Fur Metal Analysis- Mirror of Animal Health

by

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What can fur tell?

For any animal, a silky coat is not just a sign of beauty. The condition of the animal's fur is also a reflection of its health, just as hair is in humans. Hair or Fur reflects certain health problems.

- A dull or shaggy fur can indicate a chronic disease, for example of the liver or kidneys.
- Round, bald spots in the fur on an animal's body or just in individual areas are typical of fungal infestation or an excessive metal exposure
- Unusually long, curly fur or poor shedding can be signs of a hormonal disorder such as Equine Cushing Syndrome (ECS), which primarily occurs in older horses.
- Sticky or matted fur with thick crusts and scales, especially in the fetlock, can be signs of a bacterial infection such as Mauke syndrome. Nutrient deficiencies are usually involved.
- Severe fur loss or thickening of the skin, together with poor wound healing and an increased risk of infection can indicate a zinc deficiency.
- Muscle cramps and nervousness in conjunction with increased exposure to stress are often signs of a magnesium deficiency, especially in horses
- A horses tail or mane that is too thin in combination with an increased susceptibility to infection, reduced willingness to perform, lameness, itching, and brittle hooves can be signs of a selenium deficiency.

Fur, an animal's protective shield

Fur is the first barrier against chemical and mechanical injuries and protects against germs, wetness and cold. Long hair on animal's tail is used to protect horses, cows and other animals from insects.

Like humans, animals have different types of hair, namely

- Upper or top hair as part of the fur
- Longhair as in a horse's mane, tail and hair
- Whiskers above the eyes and around the mouth
- Undercoat or wool hair as part of the coat

The animal's fur consists of hair follicles, hair shafts, which are the visible part of the hair and fur roots. As with human hair, the outer layer, the so-called cuticle, consists of several layers of keratinized cells that are arranged around the hair shaft like the scales of a pine cone. If the cuticle layer is smooth, the hair shines. A rough or even damaged cuticle makes the fur appear dull and dull.

Fell growth and Change of Fur

Many factors influence fur growth in animals. As with humans, hair or fur growth is about 1cm per month. In horses, the top coat is constantly being renewed, but never to the same extent as during coat changes in spring and autumn.

In animals such as in horses, daylight actually signals the start of the coat change. This happens twice a year: In spring the thick winter fur falls out, and in its place comes the shorter and lighter summer fur. In autumn, the animal switches from its fine summer coat to its plush winter coat so that it is protected from the cold and wet.

When changing coats, the provision of sufficient nutrients is needed, not only for the growth of new hair but also for daily energy needs.

Fur reflects living conditions

The animal's coat adapts to life in the respective region it lives in, and thus reflects not only the climatic but also geological conditions. Grazing animals that eat nutrient-rich grass are better supplied with nutrients than those that live in barren conditions. If the nutritional content of the feed is not balanced, the fur and health of the animal is affected. Some nutrient elements are more needed than others.

Selenium and animal health

Selenium is an essential microelement in animal nutrition and exerts multiple actions related to animal fertility, production and disease prevention. Selenium plays a key role in the immune response or function, including the iodine metabolism.

The trace element Selenium is geologically present in soil and works its way into food and water. How much selenium is found in food and water depends greatly on the location and the soil condition. In many areas, selenium levels are low, due to geology, or depleted due to improper farming practices.

Selenium requirement for Cats and Dogs

Dogs only need a very small amount, but this microelement is still essential for the function of their metabolism, thyroid, synthesis of DNA, and for reproduction. It does play a key role in the development of cancer.

The Association of American Feed Control Officials (AAFCO) recommends a minimum of 0.35 mg of selenium per kg of a dog's body weight. The maximum limit is set to 2 mg per kg. At this time, the recommended intake is the same regardless of the dog's breed and age. For cat food, the AAFCO 2014 recommends a minimum of 0.3mg of selenium per kilogram on dry matter basis or 0.075mg per 1000 kcal ME for growth, reproduction, and adult maintenance.

Grazing animals may be at a greater risk to deficiency.

Selenium and White Muscle Disease (WMD)

White Muscle Disease (WMD) is caused by a deficiency of either of two important nutritional anti-oxidants: Vitamin E and Selenium, and in selenium-deficient areas, the disease is more common. In the Pacific Northwest soils are generally low in Selenium, as are feed that is grown there.

According to Washington University researchers, WMD is a serious but preventable disease of young livestock, including horses, causing poor performance and, if not treated, death. Young, growing animals are rapidly creating muscle mass, and therefore selenium deficiency shows itself most commonly as muscle cell degeneration. Symptoms include stiffness, lameness, and diarrhea. Adult animals are less affected. However, chronic mastitis, chronic pneumonia, infertility and miscarriages are common. If the heart muscle is involved, an affected animal may die very suddenly during exercise.[1]

The reason is that exercise causes increased oxygen delivery to the tissues. This involves oxidation of energy substrate resulting in an increase of reactive oxygen byproducts, the peroxides. Therefore, athletic horses have an increased need for antioxidants including selenium.[2]

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[1] Selenium: Essential for Livestock Health | Animal Agriculture | Washington State University (wsu.edu)

[2] Selenium Function in Horses - Kentucky Equine Research (ker.com)

Selenium requirement for horses

This essential trace element is important for enzyme functions. In horses, the need depends on the physical demand, age and health of the horse. Interestingly, horses react more sensitively to an increased supply of selenium than ruminants or pigs. In the USA and Canada, for example, acute selenium poisoning has occurred in animals fed high selenium fodder.

In horses, chronic exposure occurs when more than 2 mg of selenium per kilogram of dry matter is fed daily over a prolonged period of time. An oversupply of selenium can cause symptoms such as ring-shaped constrictions on the hooves, lameness and emaciation. If poisoning is suspected, immediate action should be taken.

In Europe, selenium poisoning usually runs subacute to chronic with latency periods of 20 days or longer. Subacute poisoning ("blind stagger") is associated with ataxia and visual impairment, and manifests itself with sudden collapse and death after heart failure. Subacute poisoning or chronic overexposure can be the result of extremely high selenium supplementation.

Iron and manganese

The drinking water supply plays an important role for all animals. Too high a content of iron and manganese in drinking water promotes the development of bacteria in water and can be responsible for the development of bacterial diseases in animals. Increased bacterial development can occur in the groundwater of soils containing iron ore. Similarly, manganese-containing pesticides and fertilizers can seep into the soil with rainwater and thus reach the groundwater.

Manganese particles also enter the air through the combustion of fossil materials (petroleum, coal) and gradually settle in bodies of water. Manganese can therefore be found in surface water, groundwater and wastewater. Interestingly, so-called manganese-bacteria are used in wastewater treatment to biochemically eliminate manganese and iron salts. It therefore makes sense for well owners to check the manganese and iron content of the water. The limit value for iron in drinking water is 0.2 mg/l and that for manganese is 0.05 mg/l.

Blood Metal Analysis

Serum and whole blood values reflect the current nutrient supply. For example, an increased selenium blood value indicates a currently increased intake. If a low value is recorded, the main cause is considered to be an insufficient daily dietary intake.

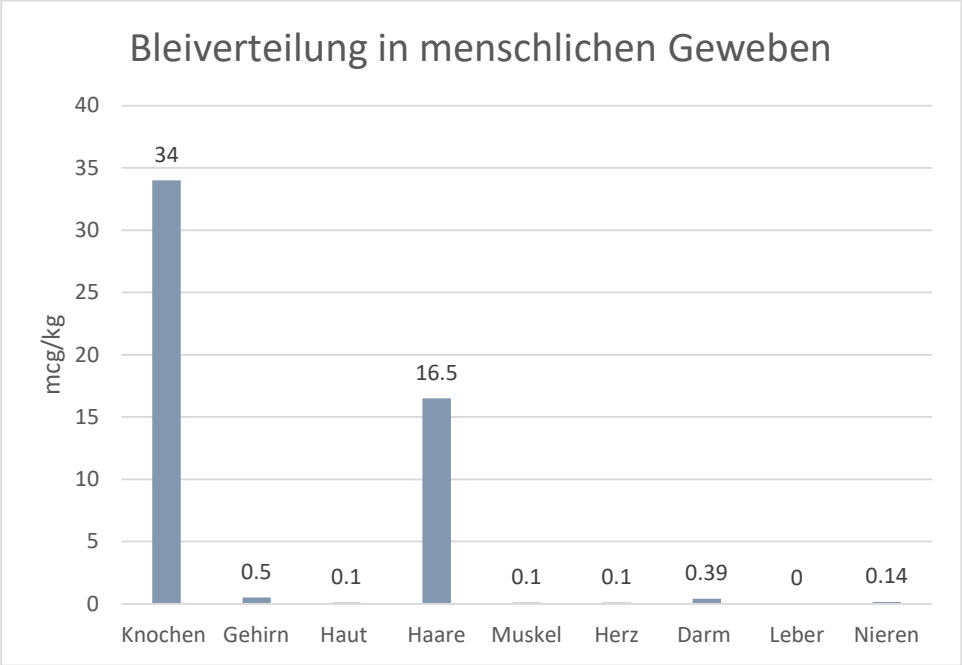
Every form of blood provides evidence of a momentary oversupply or undersupply. Excessive exposure to toxic metals, if it becomes chronic, can lead to so-called exertional myopathy (MIM), also known as muscle integrity myopathy. Environmental factors influence the development of this disease and damage the function and/or structure of the muscles. Typical symptoms include lameness, reluctance to move, behavioural changes, muscle loss and difficulty building muscle.

Diagnosing chronic overexposure

The metal test in the blood corresponds to a snapshot. It does not provide evidence of long-term exposure. This is done using fur mineral analysis, because hair, fur or hooves are tissues that store metals. The fur examination reflects the concentration or amount of minerals and trace elements stored in the respective tissues.

"The damage to individual organs depends on the different concentration of each metal in the various organs," writes Prof. L. Thomas in his textbook *Labor und Diagnose* (Med. Verlagsgesellschaft Marburg 1992). The following graph illustrates the physiological distribution of lead in human tissue (see Figure 1).

Figure 1: Lead distribution in human tissue



Source: Thomas L. Labor und Diagnose. Med.Verlagsgesellschaft Marburg 1992.

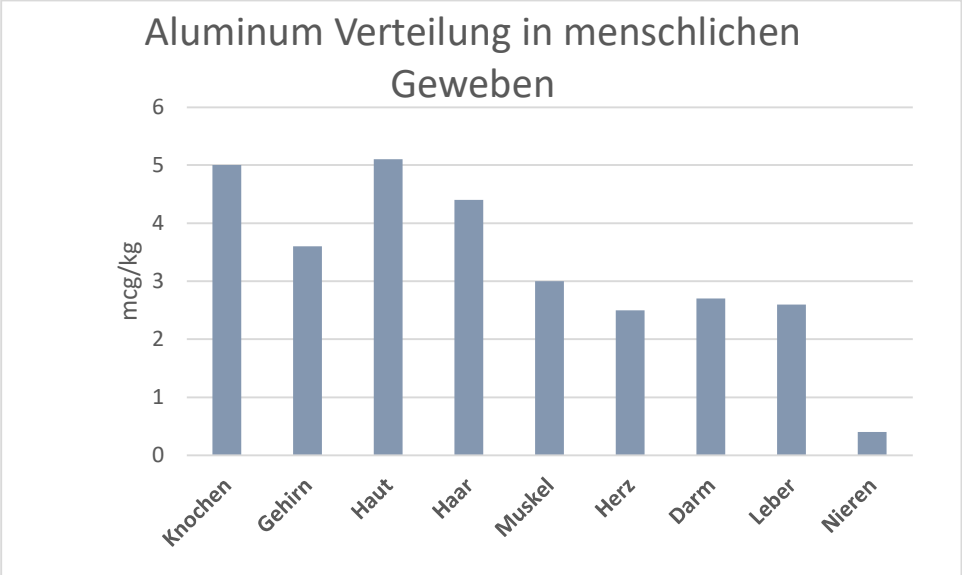
The graphical representation in Figure 1 shows the distribution of lead in human tissue, however research indicates that metal distribution in other mammals follows a similar. Lead, like calcium (Ca) and phosphorus (P), is preferentially stored in bones. The lead storage in hair tissue is much more similar to bone tissue than to other organ tissues, as is also indicated in Figure 1

According to information provided by Oregan State University approximately 99% of the Ca and 80% of the P in the animal body occur in bones and teeth. The other 1% of Ca is distributed in cellular fluids, where they are involved in different metabolic and physiologic activities such as blood coagulation, nerve impulse and cell permeability maintenance, activation of certain enzymes, muscle contraction, or serving as activators of ion channels.[3]

Certainly, not all metals are equally stored in organ tissues. Figure 2, for instance, shows that aluminum is distributed much more evenly in tissues. However, from this data can be seen that hair is a preferred storage tissue.

[3] https://open.oregonstate.education/animalnutrition

Figure 2: Aluminium distribution in human tissue



Source: Thomas L. Labor und Diagnose. Med.Verlagsgesellschaft Marburg 1992.

Fur analysis and its advantages

Aside from providing information regarding long term or chronic metal exposure, the easy access to the testing material is an advantage that should not be underestimated. Non-invasive sampling is problem-free for animals and pet owners. About half a gram of fur is required. This corresponds to about 1-2 heaped tablespoons. See Picture 1

Picture 1: Probeentnahme beim Pferd

Manes or tail hair are less suitable. Unless sampling occurs close to the skin, test results of long strands of hair would resemble a very long period of past time exposure. In most cases, this would not provide diagnostic information of interest to therapeutic treatment.

Sampled material taken can be placed in a paper envelope. The fur or hair sample does not need to be washed before shipping. This is done in the laboratory with the use of metal-free solutions.

How is testing done?

In the laboratory, the sample is washed several times with deionized, i.e. metal-free solutions. Thereafter, the sample is dried in a special oven, then weighed and dissolved in metal-free acid. The resulting solution is diluted with deionized water and analysed using ICP-MS spectrometry.

The ICP-MS Analysis

The strengths of ICP-MS include its ability to analyse almost all elements in the periodic table at concentrations in the low ng/L range. Relatively low sample volumes are generally sufficient to produce required results.

The high detection capability of the multi-element method has led to the success of ICP mass spectrometry in many element analysis applications over the last decade. Especially for trace and ultra-trace analysis, there are only a few, and usually no, alternatives to ICP-MS. In addition to macro elements such as calcium and magnesium, a large number of nutrient elements such as manganese, selenium, iron, zinc, copper, and iodine are reliably recorded in even the smallest amounts. The analysis of potentially toxic elements such as lead or uranium provide information about the long-term exposure of animals through geological sources.

From 1953 until 1980, the United States was the world's leading producer of uranium and until the early 1980s, there were active uranium mines in Arizona, Colorado, New Mexico, Oregon, South Dakota, Texas, Utah, Washington and Wyoming. In German regions such as the Black Forest, the Erzgebirge or eastern Thuringia, uranium is found geologically and can therefore be located in soil and water, possibly affecting animal health. Large lead deposits are found in many countries, including Australia, China, Peru, Siberia and the Urals. Lead mining is active in Alaska and Missouri. In Europe, lead deposits are found in Spain, Sweden and Italy.

Rare earth elements such as lanthanum, which have previously received little attention, are part of this ultra-trace analysis of hair and fur. Although lanthanum is classified as low-toxic, it has the ability to bind phosphorus. Phosphorus is important for energy and muscle functions of animals, including those of the horse.

What is tested?

In summary, fur mineral analysis is a reliable test that provides early information about long-term exposure or nutrient deficiencies - ideally long before acute health problems occur.

Depending on the requirements, over 50 elements can be analysed. Test results are compared to reference values and evaluated accordingly. This assessment allows the therapist to restore the horse's biochemical balance by changing its feed or providing appropriate supplements. Stresses or abnormalities that result from feeding can be identified and corrected. A deficiency of certain minerals or trace elements can also be avoided.

The author who founded the laboratory Trace Minerals International in Boulder, Colorado and Micro Trace Minerals in Germany, also established standard values for animals in collaboration with veterinarians in 1984. Since then, she has been carrying out hair/fur examinations on horses, cows and pets such as dogs and cats, and has tested the toxic exposure of some zoo animals. She is considered an expert in the field of mineral analysis, has taught at institutes and universities around the world, written many articles and books on the subject and continues to lead research. She can be reached via www.microtrace.de