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The Relationship among Dam's Milk Parameters, Weight, Udder Parameters and Linear Body Measurements in West African Dwarf Sheep at First Lambing

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Abstract

Dam's linear body measurements in relation to milk yield, milk composition and lambs linear body measurements were studied for a period of three months. Milk was collected daily during the period, linear body measurements of the dams and the lambs were taken weekly. Body measurements taken were height at withers, body length, heart girth, neck length, neck circumference, udder circumference, udder width, teat length, distance between teat, teat circumference, distance of teat from the ground, weight of dam, dam growth rate, weight of lambs, lambs growth rate, lamb wither height, lamb body length, lamb heart girth, lamb neck length and lamb neck circumference. Data were subjected to statistical analysis using correlation and regression procedure. The correlation analysis indicated that milk off take had a significant correlation with dam's body length ($p<0.05$), udder width ($p<0.05$), teat length ($p<0.05$), distance between teats ($p<0.05$) and teat circumference ($p<0.001$). Weight of dams had significant correlations with all the variables entered except total solid, fat and teat circumference. Weight of lambs had significant correlations with all of kid's linear body measurement as well as with fat content of the milk ($p<0.05$), udder circumference ($p<0.001$), teat circumference ($p<0.01$) and distance of the teat from the ground ($p<0.01$). The result of the multiple regression analysis indicates that the addition of other variables to milk off take would result in significant improvement in accuracy of prediction. Lamb's wither height appeared to be the best predictor of lamb's weight accounting for 48% individual contribution. The best equation based on this study for predicting the weight of lambs is

$$WL=6.07+0.61LNC+0.23WD-0.13DWH-0.30DTG+0.11LBL-0.11LHG.$$

It resulted in the highest R2 value of 80% prediction of lamb's weight. The study concluded that teat circumference and lamb's wither height are the most related variables to milk off take and lamb's weight respectively.

Keywords: Linear body measurement; Teat circumference; Lambs weight; Milk off take; Udder circumference

Introduction

Sheep are known to provide meat and milk for human consumption and it is perceived by some consumers in Nigeria that sheep milk have a better and natural taste than cow's milk [1]. Local sheep breeds in Nigeria have the potential to supply a significant portion of the milk deficit in the country because sheep numbers far exceed cattle numbers in both rural and urban communities [2,3]. The effective prolificacy of West African Dwarf ewes gives it an advantage of milk production in a large quantity, as neonatal suckling is known to enhance effective tactile teat stimulation causing the release of Oxytocin from the neurohypophysis of the pituitary gland [4]. Sheep milk has been found to be richer in critical nutrients, except lactose, than milk of humans, cattle and goats [5]. The interest in the dairy sheep udder has increased in the last few years in which anatomy has been explored in depth [6,7], linear evaluation of udder traits has been proposed [8] and genetic parameters evaluated [8]. Linear measurements of body are kind of growth indicators in animal life [9]. Body measurements are used for several purposes including prediction of growth rate, genetic improvement, body condition, conformation and carcass traits [10,11]. During the course of growth different parts of an animal change in proportion as well as size. The body structures develop more in postnatal life than the extremities. Skeletal measurements include all the height and length measurements while tissue measurements include heart girth, chest depth, punch girth, and width of hips [12]. Apart from the conventional use of scales in determining the weight of sheep, weight determination by estimating some linear parameters could be employed [13].

Materials and Methods

The study was carried out at the Small Ruminant Unit of the Directorate of University Farms (DURFARMS), Federal University of Agriculture, Abeokuta, Nigeria. The site is situated in Odeda Local Government Area of Ogun State, South-Western Nigeria (70 9' 39'' N, 30 20' 54'' E, and 76 m above sea level) (Google Earth, 2016). It is located in the derived Savannah vegetation zone of South-Western Nigeria. The region's climate according to ORBDA [14] is humid, with an annual rainfall of 1037 mm and mean relative humidity of 82%.

Experimental animals and their management

This study was conducted on nine (9) lactating West African Dwarf (WAD) ewes in their first parity and their lambs. The weights of the dams ranged from 16 kg to 25.5 kg. The animals were managed intensively in cross ventilated pens made with raised slated floor and roof constructed with corrugated iron sheet. They were fed at 5% body weight consisting of 50:50 forage to concentrate ratio. Freshly-cut Guinea grass (*Panicum maximum*) was chopped, air-dried and fed to the animals. Fresh drinking water was provided ad libitum to all the animals. Routine healthcare practices included vaccination and regular control of endo and ecto parasites. The ewes were served naturally after inducing heat in them using the male effect as described by Nnadi et al. [15].

Experimental design

The dams were grouped according to their body weight and placed in individual pens with their lambs. All the animals were tagged for easy identification.

Table 1 Means of dam's milk parameters, weight, udder parameters and linear body measurement in WAD sheep at first lambing.

Variables	N	Mean	Minimum	Maximum	S.D
MO	108	197.56	80.71	257.71	45.37
WD	108	24.83	16	33	3.83
WL	108	5.49	2.3	11.2	2.15
TS	108	14.52	9.52	19.69	2.33
PR	108	6.68	2.7	13.13	1.85
FAT	108	6.18	2	16.7	3.6
DWH	108	60.31	51	67	4.65
DBL	108	60.47	49	67	5.13
DHG	108	71.37	54	80	3.66
DNL	108	18.52	12	82	6.76
DNC	108	29.78	21	35	2.57
UC	108	27.93	19	36	3.8
UW	108	15.07	1	20	2.84
TL	108	2.68	2	3	0.46
DT	108	10.63	6	13	0.99
TC	108	4.41	3	7	1.12
DTG	108	34.72	30	42	3.59
LWH	108	46.14	37.5	56	5.27
LBL	108	38.14	22.5	43.5	3.67
LHG	108	48.42	22.5	63.5	8.78
LNL	108	13.23	8	23	3.13
LNC	108	22.19	17	27	2.87

N: number of observations, SD: standard deviation, MO: milk offftake, WD: weight of dam, WL: weight of lamb, TS: total solid, PR: protein, DWH: dam's wither height, DBL: dam's body length, DHG: dam's heart girth, DNL: dam's neck length, DNC: dam's neck circumference, UC: udder circumference, UW: udder width, TL: teat length, DT: distance between teats, TC: teat circumference, DTG: distance of teat from the ground, LWH: lamb's wither height, LBL: lamb's body length, LHG: lamb's heart girth, LNL: lamb's neck length, LNC: lambs neck circumference.

Data collection

Milk collection commenced after the lambs suckled the dams for the first seven (7) days postpartum to consume colostrum. This was also to establish a strong dam-lamb relationship and forestall rejection of lambs by their dams after overnight separation to measure milk yield [16]. Prior to milking, lambs were separated from their dams for 12 hours overnight (7 p.m. –

7 a.m.) and were only reintroduced to their dams after milking. Hand milking of the two halves of the udder was done at 07:00 – 10:00 h daily for three months. The quantity of milk collected from each of the ewes was measured using a 500 ml graduated plastic beaker. On collection days, sub-samples of 50-100 ml per animal were collected into sterile graduated polypropylene bottles (120 ml), properly labeled and transferred to the laboratory for storage at -4°C pending further chemical analysis. Live weight measurements were taken using a bathroom scale once in a week for 3 months. Linear body measurements and udder parameters were taken with the use of tape rule.

Statistical analysis

The data generated were subjected to statistical analysis using correlation and regression procedure (SAS, 1995).

Results and Discussion

Table 2 Pearson correlation coefficient between dam's milk parameters, weight, udder parameters and linear body measurement in WAD sheep at first lambing.

Parameters	MO	WD	WL	TS	PR	FAT
MO	1					
WD	0.01	1				
WL	-0.13	0.57***	1			
TS	-0.01	-0.03	0.17	1		
PR	-0.13	0.30**	0.13	-0.18	1	
FAT	-0.18	0.04	0.20*	-0.01	0.08	1
DWH	0	0.28*	-0.14	-0.05	0.17	-0.13
DBL	0.20*	0.66**	0.08	0	0.07	-0.01
DHG	0.08	0.27*	0.01	-0.03	-0.01	-0.05
DNL	-0.18	0.43*	0.07	-0.09	0.31**	0.16
DNC	0.18	0.31***	0.03	-0.06	0.12	0.09
UC	0.11	0.41***	0.50***	-0.05	0.02	0.31**
UW	0.19*	0.35***	-0.06	-0.01	0.03	0
TL	0.20*	0.20*	0.12	-0.05	-0.17	0
DT	0.21*	0.24**	-0.01	0	0.06	0.05
TC	0.49***	0.12	-0.32**	-0.19*	0.02	-0.22**
DTG	0.09	0.48***	-0.23**	-0.12	0.17	-0.13
LWH	0	0.67***	0.69***	0.17	0.06	0.08
LBL	0	0.56***	0.46***	0.08	0.19*	-0.04
LHG	0.04	0.61***	0.43***	0.13	0.05	0.04
LNL	-0.08	0.78***	0.56***	0.1	0.14	0.12
LNC	-0.02	0.81***	0.62***	0.09	0.13	0.03

MO: milk off take, WD: weight of dam, WL: weight of lamb, TS: total solid, PR: protein, DWH: dam's wither height, DBL: dam's body length, DHG: dam's heart girth, DNL: dam's neck length, DNC: dam's neck circumference, UC: udder circumference, UW: udder width, TL: teat length, DT: distance between teats, TC: teat circumference, DTG: distance of teat from the ground, LWH: lamb's wither height, LBL: lamb's body length, LHG: lamb's heart girth, LNL: lamb's neck length, LNC: lambs neck circumference. *p<0.05, **p<0.01, ***p<0.001.

Table 1 shows the means of dam's milk parameters, weight, udder parameters and linear body measurement in WAD ewes at first lambing. Correlations between measurements for udder morphology, milk parameters, weight and linear body measurements are shown in **Table 2**. Positive and significant correlations were observed between milk offtake and; dam's body length (p<0.05), udder width (p<0.05), teat length (p<0.05), distance between teats (p<0.05) and teat circumference (p<0.001). Weight of dams had significant correlations with all the variables entered except total solid, fat and teat circumference. Similarly, weight of lambs had significant correlations with all of kid's linear body measurement as well as with fat content of the milk (p<0.05), udder circumference (p<0.001), teat circumference (p<0.01) and distance of the teat from the ground (p<0.01).

There were fewer correlations between milk parameters and the other variables entered. Total solid had conversely a negative correlation with teat circumference ($p<0.05$) while fat content of the milk also had a negative correlation with teat circumference ($p<0.01$). Finally, in relation to milk parameters, protein was positively correlated with dam's neck length ($p<0.01$) and lamb's body length ($p<0.05$). Also, fat had a significant correlation with udder circumference ($p<0.01$). The correlation between milk offtake and teat circumference ($r=0.49$; $p<0.001$) was high, suggesting that increase of this single body measurement could be used as a good estimate for predicting milk offtake in West African Dwarf sheep. This is in agreement with Amao et al. [17] and Adewumi et al. [18]. These authors reported that milk yield or offtake increases resulted in an increase in udder parameters, weight and linear body measurements. In this study, udder circumference is also a good estimate for predicting the weights of lambs as it recorded a high ($p<0.001$) correlation with weight of the lambs. The correlation between milk off take and weight was not significant ($r=0.01$; $p>0.05$) in this study. This suggests that body size is not a determinant of the volume of milk production. Earlier, Mavrogenis and Papachristoforou [19] have suggested that milk yield is independent of body size.

A stepwise multiple regression analysis was carried out in which case udder parameters and linear body measurement were added to milk offtake **(Table 3)**. Teat circumference, dam's wither height, lamb's heart girth and dam's neck length qualified to enter the equation for predicting milk off take and accounted for 33% of the total variability with teat circumference making the highest partial contribution of 24% **(Table 3)**. The result of the multiple regression analysis indicates that the addition of other variables to milk off take would result in significant improvement in accuracy of prediction.

Table 3 Regression analysis between milk offtake, udder parameters and linear body measurement in WAD sheep at first lambing.

Dependent variables	Stepwise selection of parameters Regression equation		R2	P value
MO	Step 1	MO= 109.96+19.83TC	0.24	***
	Step 2	MO=214.75+22.79TC – 1.95DWH	0.27	***
	Step 3	MO=213.11+24.96TC – 2.95DWH+1.08LHG	0.31	***
	Step 4	MO=220.13+24.61TC – 2.76DWH+1.17LHG – 1.16DNL	0.33	***
MO: milk offftake, DWH: dam's wither height, DNL: dam's neck length, TC: teat circumference, LHG: lamb's heart girth. ***p<0.001.				

Table 4 Regression analysis between weight of lambs, udder parameters, weight and linear body measurement in WAD sheep at first lambing.

Dependent variables	Stepwise selection of parameters	Regression equationt	R^2	P value
WL	Step 1	WL=-7.63+0.28LWH	0.48	***
	Step 2	WL=-1.48+0.30LWH-0.20DTG	0.59	***
	Step 3	WL=2.13+0.15LWH-0.34DTG+0.33WD	0.73	***
	Step 4	WL=2.11+0.19LWH-0.35DTG+0.38WD-0.05LHG	0.76	***
	Step 5	WL=2.42+0.19LWH-0.33DTG+0.39WD-0.05LHG-0.09UW	0.77	***
	Step 6	WL=2.72+0.13LWH-0.34DTG+0.34WD-0.08LHG-0.08UW+0.24LNC	0.78	***
	Step 7	WL=7.72+0.56LNC+0.27WD-0.10DWH- 0.03UW-0.32DTG +0.01LWH-0.08LHG	0.79	***
	Step 8	WL=8.16+0.59LNC+0.27WD-0.11DWH-0.03UW-0.32DTG-0.08LHG	0.79	***
	Step 9	WL=8.25+0.60LNC+0.26WD-0.11DWH-0.33DTG-0.08LHG	0.79	***
	Step 10	WL=6.07+0.61LNC+0.23WD-0.13DWH-0.30DTG+0.11LBL-0.11LHG	0.8	***
WD: weight of dam, WL: weight of lamb, DWH: dam's wither height, UW: udder width, DTG: distance of teat from the ground, LWH: lamb's wither height, LBL: lamb's body length, LHG: lamb's heart girth, LNC: lambs neck circumference. ***p<0.001.				

Lamb's wither height appeared to be the best predictor of lamb's weight accounting for 48% individual contribution **(Table 4)**. Inclusion of the other measurements improved the prediction of lamb's weight. The best equation based on this study for predicting the weight of lambs is;

WL=6.07+0.61LNC+0.23WD–0.13DWH–0.30DTG+0.11LBL–0.11LHG.

It resulted in the highest R^2 value of 80% prediction of lamb's weight. The coefficient of determination value reported in this study (R^2=0.80) was similar to the value of 0.98 for West African Dwarf sheep obtained by Agbede et al. [20].

Conclusion

The best predictor of milk off take in West African Dwarf sheep was teat circumference (R^2=24%). Lamb's wither height was the most related variable to lamb's weight. Based on the results of the present study, it could be recommended that milk off take could possibly be determined based on teat circumference of ewes.

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