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Effect of incorporating sodium molybdate in the form of salt lick or in mixed ration on growth and performance of sheep fed palm kernel cake

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ABSTRACT

The objective of the present experiments are to determine if sheep could safely consume high amount of PKC in their diets and if sheep's consumption of PKC require a chelating agent to tie up the high copper level in PKC to protect it against toxicity. Two experiments were carried out. Experiment 1, with four treatment groups of animals, using from 30 to 100% PKC, mixed with other feed ingredients except minerals. Mineral mixtures were separately mixed with Sodium Molybdate, acting as the chelating agent, and the mineral was offered in separate feed troughs ad.libitum, in the pens for each animal group. Although all groups gave high ADG, the animals in the 100% group had high copper in their blood, which were above4 the normal physiological level at the end of the experimental duration of three months. Three animals from this group died and their liver copper contents were very high. The groups fed up to 72% PKC in their ration did not show any significant elevation of copper or toxicity. Sheep fed similar proportions of ingredients in experiment 2, but with Molybdate incorporated together into all the four similar rations as in experiment 1, did not show any signs of toxicity or elevated blood copper. The animals in all groups produced high ADG. The experiment proved that sheep can take up to 100% PKC in their diet, but a chelating agent must be incorporated into the feed to ensure its sufficient uptake to protect it against toxicity. Giving Molybdate separately from the feed would not ensure sufficient intake of the chelating agent voluntarily. This would result in copper toxicity in the animals.

INTRODUCTION

Prime lambs could be produced locally to replace imports and choice mutton could be made available at a lower cost if lambs are fattened with locally available feedstuffs. Lambs could be slaughtered at a much younger age, producing lean, tender mutton, suitable for steaks, compared to the normal, grass feed animals. Experiments showed that sheep purely grazing on pasture or sparingly supplemented with concentrate feeds to be rather slow in growth. Jaafar & Khusahry (1983) using crossbred sheep noted animals grazing in rubber plantation without feed supplement gained only an average of 23.95 gm daily, while those supplement also gained only between 46.82 to 75.14 gm daily.

Feedlot fed lambs gained much higher body weights and reached marketable weights at a much younger age. Choice of cheap, safe and suitable feed materials for feedlot fattening of lambs is important for sound, profitable venture. Yulistiani, Djajanegara & Iniguez (1990), using wheat pollard and other local byproducts to fatten Javanese Long Tail Sheep in Indonesia, obtained a daily gain of 146-163 gm. Davis & Rajion (1990), using broken corn and fishmeal obtained 149 gm ADG for Australian imported sheep. Palm Kernel Cake (PKC) could be used to feed sheep in feedlot despite it containing high levels of copper and the sheep extra intolerance to copper compared to other livestock animals. Several studies had shown that copper in PKC can be bound and made unavailable when fed with certain chelating mineral elements. Rahman *et al.* (1989), using Sodium molybdate and Hair Bejo and Alimon (1992), using Zinc and Molybdate had shown that copper in PKC were effectively bound when fed to sheep and rendered it safe against copper toxicity.

Yusoff *et al.* (1992), had reported very encouraging sheep performances from their trial when sheep were fed 30% PKC in all four rations with varying levels of maize, dried sago and cassava chips.

Molybdate had rendered the copper safe, when it was incorporated into the feed mixture. Sheep gained body weights between 138 to 192 gm daily, depending on the combinations of feed materials and they did not show any sign of copper toxicity.

The present trials were undertaken to incorporate higher levels of PKC in the feed for sheep. Molybdate were incorporated either into the salt lick mixture or into the feed mixture together with the mineral elements and the rest of the feed ingredients.

MATERIALS AND METHODS

Experiment 1

Forty young rams of the commercial Merino X Border Leicester (CMBL) breed, of four to five months of age, were alloted randomly into four goups of 10 animals each and fed rations containing varying levels of PKC as in Table 1. Mineral mixture were not incorporated into the diet but were given separately in different troughs. The mineral mixture were incorporated with Sodium Molybdate. Feed rations and mineral supplements were allowed *ad. libitum* to the animals in four different pens measuring 6 x 10m^2, according to their different feed groups.

Feed intakes were recorded daily while minerals were estimated according to differences between amount offered in troughs and leftover at the end of each months, for each group. Animals body weight gains were recorded monthly during the three months feeding trial. Their serum samples were also taken and analyzed for copper at the beginning and at the end of the trial. Metabolizable energy was determined using the methods of Menke *et al.* (1979).

Analysis of variance technique was used to evaluate results and Duncans Multiple Range Test was used to compare treatment means as described by Steel and Torrie
(1960).

Table 1. The feed composition for feedlot sheep with PKC in Experiment 1

Feed Ingredients (percent of feed)	Ration Number 1	2	3	4
Palm kernel cake, solvent	31.0	32.5	72.0	100.0
Dried palm sago	31.0	51.0	28.0	-
Ground maize	36.5	16.5	-	-
The Mineral/Salt Lick				
Tricalcium phosphate	40%			
Salt	40%			
Trace mineral premix	20%			
Sodium molybdate	50 gm/100 kg mineral mixture			
Nutrient contents for feed mixtures				
Crude protein (%)	10.5	10.5	12.0	16.0
Metabolizable energy (MJ/kg)	10.7	10.8	10.3	10.0

Experiment 2

Forty young rams of the same breed and age as in Experiment 1 were randomly allotted to four groups in a similar feedlot trial and were placed into similar sized pens. The molybdate and the other mineral elements were incorporated together into the feed mixtures. The feeding trial also lasted three months with body weight changes recorded monthly and feed intakes recorded daily as group feeding method. Blood serum and samples were also taken for copper analysis. Feed samples were taken every 10 days to determine their contents using AQAC (1984) methods. Serum Copper and Copper from liver samples of animals that died were analyzed using Atomic Absorption Spectrophotometer and the metabolizable energy was determined using the methods of Menke *et al.* (1979). The feed mixture are as in Table 2. Statistical analysis was also carried out as in Experiment 1.

RESULTS AND DISCUSSION

Experiment 1

The results of experiment 1 are shown in Table 3. Animals fed ration with higher amount of maize (Ration 1) gave the highest average daily gain (ADG) followed by Ration 2 the ration with some maize and sago with PKC ($P<0.05$). Ration 3, with higher amount of PKC plus sago produced lower ADG, next to 100% PKC, that was the ration 4, with the lowest ADG though rations 3 and 4 and rations 1 and 2 were not significantly different ($P>0.05$). The total daily dry matter (DM) intakes were similar for all rations ($P>0.05$). The cost of feed per kg. gain were similar for rations 1, 2 and 3 and between rations 1 and 4, and the feed conversion ratio (FCR) were similar for rations 1, 2 and 3 ($P>0.05$), but were significantly higher by ration 4 animals ($P<0.05$). Average serum copper levels also followed the same trend, with animals on ration 4 containing the highest level ($R<0.05$). Average mineral salt intakes were similar for all rations ($P>0.05$) but were lower than their requirements.

Table 2. The feed composition for sheep in Experiment 2

Feed Ingredients	Ration Number			
	1	2	3	4
Palm kernel cake, solvent	30.0	30	71.5	97.5
Dried palm sago	30.0	50	26.0	-
Ground maize	36.0	16.0	-	-
Urea	1.5	1.5	-	-
Tricalcium phosphate	1.0	1.0	1.0	1.0
Common salt	1.0	1.0	1.0	1.0
Trace mineral premix	0.5	0.5	0.5	0.5
Sodium molybdate	(12.5 gm/tonne feed thoroughly mixed initially with minerals)			
Nutrient contents for feed mixtures				
Crude protein (%)	12.6	11.5	12.0	15.5
Metabolizable energy (MJ/kg)	10.5	10.4	10.3	10.0

Table 3. Performance of sheep fed in feedlot with varying levels of PKC in Experiment 1

Parameters	Ration Number			
	1	2	3	4
Initial wts. (kg)	24.2	20.7	23.0	24.0
Final wts. (kg)	41.1	38.5	38.1	28.6
Avg. daily gain (gm)	200^a	183^{ab}	171^b	164^b
(mean ± SD)	(±3.4)	(±3.6)	(±3.4)	(±4.5)[2]
Avg. daily DM intake (kg)	1.13^a	1.04^a	1.01^a	1.13^a
	(±0.28)	(±0.35)	(±0.42)	(±0.43)
Avg. cost of feed day[1] (RM)	0.47	0.41	0.38	0.41
Cost per kg gain (RM)	2.35^{ab}	2.24^a	2.22^a	2.50^b
	(±0.24)	(±0.25)	(±0.32)	(±0.35)
Feed Conversion Ratio (FCR)	5.65^a	5.68^a	5.91^a	6.89^b
	(±0.59)	(±0.66)	(±0.69)	(±0.74)
Avg. Serum copper content (µg/dl)[3]	100.5^a	90.2^a	110.1^a	181.2^b
	(±4.22)	(±5.27)	(±6.92)	(±9.32)
Avg. daily mineral intake (g)	4.2^a	4.7^a	4.4^a	3.5^a

a, b means with the same superscript in the same row shows non significant difference. ($P < 0.05$)
1 cost of feed rations per kg were as follows: Ration 1, RM0.36; Ration 2, RM0.33; Ration 3, RM0.31; and Ration 4, RM0.32, and the trace mineral/salt lick with molybdate at RM0.51 per kg.
2 Results was based on 7 animals left due to 3 deaths.
3 Normal serum copper content, 80-120 µg/dl.

Three animals on ration 4, with 100% PKC, died and their copper contents in the liver averaged 1074 ppm. The normal physiological copper levels in the liver is between 200-400 ppm. Serum copper contents in animals on rations 1, 2, and 3 were within the normal level at 80 to 120 µg/dl. Those on ration 4 were above the normal range, with two of the animals containing 251 and 264 µg/dl, respectively.

The present results showed that sheep could consume higher amounts of PKC in their diet in feedlot if eaten with a chelating agent. Sodium Molybdate was found to be an effective agent as had been proven by Rahman *et al*, (1989), Hair Bejo & Alimon (1992) and Yusoff, Hussain & Rais (1992). The right amount of molybdate must be consumed simultaneously with the PKC for it to be effective. Failure to do so would result in the availability of high amount of free copper in blood and liver and could result in dealth. It is doubtful that molybdate when given separately from the feed as for example given in salt lick, would result in simultaneous uptake with the feed. This had proven true because three death of animals in 100% PKC group and another two animals had excessively high serum copper levels. The other remaining animals in ration 4 were also shown to have higher than normal level of copper in their serum. The animals with lower levels of PKC in their diet, even up to 72%, seemed to do very well, at least for that duration of feeding, with no mortality and maintaining normal levels of serum copper.

The better performances of sheep, especially their ADG, occurred in rations with addition of one or more energy feed sources like maize and sago. There was a slightly lower energy level in ration not included an energy source, like in ration 4. The type of energy feed source used also seemed to contribute to the better animal performance, as in ration 1 where maize was used instead of sago. Armstrong & Beever (1969) noted that ground maize retained the most by-pass energy through the rumen to be absorbed in the small intestine, compared to the other feedstuffs. It is therefore more advisable to incorporate the right energy feed source, firstly to obtain a higher ADG and secondly, especially if the uptake of a chelating agent is not assured, to prevent copper toxicity.

The experiment therefore showed feeding high levels of PKC supplemented with molybdate in salt lick was ineffective. Animals consumption of the minerals was unpredictable and they would result in copper toxicity.

Experiment 2

The results for this experiment are shown in Table 4. The ADG pattern was similar to those in experiment 1, with the highest being by animals in group 1, followed by 2 and 4. The lowest being group 3. Statistically there were no significant differences in ADG amongst groups 2, 3 and 4 and between groups 1 and 2 ($P>0.05$). The DM intakes were significantly similar for all groups ($P>0.05$). The cost of feed per kg. gain were not significantly different between rations 1 and 2 and rations 1,3 and 4 ($P>0.05$), but the cost was lowest by group 2 compared to groups 3 and 4 ($P<0.05$). The feed conversion ratio (FCR) were non significant for all the groups ($P>0.05$). The average serum copper contents were similar for groups 1,2 and 3, but the values were highest by group 4 ($P<0.05$) although it was not significantly different between groups 3 and 4 ($P>0.05$). Despite that they were all within the normal physiological range.

Feeding high PKC to sheep, even up to 100% level with incorporation of molybdate into the feed ration to ensure their simultaneous uptake seemed to give a positive response.

The animals physical condition were also very promising and there were no mortality and resulted in 100% survival. Molybdate incorporation into the feed mixture seemed to ascertain its uptake. Molybdate was also found to be an effective suppressor of copper, even if high copper is given as in 100% PKC in a feedlot. Merck Veterinary Manual (1991) also has suggested Molybdate to counteract and reduce copper toxicity in sheep.

Table 4. Performance of sheep fed in feedlot with varying levels of PKC in Experiment 2

Parameters	Ration Number			
	1	2	3	4
Initial wt. (kg)	20.1	19.3	19.3	19.0
Final wt. (kg)	30.9	29.7	31.8	31.7
Mean daily gain (gm)	212^{a}	208^{ab}	173^{b}	180^{b}
(mean ± SD)	(±3.4)	(±3.7)	(±3.2)	(±4.2)
Mean daily DM intake (kg)	0.92^{a}	0.92^{a}	0.94^{a}	1.00^{a}
	(±0.24)	(±0.21)	(±0.32)	(±0.31)
Mean cost of feed day[1] (RM)	0.39	0.35	0.36	0.37
Cost per kg gain (RM)	1.83^{ab}	1.68^{ab}	2.08^{b}	2.06^{b}
	(±0.27)	(±0.32)	(±0.25)	(±0.63)
Feed Conversion Ratio (FCR)	4.34^{a}	4.42^{a}	5.43^{a}	5.56^{a}
	(±0.37)	(±0.35)	(±0.52)	(±0.63)
Mean Serum copper content (µg/dl)[2]	95.2^{a}	99.0^{a}	102.2^{ab}	115.3^{b}
	(±3.33)	(±2.52)	(±4.37)	(±5.22)

a, b means with the same superscript in the same row shows non-significant difference at P + 0.05.
1 cost of feed rations per kg were as follows: Ration 1, RM0.37; Ration 2, RM0.34; Ration 3, RM0.32; and Ration 4, RM0.33 kg.
2 Normal serum copper level, 80 - 120 µg/dl.

The experiments had therefore shown the effectiveness of Molybdate as suppressor of copper in PKC for sheep in feedlot. When properly given in the feeds sheep can take 100% PKC in feedlot without any danger of toxicity. When insufficient amount or zero intake of molybdate as in Experiment 1 occurs, where it depended on the animals to lick the salt themselves, toxicity of copper occurred in the sheep fed very high levels of PKC in the diet. Results also showed that sheep fed on PKC alone could give high daily weight gains, but with the addition of another energy feed material with it would produce higher gain. The economic use of the feed materials need to be taken into consideration.

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