

'Live yeast for horses'

BY GÉRARD BERTIN AND ELINOR McCARTNEY

Research in the USA and France indicate that, for certain mechanisms, live yeasts have similar modes of action in both ruminants and non-ruminant herbivores, such as horses. However, in horses the main site of live yeast action is the hindgut where positive effects on the caecal and colonic microflora lead to improved digestion of both high-fibre and high-energy feeds. These effects reduce the risk of caecal and colonic dysfunction, with resulting benefits for all equines, including breeding stock and horses in training.

A specific strain of *Saccharomyces cerevisiae* already was widely used in animal feeds in many countries and had been awarded provisional European Union approval for food-producing ruminants, including calves, cattle for fattening, and dairy cows. However, a separate, dossier was required for provisional EU approval for use in horses (see box). Further

In horses, live yeasts act primarily on caeco-colonic microflora and digestion. In cattle, they act on microbes and digestion in the rumen.

efficacy studies are now running under EU conditions in order to achieve permanent EU authorisation for this live yeast strain in horses. These studies are an opportunity to build on previous research in this area, as well as an obligatory requirement for final EU approval.

The basic EU efficacy claim for this yeast strain as a live microbial product is increased fibre digestion—cellulose and hemicellulose—in the caecum of the horse. The supporting data indicate an increase in acetate (C2) concentrations and an increased ratio of acetate +

butyrate (C2+C4) to propionate (C3).

In addition, there is an increase in fibrolytic activity, which seems unrelated to the enzyme activities identified. The product reduces the risk of dysfunction due to acidosis in the hindgut, and allows flexibility to increase energy incorporation in the diet.



Live yeast supplementation helps equine athletes to meet their great need for energy from high-starch diets, without provoking colic or laminitis. Live yeast also enables increased milk production in mares and helps support optimum growth in nursing foals.

Live yeast—modes of action in ruminants

Research of live yeasts in ruminants is much further advanced than in equines, which are non-ruminant herbivores. Several milestones appear in the published literature:

- Yeast cultures must be metabolically active to be effective (Dawson *et al.*, 1990; El Hassan *et al.*, 1993);
- Live yeast strains vary in efficacy, as in efficiency, effectiveness, and breadth of action (Dawson and Hopkins, 1991; Newbold and Wallace, 1992; Newbold *et al.*, 1995);
- Live yeast optimises rumen pH by stimulating lactic acid utilising bacteria (Williams *et al.*, 1991; Girard *et al.*, 1993; Chaucheyras *et al.*, 1995);
- Live yeast scavenges oxygen in the rumen, reducing redox potential (Jouany *et al.*, 1994; Newbold *et al.*, 1996);
- Live yeast provides peptides and amino acids and

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Table 1. How do live yeasts act in ruminants?

Research-based hypothesis	Comment
Uptake of glucose	Live yeasts uptake glucose from rumen fluid thus inhibiting lactic-acid-producing bacteria (such as <i>Streptococcus bovis</i>). Less lactic acid is produced.
Scavenges oxygen in the rumen (reduction of redox potential)	Oxygen is toxic to many beneficial rumen cellulolytic bacteria, which are strict anaerobes.
Creation of a stable microclimate and substrate for growth of desirable microbes	Live yeast cells are large compared with many rumen micro-organisms, so could provide a useful "physical platform" for microbial growth.
Provision of nutrients (e.g. peptides, vitamins, amino acids)	Yeast cell wall breakup may partly explain positive effects, but not completely because dead yeasts also provide nutrients but are not as effective as live yeasts, which boost the activity of lactic-acid-consuming bacteria, such as <i>Megasphaera elsdenii</i> .
Produce specific peptides and nutritional cofactors	Research suggests a dynamic equilibrium where yeast peptides boost logarithmic growth of micro-organisms.

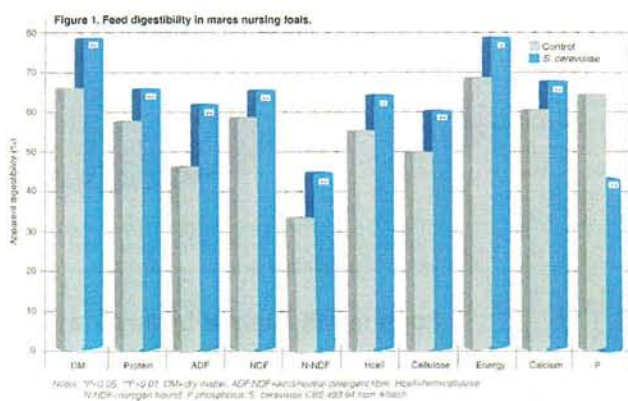


Table 2. Summary of French research in horses

Effects of high starch diets in equine hindgut	Comment
Increases caecal anaerobes and lactic acid-using bacteria	When excess starch is fed, residual starch in the hindgut provokes a dysfunction in the caecum and colon, resulting in lactic acid accumulation, low (acidic) pH, a decrease in cellulolytic bacteria, and digestive disorders such as colic and enterotoxaemia.
Decreases cellulolytic bacteria in caecum	
Increases lactobacilli and streptococci	
Increases lactic acid, decreases pH	
Decreases ratio of acetate/butyrate/propionate	
Effects of live yeast supplement in equine hindgut, primarily caecum	Comment
Stimulates total anaerobes and increases % of cellulolytic bacteria	Main effects occur in high fibre diets, thus improving fibre digestion
Modifies ratio of acetate/butyrate/propionate in colon	
Stimulates lactic acid-using bacteria	Main effects occur in high starch diets, thus reducing the risk of digestive or related disorders
Reduces lactic acid, increases pH	
Reduces caecal ammonia	
Increases caecal cellulolytic activity	Effects occur in both high fibre and high starch diets
Reduces variation in microbial numbers (lower SD)	Results in a more stable hindgut bacterial balance and fermentation.

Notes: *SD=standard deviation

increases the numbers of cellulolytic bacteria (Dawson and Hopkins, 1991; Chaucheyras *et al.*, 1993; Girard and Dawson, 1994; Girard, 1996);

- Live yeast promotes the growth of beneficial rumen bacteria, including cellulolytic and lactic acid utilising bacteria (Matthieu *et al.*, 1996; Newbold *et al.*, 1996; Wallace and Newbold, 1992);

- Live yeast improves dry matter (DM) intake by accelerating fibre digestion in the rumen (Dawson and Hopkins, 1991; Smith *et al.*, 1993; Kumar *et al.*, 1997); and

- Live yeast supports protein synthesis by boosting microbial protein turnover in the rumen and flow into the small intestine (Erasmus *et al.*, 1992).

But, exactly how does a specific live yeast strain work effectively in ruminants which are not natural hosts? To produce yeast biomass, optimal conditions for growth are pH 4.5, at 32°C, in a medium rich in sugars, vitamins, trace elements, and with high oxygen concentration. The biomass production is largely exothermic due to production of ATP (38), and the biggest challenge is maintaining the temperature.

By contrast, when a live yeast is administered to ruminants, very different, non-optimal conditions prevail—pH 6–6.6, 39°C, and low redox potency (-250–300 mV). How does the yeast survive and provide benefit to the animals?

Current research-based hypotheses suggest that the yeast survives through uptake of glucose and oxygen, and that certain live yeast strains can stabilise rumen function by these means (Table 1). Under these conditions, however,

there is a secondary effect that also helps to stabilise the rumen. The double-walled yeast cell breaks down, releasing peptides and vitamins into the rumen medium. These nutrients or nutritional co-factors promote growth of bacteria, particularly increasing the numbers of cellulolytic bacteria.

Modes of action in horses

How does a specific live yeast strain work effectively in horses, which, like cattle, are not natural hosts of yeast?

Several papers published in the late 1980s and early 1990s in breeding mares and yearlings in the USA showed that live yeast improves feed digestibility (Glade and Biesik, 1986; Glade and Sist, 1988; Glade 1991a; Glade 1991b; Glade 1991c). Researchers speculated that improvements in digestibility are linked to the capacity of yeasts to improve microbial fermentation of fibre, and in horses such processes take place in the hindgut (Figure 1).

More than a decade later, French scientists provided convincing evidence to confirm this hypothesis, demonstrating numerous similarities between the modes of action of live yeasts in horses and ruminants (Medina *et al.*, 2000, 2001, 2002). The *Saccharomyces cerevisiae* with provisional approval in the EU increased the concentration of total anaerobic bacteria and lactate users in the hindgut. This was concordant with an increase in lactate utilisation. Enzymatic activities, such as xylanase, CMCase, and xylosidase were significantly increased in the caeco-colonic system, especially in

A diet high in starch or rapid fermentable sugars (RFS) leads to sub-clinical acidosis in the caeco-colonic section of the equine gut.

Live yeast in EU: Specific strain, specific approval

The European Union's 2000 White Paper on Food Safety led to sweeping EU legislation affecting the food chain, with a strong focus on health, welfare and safety of all components of that chain, including animals, workers, consumers, and the environment. The EU aspires to the highest standards of food safety, globally, and EU feed additive registration is now the toughest in the world. By way of contrast, in the USA, live cultures such as bakers' or brewers' yeast, for example, may be fed to all animals as "generally recognised as safe" or GRAS feed ingredients, requiring no special approval process. However, in

the EU, an exacting, strain-specific registration process is required, covering safety, identity, and efficacy for each target animal category.

Therefore, even though a specific strain of *Saccharomyces cerevisiae* already had been awarded provisional EU approval for food-producing ruminants, including calves, cattle for fattening, and dairy cows, a separate, equine dossier was required for provisional approval for use in horses. This equine live yeast dossier included both safety and efficacy sections, with an abridged identity section covering stability in feeds and premixes.

Thus, the product *S. cerevisiae*

NCYC1026-CBS 493.94-EC n° 5 (Yea-Sacc®1026 from Alltech) was the first live yeast culture to achieve provisional EU approval in horses (OJ Regulation n° 490/2004). To date, this yeast strain has been provisionally approved in the EU for all classes of horses from 2 months post-weaning onwards, including pregnant mares.

Permanent EU authorisation of this product requires further significant efficacy studies under different EU husbandry conditions. Fortunately, this work is another opportunity to build on current knowledge concerning the use of live yeasts in horses. ■

In the caecum, live yeast supplementation increases microbial cellulolytic activity and reduces negative effects of sub-clinical acidosis and the incidence of colitis.

the caecum, when the live yeast was added to the feed. Essentially, live yeasts act primarily on caeco-colonic microflora and digestion in equines, but on ruminal microbes and digestion in the rumen of ruminants.

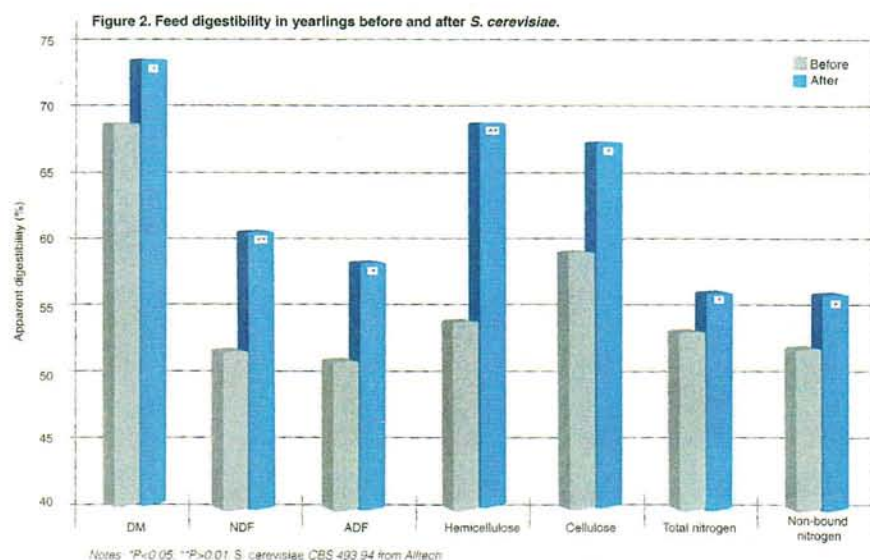
Specifically, the French studies contributed useful insights into the problem of high-starch diets in horses. Race horses and other equine athletes require high-energy diets to meet the demands of training and performance. However, cereal-rich diets are frequently implicated in colic or laminitis, which at worst mean death or euthanasia for the affected animal, and often result in long periods off work, thus ruining a promising equine career.

The main findings of the French research point to how live yeast may help equine nutritionists, owners and trainers to meet the equine athlete's need for energy, without provoking disastrous incidents of colic or laminitis (Table 2).

These findings also illustrate the parallel with ruminants. Whereas live

yeasts fed to ruminants help to reduce the incidence of acidosis and bloat, in horses there seems to be a preventive effect in relation to colic and other problems which also result from excess dietary starch. In horses, a diet with high starch and/or rapid fermentable sugars (RFS) leads to sub-clinical acidosis in the caeco-colonic section of the gut. Growth of certain micro-

bial populations—including some pathogenic populations—accelerates to the detriment of other populations, resulting in a reduction of fibrolytic activity. Live yeast supplementation influences microbial populations in the caecum, increasing cellulolytic activity and reducing negative effects of sub-clinical acidosis and the incidence of colitis.



The stabilising effect of live yeast on hindgut fermentation in the equine allows trainers to feed a larger amount of starchy cereals to provide that energy, with a lower risk of colitis, enterotoxaemia, or laminitis. Thus equine athletes have a better chance to stay in training, keeping fit and healthy, so that they can fulfill their genetic promise.

Mares with nursing foals

The most consistent effect of live yeast supplementation in horses is improved feed digestibility, particularly in mares (Figure 1) and yearlings (Figure 2). American research has evaluated the benefits of such improvement in mares and foals (Glade 1991a; Glade 1991b; Glade 1991c). Live yeast supplementation gave a 12% boost to milk production in mares, and the milk produced was more nutritious for the foal, since it contained more energy and protein, resulting in improved nutrient intake and better growth (Figures 3-5).

Thus supplemental live yeasts help nursing foals start life with optimum growth. This is particularly important for thoroughbred foals, which are officially classed as yearlings on 1st January, and which will be racing as three-year-olds, long before they reach physical maturity.

In comparison with the vast number of research papers published in relation to live yeast supplementation of ruminant feeds, there is relatively little published data on horses. These initial results are encouraging and scientists are now targeting research at defining more clearly the mechanisms by which live yeasts work in the equine hindgut. This is the subject of the second phase of work with the first strain of *S. cerevisiae* to achieve provisional EU approval for use in horses, since for definitive EU authorisation additional significant and convincing data will be required. **fi**

Complete references for this article are available from Dr. Gérard Bertin, gbertin@alltech.com.

Figure 3. Daily intakes of nursing foals.

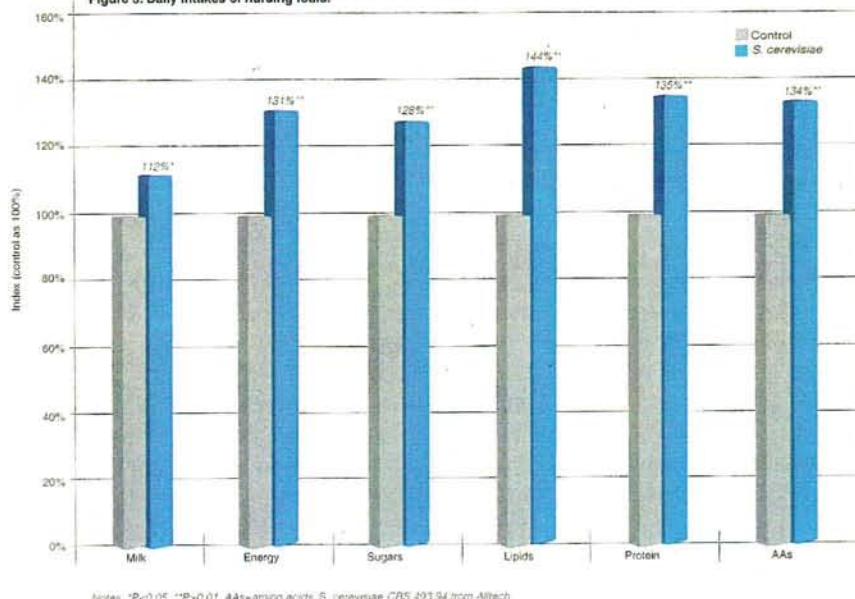


Figure 4. Growth of nursing foals.

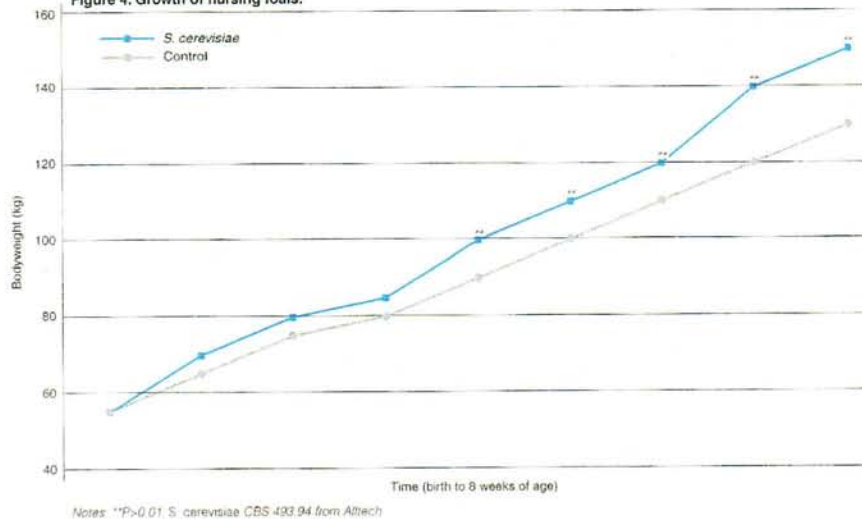


Figure 5. Height at withers of nursing foals (cm).

