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EVALUATION OF UDDER TRAITS OF WEST AFRICAN DWARF (WAD) GOATS AND SHEEP IN OGUN STATE, NIGERIA

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ABSTRACT

Udder traits of extensively managed 229 West African Dwarf (WAD) goats and 143 three West African Dwarf (WAD) sheep in Southwestern Nigeria were evaluated and factors affecting them were determined. Traits evaluated were udder and teat morphometrics including udder length (UL), udder width (UW), udder circumference (UC), distance between teats (DT), teat length (TL), teat width (TW) and teat circumference (TC). Udder and teat shapes and teat placement were also evaluated. In WAD goats, the average UL, UW, UC and DT were significantly ($p<0.05$) influenced by age, parity and physiological status (pregnancy and lactation status) but age alone significantly ($p<0.05$) influenced TL, TW and TC. In sheep, age, pregnancy and lactation status significantly ($p<0.05$) influenced TL and UC respectively. In both species, all udder and teat dimensions increased with age and parity while largest and smallest udder and teat dimensions were observed for lactating and non-lactating (dry) animals respectively. The average UL, UW, UC, DT, TL, TW and TC of WAD goats were 12.44 ± 0.15 cm, 8.81 ± 0.11 cm, 26.81 ± 0.32 cm, 8.27 ± 0.09 cm, 2.40 ± 0.02 cm, 1.22 ± 0.02 cm and 3.11 ± 0.03 cm respectively. The average UL, UW, UC, DT, TL, TW and TC of WAD sheep were 11.30 ± 0.15 cm, 8.78 ± 0.13 cm, 26.21 ± 0.36 cm, 9.02 ± 0.12 cm, 2.10 ± 0.02 cm, 1.19 ± 0.02 cm and 3.06 ± 0.03 cm respectively. It is evident that WAD goats had larger udder size than WAD sheep, thus, indicating greater milk production potentials. Udder shapes found in WAD goats and sheep were bowl, cylindrical and funnel with the latter not found in sheep. Bottle, cylindrical and funnel shaped teats were found in both species while vertical and oblique teat placements were recorded in both species. In both goats and sheep, bowl shaped udder was the most predominant with 57.20% and 83.92% occurrence respectively. Cylindrical shaped teat was most prevalent in both species with 64.43% and 83.91% occurrence respectively. Oblique (tilted) teat placement was the most frequent in both species with 77.73% and 95.10% occurrence respectively in goats. High positive significant ($p<0.05$) phenotypic correlations were found between UL and UW ($r = 0.68$), UL and UC ($r = 0.62$), UL and DT ($r = 0.42$), UW and UC ($r = 0.73$), UW and DT ($r = 0.59$), UC and DT ($r = 0.53$). In sheep, high positive significant ($p<0.05$) phenotypic correlations were also found between UL and UW ($r = 0.74$), UL and UC ($r = 0.65$), UL and DT ($r = 0.53$), UW and UC ($r = 0.72$), UW and DT ($r = 0.65$), UC and DT ($r = 0.54$). In essence, this could be a basis for selecting udder traits of WAD goats and sheep as an indirect response in multiple traits selection programme especially for milk production .

Keywords: Udder traits; WAD goats; WAD sheep

In Nigeria, livestock resources are estimated to include 22 million sheep and 35 million goats (Lufadeju *et al.,* 1995 and Lamorde, 1997), out of which West African Dwarf goats and sheep contribute 15 million and 4 million respectively (Osinowo, 1992). Recently, FAOSTAT (2006) reported 28 million goats and 23 million sheep in Nigeria. The West African Dwarf goats and sheep constitute the largest population of small ruminants in the Southwestern Nigeria. They contribute to the health and nutrition of several millions of people in developing countries, especially those on the poverty line (David and Geoff, 1994), pregnant, nursing mothers and young children (Devendra and Burns, 1983). Milk, one of the most important products from these animals is synthesized and secreted by the epithelial cells lining the alveoli of the mammary glands, which in apposition form the udder.

Udder traits comprising udder morphometrics and shapes have been shown to be important determinant of milk yield (Singh *et al.,* 1993; Prajapati *et al.,* 1995; Agbede *et al.,* 1997 and James and Osinowo, 2004) and milking ability of goats (Ovesen, 1972 and James *et al.,* 2006). Udder shapes have also been shown to determine udder size in West African Dwarf and Red Sokoto goats (Amao *et al.,* 1999). Udder dimensions have implications for susceptibility of the udder to mastitis (Montaldo and Martinez-Lozano, 1993). Udder and teat sizes and shapes are important considerations for both manual (James *et al.,* 2006) and mechanized milking (Labussiere, 1988 and *de la* Fuente *et al.,* 1996). Thus, characteristics of the udder form important criteria in evaluating and selecting dairy goats and sheep.

Many efforts have been made to improve milk yield through nutritional manipulation (Radcliff *et al.,* 2000), exogenous hormone therapy (Knight and Wilde, 1993) and health management; but detailed study on the udder which is the primary milk producing organ of West African Dwarf goats and sheep has not been extensively undertaken in Nigeria. Therefore, the objective of this study was to evaluate various udder traits of West African Dwarf goats and sheep in Southwestern Nigeria and provide base-line information from which the animals could be selected for milk production and milking ability.

MATERIALS AND METHODS

Animals, location and management

Two species of livestock, comprising two hundred and twenty-nine (229) West African Dwarf (WAD) goats and one hundred and forty-three (143) West African Dwarf (WAD) sheep were used for the study. Non-pregnant (dry), pregnant and lactating does and ewes of 2-5 years old and 1st – 6th parities were used for the study. The study was conducted between August and December, 2003 in fifty six villages and towns in Abeokuta North and South, Yewa North and South, Ado-odo, Obafemi-Owode and Odeda local Government Areas of Ogun State, Nigeria. The region lies within the humid zone of the country. It has an annual rainfall of 1458 mm. The annual temperature ranges between 28°C and 32°C. The prominent management system in the study area was extensive management system, although, some farmers practiced semi-intensive management system.

Data collection

Data on udder and teat dimensions, udder and teat shapes and teat placement were collected Measurement of udder and teats included udder length (UL), udder width (UW), udder circumference (UC), distance between teats (DT), teat length (TL), teat width (TW) and teat circumference (TC). The averages of right and left teat dimensions were calculated and used. The measurement was done by means of a flexible tape rule as described by James and Osinowo (2004) and as presented in Figure 1. Udder and teat shapes and teat placement were evaluated by visual appraisal and linear scoring system as described by Johansson and Rendal (1968), Montaldo and Martinez-Lozano, (1993) and *de la* Fuente *et al.* (1996). Bowl, cylindrical and funnel shaped udders and bottle, cylindrical and funnel shaped teats were identified and evaluated while oblique and vertical teat placement were also identified and evaluated in both animal species (Figures 2, 3 and 4). Ages of does and ewes were determined by dentition method (Misra, 1995) while parity was determined by oral interview from the livestock farmers as regards the number of times the animals had kidded or lambed. Physiological status of the animals was determined as non-pregnant (dry), pregnant and lactating.

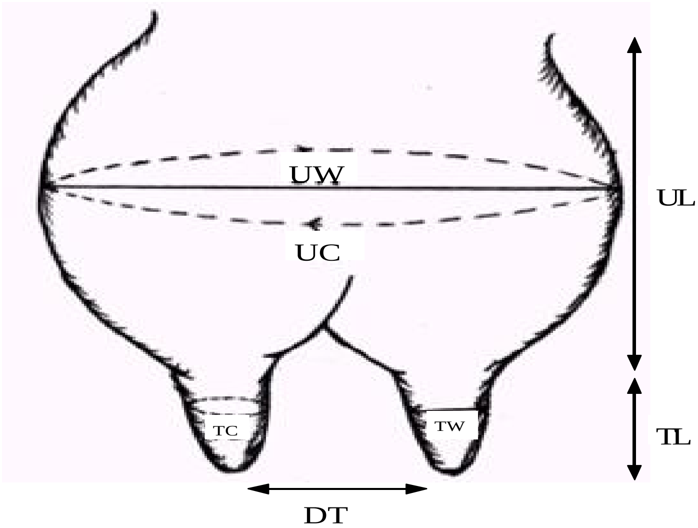


Figure 1: Udder traits' measurements in goats

Key

1. Udder length (UL): The distance between the base of udder attachment to the abdominal region and the point of teat protrusion from the udder.
2. Udder width (UW): The distance between the widest points of the udder.
3. Udder circumference (UC): The distance (perimeter) round the widest point of the udder.
4. Distance between teats (DT): The distance between the two teats tips.
5. Teat length (TL): The distance between teat tip and base of attachment to the udder.
6. Teat width (TW): The distance between the widest points of the teats (middle).
7. Teat circumference (TC): The distance round the widest points of the teats.

Pregnant and non-pregnant animals were determined by lower abdominal ballottement for evidence or absence of pregnancy (foetus), while lactating animals were determined by hand milking the udder for evidence of established lactation and by presence of suckling neonate.

Data analyses

The data generated on udder and teat dimensions were analysed by the General Linear Model (SYSTAT, 1992), using the Least squares analysis. The statistical model is as follows:

$$Y_{ijkl} = \mu + A_i + P_j + S_k + \varepsilon_{ijkl}$$

where:

Y_{ijkl}	=	The value of the trait of interest (udder and teat dimensions)
μ	=	The overall mean of the trait of interest
A_i	=	The fixed effect of the i^{th} age of animal (i = 2 - 5)
P_j	=	The fixed effect of j^{th} parity of animal (j =1 - 6)
S_k	=	The fixed effect of k^{th} physiological status of animal (k =1 - 3)
ε_{ijkl}	=	Random error associated with each record (which is normally, Independently and identically distributed with zero mean and variance).

Significant differences between means of data analysed were determined by post hoc test using Tukey procedure (SYSTAT, 1992).

Data adjustment

In order to obtain phenotypic relationship among udder and teat dimensions measured, significant environmental factors from data generated were adjusted using constant estimates generated from the least squares analysis. The adjustment equation is :

$$\delta = \theta - \alpha_i - \beta_j - \gamma_k$$

where:

δ	=	The adjusted udder and teat dimensions of animals
θ	=	The unadjusted udder and teat dimensions of animals
α_i	=	The adjustment factor for the effect of the i^{th} age (i = 2 - 5)
β_j	=	The adjustment factor for the effect of the j^{th} parity (j = 1 - 6).
γ_k	=	The adjustment factor for the effect of the k^{th} physiological status (k = 1 - 3).

RESULTS AND DISCUSSION

Udder and teat dimensions

The results of the analyses on the effects of age, parity and physiological status on udder and teat dimensions of West African Dwarf goats and sheep are presented in Tables 1 and 2, respectively. The present result revealed that udder and teat dimensions of does increased significantly ($p<0.05$) with age. The observation corroborates the findings of Akpa *et al.* (1998) and Amao (1999). This could be attributed to further *post natal* mammary growth and development associated with mammogenic hormones including oestrogen, progesterone and relaxin (Hurley, 2006). The result obtained also showed that only udder dimensions of does significantly ($p<0.05$) increased with parity but insignificant ($p>0.05$) increase was observed for teat dimensions. This observation is expected since mammary secretory tissue volume increases with the number of parity and it has been reported by Knight and Wilde (1993) that the udder is almost invariably better developed in the second lactation than in the first. They further explained that exponential growth of mammary gland during late pregnancy is greater in the subsequent lactation than in the previous lactation in goats. This is so because further re-growth and re- development occur in previously developed udder.

Table 1: Least squares means (± SE) showing the effect of age, parity and physiological status on udder and teat dimensions of the West African Dwarf goats

Factors	N	Udder dimensions (cm)				Teat dimensions (cm)		
		UL	UW	UC	DT	TL	TW	TC
Overall mean	229	12.44 ± 0.15	8.81 ± 0.11	26.81 ± 0.32	8.27 ± 0.09	2.40 ± 0.02	1.22 ± 0.02	3.11 ± 0.03
Age (years)								
2	35	10.90 ± 0.47a	8.06 ± 0.32a	22.24 ± 1.00a	7.41 ± 0.28a	2.15 ± 0.07a	1.16 ± 0.05a	3.07 ± 0.09a
3	105	11.55 ± 0.33a	8.83 ± 0.23ab	25.97 ± 0.71b	8.42 ± 0.20b	2.44 ± 0.05b	1.25 ± 0.03ab	3.29 ± 0.07b
4	82	13.31 ± 0.32bc	9.23 ± 0.22b	28.57 ± 0.69cd	8.87 ± 0.19b	2.55 ± 0.05b	1.34 ± 0.03b	3.26 ± 0.06ab
5	7	14.00 ± 1.05c	9.10 ± 0.73b	30.46 ± 2.26d	8.37 ± 0.63ab	2.45 ± 0.17ab	1.14 ± 0.11ab	2.84 ± 0.21ab
Parity								
1	24	10.49 ± 0.56a	7.74 ± 0.39a	25.35 ± 1.20a	7.39 ± 0.34a	2.33 ± 0.09	1.21 ± 0.06	2.98 ± 0.11
2	77	12.39 ± 0.41b	8.62 ± 0.28a	27.52 ± 0.87ab	8.08 ± 0.24ab	2.36 ± 0.06	1.20 ± 0.04	2.98 ± 0.08
3	76	12.88 ± 0.39bc	9.63 ± 0.27bc	29.71 ± 0.83b	8.48 ± 0.23bc	2.45 ± 0.06	1.19 ± 0.04	3.07 ± 0.08
4	36	13.82 ± 0.47c	9.59 ± 0.33bc	29.44 ± 1.01b	8.98 ± 0.28c	2.42 ± 0.07	1.17 ± 0.05	3.09 ± 0.09
5	8	12.83 ± 0.87bc	8.69 ± 0.61ab	24.43 ± 1.88ab	8.19 ± 0.53abc	2.42 ± 0.14	1.30 ± 0.09	3.15 ± 0.18
6	8	12.23 ± 0.92ab	8.56 ± 0.54ab	24.40 ± 1.97ab	8.50 ± 0.55abc	2.40 ± 0.15	1.27 ± 0.09	3.41 ± 0.18
Physiological status								
Non-pregnant	49	11.91 ± 0.42a	8.21 ± 0.29a	25.06 ± 0.90a	7.75 ± 0.25a	2.35 ± 0.07	1.18 ± 0.04	2.99 ± 0.08a
Pregnant	91	12.41 ± 0.35ab	8.93 ± 0.24b	27.22 ± 0.74b	8.31 ± 0.21ab	2.43 ± 0.06	1.26 ± 0.04	3.20 ± 0.07b
Lactating	89	13.00 ± 0.32b	9.27 ± 0.22b	28.14 ± 0.68b	8.74 ± 0.19b	2.41 ± 0.05	1.23 ± 0.03	3.15 ± 0.06b

abcd Means in the same column for a particular factor having different superscripts differ significantly ($p < 0.05$)

Table 2: Least squares means (± SE) showing the effect of age, parity and physiological status on udder and teat dimensions of the West African Dwarf sheep

Factor	N	Udder dimensions (cm)				Teat dimensions (cm)		
		UL	UW	UC	DT	TL	TW	TC
Overall mean	143	11.30 ± 0.15	8.78 ± 0.13	26.21 ± 0.36	9.02 ± 0.12	2.10 ± 0.02	1.19 ± 0.02	3.06 ± 0.03
Age (years)								
2	17	11.36 ± 0.51	8.79 ± 0.42	25.24 ± 1.18	9.02 ± 0.40	1.92 ± 0.08a	1.10 ± 0.05	2.99 ± 0.10
3	50	11.16 ± 0.37	8.55 ± 031	25.05 ± 0.86	8.98 ± 0.29	2.10 ± 0.06ab	1.16 ± 0.04	3.05 ± 0.07
4	67	11.54 ± 0.33	8.89 ± 0.28	26.58 ± 0.77	9.39 ± 0.26	2.20 ± 0.05b	1.24 ± 0.04	3.16 ± 0.07
5	9	11.14 ± 1.66	8.90 ± 0.55	27.95 ± 1.53	8.70 ± 0.52	2.18 ± 0.11b	1.26 ± 0.07	3.04 ± 0.13
Parity								
1	6	9.81 ± 0.78	8.05 ± 0.65	26.57 ± 1.81	8.15 ± 0.61	2.07 ± 0.13	1.32 ± 0.08	3.12 ± 0.16
2	41	10.75 ± 0.37	8.47 ± 0.31	25.99 ± 0.86	8.55 ± 0.29	2.08 ± 0.06	1.19 ± 0.04	3.05 ± 0.07
3	58	11.48 ± 0.33	9.27 ± 0.27	27.46 ± 0.76	8.92 ± 0.26	2.07 ± 0.05	1.17 ± 0.04	2.90 ± 0.07
4	23	11.34 ± 0.42	8.97 ± 0.35	26.61 ± 0.97	9.21 ± 0.33	2.08 ± 0.07	1.16 ± 0.04	2.98 ± 0.08
5	12	12.44 ± 0.56	9.08 ± 0.47	25.49 ± 1.31	9.39 ± 0.44	2.12 ± 0.09	1.11 ± 0.06	3.12 ± 0.11
6	3	11.96 ± 1.12	8.86 ± 0.93	25.11 ± 2.59	9.93 ± 0.87	2.18 ± 0.18	1.21 ± 0.12	3.18 ± 0.22
Physiological status								
Non-pregnant	19	10.99 ± 0.47	8.51 ± 0.39	25.50 ± 1.09a	8.62 ± 0.37	2.03 ± 0.08	1.18 ± 0.05	3.06 ± 0.09
Pregnant	50	11.08 ± 0.35	8.63 ± 0.29	25.26 ± 0.82a	8.99 ± 0.28	2.18 ± 0.06	1.21 ± 0.04	3.02 ± 0.07
Lactating	74	10.82 ± 0.31	9.20 ± 0.26	27.85 ± 0.72b	9.46 ± 0.24	2.00 ± 0.05	1.19 ± 0.03	3.08 ± 0.06

abcd Means in the same column for a particular factor having different superscripts differ significantly ($p < 0.05$)

It was also observed that non-pregnant does had the smallest udder and teat dimensions while the lactating does had the largest udder and teat dimensions. The observation was in agreement with the findings of Anderson *et al.* (1981) and Amao (1999). The observed trend could be attributed to mammary involution that occurs when lactation and milk removal cease in goats. Hurley (1989) and Strange *et al.* (1992) explained a rapid loss of tissue function, degeneration of the alveolar structure and massive loss of secretory epithelial cells leading to a programmed cell death or apoptosis that characterize mammary involution. The overall effect is reduction in udder size. Udder and teat dimensions of pregnant does were superior to the non-pregnant ones. The larger udder size results from extensive lobuloalveolar development during pregnancy (Hurley, 2006) caused by the influence of pregnancy hormones including placental lactogen, oestrogen, progesterone, growth hormone, insulin and thyroid hormones (Anderson *et al.,* 1981 and Anderson and Wahab, 1990). The largest udder size observed in lactating does corroborates the finding of Dijkstra *et al.* (1997), Amao (1999) and James (2000).

The observation in one part is due to continual increase in secretory cell number and activity in early lactation resulting to increased mass of mammary tissue for lactogenesis and galactopoiesis (Hurley, 2006) and in other part due to nursing intensity. Tucker (1966) and Kim *et al.* (1999) reported that a combination of number of nursing young and the intensity with which they nurse enhance significant mammary growth during lactation. This is so because suckling increases the number of prolactin receptors in the mammary gland thus allowing prolactin and its homologue, growth hormone to effect their mammogenic activity. Similar to WAD does, udder and teat dimensions of WAD ewes increased with age and parity but insignificantly ($p>0.05$), except for udder circumference and teat length that were significantly ($p<0.05$) influenced by physiological status and age respectively. Generally, the average udder and teat dimensions of WAD does was superior to that of ewes, thus showing their greater milk production potentials. Agbede *et al.* (1997) in their report showed that WAD does possessed larger udder size with higher milk yield than WAD ewes.

Phenotypic correlations

The results of the phenotypic correlation among udder and teat dimensions of WAD goats and sheep are presented in Tables 3 and 4 respectively. In WAD does and ewes, there were significant ($p<0.001$) positive phenotypic correlations among udder dimensions; but not between udder dimensions and teat dimensions. Only teat width ($r = 0.22$) and teat length ($r = 0.29$) were significantly correlated with distance between teats in ewes. Phenotypic correlations among teat dimensions were positive but not significant ($p>0.05$) except between teat length and teat width in does. The highly significant ($p<0.001$) positive correlations observed among udder dimensions supports the observation of Montaldo and Martinez-Lozano (1993) and Amao (1999). This could be a basis for selecting udder traits of indigenous goats and sheep as phenotypic correlation is important for predicting indirect response to selection in a multiple traits selection programme especially for milk production.

Udder and teat shapes

The present study revealed that udder and teat shapes evaluated were similar to those earlier observed for cows by Prajapati *et al.*

Table 3: Phenotypic correlations among udder and teat dimensions of the WAD goats

	1UL	UW	UC	DT	TL	TW
UW	0.68***					
UC	0.62***	0.73***				
DT	0.42***	0.59***	0.53***			
TL	0.13	0.08	0.13	0.08		
TW	0.09	0.13	0.17	0.22*	0.48***	
TC	0.19	0.01	0.04	0.06	0.15	0.17

***P<0.001 and *P<0.05
[1]See Figure 1.

Table 4: Phenotypic correlations among udder and teat dimensions of the WAD sheep

	1UL	UW	UC	DT	TL	TW
UW	0.74***					
UC	0.65***	0.72***				
DT	0.53***	0.65***	0.54***			
TL	0.18	0.32***	0.21	0.29*		
TW	0.25	0.17	0.17	0.16	0.10	
TC	0.21	0.17	0.21	0.23	0.24	0.25

***p<0.001 and *p<0.05
[1]See Figure 1.

(1995) and for goats by Amao (1999).

They differed, however, from globular and non-globular udder reported by Montaldo and Martinez-Lozano (1993) and round, egg-shaped and flat reported by Horak (1971). In both WAD does and ewes, bowl shaped udder was the most prevalent, then followed by cylindrical and funnel shapes, respectively (Figure 5) except in WAD sheep where funnel shape was absent. Teat shapes in both goats and sheep followed the same pattern. Cylindrical shaped teat was the most frequent (69.43 and 83.91%, respectively), followed by funnel shape (25.33 and 13.99%, respectively) (Figure 6) and bottle shape (5.24 and 2.10%, respectively). This observation differed from the report of Horak (1971) in Saanen goats where funnel shaped teat predominated. The variation observed could be attributed to breed differences.

Teat placement

Teat placement followed the same pattern in both WAD goats and sheep. The most prevalent teat placement was oblique (77.73 and 95.10%, respectively) (Figure 7). This observation corroborates the reports of *de la* Fuente *et al.* (1996) in sheep. Although, udder with vertical teats complies with 'udder machine' traits (Mikus, 1978) unlike the udder with tilted (oblique) teats, but in Nigeria where hand-milking predominates, this may not pose any serious problem to milking of goats and sheep.

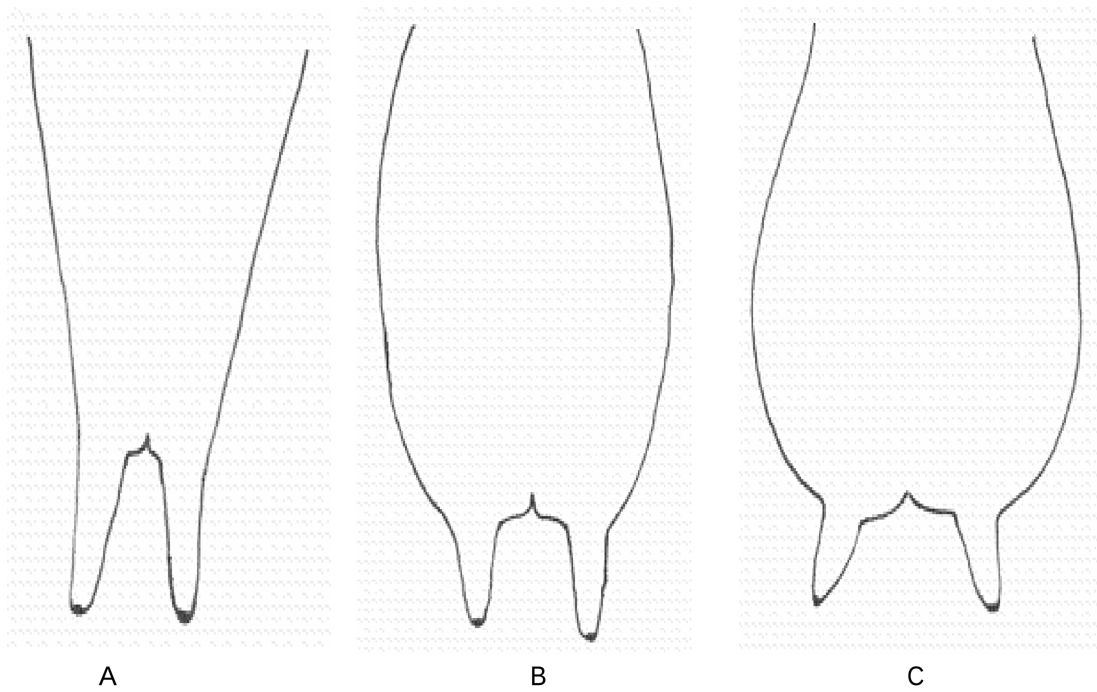


Figure 2: Shapes of udder: A, funnel; B, cylindrical; C, bowl

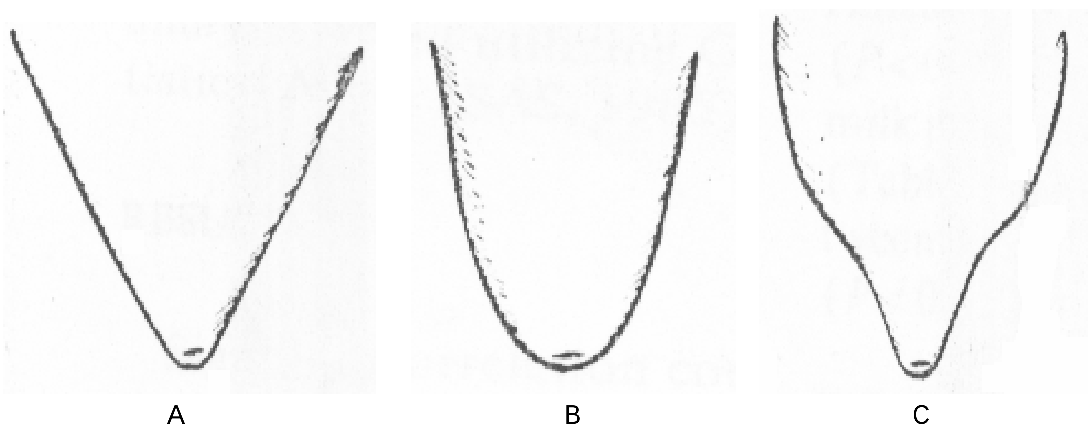
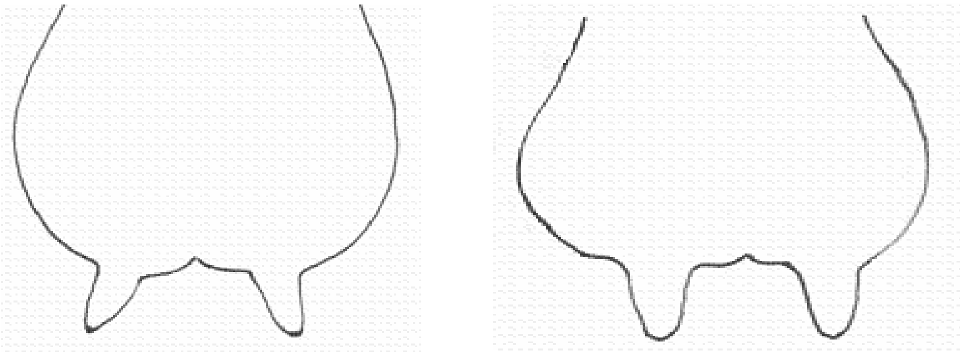


Figure 3: Shapes of teats: A, funnel; B, cylindrical; C, bottle



A B

Figure 4: Teat placement: A, oblique; B, vertical

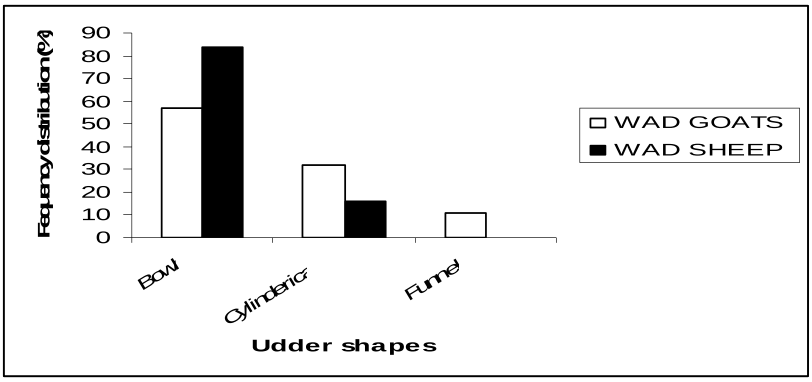


Figure 5: Frequency distribution of udder shapes of West African Dwarf goats and sheep

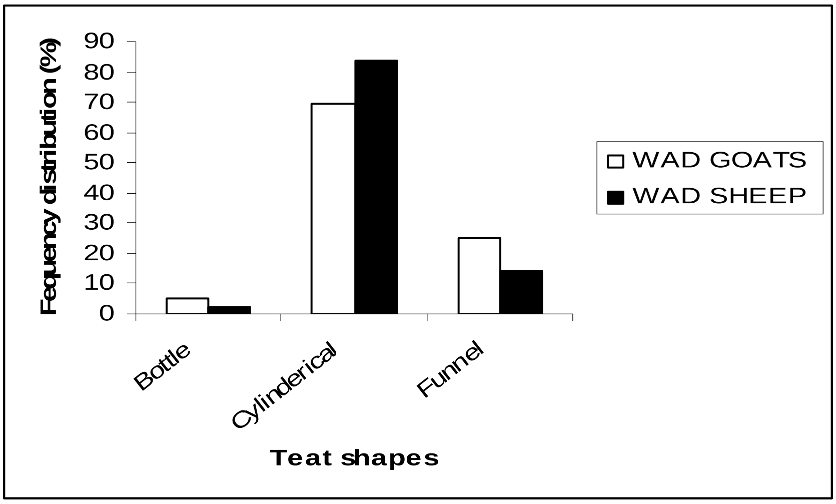


Figure 6: Frequency distribution of teat shapes of the West African Dwarf goats and sheep

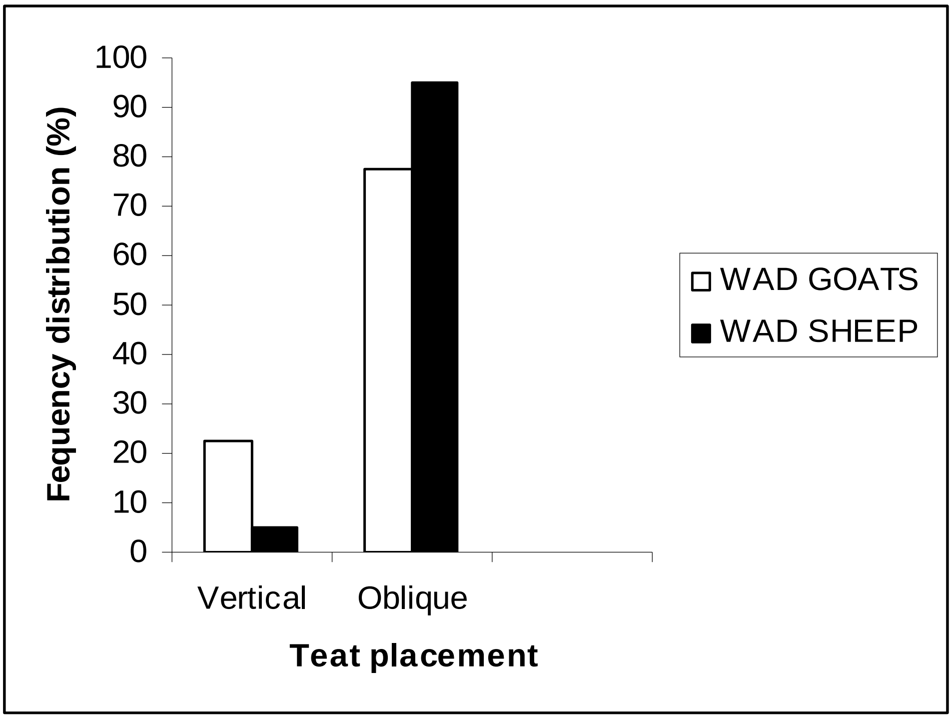


Figure 7: Frequency distribution of teat placement of the West African Dwarf goats and sheep

CONCLUSIONS

- West African Dwarf (WAD) goats had larger udder and teat size than West African Dwarf sheep, thus, indicating greater milk production potentials.
- Age, parity and physiological status had significant effects on udder dimensions but only age significantly influenced teat dimensions in WAD goats.
- Age and physiological status had significant effect only on udder circumference and teat length of WAD sheep, respectively.
- Udder shapes found in WAD goats and sheep were bowl, cylindrical, and funnel except the absence of funnel shaped udder in sheep. Bowl shaped udder was the most prevalent in both WAD goats and sheep.
- Teat shapes found in WAD goats and sheep were bottle, cylindrical and funnel. Cylindrical shaped udder was the most prevalent in both WAD goats and sheep.
- There were positive significant phenotypic correlations among udder dimensions but not among teat dimensions. This could be a basis for selecting udder dimensions in a multiple traits selection, especially for milk production.

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