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Milk Yield and its Correlation with Conformation Traits in West African Goats Reared in the Tropics

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ABSTRACT

Background and Objective: Goat milk plays a crucial nutritional role in developing countries, particularly in rural areas where most goats are raised. Research suggested that addressing protein deficiency in these regions could be achieved by promoting goat farming, which offers both meat and milk. Therefore, harnessing the genetic diversity of indigenous goat breeds could enhance milk production potential through selective breeding. This study was conducted to evaluate milk yield and conformation traits in West African dwarf goats as well as the phenotypic correlation between milk yield and conformation traits. **Materials and Methods:** A total of twenty-four West African Dwarf lactating does from eight herds were studied. Body conformation traits studied were body length (BL), height at wither (HW), hearth girth (HG), stature (ST) and body depth (BD). Body weight (BWT) of the does was also evaluated. Milk yield traits studied were average daily yield (ADY), initial yield (IY), total yield (TY), peak yield, peak day (PD) and lactation length (LL). Correlation between milk yield and conformation traits was established using Pearson correlation analysis of SPSS. **Results:** The result obtained indicated that milk yield traits were 252.96±15.21 g, 135.80±9.51 g, 12.66±0.86 kg, 28.15±0.41 days, 412.46±23.10 g and 50.60±2.65 days for ADY, IY, TY, PD, PY and LL, respectively. The body weight and the conformation traits were 20.25±1.08 kg, 57.24±1.57, 24.64±0.73, 51.22±1.45, 24.64±0.73, 51.22±1.45, 71.88±1.08 and 56.49±1.40 cm for BWT, RH, BD, HW, HG and BL, respectively. The phenotypic correlation established between investigated milk traits and body conformation traits was positive (r = 0.011-0.893) except for the relationship with PD which was negative (r = -0.002 to-0.121). The correlation coefficient established between all the conformation traits with ADY, TY and PY were positive and significant ($p<0.01$). **Conclusion:** The findings from this study indicate a positive relationship between body conformation traits and milk yield traits and this suggests a level of dependency between these traits. Therefore, any impairment in any one of these traits would elicit a correlated response in the others indicating that these conformation traits can be used as selection criteria in the improvement of milk yield traits in West African Dwarf goats.

KEYWORDS

Conformation, milk yield, traits, correlation, west african dwarf, goat

INTRODUCTION

The role of goats in developing countries like Nigeria cannot be over emphasized. It plays an important role in the economy of such countries as it provides a source of livelihood to farmers who reared them

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throughout the year[1]. Goat population in Nigeria is about 57.3 million and Nigeria contributes significantly to the population of goats in Africa (321.5 million)[2]. Goats are predominantly owned by rural households irrespective of age groups or sex[1]. Goats are the second group of animals producing milk after dairy cattle in both temperate and tropical region. Recently, the dairy goat industry is gaining popularity globally.

Goat milk play a key role in the nutrition of developing countries where it provides protein to the rural people where majority of the goats are reared. It has been observed that protein deficiency problems in developing countries could be reduced through small ruminant, provision of meat and milk[3]. Thus, utilizing genetic diversity of indigenous goats would improve milk production potential of the indigenous goats through selection. The West African Dwarf is the most predominant breed of goat in the Southern part of Nigeria.

Enhancing milk traits and performance, such as milk yield, milk fat, or protein content, relies on both direct selection for these specific traits and indirect selection of correlated traits. It's imperative to incorporate traits beyond milk yield into goat milk improvement programs, particularly those that exert direct or indirect influences on milk production, such as body conformation traits[4]. Assessing body dimensions is crucial as they serve as indicators of the morphological and physiological foundations for the expression of production and reproduction traits[5]. Notably, Zujovic *et al*.[4] reported significant correlations between traits like height at wither, body weight, breast width, breast depth and rump width with total milk production in Balkan goats. Various researchers, including Zujovic *et al*.[4], Khan *et al*.[6] and Osuhor *et al*.[7], have investigated the phenotypic relationship between milk yield and body weight across different goat breeds.

There is paucity of information on relationship between body conformation traits and milk yield traits in West African Dwarf goat, such information would help in selection programmes targeted at improving milk yield. Therefore, the objective of this study was to establish the phenotypic correlation between conformation traits and milk production traits in West African Dwarf goats.

MATERIALS AND METHODS

Study area: The experiment was conducted at Aba Ukpo, Ibesikpo Local Government in Akwa Ibom State, Nigeria. The research was carried out between the April to November, 2023 eight small holder farmers herd (with lactating does) were selected for this study. Aba Ukpo is located between Latitudes 4°30 N and 5°00N and Longitudes 70°30°E and 80°00E. The area is characterized with an average annual rainfall ranging from 3450 mm an average monthly temperature of 25°C and relative humidity between 80-90%. Aba ukpo Ibesikpo withness two distinct seasons which are dry and rainy seasons with the latter lasting for longer periods of the calendar year. It is in the tropical rainforest zone of Nigeria. The people in the study areas depend on livestock and crop production.

The animals and management: A total of 24 does (with parity 1-3; from 8 herds) age 2-4 years were hand milked twice a week. All milk measurements commenced from day seven postpartum (to allow kids assess to colostrum) and were taken till the milk was less than 100 mL.

The animals were intensively managed and fed with browse plants and grasses that were cut and fed to them in the stall. Sometimes supplementary feed in form of cassava peel, yam peel and kitchen wastes were also given to them.

During the milking process, lactating does were kept calm by providing supplements in a feeder. The quantity of milk available per doe per test day was measured using graduated plastic beakers. Kids were separated from their dams at 18 hrs on the evening preceding the day of milking. On the test day, both halves of the udder of each lactating doe were hand-milked for all the herds from 6-8 hrs and the milk yield was recorded to the nearest gram.

Milk yield characteristics were measured as follows:

- **Average daily yield (ADY):** Calculated as the average of all test day yields within the periods milked
- **Initial yield (IY):** Defined as the milk yield at day 7 postpartum
- **Total yield (TY):** Represents milk production during the study period before production drops below 100 mL
- **Peak yield (PY):** Indicates the yield with the highest test day yield
- **Peak day (PD):** Refers to the day with the highest yield
- **Lactation length (LL):** Defined as the period during which the doe was milked

Measurement of conformation traits: Conformation traits were assessed according to the methodology outlined by Sam *et al.*[3], with the following measurements recorded for each animal:

- **Body weight (BWT):** Measured using a hanging scale
- **Body length (BL):** Determined with a flexible tape, measuring from the occipital protuberance to the base of the tail in centimeters (cm)
- **Height at withers (HW):** Measured from the ground to the withers using a measuring tape, recorded in cm
- **Heart girth (HG):** Circumference of the chest measured with a measuring tape, reported in cm
- **Stature (ST):** Rump height measured from the ground to the rump using a measuring tape, in cm
- **Body depth (BD):** Circumference immediately after the hind leg towards the abdomen, measured with a measuring tape, in cm

Statistical analysis: The relationship amongst milk yield, body conformation traits as well as relationship between body conformation traits and milk yield traits were determined by correlated analysis procedure of SPSS package.

Ethical consideration: Ethical consideration every care applicable to international, national and university guidelines for the care and used of animals were followed.

RESULTS AND DISCUSSION

Summary statistics of milk yield and conformation traits in West African Dwarf goat: The mean values±standard error, minimum and maximum values as well as coefficient of variations for milk yield and body conformation traits were presented in Table 1. The results indicated that ADY was 252.95±15.21 g; IY was 135.80±9.51, TY was 12.66±0.86 g, PD was 28.15±0.41 days, PY was 412.46±23.10 g and LL was 50.60±2.65 days.

Measures of milk yield capacity in West African Dwarf lactating does exhibited low to moderate variability, varying from 6.64 to 31.31. The lowest variability was recorded for PD while the highest was IY. The mean values for body weight and conformation traits were 20.75±1.06 kg, 57.24±1.57, 24.64±0.73, 51.22±1.45, 71.88±1.08 and 56.49±1.50 cm for BWT, RH, BD, HW, HG and BL, respectively. The average daily yield (ADY) of milk in this study was found to be similar to the report of Williams *et al.*[8], who documented 255.11g/day. However, it surpassed the figures of 248.22 g, 188.22 g, 135.3 g and 140.6 g reported by Zahradden *et al.*[9] and Makun *et al.*[10], respectively. Nonetheless, it fell short of the range of 300-600 g reported by Akpa *et al.*[11] and Greying *et al.*[12]. The variations observed in ADY may be attributed to factors such as milking frequency, breed and collection method. The genetic makeup and nutritional intake of different goat breeds significantly influence milk yield and composition studied by Akpa *et al.*[13]. Additionally, Sum *et al.*[14] reported a 52.7% reduction in milk yield with once-a-day milking. The total yield (12.66±0.80) in this study was lower than the 29.35 kg in Nigerian agropastoral goats. It was also lower than the reports of Egwu *et al.*[15] and Makun *et al.*[10]. The observed differences could be attributed to the frequency of milking, lactation length as well as the breeds of animals. The variability of the milk traits

Table 1: Summary statistics for milk yield and conformation traits of lactating does of West African Dwarf goat

Trait	Mean±SE	SD	CV	Minimum	Maximum
Milk yield					
ADY (g)	252.96±15.21	68.03	26.89	174.86	396.96
IY (g)	135.80±9.51	42.53	31.31	84.00	210.01
TY (kg)	12.66±0.86	3.87	30.56	6.81	19.45
PD (days)	28.15±0.41	1.87	6.64	24.00	31.00
PY (g)	412.46±23.10	103.31	25.04	100.56	600.51
LL (days)	50.60±2.65	11.88	23.47	36.00	91.00
Body weight and conformation					
BWT (kg)	20.75±1.08	4.77	22.98	13.24	30.81
RH (cm)	57.24±1.57	7.03	12.28	50.12	70.25
BD (cm)	24.64±0.73	3.28	13.31	20.12	32.15
HW (cm)	51.22±1.45	6.50	12.69	40.35	63.21
HG (cm)	71.88±1.08	4.86	6.76	60.21	80.15
BL (cm)	56.49±1.40	6.29	11.13	48.21	76.21

ADY: Average daily yield, IY: Initial yield, TY: Total yield, PD: Peak day, PY: Peak yield, LL: Lactation length, BWT: Body weight, RH: Rump height, BD: Body depth, HW: Height at wither, HG: Heart girth and BL: Body length

Table 2: Correlation among conformation traits of lactating does of West African Dwarf goat

Trait	BWT	RH	BD	HW	HG	BL
BWT	1					
RH	0.625	1				
BD	0.714	0.647	1			
HW	0.615	0.721	0.624	1		
HG	0.912	0.710	0.719	0.674	1	
BL	0.562	0.635	0.642	0.682	0.681	1

BWT: Body weight, RH: Rump height, BD: Body depth, HW: Height at wither, HG: Heart girth and BL: Body length

Table 3: Correlation among milk yield traits of lactating does of West African Dwarf goat

Trait	ADY	IY	TY	PD	PY	LL
ADY	1					
IY	0.596	1				
TY	0.771	0.401	1			
PD	0.356	0.236	-0.022	1		
PY	0.537	0.013	0.368	0.275	1	
LL	-0.167	-0.182	0.496	-0.551	-0.194	1

ADY: Average daily yield, IY: Initial yield, TY: Total yield, PD: Peak day, PY: Peak yield and LL: Lactation length

Table 4: Correlation between milk yield traits and conformation traits of lactating does of West African Dwarf goat

Trait	ADY	IY	TY	PD	PY	LL
BWT	0.445*	0.301*	0.382*	-0.108	0.382*	0.002
RH	0.384*	0.348*	0.347*	-0.113	0.344*	0.068
BD	0.321*	0.216	0.345*	-0.121	0.354*	0.004
HW	0.893**	0.354*	0.385*	-0.001	0.378*	0.076
HG	0.354*	0.205	0.403*	-0.113	0.321*	0.014
BL	0.435*	0.413*	0.399*	-0.002	0.352*	0.011

**p<0.001, *p<0.05, ADY: Average daily yield, IY: Initial yield, TY: Total yield, PD: Peak day, PY: Peak yield, LL: Lactation length, BWT: Body weight, RH: Rump height, BD: Body depth, HW: Height at wither, HG: Heart girth and BL: Body length

studied suggest the possibility of improving these traits through selection. The body conformation traits measured in the present study were similar to those reported earlier by Sam *et al.*[3], the variabilities of these traits were low. However, results from this study indicated values higher than what was reported by Dudusola *et al.*[16]. This was probably because the previous reports by Dudusola *et al.*,[16] included both lactating and dry does. The current study focused exclusively on lactating does. The average body weight (20.75±1.06 kg) aligns with the 20-40 kg range reported by Osuhor *et al.*[7] for both male and female goats. The average values for RH, BD, HW, HG and BL were lower than the values reported by Okepku *et al.*[17], Popoola and Adekanbi[18]. However, this report was similar to previous reports by Sam *et al.*[3] and Dossa *et al.*[19].

Correlation amongst conformation traits in West African Dwarf goats: The correlation among conformation traits in West African Dwarf goats was shown in Table 2. The results indicate a highly positive and significant ($p<0.01$) correlation ($r = 0.562$-0.912) among the studied body conformation traits.The correlation between body weight and hearth girth ($r = 0.912$) recorded the highest correlation value. The positive correlation between these conformation traits in this study indicates that any increase in any one of the conformation traits would result in a corresponding increase in the other traits. Similar reports of correlation among conformation traits have been reported by Sam *et al.*[3], Yakubu[20], Sowande *et al.*[21] and Nafti *et al.*[22].

Correlation amongst milk yield trait in West African Dwarf goats: The estimates of phenotypic correlations amongst milk yield traits in this study were shown in Table 3. The results showed a significant correlation ($p<0.01$: $r = 0.356$-0.771) between ADY and all other milk yield traits except LL which was negatively correlated (-0.1183). The LL was negatively correlated with all the milk yield traits except TY which was positively and significantly ($p<0.05$; $r = 0.496$) correlated. The highest correlation was observed between ADY and TY ($r = 0.771$). The positive correlation among milk yield traits suggests a strong association among the traits, thus selection to improve any one of these traits might trigger improvement of the others. A positive relationship between milk yield traits has been reported in goats[14,23].

Correlation between milk yield traits and conformation traits of lactating does in West African Dwarf goats: Table 4 presented the correlation between milk yield traits and conformation traits of lactating does in West African Dwarf goats. The observed correlations ranged from low positive to negative estimates. Body weight showed significant positive correlations ($p<0.05$) with ADY, IY, TY and PY. However, its correlation with lactation length was minimal (0.002), while it exhibited a negative correlation with peak day (-0.018).The results indicate that ADY, TY and PY were positively and significantly ($p<0.05$ -0.001) correlated with all the conformation traits measured, the relationship between ADY and HW was highly significant ($P<0.001$; $r = 0.893$). Initial yield (IY) also had a positive and significant correlation with BWT, RH, HW and BL. The correlation between PD and all the conformation traits was negative ($r = -0.002$ to -0.121). Lactating length (LL) had a positive but very low ($r = 0.002$ -0.011) correlation with all the body conformation traits. The significant and positive relationship observed between milk yield and the conformation traits studied was in consonance with the reports of Youssef *et al.*[24], who also reported a significant correlation between average daily milk yield with body weight, wither height, rump height and udder trait. However, the result from this study was contrary to the findings of Makamu *et al.*[25], who reported that there were no significant correlations between the five body measurement studies (body length, rump height, wither height, sternum height and heat girth). The results indicated that selection for these conformation traits (that were positively correlated with milk yield traits) will also lead to improvement in these milk yield traits, that is these conformation traits can be used in predicting milk yield of West African Dwarf goats. More so, it can also be used as a selection marker for future improvement of milk yield. The relationship between body conformation traits and peak day was negative; this indicates that as body conformation traits increase, the PD will be earlier and if persistency is maintained could lead to a higher TY.

CONCLUSION

The variability of body weight and most of the conformation traits studied in West African Dwarf goats suggest the possibility of improving these traits through careful selection. More so, the positive relationship between conformation traits with milk yield traits indicates that conformation traits can be used as markers or selection criteria for the improvement of milk yield in West African Dwarf goats. The findings from this study can be used by goat farmers to improve the milk yield of the West African Dwarf goats.

SIGNIFICANCE STATEMENT

This study was conducted to established the relationship between conformation trait and milk yield in West African Dwarf goat. The study showed that there are positive and significant correlations between conformation traits and milk yield in West African Dwarf goat. The results from this study indicate that conformation traits can be used as markers or selection criteria for the improvement of milk yield in West African Dwarf goats.

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