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Original Research

The effect of feeding a commercial feedstuff on gastric squamous gastric disease (ESGD) healing and prevention of recurrence

N.J. Menzies-Gow [a,*], T. Shurlock [b]

[a] Department of Clinical Sciences and Services, Royal Veterinary College, Hawkshead Lane, North Mymms, Herts. AL9 7TA. United Kingdom
[b] West Lane House, Bishopdale, Leyburn, North Yorkshire. DL8 3TG. United Kingdom

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ABSTRACT

Feedstuffs are often recommended to mitigate potential damage from acid associated with equine squamous gastric disease (ESGD). In acidic conditions, pectin alters its structure to one like mucus and binds the stomach mucosa, whilst alfalfa has a strong intrinsic acid buffering capacity. The study aimed to determine whether feeding a commercial beet pulp/alfalfa/oat fibre mix aids ESGD healing and/or prevention of recurrence. Ten adult horses with naturally occurring ESGD were included. All animals were treated with omeprazole as per the attending veterinarian's recommendation and randomly allocated to also be fed a commercial beet pulp/alfalfa/oat fibre mix (1Kg/horse divided into 2 meals/day; n=5) or no additional feed (n=5) for one month. Gastroscopy was then repeated to assess response to therapy. If the ESGD had healed, omeprazole therapy was discontinued, and the commercial feed given to all horses for a further month. Gastroscopy was repeated to determine ESGD recurrence. The mean (±SD) age of the horses was 11.6 (±3.8) years; 4 mares and 6 geldings; various breeds were represented; and the median (range) initial ESGD grade was 2 (2-4). ESGD had healed (grade 0/4) in all animals after one month. After a further month, ESGD had recurred in significantly (p=0.04) more animals that did not receive the commercial feed initially (3/5; 60%; mean [range] ESGD grade 3 [0,4]) compared to those that did (0/5; 0%; mean [range] ESGD grade 0 [0,0]). Thus, the commercial beet pulp/alfalfa/oat fibre mix aided prevention of ESGD recurrence when fed during the healing and prevention phases.

1. Introduction

Equine Gastric Ulcer Syndrome (EGUS) is a term used to describe erosive and ulcerative diseases of the equine stomach [1]. The terminology has recently been expanded so that Equine Squamous Gastric Disease (ESGD) and Equine Glandular Gastric Disease (EGGD) are used to describe the anatomic location of the lesions [2]. These terms are more appropriate as there are significant differences in the prevalence, epidemiology, pathogenesis, and treatment of the diseases affecting the two anatomically distinct regions such that they should be seen as distinct disease entities [3].

Equine squamous gastric disease (ESGD) refers to injury of the squamous mucosa of the stomach [2] as a consequence of sustained exposure to acid [3]. The acid injury is primarily attributable to endogenous hydrochloric acid (HCl) [4], but other gastric constituents including short chain fatty acids [5,6], lactic acid [7] and bile salts [8] have been shown to act synergistically with HCL. Spontaneous healing of ESGD is variable, with reported healing rates of <5 % in horses in training [9] and up to 55 % in horses at pasture [10]. Therefore, treatment is recommended for any horse with a clear disruption of squamous epithelial integrity, i.e., ≥ grade 2/4 [3]. The drug of choice for acid suppression is the proton pump inhibitor omeprazole [3] which irreversibly inhibits the H^+/K^+ ATPase pump on the secretory surface of the gastric parietal cell [9]. Thus, omeprazole in combination with management changes to reduce the risk of acid exposure is used in the treatment and prevention of ESGD [3].

Methods to treat and/or prevent ESGD effectively without requiring the continued use of pharmaceutical agents would be desirable [11] and many commercial products are available; however, little data exists on the efficacy of these supplements. Beet pulp contains a soluble fibre component known as pectin, a beta linked polysaccharide based around galacturonic acid and arabinose which is thought to form a protective gel barrier when exposed to an acid environment [12]. Additionally, pectin reacts with mucus bringing about its stabilisation [13] and can bind bile acids in the gastric fluid [14]. Lecithin is the common term for the phospholipid phosphatidyl choline and phospholipids are probably

* Corresponding author.
E-mail address: nmenziesgow@rvc.ac.uk (N.J. Menzies-Gow).

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involved in stabilising the protective barrier of the mucin layer on the gastric mucosa [15]. The results from previous studies involving feeding pectin and lecithin have been contradictory. Whilst in two studies a commercial product containing a pectin-lecithin complex failed to prevent lesions in the gastric squamous mucosa induced by intermittent feed deprivation [11,16]; the same product was reported to be associated with improved healing of ESGD compared to untreated horses in another study [17] and a combination of a pectin-lecithin complex, live yeast and magnesium hydroxide was found to be effective in the prevention of ESGD in Thoroughbred racehorses [18]. High calcium and protein concentrations provide alfalfa a strong intrinsic acid buffering capacity [19,20]. Horses fed alfalfa had higher gastric juice pH and lower ESGD scores than the same horses fed bromegrass hay [21]. In another study, horses exercised and fed alfalfa hay had less severe ESGD than horse that were fed grass hay [22]. It was hypothesized that the calcium carbonate in the alfalfa hay buffered stomach acid or had a direct effect on gastric secretions.

Thus, the aim of this study was to determine whether feeding a commercial beet pulp/alfalfa/oat fibre mix aids ESGD healing and/or prevention of recurrence in a prospective case-control study of naturally occurring disease.

2. Material and methods

2.1. Ethical approval

This study was approved by the Royal Veterinary College Clinical Research Ethical Review Board (URN 2022 2095-3).

2.2. Horses

A convenience sample of ten adult horses with naturally occurring ESGD visible on gastroscopy but no other co-morbidities were recruited to the study at the point of diagnosis.

2.3. Gastroscopy

Gastroscopy was performed under standing sedation (detomidine [Domidine, Dechra Veterinary Products]; 10mg/Kg body weight IV) after a 16 hr fast using a 3m video endoscope (Karl Stortz Video Endoscope PV-G 28-300) passed via the ventral nasal meatus and the oesophagus. The stomach was inflated via the biopsy channel of the endoscope using a manual pump until the squamous and glandular mucosae were visible and a systematic examination of the stomach was performed [23]. First, the area around the cardia (with retroflexion of the videoendoscope) was inspected. Next, the lesser and greater curvatures of the stomach were evaluated, followed by the margo plicatus, pyloric antrum, pylorus and the anterior segment of the duodenum. Images were obtained from each region and stored. At the conclusion of the gastric examination, the stomach was deflated by suctioning air through the biopsy channel.

2.4. Treatment groups

All animals were treated with omeprazole (4 mg/kg SID P.O. [n=1] or once every 7 days via intramuscular injection [n=9]) as per the attending veterinarian's recommendation and randomly allocated to be fed a commercial beet pulp/alfalfa/oat fibre mix (Fibre-Beet [British Horse Feeds]; 1 Kg/horse divided into 2 meals/day; n=5; diet-fed group) or no additional feed (n=5; control group) alongside their usual diet for one month. Gastroscopy was repeated after one month to assess response to therapy. If the ESGD had healed (return to grade 0/4), the omeprazole therapy was discontinued, and the commercial feed given to all horses for a further month to assess its ability to prevent recurrence. Gastroscopy was repeated at the end of the second month to determine ESGD recurrence.

All gastroscopy images were graded by a single experienced blinded observer on study completion using the 0-4 grading system [1]. See flowchart (Fig. 1).

All owners were also given advice by the attending veterinarian with respect to changes in management (increase in pasture turnout, constant access to good-quality hay and reduction of non-structural carbohydrate intake) to promote ESGD healing and reduce the risk of recurrence as per normal procedure for dealing with cases of ESGD at the referral hospital. However, the diet (apart from the addition of the commercial beet pulp/alfalfa/oat fibre mix), pasture turnout, amount of time spent stabled and exercise regime were not standardised.

2.5. Statistical analysis

Data was analysed using statistical software (GraphPad Prism version 9.4.1). Continuous data (age) was assessed for normality using Shapiro-Wilk test and compared between the two treatment groups using an unpaired Student t test. Categorical data was compared between the two treatment groups using chi squared (breed, sex) or Mann-Whitney test (initial gastroscopy grade). Horses were categorised as having healed (ESGD grade 0/4) or not (ESGD grade $\geq$1/4) after one month and as having recurred (ESGD grade $\geq$1/4) or not (ESGD grade 0/4) after 2 months. The number of horses categorised as healed/recurred at each time point was compared with the number than had not between the two treatment groups using fisher's exact test. Significance was accepted at $P < 0.05$.

3. Results

The mean $\pm$ standard deviation (SD) age of the ten horses included in the study was 11.6 $\pm$ 3.8 years; 4 were mares and 6 geldings; various breeds were represented (8 horses, 2 ponies); the median (range) initial ESGD grade was 2 (2 - 4; Table 1); the initial physical examination was unremarkable for all animals; and all animals were used for pleasure riding.

There were no significant differences between the control and diet-fed groups with respect to signalment or initial ESGD grade.

ESGD had healed (grade 0) in all ten animals after 1 month and unsurprisingly there was no significant difference between the number of horses that had healed/not healed within the control and diet-fed groups. In all cases, owners reported resolution of the clinical signs suggestive of ESGD that had prompted the initial investigation.

After the second month, ESGD had recurred in significantly (p=0.04) more animals that did not receive the commercial diet initially ((3/5 [60 %] animals; mean [range] ESGD grade after 2 months 3 [0, 4]) compared to those that did (0/5 [0 %] animals; mean [range] ESGD grade 0 [0. 0]; Table 1). In all cases, owners reported that there had been no recurrence of the clinical signs suggestive of ESGD that had prompted the initial investigation and the physical examination findings remained unremarkable. Detailed questioning of the owners of the three horses in which the ESGD had recurred did not reveal the presence of any management risk factors known to be associated with an increased risk of ESGD.

4. Discussion

Numerous nutritional supplements are marketed for ESGD, often with limited evidence to support their use in the horse [3]. Pectin, a gel-forming carbohydrate polymer, alone or in combination with lecithin (an amphiphilic phospholipid) has been the subject of several studies [11,16-18] due to their suggested ability to form a protective gel barrier within the stomach. Beet pulp contains pectin and lecithin and is widely available in the UK in the form of various commercial products such as the beet pulp/alfalfa/oat fibre mix used in the present study.

The results of previous studies that evaluated the effects of feeding pectin and lecithin to aid the healing and prevention of ESGD have been

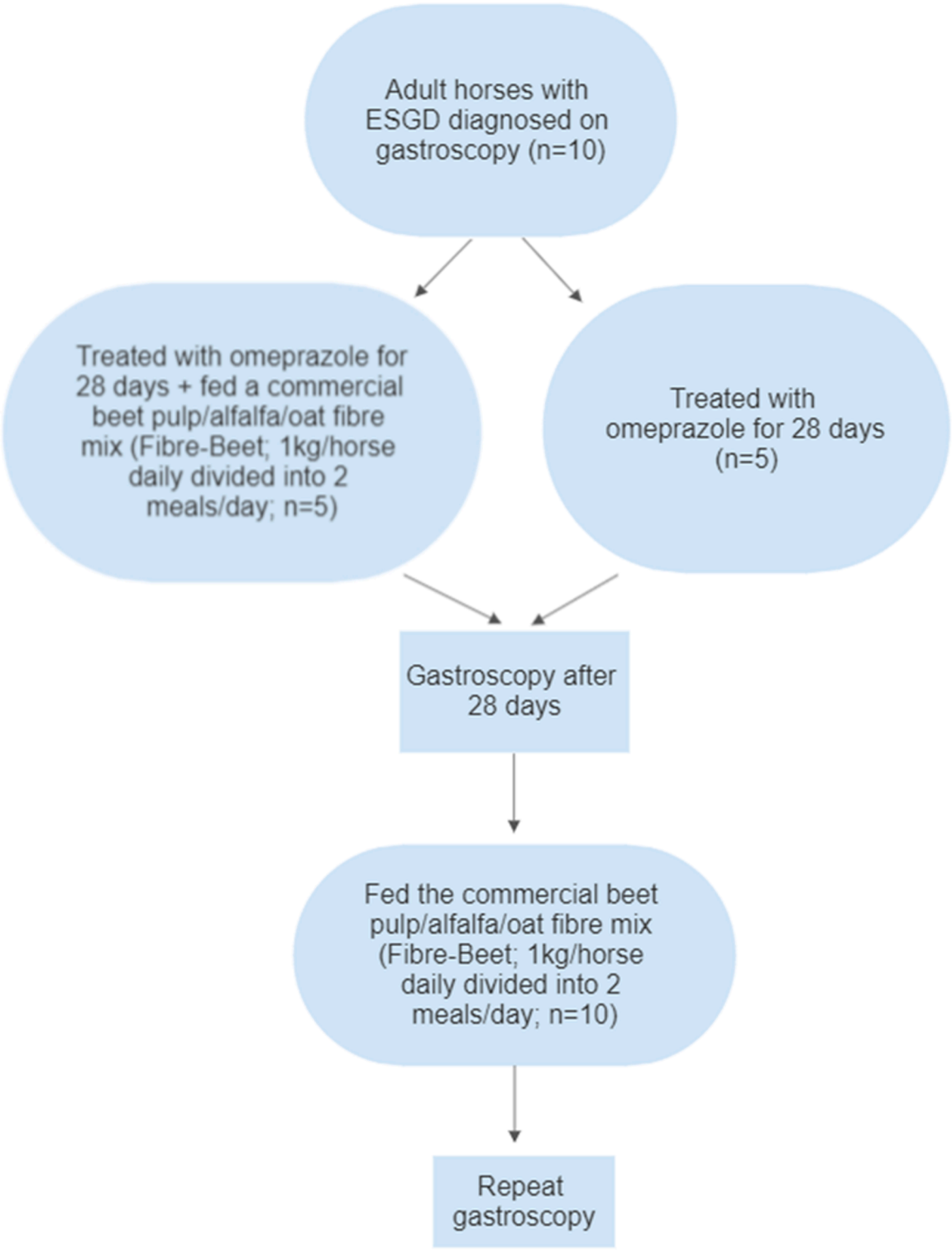

Fig. 1. Flowchart detailing study protocol.

variable. Pectin-lecithin complex (Apolectol) fed as a small amount (250 g) of a commercial supplement (Pronutrin) for 7 days previously failed to prevent ESGD lesions from developing in a feed depravation model [11]. In a second study, 10 healthy horses were fed the same supplement or no supplement for 28 days before and during intermittent feed depravation over 7 days in a cross over design [16]. However, administration of the feed supplement was ineffective at preventing squamous gastric ulceration. Limitations of these studies included only evaluating the effect of pectin-lecithin on ESGD prevention, and only involving induced disease which may be too severe and not accurately reflect the naturally occurring disease. In contrast, administration of the same supplement to 12 clinical cases with ESGD for 10 days was associated with improved healing of gastric squamous mucosal lesions compared to 12 control animals [17]. However, in that study, horses were not allocated randomly to treatment groups, the endoscopist was not blinded as to treatment and the trial lasted only 10 days which may

Table 1
Equine squamous gastric disease (ESGD) score on initial presentation, after one month of omeprazole therapy with (n=5) or without (n=5) commercial diet and one month after cessation of omeprazole and continuation of the same commercial diet (n=10).

Horse	Age (years)	Breed	Sex	Fed commercial diet initially?	Initial ESGD grade	ESGD grade after 1 month	ESGD grade after 2 months
1	7	Holsteiner X	Gelding	Yes	3	0	0
2	14	Arab X	Gelding	Yes	2	0	0
3	7	Irish sports horse	Mare	Yes	2	0	0
4	15	Crossbreed horse	Gelding	Yes	3	0	0
5	9	Thoroughbred	Mare	Yes	2	0	0
6	17	Standardbred	Gelding	No	2	0	2
7	13	New Forest	Mare	No	3	0	0
8	12	KWPN	Gelding	No	4	0	3
9	15	Cob	Gelding	No	2	0	0
10	7	Arab X	Mare	No	2	0	4

be an insufficient time frame in which to evaluate the effect of a compound that may facilitate ESGD healing since spontaneous healing of lesions can occur in 14 days [24], confounding any comparison of healing in treated and untreated animals. In another study, ten Thoroughbred horses with naturally occurring ESGD were treated with the same pectin-lecithin complex supplement once daily for 30 days without additional acid suppressant medication or management changes [25]. In three of the horses, the lesions had healed completely, and in six others the lesions had improved significantly. Again, the study lacked a control group so that spontaneous healing of the lesions could not be ruled out. Finally, feeding Trophogast pellets, a supplement containing pectin, soy lecithin, zinc oxide and Castanea sativa Mill (extract of sweet chestnut), to ten endurance horses with naturally occurring disease alongside management changes was associated with a significant decrease in ESGD grade, whereas the grade remained unchanged in the control group (n=5) [26]. In the present study, feeding a commercial beet pulp/alfalfa/oat fibre mix to horses with naturally occurring ESGD during both the healing and the prevention phase (rather than just one or other of these phases) alongside management change recommendations was associated with complete prevention of recurrence, whereas ESGD recurred in 60% of animals that were fed the commercial diet only during the prevention phase.

Other potentially beneficial effects of feeding the commercial beet pulp/alfalfa/oat fibre mix to horses with ESGD include increased water intake through feeding a moist feed which in turn promotes saliva flow and therefore gastric acid buffering, feeding a food stuff that has a low starch content (starch has a low acid binding capacity) and a high inherent acid binding capacity [20], and feeding a foodstuff that increases mucus concentration in the stomach [27]. Additionally, high calcium and protein concentrations provide alfalfa with a strong intrinsic acid buffering capacity [19,20]. Higher extracellular and intracellular calcium concentrations in gastric parietal and G cells may lower the cAMP concentration, thus reducing the production of HCl [28]. Additionally, the complex carbohydrate fractions found in alfalfa's cell walls have also been shown to provide better buffering than those found in grass hays. The number and severity of ESGD lesions were significantly lower and gastric pH significantly higher in horses fed an alfalfa hay plus grain diet compared to a bromegrass hay only diet [21]; horses exercised and fed alfalfa hay had less severe ESGD than horse that were fed grass hay [22]; whereas feeding alfalfa as chaff or pellets rather than as forage improved ESGD lesions in weanling foals in some [29] but not all [30,31] studies and had no significant effect on ESGD healing or prevention in heavily exercised adult trotters [32].

Similar to the previous studies evaluating the effect of pectin-lecithin, the limitations of this study include the small number of animals recruited to the study and the lack of inclusion of all possible control groups. A group in which animals did not receive the commercial diet during both the treatment and the prevention phase was not included as this study as financial constraints limited the number of animals that could be recruited to the study and therefore the number of possible treatment groups. Since the study was undertaken under clinical circumstances, it was not ethically possible to withhold pharmacological therapy to fully assess the impact of the diet on lesion healing. In addition, whilst all owners were given the same advice relating to management changes that would potentially aid healing of ESGD and help prevent recurrence, the implementation of these changes could not be verified nor was it possible to standardise the diet fed, exercise undertaken, or amount of time spent at pasture. Finally, whilst there were no obvious other factors that appeared to have contributed to the recurrence of the ESGD in the three affected animals, it is possible that the recurrence was attributable to factors other than the lack of receiving the diet during the treatment phase. Thus, ideally further investigations including larger numbers of animals allocated to all possible control and treatment groups are required to corroborate the findings of the present study.

5. Conclusion

In conclusion, ESGD recurred in significantly fewer animals fed a commercial beet pulp/alfalfa/oat fibre mix during the healing and prevention phases compared to those fed the diet in only the prevention phase in this small study involving animals with naturally occurring disease. Further studies are warranted to evaluate this potential beneficial effect in more detail.

6. Ethical statement

This study was approved by the Royal Veterinary College Clinical Research Ethical Review Board (URN 2022 2095-3) and was undertaken with owner informed consent.

CRediT authorship contribution statement

N.J. Menzies-Gow: Methodology, Investigation, Resources, Formal analysis, Data curation, Writing – original draft, Visualization, Investigation, Project administration. **T. Shurlock:** Conceptualization, Methodology, Writing – original draft, Funding acquisition.

Declaration of competing interest

Tom Shurlock is an equine nutrition consultant for the study funder, British Horse Feeds. Nicola Menzies-Gow does not have any financial or personal relationships that could inappropriately influence or bias the content of the paper.

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References

[1] Andrews F, Bernard W, Byars D, Cohen N, Divers TJ, MacAllister C, et al. Recommendations for the diagnosis and treatment of equine gastric ulcer syndrome (EGUS). Equine Vet Educ 1999;11:262–72.

[2] Sykes BW, Hewetson M, Hepburn RJ, Luthersson N, Tamzali Y. European college of equine internal medicine consensus statement–equine gastric ulcer syndrome in adult horses. J Vet Intern Med 2015;29:1288–99.

[3] Hewetson M, Tallon R. Equine squamous gastric disease: prevalence, impact and management. Vet Med (Auckl) 2021;12:381–99.

[4] Andrews FM, Buchanan BR, Smith SH, Elliott SB, Saxton AM. In vitro effects of hydrochloric acid and various concentrations of acetic, propionic, butyric, or valeric acids on bioelectric properties of equine gastric squamous mucosa. Am J Vet Res 2006;67:1873–82.

[5] Nadeau JA, Andrews FM, Patton CS, Argenzio RA, Mathew AG, Saxton AM. Effects of hydrochloric, acetic, butyric, and propionic acids on pathogenesis of ulcers in the nonglandular portion of the stomach of horses. Am J Vet Res 2003;64:404–12.

[6] Nadeau JA, Andrews FM, Patton CS, Argenzio RA, Mathew AG, Saxton AM. Effects of hydrochloric, valeric, and other volatile fatty acids on pathogenesis of ulcers in the nonglandular portion of the stomach of horses. Am J Vet Res 2003;64:413–7.

[7] Andrews FM, Buchanan BR, Elliott SB, Al Jassim RA, McGowan CM, Saxton AM. In vitro effects of hydrochloric and lactic acids on bioelectric properties of equine gastric squamous mucosa. Equine Vet J 2008;40:301–5.

[8] Berschneider HM, Blikslager AT, Roberts MC. Role of duodenal reflux in nonglandular gastric ulcer disease of the mature horse. Equine Vet J Suppl 1999: 24–9.

[9] Andrews FM, Sifferman RL, Bernard W, Hughes FE, Holste JE, Daurio CP, et al. Efficacy of omeprazole paste in the treatment and prevention of gastric ulcers in horses. Equine Vet J Suppl 1999:81–6.

[10] Woodward MC, Huff NK, Garza Jr F, Keowen ML, Kearney MT, Andrews FM. Effect of pectin, lecithin, and antacid feed supplements (Egusin(R)) on gastric ulcer scores, gastric fluid pH and blood gas values in horses. BMC Vet Res 2014;10(Suppl 1):S4.

[11] Murray MJ, Grady TC. The effect of a pectin-lecithin complex on prevention of gastric mucosal lesions induced by feed deprivation in ponies. Equine Vet J 2002; 34:195–8.

[12] P. Kidd Phospholipids: versatile nutraceuticals for functional foods. Functional ingredients. 2002.

[13] H Keiser-Nielsen. Mucin. Med Disp. 1947.

[14] Rydning A, Berstad A. Influence of fiber on acidity, pepsin, and bile acids in human gastric juice in vitro. Scand J Gastroenterol 1984;19:953–9.

[15] Wassef MK, Lin YN, Horowitz MI. Phospholipid-deacylating enzymes of rat stomach mucosa. Biochim Biophys Acta 1978;528:318–30.

[16] Sanz MG, Viljoen A, Saulez MN, Olorunju S, Andrews FM. Efficacy of a pectin-lecithin complex for treatment and prevention of gastric ulcers in horses. Vet Rec 2014;175:147.

[17] Venner M, Lauffs S, Deegen E. Treatment of gastric lesions in horses with pectin-lecithin complex. Equine Vet J Suppl 1999:91–6.

[18] Sykes BW, Sykes KM, Hallowell GD. Efficacy of a combination of a unique pectin-lecithin complex (Apolectol®), live yeast and magnesium hydroxide in the prevention of egus and faecal acidosis in thoroughbred racehorses: a randomised, blinded, placebo controlled clinical trial. Equine Vet J 2013;45:13.

[19] Grimm P, Julliand V, Julliand S. In vitro effect of alfalfa composition on gastric ecosystem activity. J Equine Vet Sci 2017;76:82.

[20] Lawlor PG, Lynch PB, Caffrey PJ, O'Reilly JJ, O'Connell MK. Measurements of the acid-binding capacity of ingredients used in pig diets. Ir Vet J 2005;58:447–52.

[21] Nadeau JA, Andrews FM, Mathew AG, Argenzio RA, Blackford JT, Sohtell M, et al. Evaluation of diet as a cause of gastric ulcers in horses. Am J Vet Res 2000;61: 784–90.

[22] Lybbert TGP, Cohen N, Scott B, Sigler D. Feeding alfalfa hay to exercising horses reduces the severity of gastric squamous mucosal ulceration. In: 53rd Annual Convention of the American Association of Equine Practitioners; 2007. p. 525–6.

[23] Sykes BW, Jokisalo JM. Rethinking equine gastric ulcer syndrome: Part 1-Terminology, clinical signs and diagnosis. Equine Vet Educ 2014;26:543–7.

[24] Murray MJ, Haven ML, Eichorn ES, Zhang D, Eagleson J, Hickey GJ. Effects of omeprazole on healing of naturally-occurring gastric ulcers in thoroughbred racehorses. Equine Vet J 1997;29:425–9.

[25] Ferrucci F, Zucca E, Croci C, Di Fabio V, Ferro E. Treatment of gastric ulceration in 10 standardbred racehorses with a pectin-lecithin complex. Vet Rec 2003;152: 679–81.

[26] Lo Feudo CM, Stucchi L, Conturba B, Alberti E, Zucca E, Ferrucci F. Effects of a nutraceutical supplement in the management of mild equine squamous gastric disease in endurance horses. Vet Rec 2021;189:e942.

[27] Köller G, Recknage S, Spallek A, Breuer J, Schusser GF. Concentration of mukus in gastric juice in normal adult horses withhold feed and after oral application of Pronutrin®. Pferdeheilkunde 2010;26:186–90.

[28] Fisher H, Kaufman RH, Hsu HC, Kasziba E, Farmanfarmaian A, Flancbaum LJ. Inhibition of gastric-acid secretion in the rat by high calcium. Nutr Res 1990;10: 1441–53.

[29] Lybbert TC. Gastric ulcer syndrome in exercising horses fed different types of hay. Texas A&M University; 2007.

[30] Fedtke A, Pfaff M, Volquardsen J, Venner M, Vervuert I. Effects of feeding different roughage-based diets on gastric mucosa after weaning in warmblood foals. Pferdeheilkunde 2015;31:596.

[31] Vondran S, Venner M, Vervuert I. Effects of two alfalfa preparations with different particle sizes on the gastric mucosa in weanlings: alfalfa chaff versus alfalfa pellets. BMC Vet Res 2016;12:110.

[32] Julliand S, Buttet M, Hermange T, Julliand V. Effect of replacing part of concentrates with pelleted alfalfa on squamous gastric ulcers in exercised trotters. J Equine Vet Sci 2021;100:103556.