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SULPHUR CONTAINING LICKS AND THEIR EFFECT ON THE MINERAL-VITAMIN BALANCE OF SHEEP

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OPSOMMING: SWAWELBEVATTENDE LEKKE EN HUL EFFEK OP DIE MINERAALVITAMIENBALANSE VAN SKAPE

Swawelbyvoeging in skaaplekke het die koperinhoud van lewer in beide ooie en lammers merkbaar laat daal, terwyl in die geval van die ooie alleen het mangaan, magnesium en sink gedaal, en kobalt gestyg. In beide ouderdomsgroepe het yster onveranderd gebly. Die plasma-tokoferolinhoud het gedaal as gevolg van swawelinname. Hierdie veranderinge toon dat swawel-bevattende lekke aansienlike mineraaal-wanbalanse kan veroorsaak.

SUMMARY:

The supplementation of sulphur to sheep licks markedly reduced the copper content of livers in both ewes and lambs, and in the ewes manganese, magnesium and zinc were also reduced and cobalt increased. In both age groups, iron remained unchanged. The plasma tocopherol content dropped due to sulphur intake. These changes indicate that sulphur containing licks can precipitate substantial mineral imbalances.

The animal diet has a wide spectrum of organic sulphur containing compounds of which methionine, cystine and cysteine are the prominent ones (Comar & Bronner, 1962). Amongst the compounds containing lesser amounts of sulphur, there are some of particular importance such as the vitamins thiamine and biotin. Sulphur is also ingested in the inorganic sulphide and sulphate forms, fractions of which are utilized in metabolic processes, whereas substantial portions are also excreted.

It has been determined that thiol compounds such as glutathione have a strong affinity for heavy metals, which results in the protection of biological tissues from excesses of such metals and the maintenance of the –SH groups of enzymatic proteins in the reduced state (Barron & Dickman, 1948–49).

The recognition of chondroitin sulphates in high concentrations in cartilage and possibly of all connective tissues, draws attention to the sulphated polysaccharides (Comar & Bronner, 1962). Mucoitin sulphates excreted by the cells of the gastro-intestinal tract may contain up to 10% sulphur. These products are known to act as lubricants, but their other functions are not as yet clarified.

The administration of sulphate to an animal results in recovery of the mineral primarily from the urine as glomerular filtrate which is reabsorbed to a substantial degree in the tubules when dosage is small. The majority of a high dose is however collected in the urine (Boyazoglu, 1964).

Sulphur containing licks are in common use, primarily in the sheep raising areas of the Republic. They are applied in anticipation of benefits in wool yield, seeing that the wool fibre contains substantial concentrations of sulphur containing amino-acids. The mineral is added at concentrations up to 5% of the overall mixture, with or without the addition of trace minerals.

The project was initiated to measure the possible interactions the addition of sulphur will have on related nutrients. Interaction effects between copper, molybdenum and sulphur have been observed (Dick, 1953), (Wynne & McClymont, 1956), however in this work a broader spectrum of nutrients was considered as well as the age effect.

Procedure

Thirty two South African Mutton Merino ewes were divided into 2 even groups in adjoining dry-lot camps with 2 rams for each group to insure the breeding of each in-season ewe. The sheep were fed 1 kg of chopper lucerne out of feed troughs daily, and had continuous access to a lick which supplied the treatment effects. The 2 licks used were formulated in the proportions as presented in Table 1 and utilized by the sheep during the pregnancy and lactation months.

Table 1

Lick supplements made available to two ewe groups and their lambs

Yellow mealiemeal	90 kg	90 kg
Fish meal	100	100
Dicalcium phosphate	50	50
Molasses	50	50
Salt	50 (100)[a]	50(100)
$Na_2SO_4.10H_2O$	20	–
Mean Daily lick intake per ewe	107 g	102 g
Mean Daily intake of Sulphur from $Na_2SO_4.10H_2O$	0,6 g	–

[a] Salt concentration reduced from 100 to 50 kg after the first month.

The 33 lambs were raised and at 90 days of age blood samples were taken for plasma tocopherol evaluations from both groups. At 100 days of age both lambs and ewes were sacrificed and liver samples taken in 10%

formalin as previous work has indicated (Ehret, 1971) that there is a strong correlation between the moisture content of fresh and formalinized liver samples and their mineral concentrations. The lamb livers were sampled at three sites to determine the degree of variation in mineral concentrations within a liver.

The analytical procedures used for the liver mineral evaluations made use of 1 g blocks of liver free of large blood vessels. These samples were placed in a 4 cm x 20 cm test tube containing a 1 ml acid mixture (1 part concentrated sulphuric acid and 7 parts concentrated perchloric acid.) Five milliliter concentrated nitric acid was further added and digestion on a burner for 30 minutes yielded a clear colourless liquid. Twenty milliliter 5% in aqueous solution lanthanum oxide and 79 ml water were added for a 1:100 dilution. This sample was then passed through an atomic absorption spectrophotometer which gives a reading on the recorder for iron, copper, manganese, zinc and cobalt. Further dilution to 1:500 supplies a sample for magnesium (and calcium) determination. The standard solutions contained all additives including lanthanum oxide and used as references. The readings were made on a Beckman 979 atomic absorption spectrophotometer with a turbulent flow burner and 250 mm recorder accessory. The results were calculated as milligram per kilogram on wet sample basis.

The total plasma tocopherol evaluations were conducted according to the method of Hashim & Schuttringer (1966) on heparinized blood samples.

Results

The 90-day plasma tocopherol concentration in the lambs was 0,0618 mg per 100 ml as compared to the control group's 0,0752 mg per 100 ml. The drop of 18% caused by the sulphur effect was significant ($P < 0,05$) and is indicative of an increase in the use of the biological anti-oxidant requirement of the body.

The lamb liver analyses showed no statistical significance of the variation of the three samples drawn from each lamb liver as compared to the differences between livers, indicating a constancy in the samples drawn from each animal. This observation is important as sampling was made from the caudate lobe and two wedges taken from the edge of the liver. This uniformity of mineral concentration is not achieved if samples are drawn from the body of the liver, in the proximity of large blood vessels where there is a measurable fluctuation. The lambs livers had manganese, cobalt, iron, zinc and magnesium concentrations which did not differ significantly ($P<0,05$). The copper concentrations differed markedly from 65,7 mg per kg on wet basis in the control group to 32,9 mg per kg on wet basis in the sulphur supplemented group, indicating that there was an active excretion of the mineral precipitated by the sulphate, of 50% .

The mineral patterns of the ewes livers differed markedly form the lamb mineral profile. In fact only in the case of copper could a direct comparison be made between the 2 age groups. Highly significant reductions in mineral concentrations in the ewes, which were not evident in the lamb samples were measured for manganese and magnesium and a significant drop in zinc. Iron was unaffected and cobalt provided a highly significant increase in concentration due to the sulphur effect.

Table 2

Mean lamb liver mineral concentrations in milligram per kilogram on wet basis

Mineral	Control	Sulphur	Significance
Manganese	7,1	7,1	NS[a]
Copper	65,7	32,9	**b
Cobalt	18,9	18,2	NS
Iron	171,7	189,8	NS
Zinc	128,4	122,4	NS
Magnesium	256,5	254,4	NS

[a] Not Significant
[b] Highly Significant ($P < 0,01$)

Table 3

Mean ewe liver mineral concentrations in milligram per kilogram on wet basis

Mineral	Control	Sulphur	Significance
Manganese	6,8	6,0	**
Copper	76,5	43,7	**
Cobalt	18,6	21,9	**
Iron	173,6	166,9	NS
Zinc	131,9	119,5	*
Magnesium	309,4	192,9	**

* $P < 0,05$
** $P < 0,01$
NS Not significant

Discussion

It is evident from the results that the administration of sulphur to licks brings about substantial changes in mineral retentions in the liver, the organ concentrations of which are a good reflection of the metabolic state of the minerals in the body. These changes may either aggravate existing imbalances or precipitate them, when none were previously evident. The most prominent precipitated deficiency was found to be of copper, being evident in ewes and lambs alike. In the ewes manganese, magnesium and to a lesser extent zinc were also reduced. This however, was not the case in their lambs, indicating a possible preferential protection of lambs by the ewes during the lactation period. Iron was unaffected in both age groups whereas cobalt actually increased in the case of the ewes, a phenomenon which cannot be rationalized with the existing

knowledge at hand.

The supplementation of sulphur in the lamb group also reduced circulating tocopherols, reducing the anti-oxidant capacity of the body thus increasing tissue wear and tear.

This experiment was not designed to evaluate the benefits derived from sulphur supplementation in terms of possible increased wool growth or the potential benefits in physical condition. However it is clearly evident that increased sulphur intake can be detrimental and its use should be either reduced or alternately applied simultaneous with copper, manganese, magnesium and zinc supplementation to counteract the competitive effects.

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