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HARRY WHITTINGTON

"I actually had no aspirations to be a trainer whatsoever"

EUROPEAN TRAINERS' FEDERATION

THE IMPORTANCE OF STABLE VENTILATION

WHAT IS EQUINE WELFARE?

THE IMPACT SADDLES HAVE ON PERFORMANCE

NO GUTS NO GLORY!

Can we increase the efficiency of the digestive system through dietary and supplementary manipulation in order to alter performance and recovery?

Catherine Rudenko Alamy, Catherine Rudenko

The idiom 'no guts, no glory', when taken in the literal sense, is quite an appropriate thought for the racehorse. The equine gut is a collection of organs, which when in a state of disease, causes a multitude of problems; and when functioning effectively, it is key for conversion of food to fuel and maintaining normal health.

In the same way we consider how fuel-efficient our car engines are, what power can be delivered and the influence of fuel quality on function, we can consider the horses' digestive anatomy. The state of the 'engine' in the horse is critical to the output. What is fed or supplemented, and the manner in which we do so, has fascinating and somewhat frightening effects on efficiency and recovery.

We now, in a human context, have a much better understanding of the relationship between the gut and states of disease. Before disease in a notable sense is present, we see loss of function and reduction in performance. With equines, in recent years, the focus has fallen toward ulceration and the stomach. Now interest is growing into the small and large intestines, looking at factors that influence their performance and in turn how this affects performance on the track.

In order to consider how we can positively influence gut function, first we need to understand its design and capability,

or lack of capability which is more often the problem. The horse, by definition, falls into the category of a large nonruminant herbivore—the same grouping as rhinoceroses, gorillas and elephants. The horse is well designed for a fibre-based diet, as reflected by the capacity of the large intestines, yet we must rely heavily on the small intestine when feeding racehorses. Health and function of both small and large intestine are important and are connected.

Small Intestine

The small intestine is a relatively short tube of approximately 25m in length—the same length as found in sheep or goats. The primary role of the small intestine is the digestion of protein, fats and carbohydrates. The workload of this organ is significant and is also time constrained, with feed typically moving at a rate of 30cm

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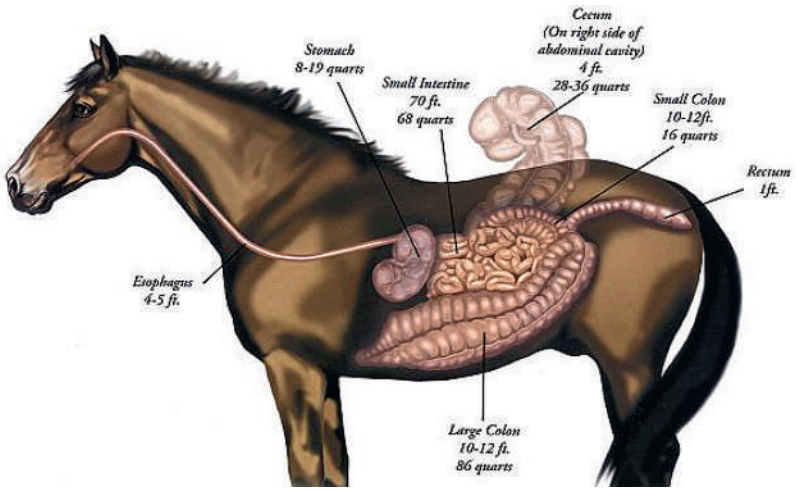
per minute (1). The rate of passage is highly influenced by whether the stomach was empty before feeding, or if forage has recently been consumed. The advice of feeding chaff with hard feed is in part to the slow rate of passage and give further time for the processes of digestion.

The mechanisms for digestion in the small intestine include pancreatic juices, bile and enzymes. Of particular interest are the various enzymes responsible for digestion of protein and carbohydrates— the key nutrients often considered when choosing a racing diet. The ability to digest carbohydrate, namely starch, is dependent on two factors: firstly, form of starch and the level of alpha-amylase—a starch-digesting enzyme found in the small intestine. Whilst the horse is quite effective in digestion of protein, there are distinct limitations around digestion of starch.

Starch digestion, or lack of digestion in the small intestine, is the area of interest. When feeding, the aim is to achieve maximum conversion of starch in the small intestine to simple sugars for absorption. This is beneficial in terms of providing a substrate readily available for use as an energy source and reducing the ill effects seen when undigested starch moves into the next section of the digestive tract. Alpha-amylase is found in very limited supply in the equine small intestine—the amount present being only approximately 5% of that found within a pig. Despite a low content, the horse can effectively digest certain cereal starches, namely oats, quite effectively without processing. However, other grains commonly used, (e.g., barley and maize [corn]), have poor digestibility unless processed. Flaked, pelleted or extruded cereals undergo a change in starch structure enabling the enzyme to operate more effectively.



Processing grains whilst improving digestion does not alter the amount of enzyme present in the individual. An upper limit exists on starch intake, after which the system is simply overloaded and the workload is beyond the capacity of the naturally present enzymes. The level is estimated at 2g starch per kilogram of bodyweight in each meal fed. In practice, this translates to 3.5kg (7 $\frac{3}{4}$ lbs) of a traditional grain-based diet of 28% starch. In bowls, this is roughly 2 bowls of cubes or 2 $\frac{1}{4}$ bowls of mix—an intake typical of an evening feed. The 'safe limit' as a concept is questionable because of other factors involved in starch digestion, including how quickly a horse will eat their feed, dental issues and individual variation in the level of alpha-amylase present.

In practice, feeding racehorses will invariably test the capacity of the small intestine as the volume of feed required to meet the demands of training is significant, and through time constraints of both horse and human results in a large-sized evening meal. The addition of amylase or other enzymes to the diet is therefore of interest. Addition of amylase is documented to increase digestion of maize (corn)—one of the most difficult grains to digest—from 47.3% to 57.5% in equines (2). Equally, wheat digestion has been evidenced to improve with a combination of beta-glucanase, alpha-amylase and xylanase in equines, increasing starch digestion from 95.1% to 99.3% (3).

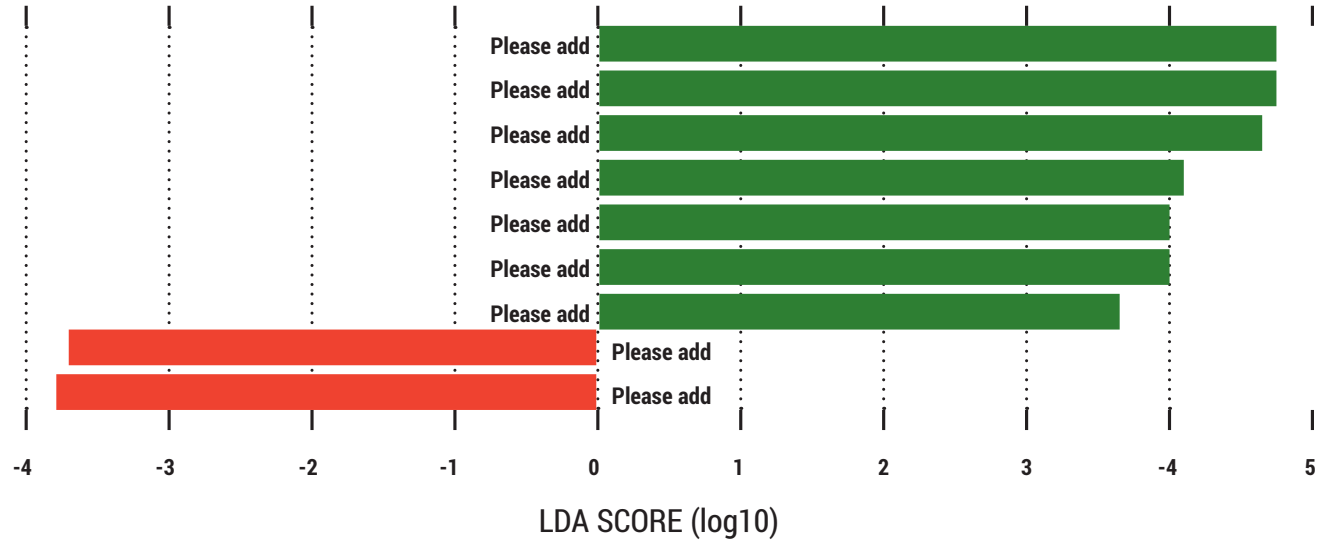
Use of enzymes in the diet has two areas of benefit: increasing starch conversion and energy availability, and reducing the amount of undigested starch that reaches the hindgut. The efficacy of the small intestine directly impacts the health of the large intestine—both of which influence performance.

Large Intestine

The caecum and colon, of which there are four segments, form the group referred to as the hindgut. Their environment and function are entirely different to that of the small intestine. Here, digestion is all about bacterial fermentation of the fibrous structures found in forages and parts of grains and other feed materials. The time taken to digest foodstuffs is also significantly different to that of the small intestine, with an average retention time of 30 hours.

The end result of fermentation is the production of fatty acids, namely acetate, butyrate and propionate—the other by-product of fermentation being lactate. The level of fatty acids and lactate produced is dependent on the profile of bacteria found within the gut, which in turn react to the type of carbohydrate reaching the hindgut. There are markedly different profiles for horses receiving a mostly fibre-based diet compared to those with a high-grain intake (see opposite).

The interaction between the microbial organisms and metabolism, which directly influences health and disease, is gaining greater understanding. By looking at the faecal metabolome, a set of small molecules that can be identified in faecal samples, and the categories



Linear discriminant analysis indicating significant differences in relative abundance of nine bacterial genera before and after supplementation. Red bars show greater abundance before supplementing, and green bars show greater abundance after supplementing. (4)

of bacteria in the gut, it is possible to investigate the interaction between the individual horse, its diet and bacteria. Of course, the first challenge is to identify what is normal or rather what is typical of a healthy horse so that comparatives can be made. Such work in horses in training, actively racing at the time of the study, has been carried out in Newmarket.

Microbiome is a term used to describe microorganisms, including bacteria, that are found within a specific environment. In the case of the horses in training, their microbiome was described before and after a period of dietary intervention. The study evidences the effect on the hindgut of including an enzyme supplement, ERME (Enzyme Rich Malt Extract). The table below shows changes in nine bacterial groups before and after supplementation.

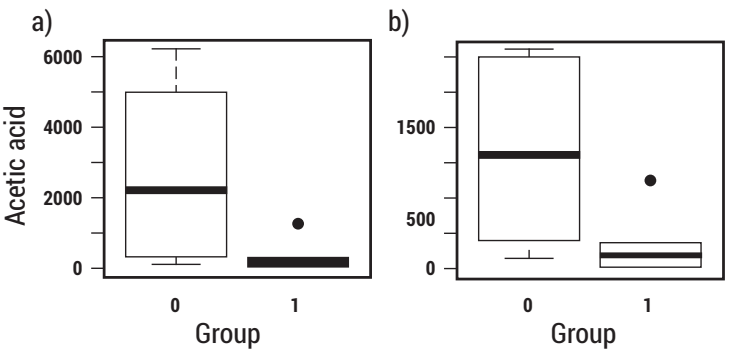
Along with changes in bacterial abundance, which were relatively small, came more significant changes within the metabolome. The small molecules found in the metabolome are primarily acids, alcohols and ketones. Of particular interest, and where statistical significance was found, were changes in acetic acid and propionic acid evidencing an effect on the digestive process.

Whilst production of fatty acids is desired and a natural outcome of fermentation, further work is needed to determine what is an optimum level of fatty acid production. This study of horses in training is an interesting insight into an area of growing interest.

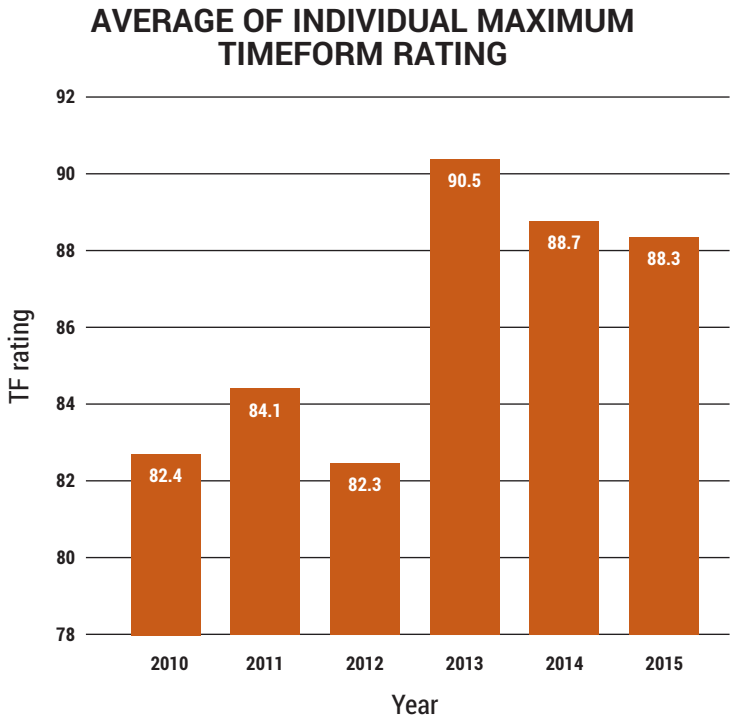
Effects on Performance & Large Intestine Function

We know that starch should ideally be digested in the small intestine and have evidence as to some of the ill effects seen when large quantities reach the large intestine. It is accepted that dietary changes influence microbial changes, and such changes are related to health status in many species. What is less well documented is the direct effect on the performance of manipulating starch digestion. It is logical to assume good health equals good performance, but data is scarce as to whether dietary manipulation could really be performance enhancing.

For the above-mentioned enzyme supplement, a field study to consider effects on performance took place following a flat yard—a minimum of 35 horses—over three seasons. The study was based on Timeform racing performance of the individuals and then averaged across the yard for each season. The three seasons of 2013, 2014 and 2015 whilst supplemented were compared to the three previous years from 2010-2012 where no supplemented was given. The average rating increased from 83.0 to 89.2 across the yard. Field studies are always challenging, having a control group without supplementation is not always practical, and so as in this case, the study is for all horses over a period of time to



Changes in abundance of acetic and propionic acid in 6 thoroughbred horses following dietary supplementation with malt extract. 0 = horses before supplement, 1 = horses after supplementation (4)



Changes in average Timeform rating for years without supplementation (2010-2012) and years with supplementation of enzymes from malt extract (2013-2015). (12)

compare the whole yard's performance. The results of this study are positive in terms of identifying an effect of dietary intervention and monitoring of performance.

Other approaches to influencing bacterial profile are through the use of probiotics and prebiotics, and these are already commonly found in the feed room. Probiotics include bacteria and yeasts designed to promote the development of 'beneficial' bacteria in the gut. Prebiotics are also frequently supplemented and include specific sugars, namely FOS (fructo oligosaccharides) and MOS (mannan oligosaccharides). Their use is recommended where gut health is challenged, or poor health already exists, as the benefit to a healthy thriving gut is questionable. Racehorses, through the training and feeding regimes required, are considered to operate in a challenging environment and so use is likely warranted.

The probiotics *Lactobacillus* species (bacteria) and *saccharomyces cerevisiae* (yeast) have been proven to survive the acidic environment of the stomach and successfully progress to the large intestine. Yeast is documented to improve digestion, specifically of dry matter and the minerals magnesium, potassium and phosphorus (5). In terms of performance, evidence exists for studs around improved milk quality and foal growth (6,7). Yeast is often supplemented within racing diets, although not all brands include this probiotic as standard. *Lactobacillus* has been considered more from a stud perspective looking at its role in reducing diarrhoea in foals.

FOS as a prebiotic has reports of clinical benefits related to reducing the incidence of colic (8) and is proven to modify the balance of bacteria found in the large intestine (9). Aside from direct benefits to the hindgut itself, studies are proving links between immune response and gut profile when supplemented. Studies in pigs and broilers have evidence improved immune response when supplemented with FOS, and an initial equine study looks promising although more work is needed (10).

MOS operates in a different manner to FOS, helping to reduce pathogen adherence to the intestine lining. Its beneficial effects come from the ability to safely bind and eliminate certain pathogens from the gut. MOS as a substance is used in many species including humans, dogs, poultry and equines. It too can influence immune response, and most work focuses on influencing the mother and her offspring in various species. In equines, mare IgA and colostrum IgA, IgM and IgG antibodies have been evidenced to improve following supplementation (11).

Summary

The health status and efficacy of both the small and large intestine are of significance when considering performance. Whether directly monitoring the effect of a dietary intervention on racing results, the improvement of nutrient conversion, the microbiome, immune response or effect on presence of pathogens, the manner in which we feed and what we supplement is of importance.

Use of enzymes, prebiotics or probiotics is an area that warrants consideration when looking at how to get more from the gut and also when wanting to reduce the risk of colic or presence of pathogens. Each of these categories of supplements has a different mode of action, and so one is not per se better than another. There is still more needed in terms of equine-specific research, particularly around direct links to on-track performance following supplementation, but what is there is promising, and the benefits already documented are relevant and worthy of attention. T

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