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Live weight changes during lactation and its relationship with milk off-take and yield in West African Dwarf and Red Sokoto goats intensively managed within the humid zone of Nigeria

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Abstract

This study focused on changes in doe live weight during lactation in West African Dwarf (WAD) and Red Sokoto (RS) goats intensively managed within the humid zone of South-western Nigeria. The data analysed was based on 202 weekly records from 17 lactations of 8 WAD and 9 RS goats from year 2000-2002. Mean live weight for RS does (21.16±0.34 kg) was higher (P<0.001) than the estimate (18.15±0.34 kg) for WAD does. Live weight decreased (P>0.05) from parturition up to fourth week and increased (P>0.05) thereafter till the 12th week of lactation. There was no significant interaction between breed and week of lactation. Cumulative mean weight changes of 0.16±0.19 kg for WAD and 0.38±0.22 kg for RS were not significantly different. Does had higher (P<0.001) body weights during the late-wet and early-dry seasons than during late-dry and early-wet seasons. Live weight increased significantly (P<0.001) with parity of doe, the trend being maintained with regards to cumulative weight change. Does that suckled male kids were less superior in body weights. This was reflected by a negative cumulative weight change. Live weight was positively correlated with milk yield (r_p = 0.24; P<0.05), estimated at 270.61±13.48 ml and 281.98±13.17 ml respectively for RS and WAD goats (P>0.05). Corresponding values for milk off-take were (14.09±3.64 and 16.45±3.56 ml; P>0.05). Milk off-take was lowly correlated with live weight (r_p = 0.06; P>0.05) while its relationship with milk yield was positive and significant (r_p = 0.40; P<0.001).

Keywords: Live weight changes, milk off-take, yield, goats

Introduction

One of the main characteristics of goats as dairy animals is their small size in comparison with cattle. Mature does of dairy breeds weigh between 30-80 kg with considerable variation in size within breeds (Gall, 1980). About 20-30% of the variation of milk yield is explained by variation in body weight. Differences in magnitude of correlations will be expected if weights are taken immediately after postpartum or at a later stage of lactation. The relationship is closest if weight is taken shortly after kidding. Significant phenotypic correlation coefficients of 0.44 for RS does rearing single kids and 0.82 for does with twin kids (Ehoche and Buvanendran, 1983) and 0.49 for Jamnapari, Beetal, Barbari and Black Bengal goats (Prasad *et al,* 1994) have been reported. In Jamnapari x Bengal goats, correlations of body weights with lactation yield were positive and significant except for 4th lactation yield with body weights at birth, 36 and 52 weeks (Mukherjee *et al,* 1994). Contrary to

these reports, Cooper *et al.* (1994) working with indigenous Malawi goats pointed out that doe weight at milking did not have any relationship with milk yield. Also, the results of a number of investigations reviewed by Gall (1980) on phenotypic relationships between body weight and milk yield range from 0.17-0.33 depending on the time of measurements. It was further indicated that multiple regressions of milk yield on body measurements have positive relationships with body weight, skeletal size, abdominal volume and udder volume but negative relationships with weight of body fat and muscles. This indicates that increased body weight favours milk yield only if it is due to scale, while it reduces milk yield if it is due to fat and muscle mass. In dairy cow, body size and economic efficiency do not seem closely related. Relationships are dependent on feeding regime because the contribution of milk yield to income over feed cost is large.

This study was aimed at evaluating the changes in doe live weight during lactation and to establish the relationship between live weight, daily milk off-take and yield in WAD and RS goats intensively managed.

Materials and methods

Animals and management

Data used for this study were obtained from two breeds of goat (WAD and RS) raised at the College of Animal Science Teaching and Research Farm, University of Agriculture, Abeokuta, Nigeria, from year 2000-2002. The climate is humid and located in the rain forest vegetation zone of South-western Nigeria. It receives a mean precipitation of 1037 mm with seasonal distribution approximated at 44.96 mm in the late-dry season (Jan.-March), 212.4 mm in the early-wet season (April-June), 259.3 mm in the late-wet season (July-Sept.) and 48.1 mm in the early-dry season (Oct.-Dec.). Relative humidity averages 82 % throughout the year. The animals were in their first to third lactation and intensively managed. Nutrition was based on zero grazing on pasture species comprising *Panicum maximum*, *Pennisetum purpureum* and *Stylosanthes hamata*. They were supplemented with concentrate feed of about 15% CP at 200-500 g/head/day. Supplements were given at higher levels during late pregnancy and early lactation periods, and also during the late dry season when the quality of forages was low. All breed groups were subjected to the same management condition during each season. Animals were routinely de-wormed and dipped.

Measurement of live weight, milk off-take and yield

Doe live weight and daily milk yield were measured on weekly intervals for a period of 12 weeks. A total of 202 weekly records were obtained from 17 lactations comprising 8 WAD and 9 RS goats. Following parturition, does and their kids were individually housed for a week before initiation of milk production measurements. Doe was hand-milked twice daily (7.00 and 15.00 h) after separation from kid(s). Live weight was measured in kg using a hanging scale prior to initial milking. The initial milking was to empty the udder of any milk retained after suckling by the kid(s). The balance of milk left in the udder of suckled does per day is a measure of daily milk off-take. Prior to final milking (8 hours after separation), the udder was washed and dried with a towel. The doe was then rapidly milked until the amount of milk obtained at each stripping was less than one ml. Total yield for 24-hour period was calculated in proportion to the time interval between initial and final milking, i.e. 3 times 8-hour yield. This is based on reports that milk production in the mammary gland of goats is constant throughout the day (Linzell, 1966). The technique of measuring daily milk yield on weekly intervals (and not on daily basis) is further justified on the basis that milk production is not likely to vary significantly within a span of eight days as reported by Cardellino and Benson (2002), working with sheep. Moreover, daily separation of kids from their dams has implication on kid survival.

The amount of milk consumed by the kids was estimated as the difference between daily milk yield and milk off-take (Bemji, 2003). Records of does with stillbirth (3) and infected cases with mastitis (2) were discarded.

Statistical analysis

The effects of breed and environmental factors on doe live weight, milk off-take and yield were investigated by analysis of variance of data using the Multivariate General Linear Model of Systat program, release 5.02 (Systat, 1993). The model used was $Y_{ijklmno} = \mu + D_i + W_j + Z_k + P_l + X_m + L_n + E_{ijklmno}$ where Y_{ijklmn} is the measured value, μ the overall mean, D_i the effect of i^{th} dam breed (i=WAD or RS), W_j the fixed effect of j^{th} week of lactation (j=1, 2, ..., 12), Z_k the fixed effect of k^{th} season of kidding (k=late-dry, early-wet, late-wet or early-dry), P_l the fixed effect of l^{th} parity of dam (l=1, 2, 3), X_m the fixed effect of m^{th} sex of kid (m=male, female or mixed), L_n the fixed effect of n^{th} litter size (n=1 or 2) and $E_{ijklmno}$ the residual error. Least squares means that differed significantly were separated using Duncan's Multiple Range Test (Gomez and Gomez, 1984). Pearson's correlation coefficients among doe live weight, milk off-take and yield were estimated using the CORR procedure following adjustment of data for significant environmental effects.

Results

Changes in doe weight during lactation

The results of analysis of variance on live weight showed that breed effect was highly significant (P<0.001) as well as season (P<0.001), parity (P<0.001) and sex of kid (P<0.05) while litter size and week of lactation did not affect live weight significantly. Least squares means (±SE) are presented in Table 1. The mean live weight for RS does (21.16±0.34 kg) was significantly higher than the estimate for WAD does (18.15±0.34 kg). Doe weight decreased from parturition up to the 4th week and increased thereafter till the 12th week of lactation (P>0.05). Does had significantly (P<0.001) higher body weights during the late wet and early dry seasons than during the late dry and early wet seasons. Live weight increased significantly (P<0.001) with parity of doe. Does that suckled male kids were less superior in body weights than does with females and mixed sexes. The latter were significantly (P<0.05) higher in live weight than does that suckled males or females.

Weekly weight change

The change in dam weight on weekly basis did not vary significantly with breed, week of lactation, season, parity, kid sex and litter size. The overall weekly change in weight was positive for both WAD (0.09±0.10 kg) and RS (0.06±0.12 kg) as indicated in Table 1.

Cumulative weight change

The least squares means for cumulative weight change (Table 1) were 0.16±0.19 kg and 0.38±0.22 kg for WAD and RS does respectively (P>0.05). Does kidding during the late-wet and late-dry seasons gained more weight while there was a significant (P<0.001) decrease in weight during the early-wet and early-dry seasons. Weight gain significantly (P<0.001) increased with parity. Does that suckled male kids lost more weight (P<0.01) than does that suckled females or mixed sexes. The effects week of lactation and litter size on cumulative weight change were not significant.

Phenotypic correlations among live weight, milk off-take and yield

It is indicative from Table 2 that positive and significant phenotypic correlation existed between live weight and milk yield (0.24; P<0.05), while the coefficient between live weight and milk off-take was low (0.06; P>0.05).

Other parameters that were significantly correlated include live weight and cumulative weight change (0.51; P<0.001), weekly weight change and cumulative weight change (0.40; P<0.001), and milk off-take and milk yield (0.40; P<0.001).

Table 1 ***Effects of breed of dam, week of lactation, season of kidding, parity of dam, sex of kid and litter size on live weight during lactation in WAD and RS goats***

		Live weight, *kg*		Weekly weight change, *kg*		Cum. Weight change, *kg*
Variable	*Sub-class*	*No*	*LSM (±SE)*	*No*	*LSM (±SE)*	*LSM (±SE)*
Dam	WAD	94	18.15±0.34[b]	86	0.09±0.10	0.16±0.19
	RS	108	21.16±0.34[a]	99	0.06±0.12	0.38±0.22
Week	1	17	19.86±0.65	17	-0.39±0.19	0.05±0.36
	2	17	19.42±0.65	17	0.03±0.19	0.04±0.36
	3	17	19.41±0.65	17	-0.02±0.19	-0.09±0.36
	4	17	19.29±0.65	17	0.15±0.19	0.02±0.36
	5	17	19.38±0.65	17	0.30±0.19	0.28±0.36
	6	17	19.64±0.65	17	-0.06±0.19	0.21±0.36
	7	17	19.59±0.65	17	0.10±0.19	0.16±0.36
	8	17	19.54±0.65	17	0.25±0.19	0.30±0.36
	9	17	19.68±0.65	17	0.18±0.19	0.44±0.36
	10	17	19.81±0.65	16	0.37±0.20	0.78±0.37
	11	16	20.16±0.68	16	-0.03±0.20	0.77±0.37
	12	16	20.09±0.68			
Season	Late dry	48	18.45±0.38[b]	44	0.24±0.16	1.43±0.30[a]
	Early wet	58	19.22±0.36[b]	53	0.04±0.11	-0.36±0.21[b]
	Late wet	60	20.66±0.46[a]	55	-0.01±0.14	0.15±0.27[b]
	Early dry	36	20.28±0.51[a]	33	0.04±0.16	-0.15±0.30[b]
Parity	1	132	15.83±0.28[c]	121	0.11±0.11	-0.40±0.20[b]
	2	36	20.55±0.51[b]	33	-0.11±0.24	-0.20±0.38[b]
	3	34	22.59±0.50[a]	31	0.23±0.16	1.40±0.29[a]
Kid sex	Male	78	18.69±0.32[b]	72	0.06±0.10	-0.31±0.19[b]
	Female	88	19.47±0.34[b]	80	0.01±0.11	0.19±0.21[b]
	Mixed	36	20.81±0.50[a]	33	0.17±0.22	0.93±0.41[a]
Liter size	1	129	20.05±0.51	119	0.01±0.19	0.19±0.35
	2	69	19.36±0.39	66	0.15±0.13	0.35±0.25

[a,b,c]Means in the same subclass having different superscripts differ significantly ($P<0.05$),

LSM = least squares means

Discussion

Changes in live weight during lactation

The observation that RS does were superior in live weight to WAD does is well established (Ngere *et al*, 1984; Osuhor *et al*, 1998). It is apparent from this study that doe live weight decreased insignificantly from parturition and became stable by the 12th week of lactation as earlier observed by James (2000). This is normal, according to a review by the foregoing author that lactating does lose weight for some periods due to lactational stress and stabilize some weeks after parturition. Live weight of indigenous Greek goats has also been shown to remain relatively constant throughout the lactation period (Zygoyiannis, 1994). Slight differences among

Table 2 *Phenotypic correlations among live weight, daily milk off-take and yield in WAD and RS goats*

	LWT	WWC	CWC	MO
WWC	0.21			
CWC	0.51***	0.40***		
MO^{+}	0.06	0.01	0.05	
MY^{+}	0.24*	-0.03	0.08	0.40***

*P<0.05, ***P<0.001; $^{+}$Least squares means reported by Bemji (2003)
LWT - Live weight
WWC - Weekly weight change
CWC - Cumulative weight change
MO - Milk off-take
MY - Milk yield

groups in live weight at the start were maintained. Devendra and Burns (1983) in a review further emphasized that loss of weight makes available the necessary energy for high yields without overstraining the digestive system, since gross production of milk precursors (volatile fatty acids) in the rumen depends on the level of feed intake by the animal and also on the digestive energy content of the dry matter ingested. This emphasizes the need for good nutritional management during pregnancy to ensure sufficient reserves at parturition and avoid excessive weight loss during lactation. The observation that does gained more weight during the late wet and late dry seasons is expected since the nutritional plane was higher than for other seasons. Concentrate feed was offered at higher levels to augment nutrients from low quality forages. Milk yield was high during these seasons (Bemji, 2003) but does still have enough nutrients for reasonable weight gains.

Does at lower parities had significantly lower body weights than third parity does, hence the tendency to be more stressed at milking leading to loss in weight as reflected in the negative values of cumulative weight change. Also, does that suckled male kids lost more weight probably due to the task of producing more milk to meet with higher demands of male kids which were superior in body weights than their female counterparts or perhaps, more aggressive at suckling.

Relationship among live weight, milk off-take and yield

The observed positive and significant relationship between live weight and milk yield corroborates other findings by Ehoche and Buvanendran (1983) and Prasad *et al* (1994). Cooper *et al* (1994) working with indigenous Malawi goats however reported positive but insignificant relationship between body weight and milk yield. It was further indicated by Gall (1980) that increased body weight favours milk yield if it is due to scale, while it reduces milk yield if it is due to fat and muscle mass. Insignificant relationship between live weight and milk off-take may be attributed to low level of milk production which was just sufficient to rear kids, since milk intake: yield ratio appears to be fairly constant (Bemji, 2003). It is indicative from the positive and significant correlation between milk off-take and yield that higher milk yield will invariably increase milk off-take.

Conclusion

Lactating does lose weight for about four weeks following parturition due to lactational stress and stabilize some weeks prior to weaning of kids. Live weight has a positive and significant

relationship with milk yield while being lowly correlated with milk off-take.

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