# Improving stress related challenges with mineral supplementation

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Nowadays the demands on animal performance in agriculture are very high.

Intensive production systems cause a lot of stress for the animals which is expressed in fights, tail-biting, cannibalism, high mortality rates during transport and sudden death syndromes, as well as in lower meat quality. In addition to the management factors that are important to minimise stress, the supplementation of minerals (especially magnesium) and trace elements plays a major role in alleviating the symptoms of stress.

Apart from potassium, magnesium is one of the most important mineral components of the cell. About 0.04% of the body mass consists of magnesium. In animal organisms, around 60% of magnesium is stored in the bones, 40% migrates into soft tissue and around 1% is found in bodily fluids.

Magnesium stored in the bones is not completely bioavailable and the content decreases with increasing age. Magnesium is not only a structural component of the skeletal system, it also acts as an enzyme activator in more than 300 enzymatic reactions. Magnesium catalyses, for example, reactions which take part in the ion transport in the nerve cell and in the maintenance of neuromuscular excitation as well as ATP-generating reactions.

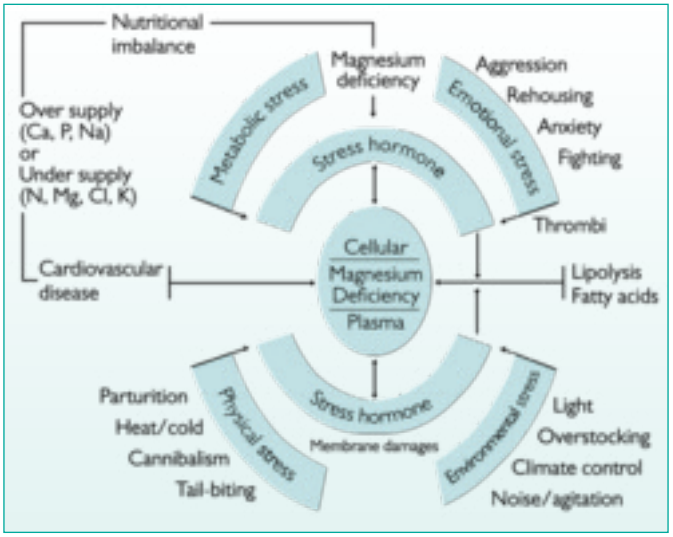


***Fig. 1. Stress and magnesium (modified from Seelig, 1997).***

Therefore ATP metabolism, muscle contraction and relaxation, normal neurological function and release of neurotransmitters are all magnesium dependent.

In modern livestock farming, animals are not suffering from a magnesium deficiency. But physical and emotional stress, like overstocking, rehousing or transport, can lead to a temporary increased demand of magnesium and can provoke a magnesium imbalance.

In stressful conditions, the animal's body releases the stress hormones catecholamines and corticosteroids that lead to an increased utilisation of substrates for energy production and for improved skeletal and cardiac muscle performance (Fig. 1).

Therefore, the risk of heart necrosis, cardio-myopathy or heart attacks increases rapidly in case the magnesium supply from the diet is insufficient during stress situations.

In monogastric animals resorption of magnesium takes place mostly in the small intestine in polygastric animals in the rumen. Sufficient supplementation is not only dependent on the analytical content of the ration but also on the availability in the organism.

The amount of magnesium in the organism is regulated by intestinal absorption, excretion through the kidney, excretion in faeces and dietary supply. Sources of magnesium supplementation in animal nutrition are of inorganic or organic origin. The organic forms in general show a better availability than inorganic forms. In practice inorganic magnesium oxide is the most commonly used source of magnesium.

The oxides can vary considerably depending on the origin, processing method (for example the temperature of calcinations) and particle sizes. Different publications state a relative availability of magnesium from magnesium oxide of 75% on average. Due to the extreme variability in origin, composition and availability of magnesium oxide sources, their use should be considered cautiously.

Furthermore, magnesium oxide has a decisive disadvantage for the application in monogastric animals in comparison to organic magnesium sources. It is a strong acid buffer. A common organic source of magnesium in the market is magnesium

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***Fig. 2. Magnesium content in skeletal muscles and heart muscle of pigs, % in DM (Günther and Mohme, 1985).***

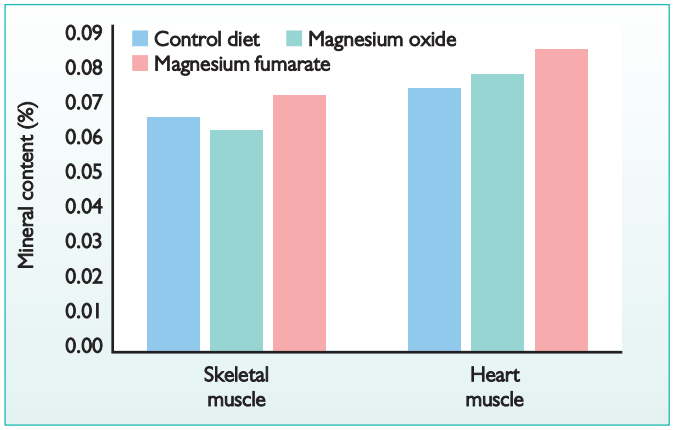
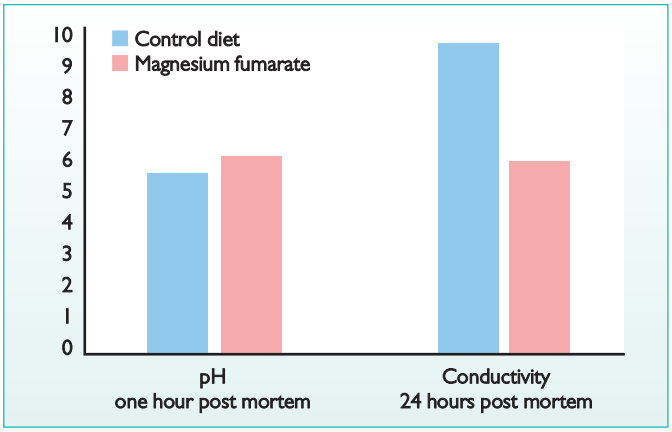



***Fig. 3. Effect of magnesium fumarate supplementation on meat quality criteria (Otten et al., 1995).***



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acetate. The relative bioavailability of magnesium from magnesium acetate is around 105-110% in comparison to magnesium oxide. Nevertheless, nutritionists are not always satisfied with the product due to the physio-chemical properties (for example acetic acid-smell, hygroscopicity).

A more feasible organic magnesium source is magnesium fumarate. Magnesium fumarate is the result of a reaction of fumaric acid, magnesium oxide and water. In contrast to magnesium acetate, available magnesium fumarate in the market (Anta Plus, Dr Eckel GmbH) is a dust-free, fine granulated and free flowing product. Magnesium in the form of magnesium fumarate seems to have a markedly better absorption rate than magnesium from inorganic sources.

Günther and Mohme (1985) demonstrated that magnesium content in skeletal muscles and heart muscles of pigs can be increased by supplementing 1.7g of magnesium fumarate per kg live weight (Fig. 2).

The group fed supplemented with magnesium oxide did not show differences compared to the control group. The magnesium fumarate group had a 9.3% higher magnesium content in the skeletal muscles and a 8.6% higher magnesium content in the heart muscle.

| Occurrence of fights | Magnesium oxide | Magnesium fumarate |
|---|---|---|
| Day 1 | 57 | 27 |
| Day 2 | 25 | 9 |
| Day 3 | 4 | 3 |
| Pigs with marked wounds after transfer | 31 | 15 |

***Table 1. Occurrence of fights among pigs after transfer to new pens (Poralla and Kohler, 1989).***

The positive effect of magnesium fumarate on available magnesium from the soft tissue can be a useful property to face some stress related challenges in livestock farming. Typical applications are the addition of magnesium fumarate to diets of pigs and broilers prior to transport to slaughter. Heugten and Frederick (2004) showed that the addition of magnesium to finisher diets decreases blood levels of stress hormones in pigs during transport and helps calm the animals.

Poralla and Kohler (1989) showed that the use of magnesium fumarate in piglet nutrition had a positive impact on animal behaviour during and after rehousing (Table 1).

In the first day after the transferral of the piglets to new pens, the authors record a markedly reduced occurrence of fights between the animals. In the magnesium fumarate group, 27 fights were counted, that is more than 50% less compared to the magnesium oxide group. Also the number of animals with marked wounds after transfer was 50% lower in the magnesium fumarate group. Beside the farmers the meat industry and the consumers can also benefit from improved 'stress management'.

Meat quality is among other things influenced by pre-slaughter transportation and slaughter conditions. The activation of stress hormones lead to a release of lactic acid into the muscles and the pH of meat decreases, leading to the occurrence of PSE meat defects.

In a trial, Otten et al. (1995) investigated the effect of adding 1.0% magnesium fumarate to a diet of fattening pigs on meat quality parameters (Fig. 3).

In general, supplementation of magnesium fumarate to the control diet influenced meat quality positively. The authors noticed that the colour of the meat was significantly less pale. In addition the pH one hour post mortem was higher compared to the control group, which indicates that less stress-related lactic acid was mobilised ante mortem.

Conductivity 24 hours post mortem was also lower in the magnesium fumarate group. Both results were significant.

Several studies have already shown that the application of magnesium can help to improve stress related challenges in animal nutrition. The supplementation of magnesium, being a central element in the nervous system and for the function of smooth muscle fibres and heart muscle fibre, can have a tranquilising effect on the animals. But not all magnesium sources are equally suitable.

Magnesium fumarate, as an organic source of magnesium with high availability and great technological properties, can be considered a useful magnesium supplementation to face stress related situations. A further application of magnesium fumarate might be the reduction of greenhouse gases in ruminants (for example methane). Therefore, further research is necessary. ■

*References are available from the author on request*