
DIETARY EFFECT OF COPPER SULPHATE ON BLOOD AND SERUM BIOCHEMICAL INDICES OF GROWING GOATS

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ABSTRACT

An in-depth analysis of blood gives a reflection of animal's responsiveness to their internal and external environment. Hence, a 56-day study was carried out using fifteen West African Dwarf (WAD) bucks of about 12-18 months, with an average body weight of 6.09 ± 0.58 kg, to evaluate their nutrient intake, haematological and serum biochemical indices when fed copper sulphate (CuSO₄) supplemented diets. A concentrate diet was formulated and divided into five equal portions and CuSO₄ was added to the diets at 0, 5, 10, 15 and 20 mg/kg diets representing treatments T-control, T2, T3, T4) and T5, respectively and fed to the goats in a Completely Randomized Design experiment. Nutrient composition and nutrient intake were determined. Blood was collected from each goat and sera were harvested from each blood sample collected. The blood samples were analyzed for whole blood count, mean corpuscular volume, mean corpuscular haemoglobin, while sera for total protein (TP), aspartate aminotransferase (AST), alkaline phosphatase. Data generated were subjected to statistical analysis. From the results, supplementation of CuSO₄ did not significantly ($P > 0.05$) influence DMI by the goats, while goats fed T5 (20 mg/kg CuSO₄) had the highest CPI (61.00g/day). Goats fed T4 and T5 had statistical similar values for PCV. Goats fed T5 had the highest value of RBC ($15.70 \times 10^6/\mu\text{L}$), WBC ($11.33 \times 10^3/\mu\text{L}$), Hb (12.70g/100mL), MCHC (33.13g/dL), TP (6.82g/dL) and AST (63.83IU/L). Conclusively, the study revealed that copper sulphate supplementation in growing goats' diet has potentials to improve blood components without deleterious effects on their health status, and could be supplemented even up to 20mg/kg.

Keywords: Blood, copper sulphate, liver biomarkers, ruminant, animal protein.

INTRODUCTION

The use of dietary copper sulphate in goats' diet will aid nutrients utilization, health status, production in an eco-friendly environment, hence reduce environmental pollution. Copper (Cu), as a micro-mineral, is essential for the growth and development of bones, connective tissue, the heart and several other organs, and optimum health of livestock (Hefnawy and El-khaiat, 2015). Further, copper is also needed for the development of antibodies and white blood cells, in addition to antioxidant enzyme production (Sharma *et al.*, 2005), prevents microcytic hypochromic anaemia, through its synergistic role in iron metabolism (Leeson and Summers, 2001). West African Dwarf (WAD) goats, possess distinctive ability to survive in this tsetse fly infested area, compared to cattle (Ifut *et al.*, 2016), and is a source of affordable animal protein by those living in the developing communities. Yet, this mineral is essential in goat' production, as its deficiency may lead to metabolic disorder, poor health and eventual death of the animal. Several studies have reported the effects of copper sulphate (CuSO₄) to aid Cu bioavailability, stabilize the rumen pH, renders the rumen environment more stable and decrease faecal Cu excretion in pigs (Scott *et al.*, 2018). Hence, this study concern itself with the evaluation the supplemental effects of graded levels of dietary copper sulphate on the health status of WAD goats using blood and serum as response criteria. This clinical assessment is believed to reveal the goats' nutritional and health status, as it may affect their performance.

MATERIALS AND METHODS

The research was carried out at the Small Ruminant Unit, Teaching and Research Farm of the Department of Animal Production and Health, The Federal University of Technology, Akure, Nigeria while the chemical analyses were carried out at the Nutrition and Microbiology Laboratory of the same Department and University. Feed ingredients, as listed in Table 1, were procured from a reputable feed mill, while cassava peels were collected at cassava or "gari" processing industry at Igbatoro, Akure. Copper sulphate (CuSO₄) was purchased at open market in Akure. The macro-ingredients were milled and thoroughly mixed in the ratio shown in Table 1. Then, copper sulphate

was added as supplement to the diets at 0 (control), 5, 10, 15 and 20 mg/kg feed, respectively; and designated as diet T1 – T5. Feed sub-samples were bulked together for chemical analysis.

Table 1: Gross and nutrient composition of a formulated concentrate for experimental WAD goats

Ingredient	Quantity (kg)	<i>Megathyrus maximus</i>
Cassava peel	52.00	-
Rice bran	8.00	-
Wheat offal	22.00	-
Bone meal	1.00	-
Urea	1.00	-
Palm kernel cake	14.00	-
Common salt	1.00	-
Premix	1.00	-
Total	100.00	-
<i>Analyzed composition (%)</i>		
Dry matter	92.76±0.05	27.63±0.03
Crude protein	12.00±0.02	9.37±0.01
Crude fibre	13.50±0.11	23.62±0.00
Neutral detergent fibre	45.92±0.11	60.00±0.00
Acid detergent fibre	34.77±0.36	38.00±0.00
Acid detergent lignin	15.58±0.21	7.00±0.00

A total number of 15 growing West African Dwarf (WAD) goats, age range 12-18 months, with an average live weight of 6.09±0.58kg were used. The goats were balanced for weight, randomly distributed and allotted to five dietary treatments, of three goats per treatment in a completely randomized design experiment. The goats were acclimatized for thirty days during which routine managements like feeding on grasses and concentrate supplement. The animals were vaccinated against *Pesté-Petit de Ruminanté* (PPR/kata) using Tissue Culture Rinderpest vaccine at the rate of 1ml per animal, treated against ecto-parasite using Diasuntol® and were also prophylactically treated against infections by using oxytetracycline LA® at the rate of 1ml per 10kg body weight of animal to stabilize the animals before the commencement of the study. The animals were housed individually and an adjustment period of 7days (after quarantine) was allowed before commencement of data collection. Animals were fed the concentrate at 5% body weight early in the morning (8:00am) while wilted *Megathyrus maximus* were fed at known quantity at 2:00pm. Cool, fresh drinkable water were supplied *ad libitum* throughout the experimental period of 63 days. The daily feed intake was determined by deducting the refusals from the quantity offered. At the end of the feeding trial, blood samples were taken from each goat via a jugular vein puncture using a 10 mL gauge syringes and needles, into; (i) anti-coagulant bottle containing ethylene diamine tetra acetic acid (EDTA) for haematological indices assay (whole blood count, while the mean cell haemoglobin, mean cell volume, mean cell haemoglobin concentration were calculated using standard procedures) and (ii) anti-coagulant free plastic tubes, allowed to coagulate at room temperature and centrifuged for 5 minutes at 3000 rpm to harvest the serum for biochemical (total protein, albumin, globulin, aspartate aminotransferase, alkaline phosphatase) analysis using standard procedures. All data generated were subjected to analysis of variance (ANOVA) using SPSS, (2011) version 22.0.

RESULTS AND DISCUSSION

The nutrient composition of copper sulphate supplemented diets were found to be adequate to support the growth and development of growing goats (Table 1). The high dry matter content of the diet could be attributed to the nature and dryness of the feed ingredients, which is believed would work in synergy with the crude fibre to encourage rumination and nutrient intake (Luka *et al.*, 2021). The crude protein of the diet being higher than 8%CP for optimum microbial activities in the rumen, and is believed to support tissue development and growth of the goats. The dietary ash is an indication that the feed is capable of releasing mineral constituents for proper animal development. Nutrient intake by the goats was significantly ($p<0.05$) influenced by copper sulphate supplementation except DMI (Table 2). Goats fed control diet (T1) had the least DMI (405.01g/day). The DM intake by the goats

might be attributed to protein quality, acceptability and palatability of the diets. However, goats fed diet T5 had the highest CPI (61.00g/d), whereas those placed on control diet had the least CPI (43.61g/d). The fibre intake by the goats could be traced to the combination of delignification and improved protein quality of the diets. Supplementation of CuSO₄ in the diets did not pose any stress on the health of the goats (Table 3) as values obtained were within the range for healthy goats. This was agreed with the report of Anaeto *et al.* (2013) that supplementing copper sulphate in ruminants' diet did not adversely affect their health status. Further, the dietary supplementation of CuSO₄ did not adversely affect haemoglobin in the cytoplasm of RBC and thus, gives an indication of the oxygen carrying capacity of the blood of the experimental goats. The values of WBC, MCV, MCH and MCHC in this present study showed that the goats possess a protective system, thus providing them a rapid and potent defense against any infectious agent (Sharma *et al.*, 2005).

The serum total protein level in goats fed diet T5 (20 mg/kg of CuSO₄) was the highest (6.82g/dL), and this is a reflection of the quality of the diets, compared to others (Table 3). The higher globulin level (3.26g/dL) in goats fed diet T4 is indicative of a stronger ability to fight infection (Leeson and Summers, 2001). Additionally, measuring AST levels is useful in diagnosing cases of myocardial infarction, cell death (necrosis) and skeletal muscle disorders, especially at raised level, which could result from poor-quality protein in the animals' diets (Fasina *et al.*, 2010). At the end of the experiment, the ALT and AST levels in the goats were within the normal range for healthy goats (Omid *et al.*, 2018), as the biomarkers are primarily used to assess hepatocellular injuries. The results of this study indicated no hepatocellular necrosis in the goats. Ajagbe (2019) noted that hepatotoxicity can lead to elevated normal values, which could result from the body's inability to excrete it through the bile, due to the congestion or obstruction of the biliary tract.

Table 2: Nutrient intake by WAD goats fed experimental diets

Parameters	T1 (0mg/kg)	T2 (5mg/kg)	T3 (10mg/kg)	T4 (15mg/kg)	T5 (20mg/kg)
Dry matter	405.01±5.67	407.01±3.12	411.68±3.59	409.10±3.91	409.31±3.52
Crude protein	43.61±0.59 ^d	50.17±2.24 ^c	54.74±1.37 ^b	59.29±0.93 ^a	61.00±0.29 ^a
Crude fibre	58.78±1.50 ^a	55.89±1.12 ^b	51.28±0.44 ^c	49.96±0.23 ^c	36.78±0.57 ^d
Ether extract	19.47±0.25 ^c	21.96±0.48 ^b	22.31±0.22 ^b	25.83±0.47 ^a	20.51±0.54 ^c
Ash	38.38±0.61 ^b	47.42±1.91 ^a	48.53±1.74 ^a	35.52±1.18 ^{bc}	33.62±0.20 ^c
NDF	179.54±2.82 ^c	193.68±2.02 ^b	197.04±1.25 ^b	223.22±3.63 ^a	218.32±8.06 ^a
Acid detergent fibre	164.37±3.17 ^b	168.32±1.29 ^b	169.62±0.74 ^b	193.69±6.35 ^a	190.33±3.91 ^a
ADL	85.69±1.19 ^c	88.62±0.64 ^c	111.68±0.24 ^b	120.09±4.04 ^a	118.54±1.73 ^a

a, b, c, d = mean within the same row, with different superscripts are significantly different (P < 0.05). NDF - Neutral detergent fibre, ADL - Acid detergent lignin

Table 3: Haematological and serum biochemical indices of WAD goats fed the experimental diets

Parameters	T1 (0mg/kg)	T2 (5mg/kg)	T3 (10mg/kg)	T4 (15mg/kg)	T5 (20mg/kg)
Blood					
Packed cell volume (%)	36.67±0.88 ^b	37.00±1.04 ^b	38.00±1.17 ^{ab}	38.67±0.88 ^a	38.33±1.45 ^a
Red blood cells (x10 ⁶ /μL)	12.40±0.58 ^c	14.27±1.07 ^b	14.50±1.24 ^b	14.83±1.41 ^b	15.70±0.35 ^a
White blood cells (x10 ³ /μL)	6.43±0.35 ^d	8.77±1.71 ^c	9.87±2.49 ^{bc}	10.87±1.27 ^b	11.33±0.81 ^a
Haemoglobin (g/100mL)	11.00±0.26 ^b	11.10±1.21 ^b	11.70±1.21 ^b	12.50±0.26 ^a	12.70±0.44 ^a
Lymphocytes (%)	50.67±0.33 ^b	57.67±2.91 ^a	57.67±2.91 ^a	56.33±1.86 ^{ab}	57.00±0.58 ^{ab}
Neutrophils (%)	47.00±0.00 ^a	40.00±2.89 ^b	39.67±3.18 ^b	40.00±1.73 ^b	41.00±0.58 ^b
Eosinophils (%)	2.00±0.00 ^a	1.33±0.33 ^b	2.00±0.00 ^a	2.00±0.00 ^a	2.00±0.00 ^a
Monocytes (%)	0.00±0.00 ^b	1.00±0.00 ^a	0.33±0.33 ^{ab}	0.33±0.33 ^{ab}	0.00±0.00 ^b
MCV (fl)	29.57±4.71 ^a	25.93±2.11 ^{ab}	26.21±4.28 ^{ab}	26.08±3.30 ^{ab}	24.40±0.21 ^b
MCH (pg)	8.87±1.41 ^a	7.78±0.63 ^{ab}	8.07±1.28 ^{ab}	8.42±0.99 ^{ab}	8.09±0.06 ^b

MCHC (g/dL)	30.00±0.78 ^b	30.79±0.04 ^b	30.79±0.01 ^b	32.32±1.39 ^a	33.13±2.08 ^a
Serum					
Total protein (g/dL)	6.26±0.16 ^b	6.54±0.25 ^{ab}	6.70±0.62 ^{ab}	6.80±0.08 ^a	6.82±0.17 ^a
Albumin (g/dL)	3.70±0.36	3.29±2.24	3.88±1.98	3.54±2.24	3.74±3.01
Globulin (g/dL)	2.55±3.08 ^b	3.25±0.10	2.82±0.63	3.26±0.03	3.09±0.06
AST (IU/L)	57.80±3.18 ^b	58.63±2.25 ^b	59.97±1.60 ^b	62.43±1.73 ^{ab}	63.83±2.94 ^a
ALT (IU/L)	6.27±1.07	7.73±0.37	9.77±0.52	9.90±0.62	9.17±2.01
ALP (IU/L)	23.80±5.76	30.75±0.68	38.93±13.07	40.20±1.50	40.70±2.17

a, b, c, d = mean within the same row, with different superscripts are significantly different ($P < 0.05$). MCV – Mean corpuscular volume; MCH – Mean corpuscular haemoglobin; MCHC – Mean corpuscular haemoglobin concentration; AST – Aspartate aminotransferase; ALT – Alkaline aminotransferase; ALP – Alkaline phosphatase.

CONCLUSION

From the foregoing, supplementation of CuSO₄ in goats' diet did not pose any detrimental challenge on the health of the animals, as all the response criteria parameters measured were within the range for healthy goats. Goats fed diets containing 20mg/kg CuSO₄ had better nutrient intake, blood and serum profile compared to other test diets, and is thereby recommended.

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