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Maintenance Behaviour of West African Dwarf Goats on Concentrate Diet Containing Incremental Sodium Humate

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ABSTRACT

Background and Objective: The maintenance behaviour of farm animals is a veritable tool to measure the welfare of the animals. This study investigated the duration and frequency of feeding, lying, walking and standing of West African Dwarf goats, in responses to the diets containing incremental sodium humate. **Materials and Methods:** Experimental diets were formulated containing sodium humate at 0, 5, 7.5, 10 and 12.5 g kg^{-1} diet (control, 5, 7.5, 10 and 12.5 HNa). Three animals in each experimental diet for 90 days were transferred to cages for behavioural observations. Video recordings from a 12 unit CP PLUS® CCTV camera (Model: CP-ER-1606E2-T) were reviewed for behavioural parametersusing Boris® software. The results were analysed using one-way ANOVA as outlined in SPSS. **Results:** The result reveals a quadratic increase ($p<0.05$) in the mean duration of feeding in the 7.5 HNa and 10 HNa groups. Feed intake and the mean duration of standing and walking were reduced ($p<0.05$) in the supplemented groups. The frequency of walking decreased ($p<0.05$) in the sodium humate groups. However, there was an increase ($p<0.05$) in the frequency of feeding and standing. **Conclusion:** It was concluded that sodium humate has the potential to improve the welfare of West African Dwarf goats under confinement.

KEYWORDS

Sodium humate, maintenance behaviour, lying, walking, feeding, standing, WAD goats

INTRODUCTION

Social consciousness about the condition of rearing farm animals has become a major alarm in recent years[1]. The report of Tremolada *et al.*[2] indicated that animal welfare is a precondition for companies to develop high-quality and sound animal products for the world market. An important criterion in the assessment of ruminant welfare is their maintenance behaviour[3] which includes feeding, standing, walking, lying etc. Maintenance behaviour refers to activities such as ingestion of feed and water, comfort-seeking and behaviour related to rest or exploration, all of which typically function to maintain the physiological

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status, comfort and appearance of the animal. Feeding behaviour includes diet selection and feeds intake and it is the major way by which an animal seeks to fulfil its metabolic needs and achieve homeostasis[4]. However, the challenge of obtaining adequate nutrients may differ among individual animals[5]. The duration and frequency of lying behaviour and the time spent standing without eating appear to be probable behavioural indicators of comfort[6]. Lying time is said to be an important behaviour for dairy cows and when given the choice, cows will prefer lying down to spending time on other activities such as feeding and socializing[7]. Research with humans and other animals suggests that walking benefits physical health[8]. Walking supports exploratory behaviour and this has an information-gathering function and may be rewarding to animals even when not directly linked to the acquisition of resources[9,10] this makes it important in achieving the welfare of the animals. Because animal welfare has become a worldwide issue[11], nutritional studies must also include the study of welfare parameters. The major advantage of behavioural measurements unlike physiological measurements is that they can be easily implemented on the farm[12]. In livestock production systems, attention should be given to animal welfare to improve productivity, quality food safety and economic returns, thereby contributing to food security and economic prosperity.

There is increased interest in the utilization of humates as a feed additive. They have been reported to have beneficial effects on digestion, growth and the immune system in poultry, swine, goats, sheep and cattle[13,14]. However, there is a dearth of information on how it affects the maintenance behaviour of ruminants, especially the West African Dwarf (WAD) goats. This research, therefore, sought to assess the maintenance behaviour of WAD goats on incremental levels of sodium humate.

MATERIALS AND METHODS

Experimental site and animals: The field experiment was done at the Small Ruminant Experimental Unit of the Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta, Nigeriain June-September, 2019, while the review of video recordings was carried out in the Postgraduate Laboratory of the Department of Animal Production and Health, Federal University of Agriculture, Abeokuta, Nigeria from October-December, 2019. Abeokuta is located in the rainforest vegetation Zone of South-Western Nigeria at latitude 7°13'49.46"N, longitude 3°26'11.98"E and an altitude of 76 m above sea level. The climate is humid with a mean annual rainfall of 1037 mm and an annual mean temperature and humidity of 43.7°C and 82, respectively (Meteorology Department, Ogun, Osun River Basin Authority, Abeokuta, Ogun State, Nigeria).

The bucks used in this study were purchased from local farmers from Abeokuta and environs. The thirty West African Dwarf bucks were aged between 10-15 months, with an average weight of 7.19±0.83 kg. On arrival, the animals were given prophylactic treatment using oxytetracycline LA (1 mL kg^{-1}) against bacteria disease while Ivomectin LA (1 mL/50 kg) was administered against both external and internal parasites. The animals were dived into five groups (treatment groups) of six animals each (each animal served as a replicate). The five groups were allocated to five experimental diets (treatment groups) containing sodium humate at 0, 5, 7.5, 10 and 12.5 g kg^{-1} diet (control, 5, 7.5, 10 and 12.5 HNa). Each animal was allotted a 1 m^2 pen and allowed to graze daily together for six hrs (9am-3pm) within a confined area containing sown *Panicum maximum*. Thereafter, they were supplemented with an experimental diet adopted from Ikyume *et al.*[15] as shown in Table 1 at 4% of their body weight. Water was provided *ad libitum*. After 90 days of managing the animals on experimental diets, three animals each from the five groups above were transferred into another pen fitted with CCTV cameras for feeding behaviour observations. The assumption is that the experimental diets were capable of influencing the feeding behaviour of the animals after feeding them for some time, as such the 90 days period was enough to influence the feeding behaviour of the animals if possible. The three animals per treatment selected from each of the six animals in the groups (experimental groups) above were because the facilities available for behavioural observations could only support that numbers. The selection also ensued the mean weight of the animals across the treatment groups was closely related. While in the pen fitted with CCTV cameras, the

Table 1: Gross composition (%) of experimental concentrate diets[15]

	Treatments (HNa)				
Ingredients	Control	5	7.5	10	12.5
Maize offal	30.00	30.00	30.00	30.00	30.00
Wheat offal	34.00	34.00	34.00	34.00	34.00
Palm kernel cake	32.00	32.00	32.00	32.00	32.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Vitamin premix	0.50	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50	0.50
HNa	-	0.50	0.75	1.00	1.25
Total	100.00	100.00	100.00	100.00	100.00
Determined analysis					
Dry matter	88.00	88.00	88.00	88.00	89.00
Crude protein	14.88	14.01	14.35	14.13	14.61
Crude fibre	9.50	9.50	10.00	9.00	10.00
Ash	5.00	5.40	5.45	6.00	6.50
Ether extract	6.50	8.00	7.50	8.00	7.56
NDF	64.00	65.00	63.00	54.00	55.00
ADF	22.00	23.00	19.00	23.00	20.00
ADL	9.00	8.50	8.00	9.00	7.00

NDF: Neutral detergent fiber, ADF: Acid detergent fiber, ADL: Acid detergent lignin, 5 HNa-5 g kg^{-1} diet sodium humate inclusion, 7.5 HNa-7.5 g kg^{-1} diet sodium humate inclusion, 10 HNa-10 g kg^{-1} diet sodium humate inclusion and 12.5 HNa-12.5 g kg^{-1} diet sodium humate inclusion

animals were allowed four days for acclimatization, thereafter, records of maintenance behaviour were taken for four days using the continuous sampling method of behavioural observations. During the period of the behavioural observations, about 1 kg of the experimental diets and *Panicum maximum* were offered to the animals at a ratio of 70:30. Weighed samples of both *Panicum maximum* and experimental diets were offered daily in the morning and afternoon, respectively. The leftover was also weighed at the end of each day to determine the feed intake. Experimental and animal management procedures were approved by the Ethics Committee of the College of Animal Science and Livestock Production, Federal University of Agriculture, Abeokuta, Nigeria (ethical clearance number COLANIM/APH/PG/14/0107).

Experimental set-up: Maintenance behaviours (standing, lying, feeding, drinking and walking) were examined 8 hrs/day (8.00-16.00 hrs) for four days of continuous video sampling from three animals per treatment. Standing was considered to be an inactive upright position (i.e., no locomotion), lying was considered as body contact with the floor, feeding was considered to be when the head position was over or in the feeder and drinking was seen as the head position over or in the drinker and walking was considered as any change in one position to the other within the pen. A 12 unit CP PLUS® CCTV camera (Model: CP-ER-1606E2-T) was used to record the behaviour of the animals at normal speed (30 frames/s). The cameras were hung at an angle above the individual pens of the animals to ensure that the entire space within the pen was visible. Three units of the cameras were hung such that they could cover two pens each. Video recordings were analyzed in their entirety by one person using Boris® software[16] and individual animal behaviour data on mean duration (per 8 hrs) was obtained. The video was reviewed at the speed at which it was initially recorded. Feed intake was also recorded during the experiment using the formula:

$$\text{Feed intake} = \text{Feed of fered-feed left over}$$

Experimental design and model: The experimental design was completely randomized. The treatment groups comprise of concentrate diet formulated to comprise 0, 5, 7.5, 10 and 12.5 g kg^{-1} diet. The statistical model is:

$$Y_{ij} = \mu + T_i + £_{ij} \quad (1)$$

Where:

Y_{ij} = Observed value of the dependent variables (feed intake, eating, lying, walking, standing)

μ = Population mean

T_i = Effect due to level of inclusion of HNa (0, 5, 7.5, 10, 12.5 g kg^{-1} diet)

$£_{ij}$ = Random residual value

Statistical analysis: The feed intake as well as the mean duration and frequency of lying, feeding, walking, drinking and standing was analyzed using a one-way analysis of variance as contained in the general linear model's procedures of SPSS (version 23) (https://www.ibm.com/support/pages/spss-statistics-230-now-available-download). The differences in means where applicable were separated using the GLM procedure of SPSS (version 23). Probability significance was declared at $p \leq 0.05$. The polynomial contrast model in the SPSS was used to determine if the various treatments had linear, quadratic or cubic degree relationships.

RESULTS

Feed intake and mean duration (min) of the daily behaviour of WAD goats on sodium humate: The daily mean duration of behavioural reactions of West African Dwarf goats to the diets containing incremental levels of sodium humate is shown in Table 2. Mean lying and drinking durations were not affected ($p>0.05$) by the inclusion of sodium humate in the diets. However, the duration of feeding tended to linearly increase in the sodium humate groups which had higher ($p<0.05$) comparable values. The mean duration of feeding was lower ($p<0.05$) in the control group. Such an increase in mean feeding duration in the sodium humate groups tended to decrease at 12.5 g kg^{-1} diet sodium humate group. Mean duration for standing and walking were observed to decrease with sodium humate supplementation. The control group had higher ($p<0.05$) mean durations for standing and walking (207.74 and 94.96, respectively) with lower comparable values of standing and walking observed in the sodium humate supplemented groups. A linear decrease in the standing and walking duration in the sodium humate groups did not have any particular pattern as a quadratic relationship was observed.

Mean frequency of daily maintenance behaviour of WAD goats on sodium humate: The result of the frequency of daily maintenance behaviour of West African Dwarf goats fed a concentrate diet containing incremental levels of sodium humate is shown in Table 3. Feeding frequency (per 8 hrs daily) increased ($p<0.05$) in the sodium humate groups. Least ($p<0.05$) frequency (62.00) was observed in the control group, with sodium humate groups having comparable higher ($p<0.05$) feeding frequency/8 hrs daily (76.00, 79.00, 76.67, 78.00 for 5, 7.5, 10 and 12.5 HNa, respectively). Standing frequency increased ($p<0.05$) in the sodium humate groups (138.00, 137.00, 136.33 and 132.33 for 5, 7.5, 10 and 12.5 HNa, respectively).

Table 2: Feed intake and mean duration (min)/8 hrs daily maintenance behaviour reactions of West African Dwarf goats on diet containing incremental levels of sodium humate

	Treatments (HNa)						Polynomial contrast		
Parameters	Control	5	7.5	10	12.5	SEM	L	Q	C
Mean body weight (kg)	9.37	10.35	10.38	10.57	10.08	0.17	NS	NS	NS
Mean feed intake (kg/goat)	321.69^{a}	235.54^{b}	223.54^{b}	242.73^{b}	238.57^{b}	10.25	**	**	*
Duration of lying	797.69	803.24	805.62	802.86	800.18	1.17	NS	NS	NS
Duration of feeding	257.61^{b}	266.92^{ab}	272.81^{a}	271.97^{a}	266.84^{ab}	1.71	*	**	NS
Duration of standing	207.74^{a}	201.52^{b}	202.95^{ab}	200.22^{b}	201.47^{b}	0.84	**	*	NS
Duration of walking	94.96^{a}	90.46^{b}	90.37^{b}	89.47^{b}	90.92^{b}	0.65	**	*	NS
Duration of drinking	17.90	18.25	18.47	17.83	18.20	0.32	NS	NS	NS

^{a,b}Means with different superscript along the raw differ significantly ($p<0.05$), 5 HNa-5 g kg^{-1} diet sodium humate inclusion, 7.5 HNa-7.5 g kg^{-1} diet sodium humate inclusion, 10 HNa-10 g kg^{-1} diet sodium humate inclusion, 12.5 HNa-12.5 g kg^{-1} diet sodium humate inclusion, SEM: Standard error of mean, L: Linear, Q: Quadratic, C: Cubic, **$p<0.005$, *$p<0.05$ and NS: Not significant

Table 3: Mean frequency (number of occurrences)/8 hrs of daily maintenance behaviour reactions of West African Dwarf goats on diet containing incremental levels of sodium humate

	Treatments (HNa)						Polynomial contrast		
Parameters	Control	5	7.5	10	12.5	SEM	L	Q	C
Frequency of lying	17.67	15.67	16.67	15.00	18.33	3.40	NS	NS	NS
Frequency of feeding	62.00^{b}	76.00^{a}	79.00^{a}	76.67^{a}	78.00^{a}	2.52	**	*	NS
Frequency of standing	117.00^{b}	138.00^{a}	137.00^{a}	136.33^{a}	132.33^{a}	10.54	NS	*	NS
Frequency of walking	136.33^{a}	123.67^{b}	124.67^{b}	125.67^{b}	124.33^{b}	6.90	NS	*	NS
Frequency of drinking	23.33	22.33	22.67	23.33	20.67	2.33	NS	NS	NS

^{a,b}Means with different superscript along the same row are different ($p<0.05$), 5 HNa-5 g kg^{-1} diet sodium humate inclusion, 7.5 HNa-7.5 g kg^{-1} diet sodium humate inclusion, 10 HNa-10 g kg^{-1} diet sodium humate inclusion, 12.5 HNa-12.5 g kg^{-1} diet sodium humate inclusion, SEM: Standard error of mean, L: Linear, Q: Quadratic, C: Cubic, **$p<0.005$, *$p<0.05$ and NS: Not significant

The control group had the least standing frequency (117.00). However, a reverse trend was observed in walking frequency with the control group having the highest ($p<0.05$) occurrences (136.33). There was less ($p<0.05$) comparable frequency of walking in the sodium humate groups (123.67, 124.67, 125.67 and 124.33 for 5, 7.5, 10 and 12.5 HNa, respectively). The frequency of lying and drinking was not affected ($p<0.05$) by the inclusion of sodium humate in the diet.

DISCUSSION

The initiation phase in seeking feed involves a switch in behaviour, usually from one activity to the act of sourcing and procuring feed. The linear increases in the mean duration of feeding observed in the sodium humate groups are an indication that pre-ingestive signals in the supplemented groups were reinforced to consume the feed. In the report of Ritter[17], once pre-ingestive signals reinforce the desire to consume feed, the ingestive, digestive and absorptive mechanism is activated almost simultaneously and all function together to augment each other's satiating effects. An increase in the mean duration of feeding in some of the supplemented groups may have been a result of the action of sodium humate to improve pH and decrease ammonia in grazing WAD goats[18]. Lower pH is reported to increase osmotic pressure in the rumen which can induce satiety thereby, decreasing the duration of feeding[19]. The increase in the mean duration of feeding in this current study did not, however, follow a particular trend in the supplemented groups (some humate groups were similar to the control) which explains the quadratic relation observed. Such an increase in mean duration may be associated with a possible reduction in rumen ammonia with sodium humate as previously reported. These findings collaborate with the fact that ammonium which is an end product of fermentation during silage production is associated with a decrease in silage intake[20]. The decrease in standing and walking duration observed in the sodium humate supplemented groups could be that the animals spent most of their active period during the day in feeding and lying. This is also true as the lying period was numerically increased in all experimental groups. There have been reports of the beneficial effect of humic acids in the management of stress in animals[21]. This effect may have been responsible for the increased duration of feeding since animals may have been leisurely eating their rations. This is to say that animals on humate may be less aggressive in their feeding behaviour and would spend more time eating to satisfy their nutritional requirement than standing and walking around.

The frequency of maintenance behaviour has been correlated with the mean duration of the behavioural responses. For instance, cows fed more frequently spent more time feeding and lower dry matter intake[22,23]. This may have been the case in this current study. As the frequency of feeding increased in the sodium humate groups, dry matter intake decreased with a potential increase in the duration of feeding. Under a semi-intensive management system, the dry matter intake of WAD goats was reduced[15] which is consistent with the decrease observed during the behavioural observation.

Standing is regarded as a measure of comfort[6], the greater frequency of standing is an indication that sodium humate improved the comfort of the animals. Recall that West African Dwarf goats are browsers and are often not adapted to confinement. This trait may have been the reason the animals on the control diet had a higher frequency of walking compared to those in the humate group. That is to say that with the inclusion of sodium humate in the diet of these goats, they may be more adapted to confinement. More standing frequency in sodium humate groups than walking implies the animals were less aggressive and this supports the finding of leisure in dairy cattle on humate rations[21]. The implication of these findings will be that for ruminant species such as WAD goats that are usually not adapted easily to confinement, the inclusion of sodium humate up to 12.5 g kg^{-1} diet in their diet will provide for easy adaptability to confinement. However, it is important to investigate the performance of these animals in confinement for a longer period with sodium humate in their diets.

CONCLUSION

The supplementation of sodium humate improved the welfare of West African Dwarf goats. The West African Dwarf goats are browsers and as such are not well adapted to confinement. The use of sodium humate in their diet can be a good strategy for improving the welfare of the animals under confinement. In achieving this, only a 5 g kg^{-1} diet of sodium humate is sufficient when the cost of production is considered.

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