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Evaluation of Udder traits in West African Dwarf Goats

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Abstract

Udder traits of West African Dwarf (WAD) goats and factors influencing them were studied using 185 does located in South Western Nigeria. Traits evaluated were udder length (UL), udder width (UW), udder circumference (UC) and udder volume (UV). Others were teat length (TL), teat width (TW), teat circumference (TC), distance between teats(DT) and height of teat from the ground (HTG). Udder length was significantly (P<0.001) influenced by age, lactation status and liveweight. The increase in UL with age was quadratic. Lactating does had longer udders than non-lactating does by 1.93cm. Effects of lactation status and liveweight on UW were highly significant (P<0.001). Lactating does had wider udders (10.46 ± 0.30 cm) than non-lactating does (8.66 ± 0.27 cm). Udder circumference was significantly (P<0.001) influenced by lactation status and liveweight. Lactating does had UC of 27.69 ± 0.51 cm compared to 23.79 ± 0.40 cm in non-lactating does. Age, lactation status and liveweight had significant (P<0.05) effects on UV. The increase in UV with age was significant, rising from 637.98 ± 49.69 cm^3 at 1-2 years to 934.51 ± 75.90 cm^3 at above 4 years. Lactating does had larger UV (923.43 ± 39.97 cm^3) (P<0.001) than non-lactating does (617.61 ± 33.00 cm^3). The mean values (± s.e.m) for the udder traits adjusted to that of 3 - 4 years old lactating doe, were for UL 11.6 ± 0.17 cm; UW, 9.42 ± 0.13 cm; UC, 25.69 ± 0.44cm and UV, 817.93 ± 25.92 cm^3. Others were 2.19 ± 0.03, 1.09 ± 0.02, 3.40 ± 0.05, 8.87 ± 0.12 and 16.14 ± 0.23 cm for TL,TW,TC,DT and HTG respectively. This study showed that age, lactation status and liveweight are major factors influencing udder traits in West African Dwarf goats. A major advantage of this study is the provision of some basic information on udder traits of West African Dwarf goats.

Keywords: Udder traits. West African Dwarf goats

Introduction

The West African Dwarf (WAD) goat is one of the indigenous breeds of goat in Nigeria with a population of about 14.62 million (FDLPCS, 1991). It is found in the humid and sub-humid zones of the country. A detailed breed description of WAD goats has been presented by Devendra and Burns (1983). It is an achondroplastic dwarf, about 45 cm in height, weighing about 20 – 25 kg at maturity (Ngere and Mbap, 1983). Growth rate and milk yield are very low, but twins and triplet births are common, while kidding occurs throughout the year. Mean weekly milk yield of 2.11 ± 0.16 kg/head has been reported by Akinsoyinu *et al.* (1977), while Adu *et al.* (1987) reported an average litter size at birth of 1.7.

The size and shape of the udder are important determinants of milk yield and ease of milking. It would be convenient to select dairy animals on the basis of udder traits if they are significantly correlated to milk yield. However there is no basic information on udder traits of WAD goats. The present study was therefore aimed at investigating udder traits in WAD goats to provide a basis for the initial screening

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of the indigenous goat population for milk production.

Materials and Methods

Animals and Management

Data were collected on 185 WAD does from herds in seventeen localities in Ogbomoso North and South Local Government Areas of Oyo State; and in Odeda Local Government Area of Ogun State, in South Western Nigeria. The study was conducted over two seasons – dry (January – February,1998) and wet (June – July, 1998). The same animals were measured during the two seasons. Each parameter was measured twice on the same animals during the experimental period and their average values used for analyses. The goats were managed under traditional system of management. They were usually released in the night and against inclement system of management. They were provided housing at night and against inclement weather conditions. They were usually released in the morning to roam about and forage. Concentrate supplements offered included household wastes (yam, cassava and plantain peels) and food processing by-products like maize, sorghum and rice offals.

Udder Measurements

Udder traits were measured in the morning before the animals were turned out. The traits measured were udder length (UL), udder width (UW) and udder circumference (UC). Others were teat length (TL), teat width (TW), teat circumference (TC), distance between teats (DT) and height of teat from the ground (HTG). Udder volume (UV) was a derived variable computed as:

$$UV = \left[\frac{4}{3}\right] (\pi)r^3$$

where $\pi = \frac{22}{7}$, $r = \left[\frac{UL + UW}{4}\right]$

Udder dimensions were taken using a flexible tape according to the method of Montaldo and Martinez-Lozano (1993). Udder length was taken as the distance between the base of the udder and the lowest point of the udder. Udder width and circumference were taken from the widest point of the udder. Teat length was measured from the base to the tip of the teat. Teat width and circumference were taken from the mid-point of the teat. Distance from the tip of the teat to the ground was taken as the height of teat from the ground. Distance between the tips of two functional teats was also measured. Average of left and right teat measurements was used.

Age,parity,liveweight,lactation status and pregnancy status

Age, parity, liveweight, lactation status and pregnancy status of does were also determined. Age was determined based on dentition (Satry and Thomas, 1980; Saini *et al.*, 1993). Parity was determined from records or by oral interview of farmers who did not keep records. Goats with history of abortion were excluded. Does were weighed using a hanging scale of 0 – 100kg range with graduation in 0.1 kg. The pregnancy status was determined by milking. Based on these, goats were classified as pregnant or non-pregnant; lactating or non-lactating. Goats with abnormal udders were not involved in the study.

Statistical Analyses

Analyses were done using Mixed Model Least-squares and Maximum Likehood Computer Program (Harvey,1990). Two full models were first fitted for the effects of season, age, parity, liveweight, lacatation status and pregnancy status on each udder trait as follows:

MODEL 1

$$Y_{ijklmn} = \mu + A_i + P_j + S_k + G_L + L_m + E_{ijklmn} \quad \ldots\ldots\ldots\ldots (1)$$

Where Y_{ijklmn} = The value of the trait of interest, μ = The overall mean for the trait of interest, A_i = The fixed effect of i^{th} age group (I = 1 to 4), P_j =The fixed effect of the j^{th} parity (j = 1 to 5), S_k = The fixed effect of the K^{th} season (k =1,2), G_L = The fixed effect of the i^{th} pregnancy status (i = 1,2), L_m = The fixed effect of the m^{th}

latation status (m = 1,2), E_{ijklmn} = Random error associated with each record.

MODEL 2

Model 2 which was a modified version of model 1 included liveweight as covariate as follows:

$Y_{ijklmn} = \mu + A_i + P_j + S_k + G_l + L_m + bW + E_{ijklmn}$.....(2)

Where Y_{ijklmn} = The value of the trait of interest, b = regression coefficient, W = liveweight (kg) used as covariate. Other components of the model are as in Model 1. Error standard deviation (ESD), coefficient of variation (CV) and coefficient of determination (R2) were used to compare the two models. Based on these, the statistical model with better error control and higher coefficient of determination for each trait was chosen and used for the analyses. Factors that had no significant effect on any trait were dropped from the model. A preliminary analysis showed that location had no significant effect on any of the traits and it was not considered in the final analyses. Significant difference between means were determined using Duncan's New Multiple Range Test (Gomez and Gomez, 1984). Prior to estimation of phenotypic correlations between the udder traits, data were adjusted using the constant estimates generated by the least-squares analysis as follows:

$Y' = Y - a_i - p_j + g_k + s_i + l_m$

Where, Y' = adjusted udder trait, Y = unadjusted udder trait, a_i , p_j, g_k, s_i and l_m are the least squares constants for the effects of i^{th} age, j^{th} parity, k^{th} pregnancy status, i^{th} season and m^{th} lactation status respectively. The adjusted data were then analysed using Pearson's correlation (Systat, 1992). Means for the udder traits were adjusted to those for a lactating, 3 –4 years doe using the adjustment factors derived from the analytical Model used.

Results

The results of this investigation are presented in Tables 1 – 4. Table 1 show the liveweights for the different age-group of does sampled. Liveweight increased significantly (P<0.05) with age.

Table 1: *Liveweight of the different age-groups of the experimental does*

Age-groups (Yrs)	No of Obs.	Liveweight(kg) (Least-square means + S.E)
1 – 2	70	16.87 ± 0.91^{d}
2 – 3	45	17.96 ± 0.62^{c}
3 – 4	41	19.56 ± 0.85^{b}
> 4	29	$23.56 + 1.30^{a}$

^{abcd} Means in the same column under the same factor differ significantly (P<0.05)

Udder dimensions

The least-square analyses revealed that UL was significantly (P<0.001) influenced by age, lactation status and liveweight (Table 2). The increase in UL with age was quadratic (P<0.001). Lactating does had larger UL than non-lactating does by 1.93cm.

Lactation status and liveweight had significant effects (P<0.001) on UW. Udder circumference was significantly (P<0.001) affected by lactation status and liveweight (Table 2). Lactating does had larger UC than non-lactating ones by 3.60cm.

Table 2: *Least-squares means (± SE) for the effects of age, lactation status and liveweight on UL, UW, UC and UV in WAD goats*

		LSM			
Factors and Subclasses	No of Obs.	UL(cm)	UW(cm)	UC(cm)	UV(cm^3)
Overall	185	12.14 ± 0.15	9.25 ± 0.12	25.73 ± 0.32	770.53 ± 26.43
Age					
1 - 2	70	10.70 ± 0.29^c			637.98 ± 49.69^c
2 – 3	45	12.48 ± 0.28^b			745.01 ± 47.27^b
3 – 4	41	12.42 ± 0.32^b			755.60 ± 54.07^b
>4	29	12.97 ± 0.44^a			943.51 ± 75.90^a
Lactation Status					
1. Lactating	70	13.11 ± 0.23^a	10.20 ± 0.20^a	27.69 ± 0.51^a	923.43 ± 39.97^a
2. Non-Lactating	115	11.18 ± 0.19^b	8.31 ± 0.15b	23.76 ± 0.40^b	617.61 ± 33.00^b
Liveweight (b)		0.27 ± 0.04	0.22 ± 0.02	0.73 ± 0.06	41.77 ± 6.46
Adjusted value*	195	11.615± 0.17	9.42± 0.13	25.69± 0.44	819.93± 35.92

^{abc} Means in the same column under the same factor followed different superscripts differ significantly($P<0.05$)
*values adjusted to those of a lactating, 3-4 year old doe.

Age ($P<0.05$), lactation status and liveweight ($P<0.001$) had significant effects on UV. The increase in UV was significant rising from 637.98 ± 49.69cm^3 at 1 –2 years to 943.51 ± 75.90 cm^3 at above 4 years. UV in lactating does was 305.82 cm^3 larger ($P<0.001$) than that of non-lactating does. The mean values (± S.E) for the udder traits adjusted to that of a 3 – 4 years old lactating doe were UL, 11.61 ± 0.17cm; UW, 9.42 ± 0.13 cm;UC, 25.69 ± 0.44 cm and UV, 817.93 ± 25.92 cm^3.

Teat dimensions

Table 3 shows the least-squares mean (± S.E) for the effects of season, age, lactation status, parity and liveweight on TL, TC, DT and HTG in WAD goats. TL was significantly ($P<0.05$) influenced by lactation status and liveweight. TL in lactating does was larger than that of non-lactating does by 0.12cm. Only liveweight had significant effect on TW.

Effect of lactation status on TC was significant ($P<0.001$). Lactating does had larger TC than non-lactating does, the difference being 0.14 ± 0.01 cm. Adjusted TC was 3.40 ± 0.05 cm. DT was significantly influenced by age and parity ($P<0.005$), and lactating status and liveweight ($P<0.001$) (Table 3). DT increased from 7.27 ± 0.36cm at 1 – 2 years to 9.75 ± 0.54 cm at above 4 years. There was a decline in DT with parity from 9.38 ± 0.38 cm in the first parity to 7.30 ± 0.39 cm in the fourth parity and above. DT was larger for lactating does than for non-lactating ones the difference being 1.31cm. Season, age and lactation status had significant ($P<0.05$) effect on HTG. During the dry season, HTG was larger compared to that of the wet season. There was a decline in HTG from 18.04 ± 0.39 cm at 1 – 2 years to 14.86 ± 0.42 cm at 3 –4 years. Height of teat from the ground in lactating does was 1.56 cm smaller than that of non-lactating does.

Table 3: *Least-squares means (± SE) for the effects of season, age, parity, lactation status and liveweight on TL, TW, TC, DT and HTG in WAD goats*

Factors and Subclasses	No of Obs.	LSM				
		TL(cm)	TW(cm)	TC(cm)	DT(cm^3)	HTG(cm)
Overall	185	2.19 ± 0.02	1.16 ± 0.01	3.37 ± 0.03	8.54 ± 0.14	15.85 ± 0.21
Season						
1. Dry	185					16.59 ± 0.27[a]
2. Wet	185					
Age						
1 –2	70				7.27 ± 0.36[d]	18.04 ± 0.39[a]
2 – 3	45				8.15 ± 0.25[c]	15.51 ± 0.37[b]
3 - 4	41				8.99 ± 0.34[b]	14.86 ± 0.42[c]
>4	29				9.75 ± 0.54[a]	14.99 ± 0.60[c]
Parity						
0	50				8.60 ± 0.49[b]	
1	34				9.38 ± 0.38[a]	
2	28				8.34 ± 0.33[c]	
3	31				8.57 ± 0.33[b]	
≥	42				7.30 ± 0.39[d]	
Lactation Status						
1. Lactating	70	2.25 ± 0.04[a]		3.44 ± 0.05[a]	9.19 ± 0.21[a]	15.07 ± 0.31[b]
2. Non-Lactating	115	2.13 ± 0.03[b]		3.30 ± 0.40[b]	7.88 ± 0.16[b]	16.63 ± 0.26[a]
Liveweight (b)		0.03 ± 0.00	0.03 ± 0.00	0.05 ± 0.01	0.20 ± 0.03	
Adjusted value*	195	2.19± 0.03	1.09± 0.02	3.04± 0.05	8.87± 0.12	16.34± 0.23

[a,b,c,d] Means in the same column under the same factor followed different superscripts differ significantly (P<0.05)
*Values Adjusted to those of a lactating, 3 – 4 years old doe.

Phenotypic correlations between udder traits Phenotypic correlations between udder traits are presented in Table 4. Udder were significantly (P<0.001) correlated with each other. Significant (P<0.001) correlations were also observed between the teat traits.

Table 4: *Phenotypic correlation (rp) between udder traits in WAD goats*

	UL	UW	UC	TL	TW	TC	DT	HTG
UL								
UW	0.777							
UC	0.824	0.840						
TL	0.575	0.500	0.572					
TW	0.592	0.522	0.569	0.661				
TC	0.574	0.543	0.570	0.631	0.784			
DT	0.706	0.744	0.815	0.445	0.461	0.421		
HTG	-0.465	-0.564	-0.586	-0.358	-0.386	-0.404	-0.539	
UC	0.894	0.913	0.867	0.518	0.527	0.523	0.731	-0.504

All "rp" significant at P<0.001
UL = Udder length
UW = Udder width
UC = Udder circumference
TL = Average of left and right teat length
TW = Average of left and right teat width
TC = Average of left and right teat circumference
DT = Distance between teats
HTG = Average height of left and right teat from the ground
UV = Udder volume

Discussion

The increase in UL with age in WAD goats agrees with the observation of Knight and Wilde (1993). Dijkstra *et al.* (1997) attributed this to an increase in cell population of the mammary gland as the mature weight of the animals increased. The larger UL for lactating does over non-lactating ones is also in agreement with earlier report of Knight and Wilde (1993) that mammary gland multiplied during gestation, increased in size during early lactation and died during declining lactation. Significant effect of lactation status on UW and UC could also be attributed to some cell proliferation which occurs during lactation. This is in agreement with the reports of Anderson *et al.* (1981) and knight and Peaker (1984). The findings that UV for lactating does was larger than that of non-lactating does was due to corresponding increase in udder size during lactation. The pattern of increase in UV with age follows closely that of UL with age. This shows that UL and UV are closely related. The nature of the pattern suggests that probably there is an age during which udder size remains constant or tends to decrease before shooting up again. The fact that TL and TC for lactating does had larger values than non-lactating ones also corroborates the observation of Knight and Wilde (1993). This could be explained by the corresponding increase in udder size.

Distance between teats increased significantly with age. This shows that as the goats advanced in age, the teats became more distant from each other. This is due to an increase in UC. The highly significant ($P<0.001$) value of DT for lactating does compared to non-lactating ones could be attributed to the increase in the mammary tissue mass and milk secretion, which engorges the udder. Although parity had significant effect on DT it did not follow a definite trend. No reason could be given for this observation. Height of teat from the ground has implications for udder health. Udders that are pendulous and close to the ground could constitute a serious risk of udder injury for the goats while foraging. They could also affect the ease of suckling by the kids. From this study the finding that HTG was smaller during the rainy season than during the dry season could be associated with the availability of good forage materials during the wet season. During this period, animals are known to grow better.

The general decline in HTG with age observed in this study was expected and was due to the corresponding increase in udder size. Since the udder is in suspension it grows downward as the general body size increases.

Phenotypic correlations between the udder traits were high. The implication of this is that by direct selection for any one of them, a certain degree of improvement in the others will be achieved as correlated responses. Furthermore, phenotypic correlations are useful for predicting indirect response to selection in a multiple trait selection program. In conclusion, this study showed that age, lactation status and liveweight are the major factors influencing udder traits in West African Dwarf goats. The benefit of this study is that it provides some basic information on udder characteristics of West African Dwarf goats. However, studies need to be conducted to relate the udder traits to milk yield in WAD goats.

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