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Proceedings of the 2nd European Equine Nutrition & Health Congress, Mar. 19-20, 2004 - Lelystad, The Netherlands.

Nutritional management in horses: Selected aspects to gastrointestinal disturbances and geriatric horses[i]

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Nutritional risk factors and dietary management in equine colic

Acute diseases of the equine abdomen associated with signs of pain are commonly called colic. The colic incidence varied between 10-26 cases/100 horses (Uhlinger 1992, Tinker et al. 1997), and is one of the most common medical problems in adult horses. Lesions associated with colic have been anatomically and functionally categorized as obstruction, strangulation, nonstrangulation infarction, enteritis, peritonitis, ulceration or ileus (Tinker et al. 1997). Epidemiologic studies have revealed several risk factors, and it is pointed out, that mistakes in feeding and feeding management will increase the risk for colic several fold. An absence of water on pastures and drylots, the consumption of whole corn, large amounts of concentrates, and changes in type of roughage are particularly notable (Reeves et al. 1995, Cohen et al. 1999).Colics which are located in the stomach are mainly due to changes in microbial fermentation or a result of motility loss. These colics appear briefly after feeding (Table 1).
In the **small intestine** the ileum is predisposed for impaction as chyme has to pass through the valva ileocacalis. Especially short chopped materials like grass silages or wood shavings with a low water holding capacity tend to accumulate in the distal ileum. Furthermore, changes in the microbial activity cause an accumulation of gas in the small intestine, which finally result in the loss of motility (Table 2). Normally small intestinal contents are watery to semi-liquid. In the **large intestine** chyme becomes firmer where water is absorbed. If chyme gets too dry, this mass cannot be transported, which resulted in impaction with pain from stretching the intestinal wall. Impaction with ingested feed is one of the common forms of colic in the cecum or

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colon (Table 3 and Table 4). Another important problem is a malfermentation by the microflora. It is well known that feeding excessive amounts of cereal grain can induce acidosis in the large intestine (Garner et al. 1975). Starch passing undigested into the equine hind-gut will be fermented rapidly by certain species of gram positive bacteria, which result in an accumulation of lactic acid (and a drop in pH) as a product of fermentation. The changes in microbial activity (increase in gram positive species and a decrease in gram negative bacteria) can cause laminitis in the horses as vasocative amines as well as other toxins (toxins released by the demise of gram negative bacteria) will be absorbed by the damaged intestinal wall into the bloodstream (Garner et al. 1975, Pollitt and van Eps 2002, Bailey et al. 2003). In recent studies it is proposed that fructans (storage polysaccharides in temperate pasture grass), which are also rapidly fermented by gram positive bacteria in the large intestine could also initiate the onset of laminits in a similar manner to starch (Pollitt and van Eps 2002, Longland and Murray 2003).
Sand and enterolithiasis are also causes for abdominal colics in horses. The highest prevalence of enteroliths in horses has been monitored in California (1973-1996: 900 cases, Hassel et al. 1999), whereas in Europe only a few cases are reported. Enteroliths are composed primarily of ammonium magnesium phosphate around a central nidus. Several factors seemed to be associated with equine enterolithiasis, including the presence of nidi (rope, stone, wood), diet (high protein, calcium and magnesium intake), high intestinal pH, soil type, gender and breed (Arabian and miniature horses). In this context a suggested association between alfalfa feeding and enterolith formation has been monitored.

The re-feeding of horses with mild colic symptoms does not always require a special diet, however mistakes in feeding or feeding management should be removed. Feedstuffs like a good quality hay, wheat bran, mechanically treated oats (200-300 g/100 kg BW) after successful treatment of the colic can enhance regular intestinal motility and digestion (salivation, gastric juice, and pancreatic juice).
However, horses with severe colic problems (several days, recurrent incidence of abdominal pain, after surgery) need a special dietary management to compensate the consequences of malfermentation,

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necrosis, and insufficient energy supply of the intestinal mucosa (Table 5 and Table 6). In general, re-introduce feed as quickly as possible. Prolonged fasting (>2-3 days), especially in hypermetabolic post-surgical cases, will result in atrophy of the intestinal mucosa, reduced wound healing, increased susceptibility to infection and diarrhoea (typhlocolitis). Hay cubes or complete pelleted feed soaked to make a slurry can be used if dehiscence is of concern. Liquid diets can be given by nasogastric tube if horses refuse feed intake (Coenen 1986, Table 7). If gastric reflux or loss of motility prevent feed intake for more than 24 to 36 hours, parenteral nutrition should be considered (Ralston 2000).

Table 1: Colics originating in the stomach (Coenen 2001)

Time of appearance: immediately after feeding (< 1 hour after feeding)						
		Feeding/feedstuff				
		Selection	**Treatment**	**Technique**	**Hygienic status**	**Contamin.**
Disorder		**A**	**B**	**C**	**D**	**E**
Obturation		Not relevant				
Impaction		Not relevant				
Malfermentation	**A**	Adhesion of wheat or rye starch				
	B	Swelling of feedstuffs (e.g. sugar beet pulp, carrot pulp)				
	C	Concentrates immediately before pasturing				
	C	Concentrates immediately before or after exercise				
	D	High microbial counts in feedstuffs				
	E	Mycotoxins?				
Loss in motility		Result of malfermentation				
	C	High amounts of concentrates				

Table 2: Colics originating in the small intestine (Coenen 2001)

Time of appearance: immediately after feeding (1-4 hours after feeding)						
		Feeding/feedstuff				
		Choice	**Treatment**	**Technique**	**Hygienic status**	**Contamin.**
Disorder		**A**	**B**	**C**	**D**	**E**
Obturation	**E**	Foreign material (e.g. wood shavings, plastic material)				
Impaction	**A**	Short chopped material (e.g. grass silage)				
Malfermentation	**C**	Concentrates immediately before pasturing				
	C	Concentrates immediately before or after exercise				
	D	High microbial counts in feedstuffs				
Loss in motility	**D**	High microbial counts in feedstuffs				
	E	Mycotoxins?, poisonous plants (e.g. Colchicum autumnale)				

Table 3: Colics originating in the caecum (Coenen 2001)

Time of appearance: ~3-6 hours after feeding						
		Feeding/feedstuff				
		Choice	**Treatment**	**Technique**	**Hygienic status**	**Conta min.**
Disorder		**A**	**B**	**C**	**D**	**E**
Obturation		Rare condition				
Impaction	**A**	Low fermentable feedstuffs (e.g. straw) and high fermentable concentrates (impoverishment of the microflora)				
Malfermentation	**A**	Concentrates with a high fat content (> 12 % crude fat)				
	B	Starch with a low prececal digestibility (caecum acidosis)				
	C	High amounts of concentrates (caecum acidosis)				
	D	High microbial counts in feedstuffs (especially roughage)				
	D	Frost damage (e.g. carrots)				
Loss in motility		Result of malfermentation				
	E	Mycotoxins?				

Table 4: Colics originating in the colon (Coenen 2001)

Time of appearance: > 4 hours after feeding						
		Feeding/feedstuff				
		Choice	**Treatment**	**Technique**	**Hygienic status**	**Conta min.**
Disorder		**A**	**B**	**C**	**D**	**E**
Obturation	**A**	High intake of Ca, Mg, and P (e.g. alfalfa) result in mineral deposition around a nidus (enterolith)				
Impaction	**A**	Low fermentable feedstuffs (e.g. straw) and high fermentable concentrates (impoverishment of the microflora)				
	C	Extraction of water				
Malfermentation	**A**	Concentrates with a high fat content (> 12 % crude fat)				
	B	Starch with a low prececal digestibility (cecum acidosis)				
	C	High amounts of concentrates (cecum acidosis)				
Loss in motility		Result of malfermentation				
	E	Mycotoxins?				
	E	Sand deposition				

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Table 5: Dietary management in the re-feeding of horses with colic (Coenen 2001)

Type of ration	Feedstuff	Supplement	Feeding technique
Stomach Malfermentation, moderate loss of motility			
Structural ration	Hay, no vegetable oils, avoid hypertonic solutions	Vinegar (~120 ml/100 kg BW), organic acids	High feeding frequency, small amounts
Loss of motility, gastric ulcer			
Mash	Diet (Table 6), oat flakes	Avoid organic acids and vegetable oils	High feeding frequency
Small intestine Disorders in the cranial part (duodenum, jejunum)			
R : C[1)] 2 : 1, energy by starch, sucrose and vegetable oils	Hay, cereal flakes, linseed meal, vegetable oils	Lecithin, glycin, glutamine, enzymes (microbial origin)	High feeding frequency, starch processing
Disorders in the distal part (ileum)			
R : C 1,5 : 1 energy by starch and sucrose	Hay, sucrose, cereal flakes, linseed meal, soybean hulls	Fat-soluble vitamins	High feeding frequency, starch processing, avoid vegetable oils
Large intestine Impaction			
R : C 1 : 1	Hay (fine stemmed and leafy), grass meal, cereal flakes, linseed meal, vegetable oils	Water-holding substances (e.g. psyllium)	High feeding frequency, avoid straw
Malfermentation			
R : C 2 : 1 Structural concentrates	Hay, salt, cereal flakes, sugar beet pulp, carrots, soybean hulls	Hydrolysable fibre, glycin, yeast, lactose, water-soluble vitamins, yoghurt, volatile fatty acids	High feeding frequency in combination with hay

[1)]R : C: Roughage Concentrate ratio

Table 6: Recipe of a diet indicate by severe gastric ulcers (Coenen 2001)

Feedstuff	Share %
Corn starch	14
Sucrose[1)]	16
Banana meal[2)]	16
Grass meal	9
Carob	5
Oat flakes	20
Obsttrester	7
Linseed	5
Soy meal	4
Propionic acid	2
Minerals	2
DE, MJ/kg	12
Digestible protein, g/kg	61

[1)]reduction by severe malfermentation, raise carob or grass meal
[2)]in some cases limited acceptance by the horse

Table 7: Recipe of a liquid diet given by nasogastric tube[1)] (Coenen 1986)

Feedstuff	Share %	Nutrient	/kg fresh matter
Grass meal	35	DE, MJ	13
Starch	23	digestible protein, g	87
Sucrose	22	Calcium, g	7
Linseed meal	15	Phosphorus, g	5
Vegetable oil	4	Magnesium, g	2
Vitamin premix	1	Sodium, g	2
Mineral premix	1	Potassium, g	15
[*]~28000 IE calculated from carotenoid (grass meal)		Chlorine, g	5
		Copper, mg	12
		Zinc, mg	60
		Selenium, mg	0,2
		Vit. A, IE	30000[*]
		Vit. D, IE	70
		Vit. E, mg	120

[1)]3 l/ 100 kg BW per meal

Summary
An excellent feeding management is necessary (feeding frequency, feedstuff quality, choice of feedstuffs, amount of roughage, or water supply) to minimize the risk for equine colic. Except in cases with severe stomach problems, rations based on a good quality hay is recommend in re-feeding horses with abdominal problems.

Feeding and care of the old horse

It is estimated that 20 % of the horse population is older than 20 years old. Common signs of age include a drooping lower lip, a sway back, deepening grooves above the eyes, accompanied by gray hair, and tooth wear. Owners of these horses often have great personal attachment to these animals, offering the chance for a special nutrition and management service for the aged horse. Areas which require special attention include body condition, teeth care, and hormonal control as pituitary dysfunction is a problem in aged horses.

Aspects of feeding the healthy, old horse

As part of the normal aging process, metabolic alterations not associated with a specific disease process can affect a wide variety of clinicopathologic and immunologic variables. In older literature a reduced digestibility of protein and phosphorus is reported (Ralston et al. 1989), but these results cannot be confirmed in recent studies (Ralston, personal communication). However, weight loss is not uncommon in old horses, which leads to the conclusion that dental abnormalities as well as a limited pancreatic function might reduce absorptive capacity in general. Therefore the nutritional objective for the aged horse is to formulate a more digestible ration. The mechanical (e.g. grounding) or thermal treatment of grain starch (e.g. popping or flaking) increase the starch digestibility in the small intestine. Beside the aspect of energy a high prececal starch digestibility is important to minimize starch flow into the large intestine which might lead to considerable alterations in the microbial fermentation. On the other hand exaggerated plasma glucose and insulin responses after carbohydrate intake has been associated with noninsulin-dependent diabetes and cardiovascular diseases in human subjects. This might be an important factor as aged horses often exhibit a relative glucose intolerance characterized by hyperglycemia and hyperinsulinemia following a glucose challenge (Ralston et al. 1988). Another striking feature is the observation that old horses (> 20 years) showed a lower lymphocyte count than younger horses (5-12 years), which might result in a less resilience to environmental stress (McFarlane et al. 1998). In addition, plasma ascorbic acid concentrations also decreased with advanced age in horses, perhaps associated with altered absorption or excretion of the vitamin (Ralston et al. 1988). As ascorbic acid deficiency enhances susceptibility to viral diseases, an ascorbic acid supplementation of 50 g daily (Ascorbyl-Palmitat, twice a day 25 g) is recommended.
The following recommendations are specifically formulated for aged horse with no medical problems other than poor dentition (Table 8).

The daily basis of the ration should be a hay (or silage, >1 kg/100 kg BW) of high quality, fine stemmed, and leafy. Processed grain (oat, barley or corn) guarantee a high prececal starch digestibility, and therefore a high energy intake. However, sugar beet pulp can also be used as an energy source (200 - 500 g/100 kg BW; 12.5 MJ DE/kg DM), and as sugar beet pulp contain high fermentable structural carbohydrates which will be fermented predominantly in the hind

gut, a low forage intake might be compensated by this feedstuff (Coenen et al. 2003). Vegetable oil (e.g. soybean oil) may be added to the ration for extra calories (1 l daily, slow introduction). Linseed oil (0.1 l daily) should be preferred in horses with inflammatory diseases (e.g. chronic laminitis) as the high amount of omega-3-fatty acids seemed to have a protective function (Morris et al. 1991).
Diets should be fed in small amounts at relatively frequent intervals (three or four times a day) to minimize postprandial shifts in metabolic rate and to maximize digestion and absorption.
An adequate supply of good-quality water is essential for all horses at all times. Inadequate water intake is detrimental as dry feed intake is decreased, followed by decreased physical activity and ability. Furthermore, pasturing without water source increase the risk for colic several fold (Reeves et al. 1996, Kaneene et al. 1997, Tinker et al. 1997).

Table 8: Recommendations for energy and nutrient supply in healthy, old horses

- **Energy supply**: maintenance or work, >20 % addition: cold weather or loosing weight
- **Protein supply**: maintenance or work, high protein quality
- **Calcium**: avoid excess
- **Phosphor**: close relation between Ca : P (< 2:1)
- **Zinc**:. 2-fold of requirement
- **Selenium**: 2-fold of requirement
- **Vitamin A**: 2-fold of requirement
- **Vitamin E**: 2-fold of requirement
- **Vitamin C**: twice a day 25 g Ascorbyl-Palmitat

Aspects of feeding the old horse with specific problems

Poor dental health

Poor dental health is one of the most common causes of an inability to maintain optimum body weight and condition. Numerous dental problems occur, such as uneven tooth wear and sharp points that damage soft tissue, loose, damaged or broken teeth (Lowder and Mueller 1998). The examination and correction of the dental disorders are the primary goal, but in many cases severe problems could not be treated in a proper way. It is important to know if pelleted feeds are preferred over grain and if the horse exhibits quidding, halitosis, or drooling. In these cases, the owner may need to wash out the horse´s mouth out daily to diminish the incidence of periodontal disease due to impacted feed materials (Lowder and Mueller 1998). Hay cubes can be used as a forage source if the aged horse is not able to chew long stem hay. In some cases soaked hay, hay cubes or pelleted feedstuffs improve the feed intake. Energy supply can be increased by flaked oats, vegetable oils (maximum 1 l, slow introduction) or sucrose (30 % in the total ration). A total refuse of all feedstuffs can be compensated by a liquid diet (grass meal, starch, sucrose, and vegetable oil), given via nasogastric tube (Table 7, Coenen 1986). In addition, some old horses benefit from having a source of warm water to drink, especially after the loss of a tooth as cold water might cause some discomfort at the alveolus (Lowder and Mueller 1998).

Pituitary dysfunction

Chronic laminitis or infections, hyperglycemia, hyperinsulinemia, polyuria, polydypsia and hirsutism are symptoms of pituitary dysfunction (equine Cushing´s disease), which is extremely common in geriatric horses (Ralston 2001). Pituitary dysfunction can be treated with either cyproheptadine or pergolide in addition to dietary modifications (Döcke 1999). The basis ration consists of roughage (hay or grass silage), which could be supplemented with beet pulp (with a reduced degree of molasses) or soybean hulls. Grain starch or sucrose should be reduced, whereas vegetable oils can add the energy supply.

Hepatic or renal dysfunction

If **hepatic dysfunction** is present, a restriction in protein supply is necessary, but protein should be of excellent quality to ensure an adequate intake of essential amino acids and to provide of minimum of aromatic amino acids (phenylalanine, tyrosine, methionine, and tryptophan) and a maximum of short-branch-chain amino acids (valine, isoleucine, leucine, Lewis 1996, Table 9). It has been shown that aromatic amino acids contribute to the development of hepatoencephalopathy (Pearson 1999).

Table 9: Amino acid ratio and protein contents (%) in different horse feeds

Feedstuffs	BCAA/AAA*	Protein (% DM)
Soybean	1.8	50
Linseed	1.9-2.1	35-50
Rice	1.35	7-9
Wheat	1.5	11-14
Oats	1.65	10-13
Barley	1.65	13
Rye	1.85	14
Corn	2.15	8-10
Sorghum	2.3	12-13

*BCAA/AAA (ratio of branched chain amino acids to aromatic amino acids): the highest ratio demonstrates the first preference for feeding horses with hepatic failure

Diets for horses with liver problems should contain high concentrations of soluble carbohydrates to minimize lipolysis and the need for hepatic glucose synthesis, and the diets should be low in salt. The supplementation of vegetable oils must be strictly avoided in horses with liver problems.

Horses with **renal failure** need a high energy diet and a reduction in protein intake (70 - 80% of requirement). Varying degrees of protein loss in the urine may, however, increase dietary protein needs. Furthermore, the phosphorus and calcium supply should be restricted as a decreased ability of the kidneys to excrete such minerals leads to life-threatening hypercalcemia. Feedstuffs like alfalfa, clover or bran should be avoided as they are rich in calcium, phosphorus and protein. Grass forages provide an adequate basis which can be added with corn and vegetable oils.

Chronic pain

A variety of conditions like chronic laminitis, arthritis, and other trauma cause chronic pain in aged horses. Until now, there is no clear nutritional concept to avoid pain. Weight control is necessary as obesity can deteriorate musculoskeletal problems. Stable rest appears to exacerbate stiffness and pain, so horses should be turned out on pasture or should be exercised. Anti-

inflammatory drugs or glucosamine or chondroitin sulfate compounds are widely used to reduce pain. In humans, the efficiency of such compounds seemed to be confirmed, however, in horses the results are conflicting when given glucosamine or chondroitin sulfate compounds orally (Hebeler 2001).

Summary

Old horses require a careful feeding and management practice. Energy and protein supply should be adapted according to recommendations for maintenance or performance. A higher requirement for zinc, selenium, vitamins A, C and E is speculated. Processed concentrates of high quality should be used to take a possible reduced digestibility into consideration. Poor dentition, weight loss or metabolic disorders like equine cushing disease, hepatic or renal dysfunction require a modified diet. A high meal frequency, clean fresh water offered ad libitum as well as exercise are additionally of great importance in old horses.

Literature

BAILEY, S.R., C.M. MAIR and J. ELLIOTT (2003): Identification and quantification of amines in the equine caecum. RVS 74, 113-118

COENEN, M. (1986): Beiträge zur Verdauungsphysiologie des Pferdes. 13. Mitteilung. Verdaulichkeit und praecaecale Passage einer suspendierfähigen Diät in Abhängigkeit von der Applikationsform (spontane Futteraufnahme bzw. flüssig per Sonde). J. Anim. Physiol. Anim. Nutr. 56, 104-117

COENEN, M. (2001): Vom Magenulkus bis zur Obstipation: Fehler in der Fütterung von Pferden. Übersichten Tierernährung 29, 172-179

COENEN, M (2001): Fütterung von Pferden nach Operationen. Übersichten Tierernährung 29, 180-187

COENEN, M., I. VERVUERT, J. MÖHRER and M. Bichmann (2003): Expanded sugar beet pulp in feeding intensively exercising horses. Proc. Equine Nutrition and Physiology 18, 138-139

COHEN, N.D., P.G. GIBBS and A.M. WOODS (1999): Dietary and other management factors associated with colic in horses. J. Am. Vet. Med. Assoc. 215, 53-60

DOECKE, F. (1999): Krankheiten der endokrinen Organe. In: Handbuch Pferdepraxis. Ferdinand Enke Verlag, Stuttgart, 611-622

GARNER, H.E., J.R. COFFMAN, A.W. HAHN, D.P. HUTCHESON and M.E. TUMBLESON (1975): Equine laminitis of alimentary origin: An experimental model. Am. J. Vet. Res. 36, 441-444

HASSEL, D.M., D.L. LANGER, J.R. SNYDER, C.M. DRAKE, M.L. GOODELL and A.WYLE (1999): Evaluation of enterolithiasis in equids: 900 cases (1973-1996). JAVMA 214, 233-237

HEBELER, D. (2001): Ergänzungsfuttermittel und Spezialprodukte zur Förderung der Funktion und Gesundheit der Gelenke. Übersichten Tierernährung 29, 163-171

KANEENE, J.B., R.A. MILLER, W.A. ROSS, K. GALLAGHER, J. MARTENIUK and J. ROOK (1997): Risk factors for colic in the Michigan (USA) equine population. Prev. Vet. Med. 30, 23-36

LEWIS, L.D. (1996): Equine clinical nutrition. Williams & Wilkins Baltimore

LONGLAND, A.C. and J.M.D. MURRAY (2003): Effect of two varieties of perennial ryegrass (Lolium perenne) differing in fructan content on fermentation parameters in vitro when incubated in vitro with a pony inoculum. Proc. Equine Nutrition and Physiology 18, 144-145

LOWDER, M.Q. and P.O.E. MUELLER (1998): Dental disease in geriatric horses. Equine Practice 14, 365-380

McFARLANE, D., D.C. SELLON, D. GAFFNEY, V. HEDGPETH, M. PAPICH and S. GIBBS (1998): Hematologic and serum biochemical variables and plasma corticotropin concentration in healthy aged horses. AJVR 59, 1247-1251

MORRIS, D.D., M. M. HENRY, J.N. MOORE and J.K. FISCHER (1991): Effect of dietary α-linolenic acid on endotoxin-induced production of tumor necrosis factor by peritoneal macrophages in horses. Am. J. Vet. Res. 52, 528-532

POLLITT, C.C. and A.W. VAN EPS (2002): Equine laminitis: A new induction model based on alimentary overload with fructan. Proc. Austr. Equine Vet. Assoc. Bain-Fallon Memorial Lectures

PEARSON, E.G. (1999): Liver disease in the mature horse. Equine Vet. Educ. 11, 87-96

RALSTON, S.L., C.F. NOCKELS and E.L. SQUIRES (1988): Differences in diagnostic test results and hematologic data between aged and young horses. Am. J. Vet. Res. 49, 1387-1392

RALSTON, S.L., C.F. NOCKELS and E.L. SQUIRES (1989): Digestion in the aged horse. J. Equine Vet. Sci. 9, 203-205

RALSTON, S.L. (2000): Feeding clinically ill horses. Gesellschaft Schweizerischer Tierärzte, 18. – 20. 05.2000, 7 - 8

RALSTON, S.L. (2001): Management of the geriatric horses. In: Advances in Equine Nutrition II, Nottingham Press, Nottingham, 393-396

REEVES, M.J., M.D. SALMAN and G. SMITH (1996): Risk factors for equine abdominal disease (colic): results from a multi-center case-control study. Prev. Vet. Med. 26, 285-301

TINKER, M.K., N.A. WHITE, P. LESSARD, C.D. THATCHER, K.D. PELZER, B. DAVIS and D.K. CARMEL (1997): Prospective study of equine colic incidence and mortality. Equine Vet. J. 29, 448-453

UHLINGER, C. (1992): Investigations into the incidence of field colic. Equine Vet. J. Suppl. 13, 16-18

[i] This article should be referred as: Vervuert, I. and Coenen, M. 2003. Nutritional management in horses: Selected aspects to gastrointestinal disturbances and geriatric horses. Proceedings of the 2nd European Equine Health & Nutrition Congress, Lelystad, The Netherlands, page 20-30.

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