

Animal Nutrition

Copper is an indispensable constituent of all living tissues. It is one of the many elements, found in the cells of plants and animals, which in trace amounts are essential for their normal growth and well being. In animals it plays a part in the utilisation of iron for haemoglobin formation.

An insufficiency of copper in an animal's tissues can occur in two ways. It can be a simple straightforward copper deficiency, brought about by an actual deficiency of the element in the fodder, or it can be of the complex type, in which the diet contains the normal amount of copper but some other factor or factors obstruct in some way its assimilation by the animal. A good example of this is molybdenum, an excess of which depletes the animal's copper reserves and the animal develops copper deficiency symptoms unless given additional copper.

Symptoms of copper deficiency in animals

An inadequate amount of copper in an animal's diet manifests itself in a number of ways. These include a general unthriftiness, retarded growth, loss of appetite, anaemia and diarrhoea. The animal has an unhealthy unkempt appearance. With sheep the wool may grow straight and straggly. With cattle the coat is rough, harsh and lacking in lustre; the colour of the hair tends to fade - in black breeds it assumes a rusty red appearance and there is greying around the face and eyes, while red breeds have a dirty yellowish appearance; there is some shedding of hair particularly around the eyes; milk yields drop.

A lack of copper has an adverse effect on the functioning of the ovaries and much evidence has accumulated which points to the necessity of an adequate intake of copper if a high level of fertility is to be achieved in a dairy herd.

A number of diseases are associated with a deficiency of copper either alone or in combination with some other element, such as a deficiency of cobalt or an excess of molybdenum. One of the early discoveries of copper deficiency in livestock was observed in Holland in 1933, when it was found that administering copper sulphate to cattle grazing on copper deficient reclaimed land prevented a disease known as 'lecksucht' (licking disease). Similar disorders have been observed in copper deficient pastures in the U.S.A., Australia, New Zealand and Great Britain, and known variously as 'salt sickness', 'falling disease', 'coast disease', etc.

Among sheep, 'swayback' in lambs in Britain and a similar affliction in Australia and New Zealand known as 'enzootic ataxia' are the result of an insufficiency of copper in the ewes' diet.

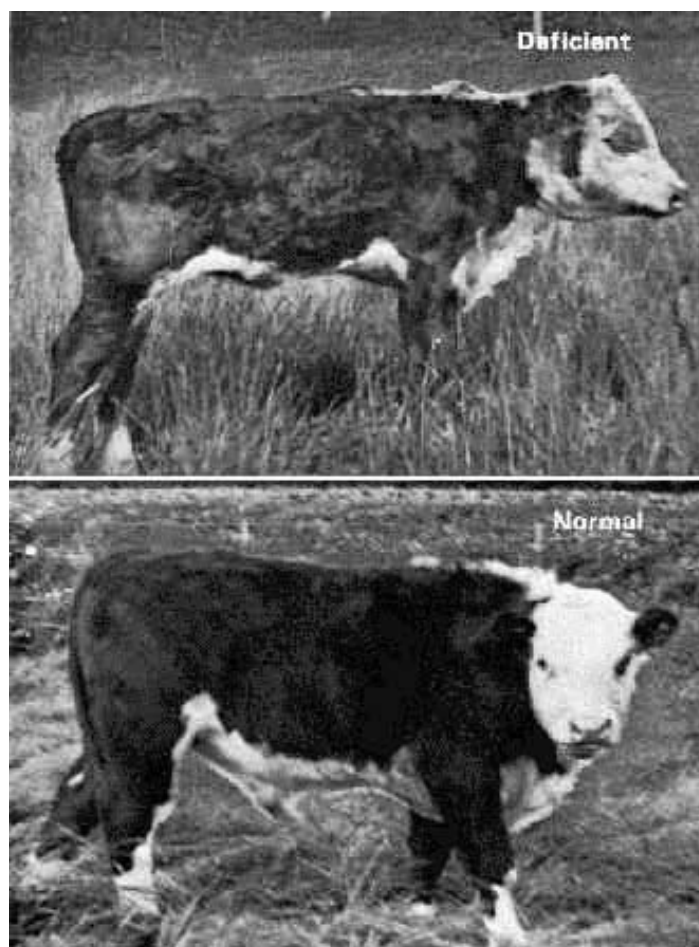
Preventative diagnosis

The liver acts as a storehouse for copper. When diets are deficient in copper, the copper stored in the liver is used until the liver reserves are exhausted to the extent that the liver can no longer provide the blood with all the copper it needs to keep the animal functioning properly, and copper deficiency symptoms appear. These symptoms usually begin to appear when liver copper drops below 20 parts per million (ppm). Copper deficiency can thus be diagnosed by estimating the copper content of either the blood or the liver. It is now a comparatively simple matter for a veterinary surgeon to take portions of the liver from living animals without causing them undue distress. The advantage of the liver analysis method of diagnosis is that copper deficiency can be detected long before any change in the blood takes place.

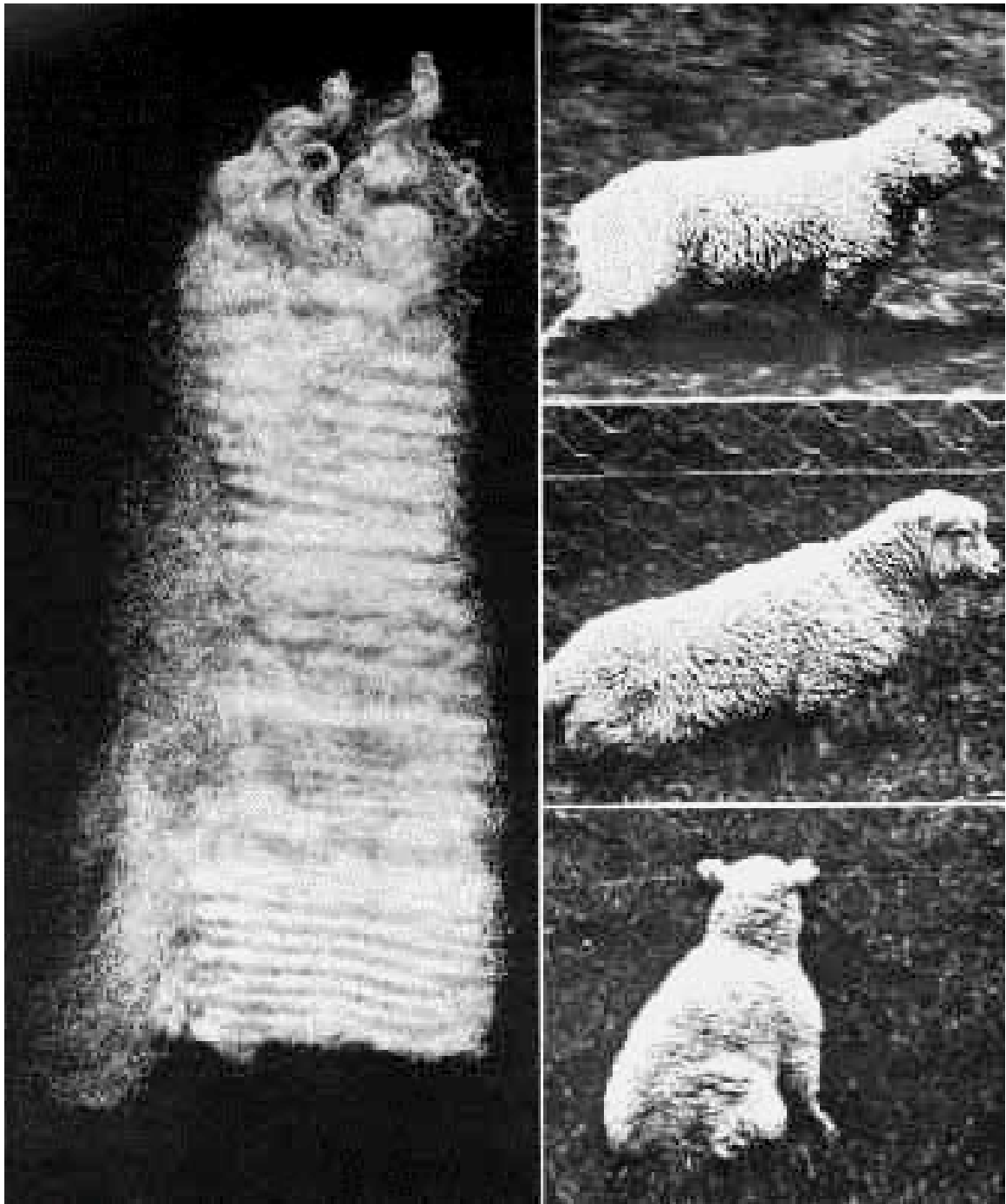
Correcting copper deficiency

Among the methods of correcting a copper deficiency in livestock is firstly to rectify a soil deficiency by spraying or spreading copper sulphate or other copper compounds. In copper deficiency trials in England calves, from a pasture sprayed during the summer with 5 kilograms of copper sulphate in 1000 litres of water per hectare, had an average weight of 573 kilograms at 30 months compared with an average of only 433 kilograms by the group of calves on the untreated copper deficient pasture. In Australia and New Zealand 'swayback' in lambs is being prevented by top dressing copper deficient pastures, with 5 to 10 kilograms of copper sulphate per hectare, some time before lambing begins.

Other methods include treatment of the animal by injecting with an organic copper salt, drenching periodically with copper sulphate; incorporating copper sulphate in salt and other mineral licks, or by what is probably the most general and satisfactory method, incorporating copper sulphate along with other minerals and vitamins in the form of carefully blended supplements in the feeding stuffs. Today concentrates fed to a large percentage of livestock, particularly in the more progressive countries of the world, contain some added copper as an insurance against an insufficiency of the element in animals' diets.



A comparison of calves of similar age, showing the effect of copper deficiency



Copper deficiency in sheep

*Left: Straight 'steely' wool from a copper deficient sheep
Right: Swayback (enzootic ataxia) in a copper deficient lamb*

Copper as a growth stimulant for pigs

An observation in the 1940s by Dr R Braude of Reading University that pigs in a newly erected piggery were licking certain copper fittings, led to the important discovery that copper had growth promoting properties. Braude frequently saw the pigs fighting for access to the copper rings which had been fitted in place of steel to prevent rusting. After a year no rings were left - they had simply been licked away. To prove that the pigs actually craved for copper, small plates of six different metals (aluminium, brass, copper, magnesium, nickel and tin) all painted alike, were next placed in the pens.

The pigs soon uncovered first the copper and then the brass (copper-zinc alloy) plates, leaving the others untouched.

Braude next replaced the metal plates with six mineral salt licks, to which he respectively added copper, cobalt, manganese, nickel, tin, and zinc as fine powder, but again the pigs were only interested in the lick containing copper. Pigs were next given the choice of two identical diets except that one contained added copper sulphate. Here, yet again, the pigs preferred the meal which contained the copper supplement and consumed about four times as much of it as of the 'no-copper' meal.



Pigs thrive on a copper-fortified diet - In a test involving six different metals, pigs quickly uncovered copper, followed by brass and systematically ignored the other metals

Ever since Braude's discovery that pigs craved for copper, scientists all over the globe have been experimenting with the feeding of copper sulphate to growing pigs. Carefully controlled trials in a number of countries over the past two decades have now firmly established that the inclusion of 250 ppm copper, i.e. 0.1% or 1000 ppm copper sulphate (copper sulphate contains 25.0% copper), in the diet of fattening pigs may be expected to produce, on average, an increased growth rate of around 100% with an improvement in feed conversion of nearly 8.0%. Looked at another way 1 kilogram of copper sulphate put into one metric ton of meal can result in pigs reaching bacon weight nearly two weeks earlier, with a saving of approximately 25 kilograms of meal. This means that for the expenditure of from £0.05 to £0.10 for 300 grams of copper sulphate, it is possible to save up to £0.75 on the feeding cost of a bacon pig. Today many, many

millions of pigs all over the world are being fed from weaning to slaughter on copper sulphate fortified diets.

How does copper sulphate promote growth?

Although several hypotheses have been advanced, the precise manner in which copper stimulates growth in pigs has not yet fully been established. It is of course known that copper has a role in haemoglobin formation and is essential for the proper functioning of certain enzymes but the copper requirements for these purposes are thought not to be much in excess of 10 ppm copper in the diet.

One explanation, for the growth promoting effects of feeding high levels of copper to pigs, is that it is due to the anthelmintic properties of copper and it has been suggested that growth is stimulated simply by the copper sulphate, which has long been known as a most efficient vermifuge, controlling the round worms.

Another explanation is that the response to copper is due to the action of copper sulphate on the micro-flora in the digestive tract in a manner similar to antibiotics.

Yet another explanation is that the copper sulphate reacts with the toxic hydrogen sulphide produced in the intestines by certain micro-organisms, thereby promoting growth by removing the poison as insoluble copper sulphide.

Whether the real explanation is a combination of all the above prognoses or whether there is a totally different mode of action, the fact remains that the feeding of high levels of copper sulphate stimulates appetite and results in faster growth and better feed conversion.

Copper sulphate v antibiotics

In recent years many trials have been conducted to compare the separate effects of copper and antibiotics as growth promoters for pigs. The results, in the large majority of trials, have shown copper sulphate to give by far the better response. This coupled with the fact that the cost of copper supplementation is only a fraction of that of antibiotics, has made copper sulphate the more favoured choice as growth promoter. Consideration must also be given to the possible long term effects, on health, of feeding antibiotics.

Feed levels for pigs

Copper sulphate has over the years shown, by its consistent effect on growth rate gain and feed conversion, that it is a most reliable growth promoter for pigs when fed at the rate of around 1 kilogram per 1000 kilograms of meal.

Several levels of copper sulphate feeding have been tried, the concentrations varying from 125 ppm copper to 500 ppm copper and higher. At the 125 ppm copper level the response obtained has generally only been about half that obtained at the 250 ppm copper level. At the 375 ppm level the response has, on the whole, been a little lower than at the 250 ppm copper level, which is now universally accepted as the best concentration to employ having regard to safety and other factors. Hundreds of trials have been done with copper sulphate at the 250 ppm copper level over the past 20 years and many millions of pigs have been fed with it since, with considerable economic benefit to the farmer.

Safety precautions

Only when the pig's diet is very low in iron and zinc and very high in calcium, is there any danger of copper toxicity developing. A high level of calcium in the basal diet will induce zinc deficiency, which in turn, along with a deficiency of iron, favours the development of copper toxicity. Where this occurs, correcting these factors will greatly extend the safety of copper supplementation. Experiments at the Rowett Research Institute, Aberdeen, have shown that, while in the absence of iron and zinc supplements 425 ppm copper produced copper toxicity symptoms, the simultaneous addition of iron and zinc eliminated all signs of toxicity.

Under normal conditions, toxic symptoms generally only begin manifesting themselves at levels of around 500 ppm copper. There is thus a fairly wide margin for errors, to meet most mixing conditions. Further, copper sulphate has a bitter taste and pigs will tend to refuse a meal containing a toxic dose. Copper sulphate has thus a sort of automatic safety device against gross overdosing through errors in mixing.

Whereas fattening pigs thrive on as much as 250 ppm copper in their diet, other animals, if fed on such high levels of copper for any length of time, may conceivably be poisoned. Care must therefore be taken to ensure that other livestock, especially sheep, do not have access to such a high copper containing diet. Care must also be taken to ensure that the copper sulphate is adequately mixed with the feed, so that each animal receives the intended proportion of copper sulphate in its diet.