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Enhancing Growing Rabbits Performance with Diets Supplemented with Copper

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Abstract: Thirty-two male rabbits between 5-6weeks of age with an average weight of 836.5g were fed diets supplemented with copper to study their Performance rate. The rabbits were grouped into 4 treatments: A, B, C and D of 8 rabbits each. Treatments B, C and D were administered with copper in the feed at the following dosage rate: 100, 200 and 300ppm respectively. Treatment A served as control in which copper was not added in the diet. All the copper supplemented groups had a positive improvement in final live weight, body weight gain and feed intake compared to the control and were significantly ($P<0.05$) different. There was no significant effect ($p>0.05$) in the feed conversion ratio of all the treatments likewise no significant ($p>0.05$) treatment effect was recorded in all the haematological and serum parameters studied except the white blood cell which was lower than the normal range reported and was significant ($p<0.05$) among treatments. Copper in liver, kidney and faecal samples were dosage dependent while the level in the muscle across the treatment was not significant.It was concluded that copper could be used as growth promoter in rabbit feeds without any negative effect.

Key words: Copper · Growth promoter · Performance · Rabbits

INTRODUCTION

Efforts to improve livestock production in Nigeria are some of the major concerns of research scientists in Nigeria. Serious efforts are therefore being made to discover new and better additives that will improve the growth rate of livestock to market weights. Some antibiotics have been used for this purpose, for example, ampicillin, cloxacillin [1], penicillin [2], anti-fungal antibiotics combination [3].

Positive growth effects have also been reported about methionine supplementation in feed [4]. Copper is an essential trace element that plays a vital role in the physiology of animals: for feotal growth and early post-natal development, bone development and inflammatory process [5]. Evidence that Copper is a dietary essential was obtained in 1928 by [6] as reviewed by [7], when experiment with rat showed that Copper was necessary for haemoglobin formation. Although copper is not essentially a constituent of haemoglobin, it is present in certain other plasma proteins such as ceruloplasmin, which is concerned with the release of iron from the cell into the plasma [7]. [8] and [9] reported that copper added at a higher level than normal requirement has a growth promoting effect and a lot of work has been done primarily using pigs with little work on rabbits. The growth promoting ability as well as feed intake, feed efficiency and feed conversion ratio of copper in animal have been well documented [10-12] with little in the tropics.

The majority of agricultural research into Copper as growth promoter involved field demonstration with application of small amount of Copper supplement to livestock especially pigs [13] and the method of Copper application reported are inclusion in drinking water, mixed with feed ingredient during the milling process as with this study or administered by intravenous injection [14].

It was reported that Copper accumulate mainly in the liver, other tissue containing high level concentration of copper are the heart, brain and kidney. Lower levels are found in muscles and are predominantly with faeces [15].

This work was therefore undertaken to determine the performance effects of dietary copper in rabbits under tropical conditions.

MATERIALS AND METHODS

Thirty-two male rabbits between 5-6 weeks of age with an average weight of 836.5g were obtained, randomly and equally allocated on weight basis to four dietary treatments in a completely randomized design. The rabbits

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Table 1: Gross composition (%) of the growing rabbit test diets.

	Diet A	Diet B	Diet C	Diet D
Ingredients	Control	100ppm Cu	200ppm Cu	300ppm Cu
Maize	14.00	14.00	14.00	14.00
Maize offal	36.40	36.40	36.40	36.40
Soya bean cake	25.00	25.00	25.00	25.00
Palm kernel cake	20.00	20.00	20.00	20.00
Fish meal	2.00	2.00	2.00	2.00
Oyster shell	1.20	1.20	1.20	1.20
Bone meal	0.80	0.80	0.80	0.80
Vitamin Premix	0.20	0.20	0.20	0.20
Salt	0.40	0.40	0.40	0.40
Copper (ppm)	-	100	200	300
Total	100.00	100.00	100.00	100.00
Calculated Nutrient				
Crude Protein (%)	18.66	18.66	18.66	18.66
M.E (kcal/kg DM)	2,518.01	2,518.01	2,518.01	2,518.01
Crude Fiber (%)	9.19	9.19	9.19	9.19

M.E: Metabolisable Energy

were weighed on weekly basis throughout the duration of the experiment that lasted for eight weeks. The animals were allowed to adapt for two weeks and treated against endo-and ectoparasites before the commencement of the experiment, thereafter they were housed individually in hutches with wire mesh base for easy and proper disposal of faeces.

The gross composition of the basal diet is presented in Table 1. Treatment A was the control with no supplemental copper but B, C and D had copper supplemented at 100, 200 and 300ppm respectively. The diets contained 18.66% crude protein, 9.19% crude fibre and 2,518 Kcal/kg digestible energy and were pelletised. Feeds were given twice daily at 8hour and 16hour respectively with no supplementary forage and water was given to the rabbits *ad-libitum.*

All the rabbits were sacrificed at the end of the experiment and blood samples for haematology were collected into test tubes with Ethylene diamine tetra acetic acid EDTA, an anti-coagulant, while samples for serum biochemical estimations were collected into test tubes without EDTA.

The Red blood cells (Rbc), White blood cells (Wbc), Packed cell volume (PCV), Haemoglobin (Hb) and differential counts were estimated by the method of [16]. The haemoglobin concentration was determined using cyanmethaemoglobin method as described by [17]. Serum total protein was determined by the biuret method while albumin values were estimated by the bromocresol green method [18]. The globulin and albumin / globulin ratio were estimated according to [19]. At the end of the feeding trial, four animals from each treatment were placed in metabolism cages and faecal samples were collected for 7 days and later analysed. Copper in muscle, liver, kidney and faecal samples were determined using the Atomic Absorption Spectrophotometer.

All data were subjected to statistical analysis using analysis of variance procedure of Statistical Analysis Software [20]. The treatment means were compared using Duncan procedure of the same software.

RESULTS

The final live weight, total weight gain and feed intake/day and total feed intake by the rabbits are shown in Table 2. All these improved significantly ($P<0.05$) with feeding copper supplemented diets compared with the control group, the copper group had a better performance in body weight gain ($P<0.05$) and the feed intake respectively.

All the haematological parameters i.e. Rbc, Hb, PCV, MCV, MCHC, MCH of the experimental rabbits were within the normal range of (5.46-7.94%, 10.4-17.4g/dl,

Table 2: Performance characteristics of growing rabbits fed varied levels of dietary copper

	Diet A	Diet B	Diet C	Diet D	
Parameters	Control	100ppm	200ppm	300ppm	±SEM*
Initial live weight (g)	792.90	800.00	935.70	817.70	60.35
Final live weight (g)	1675.00^{b}	1853.60^{a}	1910.43^{a}	1725.00^{a}	56.47
Total feed intake	2312.10^{b}	2745.00^{a}	2857.90^{a}	2835.00^{a}	77.67
Daily dry matter intake (g)	42.36^{b}	49.02^{a}	51.03	50.62^{a}	62.54
Daily weight gain (g)	15.75^{b}	18.81^{a}	19.20^{a}	19.27^{a}	6.03
Feed conversion ratio	2.77	2.66	2.71	3.21^{b}	1.19

abc: Means on same row with different superscripts differ significantly ($P<0.05$)

±SEM* Standard Error of Mean

Table 3: Haematological values of growing rabbits fed varied levels of dietary copper.

	Diet A	Diet B	Diet C	Diet D	
Parameters	Control	100ppm	200ppm	300ppm	SEM
Packed cell volume (%)	41.71	40.85	42.57	43.00	1.01
Haemoglobin (g/dl)	15.69b	15.54b	16.38a	16.70a	0.55
Erythrocytes ($x10^6$)	6.97^a	6.60	6.61	6.04	0.32
MCV* (fl)	60.75	61.44	65.17	63.56	3.92
MCHC** (%)	37.63	38.14	38.49	37.63	1.23
MCH*** (i/g)	33.12	23.54	26.06	28.11	1.72
Leukocytes ($x10^3$)	3.87B	5.00a	3.18b	3.39b	0.42
Neutrophils ($x10^3$)	4.00	4.28	4.71	4.14	0.45
Eosinophils ($x10^3$)	0.22	0.25	0.24	0.25	0.04
Lymphocytes ($x10^3$)	3.71	3.71	4.28	4.00	0.85
Monocytes ($x10^3$)	0.55	0.57	0.45	0.60	0.08
Basophils ($x10^3$)	0.32	0.33	0.37	0.32	0.04

abc: Means on same row with different superscripts differ significantly (P<0.05)

MCV*: Mean corpuscular volume, MCHC**: Mean corpuscular haemoglobin concentration, MCH***: Mean corpuscular haemoglobin.

±SEM* Standard Error of Mean

Table 4: Serum protein of growing rabbits fed dietary copper

	Diet A	Diet B	Diet C	Diet D	
Parameters	Control	100ppm	200ppm	300ppm	SEM
Total Protein(i/g /100ml)	8.01	8.22	8.26	7.48	0.40
Albumin(g/100ml)	2.57	3.10	2.57	2.57	0.19
Globulin(g/100ml)	5.44	5.12	5.68	4.72	0.43
Albumin/Globulin	0.47	0.62	0.49	0.67	0.07

±SEM* Standard Error of Mean

Table 5: Copper content of the liver, kidney, muscle and faeces of growing rabbits fed dietary copper

	Diet A	Diet B	Diet C	Diet D	
Parameters	Control	100ppm	200ppm	300ppm	SEM
Liver Cu (ig/g DM)	109.26^c	341.41^b	372.41^b	493.41^a	108.70
Kidney (ig/g DM)	10.86^c	12.21^b	13.49^b	15.08^a	2.15
Muscle (ig/g DM)	9.20	9.23	9.40	9.21	0.95
Faeces (ig/g DM)	361.12^d	398.40^c	478.17^b	685.20^a	154.30

abc: Means on same row with different superscripts differ significantly (P<0.05)

±SEM* Standard Error of Mean

33-50%, 58.5-66.5u/g, 30-37fl, 18.7-22.7u/g, respectively) as reported by [21] (Table 3), except the white blood cells (Wbc) which did not fall within the normal range of $5.50\text{-}12.5x10^3$.

All the concentrations of the total protein, albumin and globulin, in the serum taken from the experimental rabbits at the end of the experimental period were also within the normal range of 7.48-8.01, 2.57-3.10 and 4.72-5.68g/100*ml* respectively (Table 4). The values across the treatments were similar and were not significantly (p>0.05) influenced by the treatment. All the White blood cell indices which includes lymphocytes, neutrophils, basophils, eosinophils and monocytes showed no significant (p>0.05) differences among treatments and are all within the normal range as reported by [21]. The levels Copper in liver, kidney and faecal samples were significant across the treatment and dosage dependent while the muscle level across treatment was not significant (Table 5).

DISCUSSION

From the study, it was shown that dietary copper significantly improved the performance, such as body weight gain and feed intake in growing rabbits. These results are in accordance with those studies reported by [8-10] and [12] but in contrast with results obtained by [22] and [23]. The results of this study are in agreement with those of [22] who reported that the addition of copper did not improve (P>0.05) feed efficiencies in rabbits. King [24] found that copper at 200ppm tended to increase the efficiency of food utilization although not significantly (P>0.05).

Shurson, *et al*. [25] reported that the performance-enhancing effect of copper in animals may be achieved through the microbial gut flora as shown by the results of positive effect of high concentrations (283ppm) of copper. It has been reported that copper can been used as a performance enhancer in fresh water-farming because it protects fish from diseases thereby improving the growth of fish [26,27]. Copper was reported to improve digestibility and utilization of nutrients in the diets of pigs and broilers [28-30], which might be achieved through influencing activities of the hormones such as growth hormones and thyroid hormones as reported by Underwood and Suttle [30].

In the present study, the supplementation of feeds with copper for rabbits had no significant effect on haematological parameters i.e. haemoglobin, packed cell volume, red blood cell which indicated that inclusion of copper even at 300ppm does not adversely affect the levels of production of the parameters and this report is in contrast with that of [31] and [32] that reported Red blood cell (RBC) count and haematocrit values were increased significantly (P<0.01) by Copper additions of rabbits in the diet.

However all the values of the white blood cells fall below the normal range reported by [21] which could be as result of defense nature of the white blood cells in fighting the inclusion of copper or probably as observed by [33] who reported that a reduction in the White blood cell population in the blood could be as a result of low or very slow rate of production in the bone marrow.

From the study, the result of serum protein qualities indicated that the mean values of all serum protein observed were not significantly influenced by the dietary treatments and all were within the normal range. This suggests that the inclusion of copper in rabbits' diets did not adversely affect the activities of serum protein and its qualities. Copper addition had a significant effect on liver Copper content (P<0.05). A similar trend was observed by [23, 34, 22].

Kidney and faecal copper contents were also significantly (P<0.05) increased by copper addition. While [22] reported that kidney copper levels were doubled by rabbits fed a diet with 1000 ppm Cu, [23] reported that the faeces contained 29 and 1069ppm Cu for rabbits fed on the control diet and those on 400 ppm Cu diet, respectively.

The muscle copper concentrations were however not significantly (P>0.05) affected with increasing dietary copper levels and [22] and [23] reported similar results.

CONCLUSION

The main findings in the present study were the performance-enhancing effects of copper which was positive in growing rabbits and it has been established that its inclusion in the diets of rabbits had no adverse effect on the haematological and serum parameters of the animals and can positively influence total feed intake and total weight gain of the animals. The results of this study recommend the inclusion of copper as a supplement at a level of 300ppm because it has a reasonable feed intake and total weight gain compare to the other treatments likewise the copper levels in organs was dosage dependent except for the muscle. The study had shown copper to be a safe growth promoter in rabbit production.

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