The use of conventional and unconventional supplements in the thoroughbred horse

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The conventional nutrition of the racehorse over the centuries has centred around grain (oats or maize) bran, hay and water, with the addition of various other compounds to provide variety, palatability and improve the general health of the horse. These additions have included herbs, honey, molasses, Guinness, eggs and extracts of garlic. Recent years have seen the addition of more specific compounds to the diet of performing horses in the search for an extra advantage that may lead to optimum or even enhanced performance.

The use of such supplements can be divided into two categories: (1) those aimed at the prevention of depletion states which could lead to a lowering in general health and loss of athletic performance, such as vitamins, minerals, and specific amino acids, and (2) the growing number of supplements being introduced to enhance performance, such as carbohydrate and bicarbonate, as well as such substances as dimethylglycine.

Racehorse trainers often use more than one supplement, and sometimes several of a similar composition. In addition, most of the pelleted or complete feeds available today have added vitamins, electrolytes and trace elements. Due to the general lack of scientific evidence, as in man, evidence for the beneficial effects of many of these compounds is largely anecdotal. From time to time certain supplements or single substances become fashionable, depending on the success of the trainers using them. An obvious difficulty is that carrying out the large-scale controlled studies necessary to show either improved racing times of the order of 1–5% (which can mean the difference between first or last) or improved health would be extremely expensive.

A further difficulty in evaluating the effectiveness of supplements is that those racing yards that are using the most supplements tend to have better overall management, as well as a higher class of animal. Often the use of supplements is directed by economics, and therefore, in a yard with wealthy owners the extra cost of supplements can be justified, even if they are beneficial in only one in every ten or twenty horses. At the other end of the spectrum, supplements will often have to be excluded to prune costs.

In the present paper the following supplements will be considered; electrolytes, trace elements, vitamins and compounds intended to improve the efficiency of energy supply in the muscles.

Electrolytes

Today the necessity for the addition of extra sodium chloride to the diet of the working horse is generally accepted. This is because equine sweat is hypertonic, with concentrations of sodium, potassium and chloride five or more times greater than those in human sweat. This can result in large amounts of Na and K being rapidly lost during exercise (Kerr & Snow, 1982). The major problem is with Na, since the normal horse diet is low in this electrolyte, and a deficiency in Na may rapidly occur.

In horses receiving no Na supplementation only very low amounts of Na are excreted in the urine, and in a deficiency state this is reduced almost to zero. For the working horse, Meyer (1987) recommended intakes ranging from 20 mg/kg per d for maintenance to as high as 250 mg/kg per d for a horse in heavy work. Requirements are increased in hot climates where sweating is more pronounced.

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Recently a common muscle problem, rhabdomyolysis (azoturia, tying-up, setfast), has been shown sometimes to be associated with a Na imbalance (Harris & Colles, 1988). In several cases, further episodes have been prevented by increasing the NaCl in the diet.

Supplemental K is only necessary when marked sweating occurs for several hours each day, especially on a high-grain diet.

Calcium is included in many supplements, especially for the growing horse, where daily requirements are stated to be approximately 95 mg/kg, whilst maintenance requirements for the mature horse are 50 mg/kg (National Research Council, 1978). In a study carried out in racehorses in a number of stables in Australia, Cable *et al.* (1982) concluded that 40% of horses received inadequate Ca nutrition whilst being maintained on high-grain diets. Furthermore, studies in Hong Kong attributed a high percentage of lameness and fractures to Ca deficiency, with an improvement in the situation when Ca supplementation was introduced (Mason *et al.* 1988). On the other hand, Krook & Maylin (1988) have suggested that racehorses in America are being given excessive Ca, which could contribute to the increased incidence of osteochondrosis and osteopetrosis due to hypercalcitoninism. Furthermore, they questioned both the National Research Council (1978) recommendations, and the view that even six times the recommended level of Ca ingestion was of no consequence.

Some cases of rhabdomyolysis have been shown to have low Ca excretion, and to respond to additional Ca in the diet. Preliminary studies indicate that the absorption of calcium carbonate (limestone) in the horse varies greatly between individuals (P. Harris, J. Gray and D. H. Snow, unpublished results). Obviously, much more detailed research into Ca requirements, and possible interactions with phosphorus and other minerals, is required in both the growing and mature working horse.

Trace elements

Iron is a much abused mineral in the equine world. Despite there being every indication that there is sufficient Fe in the diet to maintain adequate intake, most owners or trainers of competitive horses provide extra Fe, either as part of a general supplement or by itself. Fe-deficiency anaemia in a non-parasitized horse is a rarity.

Over the past few years attention has focused on copper. This has resulted from a claim that a number of skeletal bone muscle problems such as osteochondrosis result from a Cu deficiency due to excess zinc in feeds given to young growing horses (Knight *et al.* 1985). However, preliminary studies by Coger *et al.* (1987) and Young *et al.* (1987) found no interference to Cu absorption by high levels of Zn in the diet. Coger *et al.* (1987) concluded that the National Research Council (1978) recommendation of 9 μg/kg dietary Cu was adequate.

Although 1 mg selenium/d is often given via supplements to racehorses, its necessity is questionable. Snow *et al.* (1987*b*) following a study in a number of racing yards using either no or some Se supplementation, concluded that the dietary requirement may be even less than the recommendation of 0·1 μg/kg (National Research Council, 1978). Se deficiency has also been suggested as a cause of equine rhabdomyolysis; however, this was not supported in a study by Roneus & Hakkarainen (1985).

Vitamins

The various fat- and water-soluble vitamins are usually found in most pelleted feeds and complete supplements. Unfortunately there has been very little work carried out on the requirements of these in the sedentary, let alone the working horse. As with the human athlete, some very successful trainers are using megadoses of some vitamins. Recently Snow & Frigg (1987*a*) have reported on the plasma concentrations of retinol, β-carotene, α-tocopherol and ascorbic acid in the horses of two thoroughbred racing stables using various vitamin supplements.

Ascorbic acid is a vitamin of particular interest in the horse as plasma concentrations in unsupplemented horses are lower than those found in other herbivore species. Generally plasma concentrations lie between 2 and 3 mg/l, although some horses have been found to have concentrations below 1 mg/l (Snow & Frigg, 1987*b*). This level would be considered indicative of ascorbic acid deficiency in man. Whether such low plasma concentrations reflect low tissue concentrations is unknown. It has also been reported that plasma ascorbic acid concentrations are decreased in horses with respiratory viral disease (Jaeschke, 1984). Therefore, there is a possible place for ascorbic acid supplementation in the racing or performing horse. Initially it was suggested that supplementation should be via intravenous administration as ascorbic acid was only very poorly absorbed when administered orally (Loscher *et al.* 1984). However, subsequent studies by Snow *et al.* (1987*a*) have shown that, although bioavailability following oral administration is poor, plasma concentrations can be increased by oral administration of 20 g ascorbic acid daily. No adverse effects have been seen following the administration on a daily basis of such high doses throughout the racing season. In fact, one of the leading trainers in the UK administers such an amount to all his horses. Better bioavailability and more consistent absorption results when ascorbyl palmitate rather than crystalline ascorbic acid is administered (Snow & Frigg, 1987*b*). However, ascorbyl palmitate is not commercially available.

Although it has been suggested that athletes may require additional tocopherol, due to its role in the removal of free radicals, strong evidence for this does not exist. Today, pelleted feeds have added tocopherol, and it is also contained in most general supplements. From these sources the horse would get on average between 0·5 and 1·5 g tocopherol daily. In depletion and repletion studies Roneus *et al.* (1986) estimated that the α-tocopherol requirements of the non-working horse were between 1·5 and 4·4 mg/kg, i.e. 0·75–2 g/d. Interestingly, one top thoroughbred trainer in the UK feeds, without any adverse effects, over 10 g α-tocopherol daily in plasma concentrations in excess of 10 mg/l in some animals.

Although most of the B-vitamins are found in supplements, there is no information on their requirements in the exercising horse. It is generally thought that the diet and bacterial synthesis in the large intestine should meet all the requirements. For example, plasma vitamin B_{12} concentrations in the horse receiving no supplements are considerably higher than those found in man (Allen & Powell, 1983). Therefore, there appears to be no rational reason for the frequent practice of giving vitamin B_{12} injections.

In horses in racing stables, plasma folic acid concentrations are lower than in those at grass. However, despite folic acid being incorporated into many supplements, a study by Allen (1984) suggests that unless very high amounts are given there is no increase in plasma concentration.

Biotin is now used as a supplement in horses with hoof problems. It has been reported (Comben *et al.* 1984) that the addition of 10–30 mg biotin/d for 6–9 months produces varying degrees of improvement in the hardness, integrity and conformation of the hoof horn.

Carbohydrate

Because carbohydrate loading has been used successfully in human athletes it has been suggested that similar regimes be tried in horses. In the racehorse fed on a normal diet the muscle glycogen content is of the order of 600 mmol glycosyl units/kg dry muscle

(Snow *et al.* 1987*c*), about twice that in human muscle. Over flat-race distances between one-quarter and half is utilized. Recent studies have failed to show any evidence of progressive lowering during routine training (D. H. Snow and R. C. Harris, unpublished results).

Glycogen repletion rates in the horse following exercise (Pagan *et al.* 1987; Snow *et al.* 1987*c*) are much slower than those found in human muscle (Bergstrom & Hultman, 1967), though faster than those reported to occur in cattle (McVeigh & Tarrant, 1982). In addition, glycogen repletion rates and the final concentration attained appear much more resistant to dietary manipulation; supplementation of a normal diet with either 1·2 kg of a complex polysaccharide over 4 d (D. H. Snow and R. C. Harris, unpublished results), or direct intravenous infusion of 900 g glucose (Snow *et al.* 1987*c*), was without effect. Seemingly, the normal diet contains adequate carbohydrate; only when horses where fed on a carbohydrate-deficient diet consisting of just hay was the repletion rate depressed (Snow *et al.* 1987*c*).

Fat

Fat, of course, constitutes the largest energy store in the body, but the slow rate at which it is utilized casts doubt on its contribution to the general energy pool during 1–2 min racing. However, it has become increasingly popular to add large amounts of fat to the diet, and up to 160 g fat/kg is easily tolerated. Despite claims of beneficial effect on race performance it is difficult to see how this is effected.

L-carnitine

L-carnitine mediates the transfer of free fatty acids across the inner mitochondrial membrane, and during intense activity may also be involved with carbohydrate metabolism at the level of acetyl-CoA (Foster & Harris, 1987). L-carnitine is becoming increasingly popular as a supplement amongst human athletes, but has yet to gain support in horse racing, though methionine and lysine (precursers to carnitine) are included in many supplements. Ascorbic acid is a co-factor in its biosynthesis (Rebouch, 1986). Supplementation of the equine diet with doses from 10 to 60 g/d for 2 months, doubled the plasma concentration, but had no effect on the muscle content, with the possible exception of one horse (C. V. L. Foster, R. C. Harris and D. H. Snow, unpublished results). Maximum effect on plasma concentrations, using a two-dose feeding schedule, was obtained with 10 g in the morning and 10 g in the afternoon.

It is possible that L-carnitine may be of greater benefit in the nutrition of the foal. There is growing evidence that the L-carnitine biosynthetic capability in the liver of the newborn of several species is very low, and this is also probably so in the foal, as evidenced by the low plasma concentration found in this situation (C. V. L. Foster, R. C. Harris and E. Pouret, unpublished results). It is possible that L-carnitine plays an important role in the maintenance of thermogenesis in the newborn. An increase in tissue levels by supplementation would, in this case, aid both survival and early growth. Adult plasma concentrations of L-carnitine are not reached until the 3rd year.

The use of the DL-carnitine should be avoided, as the unnatural D-isomer is probably harmful to normal mitochondrial function.

In conclusion, the greatly increased interest in equine exercise physiology will inevitably bring to the market substances reputed to be ergogenic aids. Even if these are found satisfactory by the racing authorities, to gain credibility it should be demonstrated: (1) that they (or some derived metabolite) are absorbed, (2) that they (or some derived metabolite) are taken up by the target tissue, in most cases the muscles, (3) that they enhance some identifiable metabolic or physiological function and (4) that this results in an improvement in performance. Without such guidelines, equine supplements are in danger of being regarded with the same scepticism that currently surrounds many of the supposed nutritional aids used by human athletes.

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