SELENIUM: KEY BREEDING ELEMENT

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CATHERINE DUNNETT considers how a lack of selenium in a horse's diet could lead to serious breeding problems.

APPROPRIATE mineral nutrition during pregnancy and lactation is vital in producing youngstock that are well grown and durable.

While the importance of macro minerals, such as calcium and phosphorus, and micro minerals, such as copper, have historically received considerable attention in this regard, other trace minerals of equal relevance, such as selenium, have received relatively less attention.

In horses, as in the majority of other mammals, adequate dietary selenium is essential to support the proper function of a number of selenium-containing proteins, including selenoprotein P and selenoprotein W.

There are also many selenium-containing proteins that function as enzymes, such as glutathione peroxidases. Glutathione peroxidases are antioxidant enzymes that help to protect the body from the effects of reactive oxygen species and free radicals produced during metabolism, which can damage cell membranes. Aside from glutathione peroxidases, there are at least 25 known seleniumcontaining proteins (Kryukov et al, 2003), which, collectively, are vital for the optimum functioning of the antioxidant, immune and musculoskeletal systems.

Reproductive problems

Selenium-containing proteins are involved in several aspects of metabolism, and there are many

examples of their importance in broodmares throughout the breeding cycle. Therefore, it is, perhaps, not surprising that mares receiving inadequate amounts of selenium have been reported to be more likely to experience a variety of reproductive problems than those whose selenium intake was deemed to be adequate (Maylin et al, 1980).

Throughout the world, there are areas where the selenium content of soil is reported to be low, which usually affects the natural selenium content of forages, cereals and cereal by-products (Surai, 2006) that form the mainstay of a broodmare's diet. A low endogenous level of selenium in feed underpins the necessity of appropriate selenium supplementation through complementary feeds or supplements.

The National Research Centre (NRC) recommends a daily selenium intake of 0.1mg/kg dry matter for broodmares. However, the NRC concedes the requirement for selenium for optimum immune function, for example, may be higher than the basal requirement described to prevent classical symptoms of deficiency (NRC, 2007).

Total dietary selenium intake in a broodmare is, therefore, important to maintain the level of these selenoproteins, including enzymes that have an essential contributory function to the mare's antioxidant and immune defences. By virtue of these effects, selenium has significance for all aspects of the breeding cycle, including fertility, foetal growth, parturition, lactation and the immunocompetence of the resulting foal.

However, evidence suggests that the form in which selenium is provided has a significant bearing on the physiological response to selenium supplementation.

Historically, sodium selenite was the main source of supplementary selenium, but advances in animal nutrition suggest organic forms of selenium, such as seleno yeasts, may be more bioavailable and more readily taken up into target tissues to exert physiological effects. Organic selenium – where the primary form of selenium is present as selenomethionine – is reported to represent a safer and less toxic source of selenium, compared to selenite (Surai, 2006).

A number of studies support a key role for selenium during the breeding cycle and suggest that the form of selenium provided may also be important. Endometritis, for example, is an important factor involved in infertility in mares. It is characterised by inflammation of the lining of the uterus and can develop as a result of fungal or bacterial infection.

The relevance of dietary selenium to endometritis is revealed by examining the effect of this disease on key indicators of oxidative damage and/or antioxidant status. The activity of glutathione peroxidase, a selenium-dependent enzyme that has a major antioxidant function, is reported to be decreased in mares with endometritis.

Additionally, the plasma concentration of malondialdehyde - often used as an indicator of oxidative

damage to cellular membranes – is also increased with endometritis in horses (Yaralioglu-Gurgoze et al, 2005).

While oxidative damage could be regarded as a normal biochemical consequence of inflammation in this condition, the body's ability to manage inflammation will depend on the robustness of the mare's antioxidant defences, including the activity of glutathione peroxidase. This is known to be adversely affected by reduced dietary selenium intake (Calamari et al, 2007). Glutathione peroxidase activity is maintained more effectively with organic sources of selenium, compared to sodium selenite, when selenium supplementation ceases (Calamari et al, 2007).

Retention of placenta

Retention of the placenta in broodmares following foaling is another serious issue that can lead to post-partum complications, such as endometritis, septicaemia and laminitis, and is, therefore, an important consideration for stud managers.

While many factors affect the length of time the placenta is retained by a mare before its expulsion, selenium status appears to be involved. From a group of 22 in-foal mares, those with higher serum selenium concentration, which provides an indication of selenium status, exhibited the shortest placental retention time (Ishii et al, 2002).

Additionally, in those mares whose serum selenium concentration was considered to be low, placental retention time was improved as a result of supplementing the diet with both selenium and vitamin E. Although there was a trend towards an improvement in placental expulsion in mares fed organic selenium, these results were not statistically significant.

While the effect of selenium status on mammary health in horses has not been investigated, research in other species, including dairy cows, suggests that adequate selenium intake is an important factor in reducing the instance of mammary infections, such as mastitis (Surai, 2006). This effect is presumably largely mediated through the beneficial effects of selenium on overall immune status.

Immune function

A mare's immune status is a significant factor affecting the quality of colostrum. Colostrum is the "first milk" that is produced during the last month of gestation. It is vital, as it establishes the future competency of a foal's hitherto naïve immune system.

Immunoglobulins, primarily IgG, IgM and IgA, are concentrated in the udder from the mare's circulation. The quality of colostrum, in terms of its immunoglobulin content, is dependent on a mare having a good immune status overall (Pineda, 2003).

This, in turn, is believed to be influenced by adequate dietary selenium intake as, previously, diets that were deficient in selenium were found to adversely affect aspects of immunity in ponies (Knight et al, 1990).

A positive effect of selenium supplementation on selenium status, in both mares and their foals and on indicators of immune status in those foals, has also been demonstrated, although again this effect was, in part, dependent on the selenium source. Supplementation of mares with organic selenium (3mg/day) during the latter stages of gestation and early lactation has been shown to successfully increase the serum selenium concentration in mares post-foaling, compared to those supplemented with inorganic sodium selenite (1mg/day to 3mg/day).

Perhaps the most recognised effect of selenium deficiency in foals is the development of white muscle disease. This form of muscle dysfunction or myopathy results in weakness and impaired movement, difficulty in suckling and compromised heart function. The appropriate selenium status of foals can be maintained when the mare is provided with an acceptable selenium intake, as selenium can be transferred from mare to foal through the placenta and milk.

An increased serum selenium concentration in foals has been reported in those fed either organic or inorganic (selenite) forms of selenium. The former supports significantly higher selenium concentrations in both colostrum and milk (Janicki et al, 2003). Selenium supplementation of mares was shown to support subsequent immunity in the foals, as circulating levels of IgG were higher in mares fed 3mg/day, versus 1mg/day of either organic or inorganic selenium. This dietary intake of selenium is higher than the NRC recommended level for an average-sized horse of 1mg/day (NRC, 2007), but may be better placed to support immune function (Richardson et al, 2006)

Growth concerns

The effect of selenium status on foal growth, either in utero or following parturition, remains largely undocumented.

However, it is an area of potential future interest, as the selenium-dependent enzyme iodothyronine deiodinase, which is responsible for the activation of thyroid hormone, is known to be involved in the regulation of growth. Through extrapolation from a human condition with some similar characteristics, a link has been proposed between low selenium status and skeletal disorders, such as osteochondrosis in foals (Hintz, 2001). In summary, good immune status and antioxidant function in broodmares is vital to ensure the production of healthy foals. Selenium has a crucial role in this respect and may also have a specific part to play in ensuring normal growth, and providing selenium in an organic form may offer an improved bioavailability and physiological effect.

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Supplementation can influence selenium status in mares and their foals, as well as indicators of the foal's immune health.