

Advances in Equine Nutrition

Volume II

Edited by

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STUDIES OF FAT ADAPTATION AND EXERCISE

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The concept of fat adaptation - the combination of interval training and feeding a high fat diet to improve mitochondrial oxidation of fatty acids and to spare the use of glycogen and glucose - was introduced in 1973 to prevent tying-up in racing sled dogs. It was soon found also to improve stamina.

Subsequent studies of fat adaptation in horses have confirmed the protective effect against certain types of exertional rhabdomyolysis and suggested improvement of sprinting ability as well as stamina.

The balance of a ration is measured in terms of metabolic efficiency - the maximum output of the desired product (e.g., milk, work), and the minimum generation of undesired products (e.g., feces, acid, heat). For digestive and metabolic efficiency, fat > starch > fiber = protein.

In horses, optimal fat content is 40 g/Mcal DE of diet (not just the concentrate) to maximize muscle glycogen content, according to our parabolic analysis of data in literature.

Studies

- **Palatability.** Preference tests demonstrated higher palatability (voluntary acceptability) of corn oil compared to other vegetable oils and animal fats.
- **Calmness.** Spontaneous activity (pedometers) and reactivity (spook tests) were lower in horses when fed diets fortified with corn oil or mixtures of soy lecithin and corn oil.
- **Acid-base responses.** Fewer hydrogen ions and lower levels of carbonic acid were produced in fat-adapted horses during incremental exercise tests and repeated sprints. Increases in blood lactate contributed to acidosis during rest-work transition (sprints 1-3) but not during work adapted phase (sprints 3-9). The blood pH was dependent more on carbon dioxide tension, that is, respiratory regulation, than on blood lactate accumulation, that is, metabolism.
- **Lactate threshold.** The speed at which blood lactate concentration began to increase sharply during an incremental exercise test was higher in fat adapted horses (interval trained for 11 weeks while fed a 12%

fat diet) than in controls. Unlike maximal tests, such as VO_2max determination, this submaximal test could be used to predict the metabolic potential of an unfit horse and to monitor fitness of horses in training.

- **Metabolic regulation.** In fat adapted horses, blood lactate concentration was higher during anaerobic work but lower during aerobic work. These results suggest that glycolysis is enhanced during anaerobic work, which would enable sprinting, but suppressed during aerobic work, which would confer stamina.
- **Respiratory load.** Lower CO_2 production in fat adapted horses during strenuous exercise would reduce the mechanical effort of respiration and the stimulus for panting. Thus fat adaptation may be beneficial in horses with mildly compromised pulmonary functions (EIPH, COPD), especially in hot and humid conditions.
- **Calcium.** Bone mineral density (BMC) increased about 6% in 12 weeks interval training in horses fed twice the NRC requirement but not in those fed the NRC recommendation, which appears to be inadequate. On the other hand, dietary calcium did not affect a similar loss of BMC during de-training. Since BMC correlates with bone strength and elasticity, these results suggest that BMC loss during lay-ups may increase the risk of skeletal injury upon resumption of training. In these experiments, changing chloride, hence dietary cation-anion difference (DCAD), had little effect on BMC.
- **Protein.** Lowering dietary protein raises the DCAD without depleting chloride, which may be needed for sweating. Low protein diminishes generation of acid, heat and urea, hence spares water. Protein, 30 g/Mcal fortified with lysine and threonine, is being tested against protein, 50 g/Mcal.
- **Bowel ballast.** A bioenergetic model was developed for a 500 kg equine athlete using 36 Mcal ME/day. In the model, a hay:oats:oil (45:45:10) diet compared to hay and oats (50:50) produces about 2 Mcal less heat per day, requires about 6 L less water per day, and carries about 12 kg less bowel ballast (dead weight in the large bowel). About 4 L less water in the bowel ballast is available for absorption, and this potential disadvantage must be weighed against the advantages noted above.
- **Safety.** Horses have been carefully observed by veterinarians for 34 weeks with no sign of adverse effects when fed these complete feeds.