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To cite this version:
M. Lamand, Claudine Lab, R. Roux.. COPPER DEFICIENCY PROPHYLAXIS IN GRAZING SHEEP BY COPPER OXIDE INJECTION. Annales de Recherches Vétérinaires, INRA Editions, 1978, 9 (3), pp.501-504. <hal-00901031>

HAL Id: hal-00901031
https://hal.archives-ouvertes.fr/hal-00901031

Submitted on 1 Jan 1978

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COPPER DEFICIENCY PROPHYLAXIS IN GRAZING SHEEP
BY COPPER OXIDE INJECTION

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with technical assistance of Claudine LAB and R. ROUX.


Résumé

PROPHYLAXIE DE LA CARENCE EN CUIVRE CHEZ LE MOUTON AU PATURAGE PAR INJECTION D’OXYDE DE CUIVRE. — Vingt et une brebis d’environ 46 kg ont été mises à l’herbe sur une parcelle de ray-grass carencé en cuivre. Onze des brebis ont reçu une injection intramusculaire de 60 mg de cuivre (sous forme oxyde, CuO) en suspension dans 5 ml d’huile d’olive purifiée.

La cuprémie des brebis témoins a diminué pendant toute l’expérience (67 jours). Trois d’entre elles étaient en état de carence à l’abattage. Les brebis ayant reçu une injection de cuivre ont été protégées de la carence (cuprémie significativement plus élevée que les témoins pendant 54 jours) et présentaient à l’abattage un stock de cuivre hépatique significativement supérieur à celui des témoins.

La dose de 60 mg de cuivre par mouton adulte est certainement un maximum admissible car une des brebis traitées avait un cuivre hépatique de 1 060 µg/g M.S., ce qui est proche de la limite de toxicité habituellement admise.

Introduction

Efficiency of insoluble and non ionized form of injected copper has been shown in a previous paper (Lamand, 1978). Such a form is slowly liberated from the injection site by a moderate inflammatory process. In cattle it appeared that copper oxide was preferable to metallic copper, being slightly less caustic. Inflammation found in cows is very slight and cannot be detected by palpation. The aim of this experiment was to measure the duration of the effect obtained in sheep given an intramuscular injection of copper oxide.

Several authors (Hartman and Bosman, 1970; Fisher et al., 1972; Amboulou and Lamand, 1977) showed that copper in young grass is less digestible than in hay. Thus we measured cupremia in control or injected ewes transferred to pasture in the spring.
and followed the duration of the effect of the injection.

Material and methods

21 ewes (mean live weight 46 kg) were used. The ewes had received, in the previous winter, hay without concentrate or mineral mix. They grazed on Italian Rye Grass pasture. The copper content obtained from a contiguous experimental plot of the same Rye Grass was between 4.4 and 5.0 mg/kg D.M. during the experimental period. Blood samples were collected on the first day of grazing and then 11 ewes received, by intramuscular injection in the neck, 60 mg of copper as copper oxide (CuO) suspended in 5 ml of purified olive oil.

Blood samples were obtained each week from each animal. Plasma copper was determined by atomic absorption spectrophotometry (Bellanger and Lamand, 1975) and ceruloplasmin was determined by the method of Sunderman and Nomoto (1970).

When the concentrations of copper in the plasma of injected animals and controls were no longer significantly different, all animals were slaughtered and liver samples obtained for copper determination.

Results

No inflammation or any pain appeared at injection sites in the injected animals.

After the control ewes were transferred to grass their mean plasma copper and ceruloplasmin concentration were significantly lowered.

For injected ewes, cupremia, the mean concentration of copper in plasma, was significantly higher than that of the controls from day 13 till day 54 after injection. Similarly ceruloplasmin concentration were higher from the 13th till the 47th day.

Fig. 1 and 2 show that release of injected copper, modifies plasma content on the 6th day, is maximum on the 13th day, and then continues slowly.

At slaughter, on the 67th day of the experiment the mean liver copper content of the injected ewes was 190 μg/g D.M. (range, 80 to 1060). This was significantly higher (P < 0.025) than the controls (mean 55 μg/g; range 13 to 376). Three of the control ewes had at slaughter copper concentration in plasma from 40 to 42 μg/100 ml and liver copper from 13.2 to 14.4 μg Cu/g D.M.

Discussion

Ewes wintered on hay diet without supplementary mineral were chosen to avoid a high

Fig. 1.—Changes in mean plasma copper after copper injection.

Fig. 2.—Changes in mean plasma ceruloplasmin after copper injection.
liver copper storage before the start of the experiment. The progressive reduction of blood copper concentration of the control ewes indicates that this condition was met. However no animal before transfer to grass had a plasma copper concentration below 81 μg/100 ml. If the deficiency limit is about 70 μg/100 ml, none of the animals was deficient.

The plasma copper and ceruloplasmin concentrations fell in the control group and in 3 animals in particular were clearly indicative of a deficient status. This deficiency was induced by the young and copper deficient Rye Grass (below the usual deficiency limit of 7 mg Cu/kg D.M.) and was probably aggravated by a poor availability of the plant copper.

On the contrary, injected animals were not deficient and on the 67th day still had higher liver copper than the controls and than the deficiency limit.

It may be concluded that the copper oxide injection was efficient for two and a half months to protect animals against a copper deficient diet. This period of protection is a minimum, since the animals did not receive any mineral supplement during winter and had thus a moderate or low liver copper status before the experiment began.

With copper glycinate or copper EDTA complex, several authors (reviewed by Underwood, 1971) consider 30 to 40 mg of copper injected every 3 months sufficient to prevent copper deficiency in sheep or, in the same conditions, 120 to 240 mg of copper are appropriate for cattle.

The injected quantity of copper (50 mg/ewe) is a maximum and should not exceed this limit. The liver copper level of 1 060 μg Cu/g D.M. found in one ewe is very near the toxic limit usually adopted for this element. However no hemolytic icterus appeared in any animal. 40 to 50 mg of copper per ewe seems probably an optimum in adult sheep.

Accepted for publication, April 7th 1978.

Summary
21 ewes weighing about 46 kg were transferred to grass on a copper deficient Rye Grass pasture. 11 ewes were injected intramuscularly with 60 mg of copper as copper oxide (CuO) suspended in 5 ml of purified olive oil. The concentration of copper in the plasma of control ewes declined during the 67 days of experiment and three became copper deficient. The injected ewes were protected against deficiency and had higher concentration of copper in plasma than the controls throughout the experiment. At slaughter the amount of copper in the liver of the treated animals was significantly higher than in the untreated controls. The copper dose used (60 mg) is probably a maximum for adult sheep since one of the injected ewes at slaughter had a liver copper content of 1 060 μg/g D.M. which approaches the toxic limit.

References


