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GROWTH PERFORMANCE AND SOME BLOOD PARAMETERS OF LAMBS FED COPPER SUPPLEMENTED DIETS

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ABSTRACT

Twenty four Ossimi lambs aged 4 months and averaged 20.2 ± 1.53 kg of body weight were randomly allocated to three equal groups . All groups were fed a basel diet (containing 10 ppm copper) of concentrate mixture and Alfalfa as the rate of 3 and 1 % of body weight , respectively . The three groups were assigned at random to receive either the basel diet alone or supplemented with either 15 or 30 ppm Cu . Body weight gain, nutrient digestibility coefficients, feed conversion and economical evaluations were determined. Blood samples were taken and analyzed for hemoglobin (Hb), packed cell volume (PCV), red blood cells count (RBCs), total white blood cell count (WBCs) and differential leukocytes percentages . The results showed that lambs of G2 and G3 had higher values of daily weight gain, nutrient digestibility coefficients, nutritive values and feed conversion than control. Red blood cells (RBCs), hemoglobin concentration (Hb) and packed cell volume (PCV) increased in lambs of G2 and G3 compared to control group. Lambs of G2 and G3 recorded higher values of a total leukocytes count and a marked increase in both lymphocytes and esinophils accompanied with a drop in percentage of neutrophils. Meanwhile percentage of the basophiles and monocytes did not change in the treated lambs. These results revealed that supplementation of copper might have useful role in enhancing growth performance and immune responses for growing lambs. This matter needs further detailed studies .

Keywords: Copper, nutrient digestibility, nutritive value, blood parameters, sheep.

INTRODUCTION

Copper is one of the trace element which is necessary for growing and lactating animals The importance of copper has been recognized since it plays an important role in the health of cattle and sheep. Copper is necessary for cleaning the organism from the excess of free radicals, biogenic amines and cholesterol. It acts in the proper synthesis of haemoglobin, elastin, collagen and thyroid hormones, providing the energy formed in the respiratory chain and needed for biochemical synthesis of proper physical activity (McDonell, 2002). Copper is an essential constituent of several proteins, metabolic enzymes and some naturally occurring pigments. Copper is also essential for the synthesis and maintenance of connective tissue and for copper related enzyme systems responsible for digesting cartilage before it is conversion to bone. Copper deficiency reduces the number of circulating T cells, B cells and neutrophils. Impairment of

bacterial activity can occur early in the development of Cu deficiency in cattle , sheep and rabbit (Xin *et al.,* 1991 and Lamb and Ferns 2002). Copper deficient in sheep showed an increased mortality from the bacterial infection (Chew 2000).

Despite the nutritional importance of copper , it is difficult to state exact requirements for sheep without specifying the conditions for which they apply (NRC,1985) . Since copper requirements depend on dietary and genetic factors . Factors which might affect its absorption will affect the requirements . The aim of this study was therefore to evaluate the effects of adding two levels of dietary Cu to the animal diet as a growth promoter and an immune stimulant for growth performance, nutrients digestibility and some hematological parameters of growing lambs .

MATERIALS AND METHODS

This experiment was carried out at Minia University Farm at Shosha,. Twenty four Ossimi lambs averaged 4 months of age and 20.15 ± 1.53 kg of body weight were used in this study. The animals were divided randomly into three equal groups (eight animals each) of similar initial average of live body weight. Group 1 (G1) was fed on the control diet which containing 1 % and 3% of their LBW alfalfa and concentrate feed mixture (CFM), respectively . It contained 10 ppm copper (calculated according to NRC , 1985) .. Group 2 (G2) and group 3 (G3) were fed on control diet supplemented with either 15 or 30 ppm Cu, respectively. Feed was offered individually twice daily at 9.0 a.m. and 2.0 p.m. into equal portions and adjusted biweekly according to the body weight. Water was freely available along the experimental period (120 days) . The animals were weighed individually and weekly before the morning feeding. Daily body weight gain, feed consumption , and feed conversion were estimated .

Blood samples were taken biweekly from the jugular vein of all animals. Values of haemoglobin (Hb,g/dl), packed cell volume (PCV %), red blood cells counts (RBCs,x 10 ^{6}/mm^{3}), white blood cells count (WBCs,x10^{3}/mm^{3}) and differential leukocytes count was measured in the fresh whole blood directly at the time of collection. The Hb concentration was determined by hemoglobinometer and the PCV percentage was determined using microhematocrit tubes with a microhematocrit centrifuge at 12000 rpm for 3 minutes. The RBCs and WBCs were counted under the microscope using the hemocytometer. Stained blood films with Leshman's stain were prepared for estimating the differential leucocyte percentage (Dacie and Lewis,1991).

Digestibility trials were carried out during the last two weeks of feeding period . Three animals of each group were assigned to determine digestibility coefficients of the tested diets As a percentage of body weight, animals were fed 1% of live body weight alfalfa and 3% concentrate feed mixture (CFM). Acid Insoluble Ash (AIA) was used as internal marker (Van Keulen and Young, 1977). Determinations of dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE) and ash in feeds and feces were carried out according to A.O.A.C. (1990).

The cost of feeding was calculated, assuming that the price of one ton as DM of alfalfa and CFM were 300 and 1000 LE, respectively and the price of one kg gain as live body weight is 14 LE.

Data were examined by statistical analysis (SAS,1995) . The main factors affecting blood metabolites, growth performance, and feed efficiency in this study included Cu treatment and Cu level

$Y_{ijk}= U + T_i + S_j + e_{ijk}$

U= is population mean ;

Ti=is fixed effect of i^{th} Cu treatment (1 control and 2 treatment);

S_j = is fixed effect of j^{th} level of Cu (1=control,2=15 ppm and 3= 30 ppm);

E_{ijk} = is random effect of ijk^{th} with mean =0 and variance o2.

Duncan (1955) multiple-range test was utilized to detect differences among means.

RESULTS

Proximate analysis of the concentrate mixture, alfalfa and control diet used in the study are presented in Table (1).

Table (1): Chemical composition of the ingredients used in formulating tested diets, concentrate feed mixture (CFM) and alfalfa

Ingredients	Chemical composition on DM basis (%)						
	DM	OM	CP	CF	EE	NFE	Ash
CFM*	89.57	92.43	13.52	13.55	4.66	60.70	7.57
Alfalfa	90.50	93.37	15.50	35.20	2.50	40.17	6.63
Control diet	89.80	92.67	14.02	18.96	4.12	55.57	7.34

Where: CFM* = Concentrate feed mixture composed of 35 % yellow corn, 25 % wheat bran, 20 % undicorticated cotton seed meal, 17 % rice bran, 2.0 % limestone and 1.0 % salt, DM = Dry matter, OM = Organic matter, CP = Crude protein, CF = Crude fiber, EE = Ether extract and NFE = Nitrogen free extract.

Growth performance

Results presented in Table (2) show that lambs received 30 ppm of Cu (G3) had higher ($P < 0.01$) daily weight gain (DWG) compared to those of G1 and G2 (195.20 vs 148.02 and 165.20 g), respectively. Also, DWG tended to increase for lambs of G2 compared to control ones (165.20 vs 148.02). Final body weight (FBW) tended to be higher in the treated groups compared to the control group . However , differences among groups were not significant . Feed conversion (expressed as kg feed / kg gain) was better ($P < 0.01$) for G3 compared to the control group, the values were 9.46, 8.66 and 7.68 for G1, G2 and G3, respectively. Insignificant differences were observed between control group (G1) and other two groups in average dry matter intake, the values were 1.40, 1.43 and 1.50 kg/head/day for G1, G2 and G3, respectively.

Table (2): Effect of copper as feed additives on ram lambs performance.

Item	Groups			
	G1	G2	G3	±SE
IBW,kg	20.11	20.22	20.12	1.53
FBW,kg	38.53	40.04	43.54	1.44
DWG,g	148.02[b]	165.20 [b]	195.20 [a]	6.42
F1,(kg/head/day)	1.40	1.43	1.50	0.05
FC(kg feed/kg gain)	9.46 [a]	8.65[ab]	7.68 [b]	0.49

..a,b means within the same row having different superscripts are significantly different. (*P* < 0.05), ** (*P* < 0.01). IBW (initial body weight), FBW (final body weight), DWG (daily weight gain), F1 (feed intake), FC (feed conversion).

Digestibility trials:

Nutrients digestibility coefficients:

Digestibility coefficients of OM, CP, CF, EE and NFE of different diets are presented in (Table 3). No significant increases were observed in OM and CF digestibility coefficients with copper supplementation. However, G2 and G3 showed higher values of organic matter digestibility (OMD) and crude fiber digestibility (CFD) compared to the control group (G1), the values were 64.49,66.11 and 69.31 for OMD and 43.63, 55.63 and 59.40 for CFD in G1, G2 and G3, respectively.

Digestibility coefficients of CP , EE and NFE were approximately similar in the three experimental groups .

Nutritive value:

The nutritive values of the different diets used expressed as TDN are presented in (Table 3). No significant increase were detected among G1, G2 and G3 for TDN . The values of TDN were 62.85, 64.38 and 67.24, for G1, G2 and G3 respectively.

Table (3): Nutrient digestibility coefficients and feeding values (DM basis) of the tested rations (R1, R2 and R3).

Item	Diets			±SE
	G1	G2	G3	
Digestibility coefficients %				
OM	64.49	66.11	69.31	1.07
CP	65.43	64.46	64.14	0.31
CF	43.63	55.63	59.40	2.41
EE	74.97	75.77	74.49	0.34
NFE	69.21	67.97	72.13	1.37
Nutritive value:				
TDN %	62.85	64.38	67.24	0.98

SE, Standard error.

Economical evaluation:

Results presented in Table (4) showed the calculated economical evaluation of feed cost The price of total gain (LE) was increased by 7.60 and 27.14 in lambs for G2 and G3 compared to the lambs for G1. The relation % of economical return were 14.82 and 53.18 for G2 and G3, respectively compared to the control group (G1).

Table (4): Effect of copper supplementation on economical evaluation

Item	Rations		
	G1	G2	G3
Price of total gain, LE. (1)	257.88	277.48	327.88
Cost of feed intake . LE (2)	143.67	146.45	153.06
Profit , LE (1-2)	114.12	131.03	174.82
Profit (% of control)	100.00	114.82	153.18
Cost / kg gain , LE	07.80	07.39	06.54
Relation % of cost / kg gain	100	94	83
Relation % of economical return	==	14.82	53.18

Relation % = assuming that the control is 100%
Cost / kg gain = cost of feed intake / total gain (kg)
Relation % of cost / kg gain = assuming that the control is 100%

Hematological parameters:

Results in Table (5) indicated that hematological parameters in terms of blood RBCs, Hb and PCV had increased ($P < 0.01$) in supplemented lambs than control ones. The lambs of control had the lowest values of RBCs, Hb and PCV followed by those values of G2 and G3 , respectively . The total count of leucocytes was increased ($P < 0.01$) for lambs of G2 and G3 compared to those of control (Table 5). Lambs of G2 and G3 showed a marked increase ($P < 0.01$) in both lymphocytes and eosinophils compared to the control , which was accompanied with a drop ($P < 0.01$) in percentage of neutrophils . Meanwhile, percentages of basophils and monocytes did not change due to Cu supplementation. The N:L ratio showed a consistent decrease ($P < 0.01$) with increasing the dose of Cu supplementation.

Table (5): Effect of copper as feed additives on the hematological parameters

Item	Groups			±SE
	G1	G2	G3	
Hematological parameters:				
RBC (x 10^6 / mm^3.)	9.92^b	11.44^a	12.58^a	0.15
Hb (g / d-1).	9.83^c	11.75^b	13.33^a	0.17
PCV (%).	29.58^c	35.00^b	38.00^a	0.29
Total leucocytes and its differential count				
Total leucocytes (10^3 / mm^3)	6.94^b	8.52^a	9.53^a	0.17
Neutrophils (%)	32.61^a	26.06^b	24.61^b	0.53
Eosinophils (%)	4.17^b	4.83^a	4.89^a	0.15
Basophils (%)	1.00	1.00	1.00	0.00
Lymphocytes (%)	59.72^b	65.72^a	67.06^a	0.53
Monocytes (%)	2.50	2.39	2.44	0.12
N : L ratio	0.54^a	0.42^b	0.34^c	0.008

a,b and c means within the same row having different superscripts are significantly different (*P*<0.01)

DISCUSSION

In the present study, supplementation of Cu to growing lambs enhanced their growth performance. This benefit is clearly seen at 15 ppm and 30 ppm of Cu supplementation. Those supplemented lambs recorded a

higher average daily weight gain and better feed conversion rates. While, daily gain of G2 and G3 were improved by 11.61 and 31.87% , respectively compared to the control group, also feed conversion expressed as kg feed/ kg gain (Table 2) was improved by 8.46 and 18.82%, respectively. Such improvements may be attributed to the higher efficiency of feed utilization. The growth rate response to the high level of given in the form of CuSO4 is well documented in the literature (Burnell *et al*.,1988 and Du *et al*, 1996).
Copper is required in the diet because it is the metal cofactor for the variety of enzymes including cytochrom oxidase , tyrosinase , ascorbic acid oxidase , liver , catalase and others , which are important in different basic functions (Rand and Murray , 2000)

Taking into consideration the differences between the cost of feed intake and price of total gain (LE), it is clear that Cu supplementation improved the revenue . The relative % of cost of one kg gain for G2 and G3 were 94.68 and 83.74 %, respectively compared to the control group (G1).

The present results show that blood hematological parameters such as RBCs, Hb and PCV were improved for growing lambs of G2 and G3. These observations are compatible with those obtained by Du *et al*.,(1996) . They reported that animals fed Cu complexes had a higher liver Fe which is very important for formation of hemoglobin and regeneration of RBC. Copper is essential for iron absorption and is important as a catalyst for the utilization of iron in the hemoglobin synthesis ((McDonell , 2002) .

The present results revealed an immunological response for lambs supplemented with Cu. These lambs exhibited an increase in total count of leucocytes. The supplemented lambs showed a marked increase in both lymphocytes and esinophils percentage accompanied by a drop in neutrophils.

These results may indicate an increase in immune status of supplemented lambs. Trace minerals play important roles in the health of animals. Tissue defense mechanisms against free–radical damage generally include several metalloenzymes Suich as peroxidase , catalase (Fe) and superoxide dismutase (Cu, Zn, and Mn) are critical in protecting the internal cellular constituents from oxidative damage. Both in vitro and in vivo studies showed that these nutrients generally enhance different aspects of cellular and non cellular immunity (McDonell,2002). Ballantine *et al* (2002) reported that Cu has important role in protein synthesis and immune function.

Supplementation with 15 or 30 ppm Cu to the basal diet containing 10 ppm raised concentration of Cu to 25 and 40 ppm , respectively . Theoretically , this to levels seem to be equal or beyond the maximum tolerable levels by growing sheep , being 25 ppm . However , the to applied levels in this study didn't reveal harmful effects on the growth performance of the lambs , but they even improved nutritional and physiological parameters . In fact , it has been shown that dietary amounts of copper that are adequate for some breeds are deficient for others and possibly toxic to some (Wiener and woolliams , 1983) . This is possibly due to differences in copper metabolism within and among breeds particularly in absorption . Copper absorption is negatively correlated with the concentrations of both Mo and sulfate (NRC 1985) In the present study copper with added in the form of

$CuSO_4$ which might had altered the copper absorption and hence increased the maximum tolerable level . Molybdenum should be considered in future studies since copper requirements are dependent and increases with increased Mo level in the diet . It was concluded by several authors that copper nutritional is pretty complicated (Neary , 2002).

CONCLUSION

In conclusion, copper is a unique mineral element in that it acts as a growth stimulant in Egyptian growing lamb when fed at high dietary levels (30 ppm). It is a crucial idea to use the copper element as growth promoter and immune stimulator for controlling mortality in growing young lambs .This needs further detailed studies taking into consideration its interaction with Mo and sulfate .

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خصائص النمو وبعض قياسات الدم فى الحملان المغذاه على علائق مضاف إليها النحاس

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أجريت هذه الدراسة فى محطة البحوث الزراعية بشوشة والتابعة لجامعة المنيا على ٢٤ حمل أوسيمى فى عمر أربعة أشهر بمتوسط وزن حى ٢٠,١٥ ± ١,٥٣ كجم. تم توزيع الحيوانات عشوائيا إلى ثلاثة مجاميع بحيث تضم كل مجموعة ثمانية حملان مع مراعاة أن يكون المتوسط العام للمجاميع الثلاثة متساوى. غذيت المجموعة الأولى على عليقة الكنترول والتى تتكون من ١% ، ٣% من وزن الحيوان برسيم وعلف مركز على الترتيب. والمجموعة الثانية تغذت على عليقة الكنترول + ١٥ جزء فى المليون نحاس وغذيت المجموعة الثالثة على عليقة الكنترول + ٣٠ جزء فى المليون نحاس.

وكان من أهم النتائج المتحصل عليها ما يلى:

١ – حدث تحسن ملحوظ فى كلا من معدلات النمو اليومية للحملان وكذلك معامل التحويل الغذائى ومعاملات الهضم فى الحملان التى تغذت على علائق مضاف لها عنصر النحاس وكان أعلى قيم التحسن فى المجموعة الثالثة التى تغذت على ٣٠ جزء فى المليون نحاس.

٢- كانت هناك زيادة فى محتوى الدم من كرات الدم الحمراء والهيموجلوبين والمكونات الخلوية فى مجموعة الأغنام التى غذيت على ١٥ (المجموعة الثانية) والتى غذيت على ٣٠ جزء فى المليون من النحاس فى العليقة مقارنة بمجموعة الكنترول.

٣- المجموعة الثالثة سجلت أعلى قيم فى عدد كرات الدم البيضاء مع زيادة ملحوظة فى عدد الكرات الليمفاوية والقاعدية ونقص فى الكرات المتعادلة يليها المجموعة الثانية مقارنة بالكنترول فى حين أنه لم يكن هناك اختلافات بين المجاميع الثلاث فى الكرات القاعدية وأيضا فى الكرات الوحيدة (الكبيرة).

وعموما أظهرت النتائج المتحصل عليها أن إضافة النحاس إلى علائق الأغنام يكون ذو فائدة فى تحسين خصائص النمو ورفع المقدرة المناعية للأغنام النامية.