Ghana Journal of Science, Technology and Development
Vol. 4, Issue 2. December 2016
Journal homepage: http://gjstd.org
ISSN: 2343-6727

The effect of a locally produced mineral lick on the performance of growing West African Dwarf Sheep

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Abstract

An on-station experiment was conducted to establish the nutritional value of a locally manufactured mineral lick. Twenty-one West African Dwarf (WAD) sheep were used for the study. The sheep were divided into three equal groups of seven sheep. Each group had four males and three females. Group one sheep had access to the local lick. Group two sheep had access to a purchased foreign mineral lick while Group three sheep had no access to mineral lick. Mean initial weight of each group of sheep was 17 kg. The local lick was composed of dicalcium phosphate, a piece of anthill, clay-rich naturally-occurring salt lick, common salt and ashed fodder. The experiment spanned 5 months (December to May) of the dry season. Single factor design was used to analyze the data with restrictions on randomization within sex and week. Data were collected on sheep weight gains, height gains, blood parameters, sheep body condition and mineral lick costs. Mean weight gains were 3.7 kg, 3.3 kg and 3.0 kg for sheep on local, foreign and the control, respectively, with the difference between local and control being significant ($P<0.05$). Mean heights at withers were 76 cm for sheep on either local or foreign lick and 68 cm for the control but the difference was not significant. The local lick appeared to be of greater benefit to the female animals than the males. Packed cell volumes were 27, 24 and 14% for sheep on local, foreign and control, respectively. Haemoglobin contents were 9, 8 and 6 g/dl, while red blood cells and white blood cells were 5.0, 4.3 and 3.5 x 106/ul and 10.9, 10.5 and 11.4 x 103/ul for local, foreign and control sheep, respectively. The economics of gain were US$15.86, US$12.33 and US$12.25 for sheep on local lick, foreign lick and control, respectively. One sheep on the control died during the experiment. The local lick appeared to have a good nutritional value for female sheep in particular.

Keywords: *chemical composition; local innovation; nutrition; ruminants; weight gains*

INTRODUCTION

Ruminant productivity in Ghana may generally be described as poor because of a multiplicity of factors (Bouchel et al., 1992; Avornyo et al., 2015). Mortality and morbidity rates average between 30 and 40% in ruminant flocks (Avornyo et al., 2007). Observing proper medication regimen could reduce the mortality to about 5% (Karbo et al., 2004). There are, however other observations that suggest that many ruminants in Ghana are deficient in minerals (Kemp and Guerink, 1978). Consumption of food wrappers with a salty taste is one such evidence of mineral inadequacy in the diets of many ruminants (Karbo, 2007; Nderi et al., 2014). The second observation is that ruminants that regularly ingest kaolintic mineral deposits as an adaptive behaviour seem to exhibit better qualities such as the expression of more milk, increased birth weight of offspring, improved digestion, higher frequency of twinning and reduced mortality and morbidity (Karbo, 2007; Nderi et al., 2014). For pregnant women the advantages of reduced toxicity and digestion-inhibition have been enumerated (Profet et al., 1992). By adhering to the gastrointestinal epithelia, these clays not only improve digestive efficiency but also reduce foetal exposure to toxins which the mother might tolerate (Profet et al., 1992). De Souza *et al*. (2002) reported that howling monkeys become geophagous when they consume toxic fodder. Similarly, economically disadvantaged children in the tropics also tend to consume soil. They are often undernourished and susceptible to diarrhoeal dehydration. Geophagy therefore might have the added benefit of facilitating the exploitation of marginal plant foods and concomitantly reduce the energetic costs of diarrhoea (John, 1990; Dominy et al., 2004). Consumption of natural licks may therefore offer both adsorption and cytoprotection mechanisms which are adaptive advantages.

However, for large herbivores, mineral supplementation could be an important factor (Milewski, 2000; Holdo et al., 2002). Available mineral licks in Sub-Sahara African markets are imported and often costly, and so most livestock farmers cannot afford them (Karbo, 2007; Nderi et al., 2014). In many developing African countries, information on natural licks is based on indigenous knowledge. Information is needed on how to incorporate it into livestock ration for optimal production. This could then become a cheaper mineral lick substitute for the imported lick.

The study therefore aimed to:

1. formulate a local mineral block by the use of locally available natural lick.
2. compare the nutritional value of the fabricated lick with that of imported mineral lick in a feeding trial with sheep.

MATERIALS AND METHODS

The study area

The experiment was conducted at the Council for Scientific and Industrial Research - Animal Research Institute (CSIR - ARI) Station at Nyankpala in the Tolon District of the Northern Region. Nyankpala is located on latitude 9^o 25‘ to 9^o 45’ N and longitude 0^o 58’ to 0^o 42’ W and at a height of 183 m above sea level. The vegetation is Guinea Savanna and it has a unimodal rainfall pattern that begins in May and ends in October. Mean annual rainfall is 1043 mm. Temperatures generally fluctuate between 15^{0}C and 42^{0}C with a mean annual temperature of 28.3^{0}C. Mean annual day time relative humidity is 54%. The area experiences dry cold harmattan winds from November to February and a period of warm dry conditions from March to April.

Formulation of the local mineral block

The mineral compositions of a variety of mineral sources were determined. Based on their availability, samples of alluvial clay, dicalcium phosphate, anthill, common salt and available fodder were selected for the formulation of the local mineral block (Table 1). The fodder was solar dried and ashed by torching it and allowing to burn completely and cool in the open air before use. All the materials were processed into fine particles (0.02 to 0.2 mm size) before mixing. The mineral sources were combined in predetermined proportions (Table 1) to give a final product with a mineral composition suitable for ruminants. Cassava flour was added to an aqueous solution that was used for moulding of the blocks. The blocks were allowed to dry in the sun and used in a feeding experiment on-station.

Chemical analysis of the mineral block

Samples of the local mineral block and an imported UK-made mineral block bought in a veterinary drug store were analyzed at the Soil Research Institute (SRI) of the Council for Scientific and Industrial Research (CSIR) in Kumasi, Ghana for Ca, Cl, Mg, P, K, Na, S, Co, Cu, I, Fe, Mn, Se, Zn and Pb which were important in the diet of sheep. Colorimetric method followed by Spectrophotometry, and Atomic Absorption Spectrum were used in the determination of the minerals.

Feeding trial

An on-station experiment was conducted at CSIR - Animal Research Institute, Nyankpala Station in the Tolon District of the Northern Region of Ghana. Twenty-one 9 to 11 months old West African Dwarf (WAD) sheep were used. The sheep were divided into three equal groups of seven with each group consisting of 4 young rams and 3 gimmers. Mean initial weight of each group was 17 kg. Each group was randomly assigned to a treatment. The treatments were local mineral block (treatment 1), foreign mineral block (treatment 2) and control (treatment 3). Thus sheep on treatment one were offered the local block. Treatment two sheep were given the foreign block while treatment three sheep had no mineral block. The blocks were hung in their pens. The sheep were confined at 16:00 hr GMT in the experimental pens and allowed out at 9:00 hr GMT daily throughout the experimental period to graze. Treatments one and two animals therefore had access to the blocks when they returned from grazing until the following morning when they were shepherded out. All three groups benefited from Cajanus cajan hay as supplementary feed at 20% of their daily intake requirement when they returned from grazing. Water was offered adlibitum. The experiment was done from December to May covering a total of five months.

Data were collected every fortnight on sheep weight gain using a hanging Salter scale. Height at withers was measured with a special measuring stick made with two arms one held vertically and the other at right angles to it sliding firmly up and down to record the height. Blood samples were also taken in the fourth week of the experiment from individual animals from the three treatment groups by jugular venipuncture into EDTA tubes for haematological evaluation on a Cell-Dyn 3700 analyzer (Abbot Laboratories). The blood parameters analyzed were packed cell volume, haemoglobin content, white blood cells and red blood cells. Monetary values of the weights gained and licks consumed were also determined. Single factor design was used to analyze the sheep weight and height data and the comparisons of treatment means were done within sex and week.

RESULTS AND DISCUSSION

Table 2 shows the chemical compositions of the local and imported mineral blocks. With the exception of Ca, P and Fe in the local lick, the other elements were within the maximum tolerable levels for sheep (Kearl, 1982). In the imported lick however, more minerals namely Ca, Cl, Na, Fe, Mn, Se and Zn were found to be beyond the maximum levels. Sodium and Cl contents of the imported lick seemed to be a significant departure from the maximum tolerable levels for small ruminants. The results obtained from the analysis of the local lick were similar to the recommended levels (Kearl, 1982) for K, S, Co, Cu and Se. Only the Mg content of the foreign lick was similar to the recommended level. The results in the table seemed to suggest that the local lick might be of superior nutritional quality than the imported lick. The sheep consumed an average of 12.5 g of lick per day, which was consistent with the findings of Avornyo *et al*. (2007).

The daily sheep weight gains ranged between 38 and 51 g/day with control animals recording the lowest (38 g/d) and animals on the local mineral block recording the highest (51 g/d). Sheep on the foreign lick recorded a daily weight gain of 45 g. These values appeared a bit higher than those (20 to 39 g/day) obtained by Konlan *et al.* (2012) with supplemented sheep at the same study location. Similarly, they appeared higher than 31 g/day obtained by Bouchel *et al.* (1992) in sheep raised under the free range system without feed supplementation. Nevertheless, in feed-supplemented sheep under the traditional system, Yo *et al*. (1992) obtained a daily weight gain of 43 g which is within the range observed in this study. Height gains also ranged from 0.39 to 0.52 mm/day with control animals recording the lowest value while sheep on the foreign lick obtained the highest value of 0.52 mm/day. Sheep on the local lick recorded a daily height gain of 0.41 mm.

Figure 1 appears to show that the fastest weight gains were made by the sheep on the local lick followed by those on the foreign lick before the control. The difference in weight gain between sheep on local lick and those on control was statistically significant ($P<0.05$) (Table 3). Initially, it appeared that the sheep on the foreign lick were showing the fastest growth rate. However, by the twelfth week, the sheep on the local lick were performing better. Between the tenth and the sixteenth week, there was no Cajanus cajan to offer as supplementary feed so all the animals lost weight during that period but the severity of weight loss was less pronounced in animals consuming the local lick (Figure 1).

Figure 2 shows that the young rams appeared to be growing faster at the initial stages of the experiment but they were overtaken by the females after the sixteenth week. It is possible that during this period most of the females had become gravid with foetus. Ogebe *et al*. (1995) noted that salt supplementation of browsing kids resulted in up to one month early detection of puberty.

There was a statistically significant interaction between the applied treatments and the sex of the animals for both weight and height gains ($P=0.01$). Table 3 reveals that the local lick appeared to benefit the gimmers in particular but not so much the young rams. This finding appears to support the claims that geophagy is beneficial to pregnant women (Profet *et al.*, 1992). According to them, its adsorptive quality tends to reduce the absorption of intestinal toxins such as anti-nutritive factors and diarrhoea-causing enterotoxins. The minerals in natural licks tend to increase the bioavailability of chelated compounds such as calcium oxalate (Kreulin, 1985). The result is an improvement in the overall efficiency of absorption.

The results on the height increases did not conform to a particular trend. Ogebe *et al*. (1995) made a similar observation however in addition, they noticed some increases in girth. Since a strong positive correlation exists between animal height and weight, it can be inferred that the faster growing animals had a corresponding greater increase in height. Fig. 3 suggests a faster gain in the height of the gimmers compared to the young rams ($P=0.0001$)

Table 4 shows that the sheep on either the local or foreign mineral lick had higher packed cell volumes than the control sheep. Correspondingly, their haemoglobin and red blood cell contents were also higher. These notwithstanding, the PCV and haemoglobin levels were generally low. Apparently better values were obtained by Konlan *et al*. (2012). Attoh-Kotoku *et al.* (2010) reported PCV and haemoglobin levels that ranged from 24 to 33% and 10 to 12 g/dl, respectively in rams. The white blood cell contents were not very different however there was an indication of slightly higher white blood cell content in the control sheep. Higher white blood cell content may be an indication of ill health. These are indications that the animals on the lick were probably in better health condition than those without mineral lick. One animal from the control died during the course of the experiment.

Economic evaluation of the three treatments showed the cost price per kilo of the local mineral block to be US$0.48 while that of the imported block was US$1.37 (Table 5). The total amount of local block consumed per sheep amounted to US$0.84 compared to US$2.40 for the imported block. The economics of using the mineral licks therefore appeared to favour the local block most as it had the highest margins followed by the foreign block and lastly the control (Table 5).

CONCLUSION

The formulated local lick proved to be of benefit to small ruminants both nutritionally and animal health wise. It appeared to be of more benefit to the gimmers than the young rams. The local lick was therefore a potential alternative to imported mineral lick.

ACKNOWLEDGEMENTS

The authors are grateful to the Association of Church Development Projects (ACDEP), Tamale, Ghana for securing Promoting Local Innovations (PROLINNOVA) funds for this work to be done. Special thanks go to all persons who in diverse ways contributed to the execution of this project.

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Table 1: Composition of the local lick (g/kg)

Ingredient	*Dicalcium phosphate	Anthill	Alluvial clay	Common salt	Dry fodder
Quantity	120	80	160	280	360

*Oyster shell or bone ash could substitute for dicalcium phosphate

Table 2: Chemical composition of the mineral licks viz a viz recommended and maximum tolerable levels (g/kg)

Parameter	Ca	Cl	Mg	P	K	Na	S	Co	Cu	I	Fe	Mn	Se	Zn	Pb
Local lick	34	50	2.0	23	5.0	33	1.0	10^{-4}	10^{-2}	10^{-5}	1.0	0.1	10^{-4}	0.1	10^{-3}
Imported lick	30	607	5.0	0	-	393	0	10^{-2}	0	10^{-2}	2.0	2.0	10^{-2}	2.0	0
Recommended level*	6.0	2.0	5.0	3.0	5.0	1.0	2.0	10^{-4}	10^{-2}	10^{-4}	0.5	1.0	10^{-4}	0.3	10^{-2}
Maximum tolerable level*	20	55	5.0	6.0	30	35	4.0	10^{-2}	10^{-2}	10^{-2}	0.5	1.0	10^{-3}	0.3	10^{-2}

*Source: Kearl (1982)

Table 3: Mean weight gains (kg) of the young rams and gimmers on the different treatments

Treatments	Mean sheep weight gains (kg)	
	Young rams	Gimmers
Local lick (treatment 1)	3.37 ± 1.39^{ab}	4.06 ± 0.44^{a}
Foreign lick (treatment 2)	3.50 ± 0.88^{ab}	3.02 ± 0.29^{b}
Control (treatment 3)	3.38 ± 1.84^{ab}	2.79 ± 0.73^{b}

Mean ± standard error; mean values with different superscript letters are significantly different at P<0.05

Table 4: Values of the blood parameters measured in the experimental sheep

Parameter	Sheep on local lick	Sheep on imported lick	Control sheep	Normal range
Packed cell volume (%)	27 ± 3.7^{a}	24 ± 4.5^{a}	14 ± 4.7^{b}	27 to 45
Haemoglobin (g/dl)	9.10 ± 1.25^{a}	8.02 ± 1.22^{ab}	5.67 ± 1.49^{b}	9 to 15
Red blood cells (x 10^{12})	4.97 ± 1.07^{a}	4.27 ± 0.72^{ab}	3.51 ± 0.44^{b}	9 to 15
White blood cells (x 10^{3})	10.88±0.61	10.46±1.86	11.40±1.47	4 to 12

Mean ± standard error; mean values with different superscript letters in the same row are significantly different at P<0.05

Table 5: Economics of using the treatments

Parameter	Local mineral block	Imported mineral block	Control
Treatment cost ($/kg)	0.48	1.37	0.00
Total intake/sheep (kg)	1.75	1.75	0.00
Total cost ($)	0.84	2.40	0.00
Body weight gain/sheep (kg)	7.20	6.35	5.28
Livebody weight price ($/kg)	2.32	2.32	2.32
Revenue/sheep	16.70	14.73	12.25
Margin/sheep	15.86	12.33	12.25

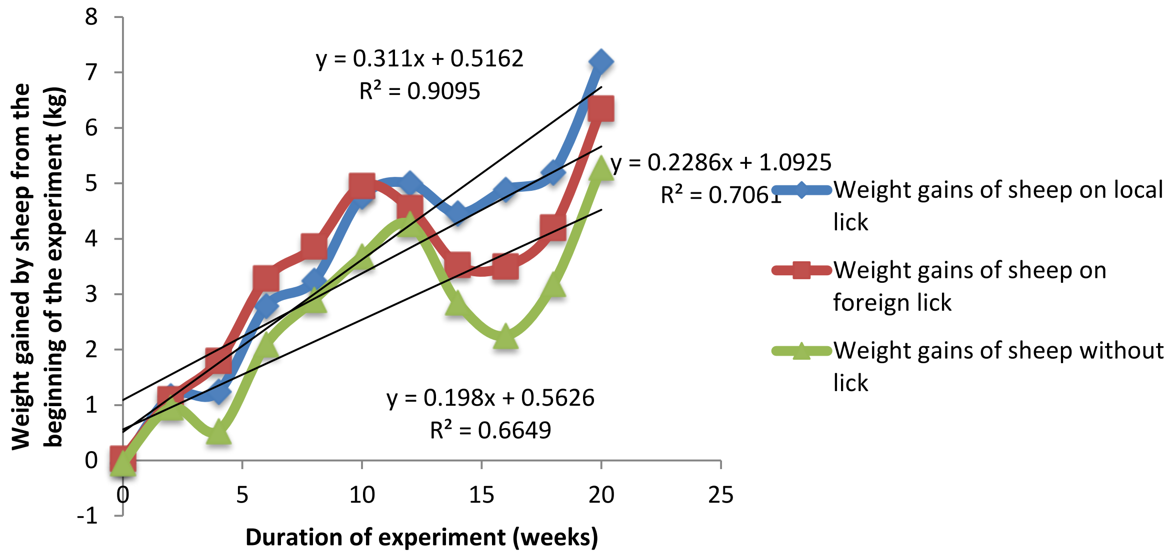

Figure 1: Weight gains of the sheep on the different treatments

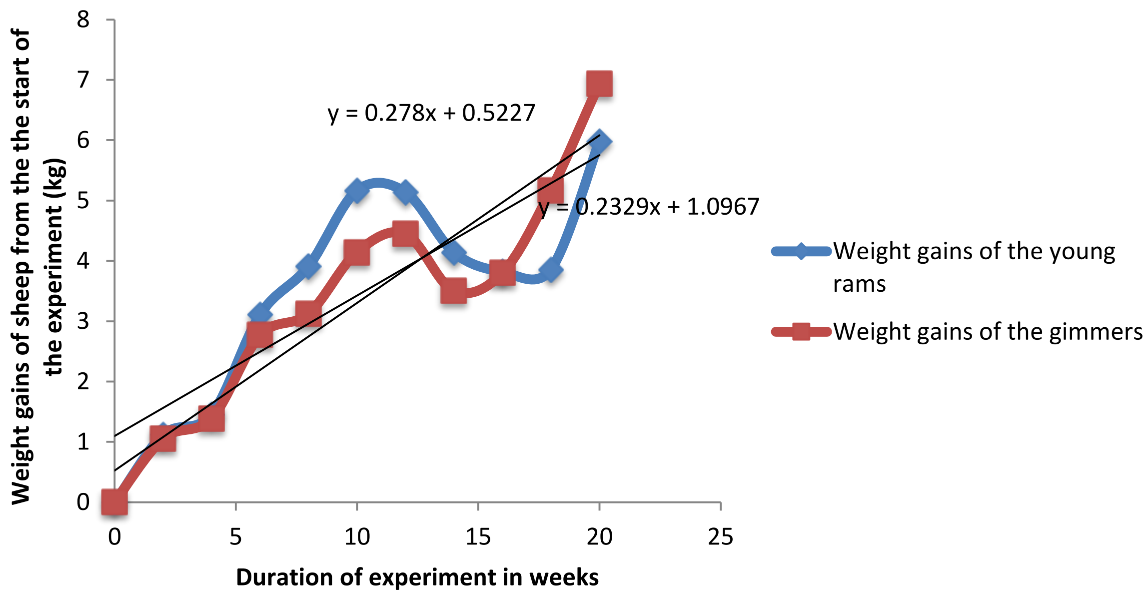

Figure 2: Weight gains of the female and male sheep on the experiment

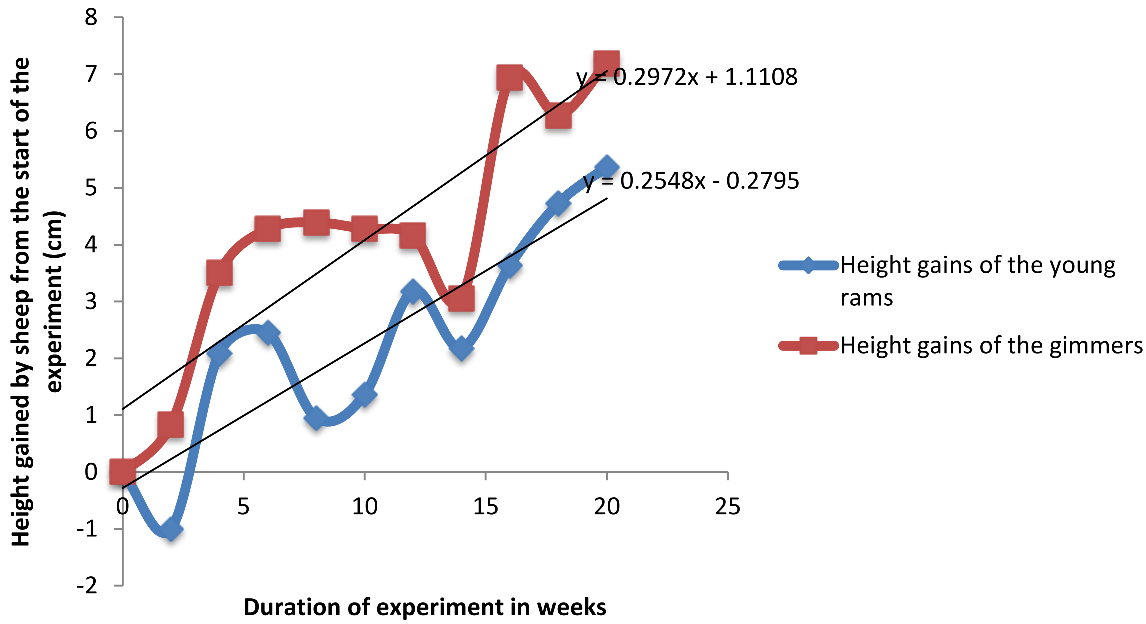

Figure 3: Height gains of the young rams and gimmers on the experiment