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A Complex Case: ’Designing A Ration For A Horse With Both Muscle Problems And Insulin Resistance

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Introduction

During this presentation, practical tools will be offered to cope with more difficult nutritional cases. In practice, an individual horse often has more than one ‘problem’ that needs nutritional advice. 1) This can simply be, a certain disease state in combination with an abnormal body condition score (BCS): too thin, or being overweight or obese. Consequently two horse with a similar disease state but with a different BCS may need quite a different feed advice. 2) The same is true for the level of activity. Some horse with clinical problems will still be able to perform at a certain level whereas others will not be able or owners do not want to work the horse. The level of activity will of course also influence the clinical feed advice. 3) The horse may also have more than one clinical problem that needs nutritional adaptation. Sometimes the nutritional solution for the combined problem is easy whereas in other cases it may be impossible to formulate an ideal diet that takes into account the nutritional guidelines for both problems. In that case, the nutritionist will need to look for the best possible solution.

In the present presentation, this will be illustrated by a hypothetical case were muscle problems are combined by insulin resistance. Also BCS and level of performance will have a clear influence on the diet that will be prescribed to the individual patient. First the nutritional advice for both muscles problems and IR will be discussed separately. Afterwards, a combined feed advice, taking into account all factors that influence the nutritional requirements will be given.

Diets for Muscle Problems

Chronic exertional myopathy is a syndrome of recurrent muscle damage that is associated with exercise. In horses it frequently results from underlying heritable myopathic conditions such as recurrent exertional rhabdomyolysis (RER) and polysaccharide storage myopathy (PSSM) (Valberg et al., 1996; 1999; McKenzie and Firshman, 2009). PSSM is characterized by increased glycogen concentrations in the skeletal muscles (Valberg et al., 1992) whereas RER is due to a heritable defect in intracellular calcium regulation (Lentz et al., 1999; 2002). Although underlying ethiologies and pathogeneses of both diseases are quite different, general nutritional advise can be given for both: reducing the intake of soluble carbohydrates and instead accurately meeting energy requirements by fat.
and fibers and meeting vitamin and mineral requirements (McKenzie and Firshman, 2009). When consuming diets with substantial amounts of non structural carbohydrates (NSC), horses with exertional rhadomyolysis are likely to develop muscle necrosis, despite the ethiology (McKenzie et al., 2003; Ribeiro et al., 2004; Mcleay et al., 2000). In PSSM high NSC intake might increase glucose uptake and glycogen storage in the muscle. In RER high NSC intake might increase excitability which is a strong trigger for rhadomylosis in these horses (McLeay et al., 1999). In contrast to PSSM, RER horses only benefit from dietary fat supplementation when energy requirements are high (McKenzie and Firshman, 2009). Also the recommended amount of fat supplementation is different for both underlying ethiologies. Since this topic is discussed in depth elsewhere in the proceedings, we refer to Valberg et al. (2011) for more details on this topic.

A Diet for IR

Insulin resistance (IR) refers to a state of reduced response of insulin sensitive cells to normal insulin concentrations (Kronfeld et al., 2005) and is linked to laminitis (Treiber et al., 2006a) and exertional rhabdomyolysis (Valentine et al., 2001). IR is one of the key factors in equine metabolic syndrome (EMS) or pre-laminic syndrome and is, together with obesity, associated with a high risk for laminitis (Geor and Frank, 2009, Geor, 2009, Geor and Harris, 2009). How exactly endocrinological and metabolic influences result in laminitis is still not completely clear (Johnson et al., 2010; de Laat et al., 2010). However, the dietary treatment of a horse with laminitis is based on two mile stones 1) prevent or treat IR and 2) reduce the intake of non structural carbohydrates (NSC).

1) Reduce the intake of non structural carbohydrates (NSC).

Intake of too much NSC (starch, sugars, fructans) can increase postprandial glucose and insulin concentrations but may also affect the large intestinal flora. A high amount of fructans or an overload of starch will both result in a change in gastro-intestinal flora, reduced intestinal pH, increased permeability with as a consequent absorption of laminitis triggering factors such as bacterial exotoxins, endotoxins and vasoactive amines (Geor, 2010; Treiber et al., 2006b; Bailey et al., 2004). Therefore, it is advised not to give more than 1.1g starch/kg BW/meal and to use forage with less than 10% NSC. As a consequence, grains and sweet feeds cannot be fed. Pasture access should be denied at certain times of the year, since NSC content can reach 30-40% of the dry matter (Geor and Harris, 2009). Commercial laboratories use a number of different analytical techniques and terminologies for NSC (Geor 2009). NSC can be defined:

-By difference:
  \[ \text{NSC} = 100 - (\text{crude protein}\% + \text{nutrient detergent fiber}\% + \text{moisture}\% + \text{crude fat}\% + \text{crude ash}\%) \]

-By analysis
  \[ \text{NSC} = \text{watersoluble carbohydrates (WSCs)} + \text{starch (enzymatic assay)} \]
NSC = ethanol soluble carbohydrates (ESCs) + starch (enzymatic assay)

2) Prevent or treat IR
Obesity has been associated with IR and laminitis and is thus an important factor to treat (Frank et al., 2010). The prevalence of overweight and/or obesity is high in horses and pony’s: 19% (Tatcher et al., 2007) - 45% (Wyse et al., 2008). To evaluate the body weight, a subjective BCS can be used (Henneke et al., 1983). One disadvantage of using the BCS is that regional adiposity may be overlooked. Therefore the cresty neck score was introduced as well since a cresty neck seems to correlate with decreased insulin sensitivity (Frank et al., 2006; Carter et al., 2009). In treating IR, reversing overweight or obese status by decreasing energy intake and increasing energy expenditure, is very important (Powell et al., 2002). On the other hand it is also important not to reduce energy intake too much at once, since that can be associated with IR, hyperlipidemia and hepatic lipidosis (Johnson et al., 2010; Waitt and Cebra, 2009). However, it has been shown that a gradual decreased energy intake at a level of 35% of maintenance requirements was necessary to lose BW at a rate of 1% per week (Van Weyenberg et al. 2008). None of the 9 ponies had any signs of hyperlipidemia and insulin sensitivity was improved significantly after 17 weeks of weight loss. It is also important that only energy intake is reduced, and those intakes of all other essential nutrients are at recommended levels. Pasture grazing should be discontinued since reducing grazing time did not reduce body weight significantly since grass intake increased in response to the decrease grazing time (Buff et al., 2006).
Several studies show a positive effect of activity on IR (Gordon et al., 2007; Powel et al., 2002; Stewart-Hunt et al., 2010; Treiber et al., 2006b). It is important to increase activity gradually and to stimulate activity on a regular basis.
In human’s magnesium and chromium supplements have a positive effect on IR. There are no studies on the effect of magnesium supplements on IR horses and consequently current recommendations are to meet maintenance requirements. Vervuert et al. (2010) noted a positive effect of chromium supplementation after an oral starch test in hyperinsulinemic pony’s and horses. However, more studies are necessary before chromium supplementation can be recommended in IR horses and pony’s.

Combination Diet
Looking at the nutrient profile for muscle problems and IR, there no clear contradictions. In fact reducing the intake of NSC is an important factor in both disease states. However, replacing NSC by fat might be a problem for overweight and obese horses. In RER horses, fat supplementation is only warranted if energy requirements are high. In contrast, it might be more challenging to design a ration for an overweight IR horse with PSSM.
References


