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Effects of enzyme Additive on Nutrient intake, Digestibility and Rumen metabolites of yearling Cattle fed Grass-hay based diet

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Target Audience: Livestock researchers, Cattle producers, Ruminant Nutritionists

Abstract

Nutrient intake, digestibility and rumen metabolites were determined in sixteen yearling cattle fed Panicum maximum hay supplemented with concentrate diet in which an exogenous fibrolytic enzyme, ROXAZYME G2® (which consist of Cellulase, hemicellulase and beta glucanase) was included at 0, 50, 100 and 150mg/kg. Enzyme inclusion significantly increased the nutrients intake as the lowest value for all the parameters measured was obtained at 0mg/kg enzyme inclusion level. There were no significant differences among other levels of inclusion for total dry matter intake, Crude protein intake and Acid Detergent Fibre intake. Dry matter, crude protein, Neutral Detergent Fibre and Acid Detergent Lignin digestibility were highest at 150mg/kg enzyme inclusion level and lowest at 0mg/kg enzyme inclusion. Enzyme inclusion reduces the pH as the experiment progressed. It ranged from 7.1-7.2 at the start to 6.50-6.90 at the end of the experiment. Ammonia-N increases as the experiment progressed and the highest value 13.50mg/100ml was obtained at 150mg/kg inclusion. The total volatile fatty acids and total viable bacteria count also follow the same trend. This study revealed that the exogenous fibrolytic enzyme used improves the nutrient intake, digestibility and rumen metabolites of yearling cattle at 150mg/kg enzyme inclusion level.

Keywords: Exogenous fibrolytic enzyme; cattle; nutrient intake; digestibility; rumen metabolites

Description of Problem

Forages have always provided the base upon which ruminant nutrition is built. Ruminants can utilize a wide range of feed resources but the bulk of their feed comes from forages hence they are primarily considered as forage consumers. In the tropics the natural pasture which supply the bulk of ruminants' feed becomes dry and of low nutritive value during the dry season leading to a marked decrease in voluntary intake and digestibility. Over the years, significant improvements in forage cell wall digestibility have been achieved through forage breeding programs and agronomic advances. Despite these improvements, low forage digestibility continues to limit the intake of available energy by ruminants and correspondingly contribute to excessive nutrient excretion by livestock (1).

It is evident that the ruminant animals consume grasses, leaves and stems rich in cellulose, hemicelluloses and lignin (2). Cellulose and hemicellulose are quantitatively the most important structural carbohydrates present in forages. Rumen microorganisms produce enzymes that catalyze their hydrolysis. However, the complex network formed by structural carbohydrates and lignin reduce the digestibility of these carbohydrates and restricts efficient utilization of forages by ruminants. Many attempts have been made to overcome this limitation and in the last few years the use of exogenous enzymes (1) has received considerable attention. Exogenous fibrolytic enzymes might enhance attachment and/or improve access to the cell wall matrix by microorganism and by doing so accelerate the rate of digestion (3). Exogenous fibrolytic enzymes also hold promise as a means of increasing forage utilization and improving the productive efficiency of ruminants (1). The aim of this work was therefore to examine the utilization of grass-hay by cattle fed exogenous fibrolytic enzyme as additive in their concentrate supplement.

Materials and Method

Location of the experiment

The study was carried out at the Cattle Unit of the Teaching and Research Farm Directorate, University of Agriculture, Abeokuta Ogun state. Nigeria. The area has an annual mean temperature of 34.7^{0}C, a relative humidity of 82% and an annual mean rainfall of 1037mm. It is in the region of 70m above sea level and lies on latitude 7^{0}5'-7^{0}8'N and longitude 3^{0}11.2'E.

Experimental animals and management

Sixteen (16) crossbred (N'dama x Muturu) yearling cattle aged 12-14 months old, weighing 70 to 80kg were used in a 84-day experiment. The cattle were housed in well ventilated individual pens. The pens were thoroughly washed and disinfected. The animals were de-wormed with Albendazole® 2.5% oral suspension (Anthelmintics) at 1ml/10kg body weight and treated against ectoparasite with Cypermethrin® Pour-on at 1ml/10kg body weight before allotting them to individual pens. There were four animals per treatment and were allowed an adaptation period of four weeks prior to commencement of the experiment during which they were maintained on fresh *Panicum maximum* and concentrate supplement at ratio 60:40. Fresh water was supplied *ad libitum*. Each animal was weighed before the commencement of the experiment and thereafter forthnightly to monitor weight changes.

Experimental feed

The basal diet for this study was *P. maximum* hay supplemented with concentrate. *P. maximum* hay was prepared by curing freshly harvested *P. maximum* on a clean concrete floor for 2-3 day-lights. The hay was loosely stored in sacks pending usage. Four concentrate diets were formulated with ROXAZYME G2® (which contain Cellulase, hemicellulase and beta glucanase) included at levels 0, 50 100 and 150mg/kg dry matter (Table 1). The enzyme was purchased commercially. The concentrate supplement was fed at 40% of the animal daily feed requirement while the hay made up the remaining 60%. Experimental animal was fed at 5% body weight with the concentrate supplement offered first at 8.00a.m and the basal diet an hour after in separate feeding troughs. Voluntary intake was determined as the difference between feed offered and feed refused. The experimental diets were outlined as follows:

T_1- Grass hay+Concentrate+0mg/kg ROXAZYME G2®
T_2- Grass hay+Concentrate+50mg/kg ROXAZYME G2®
T_3- Grass hay+Concentrate+100mg/kg ROXAZYME G2®
T_4- Grass hay+Concentrate+150mg/kg ROXAZYME G2®

Table 1: Gross Composition of Concentrate Supplements (g/kg)

	Levels of inclusion of enzyme (mg/kg)			
Ingredients	0	50	100	150
Wheat offal	650	650	650	650
Dried Brewer's grain	300	300	300	300
Blood meal	20	20	20	20
Bone meal	20	20	20	20
Common salt	10	10	10	10
Enzyme	-	+	++	+++
Total	1000	1000	1000	1000

-:0mg/kg enzyme inclusion level
+:50mg/kg enzyme inclusion level
++:100mg/kg enzyme inclusion level
+++:150mg/kg enzyme inclusion level

Nutrient digestibility study

Digestibility study was carried out by the total faecal collection (4) for 14 days. Faeces voided by each animal were collected, weighed and aliquots (10%) saved for analyses. Weights of the cattle were measured at the beginning and at the end of the collection period. The faecal samples were individually oven dried at 60^0C to constant weight, ground and stored in air tight specimen bottle till required for analysis.

Chemical analysis

The hay, concentrate feed and faecal samples were analyzed for their proximate compositions: crude protein, crude fibre, ether extract, and ash (5).

Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF) and Acid Detergent Lignin (ADL) were also determined (6). Cellulose and hemicellulose were calculated as differences between ADF and ADL and NDF and ADF, respectively.

Rumen metabolites

Measured 30ml of rumen fluid was taken at the beginning, middle and end of the experiment from all the four animals per treatment two hours after morning feeding. It was collected by means of suction tube thrust into the rumen compartment. As soon as the rumen fluid was collected, it was made free of coarse particles by filtration with cheese cloth. 5ml sample of the filtrate was then acidified with 1ml of a 5% (v/v) orthophosphoric acid solution and stored frozen at -20^{0}C in an air tight plastic-bottle container for determination of volatile fatty acid concentration.

Total volatile acids production was determined by steam distillation process (7) using Markham micro-distillation apparatus (8). Individual volatile fatty acids (acetic, propionic and butyric acids) were determined using Gas chromatography (9). Ammonia concentration and microbial content were determined (10). The pH was determined using the pH meter.

Statistical analysis

All data collected were subjected to one-way Analysis of Variance in a completely randomized design while significant differences among means were compared using Duncan's Multiple Range Test (11).

Results

Table 2 shows the chemical composition of *Panicum maximum* hay and concentrate. Variations existed in all the values obtained for *P. maximum* hay and concentrate. *P. maximum* hay had crude protein content of 7.60% while the concentrate diet had crude protein content of 15.75%. Dry matter (DM) was higher in *P. maximum* hay (88.50%) compared to 70.50% obtained in the concentrate diet. The Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF) and Acid Detergent Lignin (ADL) values (75.75%, 60.00% and 28.50% respectively) were higher in *P. maximum* hay than in the concentrate diet with the values of 56.40%, 30.00% and 14.85%, respectively. The Ether extract and ash content of concentrate diet were higher than that of *P. maximum* hay. The Calcium (Ca) and Phosphorus (P) content of concentrate diet (1.35% and 1.54% respectively) were also higher than that of *P. maximum* hay (0.10% and 0.05%, respectively).

Table 2: Chemical composition of experimental diet components (%)

Parameters	P. maximum Hay	Concentrate
Dry Matter	88.50	70.50
Crude Protein	7.60	15.75
Crude Fibre	14.40	13.50
Ether Extract	1.73	6.60
Ash	4.25	5.44
Neutral Detergent Fibre	75.75	56.40
Acid Detergent Fibre	60.00	30.00
Acid Detergent Lignin	28.50	14.85
Cellulose	31.50	15.15
Hemicellulose	15.75	26.40
Calcium	0.10	1.35
Phosphorus	0.05	1.54

Table 3 shows the summary of the performance characteristics of cattle fed *P. maximum* hay-based diet supplemented with concentrates and varying levels of enzymes. The diets significantly affected (p<0.05) all the parameters measured. T_1 had the least values in all the parameters measured except feed conversion ratio where it had the highest value (p<0.05) of (41.95) and T_2 had the lowest FCR value of 36.90. Cattle on T_1 had the lowest total weight gain (6.50kg), while cattle on T_2, T_3 and T_4 had no significant differences (P>0.05) in their total weight gain (8.00, 7.50 and 8.00kg respectively). Cattle on T_4 had the highest (p<0.05) daily feed intake of 3.53kg followed by T_2 (3.51kg), then T_3 (3.35kg) and the least daily feed intake was recorded in T_1 (3.25kg).

Table 3: Performance characteristics of cattle fed hay-based diets

	Levels of inclusion of enzyme (mg/kg)				
Parameters	0	50	100	150	SEM
Initial Weight (kg)	73.00	77.00	72.00	74.00	0.97
Average Final live Weight (kg)	79.50^{b}	85.00^{a}	79.50^{b}	82.00^{ab}	0.99
Total Weight gain (kg)	6.50^{b}	8.00^{a}	7.50^{a}	8.00^{a}	0.22
Metabolic Weight gain (g/kgW$^{0.75}$)	4.07^{c}	4.76^{a}	4.53^{b}	4.76^{a}	0.07
Daily Weight gain (g/day)	77.38^{c}	95.24^{a}	89.29^{b}	95.24^{a}	1.98
Hay Intake (kg)	152.73^{b}	151.98^{c}	142.43^{d}	158.58^{a}	1.50
Concentrate Intake (kg)	120.00^{d}	143.22^{a}	139.25^{b}	138.00^{c}	2.31
Total Feed Intake (kg)	272.73^{d}	295.20^{b}	281.68^{c}	296.58^{a}	2.55
Daily Feed Intake (kg/day)	3.25^{d}	3.51^{b}	3.35^{c}	3.53^{a}	0.12
Feed Conversion Ratio (FCR)	41.95^{a}	36.90^{d}	37.56^{b}	37.07^{c}	0.54

^{abc} *= Means in the same row having different superscripts are significant* (P<0.05)

Table 4 shows the nutrient digestibility of cattle fed grass hay-based diets. All the parameters measured were significantly influenced ($p<0.05$) by the experimental diets. The DM digestibility was significantly ($p<0.05$) highest in T_4 (65.43%) followed by T_3 (61.42%), then T_2 (59.40%) and least in T_1 (52.85%). The CP digestibility was also highest in T_4 (68.88%) although there was no significant differences ($P<0.05$) in this value with the values obtain in T_2 and T_3. T_1 had the least value. Ash, ether extract and ADF digestibility were highest in T_2 and lowest in T_1. NDF and ADL digestibility was however highest in T_4 with the values of 68.55% and 54.11% respectively.

Table 4: Nutrient Digestibility (%) of Cattle fed Hay-based diets.

	Levels of inclusion of enzyme (mg/kg)				
Parameters	0	50	100	150	SEM
Dry Matter	52.85^{c}	59.40^{b}	61.42^{b}	65.43^{a}	1.23
Crude Protein	61.80^{b}	67.78^{a}	67.80^{a}	68.88^{a}	0.60
Ether Extract	59.64^{b}	63.21^{a}	62.28^{a}	62.62^{a}	0.93
Ash	59.44^{c}	69.08^{a}	69.20^{a}	65.70^{b}	1.10
Neutral Detergent Fibre	58.80^{c}	60.32^{c}	65.41^{b}	68.55^{a}	1.04
Acid Detergent Fibre	50.78^{c}	64.87^{a}	58.40^{b}	58.15^{b}	1.36
Acid Detergent Lignin	48.63^{c}	52.85^{ab}	51.45^{b}	54.11^{a}	0.59

^{abc} = *Means in the same row having different superscripts are significant* ($P<0.05$)

Table 5 shows the nutrient intakes of cattle fed *P. Maximum* hay- based diets. The diets significantly ($P<0.05$) influenced the total CP intake, total NDF intake, total ADF intake and total ADL intake. The total CP intake was highest in T_4 (0.53kg) and lowest in T_1 (0.46kg). There were no significant differences ($P>0.05$) in the value obtained for total DM intakes across the treatments. However, T_4 have significantly ($p<0.05$) higher values for total NDF (2.76kg/d) and total ADF (1.74kg/d) intakes. Total ADL intake value was significantly highest (0.99kg/d) at T_2. In all the parameters measured T_1 had the lowest value

Table 5: Nutrient Intakes of Cattle (kg/d) fed Hay-based diets.

	Levels of inclusion of enzyme (mg/kg)				
Parameters	$T_1(0)$	T_2 (50)	T_3 (100)	$T_4(150)$	SEM
Dry Matter Intake					
Hay	1.70	1.71	1.72	1.73	0.02
Concentrate	1.21	1.25	1.23	1.22	0.02
Total	**2.91^b**	**2.96^a**	**2.95^a**	**2.95^a**	**0.03**
Crude Protein Intake					
Hay	0.18	0.19	0.18	0.19	0.00
Concentrate	0.28^b	0.32^a	0.31^a	0.34^a	0.01
Total	**0.46^b**	**0.51^a**	**0.49^a**	**0.53^a**	**0.01**
NDF Intake					
Hay	1.53^a	1.52^a	1.43^b	1.58^a	0.01
Concentrate	1.06^b	1.21^a	1.19^a	1.18^a	0.02
Total	**2.59^b**	**2.73^a**	**2.62^b**	**2.76^a**	**0.02**
ADF Intake					
Hay	1.14	1.14	1.17	1.18	0.01
Concentrate	0.48^b	0.56^a	0.55^a	0.56^a	0.01
Total	**1.62^b**	**1.70^a**	**1.72^a**	**1.74^a**	**0.01**
ADL Intake					
Hay	0.67^b	0.69^a	0.63^b	0.69^a	0.01
Concentrate	0.26	0.30	0.30	0.29	0.00
Total	**0.93^b**	**0.99^a**	**0.93^b**	**0.98^a**	**0.01**

[abc] *= Means in the same row having different superscripts are significant (P<0.05)*

Rumen parameters of cattle fed grass hay-based diets at the start, middle and end of the experiment were significantly influenced ($p<0.05$) by the diets (Table 6). The diets reduced the pH of the rumen as the experiment progressed. The pH ranged was 7.10 – 7.20 before the experiment, 6.60 – 7.00 by the middle of the experiment and 6.50 – 6.90 by the end of the experiment. The experimental diets increased NH_3-N (from a range of 8.20 – 8.70mg/100ml at the start of the experiment to 11.40 – 13.50mg/100ml by the end of the experiment) and total VFAs (from a range of 86.90 – 89.90Mm/100ml at the start of the experiment to 98.00 – 119.00mM/100ml by the end of the experiment) as the experiment progressed while reducing the acetate: Propionate ratio (from a range of 2.06 – 2.24 to 1.32 – 1.82). By the end of the experiment T_4 had the highest ($P<0.05$) value for NH_3-N (13.50mg/100ml), total VFAs (119.00Mm/100ml), acetic acid (55.00Mm/100ml), propionic acid (41.00mM/100ml) and butyric acid (18.00Mm/100ml) while T_1 had the least values for the parameters. T_4 had the least ($P<0.05$) value (1.34) for acetate:propionate ratio by the end of the experiment.

Table 6: Rumen Parameters of Cattle fed hay-based diets before, during and after the experiments.

Parameters	Levels of inclusion of enzyme (mg/kg)				
	0	50	100	150	SEM
Before					
pH	7.20[a]	7.20[a]	7.10[b]	7.10[b]	0.01
NH_3-N (mg/100ml)	8.40	8.20	8.35	8.40	0.02
Total VFAs (mM/100ml)	87.90[a]	87.00[b]	87.70[a]	86.90[b]	0.50
Acetic acid (mM/100ml)	49.00[a]	48.00[b]	49.00[a]	49.00[a]	0.11
Propionic acid (mM/100l)	23.80[a]	22.30[b]	21.90[d]	22.20c	0.19
Butyric acid (mM/100ml)	12.00[c]	12.70[b]	12.80[a]	12.75[b]	0.08
Acetic: Propionic Ratio	2.06[d]	2.15[c]	2.24[a]	2.21[b]	0.02
Mid-Experiment					
pH	6.90[a]	6.80[b]	6.50[d]	6.60[c]	0.04
NH_3-N (mg/100ml)	9.75[c]	9.05[d]	9.99[a]	9.76[b]	0.09
Total VFAs (mM/100ml)	90.70[d]	93.50[b]	92.80[c]	94.50[a]	0.36
Acetic acid (mM/100ml)	47.00[a]	42.80[c]	43.00[b]	42.60[d]	0.47
Propionic acid (mM/100ml)	25.90[d]	30.50[c]	32.00[a]	31.80[b]	0.64
Butyric acid (mM/100ml)	13.00[d]	15.50[c]	16.60[a]	16.00[b]	0.35
Acetic: Propionic Ratio	1.88[a]	1.40[b]	1.34[c]	1.34[c]	0.06
End of Experiment					
pH	6.90[a]	6.60[c]	6.50[b]	6.50[b]	0.03
NH_3-N (mg/100ml)	11.40[d]	12.80[c]	13.20[b]	13.50[a]	0.21
Total VFAs (mM/100ml)	98.00[d]	112.00[c]	116.00[b]	119.00[a]	2.08
Acetic acid (mM/100ml)	51.00[c]	51.00[c]	54.00[b]	55.00[a]	0.46
Propionic acid (mM/100l)	28.00[d]	37.00[c]	40.00[b]	41.00[a]	1.32
Butyric acid (mM/100ml)	15.00[d]	16.00[c]	17.00[b]	18.00[a]	0.29
Acetic: Propionic Ratio	1.82[a]	1.38[b]	1.35[c]	1.34[d]	0.05

[abc] = Means in the same row having different superscripts are significant *($P<0.05$)*

The values for total viable bacteria count in the rumen of cattle fed hay-based diets are presented in Table 7. Total viable count increases as the experiment progressed. It ranged from 10.20 – 11.60 at the start of the experiment, 14.10 – 18.10 at the middle of the experiment and 15.70 – 19.50 at the end of the experiment. The count was significantly ($p<0.05$) lowest in T_1 and highest in T_4 by the middle of the experimental period. By the end of the experiment, the count was highest in T_3.

Table 7: Total Viable Bacteria Count of Cattle fed Hay-based Diets

Parameters	Levels of inclusion of enzyme (mg/kg) 0	50	100	150	SEM
At the start of experiment					
Total Viable Counts ($\times10^7$cfu/ml)	11.60^a	11.30^b	10.20^d	10.90^c	0.14
Mid- experiment					
Total Viable Counts ($\times10^7$cfu/ml)	14.10^d	15.30^c	16.70^b	18.10^a	0.39
End of experiment					
Total Viable Counts ($\times10^7$cfu/ml)	15.70^d	17.80^c	19.50^a	19.40^b	0.40

^{abc} = Means in the same row having different superscripts are significant *(P<0.05)*
SEM – Standard Error of Mean

Discussion

Apparent differences in all the parameters between nutrient composition of *P. maximum* hay and concentrate diet were significant. The result revealed that the concentrate diet is of good quality compare to hay as reflected in the values of crude protein, ether extract and ash contents. This is in line with the reports of (12, 13) which showed that during the dry season, grasses decline both in quality and quantity. The fibre fractions of grass hay and the concentrate show that the diets have potentials to support proper rumen function. Exogenous fibrolytic enzymes inclusion at different levels have significant effect (P<0.05) on all the performance parameters measured. The average daily weight gain were significantly (P<0.05) improved for cattle on enzyme-supplemented diet with T_2 and T_4 having the same and highest value of the three level of inclusion (95.24g/day), which implies that at 50mg/kg and 150mg/kg enzyme inclusion levels, the animals were able to utilize the diet for appreciable weight gain. These results indicated that the use of enzyme treatments in concentrate feed when feeding poor quality forage had a positive effect on weight gain which was in line with what was reported by (14, 15) that fibrolytic enzymes increased weight gain in steers and awassi lambs, respectively. Inclusion of exogenous enzymes also improved (P<0.05) the hay-intake, concentrate intake, total feed intake and daily feed intake of enzyme supplemented diets. The control diet had the lowest value for all these parameters while T_4 had the highest value for total feed intake and daily feed intake which suggests that exogenous enzymes at 150mg/kg inclusion improves digestibility hence feed intake. This was in line with the reports of (16) who obtained improved average daily gain, feed intake and feed conversion ratio of feedlot cattle fed enzyme-treated silage. There were significant difference (p<0.05) in the FCR of the cattle with different levels of enzymes, however, T_2 had the lowest value (36.90) while control diet (T_1) had the highest value (41.95). This implies that exogenous fibrolytic enzyme inclusion at 50mg/kg had positive influence on the FCR of the cattle. El-Kady *et al.* (2) reported an improvement in feed conversion of growing cattle with exogenous enzymes supplementation.

The digestibility of DM, CP, NDF, ADF and ADL were also significantly influenced (P<0.05) by the inclusion of varying level of enzymes. The DM, CP, ADL and NDF digestibility were highest in T_4 and lowest in T_1. This could be attributed to the ability of the cattle to tolerate high fibre diets as a result of enzyme inclusion in their diet. This compares favourably with the results of (17) that fibrolytic enzyme supplementation improves fibre digestion and increased total tract digestion of feed. Yang *et al.* (18) reported that enzyme increase the rate of degradation in the rumen. Enzyme can also partially solubilize NDF, ADF and release reducing sugars in the process (2).

The total CP, NDF, ADF and ADL intakes were significantly (P<0.05) influenced by enzyme inclusion in the diet. Enzyme supplemented diets had significantly (P<0.05) higher values when compared with the control. This may be as a result of improved digestibility of the diets as a result of enzyme inclusion. The total CP intake was significantly highest in T_4. It has been shown that protein intake is a major determinant of ruminant performance due to increased availability of fermentable nitrogen and other nutrients required by rumen bacteria, as well as the greater opportunities for some of the protein to escape rumen fermentation. The inclusion of enzymes at varying levels increased the nutrient intakes of the cattle. Ruminants generally require adequate coarse insoluble fibre for normal rumen function which is associated with adequate rumination and cellulose digestion. The higher fibre intakes recorded were as a result of dried materials which constituted the diets. Higher fibre intakes are therefore, expected from dried materials than fresh ones.

The inclusion of exogenous enzyme at different levels also significantly (P<0.05) influenced the pH, ammonia, total volatile fatty acids, Propionic acid, Acetic Acid and Butyric Acid. Exogenous fibrolytic enzyme lowers the pH as the experiment progressed. This result might not be unconnected with the inclusion of exogenous enzyme in the diet of the cattle which increase the fermentation of the feed offered resulting in the production of more volatile fatty acids and low pH. The lowest pH recorded in T_4 might be as a result of accumulation of the VFAs in the rumen. According to (19), if the VFAs production rate exceeds the clearance rate, VFAs will accumulate in the rumen; this may lower rumen pH and cause the metabolic disturbance known as rumen acidosis. However, there was no case of rumen acidiosis meaning that the pH was still within the normal range for the animals. According to (20) ruminal pH values below 5.6 should be considered the threshold for rumen acidosis in beef cattle fed high concentrate diets. The higher acetic acid values obtain at the beginning of the experiment might be due to the fact that the animals depend only on grazing before the commencement of the experiment. According to (21) cellulolytic microbes produce mainly acetic acid, starch fermentation organisms normally generates relatively more propionic acids. There was reduction in the acetate: propionate ratio by the end of the experiment. This is indicative of increased bacteria activities. According to (22) acetate and butyrate are major fermentation end products of protozoa and this agree with report of (23). The ruminal NH_3 concentration at the end of the experiment (11.40 – 13.50mg/100ml) fell in the range of value reported by (24) These author reported that ruminal NH_3-N concentration had a good profile, with values between a minimum of 2mg/100ml and a maximum of 30mg/100ml suggested for maximum microbial growth in the rumen. (25) suggested that a ruminal NH_3-N concentration above 20mg/100ml is required for sufficient voluntary intake of low quality roughage while (26) reported optimum rumen ammonia concentration (RAC) ranging 5-20mg NH_3/100ml. The increase in total VFAs as obtained at the middle and end of the experiment may be due to the reduction in the pH as the experiment progresses which may be as a result of the enzyme inclusion in the diet. Maintaining a stable rumen environment is critical for diet utilization and the rumen environment can said to be improved by enzyme inclusion in the diet.

Microbial yield is important because it is an index of the amount of microbial protein made available to the cattle each day. The increase in the number of rumen bacteria as a result of exogenous enzyme inclusion may be responsible for high total VFAs. Inclusion of exogenous enzyme improves digestibility of the diets by releasing more nutrients, hence provides more VFAs which enhance microbial growth. The microbial counts in cattle fed enzyme supplemented diets were higher than that of the control (T_1). This is indicative of normal rumen environment i.e. normal pH, availability of NH_3-N and VFAs for bacteria growth. This would invariably lead to increase in the production of microbial protein. The count was highest in cattle fed diets with 150mg/kg enzyme inclusion. Bacteria count of rumen fluid is dependent on rumen ammonia concentration and pH of rumen fluid and both factors are dependent on type of diet (27). The low bacteria count on the control diet (T_1) may indicate that ammonia is limiting for bacteria growth (28).

Conclusion and Application

It was concluded that exogenous fibrolytic enzyme containing cellulase, hemicellulase and beta glucanase could be included in the concentrate supplement of yearling cattle when fed grass hay based diet at 150mg/kg for improved nutrient intake, digestibility and rumen environment.

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