THE EFFECTS OF INTRARUMINAL INFUSION OF SODIUM SELENITE ON THE *IN-SACCO* DEGRADABILITY OF *Centrosema pubescens* AND *Pennisetum purpereum* IN WEST AFRICAN DWARF SHEEP

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ABSTRACT

This trial describes the effect of intraruminal infusion of sodium selenite on the in-sacco rumen degradability of a legume, Centrosema pubescens and a grass, Pennisetum purpereum in West African dwarf (WAD) sheep. A total of sixteen WAD sheep of an average body weight, 16.19 ± 2.63 kg were used for this study. A 4 x 4 Latin square design of four sheep and four sodium selenite treatments (doses) for each forage in both the experimental (group A) and control group (group B) was adopted. Using the nylon bag technique, percentage disappearance of dry matter (DM), organic matter (OM) and crude protein (CP) fractions as well as their degradation constants were determined at time intervals of 8, 12, 24, and 48 hours following daily intraruminal infusions of 50, 100, 150 and 200µg of sodium selenite per sheep within each Latin square. The results of the study showed that addition of sodium selenite improved rumen degradability of feed fractions when compared with the control. All the concentrations of sodium selenite significantly ($p < 0.05$) increased the percentage disappearance of all the feed fractions, in a dose dependent manner, compared to the control particularly up to a maximum dose of 150µg beyond which a decline in degradability was observed for all the feed fractions. The results of the study also showed significant correlation ($r^2 = 0.56$) between period of incubation and percentage disappearance of feed fractions for both forages with relatively more time required for disappearance of DM, OM and CP in the grass (Pennisetum purpereum) than the legume (Centrosema pubescencs). It was therefore concluded that sodium selenite at a maximum concentration of 150µg, when infused into the rumen, is safe and improves rumen degradability of virtually all forage fractions. Thus sodium selenite could be valuable as a feed additive in ruminant diets particularly to improve the rumen degradability of probably more fibrous, low protein feedstuffs. This calls for a focus on sodium selenite as a possible manipulator of rumen function for efficient utilization of poorly degraded feedstuffs.

Keywords: Sodium selenite, *In-sacco* rumen, Degradability, Forages, WAD sheep

INTRODUCTION

The nylon bag or *in-sacco* technique is a very robust and powerful tool with which several aspects of ruminant nutrition are studied (Orskov and Shand, 2004). It is particularly useful in describing characteristics of protein and other feed fractions in forages as well as in the rumen simulated techniques (RUST) (Blummel and Orskov, 1993). For several years the 48 hr degradability characteristics was used as an approximation to in vivo digestibility and for this, assessment of rumen microbial activity in the rumen at a maximum period of 48 hours

is strongly recommended (Orskov and MacDonald, 1979). The *in-sacco* technique has generally afforded additional opportunities for the assessment of impacts of organic substances on nutrient digestibility. Therefore, its application in rumen biotechnology or manipulation of rumen function has gained wide acceptance. For this purpose, we adopted the *in-sacco* method in the evaluation of the impact of sodium selenite in the rumen degradability of DM, OM and CP fractions of *Centrosema pubescencs* and *Pennisetum purpereum* in WAD sheep. Current trends in rumen bioengineering involves the use of chemical agents such as antibiotics, growth promoting hormones, yeast cultures, organic acids, minerals, plant extracts etc. to manipulate rumen functions for enhanced feed breakdown and productivity of ruminants (Nielsen and Thamsborg, 2005). A number of studies support the use of chemicals such as vitamins A, B12 (or cobalt), E (or selenium) in ruminant diets to improve rumen fermentation and microbial protein flow to the postruminal segments of the gastrointestinal tract (Ramasani *et al*., 2005; El Hassan *et al.,* 1996). Apart from parasitism and the associated reduced immunosuppression, limitations to ruminant production include poor rumen degradability of fibrous plant materials, increased nitrogen losses, toxic compounds present in plant feed, oxidative stress on rumen microbes following consumption of environmental pro-oxidants, etc. Attempts to alleviate these problems focus on the manipulation of rumen function by the use of minerals as feed additives and probiotics. Selenium is one of the trace minerals that have been identified as important for normal immune function and disease resistance in many field conditions (Galyean *et al*., 1999). It has also been noted that supplementation of selenium in first lactating dairy cattle reduced the incidence and severity of clinical symptoms of mastitis (Smith *et al*., 1985). Selenium (as selenium methionine) has also been used as a non-enzyme antioxidant substance to improve rumen microbial activity with resultant improvement in rumen fermentation (Holovska *et al*., 2002). Various attempts in improving rumen fermentation including reduction of methane production, increased production of propionate, increased protein bypass and rumen retention time have been performed using various organic agents particularly minerals. The beneficial effects of selenium and other minerals in this regards has been well documented (Coop and Field, 1983; Suttle *et al*., 1992; Vellema *et al*., 1996). There is however paucity of information on the in vivo uses of sodium selenite in WAD sheep. Also the maximum tolerable dose of sodium selenite as well as its effect particularly on rumen degradability of some tropical feedstuffs or their fractions has not been clearly established in the WAD sheep. In consideration of these, and in line with the established beneficial effects of sodium selenite in rumen function, we designed this study to evaluate the possible effects of sodium selenite on the *in-situ* rumen degradability of dry matter, organic matter and crude protein fractions of two forages readily available and popularly consumed by the WAD sheep.

MATERIALS AND METHODS

Sixteen adult WAD sheep of average body weight of 16.19 ± 2.63 kg were purchased from Opi market in Nsukka area of Enugu State, South-Eastern Nigeria. They were quarantined for 14 days for observation for disease symptoms. Thereafter, they were transferred to a pen of adequate space measuring 20 x 15 ft in the animal house of the Department of Veterinary Physiology/Pharmacology. Here, they were further screened for “ecto” and “endo” parasite using the appropriate methods and acclimatized for 21 days during which they were fed twice daily (9:00 am and 4:00 pm) using freshly harvested *Centrosema pubescencs* and *Pennisetum purpereum* only, mixed at 50:50 combination ratio. Water was provided *ad libitum* while salt was provided as a lick for 48 hours per week. During the acclimatization, ectoparasites and endoparasites were routinely controlled, together with the prescribed vaccination. After the acclimatization period, they were divided into two groups of eight sheep. Each group of eight sheep was used for each forage by further subdividing them into two groups of four sheep for the experimental

and control groups. A 4 x 4 Latin Square experimental design of four treatments (dose) of sodium selenite and four sheep in the experimental group was used to study the disappearance of the feed fractions of each forage. All the sheep in all groups (both experimental and control) were fitted with rumen fistula as described by Oladosu and Akpokodje (1992) and as modified by Santra and Karim (2002).

The nylon bag incubation technique as developed and described by Mehrez and Orskov (1977) was adopted for the estimation of the disappearance of dry matter (DM), organic matter (OM) and crude protein (CP) fractions of both forages in all the experimental and control groups. The effects of sodium selenite on the *in-sacco* degradability of the forages under study were studied using four treatments (dose levels) of sodium selenite viz; 50, 100, 150 and 200µg/sheep. Each treatment (dose) was infused intraruminally, into each sheep, on daily basis for 7 days and thereafter the disappearance of each forage fraction was evaluated at 8, 12, 24 and 48 hours of incubation in each sheep in the 4 x 4 Latin square model (in the experimental groups). The period between interchanging of doses between sheep (cross over period) in the Latin square was 4 days (Bogoro *et al.*, 2006). For any given dose of sodium selenite 3 replicates of each forage were incubated per any given time interval (i.e. 12 replicates of each forage sample per dose level of sodium selenite per time interval in the experimental group).

Details of incubation procedures and protocols adopted for the estimation of degradability characteristics of each feed fraction were as described by Aregbede *et al.* (2002) and Aka and Kamalu (2004). The chemical composition of the forages was determined by the method of AOAC (1990). Degradability constants of each feed fraction DM, OM and CP were estimated by fitting the data generated into the formula of Orskov and McDonald (1979) given as: $P = a + b (1-e^{ct})$, where p is the disappearance at time t, 'a' is the rapidly disappearing fraction (i.e. zero time intercept), b is the insoluble but rumen degradable fraction, c is the rate at which the insoluble rumen degradable fraction is degraded, a + b represents the potential degradability while 100 - (a + b) is the total rumen undegraded fraction.

Treatment effect for pooled means was tested statistically by the analysis of variance (ANOVA). Differences between treatment means as well as between treatment and control means were analyzed using Least Significant Difference of mean comparison (Steel and Torrier, 1980).

RESULTS

It was observed that the protein content of *C. pubescens* (26.38 %, DM) was higher than *P. purpereum*, (17.84 %). However, the dry matter, organic matter and crude fiber contents of *P. purpereum*, DM (93.76 %), OM (79.66 %), and CF (24.88 %) were higher than *C. pubescens*, DM (82.21 %), OM (47.06 %) and CF (11.97 %) (Table 1). The *in-sacco* rumen disappearance of dry matter fraction of *C. pubescens* at different time intervals and concentrations of sodium selenite indicated that at 48 hours, the percentage disappearance of all the feed fractions was significantly ($p<0.05$) different between treatments and control. At 150µg concentration of sodium selenite, the percentage disappearance was highest (91.14 ± 3.18 %) compared to other treatments; 50µg (50.17 %); 100µg (63.42 %); 150µg (78.54 %) and control (44.91 %) at 48 hours post incubation. This showed that, increasing the concentration to 200µg produced a significant ($p<0.05$) decrease in percentage disappearance (78.54 ± 4.32 %) compared to the 150µg concentration (Table 2).

The mean percentage disappearance of OM of *C. pubescens* at different concentrations of sodium selenite indicated that at 48 hours post incubation, OM disappearance was significantly ($p < 0.05$) increased at 100µg (89.93 ± 2.95 %), 150µg (93.68 ± 3.32 %) and 200µg (91.31%) concentration of sodium selenite compared to 50µg (66.81 ± 3.67 %) and the control (59.69 ± 2.61 %). There was therefore no significant difference between the 100 and 150µg concentrations. It was observed that at 200µg concentration of sodium selenite,

Table 1: Chemical composition (%DM) of *C. pubescens* and *P. purpereum* harvested during the rainy season (August-September) in Nsukka area of south-eastern Nigeria

Forage	Chemical composition							
	DM	H_2O	OM	CP	EE	CF	ASH	NDF
C. pubescens	82.21	18	79.66	26.38	0.96	11.97	16.45	54.41
P. purpereum	93.78	6.94	47.06	17.64	0.47	24.88	23.73	52.88

Table 2: Mean percentage *in-sacco* disappearance of DM of *C. pubescens* in WAD sheep intraruminally infused with graded concentration of sodium selenite

Sodium selenite	% Disappearance at time t					
conc.(µg)	8	12	24	48	P	c
50	33.6±2.3^{a}	39.6±4.1^{a}	46.5±2.2^{a}	50.1±0.1^{e}	61.5	0.018
100	38.4±4,2^{a}	46.3±3.7^{a}	58.9±4.1^{d}	63.4±3.6^{d}	74.7	0.038
150	42.1±2.8^{a}	52.9±1.9^{c}	76.1±1.8^{c}	91.1±3.1^{c}	99.4	0.038
200	46.4±3.6^{a}	51.2±3.2^{a,c}	73.4±3.1^{b}	78.5±4.3^{b}	89.8	0.036
control	28.1±3.1^{b}	30.4±2.4^{a}	39.4±2.6^{a}	44.9±3.7^{a}	56.2	0.041

'a' = 11.30±3.0 % (immediate soluble fraction), P= potential degradability at 48 hours, c= degradation constant of 'b' Means with different superscript within column are significantly different at p<0.05.

Table 3: Mean percentage *in-sacco* disappearance of OM of *C. pubescens* in WAD sheep intraruminally infused with graded concentration of sodium selenite

Sodium selenite	% Disappearance at time t					
conc.(µg)	8	12	24	48	P	c
50	38.6±2.1^{a}	44.9±3.2^{a}	56.2±3.9^{a}	66.8±3.7^{a}	75.4	0.034
100	48.1±3.2^{b}	63.5±4.1^{b}	87.9±3.9^{b}	89.9±2.9^{b}	98.6	0.038
150	50.1±4.0^{b}	65.6±3.0^{b}	91.5±2.1^{b}	93.7±3.3^{b}	99.3	0.037
200	45.6±3.9^{b}	68.4±2.9^{b}	84.7±3.0^{b}	91.3±4.2^{b}	89.3	0.034
control	31.8±3.1^{a}	38.1±3.1^{a}	43.9±2.9^{a}	59.7±2.6^{a}	68.3	0.028

'a' = 8.63±1.96 % (immediate soluble fraction), P= potential degradability at 48 hours, c= degradation constant of 'b' Means with different superscript within column are significantly different at p<0.05.

Table 4: Mean percentage *in-sacco* disappearance of CP of *C. pubescens* in WAD sheep intraruminally infused with graded concentration of sodium selenite

Sodium selenite	% Disappearance at time t					
conc.(µg)	8	12	24	48	P	c
50	55.2±3.1^{a}	69.2±3.9^{a}	56.2±2.8^{a}	50.0±3.9^{a,b}	71.9	0.038
100	64.2±2.1^{b}	88.6±5.9^{b}	80.9±2.8^{b}	63.9±3.5^{a}	66.6	0.046
150	68.9±4.9^{b}	96.5±4.9^{b}	76.2±4.1^{b}	58.9±2.8^{a}	61.6	0.032
200	56.1±1.9^{a}	84.6±2.6^{b}	66.5±3.9^{c}	34.8±4.0^{a}	37.5	0.029
control	46.9±2.8^{a}	55.1±3.4^{c}	50.1±2.9^{a}	43.8±1.1^{b}	46.5	0.024

'a' = 2.68±3.46 % (immediate soluble fraction), P= potential degradability at 48 hours, c= degradation constant of 'b' Means with different superscript within column are significantly different at p<0.05.

Table 5: Mean percentage *in-sacco* disappearance of DM of P*. purpereum* in WAD sheep intraruminally infused with graded concentration of sodium selenite

Sodium selenite	% Disappearance at time t					
conc.(µg)	8	12	24	48	P	c
50	31.3±2.9[a]	34.9±2.1[a]	42.1±2.1[a]	46.6±3.1[a]	56.3	0.021
100	33.3±2.5[a]	40.1±2.6[a,c]	52.7±3.4[c]	60.7±3.0[b]	70.4	0.031
150	50.1±3.1[b]	67.6±3.4[b]	72.9±3.5[b]	88.9±4.1[c]	98.6	0.038
200	40.2±3.7[a,c]	49.1±2.3[c]	54.8±2.2[c]	64.4±1.9[b]	73.9	0.032
control	29.5±2.1[a]	33.6±3.1[a]	40.5±2.1[a]	47.2±2.2[a]	56.9	0.024

'a' = 9.68±2.66 % (immediate soluble fraction), P = potential degradability at 48 hours, c = degradation constant of 'b'. Means with different superscript within column are significantly different at p<0.05.

Table 6: Mean percentage *in-sacco* disappearance of OM of *P. purpereum* in WAD sheep intraruminally infused with graded concentration of sodium selenite

Sodium selenite	% Disappearance at time t					
conc.(µg)	8	12	24	48	P	c
50	33.5±2.2[a]	41.1±4.0[a]	58.4±4.6[a]	62.9±5.7[b]	89.8	0.039
100	46.2±3.2[b]	60.1±4.2[b]	64.2±3.9[b]	88.8±3.9[a]	90.7	0.041
150	48.1±2.2[b]	63.9±3.9[b]	83.5±3.6[c]	96.4±3.9[b]	99.3	0.044
200	38.0±2.9[b]	66.9±3.9[b]	77.9±4.9[a]	63.7±5.7[a]	65.5	0.026
control	36.9±3.5[a]	33.43±2.8[a]	40.3±3.1[d]	51.1±2.8[b]	57.9	0.019s

'a' = 6.84±3.37 % (immediate soluble fraction), P= potential degradability at 48 hours, c= degradation constant of 'b'. Means with different superscript within column are significantly different at p<0.05.

Table 7: Mean percentage *in-sacco* disappearance of CP of *P. purpereum* in WAD sheep intraruminally infused with graded concentration of sodium selenite

Sodium selenite	% Disappearance at time t					
conc.(µg)	8	12	24	48	P	c
50	20.7±0.9[a]	26.1±2.6[a]	39.1±2.1[a]	46.6±4.1[a]	57.7	0.057
100	36.9±1.1[b]	41.3±1.8[b]	68.3±4.0[b]	76.2±3.6[b]	77.3	0.016
150	40.1±2.6[c]	47.7±3.1[b]	78.4±1.8[c]	84.9±4.3[b]	86.1	0.064
200	44.6±1.4[c]	49.3±2.8[b]	60.1±2.0[b]	61.4±2.4[c]	62.4	0.083
control	19.9±1.6[a]	22.6±1.5[a]	38.4±2.2[a]	52.1±3.5[a]	51.2	0.046

'a' = 1.09±0.32 % (immediate soluble fraction), P= potential degradability at 48 hours, c= degradation constant of 'b'. Means with different superscript within column are significantly different at p<0.05.

the percentage disappearance was non-significantly decreased at 24 hour (84.66 ± 3.01%) as well as at 48 hours (91.31 ± 4.19 %) compared to the 150µg concentration (Table 3). These showed that 150µg treatment gave the highest disappearance at 24 and 48 hours. The general observation from this table was that between 24 and 48 hours, increasing the level of sodium selenite beyond 150µg did not produce any further increase in disappearance of the OM but rather an insignificant decline occurred.

The mean percentage disappearance of crude protein (CP) of *C. pubescens* at different treatments of sodium selenite indicated that the disappearance of CP was significant ($p < 0.05$) increased at all treatment levels at 12 hour incubation period compared to the control. However, at 50 and 200µg but not at 100µg and 150µg sodium selenite concentrations, the disappearance were not significantly ($p > 0.05$) different from the control during 8 hours incubation (Table 4). On the contrary, at 24 hours post incubation, 100, 150 and 200µg sodium selenite concentrations gave a significantly ($p < 0.05$) increased percentage disappearance compared with the 50µg treatment and control. At 48 hours a non

significant ($p > 0.05$) decline in disappearance compared to the 8, 12 and 24 hours incubation periods were observed for all treatments. Before this decline at 48hours, 200µg sodium selenite concentration recorded a significantly ($p < 0.05$) reduced percentage disappearance compared to 100 and 150µg sodium selenite concentrations.

The mean percentage of DM of *P. purpereum* at different concentration of sodium selenite showed that the 50µg concentration did not record any significant difference in the disappearance of DM compared to the control for the entire incubation periods. At 100µg, the disappearance was significantly ($p < 0.05$) increased at 12 (40.08 %), 24 (52.66 %), and 48 (60.72 %) compared to the control. At 150µg, the DM disappearance was significantly ($p<0.05$) increased compared to other treatments and control for the entire incubation period under study (Table 5). It was observed that the percentage disappearance of the DM of *P. purpereum* at 200µg concentration of sodium selenite was consistently decreased significantly compared with the 150µg of sodium selenite.

The mean disappearance of OM of *P. purpereum* at different concentrations of sodium selenite indicated that at 48 hours the disappearance was significantly ($p<0.05$) increased at 100µg (88.86 ± 3.98 %) and 150µg (96.47 ± 3.91 %) compared to the control (59.14 ± 2.89 %), but not at 50µg (62.99 %) and 200µg (63.65 %) concentrations of sodium selenite (Table 6).

Table 7 shows the percentage disappearance of crude protein (CP) of *P. purpereum* at different sodium selenite concentrations. It was observed that at 48 hours post incubation 100 and 150µg concentrations of sodium selenite gave a significantly ($P < 0.05$) increased disappearance with values at 76.16 % and 84.96 % respectively compared to 200µg concentration which had a value of 61.35 %. This disappearance value at 200µg though was significantly higher than the 50µg (56.63 %) and the control (52.09 %) was however significantly ($p < 0.05$) decreased compared to 100 and 150µg concentrations of sodium selenite.

DISCUSSION

The study has shown that rumen degradability of forage fractions are affected by different concentrations of sodium selenite. It has also been able to demonstrate that the rate of degradation of the legume and grass used in this study differ both under normal (control) and at different concentrations of sodium selenite. The legume, *C. pubescens* (with less crude fiber, table 1) was degraded faster relative to the grass, *P. purpereum* (with higher crude fiber, table 1). This supports the assertion that there is an inverse relationship between the rate of rumen disappearance of feed fractions and forage fiber levels as suggested by Umunna *et al.*, (1995) and Aka and Kamalu, (2004). Smith *et al*. (1990) and Bonsi *et al*. (1995) opined that the higher the lignocelluloses content of forage feedstuffs, the lower the rumen degradability rate. Likewise, Masama *et al*. (1995) reported that the form and type of forage affects the rate of rumen degradation particularly of the dry matter (DM) fraction. The nitrogen content of forages has been demonstrated to give rise to its increased degradability characteristic compared to other crop forages (Smith *et al.*, 1990; Mosi and Butterworth, 1985; Manyuchi, 1994). Legumes increase the activity of rumen microorganism (Pearce, 1988), with a concomitant increase in degradation of fibre (Getachew *et al.,* 1994). The increase in legume degradation as observed in this study probably was as a result of the positive influence of the legume on the rumen microorganism particularly on their biomass especially as legumes have higher nitrogen content than grasses. McMeniman *et al*. (1988), studied five legumes as supplements to rice straw and observed that degradation of the straw was increased by the presence of legume. Ndlovu and Buchanan-Smith (1985) found that Lucerne increased the rate of degradation of barley straw, brome grass and maize cobs. These studies suggest that legumes are very well degraded when fed alone and also potentate the rumen degradability of other grasses and crop forages. Kolankaya *et al*. (1985) showed that legumes are good sources of degradable nitrogen and fermentable energy and as such

the ammonia resulting from nitrogen degradation and its subsequent deamination would cause a higher growth of selected cellulolytic microorganisms.

This characteristic ability of legumes probably played much role in the observed increased in legume degradability in the rumen even under control conditions. Furthermore, forage legumes increase the total concentration of volatile fatty acids (VFAs) without affecting their relative proportions and the rumen Ph (Ndlovu and Buchana-Smith, 1985). This indicates that forage legumes are likely to maintain a stable fermentation pattern than grasses. The positive impact of legume on rumen degradability of forages have been largely reduced and sometimes abolished by evoking a reduction of rumen retention time (Manyuchi, 1994). This indicates that kinetics of rumen digesta plays a role in rate of forage degradability in the rumen. There could therefore be a possibility that legumes have positive effect on digesta kinetics in the rumen and thus may be one of the mechanisms responsible for its positive effect on forage degradability in the rumen. Manyuchi (1994) had earlier demonstrated a positive correlation between rumen degradability, feed intake and rate of passage in sheep. The better rumen degradability of the legume compared to the grass in this study is to a large extent consistent with these other earlier observations.

Though the legume was better degraded than the grass under natural condition (control), the effect of sodium selenite further revealed a significant ($p < 0.05$) improvement in the rumen degradability of both forages compared to the control group. The study observed that as the concentration of sodium selenite increased, the rumen degradability also increased. The study has also demonstrated that sodium selenite when infused into the rumen has the capacity to improve the rumen degradability of feed fractions. It was clear from this study that increasing the dose of sodium selenite up to a maximum level of 150µg/sheep produced a corresponding increase in rumen degradability of dry matter, organic matter and crude protein fractions of the forages studied. What could be the role played by sodium selenite in the increase in degradability.

Sodium selenite is an antioxidant which in trace amount is necessary for cellular function in most, if not all, animals. Forming active center of the enzymes gluthathione peroxidase and thoredoxin reductase (which indirectly reduce certain oxidized molecules in animals and some plants). When ruminants take in food and water, the oxygen molecules and organic contaminants (such as mercury chloride, lead, arsenicals etc) naturally get into the rumen within which they exert oxidative effect (stress) on both the rumen microbes and rumen epithelial cells and consequently, adversely affect rumen fermentative activity. This fact was recognized by Holovska *et al*., (2002), who working with graded levels of selenium (as seleni-methionine) reported that selenium play varied important roles in the elimination of oxidative stress within the rumen microbial ecosystem. From the observation made in this study, we concluded that the sodium selenite added into the rumen probably alleviated possible pre-existing oxidative stress imposed on the rumen microbes and rumen epithelial cells by the environmental antioxidants taken in together with food, hence the observed improvement in the forage degradability in the experimental group compared to the control. The relative decrease in the degradability of forage fractions at 200µg of sodium selenite probably was due to selenium toxicity to the rumen microbes in the experimental animals and possibly to the epimural cells of the rumen of the host animal. Although selenium is an essential trace element, it is toxic if taken in excess (Fridovich, 1978). A dietary range of 50 to 200µg of sodium selenite per day in mammals has been recommended (Fridovich, 1978). Therefore, in this study, the upper limit of 200µg probably was not well tolerated by the rumen microbes. Again, though the rumen pH was not determined, it could be that rumen pH was largely altered at the daily dose of 200µg.

Oxidative stress on rumen microbes from oxygen diffusion from blood through the wall into the rumen has been described (Mead and Jones, 1981). Thus there is a steady generation of toxic oxygen species within the population of

epimural rumen microflora. Consequently, these toxic oxygen species reduce microbial activity and population. It is probable that the increase in degradability occasioned by sodium selenite treatment was due to its anti-oxidative property on the rumen microflora which by virtue of anaerobiosis lack anti-oxidative enzymes (Storz *et al*., 1990). We then concluded that sodium selenite when infused into the rumen causes an improvement in the degradability of forage fractions probably by protection the rumen microbial cells against the potential damage evoked by the different external and internal oxidative stress factors within the rumen. This study has shown that the effect of sodium selenite is both time and dose dependent. In this study there was a direct relationship between the time/dose and the percentage disappearance particularly up to a maximum dose level of 150µg at 2 to 48 hours for DM and OM. On the contrary, the effects were more pronounced at early hours of incubation for CP. This event was relatively more overt for *C. pubescens* than for *P. purpereum*. More work towards a better understanding of the effects and mechanism of action of sodium selenite in vivo on the improvement of rumen degradability of feedstuffs particularly on rumen ecology and microbial enzyme systems would provide better opportunities for effective utilization of poorly degradable feedstuffs by ruminants. This is particularly important in areas where cellulosic roughages are likely to be the most available or where high quality supplements (e.g. brans and oil seed cakes) are scarce.

REFERENCES

AKA, L. O. and KAMALU, T. N. (2004). Rumen degradability characteristics of *S. gracilis, P. maximum, P. purpereum and C. pubescens* in sheep. *Nigerian Veterinary Journal,* 25: 14 – 20.

AOAC (1990). *Official Methods of Analysis, 15th Edition, Association of Analytical Chemistry*. Washington D.C, USA.

AREGBEDE, O. M., BAMIKOLE, M. A., OLANITE, J. A., JOLAOSHO, A. O. and ONIFADE, O. S. (2002). Seasonal degradability of dry matter, organic matter and crude protein in some multipurpose tree species by West African dwarf goats. *Proceedings of Animal Conference of Nigerian Society for Animal production, Ogun State, Nigeria.*

BLUMMEL, M. and ORSKOV, E. R. (1993). Comparison of in vitro gas production and nylon bag degradability of roughages in predicting feed intake in cattle. *Animal Feed Science and Technology,* 40: 109 – 119.

BOGORO, S., KALIA, D. J. U. and FOMUKONG, B. (2006). Chemical composition and in situ rumen degradability of blood meal and urea-treated crop residues. *Nigerian Journal of Experimental and Applied Biology,* 7(1): 27 – 35.

BONSI, M. L. K., OSUJI, P. O. and TUAH, A. K. (1995). Effect of supplementing teff straw with different levels of leucaena or sesbania leaves on the degradability of teff straw, *Sesbania, Leucana, Tagasaste* and *Vernonia* and on certain rumen and blood metabolites in Ethiopian Menze sheep. *Animal Feed Science and Technology,* 38: 196 – 200.

COOP. R. L. and FIELD, A. C. (1983). Effect of phosphorus intake on growth rate, food intake and quality of skeleton of growing lambs infected with the intestinal nematode *Trichostrongylus vitrinus. Research in Veterinary Science,* 35: 175 – 181.

FRIDORICH, I. (1978). The biology of oxygen radicals. *Science,* 201: 875 – 880.

GALYEAN, M. L., PERINO, L. J. and DUFF, D. C. (1999). Interaction of cattle health/immunity and nutrition. *Journal of Animal Science,* 77: 1120 – 1134.

GATECHEW, G., SAID, A. N. and SUNDSTOL, F. (1994). The effect of forage legume supplementation and body weight gain by sheep fed a basal diet of maize stover. *Animal Feed Science,* 46: 97 – 108.

HOLOVSKA, K., LENARTOVA, V., PROSTAS, P. and JAVORSKY, P. (2002). Are ruminal bacteria protected against environmental stress by plant

antioxidants? *Letters in Applied Microbiology,* 35: 301 – 304.

KOLANKAYA, N., STEWARD, C. S., DUNCAN, S. H., CHENG, K. J. and COSTERTON, J. W. (1985). The effect of ammonia treatment on solubilization and growth of cellulolytic rumen bacteria. *Journal of Applied Bacteriology*, 58: 371 – 379.

MANYUCHI, B. (1994). *High quality forages as supplements to low quality forages for ruminants. Effect on intake, digestibility and rumen digesta dynamics.* PhD Thesis, University of Aberdeen, United Kingdom.

MASAMA, E., TOPPS, J. H., NGONGONI, N. T. and MAASDORP, B. V. (1995). The differential effects of supplementation with fodder from different tree legumes on feed intake and digestibility of nutrients in sheep fed on maize stover. *Animal Feed Science and Technology,* 38: 230 – 236.

MCMENIMAN, N. P., ELLIOT, R. and ASH, A. J. (1988). Supplementation of rice straw with crop by-products. 1. Legume straw supplementation. *Animal Feed Science and Technology,* 19: 43 – 53.

MEAD, L. J. and JONES, G. A. (1981). Isolation and presumptive of adherent epithelial bacteria (Epimural bacteria) from the ovine rumen wall. *Applied and Environmental Microbiology,* 41: 1020 – 1028.

MEHREZ, D. and ORSKOV, E. R. (1977). Estimation of extent of protein degradability from basal feeds in the rumen of sheep. *Proceedings of the Nutrition Society of England,* 36: 784 – 789.

MOSI, A. K. and BUTTERWORTH, M. H. (1985). The voluntary intake and digestibility of cereal crop residues and legumes hay for sheep. *Animal Feed Science and Technology,* 12: 241 – 251.

NDLOVU, L. R. and BUCHANAN-SMITH, J. G. (1985). Utilization of poor quality roughage by sheep. Effects of alfa-alfa supplementation on ruminal parameters, fiber digestion and rate of passage from the rumen. *Canadian Journal of Animal Science,* 65: 692 – 703.

OLADOSU, L. A. and APKOKOJDE, J. U. 1992. Rumen fistulation of West African dwarf Rams for digestibility studies. *Tropical Veterinarian,* 10: 33 – 36.

ORSKOV, E. R. and SHAND, W. J. (2004). Use of the nylon bag technique for protein and energy evaluation and for rumen environment studies in ruminants. *htt://www.cipav.org.co/lrrd/lrrdg/i/orskov.htm2/4/2004*.

ORSKOV, E. R. and MCDONALD, I. (1979). The estimation of protein degradability in the rumen from incubation measurements weighted according to rate of passage. *Journal of Agricultural Science,* 92: 499 – 503.

PEARCE, G. R. (1988). Variability in the composition and *in-vitro* digestibility of cereal straws. Pages 417 – 420. *In:* Feed Formulation and Animal Production. *Proceedings of the 2nd Symposium of International Network of Feed Formulation Centres,* Queensland, Australia.

SANTRA, A. and KARIM, S. A. (2002). Rumen cannulation in sheep and goats: Fabrication of cannula and surgical procedure for its implantation. *Indian Journal Science,* 72: 978 – 980.

SMITH, K. L., CONRAD, H. R., AMIET, B. A., SCHENBERGER, P. S. and TODHUNTER, D. A. (1985). Effect of vitamin E and selenium dietary supplementation on mastitis in first lactation cows. *Journal of Dairy Science,* 86 (supplement 1): 190 – 98.

SMITH, T., MANYUCHI, B. M. and KAYIRI, S. (1990). Legume supplementation of maize stover. Pages 303 – 320. *In:* DZOWELA, B. H., SAID, A. N., WENDEM-AGENEHU, A. and KATEGILE, J. A. (Eds). *Utilization of research results on forage and agricultural by-product materials as animal feed resources in Africa. Proceedings of the Joint Workshop, Liongwe, Malawi. 5-9. December, 1988. ILCA (International*

Livestock Center for Africa), Addis-Ababa, Ethiopia.

STEEL, R. D. G. and TORRIER, J. G. (1980). *Principle and Procedures of Statistics. A Biometric Approach*. 2nd Edition, McGraw Hill, New York.

STORZ, G., TARTAGLIA, L. A., FARR, S. B. and AMES, B. N. (1990). Bacterial defenses against oxidative stress. *Trends in Genetics,* 6: 363 – 368.

SUTTLE, N. F., KNOX, D. P., JACKONS, F., COOP, R. L. and ARGUS, K. W. (1992). Effects of dietary molybdenum on nematode and host during *Trichostrongylus vitrinus* infection in lambs. *Research in Veterinary Science,* 52: 236 – 242.

UMUNNA, N. N., OSUJI, P. O., NSAHLAI, I. V., KHALILI, H. and MOLAMODSALEEM, M. A. (1995). The effect of supplementing oat hay with lablab, sesbania, tagasate or wheat middling on the voluntary intake, nitrogen utilization and gain of Ethiopian Menze sheep. *Journal of Animal Science,* 68: 789 – 794.

VELLAMA, P., RUTTEN, V. P. M. G., HOEK, A., MOLL, L. and WENTINK, G. H. (1996). The effect of cobalt supplementation on the immune response in vitamin B 12 deficient Texas lambs. *Veterinary Immunology and Immunopathology*, 55: 151 – 161.