The retention of copper in sheep fed palm kernel cake supplemented with molybdenum, molybdenum plus sulphur and zinc

A.R. Alimon,*†[1] R. A. Al-kirshi† and Z.A. Jelan†

*Faculty of Agriculture, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia;
†Institute of Tropical Agriculture, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

ABSTRACT: An experiment was conducted to determine the effect of supplementation with molybdenum (Mo), Mo + Sulphur and zinc (Zn) on the digestibility of copper (Cu) in sheep fed palm kernel cake (PKC) based diet. Twenty local cross-bred sheep were allotted to four groups and given PKC-based diets containing either, 0 (Control), 20 ppm Mo +1000 ppm sulphur (S) (Diet MoS), 500 ppm Zn (Diet ZN) or 30ppm Mo (Diet Mo). The apparent digestibility of Cu in sheep fed the control diet was significantly higher ($p<0.01$) compared to those in the other diets. The retention of Cu for sheep on Diet MoS was significantly lower ($p<0.05$) (2.49%), compared to the other dietary treatments. Subsequently, the faecal excretion of Cu for sheep fed Diet MoS, Diet ZN and Diet Mo higher ($p<0.05$) than the control group. The highest urinary excretion of Cu was also observed in sheep fed Diet MoS (0.64 ppm). It appears that the retention of Cu was effectively reduced when Mo + S was supplemented in PKC based diet. The effect of Zn and Mo alone, on urinary excretion of Cu was lower when compared to Mo + S. The liver and kidney Cu concentration of sheep fed Diets MoS, Diet ZN and Diet Mo were significantly lower ($p<0.05$) than those in the control group. It can be concluded that supplementing with either Mo, Zinc or Mo+S significantly reduced the retention of Cu in sheep and thet Mo+S appears to be more effective than Mo or Zn in reducing the concentration of Cu in the liver and kidney.

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Key words: palm kernel cake, copper, molybdenum, zinc, copper retention, liver copper concentration

INTRODUCTION

Palm kernel cake (PKC) is a by-product obtained after the extraction of oil from the kernel of the palm nut. It has been regarded as an important source of energy and protein for ruminants in Malaysia, because of its high contents of crude protein of 14-16% and 9.5-10.5 MJ/kg metabolizable energy (Wong and Wan Zahari, 1997). However, its use in rations for small ruminants especially sheep is restricted to a maximum of 50% of the dietary matter (DM). This is due to copper content of PKC that can reach up to 30ppm (Abd. Rahman *et al*. 1989). Several studies have been conducted to determine the nutritive values of PKC and ways to optimize its utilization either as a sole feed or an ingredient in feed formulations for ruminants. Studies on characterization of PKC using digestibility trials have been widely reported Miyashige, *et al*. (1987) and Charurat (2001). And almost all reports and studies on PKC demonstrated the effect of Cu toxicity and its accumulation in plasma and organs in sheep and goats. Therefore, the present study was focused to determine the digestibility of copper in PKC diets supplemented with Mo, Mo+S and Zn in balance trials using sheep with measurement of the copper content in feed as well as faecas, Cu digestibility, urinary Cu, Cu balance and Cu concentration in the liver and kidney.

MATERIALS AND METHODS

Twenty male Malin crosses sheep, averaging 19kg, were randomly allocated to three groups, each of five animals, housed in the individual pens and free access of water. Sheep in the Control group was fed a basal diet (PKC 86.2%, grass-hay 10%, 1% cobalt-iodized salt and 2.8% limestone (34%

[1] Corresponding author: ralimon@agri.upm.edu.my

Ca). Vitamins A, E and D were added to supply 600, 15 and 1100 IU/kg, respectively, in the diet. Animals in Diet MoS were given the basal diet, supplemented with 20 ppm Mo (ammonium molybdate) plus 1000 ppm Sulphur (sodium sulphate) per kg dry matter, while those in Diet ZN were fed the basal diet + 500 ppm Zn (Zinc sulphate) per kg DM, and sheep on Diet Mo was given the basal diet supplemented with 30 ppm Mo per kg DM. In this study, PKC contained 90.35% DM, 9.05% ash, 15% (CP), 45% (ADF), 22.95 ppm Cu, 58.92 ppm Zn, 1512.51 ppm Fe. The hay used contained 92.19% (DM), 4.96% ash, 4.13% (CP), 45.08% (ADF), 7.72 Cu, 52.12 ppm Zn, and 1122 ppm Fe. After 3 weeks adaption period the total collection procedures were used to measure daily feed and water intake. Faecal and urinary outputs were collected daily during the last 6 days. At the end of the trial the sheep were slaughtered and the right liver lobes and kidney were isolated for mineral analysis. Chemical analysis was done according to (AOAC, 1984). Data were subjected to one-way analysis of variance using SPSS (1999). Duncan's multiple range tests were used to compare treatment means. The experiment lasted for 4 months.

RESULTS AND DISCUSSION

The copper concentration in each experimental diet, in the faeces and urine are presented in Table 1. There were no significant differences ($p>0.05$) in copper intake between treatment groups. The excretion and digestibility of Cu in the faeces was significant ($p<0.05$) difference. It seems that all treatments excreted the same amount of Cu. But the apparent digestibility of Cu in control group was higher in comparison with those in group 2 and 3 ($p<0.01$). It was considered that treatment with Mo+S,Zn and Mo excreted more Cu than control and treatment with Zn. These results were in agreement with those reported by Smith *et al*. (1968) that supplementation of Mo+S to sheep increased the endogenous Cu faecal excretion. Hidiroglou *et al*. (1984) also indicated that there was increased faecal Cu excretion in Cu-poisoned lambs at 4 days after initiation of Mo+S supplementation. From the results of urinary excretion, retention and balance, there was significant ($p<0.01$) increase of Cu urinary excretion in sheep fed Diet MoS suggesting.

Table 1. The Effect of Dietary Mo+ S, Zn and Mo on the daily faecal and urinary outputs, apparent digestibility, and retention of Cu in sheep fed PKC based diets and hay

Treatment	Control	MoS	ZN	Mo	Lev.of Sig.
Intake, ppm/d	13.40±1.18	14.39±2.15	13.44±2.08	15.72±1.74	NS
Faeces, ppm/d	9.88±1.02^{a}	13.39±2.17^{b}	12.36±1.74^{b}	14.39±1.6^{b}	*
Urine, ppm/d	0.22±0.04^{a}	0.64±0.06^{b}	0.21±0.05^{a}	0.27±0.12^{a}	**
Digestibility, %	26.34±1.28^{b}	7.07±1.21^{a}	7.96±1.23^{a}	8.48±0.49^{a}	**
Retention, ppm/d	3.30±0.23^{c}	0.35±0.08^{a}	0.87±0.31^{b}	1.06±0.11^{a}	**
Liver Cu, ppm	1196±27^{c}	199±83^{a}	674±18^{b}	571±188^{b}	***
Kidney Cu, ppm	468±91^{b}	138±11^{a}	67±0.1^{a}	106±45^{a}	*

$^{a.b.c}$ Values with different superscripts within the same row are significantly different ($p<0.05$).
Mean± SD, NS : Not significantly different ($p<0.05$),
*: Significantly different ($p<0.05$),
**:Significantly different ($p<0.01$),
***: Significantly different ($p<0.001$)

That this diet was effective in reducing accumulation of Cu in the liver or in the kidneys. This confirmed earlier observation on sheep whereas increased losses of endogenous Cu in both faeces and urine were found in response to supplemental Mo (5 to 25 mg/day) when 1.1g/day S was added to the basal diet Weber *et al*. (1983). In contrast, Hidiroglou *et al* (1984) reported that there was no effect of the Mo+S supplementation on urinary excretion of Cu. If retention of Cu is reduced by Mo+S treatment, the losses of Cu by way of the urine would represents an important factor in the depletion of body stores. These suggest that dietary supplementation of Mo+S did affect the absorption of Cu. The Zn and Mo alone have less effect on total urinary Cu excretion in comparison with Mo+S. But they have same effect on faecal Cu excretion. The concentration of copper in the liver Cu concentration was lower ($p<0.05$) in the treated groups compared to those in the control group. The effect of Mo+S supplement was highly significant ($p<0.001$) and this is in agreement with previous

reports (Van der Shee *et al.*, 1980; Ivan *et al.*, 1999). The concentration of Cu in the kidney of the treatment groups are lower than those in the control group. From the data obtained on the excretion of urinary Cu, it was evident that dietary Mo + S increased the loss of Cu from the body through the kidney. There finding was in agreement with those of McDowell (1992).

CONCLUSION

It can be concluded that supplementation with Mo or Zn were effective means of reducing Cu retention in sheep, however addition of S to the Mo further increased the urinary excretion of Cu.

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