Liver copper concentrations in culled cattle in the UK: are cattle being copper loaded?

N. R. Kendall, H. R. Holmes-Pavord, P. A. Bone, E. L. Ander, S. D. Young

Context
With the release of the DEFRA and Advisory Committee on Animal Feedingstuffs' (ACAF) ‘Guidance Note for Supplementation Copper to Bovines’ it was noted that the current copper status of the national herd was unknown. Copper toxicity is a clinical condition that releases copper from the liver, usually resulting in the death of the animal, whereas copper loading is the accumulation of copper within the liver without any signs of clinical toxicity.

Main conclusion
More than 50 per cent of the liver samples tested had greater than normal concentrations of copper, with almost 40 per cent of the female dairy cattle having liver copper concentrations above the Animal Health and Veterinary Laboratories Agency (AHVLA) reference range of 8000 µmol/kg dry matter (DM), indicating that a significant proportion of the UK herd is at risk of chronic copper toxicity.

Approach
Liver samples were recovered from 510 culled cattle at a single abattoir across a period of three days. The samples were wet-ashed and liver copper concentrations determined by inductively coupled plasma mass spectrometry. Breed, age and previous location information were obtained from the British Cattle Movement Service and parish areas were compared to geological copper obtained from the British Geological Survey.

Results
The dairy breeds had higher liver copper concentrations than beef breeds, with 38.4 per cent above the AHVLA reference range, compared to only 17.6 per cent of the combined beef breeds and bulls (Table 1). If the slightly lower laboratory normal range of 1405 to 5618 µmol/kg DM was applied, then 57.8 per cent of dairy cows and 26.4 per cent of bulls and beef cows were above this range. A much greater proportion of the beef cows and bulls were below the normal range (51.6 per cent) compared with dairy cows (8.6 per cent). Age had little effect except that the liver copper concentrations of the youngest cows appeared to differ from the rest of the cattle; higher for beef breeds and lower for dairy breeds. It was found that underlying topsoil copper concentration was not related to liver copper content.

Interpretation
The survey analysed a large number of samples (510); however, these were taken over a three-day period and although it is expected that there will not be any major seasonality effects this has not been proven. The long time required to reduce liver copper concentrations from toxic to normal levels (often greater than one year) adds evidence to the lack of major seasonal effects with steady accumulation rather than short-term peaks and troughs likely. Care should be taken interpreting the results for the effect of age due to low numbers of animals for each age category, particularly for the beef cows and bulls. The geological comparisons were based on the parish of the final holding. This raises two issues: how long the animal was on that holding before slaughter, and that local variations in geological status within a parish are not fully accounted for.

Significance of findings
Although a high liver copper concentration increases the risk of copper toxicity it does not actually cause the clinical signs. There is often a trigger event or condition that precipitates the clinical copper toxicity case. This study suggests that over 50 per cent of dairy cattle are at risk of this, with higher liver copper concentrations likely to increase the risk further. The lack of any relationship to the geology is to be expected, especially in dairy cattle as the majority are fed at least some purchased feeds, their diets are usually mineral supplemented and additional direct-to-animal supplements are often also administered.

The numbers of cattle at risk support the suggested approaches of the DEFRA/ACAF’s ‘Guidance Note for Supplementation Copper to Bovines’ and many farms need to revisit their copper supplementation protocols. Actual supplementary need should be determined given background copper concentrations from dietary inputs and animal status, and consideration given to the forms and amounts of copper being fed. There is also a need for the dietary interaction of copper with molybdenum, sulphur and iron to be better understood and not used as a reason for inappropriate copper supplementation.

TABLE 1: Numerical distribution (per cent) of liver copper concentration categorised by laboratory normal range and AHVLA toxicity reference for dairy cows and for bulls and beef cows

<table>
<thead>
<tr>
<th>Category</th>
<th>Dairy cows</th>
<th>Bulls and beef cows</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below normal (&lt; 1405 µmol/kg DM)</td>
<td>36 (8.6 per cent)</td>
<td>47 (51.6 per cent)</td>
<td>83</td>
</tr>
<tr>
<td>Normal (1406-5618 µmol/kg DM)</td>
<td>141 (33.7 per cent)</td>
<td>20 (22.0 per cent)</td>
<td>161</td>
</tr>
<tr>
<td>(5619-8000 µmol/kg DM)</td>
<td>81 (19.3 per cent)</td>
<td>8 (8.8 per cent)</td>
<td>89</td>
</tr>
<tr>
<td>Above AHVLA reference (&gt;8000 µmol/kg DM)</td>
<td>16 (38.4 per cent)</td>
<td>16 (17.6 per cent)</td>
<td>177</td>
</tr>
<tr>
<td>Total</td>
<td>419</td>
<td>91</td>
<td>510</td>
</tr>
</tbody>
</table>

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