

# L-carnitine

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## **Introduction to L-carnitine**

L-carnitine is a type of amino acid with 3 attached methyl groups. It is synthesised from the essential amino acid lysine, but there are many other micro nutrients that are required to complete its synthesis including: methionine, S-adenosylmethionine (SAME), magnesium, vitamin C, iron, vitamins B3 and B6, alpha-ketoglutarate, folic acid, vitamin B12, and betaine.

Although L-carnitine is found naturally in both plants and animals, the level found in plants is extremely low, whilst meat has a far higher content. As an herbivore therefore, the horse has a relatively low natural dietary intake of L-carnitine. This is reflected in the relatively low plasma concentration of carnitine observed in racehorses and broodmares (Foster et al. 1989). However, carnitine status can be improved through dietary supplementation. Previous feeding studies have shown that supplementation of the diet with L-carnitine increased the concentration in plasma showing that it is adequately absorbed (Foster et al. 1988; Foster and Harris 1989). In Man supplementation with relatively low amounts of carnitine is regarded as being optimal as the absorption mechanisms are easily overwhelmed by a greater daily intake.

## **What is the role of L-carnitine in horses?**

Carnitine is a very important nutrient, as it is intimately involved in energy generation and is required for the proper metabolism of long chain fatty acids, which form an important fuel source in the horse (Orme et al. 1995). Carnitine is specifically needed for long chain fatty acids to travel across the mitochondrial membrane, to allow their full oxidation to produce energy (ATP) during a process known as beta oxidation. Fat in the form of long chain fatty acids is a very important fuel supply for horses both at rest and during exercise of varying intensities.

Carnitine, however, is also thought to support complete carbohydrate oxidation, reducing lactic acid formation by affecting a crucial regulatory step in the metabolic pathway. Carnitine buffers the buildup of acetyl-CoA, an intermediary in the oxidation of carbohydrate, and reduces the ratio of acetyl-CoA: CoA. In so doing, carnitine helps regulate carbohydrate oxidation at the gateway to the tricarboxylic acid cycle (TCA) and reduces the formation of lactic acid.

The intimate involvement of carnitine in energy generating pathways means that carnitine supplementation is potentially of benefit to horses through many different life stages:

### **L-carnitine for Foals and other Youngstock**

The carnitine content of plasma increases with age, which is likely to be due to an age related improvement in endogenous biosynthesis of carnitine (Foster et al. 1989). In foals, especially those that are premature, L-carnitine supplementation may be of benefit, as the ability to synthesize carnitine is unlikely to be sufficient to support the needs of growth. This may also be true in yearlings and two year olds. Carnitine supplementation of broodmares has been shown to effectively increase the plasma carnitine content in their foals (Benamou and Harris 1993). There is also a tendency for the carnitine content of mares' milk to be higher during carnitine supplementation.

### **L-carnitine for Stallions**

Studies in other species have shown that L-carnitine supplementation has a positive effect on semen characteristics (Jacyno et al. 2007). This is probably due to an improvement in energy generation within the spermatozoa themselves. In stallions, carnitine is suggested to be a useful marker of sperm quality and is thought to improve the viability of semen following cold-storage during artificial insemination (Stradaioli et al. 2000). More recently, supplementation with L-carnitine has also been shown to directly benefit sub-fertile stallions through improvements in sperm motility and morphology (Stradaioli et al. 2004).

### **L-carnitine for Performance horses**

Improved efficiency of energy generating pathways is likely to support improved exercise performance. Some studies in Man confirm an increase in the use of fat as a fuel source during exercise following L-carnitine supplementation (Muller et al. 2002). Logically this could result in improvements in performance in some equestrian disciplines, although there are only a few studies that have investigated this proposal. Certainly, the work of (Rivero et al. 2002) suggests that supplementation of horses in exercise training with L-carnitine is thought to increase the level of carnitine in muscle above that observed with training alone. L-carnitine supplementation has also shown some beneficial results during exercise performance, but the results to date are not consistent (Biagi et al. 1985; Souffleux 1994; Iben et al. 1999).

### **L-carnitine for Obesity and Metabolic Syndrome**

An increasing proportion of horses and ponies are overweight and many suffer from decreased insulin sensitivity, equine metabolic syndrome or laminitis. It has recently been reported that supplementation with L-carnitine improves the body's ability to manage dietary carbohydrate, through its beneficial effect on insulin sensitivity (Van Weyenberg et al. 2009). In addition, L-carnitine supplementation is also associated with a rise in the circulating level of leptin following feeding. Leptin helps suppress appetite and so this could be beneficial in the fight against obesity in horses and ponies.

The inclusion of L-carnitine in horse feeds therefore offers a significant advantage for young and growing horses as well as those in active competition or racing. New research also suggests that L-carnitine will benefit leisure horses with a predisposition to being overweight or with metabolic problems such as metabolic syndrome

## References

- Benamou, A. E. and R. C. Harris (1993). Effect of carnitine supplement to the dam on plasma carnitine concentration in the sucking foal. *Equine veterinary journal* **25**(1): 49-52.
- Biagi, G., R. Luddi, et al. (1985). Use of l-carnitine in the working American trotting horse. *Atti della Societa Italiana delle Scienze Veterinarie* **39**(2): 305-308.
- Foster, C. V., R. C. Harris, et al. (1989). Survey of plasma free carnitine levels in 74 Thoroughbred horses at stud and in training. *Equine veterinary journal* **21**(2): 139-141.
- Foster, C. V. L. and R. C. Harris (1989). Plasma carnitine concentrations in the horse following oral supplementation using a triple dose regime. *Equine Veterinary Journal* **21**(5): 376-377.
- Foster, C. V. L., R. C. Harris, et al. (1988). The effect of oral L-carnitine supplementation on the muscle and plasma concentrations in the Thoroughbred horse. *Comparative Biochemistry and Physiology, A (Comparative Physiology)* **91**(4): 827-835.
- Iben, C., E. Moschitz, et al. (1999). Effect of L-carnitine supplementation on heart rate and some blood parameters in the eventing horse. *Wiener Tierarztliche Monatsschrift* **86**(10): 330-338.
- Jacyno, E., Ako?odziej, et al. (2007). Effect of L-carnitine supplementation on boar semen quality. *Acta Veterinaria Brno* **76**(4): 595-600.
- Muller, D. M., H. Seim, et al. (2002). Effects of oral L-carnitine supplementation on in vivo long-chain fatty acid oxidation in healthy adults. *Metabolism: Clinical and Experimental* **51**(11): 1389-1391.
- Orme, C. E., R. C. Harris, et al. (1995). Effect of elevated plasma FFA on fat utilisation during low intensity exercise. *Equine Vet. J* **Suppl. 18**: 199-204.
- Rivero, J. L., H. P. Sporleder, et al. (2002). Oral L-carnitine combined with training promotes changes in skeletal muscle. *Equine veterinary journal. Supplement*(34): 269-274.
- Souffleux, G. (1994). Benefit of using Rossovet carnitine for horses in preparation for amateur carriage-racing. *Pratique Veterinaire Equine* **26**(4): 241-248.
- Stradaioli, G., L. Sylla, et al. (2004). Effect of L-carnitine administration on the seminal characteristics of oligoasthenospermic stallions. *Theriogenology* **62**(3-4): 761-777.

- Stradaioli, G., L. Sylla, et al. (2000). Seminal carnitine and acetylcarnitine content and carnitine acetyltransferase activity in young Maremmano stallions. *Animal Reproduction Science* **64**(3/4): 233-245.
- Van Weyenberg, S., J. Buyse, et al. (2009). Increased plasma leptin through l-carnitine supplementation is associated with an enhanced glucose tolerance in healthy ponies. *Journal of Animal Physiology and Animal Nutrition* **93**(2): 203-208.