THE INFLUENCE OF COPPER SUPPLEMENTATION ON GROWTH PERFORMANCE AND RUMEN FERMENTATION PARAMETERS OF WEST AFRICAN DWARF SHEEP

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ABSTRACT
Addition of copper in the diet has been proved to be beneficial to micro flora enhancing rumination. Hence, this study was designed to evaluate the influence of copper glycine (Cu-G) on growth performance and rumen fermentation parameters of West African dwarf (WAD) sheep fed diets containing graded levels of Cu-G supplementation; incorporated into the concentrate diet at 0, 5, 10 and 15 mg/kg respectively to formulate four (4) experimental diets. A total of sixteen (16) WAD sheep were randomly allotted to 4 dietary treatments for 84 days with 4 animals per treatment in a completely randomized design having an average live weight of 13.00 ± 2.00 kg. Data were collected on growth performance and rumen fermentation parameters. Body weights were measured at the end of each week and the rumen fluid collection was carried out at the end of the experiment. Results revealed that there was no significant (p>0.05) difference on the growth performance parameters across the dietary treatments. The final weight gain, metabolic weight, total feed intake and feed conversion ratio values obtained in this study ranged from 22.16-24.85 kg, 27.39-36.64 g/dw0.75, 508.22-556.96 g/d and 4.96-6.84 respectively. The rumen fermentation parameters was not significantly (p>0.05) influenced by Cu-G supplementation except total fungi count (TFC), total coliform count (TCC) and protozoan count which ranged from 1.29-1.49×103cfu/ml, 2.23-2.48×102cfu/ml and 2.25-2.72×105cfu/mlrespectively. Furthermore, the TFC, TCC and protozoan values obtained in this study increased across the dietary treatments as the Cu-G supplementation increased. Sheep fed 5, 10 and 15 mg/kg recorded the highest values for TCC, TFC and protozoan count obtained in this study. It can therefore be concluded that copper glycine included in diet at 15 mg/kg inclusion level had the highest microbial count in the rumen environment thereby positively influencing ruminal fermentation but had no influence on the growth performance of the West African dwarf sheep.
Keywords: Copper glycine, Rumen fermentation, West African dwarf sheep, Microbial count

INTRODUCTION
Copper additive in the diet, proved that it has a beneficial effect on weight gain, feed conversion ratio and modification of the bacterial microflora in the alimentary tract (Ruiz *et al*., 2000). Fermentation is a metabolic process that produces chemical changes in organic substrates through the action of enzymes. In biochemisty, it is narrowly defined as the extraction of energy from carbohydrates in the absence of oxygen. Copperis an essential microelement among the minerals that presents a variety of functions in animal organisms. It plays a part in the active center of more than twentymetalloenzymes, cofactors, and metalloproteins that are connected with destruction of free radicals, synthesis of connective tissues, formation of myelin and bones, pigmentation and formation of fur and wool. It also acts indirectly in hematopoiesis (Ortolani, *et al.,* 2003). However, copper deficiency is taken to be a severe nutritional problem in tropical regions, because of the low copper concentrations in animals' diets and/or because of high concentrations of elements that are antagonistic towards copper, such as molybdenum (Mo), sulfur(S), and iron (Fe) (Marques *et al.,* 2003). Previous studies have reported that dietary Copper might affect ruminant fermentation, (Engle and Spears 2001) and performance in cattle (Dorton*et al.,* 2006). Hence, this present study was carried out to evaluate the efficacy of copper glycine supplementation on the growth performance and rumen fermentation parameters of West African dwarf Sheep.

Materials and method

Experimental site, duration and diets

The experiment was conducted at the Teaching and Research Farm, Federal College of Animal Health and Production Technology, Moor Plantation, Apata, Ibadan for a period of84 days. The test ingredient used was Copper glycine (Cu-G); it was incorporated at varying levels of 0, 5, 10 and 15 mg/kg respectively with other ingredients to formulate four experimental diets (Table 1). Starch and molasses were introduced into the feed at ratio of 1:2 purposely to formulate 6 mm pelletized feed. Starch served as binder while molasses was used as sweetener.

Table1: Gross and Chemical Composition of the experimental diet

	Cu-G supplementation (mg/Kg)				
Ingredients	0	5	10	15	
Maize bran	48.00	48.00	48.00	48.00	
Corn cob	5.50	5.50	5.50	5.50	
Wheat offal	34.00	34.00	34.00	34.00	
Groundnut cake	5.00	5.00	5.00	5.00	
Premix (Cu free)	0.50	0.50	0.50	0.50	
Limestone	3.00	3.00	3.00	3.00	
Common Salt	1.00	1.00	1.00	1.00	
Starch/molasses	3.00	3.00	3.00	3.00	
Total	**100.00**	**100.00**	**100.00**	**100.00**	
Calculated analysis					
Crude protein (%)	14.11	14.11	14.11	14.11	
Crude fibre (%)	10.04	10.04	10.04	10.04	
ME(MJ/Kg)	21.11	21.11	21.11	21.11	
Basal Cu Level	4.58	4.58	4.58	4.58	
Total Cu Level	4.58	9.58	14.58	19.58	
Determined Analysis					*P. purpureum*
Dry Matter	75.93	74.09	72.59	74.17	75.05
Crude Protein	12.55	12.63	12.63	11.02	13.35
Ether Extract	3.19	2.99	2.25	3.02	0.4
Ash	27.43	25.48	16.28	29.19	12.67
Nitrogen FreeExtract	37.51	47.4	45.67	39.61	31.33
Acid Detergent Fibre	5.14	5.81	3.95	3.95	9.94
Acid Detergent Lignin	1.81	1.82	1.09	1.06	4.76
Neutral DetergentFibre	16.18	16.02	14.59	11.83	34.69
Hemicellulose	11.04	10.21	10.64	7.90	24.75
Cellulose	3.33	4.49	2.86	2.89	5.18

Cu-G: Copper Glycine, **GNC:** Groundnut cake, **ME:** Metabolizable energy

Experimental animals, management and design

A total number of sixteen (16) West African dwarf (WAD) sheep were purchased from Akinyele market in Ibadan, Oyo state. The pens were thoroughly washed and disinfected with DD Force and allowed to dry before the arrival of the animals while wood shavings served as the bedding materials.On arrival, the animals were given prophylactic treatments, using standard procedure of health management. After adaptation period of 28 days, the animals were randomly assigned to four dietary treatments, with four animals per treatment, in a completely randomised design.

Data Collection

The weights of the animals were taken at the start of the experiment (initial weights) followed by weighing on a weekly basis prior to feeding to monitor their growth in response to the experimental diets. Feeds offered daily per animal were recorded and refusals were weighed and recorded to compute feed intake on daily basis while feed conversion ratio (FCR) was also calculated.

At the end of the experiment, rumen fluid was collected from three sheep in each treatment for determination of rumen pH, ammonia, nitrogen, volatile fatty acids with suction tube inserted through the oesophagus according to procedure described by Babayemi and Bamikole (2006). After collection, the rumen fluid were stored in ice-packed container pending laboratory analysis.

Statistical Analysis

The data obtained were subjected to analysis of variance (SAS, 2005). The means among the variables were separated using Duncan multiple range test of the same statistical package.

RESULTS AND DISCUSSION

The influence of Copper glycine (Cu-G) Supplementation on growth performance of West African dwarf (WAD) sheep is indicated in Table 2. There were no significant differences (p>0.05) in the parameters evaluated. The final weight gain and total feed intake values obtained in this study ranged from 22.16-24.85 kg and 508.22-556.96 g/d respectively.The non-significant difference observed on growth performance up to 15 mg/kg does not have any detrimental effect on the growth and feed utilization efficiency of the animals. However, such growth-promoting effects of Cu have been commonly reported in fur-bearing animals (Wu *et al*., 2014) and swine (Coble *et al*., 2017), but it has

Table 2: Influence of copper glycine supplementation on growth performance of West dwarf sheep

Parameters	Cu-G supplementation (mg/Kg)				
	0	5	10	15	SEM
Initial weight (kg)	15.18	14.44	14.42	14.52	0.31
Final weight (kg)	22.16	22.53	24.85	24.33	0.87
Weight gain (kg)	6.98	8.10	10.44	9.81	0.78
ADWG (g/d)	83.04	96.37	124.23	116.73	9.32
Metabolic Weight (g/dW$^{0.75}$)	27.39	30.63	36.64	35.23	2.15
DMFI(g/d)	13189	16301	17060	14809	780.97
DMCI(g/d)	33596	26390	29118	30824	2097.16
TFI (g/d)	556.96	508.22	549.74	543.25	21.44
Feed Conversion Ratio	6.84	5.30	5.38	4.96	0.44

^{abc} means along the same row with different superscripts are significantly different (p<0.05)
ADWG: Average Daily Weight Gain, **DMFI:** Dry Matter Total Forage Intake,
DMCI: DryMatter Total Concentrate Intake, **TFI:** Total Feed Intake

Table 3: Influence of copper glycine supplementation on rumen fermentation parameters

Parameters	Cu – G supplementation mg/kg					
	0	5	10	15	SEM	SEM
Acetic Acid (mmol/100mL)	11.33	12.36	13.70	14.83	0.80	0.80
Propionic acid (mmol/100mL)	10.80	11.79	13.06	14.14	0.76	0.76
Butyric Acid (mmol/100ml)	10.32	11.26	12.48	13.51	0.7	0.73
TVFA(mmol/100ml)	32.45	35.40	39.24	42.48	2.29	2.29
Acetic-Propionic Acid ratio	1.05	1.05	1.05	1.05	0.00	0.00
Valeric Acid (mmol/100ml)	10.27	11.21	12.42	13.45	0.73	0.73
pH	6.62	6.88	6.72	6.68	0.09	0.09
NH_3 (mg/100mL)	0.43	0.49	0.47	0.48	0.02	0.02
Microbial Counts						
TBC($\times10^6$cfu/mL)	3.67	3.92	3.73	3.75	0.10	0.10
TCC($\times10^2$cfu/mL)	2.23^b	2.48^a	2.31^{ab}	2.47^a	0.04	0.04
TFC($\times10^3$cfu/mL)	1.29^b	1.42^a	1.49^a	1.48^a	0.03	0.03
Protozoan count($\times10^5$cfu/ml)	2.25^b	2.63^a	2.62^a	2.72^a	0.07	0.07

^{abc} means along the same row with different superscripts are significantly different (p<0.05)
TVFA: Total volatile fatty acid, **NH_3:** Ammonia Nitrogen, **SEM:** Standard error of mean
TBC: Total Bacteria Count **TCC:** Total Coliform Count **TFC:** Total Fungi Count

also been reported that growth performance was not affected by Cu supplementation when fed over the entire finishing period in finishing steers (Engle *et al*., 2000). In another study, Cu supplementation increased the performance of cattle (Engle and Spears, 2000). Copper supplementation had no effect on average daily gain which is consistent with Luginbuhl*et al.* (2000) who reported that Cu had no effect on average daily feed intake and daily gain in goat. The influence of Copper glycine (Cu-G) Supplementation on rumen fermentation parameters of WAD sheep is shown in Table 3. The Cu-G supplementation significantly ($p<0.05$) influenced the total fungi count, total coliform count and protozoan counts. Sheep fed 5, 10 and 15 mg/kg.

The TFC and TCC values ranged from $1.29\text{-}1.49\times10^6$cfu/mland $2.23\text{-}2.48\times10^6$cfu/ml respectively. According to Preston and Leng (1987), rumen fungi are known to digest cellulose and xylans which shows that they may play a role in helping the ruminant host to digest plant materials**.**

CONCLUSION AND RECOMMENDATION

It can be concluded that copper glycine included in the diet at 15 mg/kg inclusion level had the highest microbial counts in the rumen environment thereby positively influencing ruminal fermentation but had no influence on the growth performance of the West African dwarf sheep.

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