



Original Research

The influence of two lucerne-based forage feeds, FiberProtect® and FiberEdge® on Equine Gastric Ulcer Syndrome in horses

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Summary

Equine Gastric Ulcer Syndrome (EGUS) is extremely prevalent in both racing and non-racing horse populations. The exact aetiology of EGUS is unclear but many stress related risk factors have been implicated including the feeding of grain-based diets. Current treatment techniques often necessitate drug therapy which, when added to feed costs, can be expensive and may have a detrimental effect on digestion due to the mode of action of these therapies. The following experiment set out to investigate if feeding fermented, forage-based feeds (Modified Bio-Fermentation (MBF) lucerne feeds treated with Xanolyde[®], registered as FiberProtect[®] and FiberEdge[®]; Fiber Fresh Feeds Ltd, Reporoa, New Zealand), could assist in the healing and prevention of ulceration. Nine adult horses with demonstrable and sustained gastric ulceration (diagnosed by gastric endoscopy), were used in a two part study. The first 42 d healing phase investigated the impact of feeding FiberProtect[®] (FPT) or FiberEdge[®] (FED) on established gastric ulcers. After 14 d on these diets 44% (4/9) of horses had no ulceration or hyperaemia (inflammation) (EGUC grade 0) and all horses were ulcer free (EGUC grade 0) at d 42. A significant ($P < 0.01$) relationship was determined between length of time fed and disappearance of ulcers ($R^2 = 0.9004$; $DF = 2$). The prevention phase utilised the same horses, ulcer-free at d 42, and fed them a grain-based high energy racing diet alongside FPT at 40% and 60% of the total diet (DM basis). The horses were monitored for a further 28 d (d 42 – d 70), and only three showed a recurrence of ulceration throughout this period. At d 70, eight out of nine horses were ulcer free (EGUC grade 0). The findings suggest that FPT and FED can be used to heal and prevent gastric ulceration, and that FPT can be fed alongside a high grain diet to prevent recurrence of gastric ulcers.

Keywords: horse: ulceration: lucerne: fermented: gastric: dietary management: alfalfa: treatment

(Received 10 October 2012 – Accepted 17 April 2013)

Introduction

Equine Gastric Ulcer Syndrome (EGUS) is characterised by ulceration of the oesophagus, stomach and duodenum (Reese and Andrews, 2009, Videla and Andrews, 2009). There are two main types of EGUS; the rarer glandular form, which affects neonates and foals, and the predominant non-glandular form which affects adult horses (Bell *et al.*, 2007). The prevalence of gastric ulceration in New Zealand Thoroughbred and Standardbred racehorses in training has been reported at 87% and 95% respectively, (Bell *et al.*, 2007) and is comparable to the prevalence

reported overseas (Bezdekova *et al.*, 2007, Murray, 1997). Further studies have shown a high prevalence of EGUS in broodmares (le Jeune *et al.*, 2009), endurance horses (Nieto *et al.*, 2004) and show horses (McClure *et al.*, 1999).

The horse has a simple stomach which is divided into two regions (the non-glandular, upper squamous region, and the glandular, lower region) separated by the *margo plicatus*, a border between areas of the stomach characterised by its dark red appearance (Bell *et al.*, 2007). The proximal (upper) third of the stomach is comprised of non-glandular squamous epithelium which contains no

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glandular structures and where there is no active transport of ions in or out of cells (Luthersson *et al.*, 2009, Merritt, 1999). In comparison, the remaining distal part of the stomach (lower two thirds) is covered by glandular mucosa which contains mucus-secreting cells and gastric glands (Bell *et al.*, 2007, Luthersson *et al.*, 2009, Reese and Andrews, 2009). This region secretes hydrochloric acid, mucus, bicarbonate and pepsinogen (Buchanan and Andrews, 2003, Reese and Andrews, 2009). The mean pH of gastric juices in non-fasted horses has been reported as being variously 2.72 ± 1.86 (Murray and Grodinsky, 1989), 3.10 (Murray and Schusser, 1993), and 3.20 ± 2.00 (Nadeau *et al.*, 2000).

The majority of ulcers occur in the non-glandular (proximal) squamous mucosa (Reese and Andrews, 2009). Vatisas *et al.* (1994) reported that 81% of the ulcers found in adult horses were located in the squamous mucosa and Ferruci *et al.* (2003) found 4% in the (distal) glandular mucosa. The reason the non-glandular mucosa is more often ulcerated is because this region is more susceptible to damage by hydrochloric acid, pepsin, volatile fatty acids and bile acids (which cause a low pH/acidic environment) because it lacks a protective layer of mucus and bicarbonate (Ferrucci *et al.*, 2003, Nadeau and Andrews, 2009, Reese and Andrews, 2009).

Horses have evolved to graze continuously on a high fibre, low starch, forage diet and, as a result, secrete gastric acid continuously, even when there is no food in the stomach (Murray and Schusser, 1993). This feeding pattern, however, is very different to many modern feeding practices, where high-grain diets are used and long periods without access to any feed may occur. Due to the acidic environment in the stomach, certain defence systems are in place to help protect the lining of the stomach from acid damage. The glandular mucosal defence system is comprised of epidermal growth factor (EGF), bicarbonate buffering, mucosal blood flow, mucus secretion, cellular repair and prostaglandins (Miller, 1983). The most important of these is believed to be mucosal blood flow (Wallace, 2001). It may be that genetic or early nutritional experiences can dictate the development and maintenance of the horse's natural defences against ulceration.

Modern management practices for performance and race horses, such as feeding large amounts of grain, stall confinement, high concentrate/low forage diets, and intensive training, are believed to contribute to a poorly buffered, acidic stomach environment (Andrews *et al.*, 2006, Davidson and Harris, 2007) and an increased risk of developing ulcers (Buchanan and Andrews, 2003).

However, the energy demands on these horses means it can be difficult to achieve suitable energy intake without using such high energy concentrate feeds.

Feeding, certain feed types and saliva have buffering effects on gastric pH (Andrews *et al.*, 2006, Bell *et al.*, 2007). Previous studies have shown that horses fed alfalfa hay and a pelleted concentrate diet had lower gastric ulcer grades than those fed Bermuda hay alone (Andrews *et al.*, 2006). It is thought that diets rich in calcium and protein such as alfalfa (lucerne) hay, may have a protective effect from the detrimental effects of the acid on the non-glandular mucosa (Nadeau *et al.*, 2000).

The aims of this study were to establish if feeding FiberProtect[®] (FPT) or FiberEdge[®] (FED) alone had any influence on: (1) the healing and (2) the prevention of ulcer recurrence in a group of horses with established gastric ulceration, the latter when fed in combination with a commercial race mix feed.

Materials and methods

Nine mature Thoroughbred and Thoroughbred cross mares (2) and geldings (7) (average age 9.1 years; mean body weight 490 kg and body condition score (BCS) mean of 3.7 ± 0.7 (Henneke *et al.*, 1983) were used in the study. Horses were gastroscoped within one month prior to the commencement of the study to identify suitable candidates with existing gastric ulceration (d -30). Once identified, owners/keepers were instructed to maintain their existing feed and management regime prior to the study. The horses selected with ulcers came from a variety of backgrounds, and, according to their owners/keepers, two had been pasture-fed only, one had been fed grain based feeds alongside pasture and six had been supplementary fed with waste bread in addition to pasture. All of the horses were spelling (in no work) prior to the commencement of the trial. The horses were gastroscoped (Olympus America Ltd, Olympus Evis Exera II, 9.9 mm \times 3 m equine gastric flexible scope) at the start of the study to ensure the ulcers were still present at the same levels as previously observed, and to establish a baseline of ulceration for comparison with any changes during the trial period. Due to the difficulty of identifying and enlisting suitable horses for the trial period required, and the residual variance within the group, each horse was used as its own control and changes in ulceration over time were compared against initial ulceration grades at d 0 (Table 2). All horses were body condition scored by the site veterinarian (J. O'Brien (JO)) on d 0 and

throughout the study. During the initial healing phase of the study (d 0 – d 42), the horses were fed FPT or FED alone to provide a minimum of 74 MJ digestible energy (DE) per horse per day (14.4 kg/d FPT (100% MBF lucerne: DE 11.08 MJ/kg, DM 47%) or 11.2 kg/d FED (70% MBF lucerne, 30% Captured Grain[®] (crushed oats) including vitamin/mineral premix: DE 12.01 MJ/kg, DM 55%)) ‘as fed’ split into two equal feeds at 06:00 and 18:00 daily, as required for a 500 kg horse not in work (NRC, 2007). Horses with particularly poor BCS (≤ 3) were offered elevated feed levels (22.7 kg per horse per day of FPT or 25 kg per horse per day of FED between d 7 – d 14) when they started to gain weight and reached a BCS of ≥ 4 according to weekly onsite monitoring and fortnightly assessment by the site veterinarian (JO).

Horses were randomly allocated to outdoor 3.6 m \times 4 m pens bedded on wood chip, with individual feeders and *ad libitum* access to water via automatic drinkers in each pen. The study was conducted according to requirements outlined in the Animal Welfare Act (Ministry for Primary Industries, 1999) and under veterinary supervision, following established gastroscopy procedures used within New Zealand (Gordon, 2010). Horses were allocated an exercise period in a large yard with a wood chip surface every day, and were individually monitored for changes in faecal quality and BCS. All horses were covered as appropriate to the climatic conditions.

Gastroscopy was carried out to diagnose ulceration and was conducted every 14 days for the 70 day trial period. One veterinarian (JO) carried out all gastroscopy and was blinded to horses and treatments. Feed and water were removed 16 h prior to gastroscopy (Gordon, 2010) to allow for stomach clearance. Immediately before gastroscopy, horses were sedated (Phoenix Pharm Xylazine 10% injection[®] (Xylazine 10 mg/ml): 1 ml/100 kg BW and Butorgesic[®] (Butorphanol 10 mg/l):

Table 1. The Equine Gastric Ulceration Council (EGUC) grading system (Andrews *et al.*, 1999)

| EGUC Grade | Gastric mucosa |
|------------|--|
| 0 | Intact epithelium |
| 1 | Intact mucosa: hyperkeratosis/hypaemia (healing in progress) |
| 2 | Small lesions – single/multifocal |
| 3 | Large lesions – single/multifocal |
| 4 | Extensive lesions & deep ulceration |

0.125 ml/ 100 kg BW) and the gastroscope introduced nasally, as per established gastroscopy practises. The glandular area and both the lesser and greater curvature of the non-glandular areas of the stomach were examined for ulcers. Results were expressed as Equine Gastric Ulceration Council (EGUC) (Andrews *et al.*, 1999) standard grades (Table 1), as well as by the Number Severity (N/S) scoring system (MacAllister *et al.*, 1997) (Table 2).

Following gastroscopy, horses were fed their morning allocation of feed and had free access to water. On the same day as the gastroscopy, body condition scoring of all horses was performed by the veterinarian (JO) to monitor any weight gain or loss, and feeding levels adjusted accordingly. The resulting responses, in terms of ulcer healing over time, were analysed using the R^2 function of Excel for Windows 7 and the resulting R^2 value compared to regression coefficient tables (Tucker, 2003) to establish level of significance of the relationship (DF = 2).

At the end of the healing phase (d 42), all horses were fed a racing-type ration that consisted of FPT and a commercial racing feed (Dunstan Racemix; Dunstan Nutrition Ltd, Hamilton, New Zealand) in the following proportions; (1) 40% FPT and 60% Dunstan Racemix (15 MJ/kg; 85% DM), or (2) 60% FPT and 40% Racemix[®] (on a DM basis) for a further 28 days. Diets were supplied to provide sufficient energy per day for a

Table 2. Individual healing results for ulceration in Thoroughbred and Thoroughbred cross horses fed FPT or FED based on standardised EGUC grading system

| Horse | Diet | EGUC grade | | | | |
|-------|------|------------|-----|------|------|------|
| | | d-30 | d 0 | d 14 | d 28 | d 42 |
| 1 | FPT | 2 | 2 | 0 | 0 | 0 |
| 2 | FPT | 3 | 3 | 1 | 0 | 0 |
| 3 | FPT | 3 | 2 | 3 | 0 | 0 |
| 4 | FPT | 3 | 2 | 0 | 0 | 0 |
| 5 | FPT | 2 | 2 | 0 | 0 | 0 |
| 6 | FED | 2 | 1 | 0 | 0 | 0 |
| 7 | FED | 4 | 4 | 2 | 0 | 0 |
| 8 | FED | 3 | 3 | 2 | 2 | 0 |
| 9 | FED | 3 | 3 | 1 | 3 | 0 |

500 kg horse in heavy work (134 MJ/day; (1); 40% FPT – 8.9 kg FPT and 7.1 kg Racemix per day; (2) 60% FPT – 13.4 kg FPT plus 4.7 kg Racemix per day), and the horses were gradually adapted to this new feeding regime over a seven day period. The daily diet allocation was split into two feeds, given at 06:00 and 18:00. Gastroscopy was conducted on d 56 and d 70 of the prevention phase of the study to monitor any changes in ulceration status of each animal. At the end of the study, the data was tabulated, showing changes in ulceration over time.

Results and Discussion

The candidate horses identified for use in the study varied widely in their BCS, levels of work, feeding and management regimes. This suggested that the symptoms and practises commonly used as external identifiers of potential ulceration in horses may not be entirely valid. Faecal quality remained stable throughout the trial period. Gastrosopic examination revealed that the majority of ulcers were located along the *margo plicatus*, extending up into the greater curvature of the non-glandular area of the stomach. Irrespective of the degree of ulceration, it was rare to find ulcers or hyperaemia in the lesser curvature over the whole trial period (3/54; 5.6%). **Figures 1a and b** illustrate a badly ulcerated equine stomach versus a non-ulcerated case respectively, taken directly from captured images from gastroscopy.

Healing phase

Gastrosopic examination revealed that four out of nine (44%) horses were completely healed with no hyperaemia by d 14 (EGUC grade 0 – **Table 2**). By d 28, seven out of nine (78%) horses presented with no gastric ulceration or hyperaemia (EGUC grade 0) and by d 42, all horses had no gastric ulceration or hyperaemia (EGUC grade 0). Furthermore, all horses on the FPT diet were ulcer free by d 28, indicating that healing occurred at a faster rate in FPT horses than in horses fed FED (**Figure 2**). The rate of healing may be a function of both the total amount of Xanotylde® treated MBF lucerne and the proportion of grain in the diet. Previous studies carried out in horses have demonstrated a limited healing effect of lucerne-based diets on gastric ulceration (Nadeau *et al.*, 2000), however the authors are unaware of any studies to date that have proven the effect of any lucerne-based product to provide complete and rapid healing of gastric ulcers in horses (as achieved by FPT or FED). It has been established that

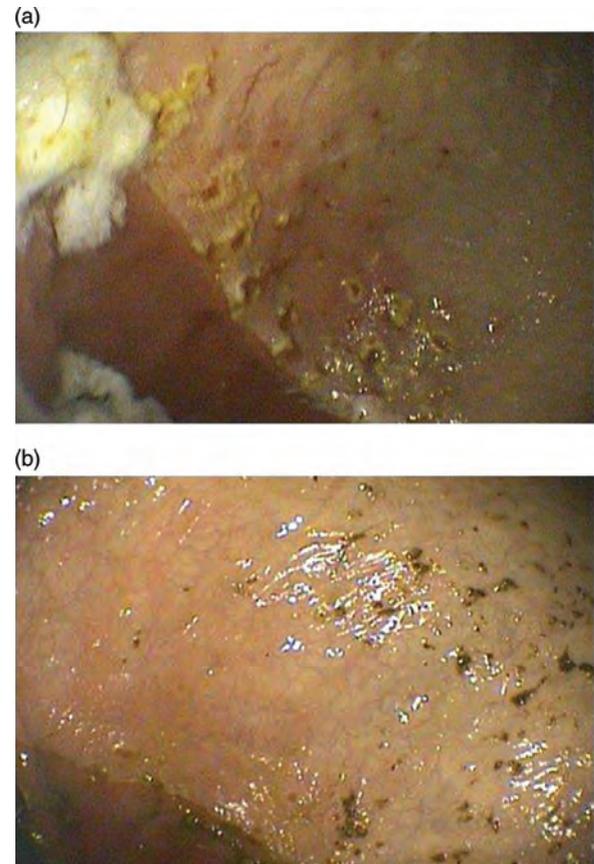


Figure 1. a. Ulcerated and eroded equine stomach at margo plicatus (dark red region) in greater curvature of the non-glandular region, b. Non-ulcerated stomach in same region and with the same magnification scale

once pharmaceutical treatment is discontinued, ulceration is likely to re-occur (Reese and Andrews, 2009), thus FPT and FED could provide a sustainable dietary treatment and prevention strategy to heal and avoid recurrence of gastric ulceration in susceptible horses.

The relationship between time on the FPT and FED diets and reduction in ulceration is shown in **Figure 2**, along with the relationship between mean grades and significance. A rapid onset of healing with accelerated gut-wall repair was noted during gastroscopic examinations. There was a significant relationship between mean ulcer reduction and time on the diet with horses fed FPT ($R^2 = 0.9994$, $P < 0.01$ $DF = 2$) or FED ($R^2 = 0.9004$, $P < 0.01$ $DF = 2$).

Prevention phase

The prevention phase (d 42 – d 70) followed immediately after the completion of the healing phase (d 0 – d 42), and the results for individual horses are shown in **Table 3**. Although three out of the nine (33%) horses

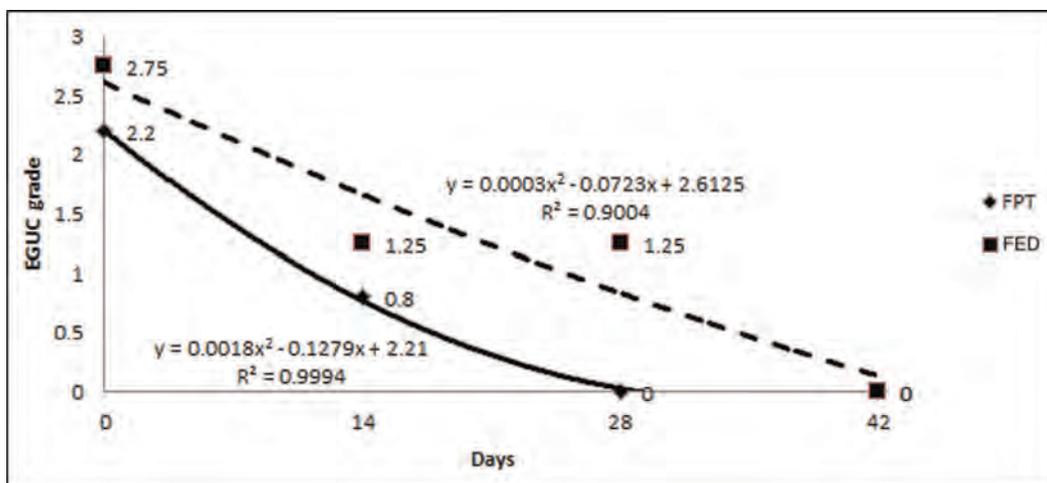


Figure 2. Mean reduction in ulceration in horses fed FPT or FED only during the healing phase (EGUC grade).

Table 3. Individual EGUC grades of Thoroughbred and Thoroughbred cross horses fed 40% FPT and 60% Racemix or 60% FPT and 40% Racemix on a DM basis during the prevention phase

| Horse | Diet | EGUC grade | | |
|-------|---------|------------|------|------|
| | | D 42 | D 56 | D 70 |
| 1 | 60% FPT | 0 | 3 | 0 |
| 2 | 60% FPT | 0 | 0 | 0 |
| 3 | 60% FPT | 0 | 0 | 0 |
| 4 | 60% FPT | 0 | 0 | 2 |
| 5 | 60% FPT | 0 | 0 | 0 |
| 6 | 40% FPT | 0 | 2 | 0 |
| 7 | 40% FPT | 0 | 0 | 0 |
| 8 | 40% FPT | 0 | 2 | 0 |
| 9 | 40% FPT | 0 | 0 | 0 |

showed a recurrence of ulcers at d 56 during the prevention phase, only one horse had any visible lesions at d 70.

This ulcer recurrence may be explained by the addition of a high energy, grain-based diet that could have recreated the conditions within the stomach that promote ulceration in these individuals, and suggests that these three horses were especially susceptible. For example, they may have exhibited certain behaviours related to ulceration, such as selectively consuming grain before the forage by ‘oral sorting’, which could be linked to recurrence. Despite the high grain-based feeding regime, the majority of horses (5/9; 56%), remained ulcer free for the whole 28 d prevention phase. This demonstrates that, even in a population of horses with a history of developing ulcers, feeding as low as 40% FPT alongside a high grain-based diet, can prevent gastric ulcer recurrence.

Conclusions

The findings of this study illustrate the potential for FPT and FED as dietary management aids to completely heal

and prevent gastric ulceration in horses and provide practical guidelines for incorporating such feeds into an existing feeding regime, even where a large quantity of grain-based concentrate is fed. MBF lucerne treated with Xanolyde® had a positive influence on the healing rate of gastric ulceration.

Gastric ulceration in horses was eliminated within 14–42 days by feeding FPT or FED alone and, in the majority of horses was maintained for a further 14–28 days, even after a grain based diet was introduced. FPT and FED have rapid healing and sustained ulcer prevention properties and may provide the racing and other equine industries with an effective, non-pharmaceutical based strategy to manage gastric ulceration. Further studies are being carried out to identify how FPT or FED can be effectively implemented in practical situations to address EGUS.

Acknowledgements

The authors would like to thank the New Zealand Ministry of Science and Innovation and Fiber Fresh

Feeds Ltd for their financial support of this project. The authors would also like to extend their appreciation to Massey University for rental of the gastroscope and advice on gastroscopic procedures.

Declaration of Interest

The authors I.D. Pryor and N.L. Stowers are employees of Fiber Fresh Feeds Ltd, New Zealand. Fiber Fresh Feeds Ltd partially funded this research and FiberProtect[®], FiberEdge[®] and Xanotyde[®] are trademarks of Fiber Fresh Feeds Ltd.

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