sciendo

Archiva Zootechnica 28:2, 80-96, 2025
DOI: 10.2478/azibna-2025-0016

Milk Yield of West African Dwarf Goats as affected by Milking Methods, Wattle and its Relationship with Udder Dimensions

Oluwadamilare Olumoko*[,1], Tolulope Williams[1], Micheal Ozoje[2], Oyegunle Oke[1], Ezekiel Adekunle[1] and Adebisi Odeyemi[1]

*corresponding author: adelajaolumoko@gmail.com

[1] Animal Physiology Department, Federal University of Agriculture, College of Animal Science and Livestock Production, P.M.B. 2240, Abeokuta, Nigeria
[2] Animal Breeding and Genetics Department, Federal University of Agriculture, College of Animal Science and Livestock Production, P.M.B. 2240, Abeokuta, Nigeria

ABSTRACT

This study evaluated the influence of milking methods and wattle on daily milk yield and its relationship between udder dimensions of West African dwarf does. Forty-eight does with age 3–4, parity 2–3 and liveweight 20–25 kg was put into three milking regimens, each consisting of sixteen duplicates, after spontaneously mating. Udder dimensions evaluated were teat length, distance between teats, udder circumference, and udder length. Milking was done three times a week and once a day at 8:00 a.m for 12 weeks while udder dimensions were taken before each milking program. SYSTAT (1992) was used to perform an analysis of variance on the collected data. High daily milk yield ($p < 0.05$) was recorded in goats milked through suckle-hand compared to weigh-suckle-weigh and hand-milking methods. Wattle had no discernible effect on the daily milk output or udder size ($p > 0.05$). Both udder dimensions and udder features showed positive relationships ($p < 0.05$) with daily milk yield. The study concluded that WAD does with or without wattle but with good udder traits should be considered for milk production and be milked with suckle-hand method owning to it significance in total milk extraction.

Keywords: milk yield, milking methods, udder dimensions, wattle, West African dwarf goats.

INTRODUCTION

According to Zeder and Hasse (2000), goats were likely the first ruminant livestock and the first domesticated animal. Morand-Fehr (2004) reported

that goats are one of the smallest domesticated ruminants, bred for the production of milk, meat and leather in dry, semi-tropical nations. According to Hodges (2002), the humid woodland region in southern Nigeria is home to West African dwarf (WAD) goats with some having wattles while others do not. The congenital thumb-shaped appendages on the ventral throat that are typical of domestic goats are represented by wattle (Reber et al. 2015) whose function is still under debate. However, because it correlates with higher body weight, Sabbioni et al. (2011) believed that wattle may be used during selection for beneficial objectives (Adewumi et al. 2006) and milk yield in sheep (Williams et al. 2015). Wattle was also found to have an impact on milk production in Red Sokoto goats by Abubakar et al. (2022). Milk is an important source of food for human because it contains nutrients needed by the body (Vahcic et al. 2010). The demand for milk has increased tremendously in the world due to increase in population growth (Mirzadeh et al. 2010). In Nigeria, indigenous cattle have long been a major source of meat and milk (Zahraddeen et al. 2007), yet the populace still consumes less quantity of animal protein (Ibe 2000) because meat, milk and its products are still imported.

Goat milking skill and milk supply have been demonstrated to be significantly influenced by udder characteristics, including udder morphometrics and morphologies (James and Osinowo, 2004; James et al., 2006). The size and shape of the udder and teat are important considerations for milking (James et al. 2006). A number of parameters, such as milk yield, lactation stage, and genotype, influence udder morphology and milking efficiency (Dzidic et al. 2004; Casu et al. 2006). There are several methods that have been described for evaluating the milk production of female ruminants, including weigh-suckle-weigh, hand milking, and machine milking (Mellor et al. 1993).

One of the most commonly used methods for measuring milk production is weighing the kids before and after nursing. However, this method has several drawbacks, such as the inability to measure the small amounts of milk that kid consume, changes in kid appetite at particular times of measurements, the inability to sample for milk composition at the same time, and errors related to urine and fecal losses between weighing (Benson et al. 1999). These drawbacks suggest that an alternative method for accurately measuring milk production is required. The needs of nursing does and the growth requirements of milk-fed kids can be further refined with the capacity to assess doe milk output in a regular and reliable manner (Benson et al. 1999). Information about how West African dwarf goat's milk can be collected is limited, and there is conflicting information about how the Wattle gene affects the traits of milk yield in these goats. Thus, the purpose of this study was to investigate the effects of wattle gene, udder size, and milking procedures on the milk production of West African dwarf goats. Specifically,

the study is aimed to: i) evaluate the daily milk production of West African dwarf goats milked using the hand-milking, weigh-suckle-weigh, and suckle-hand techniques, ii) ascertain the impact of the wattle gene on West African dwarf goats' daily milk production, iii) identify the udder characteristics that greatly affect these goats' daily milk production, and iv) determine how West African dwarf goats' udder characteristics relate to their daily milk production.

MATERIALS AND METHODS

Experimental location

The study was carried out at the Small Ruminant Unit within the Directorate of University Farm (DUFARM) at the Federal University of Agriculture Abeokuta, located in Ogun state, Nigeria. It is located between the latitudes of 7º18'2"N and 7º18'30"N, as well as between the longitudes of 3º22'10"E and 3º22'41"E (OORBDA, 2024). During the rainy season, relative humidity is elevated, ranging from 63% to 96%, in contrast to the dry season (55% – 84%). The soil temperature varies between 24.5ºC and 31.0ºC (Google Earth, 2024).

Experimental Animal and Management

Fifty four (54) matured West African dwarf goats comprising of 6 bucks and 48 multiparous does with age range of 3–4 years, parity between 2–3 and liveweight between 20– 25 kg were utilized for the research task. The animals were kept under an intensive management system with zero grazing, ear-tagged for identification, dewormed and vaccinated at the start of the study and throughout its duration. The does were naturally mated by the six (6) matured bucks at the start of the research in a ratio 8 does: 1 buck. Routine management was carried out daily. The animals were fed combination of chopped forages and concentrate (Table 1) at 5% body weight in a ratio 50:50. The experiment lasted for sixteen months (January, 2024 to April, 2025).

Experimental Design

The experiment was designed using a Randomized Completely Block Design (RCBD) that includes three treatments. Treatment one to three (T1–T3) had equal number of WAD does (16) with each treatment having a specific milking method. WAD does assign to T1, T2, T3 were milked with hand-milking (HM), weigh-suckle-weigh (WSW) and suckle-hand (SH) methods respectively. Within the group of each milking methods or treatment (16 goats/milking method), there were equal number of animals having wattle gene or not (Table 2).

Table 1: The overall makeup of the concentrate that WAD goats are fed

Ingredients	Quantity (kg)
Maize	5.00
Wheat offal	40.00
Palm Kernel cake	18.00
Dry brewers grain	35.00
Bone meal	1.00
Common salt	1.00
Total	**100**
Calculated nutrients	
Crude protein (%)	16.84
Crude fibre (%)	12.66
Ether extract (%)	4.78
Calcium (%)	0.52
Available phosphorus (%)	0.34
Digestible energy (kcal/kg)	8391.18

The daily milk yield of the WAD does was determined using the considered factors (wattle and milking methods), which were organized in a 2 × 3 factorial design. Each factor's effects and how they interacted with one another were assessed in relation to daily milk yield. Specific udder dimensions were taken generally on all WAD does early in the morning before milking of the does to evaluate their relationship with milk yield as illustrated by James et al. (2002).

Table 2: Wattle and Milking method distribution

Trait	Milking methods			
	Suckle-hand	Weigh-suckle-weigh	Hand milking	Total
Wattle	8 does	8 does	8 does	24 does
Non-wattle	8 does	8 does	8 does	24 does
Replicate	16 does	16 does	16 does	48 does

Data Collection

Milking methods and Milk yield measurement

Milk production was monitored on both dams and kids for sixteen months (January, 2024 to April, 2025). Kids were permitted to suckle their dam for a week following parturition in order to gain access to the dam's colostrum and to increase the likelihood that they would survive.

Milk collection procedure which commenced immediately after the first one week of lactation was done for 12 weeks for each WAD doe and it followed the procedure done by Williams et al. (2019). Milk was collected

once daily at 8:00 a.m. and three times a week on Mondays, Wednesdays, and Fridays. This is done to promote kid survival by allowing the kids to have enough access to milk. Kids were taken away from their dam at 5:00 p.m. on the day before milking and brought back right away after the next day's milk collection. However, to prevent starvation during the time of separation, kids were bottle fed the goats' milk and forages.

The milking of the does, which started at 8:00 am after the kids were separated at 5:00 pm the day before, produced a milk yield of 15 hours. This was then multiplied by 24 hours and divided by 15 hours to produce a milk yield of 24 hours, as reported by Williams et al. (2019). A calibrated cylinder and a sensitive weighing scale were used to measure the volume and weight of the milk collected from both sides of the udder in order to determine the milk yield. However, because three distinct milking techniques: hand-milking, weigh-suckle-weigh, and suckle-hand methods were employed to ascertain and compare the maximal milk extraction during the experiment, the process of collecting milk was contingent upon the technique allocated to the animals. The process of milk collection based on method of milking involves:

i) Hand-milking method (HM): This process of milk collection involves, calmly restraining the WAD doe using a rope to the side of the pen and the rear leg tied to the side of the pen to have an access to the udder. The udder was cleaned using a damped clean towel (this is to stimulate the udder and prevent contamination of the milk) after which hand was used using the thumb and the first finger to jap the teat for milk secretion and this was done until little or no milk was left to collect from both udders. Milk was collected into a milking cup and then weighed on a sensitive scale and values recorded in gram/day (g/day).

ii) Weigh-suckle-weigh method (WSW): Separating the kid or kids from the dam in the evening before the milking day is a step in the milk determination process. The following day at 08:00hr in the morning, the weight (W1) of the kid(s) was first taking using a weighing scale before being allowed to suckle the dam until the dam stops or refuses the kid(s) to continue suckling and then the kid(s) were withdrawn and weighed again (W2). The difference in kid's weight stands as the milk yield for that animal.

iii) Suckle-hand method (SH): This process also involves separation of the kid(s) from the dam a day before milking. The following day, the kid(s) were weighed first using a weighing scale and weight recorded as initial weight (W1), then introduced to the dam (calmly restrained) to suckle. After kid (s) suckling, the kid(s) were weighed again and weight recorded as final weight (W2). The remaining milk in the udder was then removed by hand-milking the doe. The difference between the kid's weight and the amount of milk received was added to determine the milk production.

Milk yield (g) = difference in kid weight (W2- W1) + Residual milk

Udder Measurements

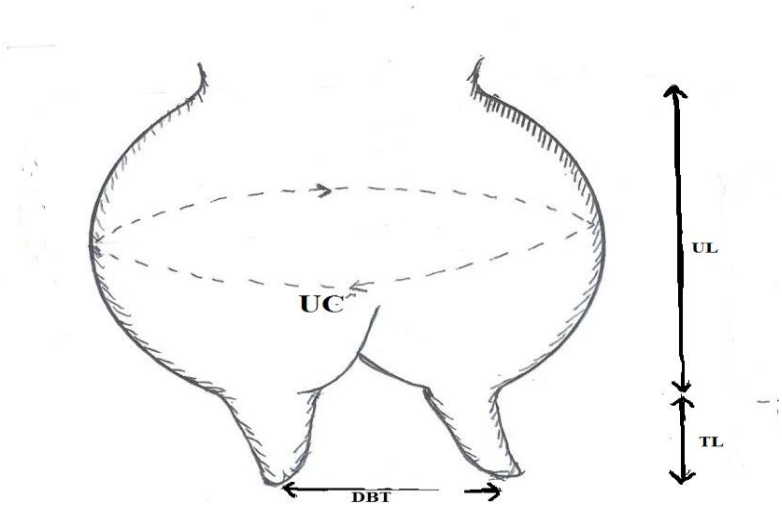
Measurements of the udder were made regardless of the milking technique; however, wattle possession was taken into account in order to assess the correlation between udder characteristics and both milk yield and wattle. Before milking, a tape rule was used to measure the udder circumference (UC), udder length (UL), distance between teats (DBT), and teat length (TL). An illustration of the various udder and teat dimensions is presented in Figure 1. The chosen udder traits were selected based on their significant influence on milk yield in the report by James et al. (2002). The udder and teat dimensions measured during the study in centimeters (cm) include the following:

i) Udder circumference (UC): This was calculated by measuring the distance around the udder's mid-udder region

ii) Udder length (UL): The vertical distance between the teat's attachment to the udder and the udder's attachment to the dam's body was measured.

iii) Distance between teats (DBT): This was determined by taking a measurement from the midline of the teat to the distance between the left and right teats.

iv) Teat length (TL): This was determined by measuring the separation between the udder's base and the teat tips.



Key: UC= Udder circumference; UL= Udder length; DBT= Distance between teats
TL= Teat length

Figure 1: Measurement of udder characteristics in WAD goats

Statistical Model and Analysis

A Randomized Completely Block Design (RCBD) was used for the experiment, and SYSTAT (1992) was used to analyze the data. The same

statistical package's Turkey's honest significance difference (HSD) test was used to compare significant least square means. Pearson's correlation technique was used to assess the connection between udder and teat measures and daily milk yield (DMY) (SYSTAT, 1992). At $p < 0.05$, the study's findings were deemed significant. Significant relationships were categorized as weak ($r < 0.3$), moderate (r between 0.3 and 0.7), or high ($r > 0.7$), according to Bilandzic et al. (2014). The daily milk yield was calculated using the following statistical model:

$$Yijk = \mu + Ai + Bj + ABij + \sum ijk$$

Yijk = Daily milk yield, μ = Population means

Ai = Fixed effect of the ith milking methods (i =1-3), Bj = Fixed effect of the jth wattle (j =1-2)

ABij = Interaction between ith milking methods and jth wattle, ∑ijk = Random residual error

RESULTS AND DISCUSSION

Dairy animals' milk production could be measured using methods such as weigh-suckle-weigh, hand-milking, and machine-milking (Banda et al. 2007: Benson et al. 1999). Table 3 shows the effects of wattle gene and milking practices on the daily milk production of West African dwarf (WAD) goats, which is consistent with the findings of Unal et al. (2007). The milk extraction technique had a substantial ($p<0.05$) impact on the daily milk yield of WAD goats. Results showed that daily milk yield obtained from goats milked by weigh-suckle-weigh (293.6 g/goat/day) and hand-milking methods (292.3 g/goat/day) were significantly lower to that obtained through the use of suckle-hand method (338.6 g/goat/day). And this is because there was a complete milk extraction was obtained using the Suckle-hand method and this might be due to the effect of increase in oxytocin released following the synergetic tactile stimulation of the mammary gland by suckling done by the kids and the immediate use of hand to milk the udder to get the residual milk after kid suckling leading to maximum milk extraction from the udder, and this new discovery supports the findings of Banda et al. (2007), who observed that estimate of milk yield from local Malawian ewes by suckling was significantly higher than that of its hand milking counterpart. Many production traits are correlated with wattle like growth and milk yield (Ozoje and Mgere, 2002; Williams et al. 2015) and higher body weight (Adedeji et al. 2012).

This study found that neither the existence of the wattle gene in West African dwarf does nor its presence had a significant ($p>0.05$) impact on daily milk output and this is in agreement with the report of Stultz (2016) in dairy goats but in disagreement with some previous reports (Abubakar et al. 2022;

Ijomanta, 2012; Kolo et al. 2023) in Red Sokoto goats, Hermiz et al. (2016) in Shami goat and Williams et al. (2015) in West African dwarf goats. The method of milk extraction utilized to determine milk yield, the breed of goat, the age and parity of the animals employed, the season, and the diet the animals were given could all be contributing factors to the differences between this study and previous research. Milk yield of WAD does with wattle differ with response to the use of milking methods used.

Table 3: Effect of milking methods and wattle on daily milk yield of WAD goats

Factors	Variations	Daily milk yield (g/goat/day)
Milking methods	Hand-milking	292.3 ± 11.41[b]
	Suckle-hand	338.6 ± 10.06[a]
	Weigh-suckle-weigh	293.6 ± 10.57[b]
Wattle	Present	311.2 ± 9.86
	Absent	300.5 ± 11.04

[a-b]Means in the same column having different superscripts differ significantly ($P < 0.05$)

Table 4 shows how the milking techniques and wattle presence or absence interact to affect the daily milk production of WAD goats. The findings indicated that the daily milk yield was significantly ($p<0.05$) influenced by the interactions between milking methods and wattle. The highest daily milk yield was recorded in WAD goats milked with the weigh-suckle-weigh method and with the wattle gene present (359.60 g/goat/day) and WAD goats milked with the suckle-hand method and without the wattle gene (354.80 g/goat/day), while the lowest daily milk yield was recorded in WAD goats milked with the weigh-suckle-weigh method and without the wattle gene (225.60 g/goat/day). One possible explanation for this could be the way the animals were milked, where the kids' stimulation of the udder led to an increase in oxytocin secretion that helped the milk letdown flow. This is consistent with the findings of Somerville and Lowman (1980), who found that the weigh-suckle-weigh method is more appropriate for estimating milk yield in beef cattle.

The average values of 225.6-359.6 g found in this study fall within the range of the daily milk yield values of 140.6 g, 248.22 g, 255.11 g, and 252.95 g reported by Makun et al. (2008); Zahraddeen et al. (2009); Williams et al. (2015), and Idorenyin (2024) respectively. However, it fell short of the 300–600 g range described by Greying et al. (2004) and Akpa et al. (2002). According to Akpa et al. (2003), the genetic composition, milking frequency, breed, collection technique, and nutritional intake of various goat breeds may all be responsible for the variances in average daily milk supply.

Several authors' previous research (Ozoje and Mgbere, 2002; Williams et al., 2015) suggested that wattle features and animal performances specifically, growth, reproduction, and milk yield were positively correlated.

Table 4: Effect of interaction between milking methods and wattle on daily milk yield of WAD goats

Wattle	Milking methods	Daily milk yield (g/goat/day)
Wattle	Suckle-hand	322.40 ± 14.43[ab]
	Weigh-suckle-weigh	359.60 ± 13.29[a]
	Hand-milking	269.60 ± 28.88[b]
Non-wattle	Suckle-hand	354.80 ± 15.34[a]
	Weigh-suckle-weigh	225.60 ± 18.49[c]
	Hand-milking	321.00 ± 10.83[ab]

[abc]Means in the same column having different superscripts differ significantly (P < 0.05)

Since there was no difference in the size of the traits, the effect of the wattle gene's presence or absence on the udder traits of West African dwarf goats, as displayed in Table 5, was found to be non-significant. This is in contrast to the findings of Abubakar et al. (2022), who found a significant difference in udder traits between Red Sokoto goats with and without the wattle gene. The non-significant effect of wattle on milk production in WAD goats in this study may be due to the wattle gene's lack of effect on udder characteristics. The study's mean values for udder morphological features are higher than those published by Adewumi et al. (2017), Abubakar et al. (2022), and Zahraddeen et al. (2007).

Table 5: Effect of wattle gene on Udder and teat traits of West African dwarf Goats

			Udder and	**teat traits**	
Traits	N	UC (cm)	UL (cm)	DBT (cm)	TL (cm)
Wattle	24	32±0.2	12.8±0.23	2.6±0.1	9.8±0.1
Non-wattle	24	31.8±0.5	13±0.18	2.59±0.2	9.9±0.05

The lactation curve of WAD goats subjected to three milking methods over thirty-six (36) days of milking is presented in Figure 2. Generally, milk yield increases from the beginning of the lactation period, peaked and then declined towards the end of the lactation period. However, different peak periods were observed for daily milk yield based on milking methods. From the graph, it was observed that the peak week and yield for WAD goats that were milked through the use of hand-milking (493.95g) and suckle-hand (536.22g) method occurred at the second week, while that of does milked via weigh-suckle-weigh method peaked at third week (545.48g). The lactation curve shows the rise and fall in milk production with the lactation cycle's peak time. This study supports the findings of several authors (James et al. 2002; Mahmoud et al. 2014; Norris et al. 2011; Williams et al. 2012a, 2012b) who reported a decrease in goat milk yield as lactation progresses, primarily due to a decrease in secretory tissues and a decrease in the rate of secretion per cell.

The daily milk yield of WAD did increase from the beginning of lactation, peaked at weeks two and three (depending on the method employed), and decreased towards the end of lactation. According to a number of studies, nursing animals' peak milk yields occurred at different times throughout lactation (Ayadi et al. 2011; Makun et al. 2013; Sangare and Pandey, 2000; Zahraddeen et al. 2009). In this study, the peak milk yield for the methods used peaked on different weeks whereby WAD does milked with suckle-hand and does milked with hand milking methods had their peak period at week 2 of lactation while WAD does milked through the use of weigh-suckle-weigh method had a peak period in week 3. A possible reason for variations in result in peak period and peak milk yield obtained from the three different methods could arise from the way the WAD does respond to the techniques used, the difference in their litter size, body weight and parity of the animals.

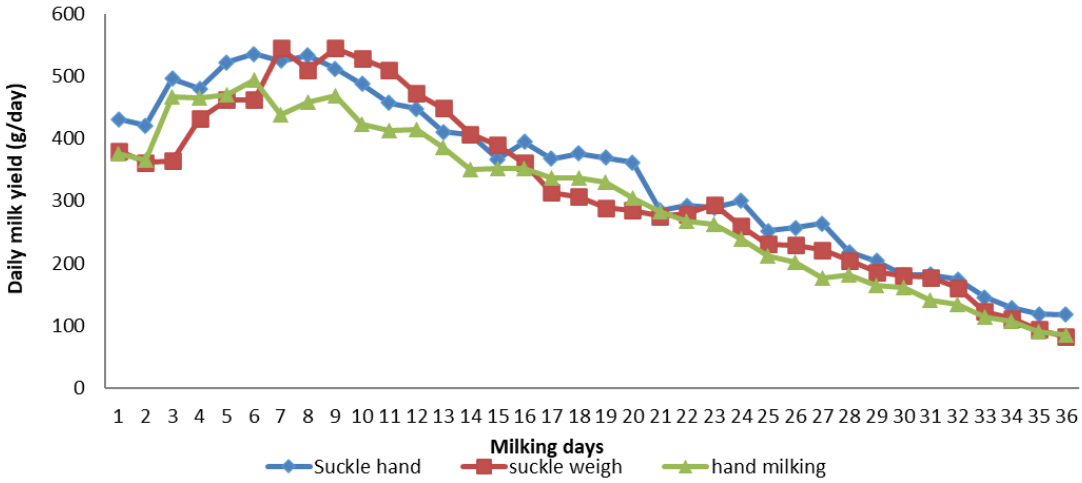


Figure 2: Lactation curve of WAD does subjected to three milking methods

Generally speaking, correlations between economically significant qualities are necessary to predict how one feature will change in response to selection for another, assess whether it is feasible to select for multiple traits simultaneously, and forecast the overall outcomes of a selection program (Wattiaux, 2002). The udder dimension features and daily milk output in this investigation were significantly and favorably correlated (Table 6). Daily milk output was found to have a somewhat favorable link with TL (r = 0.406), as well as a high and positive correlation with UC (r = 0.818), UL (r = 0.792), and DBT (r = 0.760). Result also showed a positive correlation within the udder traits whereby, UC had a strong and positive correlation with UL (r = 0.763), DBT (r = 0.737) but weak with TL (r = 0.166). UL had a moderate positive

correlation with DBT (r = 0.403) and weak with TL (r = 0.321) while DBT showed a moderate positive correlation with TL (r = 0.348).

The observed positive correlations between udder traits (udder length, udder circumference, and distance between teats and teat length) and daily milk yield suggest that these traits are interdependent. Therefore, selection for lengthening or measuring the targeted traits may result in higher milk yield (Adewumi et al. 2006; Iniguez et al. 2009; James et al. 2002 and Sam et al. 2017). The results of this investigation showed that milk output and udder length and circumference were positively correlated. These findings are consistent with those of Merkhan and Alkass (2011) in Black and Meriz goats, Adewunmi et al. (2006) in Yankasa and WAD ewes, Patel et al. (2016) in crossbred cows, and Kolo et al. (2023) in Red Sokoto does between daily milk yield and distance between teats were significant and positive and this agrees with the report of James et al. (2002). A report by Adewumi et al. (2006) also acknowledge that a weak and positive correlation exist between milk yield and teat length and this support these present findings of correlation between teat length and milk yield but in disagreement with the report of Kolo et al. (2023) who reported a negative correlation between teat length and milk yield in Red Sokoto goats.

Table 6: Pearson's correlation between udder and teat dimensions and daily milk yield

	DMY	**UC**	**UL**	**DBT**	**TL**
DMY	1.000				
UC	0.818***	1.000			
UL	0.792***	0.763***	1.000		
DBT	0.760***	0.737***	0.403**	1.000	
TL	0.406***	0.166**	0.321*	0.348**	1.000

Significantly correlated at *P < 0.05; **p < 0.01; ***P < 0.001
DMY= daily milk yield (g), UL= udder length (cm), UC= udder circumference (cm) DBT= distance between teat (cm), TL= teat length (cm)

There has also been evidence of a strong correlation between milk supply and udder size in cattle (Kilekoung et al. 2017) and sheep (Kukovics et al. 2006). Daily milk yield increase in this study corresponds with increase in udder size and this finding supports the observation of James and Osinowo (2004) and James et al. (2006) who reported that udder size of goats has a direct relationship with milk yield. Therefore, milk yield could possibly be predetermined based on udder size of does and increase in udder size would increase milk yield. Positive correlations that exist between the udder traits measured, means that these traits depend on each other and this supports the observation of James et al. (2002). Since phenotypic correlation is crucial for

forecasting indirect response to selection in a multiple characteristic's selection program, particularly for milk production, this could serve as a foundation for choosing udder traits of native goats.

CONCLUSION

The manner of milking had a substantial impact on the daily milk yield of West African dwarf (WAD) does, although wattle presence or absence had no effect on udder features or daily milk yield. Udder length, teat distance, and daily milk production are all positively and significantly correlated with one another. The more milk that WAD does produces, the greater the udder's size, length, and distance between the teats.

ACKNOWLEDGEMENTS

Without the help of numerous individuals, this study would not have been able to be completed, and their contributions are truly valued and thanked. But I want to specially thank Professor T.J. Williams, Professor M.O. Ozoje, Dr. O.E. Oke, Dr. E.O. Adekunle, Dr. A.J. Odeyemi, all of the academic and non-academic staff of the Department of Animal Physiology, and the entire staff of the Directorate of University Farm (DUFARM) of the Federal University of Agriculture, Abeokuta, Ogun State, Nigeria, in particular, for their understanding and support during the research period

REFERENCES

Abubakar, M.Y., Kabir, M., Orunmuyi, M., 2022. Influence of Wattle gene on Udder and milk yield characteristics in Red Sokoto Goats. Proceeding of 47th Annual Conference. Nigerian Society of Animal Production (NSAP). 37, 131-135.

Adedeji, T., Ozoje, M., Otunta, T., Ojedapo, L., Ojediran, T., Ige, A., 2012. Effect of wattle trait on body sizes and scrotal dimensions of traditionally reared West African dwarf (WAD) bucks in the derived savannah environment. Iran J. Appl. Anim. Sci. 2 (1): 69-72.

Adewumi, O.O., Chineke, C.A., Alokun,. JA., Oladipupo, O.A., 2006. Effects of genotype and sex on linear body measurement in sheep. Proceedings of the 11thannual Conference of the Animal Science Association of Nigeria held at Institute of Agricultural Research and Training, Ibadan, Nigeria. 10: 207-210.

Adewumi, O.O., Osunlaja, O.S., Tona, G.O., Idowu, S.T., 2017. Milk yield, Udder and Teat dimensions before and after milking of West African Dwarf goats at early lactation and at first parity. Proceedings of 42nd Annual Conference of Nigerian Society of Animal Production. Landmark University Omu-Aran, Kwara State. Pp. 917-920.

Akpa, G.N., Asiribo, O.E., Oni, O.O., Alawa, .JP., Dim, N.I., Osinowo, O.A., Abubakar, B.Y., 2002. Milk production by Agropastoral Red Sokoto goats in Nigeria. Trop. Anim. Health Prod. 34: 525-533.

Akpa, G.N., Asiribo, O.E., Oni, O.O., 2003. Relationships among udder and teat size characteristics with milk yield in Red Sokoto goats. Trop. Agric. 80: 114-117

Ayadi, M., Such, X., Ezzehizi, N., Zouari, M., Najar, T., Casals, R., 2011. Relationship between mammary morphology traits and milk yield of Sicilo-Sarde dairy sheep in Tunisia. Small Rumin. Res. 96: 41-45.

Banda, J.W., Steinbach, J., Zerfas, H.P., 2007. Composition and yield of milk from non-dairy goat and sheep in Malawi. J. Dairy Res. Pp 1-18.

Benson, M.E., Henry, M.J., Cardellino, R.A., 1999. Comparison of weigh-suckle-weigh and Machine milking for Measuring Ewe milk production. J. Anim. Sci. 77: 2330-2335.

Bilandzic, N., Sedak, M., Dokic, M., Kolanovic, B.S., Varenina, I., Bozic, D., Koncurat, A., 2014. Differences of the essential mineral element levels in the Milk of Croatian cold blood horse and littoral-dinaric donkey. Mljekarsivo. 64(1):12-18.

Casu, S., Pernazza, I., Carta, A., 2006. Feasibility of a linear scoring meted of udder morphology for the selection scheme of Sardinian sheep. J. Dairy Sci. 89:2200-2209

Dzidic, A., Kaps, M., Bruckmaier, R.M., 2004. Machine milking of Istrian dairy crossbreed ewes, udder morphology and milking characteristics. Small Rumin. Res 55:183–189.

Google Earth., 2016. http://www.google.earth. Accessed on the 10 of February, 2016.

Greyling, J.P., Mmbengwa, V.M., Schwalbach, L.M.J., Muller, T., 2004, Comparative milk production potential of indigenous and Boer goats under two feeding systems in South Africa. Small Rumin. Res. 55: 97-105.

Hermiz, H.W., Shaker, A.S., Al-Khatib, T.R., Ameen, S.H.N., Ahmed, A.M., Hamad, B.D., 2016. Inheritance of Wattle and their Effect on Twinning and Some Productive Traits in Shami goats. Int. J. Adv. Sci. Eng. technol. 4:1-5.

Hodges, J., 2002. Conservation of farm Animals biodiversity: History and prospects. Animal care information. 32: 1-2.

Ibe, S.N., 2000. Livestock Production in the South East Zone: Prospects and strategies in the new millennium. Proceedings of the 14th Annual Farming System Research and Extension Workshop in South-Eastern Nigeria, Umudike, Abia State. 64: 324-329.

Idorenyin, M.S., 2024. Milk Yield and its Correlation with Conformation Traits in West African Goats Reared in the Tropics. Res. J. Vet. Sci. 17 (1): 17-23

Ijomanta, E.O., 2012. Genetic Profile of Morphological Traits and their Association with Production Capacity of the Red Sokoto Goats in Katsina State of Nigeria. MSc Dissertation. Department of Animal Science, ABU, Zaria.

Iniguez, L., Hilali, M., Thomas, D.L., Jesry, G., 2009. Udder measurements and milk production in two Awassi sheep genotypes and their crosses. J. Dairy. Sci.92:4613-4620.

James, I.J., Osinowo, O.A., Ozoje, M.O., Biobaku, W.O., Fanimo, A.O., 2002. Changes in Udder dimensions of West African dwarf, Red Sokoto and Sahel goats during lactation and their phenotypic relationship with partial daily milk yield. Proceedings of the 7thAnnual Conference of Animal Science Association of Nigeria (ASAN) held at University of Agriculture, Abeokuta, Nigeria. Pp. 33-36.

James, I.J., Osinowo, O.A., 2004. Changes in udder size and live weight of West African dwarf, Red Sokoto and Sahel goats during lactation and their phenotypic relationship with partial daily milk yield in goats. Nig. J. Anim. prod. 31 (1) Pp:252-262.

James, I.J., Osinowo, O.A., Oni, O.A., 2006. Relationship between teat dimensions and milk ability of West African dwarf and Red Sokoto goats. Proceedings of the 31st Annual Conference of Nigerian Society for Animal Production held at Bayern University, Kano, Nigeria. Pp. 38-42.

Kolo, P.S., Alemede, I.C., Egena, S.S.A., Adama, J.Y., Banjo, A.A., Out, B.O., 2023. Influence of wattle on udder measurements and milk yield of Red Sokoto (Maradi) does raised semi intensively in Minna, Niger state, Nigeria. Nig. J. Anim. Sci. 25 (1): 35-46

Kukovics, S., Andras, M., Maria, A., Timea, N., Istvan, K., 2006. Effect of udder traits on milk yield of sheep. Arch. Anim. Breed. 49 (2), 165-175.

Kilekoung, J.P.M., Julius, A.N., Houinga, D., Pagnah, A., 2017. Effects of body conformation and udder morphology on milk yield of Zebu cows in North region of Cameroon.Vet.World. 10(8): 901-905.

Makun, H.J., Ajanusi, J.O., Ehoche, O.W., Lakpini, C.A.M., Otaru, S.M., 2008. Growth rates and milk production potential of Sahelian and red Sokoto breeds of goats in Northern Guinea Savannah. Pak. J. Biol. Sci. 11: 601-606.

Mahmoud, N.M.A., El Zubeir, I.E.M., Fadlelmoula, A.A., 2014. Effect of stage of lactation on Milk yield and composition of first kidder Damascus does in the Sudan. J. Anim. Prod. Adv. 4(3): 355-362.

Makun, H., Otaru, S.M., Dung, D., 2013. Effect of management practices on milk yield and live weight changes of indigenous breeds of goats supplemented with groundnut haulms and concentrate in sub humid zone of Nigeria. Sokoto J. Vet. Sci. 11(1):45-50.

Mellor, D.J., Dingwall, R.A., King, T.J., 1993. Successful fostering of orphan lambs by non-pregnant ewes induced to lactate using exogenous hormone treatment. J. NZ. Vet. 41: 200–204.

Merkhan, K.Y., Alkass, J.E., 2011. Influence of udder and teat size on milk yield in Black and Meriz goats. Res. Opin. Anim. Vet. Sci. 1: 601-605

Mirzadeh, K.H., Masoudi, A., Chaji, A., Bojarpour, M., 2010. The Composition of raw milk produced by some dairy farms in Lordegan region of Iran. J. Anim. Vet. Adv. 9(11):1582 1583.

Morand-Fehr, P., 2004. Proposals for improving the research efficiency in goats. Small Rumin. Res. 51:145-153.

Norris, D., Ngambi, J.W., Benyi, K., Mbajiorgu, C.A., 2011. Milk production of three exotic dairy goat genotypes in Limpopo province, South Africa. Asian J. Anim. Vet. Adv. 6(3): 274 281.

OORBDA., 2016. Ogun Osun River Development Authority. Annual Report.

Ozoje, M.O., Mgere, O.O., 2002. Coat pigmentation effects in West African dwarf (WAD) goat's live weight and body dimensions. Nig. J. Anim. Prod. 29: 510.

Patel, Y.G., Trivedi, M.M., Rajpura, R.M., Savaliya, F.P., Monika, P., 2016. Udder and teat measurements and their relation with milk production in crossbred cows. Inter. J. Environ. Sci. Technol, 5(5), 3048-3054.

Reber, I., Keller, I., Becker, D., Flury, C., Welle, M., Drogemuller, C., 2015. Wattles in Goats are Associated with FMNI/GREMI Region on Chromosome 10. Anim Gen.46:316-320.

Sabbioni, A., Beretti, V., Paini, V., Superchi, P., 2011. Occurrence and inheritance of wattles and effects of genotype on wattle growth curve parameters in "Nero di Parma" pigs. Liv.Sci. Pp137:226–230.

Sam, I.M, Akpa, G.N., Alphonsus, C., 2017. Factors influencing udder and milk yield characteristics of indigenous goats in North-West Nigeria. Asian Res. J. Agric. 10(3): 159-162

Sangare, M., Pandey, V.S., 2000. Food intake, milk production and growth of kids of local, multipurpose goats grazing on dry season natural Sahelian rangeland in Mali. J. Anm. Sci. 71: 165-173.

Somerville, S.H., Lowman, B.G., 1980. A comparison of machine-milking and the calf suckling technique as methods of measuring the milk yield of beef cows. Anim. Prod. 30:365-372.

Stultz, J., 2016. What are wattles? Dairy Goat Journal. https://backyardgoats.iamcountrys ide.com/ownership/all-about-goat wattles. Accessed March 14 2019.

SYSTAT., 1992. Computer Package, Version 5.02 SYSTAT, Inc. 1800 Sherman Av.Evanston, IL USA, 6021, 708.864.5670.

Unal, N., Atasoy, F., Akcapinar, H., Kocak, S., Yakan, A., Erol, H., Ugurlu, M., 2007. Milk yield measured by oxytocin and hand milking and

weigh-suckle-weigh methods in ewes originating from local crossbred in Turkey. Rev. Med. Vet. Pp 159: 320-325.

Vahcic, N., Hruskar, M., Markovic, K., Banovic, M., Colic, I., 2010. Essential minerals in milk and their daily intake through milk consumption. Mljekarsivo. 60:77-85.

Wattiaux, M.A., 2002. Technical dairy guide: Reproduction and Genetic selection. The Babcock institute for international dairy Research and Development University of Wisconsin. pp. 111-132.

Williams, T.J., Osinowo, O.A., Smith, O.F., James, I.J., Ikeobi, C.O.N., Onagbesan, O.M.,Shittu, O.O., Solola, F.T. ,2012a. Effects of milking frequency on milk yield, dry matter intake and efficiency of feed utilization in West African dwarf goats. Univ. Cordoba, Spain.61(235): 457-465.

Williams, T.J., James, I.J., Abdulateef, R.M., Onagbesan, I.O., Jinadu, S.O., Falade, Y.O., Solola, F.T.,Adewunmi OO, Oke OE (2012b) Composition and specific gravity of milk of West African dwarf sheep as affected by stage of lactation and parity. Nig. J. Anim. Prod. 39(11): 49-56.

Williams, T.J., James, I.J., Adewumi, O.O., Ozoje, M.O., Ajibola, A.T., Ohayi, M.O. 2015. Milk yield and rectal temperature in West African dwarf goats as affected by wattle and litter size. Nig. J. Anim. Prod. 42(2):34-45.

Williams, T.J., Ozoje, M.O., Okwelum, N., Adewumi, O.O., Iyasere, O.S., Abioja, M.O., Opeloyeru, O.K., Awotedu, O.O. 2019. Milk yield in West African dwarf goats as influenced by coat colour, live weight,week of lactation and udder circumference. Nig. J. Anim. Prod. 46 (3):325-332.

Zahraddeen, D., Butswat, I.S.R., Mbap, S.T., 2007. Evaluation of some factors affecting milk composition of indigenous goats in Nigeria. Liv Res Rural Dev. 19:166-176.

Zahraddeen, D., Butswat, I.S.R., Mbap, S.T., 2009. A note on factors influencing milk yield of local goats under semi-intensive system in Sudan Savannah ecological zone of Nigeria. LivRes Rural Dev. 1: 1-6.

Zeder, M.A., Hasse, B., 2000. The initial domestication of goats (Capra hircus) in the Zagros Mountains 10,000 years ago. 287:2254-2257.