
Influence of feeding frequency on changes in body measurements and carcass characteristics of Red Sokoto Goats

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Abstract

Changes in body measurements and carcass characteristics were studied in Red Sokoto goats raised for 108 days on three feeding regimes. Twenty one growing intact male goats with average weight of 8.70 ± 0.23 kg were randomly grouped into three, corresponding to the number of feeding (treatments) per day, viz, once OPD (08.00h), twice TPD (08.00h and 13.00h) and thrice HPD (08.00, 13.00, 18.00) in a completely randomized design. Each goat was offered grass, *Panicum maximum* and concentrate (17% CP and 3.97 ME, Mcal/kgDM) supplement in separate containers at daily rates of 0.70 and 0.50 kg/head/ day based on the number of feedings. Body weights and linear body measurements were taken weekly. Four representative goats were slaughtered at the close of the feeding periods to evaluate effect of level of feeding on carcass characteristics. Goats fed twice per day, TPD, had highest ($P < 0.05$) average weight gain (g/d) of 81.01, against 37.03 and 69.44 obtained for OPD and HPD fed goats. There were significant differences ($P < 0.05$) in the changes in body weight, length, chest girth, and height at withers values of goats as the trial progressed. Skeletal growth as represented by the height at withers HW was observed in all goats but more prominent and steady in OPD and TPD fed goats. Changes (cm) in HW of goats monitored in three stages of 36 days each of 108 day trial were: OPD goats; 3.50, 2.00, and 1.50; TPD goats, 1.00, 5.00 and 0.05; HPD goats, 6.00, 3.00 and 0.20. Regression of body measurements on changes in body weight ($P < 0.01$) showed that chest girth was best in predicting changes in body weight on account of its highest correlation ($r^2 = 0.77$). Similarly, TPD fed goats had highest ($P < 0.05$) dressing % (58.30), carcass weight (7.90kg), carcass condition score (2.50) and offal composition. Corresponding values of 47.48 and 55.70 %, 5.00 and 7.00kg, and 1.00 and 1.90 were obtained for OPD and HPD fed goats respectively. Therefore, feeding goats twice per day improved production, and could prevent waste of farmer's resources that is associated with higher number of feeding.

Key words: Feeding frequency, body measurement, carcass, goats.

Introduction

In Nigeria, the traditional goat rearing system consists of extensive and semi intensive herding. In these systems, goats are free to graze on natural pasture and kitchen residues with little or no concentrate supplementation. Poor general performance was evident as a consequence of malnutrition and undernourishment associated with the production systems. Hence, improved management system characterized by adequate nutrition is a requisite to high animal performance. Goonewardene *et al.* (2005) reported higher feed utilization in steers when feeds were offered in more than one installment per day; suggesting that animals could do better if fed adequately with good diet. Voluntary feed intake by ruminant is often influenced by the quality of feed offered with consistent feeding frequency (Devendra, 1987). There is lack of published information on the effects of feeding frequency on skeletal growth and carcass characteristics of local goat breeds in Nigeria. The present research investigated the effect of feeding frequency on performance, changes in the body measurements and the carcass characteristics of Red Sokoto goats, as part of general study on goat production system in Nigeria

Materials and Methods

Animal management and design

Twenty one yearling Red Sokoto (Maradi) intact bucks with average weight of 8.70 ± 0.23 kg were used in 108 days feeding trial at the Teaching and Research Farm of the University of

Agriculture, Abeokuta, Nigeria. The animals were randomly grouped into three corresponding to the number of feeding per day, viz, once (08.00h), twice (08.00h and 13.00h) and thrice (08.00, 13.00, 18.00) which represented the three treatments respectively, in a completely randomized design. Balancing for live weight of bucks in each group was done to minimize variations due to body weights.

Animals were fed basal diet of *Panicum maximum* grass supplemented with concentrate ration. The grass and the concentrate supplement offered in separate containers at daily rates of 0.70 and 0.50 kg/head either once, twice (two equal instalments) or thrice (three equal instalments)/day corresponding to the number of feeding per day respectively, were given following a one - month adjustment period in which the voluntary intake was assessed. The grass was cut at about 4 weeks of age with cutting height of 6cm above the ground level, chopped into smaller length of 2 cm to increase intake, and wilted before offering. Concentrate diet (17.15% CP and 3.97 ME Mcal/Kg DM) fed to the sheep contained: maize 32%, BDG 55%, GNC 10%, bone meal 1%, salt 1%, and mineral/vitamin premix 1%. Fresh clean water and trace mineralized salt blocks were provided to the animals *ad libitum*. Bucks were weighed weekly before feeding to monitor body weight changes throughout the 108-day experimental period.

Body measurement

In order to examine changes in body measurements the experimental period was

segmented into three trials of 36 days each. Body measurements and body condition scoring were done according to the procedures of De Boer *et al.* (1974) and Santucci and Maestrini (1985) respectively.

Carcass characteristics

At the end of the 108 days feeding trial, four representative bucks were slaughtered by Islamic rites to assess carcass characteristics. Prior to slaughtering, bucks were fasted overnight with free access to clean water and weighed (Owen and Norman, 1977). The animals were decapitated and blood was drained into a bucket and weighed. Skin, head and legs were removed according to the procedure of Okello *et al.* (1990). Carcass value was assessed on the scale 0-3 (Okello *et al.*, 1990) as follows: 0: Emaciated; 1: Lean carcass 2: Moderately fatty carcass; and 3: Full fatty Carcass. Carcasses were eviscerated, and the abdominal fats removed

(Payne, 1990). Thickness of brisket fat and longissimus dorsi muscle was also measured using Okello *et al.* (1990) method. Pearson Correlation model was used to examine the correlation between the carcass components and corresponding live weights of goat. Dressing percentage and empty body weight of the carcass were calculated, using Payne (1990) formulae.

Statistical analysis

Data collected from the investigated parameters were subjected to the analysis of variance in Completely Randomized Design using the procedure of SAS (2000).

Results

The dry matter content (%) of concentrate and *Panicum maximum* were 89.47 and 34.00 respectively (Table 1). Grass and concentrate ME contents (Mcal/kgDM) were 3.58 and 3.97 respectively. Being a cellulosic material, grass

Table 1: Chemical composition (%) of experimental diets

	Concentrate	<i>Panicum maximum</i>
Dry matter	89.47	34.00
Crude protein	17.15	9.06
Crude fat	3.68	1.92
Crude fibre	6.89	47.00
Ash	8.15	22.00
ME (Mcal/kgDM)	3.97	3.58
Neutral detergent fibre, NDF	41.24	53.69
Acid detergent fibre, ADF	18.37	40.34
Acid detergent lignin, ADL	6.31	3.14

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had higher content (%) of neutral detergent fibre, acid detergent fibre and acid detergent lignin (41.24, 18.37 and 6.31) respectively, than the concentrate.

Feed intake (grass and concentrate) of the experimental animals increased ($P < 0.05$) with the levels of feeding frequency with animals fed thrice per day (HPD) having highest value of 749.38 g/d (Table 2). Similarly, the feeding frequency significantly ($P < 0.05$) influenced the body weight changes of the goats. Animals fed twice per day (TPD) had ($P < 0.05$) highest average daily gain (81.01 g/d) and feed efficiency (129.47), while those on OPD had least value. Goats on OPD feeding regime showed decrease (-1.00cm) in chest girth, (CG), but increase in height at withers HW and body length, (BL) during the feeding period particularly in the early

part (Table 3). At the close of the first trial there was slight increase ($P > 0.05$) in the BL values of goats fed OPD and TPD (0.01 and 0.02 cm respectively) compared to higher ($P < 0.05$) value (1.00cm) observed for those fed HPD. In the last trial, all treatment groups exhibited positive changes (cm) but at a lower rate compared to the observation in the second stage. The chest girth had the highest ($P < 0.01$) correlation coefficient of $r = 0.77$ with live weight (Table 4). Starved live weights (kg) of goats on TPD (16.90) and HPD (15.84) were similar ($P > 0.05$), but different ($P < 0.05$) from 12.80 of OPD bucks. Carcass dressing percentage of TPD (46.75) and HPD (44.57) carcasses were statistically similar ($P > 0.05$), but higher ($P < 0.05$) than 39.06 recorded for OPD counterparts. Feeding frequency also significantly ($P < 0.05$) influenced

Table 2: Performance characteristics of Red Sokoto goats raised on three feeding regimes

Parameter	Treatments/Feeding frequency			SEM
	OPD	TPD	HPD	
Feed Consumption				
Feed intake (g/day)	453.29 ^b	713.20 ^a	749.38 ^a	25.20
Grass (g/day)	252.00 ^c	450.3 ^a	399.28 ^b	20.00
Concentrate (g/day)	201.29 ^c	262.9 ^b	350.10 ^a	34.12
Dry matter intake (g/day)	397.68 ^a	625.7 ^b	657.43 ^b	77.27
Dry matter intake (g/day/kg/Bw ^{0.75})	131.44 ^b	186.03 ^a	200.83 ^a	10.25
Body weight changes				
Initial live weight (kg)	8.98	8.63	8.50	0.28
Final body weight (kg)	12.98 ^a	17.38 ^b	16.00 ^b	1.72
Average daily gain (g/d)	37.03 ^a	81.01 ^b	69.44 ^b	5.14
FE, g of ADG/kg DMI	93.12 ^a	129.47 ^c	105.62 ^b	11.51

^{abc} Means in a row with different superscripts are significantly different ($p < 0.05$).
 OPD, TPD, HPD: Once per day, twice per day and thrice per day respectively
 FE: Feed efficiency

Table 3: Changes in body measurement (cm) of Red Sokoto goats as influenced by the feeding frequency

Days of Trial	Parameter	Treatments/Feeding frequency			SEM
		OPD	TPD	HPD	
0-36 ¹	BL	0.01 ^a	0.02 ^a	1.00 ^b	0.15
	CG	-1.00 ^a	5.00 ^b	3.25 ^b	0.81
	HW	3.50 ^c	1.00 ^a	6.00 ^b	0.66
37-72 ²	BL	3.05 ^a	8.00 ^b	5.52 ^{ab}	1.74
	CG	4.00 ^b	4.00 ^b	0.25 ^a	1.62
	HW	2.00 ^a	5.00 ^b	3.00 ^a	1.00
73-108 ³	BL	0.01 ^a	2.00 ^b	1.00 ^b	0.28
	CG	1.00 ^a	0.20 ^a	3.50 ^b	0.45
	HW	1.50 ^b	0.05 ^a	0.20 ^a	0.21

^{abc}: Means on same row with different superscripts are significantly different ($p < 0.05$).

¹: Body Measurement at day 36 less initial body measurement

²: Body measurement at day 72 less body measurement at day 36

³: Body measurement at day 108 less body measurement at day 72

BL: Body length, CG: Chest girth, WH: Wither height.

OPD, TPD, HPD: Once per day, twice per day and thrice per day respectively

Table 4: Correlation coefficient (r) of changes in body measurements intact male Red Sokoto goats with changes in body weight

Parameters	a	b	r	Sig
Body length	3.58	0.59	0.63	*
Chest girth	3.69	0.55	0.77	**
Height at withers	6.51	0.02	0.01	NS

* Significant at 5%

** Significant at 1%

NS: not significant

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slaughter, empty body carcass and pluck weights, as well as thickness of brisket fat and testicular circumference (Table 5). In contrast, TPD fed goats had least ($P > 0.05$) value (6.00 cm) for longissimus dorsi muscle thickness. External and internal (except blood weight) offal components including abdominal fats of goats (Table 6) varied significantly ($P < 0.05$) with those fed TPD recorded highest mean values. Except the testicular circumference, highly significant ($P < 0.01$) relationships existed between carcass components and corresponding live weights of Red Sokoto goats (Table 7). The empty body weight had highest correlation coefficient ($r = 0.99$) with live weight.

Discussion

The high crude protein content of the concentrate over the grass suggested the need for supplementation of the grass in order to meet protein requirement of the goat for optimum performance. However, grass ME content (Mcal/kgDM) of 3.58 and concentrate, 3.97 were similar to the value of 4.02 recommended by Lu and Poitchoba (1988) for growing goats. Highest feed consumption and average daily gain of TPD bucks indicate better nutrient utilization than in the corresponding goats. The least daily gain value of 37.03 g/d recorded in OPD goats could be attributed to the low feed intake in the treatment.

Table 5: Carcass characteristics of Red Sokoto goats as influenced by the feeding frequency.

Parameters	Treatments/Feeding frequency			SEM
	OPD	TPD	HPD	
Body condition score	2.40 ^a	3.20 ^b	2.80 ^{ab}	0.14
Starved live weight (kg)	12.80 ^a	16.90 ^b	15.84 ^b	0.71
Slaughter weight (kg)	12.33 ^a	16.33 ^b	15.45 ^b	0.69
Empty body weight (kg)	10.47 ^a	13.55 ^b	12.73 ^{ab}	0.59
Carcass weight (kg)	5.00 ^a	7.90 ^b	7.0b ^b	0.48
Dressing percentage (%)	39.06 ^a	46.75 ^b	44.57 ^b	1.09
Carcass value	1.00 ^a	2.50 ^b	2.00 ^b	0.24
Body measurement (cm)				
Brisket	1.00 ^a	2.10 ^b	1.90 ^b	0.16
Longissimus dorsi muscle	1.90	2.00	2.30	0.58
Testicular circumference	10.00 ^b	6.00 ^a	11.00 ^b	0.79

^{abc}: Means in a row with different superscript are significantly different ($p < 0.05$)
OPD, TPD, HPD: feeding once per day, twice per day and thrice per day respectively.

Table 6: Offal components of Red Sokoto goats as influenced by feeding frequency

Parameters	Treatments/Feeding frequency			SEM
	OPD	TPD	HPD	
External offals				
Head weight (kg)	0.88 ^a	1.25 ^c	1.06 ^b	0.05
Skin weight (kg)	0.78 ^a	1.33 ^b	1.30 ^b	0.08
Feet weight (kg)	0.20 ^a	0.28 ^c	0.24 ^b	0.01
Tail weight (g)	12.50 ^a	40.00 ^b	20.00 ^a	0.74
Internal offals				
Rumen weight (kg)	0.43 ^a	0.68 ^c	0.50 ^b	0.03
Intestine weight (kg)	0.50 ^a	0.71 ^b	0.54 ^a	0.03
Blood weight (kg)	0.47	0.57	0.39	0.28
Pluck weight (kg)	0.62 ^a	0.88 ^b	0.68 ^a	0.22
Gut content (kg)	1.86 ^a	2.73 ^b	2.72 ^b	0.13
Abdominal fats				
Kidney fat weight (g)	25.50 ^c	18.75 ^a	13.00 ^b	1.61
Omental fat weight (g)	125.00 ^a	400.00 ^c	200.00 ^b	38.39
Mesenteric fat weight (g)	175.00 ^a	450.00 ^c	300.00 ^b	34.39

^{abc}: Means in a row with different-superscripts are significantly different ($P < 0.05$).
 Rumen denotes: Rumen, reticulum, omasum and abomasums.
 Intestine denotes: Small and large intestines

Table 7: Correlation coefficient (r) of carcass components and live weights of intact male Red Sokoto goats raised on three feeding regimes.

Parameters	a	b	r	sig
Empty body weight	0.72	1.18	0.99	**
Feet weight	0.12	63.36	0.94	**
Head weight	1.93	12.48	0.95	**
Pluck weight	4.11	15.28	0.71	**
Dress weight	5.42	1.46	0.98	**
Empty gut weight	4.88	8.97	0.80	**
Tail weight	11.43	0.16	0.84	**
Longissimus dorsi	2.26	6.11	0.73	**
Testicular circumference	14.89	0.03	0.03	NS

** Significant at 1%
 * Significant at 5%
 NS - Not Significant

The least growth in OPD bucks in CG could be interpreted to mean that CG was more severely affected than HW and BL by once per day feeding system. This observation is expected since increase in body size of animals arising from laying down of body tissues has been reported by James *et al.* (2007) to be directly related to weight of the animals. The observed skeletal growth pattern as represented by HW in all bucks with lowest rate in OPD bucks agreed with the earlier report by Ehoche *et al.* (1989) for cattle. The general low rate of changes in BL and WH in the third trial compared to the previous trial could be due to the fact that the animals were approaching their maximum body growth. Highly significant positive correlation of CG with live weight indicates that CG could best predict changes in body weight, because the higher association of body weight with chest girth was possible due to relatively larger contribution to body weight by chest girth consisting of bones, muscles and viscera (Slippers *et al.*, 2001; Topal and Macut, 2004; Thiruvankadan, 2005).

Though goats on TPD consumed less quantity of feed than HPD goats, they had higher feed utilizing efficiency (Table 2) with concomitant nutrient conservation resulting into higher body condition score, dressing %, carcass weight and carcass value. This is in agreement with Rea (2002) who observed that body condition score is a subjective measure of nutrient reserve. Low carcass performance characteristics of OPD bucks could be attributed to the insufficient feed consumption, similar to the observation Goonewardene *et al.* (2005)

reported for poorly fed steers. The smallish nature of testicular circumference of TPD bucks despite their highest dressing % could not be nutritionally explained.

The better performance of TPD bucks in offal and internal fat composition is a probable reflection of the high daily gain and efficient nutrients utilization. Similarly, pluck weight patterns ($P < 0.05$) across the treatments were different from the findings of Leche (1973) who stated that level of feeding and nutrition had no effect on pluck weight. Moreover, least gut content value of 1.86kg of OPD bucks is a further attestation of their low feed and dry matter intakes.

The highest correlation of empty body weight (EBW) with live weight can be interpreted to mean that EBW could best estimate or predict live weight (James *et al.*, 2007) the observed positive correlations ($P < 0.01$) of carcass components with live weights in the present study suggest that the apparent dietary effect on body parts was associated with differences in live weights of goats placed on different feeding levels. Besides, it also confirms that the development of body components followed the allometry of growth (Okello *et al.*, 1990).

Conclusion

Feeding frequency has a significant influence on the general performance of goats. This was evident by the low performances of OPD-fed intact male Red Sokoto goats relative to those fed more than once per day. Performances of goats on TPD and HPD feeding frequencies were

statistically similar in the majority of cases especially for growth rate, changes in body measurements, dressing percentage, and carcass weight and components. It was evident in this study that the performance of animals in OPD feeding frequency was relatively low, the performance was not likened to gross starvation. Optimum performance of goat can be achieved with feeding twice per day, in the morning and evening, without wasting farmers' resources. This serves as a vehicle of useful information to livestock farmers and fattening stations where plane of nutrition is a tool to a successful enterprise.

References

- De Boar, H., Dumont, B.L., Fomeroy, R.W., and Weniger, J.H. 1974.** Manual on E.A.A.P reference methods for the assessment of carcass characteristics in cattle. *Livest. Prod. Sci.* 1, 131-164.
- Devendra, C. 1987.** Small ruminant production system in South and South East Asia. Proceedings of Workshop, Benger Indonesia, Publication No. 256e, 414 pp.
- Ehoche, O.W., Alhassan, W.S., Umoh, J.E., and Buranendvan, V. 1989.** Changes in body measurements and properties of offal components during and after a period of feed restriction Sokoto Gudali bulls. Proceedings of the 14th Annual Conference of Nigerian Society for Animal Production, University of Agriculture, Markudi, Nigeria, pp 85 – 99.
- Goonewardene, L .A., Zobell, D.R., and Engstrom, D.F. 2005.** Feeding frequency and its effect on feed and weight performance in Steers. *J. Anim. Sci.* 75: 225-257.
- James, I. J., Osinowo, O. A., and Amoo, T. O. 2007.** Estimation of live weight from chest girth and wither height measurements in West African Dwarf Goats. *Nig. J. Anim. Prod.* 34(2): 181-187.
- Leche, T.F. 1973.** Proportions of carcass and offal components in Jersey and Friesian bulls in relation to plane of nutrition. *Austr. J. Agric. Res.* 24: 623-631.
- Lu, C.D. and Potchoiba, M.J. 1988.** "Intake and weight gain of growing goats fed diets of various energy and protein levels". *Report of American Institute for goat research*, p.13.
- Okello, K.L., Ebong, C. and Opuda-Asibo, J. 1990.** Effect of feed supplements on weight gain and carcass characteristics of intact male Mubende goats fed elephant grass (*Pennisetum purpureum*) ad libitum in Uganda. In: Proceedings of the third Biennial Conference of the African Small Ruminant Research Network. Small

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- Ruminant Research and Development in Africa, pp 183 -187.
- Owen, J. E. and Norman, G. A. 1977.** Studies on the meat production characteristics of Botswana goats and sheep. Part I: General body composition, carcass measurements and join disacition. *Meat Science* 1: 283-306.
- Payne, W.J.A. 1990.** An introduction to animal husbandry in the tropics: 4TH edition, Longman, Singapore, pp 811.
- Rae, D.O., 2002.** Managing for profit: Nutritional priorities- cow age and body condition. <http://gno.ifesufi.edu/animal/shortas/roe.htm>.
- Santucci, P. and Maestrini, O. 1985.** Body condition of Dairy goats in Extensive system of production: methods of estimates. *Am. Zootech*, 34: 473-474.
- SAS, Statistical Analysis Institute, 2000.** The SAS system for windows. Release 801, SAS Institute, Cary, USA, pp 943.
- Slippers, S.C., Letty, B.A., and de Viler, J.F. 2001.** Prediction of body weight of Nguri goat. *South African Journal of Animal Science* 30: 127-128.
- Thiruvankadan, A.K. 2005.** Determination of best fitted regression model for estimation of body weight in Kann and Adu kids under farmer's management system. *Livestock Research for Rural Development*. 17: 214 -218.
- Topal, M. and Macut, M. 2004.** Prediction of body weight from body measurement in Morkaraman sheep. *J. Applied Anim. Res* 25: 97-100.

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