yield, milk composition, nutrient intake and digestibility of Red
3 Sokoto goats supplemented with crop-residue based rations during the long-dry period were
4 investigated. Ration A, the conventional concentrate ration, was used as the positive control,
5 Rations B and C were the two crop-residue test diets, while Ration D the unsupplemented
6 treatment, was used as the negative control. Each of the supplementation rations was fed at 1
7 and 2% of the goat's body weight (designated as 1A, 2A, 1B, 2B and 1C, 2C respectively). The
8 supplemented group of goats had significantly higher ($P<0.05$) dry matter (DM) and crude
9 protein (CP) intakes as well as nutrient digestibilities than the unsupplemented groups. DM
10 digestibility improved with supplementation by a range of 4.1 to 27.9%, while CP digestibility
11 improved by 17.1 to 42.2%, the highest value being in does on Ration A. It was evident that
12 supplementation significantly ($P<0.01$) influenced weight gains and milk yield of dams. Goats
13 on ration 2C recorded the highest average daily gains of 39.29 g/day while their counterparts
14 fed rations 1B and D lost 28.57 and 92.86 g/day respectively. Ration 1C which comprised
15 mainly of crop residue with much lesser protein levels than the concentrate ration, produced 54
16 kg of milk over a 90-day lactation period averaging 0.60 kg per day. Goats on Ration D had
17 the shortest lactation length of 41 days and the least total and average daily milk yields of 10.2
18 and 0.25 kg respectively. Milk from does on ration 2A contained the highest percentages of fat
19 (6%), protein (6.33%), total solids (21.85%) and solids-not-fat (15.85%). Milk from goats on
20 ration D ranked least with respect to all parameters studied. It was concluded that the goats
21 made appreciable gains in the long dry season on crop-residue based diets that compared
22 favourably with the conventional concentrate rations. Ration C fed at 1% level was a good
23 supplementary feed package for increased live weight gains and milk production in Red Sokoto
24 goats.

25 Keywords: Red Sokoto goats, crop residue, supplementation, weight gains, milk yield, milk composition

1 1. Introduction

2 Between 40-100% of patients allergic to cow milk tolerate goat milk (Park, 1994). Goat milk
3 has been recommended as a substitute for those who suffer from allergies to cow milk or other
4 food sources (Van der Horst, 1976). Therefore, there is a growing awareness of the
5 importance of goats as a source of milk for man (Prakash and Jenness , 1968) and world-wide,
6 more people drink goat milk than milk from other species (Park and Chukwu , 1989). The
7 potential for increased use of goats as the most effective animals for milk production in many
8 developing countries is quite high. The Northern regions of Nigeria are concentrated with most
9 of the nation's ruminant livestock. However, these areas are characterised by a long and
10 pronounced dry season (6-9 months), and this often causes serious shortage of feed for the
11 ruminants. The problem of dry season livestock feeding in particular, has directed research
12 efforts towards harnessing and enhancing the utilization of arable by-products and crop
13 residues. The abundance of crop residues makes them cheap sources of nutrients for
14 ruminants. Nevertheless, they are generally low in nutrients (Nicholson, 1984). Various
15 strategies have been adopted to improve their nutrients and utilisation (Leng, 1990). One of
16 such is by judicious supplementation to provide the most limiting nutrients (Preston, 1982;
17 Alhassan, 1988). However, appropriate feeding packages for improved liveweight gains and
18 milk production to guide small ruminant producers in Nigeria have not been developed. Also,
19 relevant information on cheap, alternative sources of feeds crucial to dry season feeding in
20 Nigeria's subhumid zone has not been passed on to small ruminant producers. Therefore, this
21 study was undertaken to determine the nutrient composition, intakes, digestibilities and
22 affordability of some locally available crop residue feed resources and their impact on
23 liveweight gain, milk yield and composition of Red Sokoto goats in the sub-humid zone of
24 Nigeria, in comparison with the conventional concentrate supplementation ration.

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1 2. Materials and methods

2 2.1 Location and management of experimental animals

3 The experiments were conducted during the dry seasons (between October and March) in the
4 Experimental Unit of the Small Ruminant Research Programme of the National Animal
5 Production Research Institute, Shika, Zaria, Nigeria. Shika falls between latitudes 11 and 12°N
6 and between longitudes 7 and 8 °E, with an altitude of 640m above sea level. Shika is located
7 within the Northern Guinea Savannah Zone with an average annual rainfall and temperature of
8 1,107 mm and 24.4°C respectively. The seasonal distribution of the annual rainfall is
9 approximately 0.1% (11.0 mm) in the late-dry season (January-March), 25.8% (285.6 mm) in
10 the early-wet season (April-June), 69.6% (770.4 mm) in the late-wet season (July-September)
11 and 4.5 % (49.8 mm) in the early dry season (October-December). The animals were routinely
12 dewormed with anthelmintic drugs and dipped in an acaricide (Asuntol) solution against
13 ectoparasites. The animals were housed in well-ventilated pens during the night.

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15 2.2 Digestibility trial: Twenty-eight adult Red Sokoto does ranging between 24.6 and 26.4 kg
16 were used for this experiment. The animals were balanced for weight and blocked into seven
17 groups with four animals per group. The component ingredients in the different rations are
18 shown in Table 1. Each doe was individually offered its appropriate corresponding ration to
19 evaluate the digestibility of the diets. The study comprised a two-week preliminary period of
20 realimentation and adjustment, and one week of sample collection. The animals were housed
21 in individual metabolism cages with facilities for separate collection of faeces and urine. The
22 animals were weighed at the beginning and end of the study. Faeces were collected each
23 morning just before feeding. A sample of 10% of each daily faecal output was collected for
24 chemical analyses. Samples of the different rations fed were taken daily and bulked, from
25 which sub-samples were taken for laboratory analysis. Also, samples of the individual feed

1 ingredients were analysed in the laboratory. Water was made available to the animals ad
2 libitum. The inventory, abundance and palatability of the plant species in the grazed paddock
3 was conducted as described by Lakpini et al. (1997).

4

5 2.3 Milk yield and composition: Measurements for milk yield and composition commenced
6 from day 7 postpartum to allow kids access to all their dams' colostrum. Thereafter, the kids
7 were separated from their dams and moved to the bucket-fed unit. The two halves of the udder
8 of each lactating doe were hand-milked early in the morning and in the evenings. The quantity
9 of milk collected at each milking was recorded and does were monitored from a week after
10 delivery to the last day of milk let-down when the total lactation length was recorded. Daily milk
11 yield was bulked from Weeks 2 to 6 for laboratory analysis to determine milk composition using
12 AOAC (1980) procedures.

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14 2.4 Laboratory analyses: Proximate analyses of feed and faecal samples were carried out by
15 the AOAC (1980) methods. Dry matter of samples was determined by drying the samples in an
16 oven at 105°C for 48 hours. Nitrogen determination was by the Micro Kjeldahl method, while
17 the Soxhlet extraction procedure was used for ether extraction. Crude fibre was determined by
18 alternate refluxing with weak solutions of H₂SO₄ and KOH. The detergent fibre fractions
19 (Neutral detergent fibre, acid detergent fibre and lignin) were determined according to Goering
20 and Van Soest (1970). Dry matter intake (DMI) was determined using the following equation:

21 $DMI (g/day) = \%DM/100 \times \text{feed intake} .$

22 Dry matter digestibility (DMD (%)) was calculated as:

23 $100 - [DM \text{ output } (g)/DM \text{ intake } (g)] \times 100.$

24 The other digestibilities were calculated as above.

1 2.5 Statistical analysis: Differences in feed intake, digestibility, liveweight gain, milk yield and
2 composition were analysed using the Generalised Linear Models Procedure (PROC GLM) of
3 SAS (1987). The effect of treatment was tested and significant differences between treatment
4 means established by Duncan's Multiple Range Test.

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6 3. Results

7 The chemical composition of the individual feed ingredients and the experimental diets are
8 shown in Tables 2 and 3 respectively. Table 3 shows that all the rations had high dry matter
9 (DM) contents with a mean value of about 95%. Ration A had the highest crude protein (CP)
10 followed by Rations B and C , respectively. The CP value of the dry season-grazed pastures
11 was the lowest. The least ash content value was obtained in Ration D : hay (8.47%) and grazed
12 pasture (7.02%). The highest ash content was obtained in Ration A. Ration A also had the
13 highest ether extract (EE) and Ration D, the least. Acid detergent fibre (ADF), neutral
14 detergent fibre (NDF) and lignin contents were least in Ration A . Ration D on the other hand,
15 contained the highest ADF, NDF and lignin values. The calculated chemical analysis of the
16 experimental rations (Table 3) revealed that Ration A had a CP content of 17.05% while the
17 test rations B and C had 9.82 and 10.85%, respectively. Ration A also had a metabolisable
18 energy (ME) of 11.17 MJ/kg DM, while Rations B and C had 10.29 and 10.17 MJ/kg DM
19 respectively. Table 4 shows the DM and CP intakes and digestibilities of the nutrients. The
20 Table shows that generally, the supplemented groups had significantly higher ($P<0.05$) DM
21 and CP intakes and digestibilities than the unsupplemented group except animals on Ration B
22 that had similar values to the unsupplemented group. It was also evident that increasing the
23 level of supplementation also resulted in significantly ($P<0.05$) increased DM and CP intakes. It
24 was also observed that supplementation increased the digestibility of all the nutrients. However,
25 animals on Ration B recorded very poor digestibility values and their counterparts in the

1 unsupplemented group had the least. Even though the digestibility of nutrients decreased with
2 increasing levels of supplementation, these decreases were not significant ($P>0.05$). Ration 1A
3 (the conventional concentrate at 1% of body weight) gave the highest digestibility values. A
4 comparison of the unsupplemented animals with all the other treatment groups reveals that
5 DM digestibility improved by a range of 4.1 to 27.9% and CP digestibility by 17.1 to 42.2%, the
6 highest being in animals on Ration A at 1% level. Similar improvements trends were also
7 noticeable for neutral detergent fibre (NDF) and acid detergent fibre (ADF). A simple economic
8 analysis (Table 4) revealed that the conventional concentrate feed was the most expensive for
9 supplementation particularly, at the 2% level (4.42 naira per animal per day). Of the two tested
10 crop-residue rations, Ration 1B was significantly cheaper ($P<0.05$) than Rations 2B and 2C,
11 but similar to Ration 1C.

12 The effect of ration supplementation on weight gains and average daily gains of the
13 dams are depicted on Table 5. It shows that by the end of the study, dams fed rations 1B and
14 D lost weights (2.0 and 6.5 Kg, mean loss of 28.57 and 92.86g/day respectively), while those
15 on ration 2C gained the highest weight of 2.75 Kg, mean gain of 39.29 g/day. This was
16 followed by rations 2A and 1C with 1.5 Kg weight gain each, mean gain of 21.43 g/day.

17 Table 6 shows results of the lactation length, total milk yield and average daily milk
18 yield of does on different rations. Dams on Rations 1A and 2A lactated for 80 and 88 days,
19 gave total milk yields of 38.4 and 54.5 kg and averaging 0.48 and 0.62 kg/day, respectively.
20 Interestingly, Ration 1C which comprised of mainly crop residue with much lesser protein
21 levels produced 54 kg of milk over a 90-day lactation length averaging 0.60 kg per day. At the
22 other extreme, dams that fed on the negative control ration D comprising of *Digitaria* hay and
23 natural grazed pastures, had the shortest lactation length and therefore least total and average
24 daily milk yields (Table 6).

1 Results of the milk composition of Red Sokoto does is shown in Table 7. It was evident
2 that in absolute terms, milk from does on Ration 2A contained the highest percentages of fat,
3 protein, total solids and SNF. As expected, milk from does on the negative control ration
4 ranked least with respect to all the parameters studied. Figure 1 shows that all phenotypic
5 correlations between the milk components (total solids, crude protein, fat and solids -not-fat)
6 were positive, and the highest correlation of 0.84 was between total solids and crude protein
7 (excluding the perfect correlation of 1.00 between a variable and itself). This indicates a very
8 strong relationship between these components in which there is a corresponding increase in
9 crude protein as total solids percentage increases and vice-versa. However, between solids-
10 not-fat and fat, though positive, was not significant (0.38).

11

12 4. Discussion

13 The quantity and type of ingredients used in formulating the rations influenced their chemical
14 compositions. In Ration A, the inclusion of wheat offal and cotton seed cake boosted the
15 protein level of the ration giving it a value of 17.19%. This value is higher than the
16 recommended CP level of 15% for optimum maintenance of production by Nuru (1985) and 8.9
17 – 16.0% by NRC (1975). The metabolisable energy (ME) value of Ration A (11.17 MJ/kg DM)
18 is also higher than the 9.5 MJ/kg DM recommended for maintenance by INRA (1988), but
19 lower than the latter's recommended value for pregnant and lactating goats. Rations B and C
20 had similar CP and ME values indicating that they are isocaloric and isonitrogenous rations.
21 The preponderance of crop residues in Rations B and C was responsible for their high crude
22 fibre and lignin levels. The current study showed that inspite of Rations B and C being
23 isocaloric and isonitrogenous, animals on Ration C had better intakes and digestibilities than
24 those on Ration B, possibly due to the low palatability, hence low voluntary intake, and poor
25 digestibility of Ration B.

1 The observed higher digestibilities of DM, CP, NDF and ADF at 1% level (rations 1A,
2 1B, 1C) in comparison to 2% level (rations 2A, 2B, 2C) can be attributed to the higher feed
3 intake at the 2% level of inclusion. It has been established that higher feed intake results in a
4 faster rate of passage of digesta from the reticulo-rumen (Swan and Lamming, 1967). This
5 does not allow for effective degradation, hence lowering the digestibility of feed. Increasing the
6 level of crop residue in the diet also increased the amount of lignin, which depressed the
7 digestibility of the ration (McDonald et al., 1988), because the rate of microbial colonisation of
8 a feed with high fibre content is comparatively lower (Silva and Orskov, 1988). The poor intake
9 and digestibility values obtained for the unsupplemented animals is due to the fact that Ra tion
10 D had crude protein levels that are below the recommended minimum values for maintenance.
11 This shows that there is the need for dry season supplementation in goats because the
12 available feeds at that time are limiting in crude protein.

13 Of the two tested rations, Ration C seemed to have produced better intakes and
14 digestibilities in the animals, possibly due to the composition of the rations. It contained maize
15 offal which has very low fibre content (Alawa and Umunna, 1993), groundnut haulms which
16 have been demonstrated to be better quality roughages than *Digitaria smutsii* hay and contain
17 adequate protein to maintain ruminants without any form of supplementation during the periods
18 of feed scarcity (Ikhatua and Adu, 1984). The groundnut shells fed to the animals were also
19 crushed before inclusion into the ration as suggested by Alawa and Umunna (1993). This must
20 have aided their consumption and digestibility. Even though Ration B contained groundnut
21 haulms, the combination of Guinea corn bran and cowpea h usk which had low crude protein
22 percentages, must have reduced the intake and digestibility of the ration. Alhassan et al.
23 (1984) observed lower digestibility values in sheep and goats (48.8 and 56.3% respectively)
24 compared with cattle (73.6%) when they fed them cowpea vines. This might imply that cattle
25 do better on cowpea residues than small ruminants. From the economic analysis, the high cost

1 of the conventional concentrate ration shows that it is beyond the reach of a typical smallholder
2 goat farmer, whereas the crop-residue based rations seem quite affordable. Even though
3 Ration B had the least cost, it was obvious that it had lower intake and digestibility compared
4 to Ration C, indicating in essence, that Ration C had a better efficiency of utilisation

5 The effects of various crop residues on feed intake, liveweight gains and
6 growth performance of ruminants have been reported by Adu and Lakpini (1983b) and Ikhatua
7 and Adu (1984). Adu and Lakpini (1983b) obtained liveweight gains of 90.2 g per day in
8 Yankasa lambs fed sole diet of unchopped groundnut haulms. In the study by Ikhatua and Adu
9 (1984), supplementation of groundnut haulms with concentrate further enhanced intake and
10 performance of the animals. Similar effects of supplementation have been observed in this
11 study.

12 The efficiency of conversion of feed to meat as reflected by liveweight gains, was
13 highest in does fed ration 2C and lowest in those fed rations D and 1B. The better weight gains
14 of does fed ration 2C over those fed the conventional concentrate ration (1A and 2A) indicate
15 that does in the latter groups converted more of their feed to milk rather than meat as
16 evidenced by their higher milk yield values. The observed liveweight gains in this study were
17 lower than those reported by Adeneye and Oyenuga (1976), Adu and Lakpini (1983a, 1983b)
18 and Ikhatua and Adu (1984). However, they agreed with the report of Adebowale (1989) who
19 included 40% untreated maize cobs in the diets of goats and obtained 24.9 g/day weight gain.
20 The weight losses observed in does fed rations 1B and D could be attributed to the low
21 palatability, low intake and poor digestibility of the feeds.

22 The milk yield, lactation length and milk composition values in the present study were
23 in agreement with those of other experiments with goats reported by Prakash and Jenness
24 (1968), Ramos and Juarez (1981) and Sibanda et al. (1990). This study also confirmed that
25 the milk yield of goats could be improved by supplementing their pasture diets with some

1 concentrates (Garmo, 1986). The observed values of total milk yield, lactation length and
2 average daily yield in goats fed rations 2A and 1C were higher than those reported by Adu et
3 al. (1979), Akinsoyinu et al. (1982) and Ehoche and Buvanendran (1983). This increase in milk
4 yield may be due to improvement as a result of selection over the years within the Red Sokoto
5 breed. The inference that can be drawn from this observation is that feeding lactating does on
6 ration 1C irrespective of the fact that it was a mainly crop residue ration, gave just as good a
7 result in terms of average daily and total milk yields, as full concentrate rations. This holds
8 hope for smallholders interested in improving the milk yield of their Red Sokoto dams without
9 necessarily embarking on an expensive concentrate ration. It was observed that although the
10 animals on rations B and D had diets with high crude fibre (CF), ADF and NDF, the fat levels of
11 their milk compositions were the least. This did not conform to the reports by Sachdeva et al.
12 (1974) and Abdel-Rahman and Mehaia (1996), possibly because the diets in this study were
13 not as palatable as the other diets and therefore were not consumed well enough.

14 The significantly strong and positive correlations ($P < 0.001$) between the percentages
15 of milk crude protein, total solids, fat and solids-not-fat obtained in this study agreed with the
16 findings of Mba et al. (1975), Akinsoyinu et al. (1982), Ehoche and Buvanendran (1983) (for fat
17 and protein), Fajemisin and Mohammed (1990) (unpublished paper) and Malau-Aduli and
18 Anlade (2001, 2002). The observed highly positive correlations between the milk components
19 will aid genetic improvement by incorporating these traits in a selection index.

20 In conclusion, goats are able to subsist and make appreciable gains even in the long dry
21 seasons of the sub-humid zone of Nigeria on crop-residue based diets. This study has also
22 demonstrated that ration C elicited as much favourable response in the liveweight gain, milk
23 yield and composition of Red Sokoto goats as the conventional concentrate ration A, which
24 may be too expensive for the local farmer to purchase. Furthermore, Ration C was a better
25 package than Ration B and is therefore recommended at 1% level of inclusion, to small

1 ruminant farmers due to its high intake and digestibility as well as its affordability than at 2%
2 level of inclusion.

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Table 1. Component ingredients in the different rations

Ration	Ingredients	% inclusion	Remarks
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1A + Basal diet	Maize Wheat offal Cottonseed cake Bone meal Salt	40 35 20 3 2	Positive control (conventional concentrate) offered at 1% of body weight
2A + Basal diet	✓	✓	Positive control (conventional concentrate) offered at 2% of body weight
1B + Basal diet	Guinea-corn bran Cowpea husk G/Nut haulms Salt	39.5 30 30 0.5	Test Ration 1 offered at 1% of body weight
2B + Basal diet	✓	✓	Test Ration 1 offered at 2% of body weight
1C + Basal diet	Maize offal G/Nut shells G/Nut haulms Salt	49.5 20 30 0.5	Test Ration 2 offered at 1% of body weight
2C + Basal diet	✓	✓	Test Ration 2 offered at 2% of body weight
D (Basal Diet)	Digitaria hay and dry season-naturally grazed pasture	Ad libitum	Negative control (unsupplemented)

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14 Table 2. Chemical composition of the major feed ingredients (DM basis) (%)

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Feedstuff	DM	CP	CF	Ash	EE	NFE
Maize	90.73	9.56	2.20	9.67	4.05	74.52
Wheat offal	87.60	16.90	11.30	6.40	3.80	61.60
Cottonseed cake	93.60	29.94	23.50	5.16	5.76	35.64
Bone meal	75.00	36.00	3.00	49.00	4.00	8.00
Guinea corn bran	93.33	7.60	24.80	6.95	3.01	59.90
Cowpea husks	91.41	7.10	33.40	7.14	0.65	58.91
Groundnut haulms	93.65	15.63	23.26	8.0	2.43	51.0
Maize offal	89.07	10.08	1.5	0.8	1.7	60.30
Groundnut shells	96.05	5.90	31.8	8.5	1.31	50.3

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15 Table 3. Chemical composition of the experimental diets (dry matter basis) (%)

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Ration	DM	CP	Ash	EE	ADF	NDF	LIGNIN
Ration A	93.87	17.19	13.85	14.08	20.00	40.01	4.64
Ration B	94.97	9.54	10.55	10.43	38.10	68.42	8.94
Ration C	95.94	10.38	11.97	12.45	36.65	54.74	8.23
Ration D (Hay)	94.78	4.75	8.47	2.40	49.14	74.73	9.49
Ration D (dry season naturally grazed pastures)	96.26	2.76	7.02	0.78	50.29	80.27	11.5

1 Calculated analysis of the experimental rations

	Ration A	Ration B	Ration C
CP (%)	17.05	9.82	10.85
ME (MJ/kg DM)	11.17	10.29	10.17

2 The ME values of the experimental rations were calculated as per Alderman (1985) :
3 $ME (MJ/kg DM) = 11.78 + 0.00654CP + (0.000665EE)^2 - CF(0.00414EE) - 0.0118A$
4 where CP = Crude Protein, EE = Ether Extract, CF = Crude Fibre, A = Ash
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17 Table 4. Mean nutrient intake, apparent digestibility coefficients and cost of the experimental
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Ration	1A	2A	1B	2B	1C	2C	D	SEM
<u>Nutrient intake (kg/day)</u>								
DMI	0.24 ^b	0.47 ^a	0.21 ^{bc}	0.30 ^{ab}	0.23 ^b	0.42 ^a	0.15 ^c	± 0.02
CPI	0.044 ^a	0.087 ^a	0.012 ^b	0.017 ^b	0.032 ^a	0.072 ^a	0.009 ^b	± 0.01
<u>Apparent digestibility of nutrients (%)</u>								
DM	84.3 ^a	83.0 ^a	62.5 ^d	60.5 ^e	75.8 ^b	67.8 ^c	56.4 ^f	± 2.84
CP	90.6 ^a	89.2 ^a	69.5 ^d	65.5 ^e	82.7 ^b	78.1 ^c	48.4 ^f	± 3.07
NDF	69.5 ^a	66.6 ^b	62.1 ^{cd}	61.9 ^d	65.9 ^b	63.7 ^c	60.1 ^e	± 3.23
ADF	51.7 ^a	49.8 ^a	43.9 ^{bc}	42.8 ^c	46.1 ^b	44.4 ^{bc}	42.3 ^{bc}	± 5.01
<u>Economic analysis of the feeds (Naira)*</u>								
Cost of feed consumed per animal per day	2.19 ^b	4.42 ^a	0.50 ^e	1.06 ^d	0.83 ^{de}	1.55 ^c	-	± 0.15

a,b,c,d,e,f means within the same row bearing different superscript letters differ significantly (P<0 .05)
 Naira = Nigerian currency (100 kobo make 1 naira and current exchange rate is 1US\$ = 140 Naira)

Table 5. Effect of ration supplementation on weight gains of Red Sokoto does (± s.e.m)

Ration	Initial WT (Kg)	Final weight (Kg)	WT gain (Kg)	ADG (g/day)
1A	29.00	29.25 ^a	0.25 ^d	3.57 ^d
2A	27.50	29.00 ^a	1.50 ^b	21.43 ^b
1B	29.75	27.75 ^b	-2.00 ^e	-28.57 ^e
2B	28.75	29.75 ^a	1.00 ^c	14.28 ^c
1C	27.25	28.75 ^b	1.50 ^b	21.43 ^b
2C	26.75	29.50 ^a	2.75 ^a	39.29 ^a
D	27.25	20.75 ^c	-6.5 ^f	-92.86 ^f
± s.e.m	± 4.25	± 4.30	± 0.12	± 1.82

Column means bearing different superscripts differ from each other significantly (P<0.01)

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Table 6. Effect of ration supplementation on lactation length, total milk yield and average daily milk yield (± s.e.m.) in Red Sokoto does

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Ration	Lactation Length (days)	Total Milk Yield (Kg)	Ave. Daily Yield (Kg)
1A	80 ^a	38.4 ^b	0.48 ^b
2A	88 ^a	54.5 ^a	0.62 ^a
1B	48 ^c	12.9 ^d	0.27 ^d
2B	64 ^b	23.0 ^c	0.36 ^c
1C	90 ^a	54.0 ^a	0.60 ^a
2C	72 ^b	35.5 ^b	0.45 ^b
D	41 ^c	10.2 ^d	0.25 ^d
s.e.m.	± 4.7	± 3.3	± 0.03

Column means bearing different superscripts are significantly different (P<0.05)

Table 7. Effect of ration supplementation on the milk composition of Red Sokoto does (%) (± s.e.m.)

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Ration	Fat	Protein	SNF	Total solids	Ash
1A	5.66 ^a	6.00 ^a	15.75 ^a	21.41 ^a	0.81
2A	6.00 ^a	6.33 ^a	15.85 ^a	21.85 ^a	0.83
1B	3.50 ^d	3.67 ^b	10.75 ^c	14.25 ^c	0.76
2B	3.75 ^d	4.90 ^b	13.75 ^b	17.50 ^b	0.79
1C	4.33 ^c	6.00 ^a	15.66 ^a	19.99 ^a	0.80
2C	5.25 ^b	6.67 ^a	16.00 ^a	21.25 ^a	0.82
D	2.33 ^e	3.25 ^c	10.00 ^c	12.33 ^c	0.75
± s.e.m.	± 0.7	± 0.8	± 1.3	± 1.8	± 0.05

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Column means bearing different superscripts are significantly different (P<0.05)

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