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Breed and Environmental Effects on Linear Measurements of Goats in a Semi Arid Region of Nigeria

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Abstract: At the University of Maiduguri Teaching and Research farm, breed and environmental effects on body measurements were investigated using 192 individual kid records of Sahel (S), Red Sokoto (RS) and West African Dwarf (WAD) breeds of goat. The Body Measurements (BM) were Heart Girth (HGT), Height at Withers (HWT), Body Length (BLT) and Diagonal Length (DLT). Body measurements increased with age. Average HGT, HWT, BLT and DLT at birth were 24.70, 27.65, 31.36 and 19.02 cm, respectively while the corresponding values at 9 months of age were 47.40, 50.17, 66.25 and 40.66 cm. At all ages, S and RS had similar body measurements but, both, significantly ($p<0.001$) performed better than WAD. Seasonal effect became significant only at the older ages. Animals born in the wet and dry seasons were more superior to those born in the dry hot season. Year of birth effect was significant on HGT and BLT at all ages except 90days (GHT) and 30 days (BLT). Significant effect of year of birth was recorded at 60, 240 and 270 days of age for DLT and 270 days of age for HWT. Among all the measurements, only DLT was significantly affected ($p<0.05$) by parity between 60 days and 240 days of age. Litter size and sex affected all the BM (except DLT) at all ages. For DLT, non significant effects of litter size and sex were recorded at birth and 270 days of age.

Key words: Breed, environment, goats, linear measurements

INTRODUCTION

Traditionally, in livestock management, body weight is considered as a tool for improving the genetic quality of meat animals. However, it has been discovered that its use is limited by short term changes as a result of management system, pregnancy, lactation and season (Ozoje and Herbert, 1997). Another alternative, the physical body characteristics (linear measurements), when compared with body weight, are less affected by these factors and therefore, allow comparison of growth of different body parts at any stage or phase of growth (Russell, 1975).

Linear measurements have been used to study interaction between heredity and environment (Dunlop, 1963) and also to investigate possible correlates of carcass composition (Wynn and Thwaites, 1981). Measurements of various body conformations are of value in judging quantitative characteristics of meat and are also helpful in developing suitable selection criteria (Sarma *et al*., 1984). Moreover, it is possible to estimate body weight of a large animal from its physical conformations (Bhattacharya *et al*., 1984).

The aims of this work were to characterise Sahel, Red Sokoto and West African Dwarf breeds of goat based on their linear measurements and check whether there were effects of breed and environmental factors at different ages.

MATERIALS AND METHODS

Location of the experiment: Monthly data (from birth to nine months of age) used in this study were generated from an experiment conducted at the University of Maiduguri. Maiduguri, a town located 354 m above sea level, is on latitude 11°38 and longitude 32°17 and. It is within semi arid region which is characterised by short rainy season (2-4 months) between June and September. Relative humidity ranges from 5-45%, while the temperature ranges from 23-40.7°C. The vegetation is classified as extreme dry steppe (open grass) with woody widely spread trees interspaced with herbs and perennial grasses.

Management of the experimental materials: Animals were on semi intensively of management. They were grazed

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twice (morning and evening) a day with supplementations in form of groundnut hay, cowpea husk and wheat offal. Kids were allowed to run and suckle the dams during the preweaning period (birth to three months of age). Adequate veterinary and hygiene measures were taken.

Data collection and analysis: Linear measurements taken include Heart Girth (HGT), Height at Wither (HWT), Body Length (BLT) and Diagonal Length (DLT). The effects of breed, season year, parity, litter size and sex were analysed using the General Linear Model of SPSS (2001). The fixed effect model used was as follows:

$$Y_{ijklmn} = U+Y_i+S_k+P_l+B_l+L_{m+} X_n+e_{ijklmn}$$

Y_{ijklmn} = Observation of an individual of the ith breed (1,3) and kth parity (1,7) belonging to nth sex (1,3), mth litter (1,3) and born within jth season of the ith year (1,4).

U = Overall mean.

RESULTS AND DISCUSSION

The least squares means of linear measurements shown in Table 1-4 are similar to those of light breeds but lower than those of heavy breeds recorded in the literature. For example, heart girth (Table 1) values (24.70, 31.15, 39.95 and 43.34 cm) are lower than the corresponding values (35.66, 42.80, 53.36 and 56.08 cm) reported by Kumar and Singh (1983) in Saanen breed. Higher values of 46.48 cm (4 months) and 53.35 cm (6 months) were also recorded for Kanni Adu goats by Thiruvenkadan *et al.* (2000). However, 26.95, 40.95 and 44.98 cm recorded by Ozoje and Herbert (1997) at birth, 90 and 150 days, respectively in West African Dwarf goats are comparable to those recorded in this study.

For wither height (Table 2), values (27.65, 33.74, 42.29 and 45.55 cm) recorded in this study at birth, 1, 4 and 6 months, respectively are lower than those recorded by Kumar and Singh (1983) for Saanen and Jumnapari breeds at birth (34.70 and 33.48 cm), one month (42.83 and 41.13 cm), 4months (52.68 and 50.62) and 6months (56.22 and 50.62 cm), respectively. Similar, values (28.08, 35.73,

Table 1: Least squares means of individual heart girth (cm) at various ages (days)

	HGT0	HGT30	HGT60	HGT90	HGT120	HGT150	HGT180	HGT210	HGT240	HGT270
n	192	133	119	111	107	105	103	100	98	94
OM	24.70	31.15	35.25	38.25	38.43	39.95	41.72	43.34	45.25	46.89
SE	0.45	0.67	0.84	0.92	0.94	0.99	1.08	1.22	1.14	1.38
Gen	***	***	***	***	***	***	***	***	***	**
S	27.33	33.32	37.47	40.94	42.38	44.54	46.51	47.77	49.35	49.79
RS	25.92	33.31	38.01	41.06	43.07	44.52	46.14	48.51	50.03	51.05
W	24.43	26.83	30.26	33.29	34.40	36.11	37.37	39.47	41.28	41.36
Season	n.s	**	n.s	n.s	***	***	***	**	**	n.s
DH	24.84	31.87	36.04	38.24	39.32	40.21	41.65	43.02	45.21	46.86
DC	24.83	31.41	34.81	37.84	38.72	40.96	43.25	46.69	48.65	48.81
W	24.43	30.18	34.89	39.20	41.80	44.00	45.12	46.04	46.81	46.53
Year	*	**	**	n.s.	**	**	**	*	**	***
2000	25.33	32.20	37.00	40.14	42.44	44.41	46.11	47.91	50.10	51.46
2001	24.28	29.67	32.66	36.80	39.08	41.24	43.15	45.54	46.94	47.42
2002	24.21	31.57	35.83	38.46	40.74	42.50	43.63	45.56	47.33	48.61
2003	25.00	31.18	35.48	38.31	37.53	38.74	40.48	41.99	43.19	42.11
Parity	***	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
1	23.92	30.80	34.82	37.93	39.70	41.45	43.27	44.87	46.15	47.27
2	24.40	32.21	36.81	39.56	40.46	42.24	43.49	44.80	45.86	46.82
3	24.70	31.17	36.00	39.22	40.59	41.90	43.42	44.73	46.51	47.32
4	25.23	31.64	35.83	39.38	41.74	44.00	45.03	46.15	48.25	49.46
5	24.63	31.30	34.43	38.84	38.85	41.11	42.40	43.40	44.18	47.20
6	24.18	29.80	33.49	35.63	38.36	39.62	42.42	43.40	45.38	46.34
7	25.88	-	-	-	-	-	-	-	-	-
LS	***	***	***	***	**	***	**	*	**	*
1	25.78	32.99	36.71	40.05	41.70	44.05	45.93	47.48	49.34	49.45
2	23.65	29.79	33.54	36.67	39.16	40.60	42.75	44.67	46.00	47.13
3	24.69	30.68	35.49	38.56	38.99	40.51	41.34	43.59	45.33	45.62
Sex	**	**	***	***	***	***	***	**	**	**
1	25.14	31.90	36.16	39.59	41.23	42.87	44.31	46.49	47.86	48.46
2	24.26	30.41	34.33	37.27	38.67	40.57	42.37	44.01	45.92	46.34

*,**,*** are $p<0.05$, $p<0.01$ and $p<0.001$ levels of significance, respectively, n = no. of animals, n.s = non significant, HGT = Heart Girth, O.M. = Overall Mean, W.AD. = West African Dwarf, SE = Standard Error, Gen = Genotype, DH = Dry Hot = DC = Dry Cold, W = Wet, LS = Litter Size, Sex: 1 = Male, 2 = Female

Table 2: Least squares means of individual heights at wither (cm) at various ages (days)

	HWT0	HWT30	HWT60	HWT90	HWT120	HWT150	HWT180	HWT210	HWT240	HWT270
n	192	133	119	111	107	105	103	100	98	94
OM	27.65	33.74	37.23	40.22	42.29	44.44	45.55	48.31	49.43	50.17
SE	0.42	0.74	0.89	0.99	0.98	1.10	1.20	1.28	1.20	1.30
Gen	***	***	***	***	***	***	***	***	***	**
S	30.79	36.54	40.66	45.90	45.91	48.20	49.63	52.68	54.08	48.98
RS	29.53	35.61	40.11	43.09	45.54	47.81	48.76	51.16	52.56	54.06
W	22.64	27.57	30.92	33.68	35.41	37.31	38.27	41.08	41.66	50.43
Season	n.s	**	n.s	n.s	***	***	***	**	**	n.s
DH	28.19	33.69	38.03	39.96	41.22	42.81	43.47	46.01	47.80	48.98
DC	27.90	33.06	37.70	40.02	42.11	44.01	45.26	48.58	49.81	51.10
W	26.87	32.98	39.97	40.69	43.54	46.50	47.92	50.33	50.69	50.43
Year	*	**	**	n.s.	**	**	**	*	**	***
2000	28.06	33.33	37.66	41.41	44.14	46.11	47.23	50.00	51.78	53.59
2001	26.90	32.36	35.80	38.97	42.04	44.51	46.17	49.14	50.14	50.93
2002	27.69	33.76	37.73	39.89	42.11	44.89	45.55	48.01	49.45	50.51
2003	27.96	33.54	37.73	40.62	40.86	40.25	43.27	46.08	46.35	45.66
Parity	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
1	26.64	33.51	36.60	38.93	40.56	43.20	44.02	46.26	47.65	47.87
2	27.27	34.97	38.89	41.68	42.86	44.89	45.24	46.91	47.33	48.20
3	27.17	33.40	37.85	41.01	42.71	44.74	45.38	47.05	48.09	49.33
4	27.52	33.65	37.30	40.70	42.90	45.55	46.94	48.50	49.45	50.93
5	27.06	33.81	36.84	40.49	42.44	44.37	44.57	47.21	48.44	49.41
6	26.92	30.81	35.91	38.53	42.26	43.90	44.16	44.92	45.63	46.29
7	27.50	-	-	-	-	-	-	-	-	-
LS	***	**	**	**	**	**	*	*	*	*
1	28.13	34.00	38.48	41.74	43.87	45.46	47.65	50.23	51.38	52.28
2	26.89	31.73	35.63	38.57	41.12	42.64	44.68	46.98	48.34	49.30
3	27.94	34.00	37.59	40.35	41.86	44.32	47.71	48.71	48.57	48.93
Sex	**	**	***	***	***	***	***	**	**	**
1	28.03	33.88	36.16	38.24	41.56	43.67	45.73	49.58	50.32	51.07
2	27.28	32.61	36.23	38.89	40.90	43.15	44.18	47.04	48.55	49.27

*,**,*** are $p<0.05$, $p<0.01$ and $p<0.001$ levels of significance, respectively, n = no. of animals, n.s = Non significant, HWT = Height at withers, O.M. = Overall Mean, W.AD. = West African Dwarf, SE = Standard Error, Gen = Genotype, DH = Dry Hot = DC = Dry Cold, W = Wet, LS = Litter Size, Sex: 1 = Male, 2 = Female

45.18 and 48.00 cm) were reported by Kumar and Singh (1983) in Barbari breed while 31.3, 40.0, 53.1 and 57.6 cm reported by Muhammed and Amin (1996) for Sahel breed are also higher.

At birth, 1, 4 and 6 months of age average body lengths (Table 3) recorded in this study exceed those reported by Kumar and Singh (1983) for Saanen (34.30, 42.43, 52.96 and 56.80 cm), Jamnapari (50.65, 39.68, 50.84 and 56.83 cm) and Barbari (25.97, 33.75, 44.01 and 47.99 cm). Lower values were equally reported by Ozoje and Herbert (1997) in West African Dwarf. The values in this study are, however, lower than those reported by Muhammed and Amin (1996) for Sahel goats.

Breed effect showed that Sahel and Red Sokoto had similar body measurements, but, both performed better than West African Dwarf. Genotypic differences with respect to body measurements have also been reported by Bilaspuri and Singh (1993) who observed superiority of Malabari over Beetal goats in leg and ear length. Due to the characteristically small size of West African Dwarf goats, Ozoje and Hebert (1997) suggested crossbreeding them with Red Sokoto and French Alpine breeds for improved performance. Breed differences had been attributed to differences in the body weight of animals of different breeds (Alade *et al*., 2008) and stage of maturity reached by different body parts of different breeds at a given body weight (Weiner and Hayter, 1974).

Regarding the effects of factors considered, parity did not have significant effect on all the body measurements while year of birth had no significant effect on wither height at all ages.

Generally, season did not have significant effect on body measurements during the preweaning stages. However, as the source of diet changed from liquid to solid, the effect of birth season became significant. This is an indication that seasonal variation in the availability of feed had more effect on body measurements that milk supply from dam; a finding that agrees with reports of Ozoje and Herbert (1997) on linear measurements of West African Dwarf and its crosses with Red Sokoto goats. Searle *et al*. (1989) have also shown that nutritional differences actually contribute to growth differences in different body parts. The shape of an animal may therefore be altered by feed restriction so that bone development occurs at the expense of other tissues (Allden, 1984).

Table 3: Least squares means of individual body lengths (cm) at various ages (days)

	BLT0	BLT30	BLT60	BLT90	BLT120	BLT150	BLT180	BLT210	BLT240	BLT270
n	192	133	119	111	107	105	103	100	98	94
OM	31.36	44.02	49.30	53.87	56.68	56.37	60.81	64.05	64.98	66.25
SE	0.55	0.96	1.21	1.29	1.32	1.28	1.40	1.47	1.46	1.60
Gen	***	***	***	***	***	***	***	***	***	**
S	34.68	47.75	52.87	58.06	60.68	62.54	65.44	68.68	68.81	71.30
RS	33.19	46.90	53.38	57.51	60.75	62.29	64.29	67.10	68.56	70.22
W	26.22	37.41	41.65	46.04	48.62	50.29	52.72	56.37	56.56	57.23
Season	n.s	*	n.s	n.s	n.s	*	**	**	*	n.s
DH	31.57	44.04	49.78	54.27	56.38	56.80	58.89	61.50	63.19	65.61
DC	31.73	42.25	49.23	53.11	55.81	58.16	60.29	64.14	65.30	66.60
W	30.79	42.77	34.90	54.24	57.86	60.15	63.28	66.51	66.44	66.55
Year	*	**	**	n.s.	**	**	**	*	**	***
2000	32.77	45.54	52.37	57.14	60.52	62.34	64.10	66.65	68.76	70.35
2001	30.10	43.03	46.99	50.84	55.52	57.96	60.48	64.36	65.59	66.46
2002	31.03	43.62	49.64	54.47	56.66	58.26	60.92	63.63	64.97	67.35
2003	31.52	43.88	48.19	53.04	54.02	54.93	57.78	61.57	60.59	60.85
Parity	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
1	30.74	43.53	48.22	52.89	55.09	57.16	59.45	61.62	62.90	63.74
2	31.74	45.24	50.98	55.87	58.25	59.13	61.24	63.25	63.24	65.06
3	31.05	42.48	49.96	54.54	57.21	58.28	61.20	69.21	63.23	64.04
4	31.88	44.05	49.34	53.56	58.14	60.27	62.22	64.83	65.66	67.19
5	31.32	44.80	48.72	53.38	55.35	57.37	58.97	61.64	62.18	65.87
6	30.67	44.01	48.59	62.99	56.05	58.02	56.84	58.05	59.65	61.61
7	30.13	-	-	-	-	-	-	-	-	-
LS	***	***	**	*	*	***	**	*	**	*
1	31.52	45.30	50.89	55.13	58.38	60.90	63.16	66.49	67.92	69.35
2	30.53	42.25	47.90	51.84	54.84	56.97	59.25	61.81	63.60	65.01
3	32.53	44.50	49.11	54.65	56.82	57.25	60.05	63.85	63.41	64.40
Sex	n.s	**	*	*	**	**	**	*	*	n.s
1	31.76	45.02	50.31	54.82	57.99	59.63	62.08	65.21	65.99	66.99
2	30.96	43.01	48.29	52.93	55.28	57.12	59.56	62.89	63.96	65.51

*,**,*** are p<0.05, p<0.01, p<0.001 levels of significance, n = no. of animals, n.s = non significant, BLT = Body Length, O.M. = Overall Mean, W.AD. = West African Dwarf, SE = Standard Error, Gen = Genotype, DH = Dry Hot = DC = Dry Cold, W = Wet, LS = Litter Size, Sex: 1 = male, 2 = female

Table 4: Least squares means of individual diagonal lengths (cm) at various ages (days)

	DLT0	DLT30	DLT60	DLT90	DLT120	DLT150	DLT180	DLT210	DLT240	DLT270
n	192	133	119	111	107	105	103	100	98	94
OM	19.02	26.81	31.15	33.83	35.59	37.15	38.25	41.17	50.15	40.66
SE	0.52	0.66	0.79	0.92	0.94	0.98	1.09	1.19	1.20	1.41
Gen	***	***	***	***	***	***	***	***	***	***
S	21.26	29.00	33.53	36.23	38.20	40.29	41.45	44.23	43.29	43.87
RS	20.10	28.65	33.19	35.89	37.92	39.07	40.35	43.00	42.60	43.28
W	15.68	22.80	26.74	29.36	30.64	32.10	32.95	36.28	34.56	34.84
Season	n.s	n.s	n.s	*	***	***	***	***	**	n.s
DH	18.96	26.66	31.55	33.33	34.52	35.43	35.97	38.87	38.75	40.10
DC	19.05	27.43	30.70	33.06	34.51	36.06	38.00	42.08	41.12	41.96
W	19.04	26.35	31.21	35.09	37.73	39.97	40.79	42.55	40.58	39.93
Year	n.s	n.s	*	n.s.	n.s	n.s	n.s	n.s	*	**
2000	18.26	26.73	31.37	33.74	36.20	37.84	39.25	41.87	42.83	43.87
2001	18.89	26.48	29.51	32.93	35.41	37.06	38.75	41.63	41.19	41.66
2002	19.25	27.35	31.54	34.05	39.97	38.28	38.95	41.11	41.48	42.28
2003	19.67	26.70	32.19	34.59	34.77	35.45	39.06	40.07	35.10	35.43
Parity	n.s	n.s	*	*	*	*	*	*	*	n.s
1	18.68	26.62	31.34	34.64	36.11	37.90	38.74	41.02	40.60	40.99
2	19.80	28.11	33.01	36.24	37.40	39.07	39.59	41.77	40.74	41.48
3	19.15	27.28	32.54	35.13	37.25	38.07	38.89	40.95	40.25	41.48
4	19.47	27.41	31.73	34.84	37.16	38.52	39.53	41.69	41.60	41.90
5	19.15	27.38	29.88	32.96	34.15	35.69	35.56	39.37	34.79	35.97
6	18.29	24.09	28.41	29.16	31.47	33.68	37.21	42.20	42.92	42.69
7	18.56	-	-	-	-	-	-	-	-	-
LS	n.s	***	***	**	n.s	*	*	*	*	n.s
1	19.42	27.44	31.24	33.89	35.70	37.66	39.38	41.90	41.39	42.54
2	18.61	25.35	28.99	31.82	34.14	35.58	37.49	39.84	39.65	41.00
3	19.01	27.65	33.22	35.78	34.93	28.23	31.89	35.76	36.41	38.48
Sex	n.s	**	**	**	**	**	*	**	*	n.s
1	19.20	27.34	31.86	34.52	36.46	38.11	39.04	42.20	40.79	41.19
2	18.80	29.29	30.42	33.14	34.72	36.20	37.47	40.13	39.51	40.34

*,**,*** are p<0.05, p<0.01, p<0.001 levels of significance, n = no. of animals, n.s = non significant, DLT = Diagonal Length, O.M. = Overall Mean, W.AD. = West Afr. Dwarf, SE = Standard Error, Gen = Genotype, DH = Dry Hot = DC = Dry Cold, W = Wet, LS = Litter Size, Sex: 1 = male, 2 = female

The significant effect of year recorded for heart girth and body length agrees with the reports of Singh and Parekh (1986), Saha and Parekh (1990) and Gilbert *et al.* (1993) in cattle. Year of birth had a significant effect on body measurements at birth and growth thereafter (Sacker *et al.*, 1971). Effect of year of birth between may be due to differences in management between years.

The significant effect of type of birth on all body measurements at all ages confirms the reports of Weiner and Hayter (1974) on sheep. They reported marked type of birth effect in the first six months of lamb's life. Rony *et al.* (1981) and Shrestha *et al.* (1984) made contrary observations in cattle and sheep, respectively. Contradictions to the result of the present study are mainly due to the system of rearing and management. Ozoje and Herbert (1997) obtained non significant effect of birth type because, between birth and 3 months of age, kids were offered milk supplementation. In their own study, Weiner and Hayter (1974) did not obtain significant differences in linear measurements of singles and multiples because multiples were reared as singles.

Sex had significant effect on body measurements at all ages. This is in line with reports in the literature. Hassan and Ciroma (1992), Katongole *et al.* (1996) and Chalya (1998) reported such differences in different breeds of goats. Salako (1997) in his study observed that the effect of sex on body measurements varies according to age and type of measurements. However, Biswas *et al.* (1990) and Ozoje and Herbert (1007) reported non significant sex effect on linear measurements in goats. Effect of type of birth and sex on linear measurements on linear measurements may be due to weight differences between animals from different litter sizes and sexes. Male animals and those from single birth are known to excel females and those from multiple births, respectively (Alade *et al.*, 2008), hence their superiority in body measurements.

CONCLUSION

- The result of this study showed similarity in body measurements of Sahel and Red Sokoto breeds of goats, but both were superior to West African Dwarf breed.
- Good nutrition is required during the period of feed scarcity for uniformity among animals born in different seasons while, selection for improvement should be within sex of a particular litter size to avoid bias against female sex and multiple kids, respectively.

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