Proceedings of the Society for Theriogenology
Annual Conference 2015

Aug. 5-9, 2015 – San Antonio, TX, USA

Next SFT Meeting:

Jul. 27 – 30, 2016 – Asheville, NC, USA

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Feeding and supplementing the stallion for maximum fertility
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Introduction
Nutrition plays a major role in maintaining the health and condition of the stallion. Ideally, stallions should be maintained in moderate body condition (BCS; condition score of five or six) before, during and after the breeding season. If the stallion tends to lose weight during the breeding season, having a BCS of six or seven prior to the start of the breeding season will help ensure that the stallion does not become too thin when energy demands are high during the season. With regards to nutritional requirements, breeding can be considered “work” and as such, the stallion should be on a similar feeding program to that of working or performance horses. The nutrient requirements in dietary dry matter for breeding stallions are 1.15 - 1.3 Mcal/lb, 10-11% protein, 0.3% calcium, and 0.25% phosphorus. When fed in sufficient quantities (1.5 - 2% of body weight), good quality forage can meet the breeding stallion’s minimum protein, calcium, and phosphorus requirements, but will fall short of the energy requirements. Therefore, the additional energy will need to be supplied in the form of grains and/or oils. So, for most stallions, breeding does not require an increase in any nutrient other than digestible energy and the requisite increase in crude protein. However, for stallions with marginal or low fertility, dietary modifications may be necessary to optimize their semen quality.

Vitamins and antioxidants
Vitamins C and E are well known for their antioxidant properties and are those that have been the most extensively examined for their effects on semen quality. In a number of species, dietary supplementation with vitamin C, vitamin E or a combination of these increased, total sperm output, sperm concentration and sperm motility while decreasing dead and abnormal sperm. In humans, vitamin C supplementation was associated with higher sperm numbers and concentrations in ejaculates, whereas vitamin E appeared to exert its effects by improving sperm motility. In semen from infertile men, supplementation with vitamin C and vitamin E also resulted in a significant reduction in sperm DNA fragmentation. German and Russian investigators reported improved semen quality by supplementing stallions with vitamins A, D and E. While the intake of high levels of antioxidant vitamins was associated with better semen quality, moderate intake did not appear to be effective. Results such as these are not universal, and there have been numerous studies that have failed to demonstrate beneficial effects on semen quality, even by giving large doses of vitamins.

Another antioxidant, showing promise for improving semen quality is levocarnitine (L-carnitine). Along with its antioxidant properties, L-carnitine is essential for mitochondrial energy metabolism. Both L-carnitine and L-acetyl-carnitine are found in high concentrations in the epididymis and both are accumulated by sperm and in men with asthenozoospermia, combined treatment with L-carnitine and L-acetyl-carnitine was effective in increasing sperm motility. The most significant improvements were seen in men with the lowest numbers of motile sperm prior to treatment. Feeding L-carnitine to boars resulted in higher semen volumes and sperm concentrations thereby increasing the total number of available sperm in ejaculates for artificial insemination.

Combining antioxidant vitamins and micronutrients may also have some benefit. When the standard diet of stallions with normal fertility was supplemented with 1500 mg of alpha-tocopherol acetate, 360 mg of zinc, and 2.5 mg of organic selenium on a daily basis for 60 days, a significant improvement in average path velocity, straightness, viability, progressive motility, and sperm morphology was reported.

Micronutrients
The supplementation of organic selenium has been shown to improve the progressive motility of boar sperm and increased their resistance to thermal challenges. Organic selenium supplementation also improved the short term storage ability of preserved semen and increasing the fertility rate in gilts.
Bulls supplemented with organic trace minerals (Zn, Cu, Co, and Mn) had a greater percentage of motile, progressively motile sperm, and rapidly motile sperm than those supplemented with inorganic trace minerals.13 After 60 days of supplementation with both zinc and selenium, the semen quality of caprine bucks was enhanced in terms of a significant increase in sperm numbers, progressive motility, percentage of live spermatozoa, acrosomal integrity and a decrease in abnormal spermatozoa.14 A recent study in humans showed that treatment of asthenospermic patients with zinc supplementation leads to, among other things, restored nitric oxide synthase (NOS) activity to normal values and improvement of semen parameters.15 However in another study, zinc sulphate and folic acid supplementation did not improve semen quality in infertile men with severely compromised sperm parameters due to oligoasthenoteratozoospermia.16

Polyamines
Polyamines are products of metabolism of the amino acid arginine and are found in seminal plasma in relatively high concentrations.17 L-arginine is a substrate for the NOS producing nitric oxide (NO), a reactive molecule that participates in a variety of male reproductive functions. At low levels, NO is necessary for spermatogenesis, spermiation, sperm motility, sperm capacitation, the acrosome reaction, and sperm/oocyte fusion.18-20 However, high levels of NO can result in adverse effects on sperm motility, morphology and DNA stability.21,22 L-arginine has been shown to have a protective effect on spermatozoa against the sperm plasma membrane lipid peroxidation as well as to enhance sperm metabolism and maintain sperm motility.23,24 In frozen stallion semen, NO production was positively correlated with sperm motility and velocity after thawing.25 Oral L-arginine supplementation for 62 days improved both sperm motility and morphology (from 40% to 69%) in semen from sub-fertile dogs with oligoasthenoteratozoospermia, and also increased sperm motility in fertile dogs with normal semen characteristics.26 Dietary supplementation with 1% L-arginine-HCl for 30 days increased both sperm numbers and sperm motility in boar semen.17 Interestingly, the human fertility supplement, “Sperm-Aid” is a tablet containing 500 mg of L-arginine. Note however, that as with NO, there is evidence that too much L-arginine can adversely affect sperm motility and fertility.27,28

Anecdotal information exists from equine practitioners using a compounded herbal supplement for stallions called “SpermAid”. The active ingredients in this product are spermine and spermidine, which are found in radish leaves, radish root, cucumber fruit, and oats. Spermine and spermidine are polyamines that are produced by the prostate and found in the semen of most mammals. In rams, ejaculates with sperm motility greater than 85% had almost double the spermine and total sperm polyamine content than ejaculates with lower motility.29 Lower levels of spermidine are found in the seminal plasma of men with idiopathic asthenozoospermia as well as those with asthenozoospermia associated with diabetes.30 For stallions, feeding of the supplement is typically initiated three weeks prior to the breeding season. While significant improvements in sperm motility have not been reported with the use of this product, a number of slow breeding stallions have apparently shown dramatic improvements in libido.

Fatty acids
Semen from virtually all species examined contains relatively large amounts of lipid, in the form of polyunsaturated fatty acids (PUFAs) which plays a major role in motion characteristics, sensitivity to cold shock and fertilizing capacity of sperm.31 In particular, docosahexaenoic acid (DHA; an omega-3 fatty acid) and docosapentaenoic acid (DPA; an omega-6 fatty acid) are the major polyunsaturated fatty acids (PUFAs) in semen.32 The level of DHA in seminal plasma as well as the ratio of omega-3 to omega-6 fatty acids in sperm of men with poor sperm motility, was found to be significantly lower than in men with normal semen quality.33 Increasing the ratio of DHA to DPA in semen has been shown to increase fertilizing capacity and semen quality; whereas higher levels of DPA relative to DHA results in reduced fertility.34,35

Since animals are unable to synthesize PUFAs, they must acquire them from precursor PUFAs in their diet and the transfer of PUFAs from the diet to semen occurs in a number of species, including the
Vegetable oils, such as corn and soybean oil, found in most equine diets, contain high levels of linoleic acid, the parent compound of DPA, while the precursors for omega-3 fatty acids, such as DHA, are very low. A diet of this nature would favor the formation of DPA over DHA since the conversion of precursors to DPA and DHA uses the same competitive enzymatic pathway. Omega-3 fatty acids cannot be converted to omega-6 fatty acids or vice-versa. Since high DPA to DHA ratios in semen are associated with reduced sperm quality and fertility, typical equine diets could have a negative impact on quality of stallion semen and its tolerance to cooling and freezing.

Simply supplementing the stallion’s diet with precursors to omega-3 fatty acids such as cod liver oil or flaxseed oil can increase the overall level of omega-3 fatty acids in semen, but this may not result in the desired effects of improved semen quality. However, supplementing the diet with omega-3 precursors along with pre-formed DHA and antioxidants has been shown to increase semen quality in boars and stallions.

Researchers at Texas A&M fed a supplement, which resulted in a three-fold increase in semen DHA levels and a doubling of the ratio of DHA to DPA in the semen. Beneficial effects including increases in total motility, progressive motility and rapid motility were most apparent after 48 hours of cooling and storage. The sperm concentration of stallions fed the supplement was almost double that of those fed the control diet. Total motility, progressive motility, and percentage of sperm exhibiting rapid motility were also significantly higher in frozen-thawed semen of stallions being fed the supplement. Subsequently, similar studies carried out at other institutions resulted in improved total numbers, morphology and percentages of live sperm. In all of these studies, the improvements were most noticeable for stallions that initially had poorest semen quality.

In spite of the improvements in semen quality observed in the Texas A&M study, the level of DPA in semen remained higher than DHA. The stallions’ rations were typical equine formulations containing corn and soybean oils. It was hypothesized that even more dramatic improvements in semen quality may have been observed if the fat content of the stallion diets were modified to favor more DHA precursors and incorporated with the DHA supplement. Flaxseed (meal and oil), which is very rich in the omega-3 fatty acid alpha-linolenic acid (ALA), may be such an alternative energy source. However, since most of the ALA is converted to another omega-3 fatty acid, eicosapentaenoic acid (EPA), the conversion of ALA to DHA in horses does not appear to be very efficient. Even so, because of the competitive enzymatic pathway, reducing the amount of omega-6 precursors in the diet by substituting them with omega-3 precursors and supplementing with preformed DHA, should be beneficial for some stallions with poor semen quality. Recently, Austrian workers reported that dietary supplementation of stallions with linseed oil (flaxseed oil) plus antioxidants mitigated the decline in motility and membrane integrity of cooled-stored stallion semen during winter, a similar effect was not observed for frozen-thawed semen. As early as the 1950’s, it was reported that adding fish meal to the diet improved sperm motility and survival in stallion semen. Supplementing the diet of miniature Caspian stallions with a combination of fish oil and thyme (Thymus vulgaris), which is rich in antioxidative substances, improved total and progressive motility, plasma membrane integrity and functionality of cooled stored sperm. While marine sources of DHA and its precursors (fish oil or algae) may be superior to flaxseed for increasing DHA levels in stallions, but palatability and supplement refusal can be problematic.

Conclusions

It is clear that dietary alterations can have an effect on semen quality and in some cases, fertility. Controlled studies in stallions are few, but those investigating fatty acids, in particular omega-3 fatty acids such as DHA, have shown real potential. Supplementing the diet of highly fertile stallions or those that produce sperm that survive cooling and freezing well does not appear warranted. However, stallions of marginal fertility and those whose sperm have poor tolerance to cooling and freezing would be horses that might benefit most from being fed dietary supplements.

Altering the diet of marginally fertile stallions by optimizing levels of DHA and its precursors, as well as adding antioxidants and micronutrients may improve their semen quality sufficiently enough to make them commercially viable for cooling or freezing. Further studies involving optimal levels of...
individual supplements and combinations of supplements which could act synergistically to improve stallion semen quality are needed. Since maintaining a healthy balance of all nutrients is imperative to overall health, one should exert caution and an equine nutritionist should be consulted before making any dramatic changes to the horse’s diet.

References


