PHENOTYPIC RELATIONSHIP AMONG UDDER AND TEAT DIMENSIONS OF BUNAJI COWS IN KADUNA STATE.

[1]Abubakar, I. [1]Mallam, I. and [2]Achi, N.P.
[1]Department of Animal Science, Kaduna State University.
[2]National Animal Production Research Institute/Ahmadu Bello University, Shika-Zaria, Nigeria
Corresponding author: E-mail: iabubakar432@gmail.com. Phone: +2347036257208

ABSTRACT
An investigation was undertaken to study the phenotypic relationship among various udder and teat dimensions in Bunaji cows in Kaduna State. A total of 214 Bunaji cows were sampled from three (3) local government areas namely; Kaduna North, Kubau and Zango Kataf. The morphological parameters measured were, udder length, udder depth, udder width, teat length, teat diameter, distance between fore teats, distance between the hind teats and distance between the fore and the hind teats. All the parameters with the exception of teat diameter were measured using measuring tape in centimeters. Data collected were subjected to correlation and analysis procedure of SAS (SAS, 2004). The results obtained indicates positive correlations in both the udder and teat dimensions and ranges from 0.53-0.78 and 0.15-0.89 for udder and teat, respectively. It can be concluded that there is low to high and positive correlations in both the udder and teat dimensions among Bunaji cows in Kaduna State and these parameters can be used to predict the amount of milk yield.

Keywords: Udder, Teat, Relationship, Bunaji, Cow.

INTRODUCTION
The largest milk producing country in West Africa is Nigeria and they are third largest in cow milk production in Africa (FAO, 2011). The Bunaji (White Fulani) cattle are the most numerous and widespread of all Nigerian cattle breeds (Blench, 1993; Meghen *et al.,* 1999); representing about 14.73 million cattle consisting of 1.47 million milking cows and 13.26 million beef cattle (Tibi and Alphunu, 2010), and they are estimated to represent 37% of the national herd by the Nigerian National Livestock Research Survey (NNLRS, 1999; Alphonsus *et al.,* 2012). The udder is a very important organ of the dairy animal and its morphological characteristics are linked to their dairy performance (Kominakis *et al.,* 2009). The most important traits of udder are shape, size and placement of udder and teats attachment (Abdelgadir *et al.,* 2017). Udder and teat characteristics have been shown to be influenced by several factors such as genotype, breeding and management systems (Milerski *et al.,* 2006). Teats are categorized into different shapes, namely; bottle, cylindrical, funnel and pear-shaped teats as per the visual appraisal method. The teat shape plays an important role in milk flow or let-down of milk from the udder (Hiremath *et al.,* 2019). The udder and teat shapes as well as their dimensions can be used as a breeding tool to improve milk production in dairy animals (Bhuiyan *et al.,* 2004). Udder and teat sizes and shapes are important considerations for both manual (James *et al.,* 2006) and mechanized milking (Labussiere, 1988; De la Fuente *et al.,* 1996). Tripathi *et al* (1982) reported positive correlations between various udder dimensions like udder length, udder depth and udder circumference and there is also correlation among teat dimensions such as teat length, teat diameter, distance between fore and hind teats. The authors reported a correlation between the teat length and teat diameter. Therefore, it is important to study the correlation amongst the udder and teat morphological characteristics in cows. The objective of the study was to ascertain the relationship among morphological characteristics (dimensions) of udder and teat of Bunaji cows in Kaduna State.

MATERIALS AND METHODS
Study location
The study was carried out in three (3) Local Government Areas of Kaduna State, Nigeria. The Local Government Areas were Kaduna North, Kubau and Zango Kataf. Kaduna State is located in the Northwest Geopolitical Zone of Nigeria and it lies between latitude 10° 31' 35.08" North and longitude 7°

26' 19.64" East (Satellite Map of Kaduna, 2021). It has distinct wet and dry seasons within the Guinea Savannah and part of the Sudan Savannah in Nigeria.

Sampled population

A total of 214 Bunaji (White Fulani) cows of ages 5 years and above were randomly sampled from three Local Government Areas, namely; Kaduna North (72), Kubau (63), and Zango Kataf (80).

Morphological characteristics (dimensions) of udder and teat measured

The udder and teat parameters measured were udder length, udder depth, udder width, teat length, teat diameter, distance between fore teats, distance between the hind teats and distance between the fore and the hind teats. All the parameters with the exception of teat diameter were measured with measuring tape in centimeters.

Udder length (UL): Measured as the distance between front and rear attachment of the udder (cm).

Udder depth (UD): Was measured as the distance from the base to the lowest point of the udder at the place of attachment of the teats (cm).

Udder width (UW): Was measured at the widest point of the udder (cm).

Teat length (TL): Measured as distance from the teat insertion base to the teat orifice (cm).

Teat diameter (TD): Defined as the distance between the widest points of the teat's circumference (cm).It was measured with the Vernier caliper at the middle point of the teat to the nearest 0.01cm.

Distance between fore teats (DBFT): Measured as the distance between the two fore (front) teats at the tip of the teats (cm).

Distance between hind teats (DBHT): Measured as the distance between two hind (rear) teats (cm).

Distance between fore and hind teats (DBFHT): Was measured as the distance from one of the fore teat to hind teat of the same side (cm).

Statistical analysis

The relationships amongst the parameters measured were determined using Linear Correlation and Analysis Procedure of SAS (SAS, 2004).

RESULTS AND DISCUSSION

Table 1 shows correlation coefficients among udder dimensions in Bunaji cows in Kaduna State. The results obtained showed a positive and high correlations among the various udder dimensions and ranges from 0.53-0.78 and significantly ($P<0.05$) different and highly significant ($P<0.01$). This is similar with the report of Patel *et al.* (2016) who reported positive and significant ($P<0.05$) to highly significant ($P<0.01$) relationship of udder width and udder depth, udder length was significantly ($P<0.05$) correlated with teat diameter traits, that is, fore teat diameter, rear teat diameter and overall teat diameter. The authors also observed significant ($P<0.05$) relationship of udder length, udder width and udder depth with overall teat length and overall teat diameter were reported in among cows. This current study disagreed with the report of Sinha *et al.* (2021) who reported that the udder width had a weak but positive correlation with the udder depth (0.06); udder circumference had a weak but positive correlation with the udder depth (0.07). The authors also reported a strong and positive correlation between udder width and udder length (0.90). This could be as a result of breed and other environmental factors.

Table 1: Correlation coefficients among udder dimensions in Bunaji cows in Kaduna State

Dimensions (cm)	UC	UD	UL	UW
UC	-			
UD	0.67**	-		
UL	0.78***	0.77***	-	
UW	0.54**	0.53**	0.64**	-

UC= Udder circumference, UD=Udder depth, UL=Udder length, UW= Udder width.

Correlation coefficients of various teat dimensions among Bunaji cows in Kaduna State are presented in Table 2. The results indicated a low to high correlations and are positively correlated and significant ($P<0.05$; $P< 0.01$). The highest correlation among the parameters measured was found

between RHTL and LHTL (0.89) and the lowest was obtained RHTL and DBFT (0.15). This is in agreement with the result of Tripathi *et al*. (1982) who reported positive correlations between various teat measurements namely; fore teat length, rear teat length, fore teat diameter and rear teat diameter. The authors also observed a correlation between the teat length and teat diameter which is similarly with this study. Although the correlation coefficients here are lower than the value reported by the authors. The results of this study disagreed with the report of Sinha *et al*. (2021) who reported that there is a weak and negative correlation (-0.01) between fore and hind teat hind length.

Table 2: Correlation coefficients of various teat dimensions among Bunaji cows in Kaduna State

Parameters (cm)	DBFHT	DBFT	DBHT	LFTD	LFTL	LHTD	LHTL	RFTD	RFTL	RHTD	RHTL
DBFHT	-										
DBFT	0.48*	-									
DBHT	0.59**	0.72***	-								
LFTD	0.37*	0.29*	0.19*	-							
LFTL	0.38*	0.21*	0.23*	0.37*	-						
LHTD	0.36*	0.39**	0.27*	0.47*	0.39*	-					
LHTL	0.29*	0.24*	0.25*	0.25*	0.72**	0.52*	-				
RFTD	0.46*	0.36*	0.26*	0.72***	0.53**	0.63*	0.44*	-			
RFTL	0.31*	0.22*	0.23*	0.38*	0.86***	0.40*	0.71***	0.59*	-		
RHTD	0.36*	0.35*	0.33*	0.61**	0.29*	0.60**	0.43*	0.58**	0.29*	-	
RHTL	0.33*	0.15*	0.24	0.19*	0.73***	0.47*	0.89***	0.35*	0.68**	0.42*	-

DBFHT= Distance between fore and hind teat, DBFT=Distance between fore teats, DBHT =Distance between hind teats, LFTD= Left fore teat diameter, LFTL=Left fore teat length, LHTD=Left hind teat diameter, LHTL= Left hind teat length, RFTD= Right fore teat diameter, RFTL= Right fore teat length, RHTD= Right hind teat diameter, RHTL=Right hind teat length.

CONCLUSION AND RECOMMENDATIONS

There is positive, low to high phenotypic correlations in various udder and teat dimensions among Bunaji cows in Kaduna State. More udder and teat dimensions (traits) should be explored to check their levels of relationship as well as their effect on milk yield.

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