In vitro fermentation kinetics of a range of alternative forages, and their suitability as forage feeds for horses

Catherine E. Hale[1] and Charles J. Newbold[2]

Writtle College, Writtle, Chelmsford, Essex[1] and Institute of Rural Sciences, University of Wales, Aberystwyth[2], UK

Introduction

Traditional forage-based diets of hay and grass are unable to provide domesticated equidae with the energy required for the athletic performance and draught work imposed by man. It is therefore deemed necessary that horses with a high energy demand are fed cereal-based concentrate foods that are usually high in starch. A practice that may induce metabolic disorders such as laminitis (*Bailey* et al. 2004, *King* and *Mansmann* 2004). A forage that is of superior quality, and one which would enable the animal to meet the energy demands of work, would be a preferable food to replace some, if not all, the concentrate portion of the diet.

It has been identified that red clover is a palatable high energy component of animal pastures (*Rutter* et al. 1998) and recently its popularity as an ensiled product has increased. It has been found that when fed to ruminant animals, ensiled red clover leads to an increase in both voluntary feed intake (VFI) and animal production, and it has been found to have a higher D-value, when compared to grass silage, (*Freudenberger* et al. 1994, *Rutter* et al. 1998). Recent studies have shown that when fed to ponies, red clover silage had a significantly higher apparent digestibility and VFI than either grass silage or hay (*Hale* and *Moore-Colyer* 2001). Indicating that red clover inclusion might increase the energy density of equine diets, thus removing the need to rely on starch based supplements such as cereals.

The aim of this study was to investigate the potential benefits of several alternative forages as suitable feeds for horses. Degradation of ensiled products (red clover, white clover, perennial rye grass, lucerne, and clover/grass mixes), were estimated using in vitro gas production techniques.

Materials and methods

Two experiments were carried out to examine in vitro fermentation kinetics of a range of alternative forages, in order to assess their likely suitability as forage feeds for horses. The substrates used in each of the experiments were: Experiment 1 – big bale red clover silage (RCS), big bale perennial rye grass silage (GS) and seed hay (H); Experiment 2 – RCS, GS, H, big bale white clover silage (WCS), big bale lucerne silage (LS), big bale red clover and perennial rye grass silage (RCS+G) and big bale white clover and perennial rye grass silage (WCS+G). The extent and rate of degradation of the all the forages tested was measured using the gas production technique as described by *Theodorou* et al. (1994). Substrates were tested either with, or without pepsin pre-treatment (substrates incubated at 40 g DM/l in pepsin HCL solution, 2 mg/ml pepsin in 0.075 M HCL, for 2 h at 39°C and extensively rinsed prior to use). Substrates (400mg ground and freeze dried) were incubated in a faecal slurry (50 ml) at 39°C and gas production measured over a 96 h period using the gas transducer technique (*Theodorou* et al. 1994). Faecal slurries were prepared from faeces collected prior to the morning feed from five horses fed a mixed concentrated forage diet. The faeces were mixed with anaerobic buffer, as described by *Theodorou* et al. (1994) (1:2 w/v) and strained through 4 layers of muslin prior to use. Each substrate was incubated, in duplicate, with the slurry from each horse (n=5).

Results

Experiment 1

It was found that the extent of gas production from red clover and grass silage was higher, a trend that approached significance (P=0.07), following pre-treatment with pepsin HCL. Although numerically close, this was not observed with hay (Figure 1). The results were fitted to the model p = a + b (l - e-ct), where p = volume of gas after time t; a = the intercept of gas volume curve at t = 0; b = volume of gas produced at asymptote; c= rate constant of gas production (h-1), (*Ørskov* and *McDonald* 1979). It was found that the initial rate of gas production (c) from pepsin treated red clover silage was significantly higher than from either pepsin treated grass silage or hay (P<0.05). However, by 96h there was a numerically greater gas production from pepsin treated grass silage compared to pre-treated red clover silage and pre-treated hay.

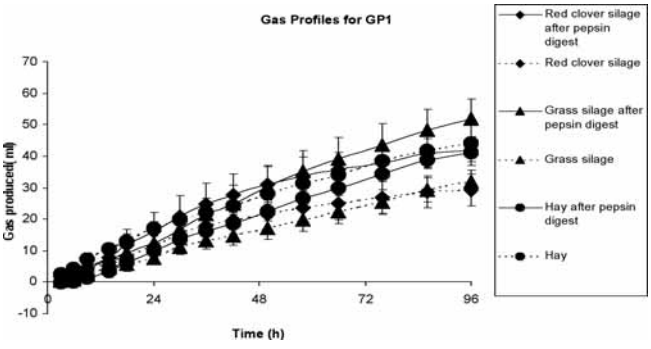

Figure 1 Gas production profiles for experiment 1.

Experiment 2

As in experiment 1, the results were fitted to the model p = a + b (l - e-ct). In contrast to experiment 1, it was found that the rate of gas production (c) for non pre-treated substrates was significantly higher (p>0.05) than pre-treated substrates,

although after 96 hours, pre-treated WCS and pre-treated LS were numerically higher than non pre-treated WCS and LS. Both WCS and RCS had significantly higher c values than all other substrates ($p>0.05$).

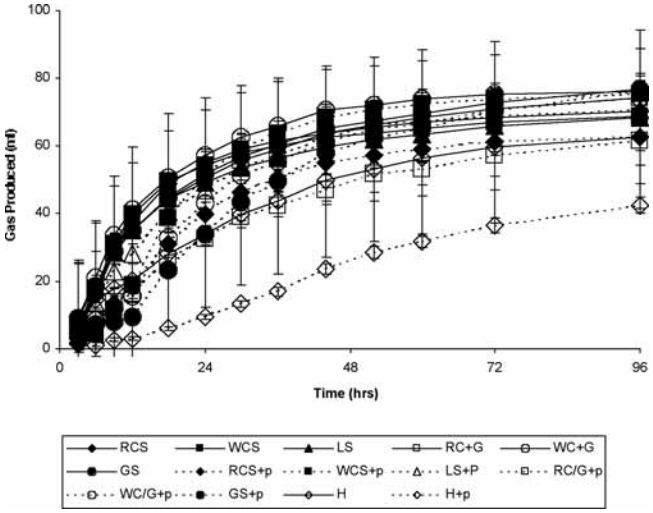

Figure 2 Gas production profiles for experiment 2.

Discussion

Due to mean retention times (MRT) for horses being around 28-38hrs (*Moore-Colyer* and *Longland* 2004), it is prudent to consider the rate of gas production, rather than the extent. In experiment 1, the rate of gas production (c) from pre-treated RCS was significantly higher than GS+P and H+P (s.e.d. $0.0021 P<0.01$).

In experiment 2, both WCS and RCS had significantly higher c values than the other substrates. Experiment 1 showed that the pepsin pre-treatment had marked effects on the degradation of the substrates, with pre-treated substrates having a higher c value than those that had not been pre-treated. This could possibly indicate that the soluble portion of the food was made more accessible after pre-treatment, ensuring a faster fermentation during the experiment. In experiment 2, however, the reverse was true, with untreated substrates proving to have significantly higher ($P>0.05$) c values than treated substrates. This could be due to the soluble fractions being washed out during the pre-treatment, more work would need to be carried out to establish exactly the reason.

Conclusions

Feeding high quality, highly digestible forages to horses, as a means of increasing energy provision, is a more natural feeding method than providing the horse's energy requirements with cereal-based, starchy foods. It can be concluded that, using the gas production technique to estimate forage degradability has shown that red clover silage and white clover silage are more readily digested than other forage sources, which is in keeping with previous in-vivo work. Thus proving that these forages could indeed be used to provide the energy requirements of the horse.

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C. E. Hale
Writtle College
Writtle, Chelmsford, Essex, CM1 3RR
UK
catherine_hale17@hotmail.com