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Milk yield in West African dwarf goats as influenced by coat colour, liveweight, week of lactation and udder circumference

[1]Williams, T. J., [2]Ozoje, M. O., [3]Okwelum, N., [4]Adewumi, O. O. O., Iyasere, O. S., [1]Abioja, M. O., [1]Opeloyeru, O. K. and [1]Awotedu O. O.

[1]Department of Animal Physiology, [2]Department of Animal Breeding and Genetics, [3]Institute of Food Security, Environmental Resources and Agricultural Research, [4]Department of Animal Production and Health, Federal University of Agriculture, Abeokuta, Ogun State Nigeria

Corresponding author: tolwilly@gmail.com

Abstract

In this study the effect of coat colour, dam live weight, week of lactation and udder circumference on milk yield in West African Dwarf (WAD) goats was investigated. Twenty-eight WAD does of different coat colour (black, brown, and combinations of black and white, brown and black, and brown and white) were further grouped on live weight basis into four: 13-15, 16-18, 19-21 and 22-24 kg. The animals were housed individually in well-ventilated pens with slatted floors following parturition. Kids were separated from dams at 5pm and dams were hand milked at 8am the following morning. Milk was collected once per day and thrice per week for 12 weeks. The 15-hour milk yield was converted to 24-hour. Udder circumference was measured before and after milking to determine changes in udder volume. Animals were fed a combination of grass and concentrate in ratio 50:50 at 5% body weight (dry matter basis) twice daily. Results showed that all parameters studied had significant ($P<0.05$) effect on milk yield. Animals with combination of black and white coat colour had higher milk yield of 339.20 g/dam/day compared with others. Animals with live weight of 22-24 kg produced higher milk yield of 396.06 g/dam/day followed by animals in 19-21 kg weight group. Milk yield was highest in first week of lactation and decline progressively. Positive and significant relationship was observed between milk yield and udder circumference. Combination of black and white coat colour had highest change in udder circumference (6.47 cm) while the lowest value was found with brown and black coat colour (4.79 cm). It is concluded that animals with combination of black and white coat colour with higher live weight be used for milk production and this can help when choosing for breeding stock.

Keywords: Milk yield, coat colours, WAD goats, lactation.

Introduction

Goat milk plays important role in nutrition and socioeconomic wellbeing of developing and underdeveloped countries, where it provides basic nutrition and subsistence to the rural people, which are the majority of their populations (Park and Haenlein, 2007). West African Dwarf (WAD) goats are one of the indigenous breeds of goats that are found predominantly in the humid and sub humid zones of Nigeria. They are found in large number in the southern part of Nigeria and most especially in rural areas. They possess the widest margin of adaptation amongst the ruminants (Oni, 2003). They are small, hardy, early maturing, prolific, non-seasonal breeder and plump, measuring less than 50cm in height and weighs between 20-25 kg (Ozoje, 2002). They are trypanotolerant. Their coat colour varies, ranging from black, brown, white and combinations of these three colours in various proportions. Coat colour is a qualitative trait and an indicator of genetic superiority or productive adaptability of

animals to heat tolerance (Helal *et al.,* 2010; McManus *et al.,* 2011). Coat colour is a highly repeatable character with a high heritability estimate (Adalsteinsson *et al.,* 1994; Renieri *et al.,* 2008) and could adapt animals to different climatic zones as well as influencing the performance of various animals (Ebozoje and Ikeobi, 1998). Dam weight has been associated with lamb weight while the age of dam did not affect milk production in sheep (Minick *et al*., 2001). The udder is a very important gland in reproducing animals and for milk production. It has been confirmed that udder and teat characteristics are important determinants of milk yield and ease of milking or milking ability in dairy animals (Akpa *et al*., 2002). Udder and teat characteristics have been shown to be influenced by several factors such as genotype, breeding and management systems (Milerski *et al.*, 2006). The udder circumference (UC), width and height have been identified as traits which could replace the udder volume measurement because they are easy to measure and have high repeatabilities (Martinez *et al*., 2011). Udder circumference appears to have a predictive ability for milk production traits. It is simple to measure or score, is repeatable between lactations, and could be useful for simple milk prediction and recording in dairy goat (James, 2000). WAD does with higher UC tended to produce higher milk yield (Williams *et al*., 2009). Milk yield is a function of sensory activity, number of mammary epithelial cells, size of cistern, breed and physiological state of the animal (Capuco, 2002). The quantity and quality of milk is of utmost importance as it affects the physiological and growth state of the offspring in terms of live weight gain, and adaptability and general health condition. According to (Akpa *et al.,* 2003), lactation status has significant effect on length and udder circumference. Keskin *et al.,* 2005) reported the positive effects of udder circumference and udder bottom height (UBH) on daily milk yield. Information on possible effect of coat colour on milk yield including dam live weight and udder circumference in WAD goats is scarce, hence this study.

Materials and methods

Experimental location The experiment was conducted at the Directorate of the University Farm (DUFARMS) of the Federal University of Agriculture, Abeokuta, Ogun state, Nigeria. The region is a tropical humid climate with an elevation of 141m and an altitude of 76 m above sea level. The Unit is located in the forest zone of South Western Nigeria which lies along latitude $7^{0}11^{1}$, 30.65^{11} N and longitude $3^{0}25^{1}$, 55.67^{11}E (Google Earth, 2014) with an average rainfall of 1037 mm and temperature of about 34.7°c (OORBDA, 2004).

Experimental animals and management

A total of 28 WAD does consisting of six black, four brown, and combinations of five black and white, six brown and black and seven brown and white were housed individually in well-ventilated pens with slatted floors. The animal's live weight were grouped into four: 13-15 kg (G1) 16-18 kg (G2), 19-21 kg (G3) and 22-24 kg (G4). The does were housed in separate pen immediately after parturition, after which dam's live weight was taken and recorded. The animals were fed a combination of freshly cut grass (*Panicum maximum* and *Pennisetum purpureum)* and concentrate in ratio 50:50 at 5% body weight (dry matter basis) twice daily (morning and evening).

Experimental procedure

Kids were separated from their dams at 5pm in the evening and dams were hand milked at 8am (5pm – 8 am) the following morning. This gave 15 hour milk yield. The

15 hour milk yield was converted to daily milk yield by dividing by 15 and multiplying by 24. The dams were hand milked once per day and thrice per week for the duration of 12 weeks. Before milking, the teats were washed and cleaned using towel. Milk yield was weighed and recoded in grammes.

Statistical analysis

Data collected were subjected to analysis of variance in randomized complete block design and analyzed using SAS (2003) statistical package. Significant means were ranked according to same package.

Table 1. Composition of concentrate for the experimental animals

Ingredients	Composition (%)
Maize	15
Groundnut cake	10
Wheat offal	46
Palm kernel cake	25
Bone meal	2
Salt	2
Total	100
Calculated nutrients (%)	
Crude protein	17.85
Crude fibre	7.48
Ether extract	4.43
Calcium	1.05
Available phosphorus	0.56
Metabolizable energy (kcal/kg)	2257.8

Measurement of udder circumference

Udder circumference, the distance (perimeter) round the widest point of the udder (Fig 1.) was measured before and after milking to determine changes in udder volume. This was achieved by wrapping a canvass measuring tape around the udder of each doe then subtracting measurement after milking from that before milking. The difference was recorded in cm.

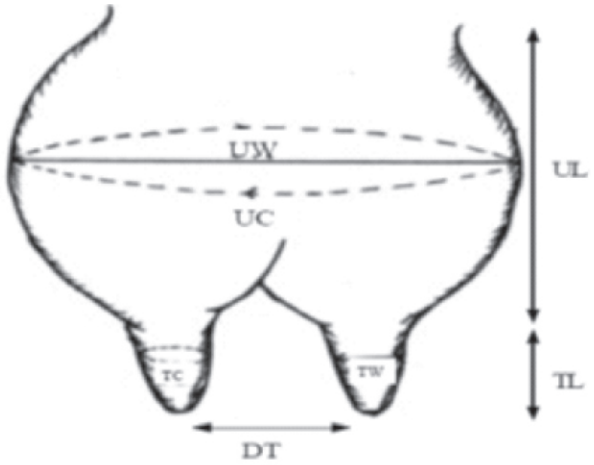

Figure 1. Measurement of udder traits in goats (James *et al.*, 2009)

Results

The summary of analysis of variance showing the effect of coat colours, dam live weight and weeks of lactation on milk yield in WAD goats is presented in Table 2. The result showed that all parameters studied had significant (P<0.05) effect on milk yield. The least square means revealed that goats with combination of black and white coat colours had highest (P < 0.05) milk yield of 339.20 g/dam/day followed by black coat colour (292.23 g/dam/day), brown coat colour (288.11 g/dam/day), combination of brown and white coat colour (262.84 g/dam/day) while the lowest milk yield was obtained in goats with combination of brown and black coat colours (209.20 g/dam/day).

Table 2: Least square means showing effect of coat colours, dam live weight and week of lactation on milk yield in WAD goats

Source of Variation	Sub Class	No. of Observation	Milk Yield (g/dam/day)
Coat colours	Black	216	292.23^{b}
	Brown	144	288.11^{b}
	Black and White	180	339.20^{a}
	Brown and Black	216	209.20^{c}
	Brown and White	252	262.84^{b}
Dam live weight (kg)	G1	180	217.80^{c}
	G2	324	227.07^{c}
	G3	324	287.12^{b}
	G4	180	396.06^{a}
Week of lactation	1	84	414.55^{a}
	2	84	354.86^{b}
	3	84	326.41^{bc}
	4	84	327.11^{bc}
	5	84	300.12^{cd}
	6	84	285.48^{cd}
	7	84	266.99^{de}
	8	84	242.13^{ef}
	9	84	218.19^{fg}
	10	84	198.33^{gh}
	11	84	191.31^{gh}
	12	84	173.20^{h}

G1, 13-15 kg, G2, 16-18 kg, G3, 19-21 kg, and G4, 22-24 kg

$^{a\,b\,c\,d\,e\,f\,g\,h}$ means within same group with different superscript are significantly different (P < 0.05)

The results also showed that effects of dam live weight and week of lactation on milk yield was significant. The trend showed that animals of G4 had the highest (P < 0.001) milk yield of 396.06 g/dam/day followed by G3 (287.12 g/dam/day). However, the milk yields of G2 and G1 were not significantly different. The week of lactation had significant effect on milk yield (P<0.05). WAD goats at week one of lactation has a high significant milk yield compared to week two of lactation. The result also showed that, at week two of lactation milk yield was significantly different compared to animal at week three. The result showed that there is a negative relationship between week of lactation and milk yield. As week of lactation progresses milk yield declined. Least square means on change in UC before and after milking is presented in (Table 3).

The result revealed same pattern as observed in Table 2. Animals with combination of black and white coat colours had the highest change in udder circumference of 6.47 cm followed by brown (5.76 cm) and black (5.73 cm).

Table 3: Least square means of change in udder circumference before and after milking on milk yield in WAD Goats

Source of variation	Individual colour	No of observation	Difference in udder circumference	Milk yield (g/dam/day)
Coat colour	Black	216	5.73^{b}	292.23^{b}
	Brown	144	5.76^{b}	288.11^{b}
	Black and white	180	6.47^{a}	339.20^{a}
	Brown and black	216	4.79^{c}	209.20^{c}
	Brown and white	252	5.07^{c}	262.84^{b}

^{abc} Means in the same column having different superscripts differ significantly (P< 0.05)

Discussion

The significant effect of coat colour on milk yield in the present study is not in agreement with the previous findings of Mustafa *et al.,* (2011) who reported that there is no significant effect of coat colour on lactation, milk production and lactation duration. The study revealed that animals with combination of black and white coat colours had the highest milk yield. This could probably be as result of the interplay between heat absorption and reflection. Silanikove (2000) opined that the amount of heat absorbed by an object from direct (solar) radiated heat depends not only on the temperature of the object, but on its colour and texture with dark surfaces radiating and or absorbing more heat than light coloured surfaces at the same temperature. Black colour absorbed heat while white colour reflects. This could possibly mean that animals with such colour were less stressed as compared to their counterparts. Dark coat colour could also be a form of adaptive mechanism because of the role it plays in temperature regulation especially in the cold season when dark pigmented animals warm up earlier and more quickly than their light-coloured counterparts. Also lighter colouration could be an advantage in an intense radiant environment due to its reflectance property as reported by Hensen (1990). The author opined that animals with higher percentage of light colour offer a better resistance to heat in environment characterized by higher solar radiation. This makes light coloured goats more adaptable to the hot and humid environments hence making them more heat-stress tolerant. The result buttresses the earlier study of Schleger (1967) who reported an increase in milk yield with decrease in the intensity of pigmentation. The significant effect of dam live weight on milk yield in the present study agrees with the previous findings of Ekneas *et al.* (2006). The authors reported that milk yield has a direct consequence on dam weight. This is evident by a decrease in maternal live weight during the first few weeks of lactation. The study observed that dams were at heaviest weight at the first week of lactation, progressively decreasing up to the 6th week before recovery. As lactation progresses, the animals were able to mobilize body fat reserve to produce the milk required for their off-spring (Ekneas *et al.,* 2006). Unlike the dams, the mean kid weight is usually lowest at birth, as expected and observed in this study. The kid weight linearly increased thereafter to the

end of the study. The result showed that there the relationship between week of lactation and milk yield was negative. As week of lactation progresses milk yield declined. This might be as a result of the decreasing status of the alveoli cells in the mammary gland as week of lactation progresses. Milk yield is a function of the number of mammary secretory cells and their metabolic activity are not static, but change during the course of lactation (Stelwagen, 2001). Udder circumference was observed to significantly influence milk yield in WAD goats. This result is similar to the findings of Amao *et al.* (2003) that lactation status significantly influences the udder circumference in WAD goats. Peris *et al. (*1999) **also** reported significant correlations among udder traits, udder volume, body weight, milk yield, and milking traits in Murciano-Gradina dairy goat. A strong positive correlation between milk yield and udder size was reported in goats and sheep (Agbede *et al.* 1997). The author noted that udder size of goats and sheep increased with milk yield up to the peak of lactation, which occurred between third and fourth week and decreased in size thereafter. The larger the udder and teat sizes, the higher the milk produced by West African Dwarf, Red Sokoto and Sahel goats in Nigeria (James, 2000).**Conclusion**The findings in the present study indicated that coat colours, live weight, udder circumference and week of lactation influenced milk yield of West African dwarf goats. Animals with combination of black and white coat colours have larger udder circumference and produced more milk than other coat colours. West African dwarf does with higher live weight produced more milk when compared with other live weight groups. There was a progressive decline in milk yield as week of lactation increased. Therefore, West African dwarf does with black and white coat colours, high live body weight and udder circumference improved milk yield, and these traits can be used as a selection criterion to improve milk production in West African dwarf goats.

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