Feeding the Mare for Fertility and Reproduction

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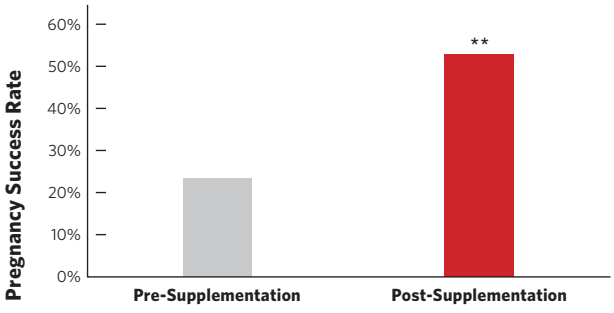
Nutrition plays a pivotal role in fertility and reproduction, impacting both the male and female. In addition to a well-balanced diet, supplementation with specific nutrients can improve fertility and reproductive success by increasing the number and quality of eggs, improving the environment for the developing fetus, and enhancing the health of the neonate. Not only can adequate intake of omega-3 fatty acids and antioxidants provide the foundation for continued reproduction, but supplementation with these nutrients can also help improve pregnancy outcomes.

Fertility and Pregnancy Success

Omega-3 fatty acid consumption affects fertility rates in females. For example, ovulation is increased in rats consuming a high omega-3 fatty acid diet provided as either the long chain eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) or the shorter chain alpha-linolenic acid.[1,2] Improved egg quality and increased fertility lifespan (e.g., age to which pregnancy is possible) has been associated with omega-3 fatty acid intake in rodent models.[3] While the mechanisms underlying these effects are not fully known, one possible link could be fatty acid-induced changes in prostaglandin synthesis.[4,5] Indeed, increased concentrations of markers associated with chronic inflammation are purported to be predictors of female infertility and spontaneous loss of pregnancy in other species.[6,7]

To examine a possible effect of omega-3 fatty acids and micronutrients on fertility, researchers at Colorado State University's Equine Reproduction Lab studied mares, ranging from 6 to 25 years old (average = 20 yrs), most of which had histories of suboptimal fertility. At the start of the study, the mares consumed a hay diet supplemented with a commercial complete feed. Eggs were harvested from the mares and implanted into recipient mares, either as fertilized eggs (embryos) after assisted fertilization *in vitro* or as unfertilized eggs, after which the recipient mare was inseminated. Pregnancy rates were approximately 23% per transfer. The mares were then fed a mostly hay diet supplemented for 8 to 16 weeks with 2 scoops/day of an omega-3 and micronutrient supplement.* Eggs were once again harvested from these mares and transferred to recipient mares. This time, however, the pregnancy rates in the recipient mares significantly increased to 51%, which was a 129% increase (Figure 1).

Figure 1. **Pregnancy Success Rates Per Transfer Among Mares Before and After Omega-3 and Micronutrient Supplementation***



**Significantly greater than Pre-Supplementation value ($p < 0.05$)

One possible explanation for the improvement in fertility could be alterations in the inflammatory state of the donor mares. For example, serum concentrations of TNF-α, a pro-inflammatory cytokine associated with poor pregnancy outcomes and infertility in women,[6,8] decreased more than 51% (Figure 2). Although other factors may have

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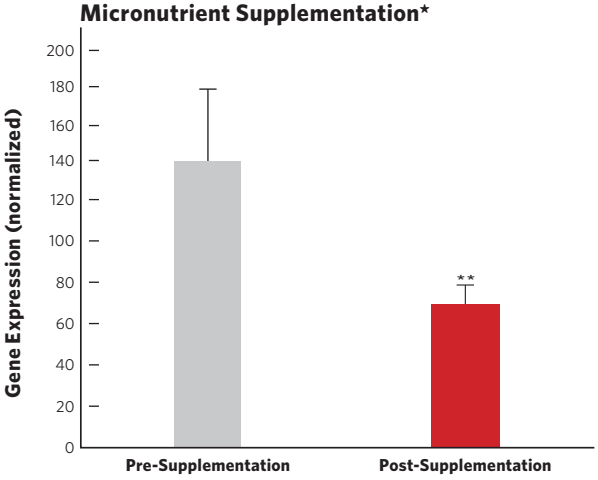
affected pregnancy rates, the results suggest that supplementation affected viability of follicles and/or eggs from the mares in this study. Although little research has been performed to examine the role of the ovary in subfertile mares, it could have a profound effect on reproductive success, especially in older problem mares as seen in this study.

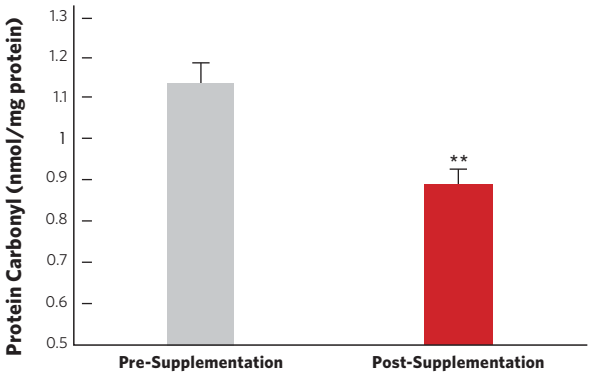
Figure 2. **TNF-Alpha Gene Expression Among Mares Before and After Omega-3 and Micronutrient Supplementation***



**Significantly less than Pre-Supplementation value ($p<0.05$)

Another factor that may play a role in low fertility rates is oxidative damage due to excessive production of free radicals and/or insufficient defenses against oxidative stress. Although there is strong evidence to support a role of oxidative damage in sperm number and function, implications in females are less clear. This is complicated by the fact that free radical production is a natural sequence in normal fertilization and fetal development. However, there is increasing evidence for connections among oxidative stress, low oocyte quality and poor fertility rates.[9] For example, women with unexplained infertility have higher levels of reactive oxygen species in peritoneal fluid—which bathes the uterus, fallopian tubes, and the ovaries—as compared to fertile women.[10,11] Among the mares in the CSU fertility trial receiving the omega-3 and micronutrient supplement, circulating concentrations of blood protein carbonyls—a measure of oxidized systemic proteins—decreased significantly (Figure 3), suggesting that an improvement in the balance between the production and elimination of free radicals occurred. This improved oxidative state may have contributed to healthier eggs with a greater likelihood of successful fertilization and development.

Figure 3. **Protein Damage in Blood Decreases After Omega-3 and Micronutrient Supplementation* in Mares**



**Significantly less than Pre-Supplementation value ($p < 0.05$)

Gestational Nutrition on Foal Health

Not only may omega-3 fatty acids improve fertility and pregnancy rates in the mare, they also will have a significant role in the growth, development, and overall health of the offspring. DHA has long been recognized as an important component in the neural development of a fetus.[12] In addition, human research suggests increased intake of omega-3 fatty acids can improve gestation time and birth weights.[13,14] Researchers even suggest that the susceptibility of the fetus to chronic diseases may be altered by changing the mother's intake of omega-3 fatty acids, as well as other nutrients. For example, supplementation with EPA and DHA during pregnancy can contribute to an alleviation of allergic responses and respiratory illness among human infants.[15,16] Furthermore, zinc homeostasis, a mechanism in the development and progression of neurological disease in humans, is altered in rat pups whose mothers had changes in their dietary intake of omega-3 fatty acid during pregnancy.[17] Foals born to mares supplemented with vitamin E during pregnancy may benefit from a stronger immune system as noted by higher levels of serum IgE when compared to foals of non-supplemented mares.[18] The risk of adult

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metabolic disorders could be affected by maternal diet, as well. For example, mares on a high-starch diet have been shown to have foals with reduced insulin sensitivity, which may increase the foal's risk for metabolic syndrome upon maturity.[19]

The high degree of immune-modulation that occurs during the perinatal period in conjunction with the effects of omega-3 fatty acids and other key nutrient intake during pregnancy and lactation on allergic responses and metabolic alterations suggest that many chronic immune-mediated diseases in the offspring may be influenced by making appropriate alterations in the maternal diet.

Summary

Provision of a diet adequate in both macro- and micronutrients is the foundation for equine fertility and reproduction. Furthermore, inclusion of supplemental nutrients, including omega-3 fatty acids and antioxidants, may help prevent poor fertility and improve reproductive performance as well as the long-term health of the foal.

Putting it into Practice

- To ensure the overall health of the breeding mare, provide a high-forage diet low in starch and supplemented with vitamins, minerals, and omega-3 fatty acids.
- To avoid undue oxidative stress, reduce intake of rancid feeds.
- For optimal overall mare health and to help ensure a healthy foal, supplement with omega-3 fatty acids, antioxidants, trace minerals and vitamins.

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