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Influence of Coat Pigmentation on Feed and Water Consumption of West African Dwarf Sheep Raised in Humid Tropics

Adelodun Opeyemi Fadare

Department of Environmental Biology and Fisheries, Adekunle Ajasin University, Akungba-Akoko, Ondo-State, Nigeria.

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Corresponding Author
Adelodun Opeyemi Fadare
E-mail: *delodunfadare @gmail.com/ adelodunopeyemi@ yahoo.com*
Phone: *+2348034782356*

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ABSTRACT

This experiment was carried out to determine the effect of coat pigmentation on feed and water intake of West Africa Dwarf Sheep using 24 weaned lambs with different coat pigmentations. Feed intake of *Panicum maximum* and concentrate feed, water consumption, weight gain as well as feed efficiency were measured. The analysis of variance showed that the effect of coat pigmentation was significant ($p< 0.05$) on forage intake, weight gain, feed efficiency and water consumption. However, concentrate feed intake was not significantly ($p>0.05$) affected by coat pigmentation. The least value of weight gain was recorded for black sheep with the weekly gain of 0.49 ± 0.19kg. There was no significant difference in the weekly weight gain of brown sheep and white sheep with 0.69 ±0.12kg and 0.60 ± 0.15kg respectively. Brown coat pigmentation type had the highest feed efficiency of 0.25± 0.05 followed by white sheep (0.21 ±0.03) while the black sheep had the least feed efficiency (0.18 ± 0.02). The mean daily water consumption of the WAD sheep ranged from 0.96 ± 0.02 litre to 1.50 ±0.02 litre with the brown sheep having the highest water consumption while black sheep had the least. Female sheep had lower feed efficiency and water consumption than male sheep. In conclusion, animals with light pigmentation had higher values for feed intake, daily water consumption and feed efficiency than the dark (black) pigmentation.

INTRODUCTION

Coat pigmentation plays an important role in the adaptation of animals to different climatic zones (Adedeji *et al* 2011). In sheep, as in other mammals, there are two types of coat pigments, eumelanin responsible for black or a brown pigmentation and the phaeomelanin which results in a tan, white or yellow pigmentation (Lundie 2011). The West African Dwarf sheep (Djallonke) which is native to the humid and sub-humid zones of West and Central Africa, have a range of coat pigmentation that vary from white, brown, black to combinations of these pigmentation in various proportions. The different shades and pigmentations are therefore brought about by variations in the size, density and the distribution of the pigment granules (Adalsteinsson 1994).

The West African Dwarf sheep is the most prevalent sheep breed in Southern Nigeria, where they are raised by large number of rural households and they have quite specific physiological properties that made acclimatization possible (Oni, 2003) They are hardy, small, short legged, early maturing, prolific and non-seasonal breeders. They are found throughout the humid tropics to which they are adapted. The importance of the Dwarf breed lies in the unique adaptation to the humid zone and their tolerance to Trypanosomiasis.

Water is an important nutrient in animal feeding and animal health. It is the most abundant ingredient of the animal body in all phases of growth and development (Harris and VanHorn, 2008). Water is the medium in which all chemical reactions in the body takes place. Water functions include control of body temperature, digestion and absorption of food, transport of nutrients, elimination of water products via urine from the body (Jafari *et al*., 2006) and acts as buffering agent to regulate the pH of body fluid (Harris and VanHorn, 2008).

The water consumption of animals is influenced by many factors including breed, body size, ambient environment, water temperature, humidity, feed supply, salt and level of production. Water palatability and odour as well as high levels of minerals such as iron and sulphur reduce consumption (Harris and VanHorn, 2008). Feed rations that are high in salt or protein increase water intake (Harris and VanHorn, 2008).

Feed consumption which is generally expressed in terms of dry matter intake is the weight of feed material consumed excluding the moisture it contains. A large number of factors affect the dry matter intake of animals. This includes breed, age, physiological status, palatability of the feed among others. According to Jiao *et al.* (2014), there is a moderate positive genetic correlation between growth and feed intake as well as a positive correlation between average daily gain and feed conversion rate. Schoeman and Visser (1995) reported a breed difference in average daily water intakes of the Blackhead Persian, Dorper and Mutton Merino sheep. However, little is known about the effect of coat pigmentation on water and feed intake of sheep in a tropical environment. Therefore, this experiment was carried out to determine the effect of coat pigmentation on feed and water intake of West Africa Dwarf Sheep.

Experimental Site

The experiment was carried out at the sheep unit of the Teaching and Research Farm, University of Agriculture, Alabata road, Abeokuta, Ogun State, Nigeria. The University Teaching and Research Farm (7^0 10^1 and 3^0 2^1 E) is located in Odeda Local Government Area of Ogun State, Nigeria. The area which lies in the South Western part of Nigeria has a prevailing tropical climate with a mean annual rainfall of about 1037mm. The mean ambient temperature ranges from 28ºC in December to 36ºC in February with a yearly average humidity of about 82%. The vegetation represents an interphase between the tropical rainforest and the derived savannah. (Ilori *et al.,* 2010)

Experimental Animals and their Management

Twenty four lambs with different coat pigmentation types (eight black, eight brown and eight white) were used for this study. The animals were tagged according to their coat pigmentation and were housed in slated floor pens. Concentrate feed which was composed of maize (15%), wheat offal (45%), PKC (30%), oyster shell (3.5%), bone meal (5%), salt (1%) and premix (0.5%) was supplied to the animals besides the basal diet of *Panicum maximum*. Each of the lamb was supplied with the concentrate feed in the morning and the basal diet in the afternoon. Ecto- and endo-parasites medications were given to the animals during the period of the experiment. The health status of all the animals was also properly monitored and immediate adequate treatment was given to sick animals. Peniciling-streptomycin and Oxytetraciline injection were used as broad spectrum antibiotics. The lambs were allocated to separate pens for a period of 12 weeks to avoid group feeding so as to determine the feed intake on other parameters for each animal as this may be affected when the lambs are fed in groups.

DATA COLLECTION

Determination of water consumption

Clean water was provided *ad libitum* for each animal; the water provided was measured in litres. Water was provided for the animals every morning, the volume of the remaining water was taken every 24 hours and subtracted from the initial volume of water provided to determine the water intake. Water intake was measured

every 24 hours in litres. Measuring cylinder was used for the measurement. The measurement was taken for 12 weeks.

Feed intake: A quantity of *Panicum maximum* and concentrate feed were given to each of the experimental animal in their pen. The amount of feed left over was weighed and subtracted from the amount of feed given to determine daily feed intake within 24 hours as follows:

Feed intake (kg) = Feed supplied (kg) – Left over feed (kg).

Weight gain: This was determined by measuring the initial and final weight of each lamb using a hanging measuring scale.

Weight gain (kg) = Final weight (kg) – Initial weight (kg)

Feed efficiency

Feed efficiency of animals with different coat pigmentation was determined by calculating the ratio of total feed intake to total weight gain as follows:

$$\text{Feed efficiency} = \frac{\text{Total weight gain (kg)}}{\text{Total feed intake (kg)}}$$

Statistical Analysis

Data were analyzed using a General Linear Model (GLM) procedure of SAS (2007). The model is as stated below:

$Y_{ijk} = \mu + C_i + S_j + (CS)_{ij} + e_{ijk}$
Y_{ijk} = the parameter of interest
μ = overall mean for the parameter of interest
C_i = fixed effect of ith lamb coat colour type
S_j = fixed effect of jth lamb sex
$(CS)_{ij}$ = interaction effect of coat colour and sex
e_{ijkl} = random error associated with each record (normally, independently and identically distributed with zero mean and variance $\sigma^2 e$).

The means were separated with the Duncan means separation of the package

RESULTS

The proximate composition of the concentrate feed diet and the basal diet (Panicum maximum) on Table 1 showed that the concentrate feed diet had higher crude protein and lower moisture content than the basal diet. Nevertheless, the forage had higher gross energy and crude fibre content than the concentrate feed. The analysis of variance for feed intake, weight gain and feed efficiency of West African Dwarf sheep presented on Table 2 showed that the effect of coat pigmentation was significant ($p< 0.05$) on forage intake and the effect was also significant ($p < 0.05$) on the weight gain and the feed efficiency of WAD sheep. In the same vein, the daily water consumption was significantly ($p < 0.05$) affected by coat pigmentation. However, the average daily concentrate feed intake was not significantly ($p>0.05$) affected by coat pigmentation (Table 2). The highest forage intake (2.59 ± 0.06kg) was recorded for sheep with brown coat pigmentation while the least value of 2.10 ± 0.07 kg was recorded for black coat pigmentation. There was no significant difference in the forage intake of brown sheep and white sheep as shown on Table 3

Table 1: Proximate Composition of Concentrate Feed and Forage

Concentrate Feed

Moisture content 10.00%
Crude protein 15.25%
Ether extracts 4.60%
Crude fibre 9.34 %
Ash 5.44%
Nitrogen free extracts 49.76%
Metabolisable energy (Kcal/kg) 2705.53

Panicum maximum

Moisture content 51.11 %
Crude protein 7.63%
Ether extract 2.76%
Crude fibre 18.4 %
Ash 6.78.%
Nitrogen free extracts 13.32%
Metabolisable energy (Kcal/kg) 3890.00

Table 2: F values from the analysis of variance for feed intake, weight gain and feed efficiency of WAD sheep.

Source of Variation	DF	Feed intake		Weight gain	Feed efficiency
		Forage	Concentrate		
Coat pigmentation	2	4.778*	0.004 ns	3.943*	7.584*
Sex	1	0.001 ns	0.018*	4.059*	13.328*
Coat X Sex	2	0.099 ns	0.005 ns	0.031 ns	0.300 ns
Error	114	0.178	0.002	1.171	3.564

* - significant (P<0.05)
ns - not significant (P>0.05)

Table 3: Means and SEM of feed intake, weight gain and feed efficiency of WAD sheep.

Coat Pigmentation	Feed intake (kg)		Weight gain(kg)	Feed efficiency
	Forage	Concentrate		
Black	2.10±0.07 [b]	0.60±0.01	0.49±0.19 [b]	0.18±0.02 [c]
Brown	2.59±0.06 [a]	0.59±0.01	0.69±0.12 [a]	0.25±0.05 [a]
White	2.53±0.05 [a]	0.58±0.01	0.60±0.15 [a]	0.21±0.03 [b]
Sex				
Female	3.33±0.07	0.58±0.01 [b]	0.42±0.13 [b]	0.14±0.40 [b]
Male	3.40±0.06	0.61±0.07 [a]	0.74±0.14 [a]	0.25±0.05 [a]

[a, b, c] Means in the same column with the different superscripts are significantly different (P<0.05) for coat pigmentation and sex

The least value of weight gain was recorded for black sheep with the weekly gain of 0.49 ± 0.19. There was no significant difference in the weekly weight gain of brown sheep and white sheep with 0.69 ±0.12kg and 0.60 ± 0.15kg respectively (Table 3). Brown coat pigmentation type had the highest feed efficiency of 0.25± 0.05 followed by white sheep with feed efficiency of 0.21 ±0.03 while the black sheep had the least feed efficiency (0.18 ± 0.02).

The mean daily water consumption of the WAD sheep ranged from 0.96 ± 0.02 litre to 1.50 ±0.02 litre with the brown sheep having the highest water consumption followed by black sheep while the white sheep had the least. The daily water consumption of brown sheep was significantly ($p < 0.05$) different from that of the white sheep. The black sheep had lower values for ratio of water to concentrate feed intake as well water intake to roughage intake ratio compared with white sheep.

Sex of the animal had significant effect on concentrate feed intake, weight gain and feed efficiency of WAD sheep. The concentrate feed intake of male sheep (0.61 ±0.07kg) was significant higher than that of female sheep with concentrate intake of 0.58 ±0.01kg. Higher weight gain of 0.74 ±0.14kg was recorded for male sheep compared with their female counterpart with weight gain of 0.42 ±0.13. The least square means of feed efficiency of WAD sheep as affected by sex showed that female sheep had a lower feed efficiency (0.14 ±0.04)) than male sheep with feed efficiency of 0.25 ±0.05. Sex had significant ($p < 0.05$) effect on daily water consumption. The quantity of daily water consumption of male sheep (1.39 ± 0.02 L) was significantly ($p < 0.05$) higher than that of the female sheep (1.15 ± 0.02L) as shown on Table 4. The ratio of water to concentrate feed intake as well water intake to roughage intake ratio follows the same pattern with the daily water consumption. The female sheep had lower values for these ratios compared with their male counterparts

Table 4: Means and SEM of daily water consumption as affected by coat pigmentation and sex

Coat pigmentation	Daily water intake(L)	Water/Conc.Feed intake(L/Kg)	Water /Roughage intake (L/Kg)
Black	1.36 ± 0.03[b]	2.34± 0.02[b]	0.46± 0.001[c]
Brown	1.50 ± 0.02[a]	2.54± 0.02[a]	0.58± 0.003[a]
White	0.96 ± 0.02[c]	1.60 ± 0.01[c]	0.54± 0.002[b]
Sex			
Female	1.15 ± 0.02[b]	1.98± 0.02[b]	0.35± 0.002[b]
Male	1.39 ± 0.02[a]	2.28± 0.02[a]	0.41 ± 0.0012[a]

[a, b, c] Means in the same column with different superscripts are significantly different (P<0.05) for coat pigmentation and sex

DISCUSSION

The present study revealed that coat pigmentation had significant effect on feed intake and feed efficiency of West African Dwarf sheep. Brown sheep had better feed intake and feed efficiency when compared with sheep with black coat pigmentation in the humid tropics. This could be as a result of low absorption of heat which is directly related to the degree of pigmentation and this enhances appetite. Fadare *et al*, 2012 and Mc Manus *et al.* (2011) had earlier reported that brown WAD sheep and Brazilian hair sheep respectively absorbed less

solar radiation than black sheep. Animals with dark pigmentation are predisposed to higher heat load. The lighter coat pigmentation is reflective and absorbs less solar radiation (Mc Manus *et a*l., 2011, Fadare *et al*, 2012 and Adedeji *et al*, 2011). Low absorption of heat enhances more appetite and better feed intake resulting in faster growth and attainment of puberty (Adedeji, *et al*, 2011). According to Habeeb *et al*. (1992), the effect of elevated temperature on growth performance is a product of a decreased anabolic activity. This decrease in anabolism is essentially caused by a decrease in voluntary feed intake of essential nutrients. The excess heat load must be eliminated from the animal so as to be in thermal balance state and this involves energy which could have been channeled towards production like growth. At temperatures above 21.1°C, the animal's respiration rate begins to increase and increasing amounts of water are lost from the lungs and skin. Increased losses of water signal the animal to consume more water to replace the losses (Harris and VanHorn, 2008).

The dry matter consumption per unit body weight, the digestibility and absorption of nutrient from the intestine decreased with increase in heat stress. Exposure of animal to a high environmental temperature stimulates the peripheral thermal receptors to transmit suppressive nerve impulses to the appetite center in the hypothalamus, causing a decrease in feed intake (Habeeb *et al*., 1992). According to Marai *et al.* (2003), animals with higher heat load make effort to dissipate body heat resulting in increased body temperature, as well as increase in consumption of water and a decline in feed intake.

The effect of sex of animal was significant on the feed intake and feed conversion ratio of WAD sheep in this study. Male sheep were superior to female counterparts with respect to feed intake and feed efficiency. This could be as a result of hormonal differences between male and female animals and the aggressive feeding behaviour of male animals.

In this study, coat pigmentation also had significant effect on water consumption of West African Dwarf sheep. Contrary to the expectation of higher water consumption by black sheep to dissipate their higher body heat load, brown sheep were superior in water consumption compared to other coat pigmentation types. The highest water consumption among brown sheep in this study could probably be attributed to larger quantity dry matter intake of forage demonstrated by this coat pigmentation type. Adegbola and Obioha (1984) observed that there is a direct relationship between feed intake and water consumption. An animal consuming a large quantity of feed needs more water for normal digestion and utilization of the feed nutrients. Gatenby (2002) also reported that the water consumption of sheep is majorly affected by the dry matter intake and the physiological status of the sheep.

The sex of the animal plays an important role as a source of variation on water consumption among West African Dwarf sheep in this present study. Male sheep consumed larger quantity of water compared to their female counterparts. The reason for this could not be far from the fact that male animals had higher values of feed intake than the female animals. According to Adegbola and Obioha (1984), concentrate feeding and grazing significantly increase the free water intake of West Africa Dwarf sheep. The authors also noted that though grazing, sheep did not require more total water than penned sheep, the total water intake increased by concentrate supplementation.

CONCLUSION

Feed intake, feed efficiency and daily water consumption was affected by coat pigmentation. Animals with light pigmentation had higher values for feed intake, daily water consumption and feed efficiency than the dark (black) pigmentation. Male sheep were superior to their female counterparts with respect to feed intake and feed efficiency. Female sheep consumed smaller quantity of water than the male sheep. The coat pigmentation of sheep should be considered in the management of sheep in the humid tropics which is characterized with high ambient temperature and relative humidity.

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COMPETING INTEREST

None

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