Analysis of trace elements in cattle

Trace elements are essential for life. As central parts of enzymes and hormones they are indispensable for development and stabilisation of bones, in the metabolism of muscles, skin, hooves as well as fertility and immunity. That is why analysis of the trace element supply is frequently asked for, but how is it done best?

The analysis is not straighforward. Indeed, all trace elements can be determined in serum samples. However, for some of them the interpretation of serum values is difficult, and other material may be more suitable. For others again it is advisable to determine a different substance as an indicator for a specific trace element.

Generally, serum values should be considered as a „snapshot" whereas other tissues, i.e. hair or liver tissue, reflect the supply of the animal over a longer period.

On that account an overview is provided over diagnostically important trace elements and the most appropriate ways of analysis:

Selenium:

*A sufficient selenium supply is indispensable, especially in view of **fertility** (frequence of mastitis, retentio secundinarum, development of calves etc.). Selenium deficiency in calves leads to **sucking weakness** and **White muscle disease**. Serum values are age dependent, with calves showing lower values than adult cows. In general, Germany is considered as an area with low selenium content in the soil. However, it is advisable to know about the local conditions and thus chose the right amount of selenium addition to the feed (too much selenium has toxic effects!).*

***Serum** is very suitable to assess the selenium supply of animals. If the results are marginal, an **analysis of cover hair** is possible as well. Pigmented hair should be cut fom the rump, preferably near to the skin. It is not necessary to pluck out the hair. Please note that sample collection should not take place in the time of change of haircoat (optimal is May to February). The reason is an accumulation of trace elements in the hair before shedding, thereby possibly masking a deficient supply. Liver and kidney are good indicators of selenium supply, however, tissue collection from a living animal is rather elaborate. Irrespective of the material the analysis is done by using atom absorption spectrophotometry (AAS). Selenium in the serum is hereby analysed directly.*

*Selenium supply can also be determined indirectly via **glutathion peroxidase** (GSH-Px or GPX) activity in the red blood cells. Caution, **EDTA- or heparin blood** is needed. GPX is a selenium-dependent enzyme, which together with vitamin E plays a major role in the antioxidative metabolism. The determination of its acitivity is done photometrically. GPX activity represents the selenium supply at the time of erythropoiesis. This should be considered if an analysis shall be done to monitor the effect of feed additives or selenium boli. Please note that GPX is not suitable to detect oversupplies or toxic supplies of selenium!*

Copper:

*As an enzyme cofactor, copper is involved in the **synthesis of haemoglobin, pigmentation/hair structure, bones** and **CNS development**. Furthermore it is essential für **fertility** and **immunity**. This explains the symptoms following a copper deficiency: embryonic death, abortion, prolonged cycles, anaemia, weight loss, enzootic ataxia, to mention a few. A distinctive symptom is the depigmentation of the haircoat around the eyes, which in the end resembles spectacles. Also an oversupply of copper is dangerous and causes liver damage accompanied by a haemolytic crisis. Nowadays, chronic copper intoxication is more common than acute intoxication, and it may remain undetected for a long time.*

*On the contrast to selenium, copper analysis should not only be done in **serum** samples. Even when the supply is marginal or too low, serum values may be in the normal range. For proof of oversupply or intoxication serum is not suitable at all. Indicator organs such as **liver, brain and cover hair** reflect the copper supply optimally, whereas collection of hair is the most practical method for routine examinations. If intoxication is suspected a liver sample should be sent for analysis. Low serum values should always be confirmed by analysis of cover hair.*

*Another possibility is the analysis of **ceruloplasmin**. In the literature, however, there are controverse opinions about this method.*

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Zinc:

*Zinc is part and activator of various enzymes responsible for **synthesis of nucleic acids, proteins** as well as enzymes of **carbon metabolism, fat metabolism and protein metabolism**. Thus it is involved in nearly all life processes. In case of zinc deficiency, tissue with a high rate of cell division (skin, immune system) or high performance (mammary gland) are particularly affected leading to reduced fertility, growth and immunosuppresion. Also, parakeratosis and hair loss are typical symptoms.*

*In **serum**, zinc is **controlled very well homeostatically**, which is why decreased values can only be found when there is a distinct zinc deficiency.*

*On the other hand, haemolysis may increase zinc values even when it is minimal and thus lead to falsely high serum values. Examination of **cover hair samples** by using AAS are a good alternative. A **rib serves as an indicator** organ.*

Cobalt:

*Cobalt is a **central part of vitamin B12**, cobalamin, which is produced by ruminal bacteria. Thus, cobalt influences feed conversion ratio, metabolic processes and hematopoiesis. Cobalt deficiency leads to symptoms of vitamin B12 deficiency: **reduced milk production, growth and fertility, rough haircoat, weight loss, anaemia**. Notably, except for the mentioned function cobalt has no other (so far) known function in higher organisms but is reabsorbed nonetheless. To determine cobalt deficiencies, **analysis of vitamin B12 in serum** is practicable. This is done by using chemiluminescent immunoassay (CLIA). The analysis of cobalt in **cover hair** by using AAS is a suitable alternative. Please note that cattle with an impaired liver function excrete less vitamin B12 followed by (falsely) increased serum values.*

Manganese:

*Same as for all the mentioned trace elements, manganese is essential for the **fertility** of the livestock. Furthermore it takes part in the synthesis of bone and cartilage, cholesterol and fat as well as erythropoiesis and development of immunity.*

*A manganese **deficiency** affects reproduction and leads to **infertility, irregular cycle of the cow, embryonic death, repeat breeding**. It is notable that **more male than female calves** are born due to manganese deficiency. Reason for an insufficient manganese supply is not only the absolute manganese content of feed but also the presence of **antagonists**. Primarily these are iron, calcium and phosphorus. High concentrations of the elements **inhibit manganese absorption**.*

***Hair and liver samples** are best for diagnostic purposes. Due to the only minimal concentrations, examination of serum samples is not advisable. It should at least be accompanied by an analysis of the haircoat.*

Overview:

trace element	***suitable material***	***range***	***antagonists***	***alternatives***
selenium	*serum/plasma* *cover hair*	*40 – 70 µg/l* *≥ 0,25 mg/kg TS*	*nitrate/nitrite, unsaturated fatty acids, ruminal acidosis*	*glutathion-peroxidase*
copper	*cover hair* *serum (deficiency only!)*	*> 6 mg/kg TS* *51-208 µg/dl*	*Mo, S, Cd, Zn, Ca, Phytate*	*liver*
manganese	*cover hair*	*> 6 mg/kg TS*	*Fe, Ca, P, Cu, Mo, Mg, Co*	*liver*
zinc	*cover hair* *serum (deficiency only!)*	*≥ 100 mg/kg TS* *70-130 µg/dl*	*Ca, Fe, Cd, Cu, P, S, Phytin*	*rip*
cobalt	*cover hair*	*> 0,12 mg/kg*	*Mn, K, Fe*	*vitamin B 12 (Cobalamin)*

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