Stiftung Tierärztliche Hochschule Hannover
University of Veterinary Medicine Hannover, Foundation

A case of secondary copper deficiency in dairy cows

Residency Class

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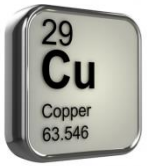
Preliminary report

In summer 2015, several cows on a dairy farm attracted owner‘s attention due to “brightening“ of the hair around the eyes.

Presumed diagnosis: Copper (Cu) deficiency?

Copper



http://www.medicalnewstoday.com

- Essential trace element and constituent of numerous enzymes (i.a. Cytochrom c Oxidase, Tyrosinase)
- Present in all tissues, especially in the brain, bone marrow and liver (main storage organ, Cu is released in periods of insufficient supply)
- Important role in haemoglobin synthesis and detoxification of peroxide radicals
- „Copper pumps“ in cell membranes are expected to prevent intracellular Cu accumulation

Reference:
KLEE and METZNER (2015);
MCDONALD et al. (2002);
NRC (2001)

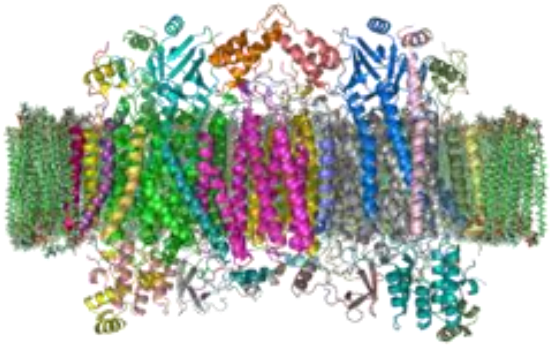


Abb.: Band model of a Cytochrom c Oxidase Dimer of cattle in the membran acc. to PDB 1OCC

Background

- Fulfilment of Cu requirement mainly by intraintestinal resorption rate (2 - 40 %)
- Resorption rate is reduced by so-called antagonists, e. g. Mo and S
  (further elements of interest: Se, Cd, Pb, Ca, Fe, Zn, Ag)
- Availability of Cu in a ration in real is not easy to determine
- Cu requirement of cattle varies between 8 - 16 mg/kg DM (in the diet)
  [calves and lambs: 1 mg/kg DM; adult sheep: 4 – 8 mg/kg DM]
- Blood level remains in the reference range (10 - 40 µmol/l), if the Cu content in liver exceeds 35 mg/kg DM

Reference:
KLEE and METZNER (2015)

Epidemiology of copper deficiency

- **Primary Cu deficiency:**

Dietary inadequacy, low dietary level of Cu

(inadequate Cu level of the soil and subsequently of the green fodder, often found in sandy soil areas, marshy areas and in heathland; LAIBLIN and STOEBER 2006)

- **Secondary Cu deficiency:**

Interactions with other elements (hindrance for Cu absorption; impaired absorption; LAIBLIN and STOEBER 2006; SUTTLE 2010; TELFER and JOHNSON 1992)

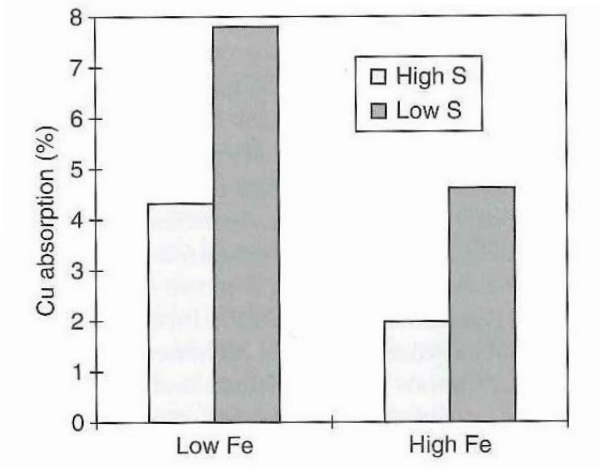


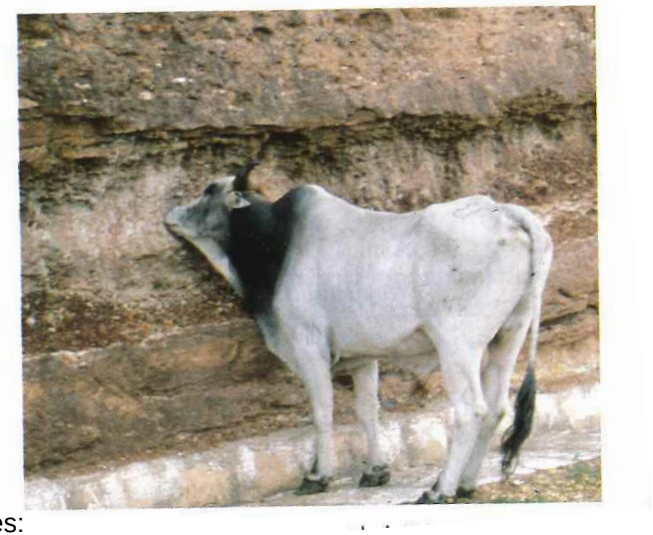
Fig.: The absorbability of Cu in diets for weaned ruminants, affected by interactions between Cu and Fe, partly dependant on S; Suttle (2010)

Clinical appearance of Cu deficiency

- Calves and lambs: disturbance of the prenatal and postnatal development of the white matter of brain and medulla (enzootic Ataxia or Swayback of lambs)

- Disturbed development in calves (black and white cows → reddish discoloration of the hair), disturbed enchondral ossification with lameness and increased risk for bone fractures, decrease of immunocompetence

- Adult ruminants:



depigmentation of the hair

(Achromotrichia due to decreased tyrosinase activity - Cu is a cofactor - important for eumelanin synthesis),

intensive licking,

hypochromic macrocytic anaemia,

diarrhoea,

fertility impaired,

drop in milk yield,

emaciation,

sudden death ("falling disease")

References:
KLEE and METZNER (2015); LAIBLIN and STOEBER (2006); POND et al. (2005); MCDONALD et al. (2002)

Further approach?

- **Questions regarding keeping and feeding management**
  → loose-housing barn
  → Partial-TMR (TMR = total mixed ration)
  (above all grass silage and corn silage, mineralized supplementary feed concentrate), dairy concentrate and mineral feed

  Appropriate amounts, no refusals

- **Chemical analyses of feed samples**
  → Grass silage
  → Partial-TMR

Chemical analyses of feed samples

Parameter	Grass silage	Partial TMR	Claim/Requirement
Cu (mg/kg DM)	11.5	22.7	Requirement: 8-16

Reference:
LAIBLIN and STOEBER (2006)

Chemical analyses of feed samples

Parameter	Grass silage	Partial TMR	Claim/Requirement
Cu (mg/kg DM)	11.5	22.7	Requirement: 8-16
Crude ash (g/kg DM)			
Mo (mg/kg DM)			
S (g/kg DM)			
Fe (mg/kg DM)			

Reference:
LAIBLIN and STOEBER (2006)

Chemical analyses of feed samples

Parameter	Grass silage	Partial TMR	Claim/Requirement
Cu (mg/kg DM)	11.5	22.7	Requirement: 8-16
Crude ash (g/kg DM)	127	105	
Mo (mg/kg DM)	1.29	1.79	$\frac{Cu}{Mo}$ = min. 2-3
S (g/kg DM)	3.94	2.98	max. 3
Fe (mg/kg DM)	1061	955	max. 350

Reference:
LAIBLIN and STOEBER (2006)

Conclusions/Recommendations

⇨ Secondary Cu deficiency because of high crude ash and Fe contents in the used grass silage.

1. Prevention of crude ash contents > 100 g/kg DM → harvesting technology!
   (Crude ash and Fe contents in grass silages in 2015, Germany:
   40-434 g crude ash/kg DM; 21-6988 mg Fe/kg DM; FRITZ 2016)

2. Prudent use of S containing fertilizers
   (S median in German grass clippings: 2.66 g/kg DM; DOHM 2015)

3. Molybdenum: no actions possible

4. Less grass silage, more corn silage

5. To confirm the suspicion:

- Liver of animals for slaughter
- Hair analytics?
- Further problems
  due to high Fe and S levels: Se!

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Thanks for your attention!