Journal of Equine Veterinary Science 61 (2018) 108–113

Contents lists available at ScienceDirect

Journal of Equine Veterinary Science

journal homepage: www.j-evs.com

Original Research

Feeding and Management Practices for Racehorses in Turkey

Gulsah Kaya-Karasu [a], Peter Huntington [b], Christine Iben [c,*], Jo-Anne Murray [d]

[a] Turkish Jockey Club Racecourse Equine Hospital, Istanbul, Turkey
[b] Kentucky Equine Research, Mulgrave, Victoria, Australia
[c] Department of Farm Animals and Veterinary Public Health, University of Veterinary Medicine, Vienna, Austria
[d] School of Veterinary Medicine, University of Glasgow, Glasgow, UK

ARTICLE INFO

Article history:
Received 30 January 2017
Received in revised form 20 April 2017
Accepted 24 April 2017
Available online 4 May 2017

Keywords:
Racehorse
Equine nutrition
Feeding practice
Survey

ABSTRACT

The aim of this study was to gather information on feeding practices and to identify nutrient imbalances of racehorses in Turkey. A total of 134 racehorses who visited the Turkish Jockey Club Racecourse Equine Hospital in Istanbul were referred for professional nutritional advice in 2013. Each horse was examined, and body weight (BW), body condition score (BCS), exercise level, feeding practices, reasons for the veterinary visit as well as feed and supplement intake were recorded. Intakes of energy, crude nutrients, starch, sugar, and minerals were calculated and compared to the requirements. Descriptive data were calculated using commercial statistical software (IBM SPSS Statistics 24, Chicago, IL). The median age of the population was 3 years. The mean BW of the horses was 423 ± 38.4 kg, and BCS was 4.5/9 ± 0.7. Nearly all (99.2%) horses were fed grass hay, and 61% of the horses received alfalfa as well. The average forage intake was 1.0 ± 0.4% of BW/d. The average intake of concentrate was 1.2 ± 0.4% of BW. Forty-nine percent of the horses were fed supplements, and only 12% received oil. The mean metabolizable energy (ME) intake was 1.0 ± 0.2 MJ ME/kg $BW^{0.75}$ for thoroughbreds and 0.9 ± 0.1 MJ ME/kg $BW^{0.75}$ for Arabians. The calculated mean starch intake was 5.0 ± 2.2 g/kg BW, and the sugar intake was 1.2 ± 0.4 g/kg BW. Communication between horse owners/trainers and the equine nutritionists are needed with regard to formulating a proper diet for each horse.

1. Introduction

Nutrition is an important aspect of health in all species. In horses, nutritional imbalances can contribute to various disease conditions such as gastric ulcer, colic, musculoskeletal problems, and obesity [1].

There are many surveys (nutritional-related pathologies and their nutritional treatment) in particular for sick horses that have been published. Equine gastric ulceration syndrome [2], chronic diarrhea [3], colic [4], obesity [5], and the related countermeasures were some of the frequently encountered nutritional-related health problems. However, less data are available about healthy horses [1,6–12]. Common feeding practices range from feeding traditional home cereal-based mixes to various forms of manufactured feeds. Common additions include various types of vegetable oil, succulents, one or more vitamin and mineral mixes, herbal mixes, supplements for joint health and certain ergogenic agents with performance-enhancing claims. Many horse products are available on the market,

Animal welfare/ethical statement: None.
Conflict of interest: The authors declare no conflicts of interest.

* Corresponding author at: Christine Iben, Department of Farm Animals and Veterinary Public Health, University of Veterinary Medicine, Veterinärstrasse 1, 1210 Vienna, Austria.
E-mail address: christine.iben@vetmeduni.ac.at (C. Iben).

0737-0806/$ – see front matter © 2017 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.jevs.2017.04.009

with promises ranging from behavioral modification to increased athletic performance. Dietary supplementation information also is available from several studies [13–15], and overall, it would appear that more than 60% of horses receive a dietary supplement in the form of commercial vitamins or mineral mixtures.

The interest in the optimal feeding of racehorses has increased in recent years, with some evaluation of the dietary management of racehorses in Turkey available [14]. However, research in this area is extremely limited, and consequently, the aim of this study was to gather information on feeding practices and dietary supplement use and to identify nutrient imbalances and relationships with nutritional diseases and management conditions of racehorses in Turkey.

2. Materials and Methods

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

This study was conducted between April and October 2013 at the Turkish Jockey Club Racecourse Equine Hospital, Istanbul, Turkey. One hundred thirty-four Arab or Thoroughbred patients referred for professional nutritional advice were involved in the study. The most common breed represented were thoroughbreds (73.8%), with the remainder being Arabians.

Body weight (BW) was measured using a weight scale, and body condition score (BCS) was based on the 1–9 point system by Henneke et al [16]. The study consisted of four sections: the first section collected anamnestic information including breed, age, sex, training schedule, general management (bedding material, deworming), fecal appearance, abnormal behaviors, and reason for veterinary visit. The second section collected information on nutritional protocols from horse trainers/owners. The questions covered type and amount of roughage and concentrates, supplements, succulents, oils, and water consumption and meals. Section three was for collection and analysis of feed materials. All horses were fed with the same hay, alfalfa, oat, barley, soybean meal, and samples were taken to evaluate the nutrient contents of the feedstuffs. The feed samples (n = 5) for forages and concentrates were analyzed at the governmental laboratory (Tubitak Mam) in Turkey to determine moisture, crude protein, crude fat, crude fiber, and ash. The metabolizable energy (ME) value of the feedstuffs was calculated according to Kienzle and Zeyner [17]. The mineral and vitamin levels in forages and concentrates were estimated from the "Nutrient Requirement of Horses" tables [18]. When horses were fed commercial products, the values on the declaration were used. The final section was related to current diet analysis and making adjustment to balance the diet, if necessary. For this purpose, two calculations were made for each horse: first the current and second the required nutrient intakes were calculated for energy, starch, crude fat, crude protein, macrominerals and microminerals, and vitamins. The ME requirement for horses between 200 and 800 kg was calculated according to Kienzle and Zeyner [17]. The energy requirement calculation included an adjustment for activity level. The assignment of the ME increments above maintenance (20%, 40%, 60%, and 90%) to the arbitrary classifications "light," "moderate," "heavy," and "very heavy" was used. The provision of nutrients was classified as very low (0%–50%), low (50%–80%), normal (80%–150%), and high (150%–250%) of the requirement compared to the NRC recommendations [18].

2.1. Follow-up

Each patient was reexamined 2 weeks after the new feeding program was introduced.

2.2. Statistical Analysis

SPSS 16.0 (IBM SPSS Statistics 24, Chicago, IL) was used to perform descriptive statistics. Normally distributed data are presented as mean ± standard deviation, whereas skewed data are presented as median.

3. Results

Reasons for visiting the hospital varied, with the most common being internal medicine (n = 94) and orthopedic problems (n = 40). The reported reasons for diet modification were weight loss or poor body condition (n = 37), gastric ulcers (n = 36), hard feces (n = 11), developmental orthopedic disease (n = 9), myopathies (n = 7), synovitis (n = 7), osteopenia (n = 6), soft feces (n = 5), continuous colic (n = 4), sore shins (n = 3), exostosis (n = 3), coprophagy (n = 2), laminitis (n = 2), hoof problems (n = 2), bone spavin (n = 1), and behavioral abnormalities (n = 1). Some horses were given a modified diet for more than one reason. The median number of visits to the hospital for nutrition consulting was 1 (range, 1–9).

The median age of the population was 3, varying from 2 to 7 years. The majority of the horses were geldings (52%). The mean BW for Arabians was 404 ± 40.4 kg, for thoroughbreds 430 ± 35.4 kg, with an overall mean BW of 423 ± 38.3 kg. The median BW of these horses was 408 kg for Arabians (range, 303–461 kg) and 430 kg (range, 345–505 kg) for thoroughbreds. The mean BCS was 4.5 ± 0.7 (range, 3–6/9).

The majority of the horses had a good appetite (79%), a few horses had excessive appetite (2%), and 19% had a poor appetite. Most of the horses had moderate levels of water consumption (85%), a few had polydipsia (2%), and the rest had low water intake. With regard to deworming during the last 3 months, most of the horses were dewormed (57%), with a few horses definitely not dewormed (4%); 39% of the horse owners/trainers reported not knowing whether their horse had been dewormed or not. Ivermectin and fenbendazole were the most common deworming ingredients. Sixty-eight percent of the horses had normal feces quality, whereas 8% of the horses had hard or dry feces. In this study, straw was the most frequently used bedding material (88%), although shavings (7%) and grass hay (5%) were also used. The chemical compositions of the feedstuffs are shown in Table 1.

Table 1
The nutrient content of feedstuff on as fed basis.

Nutrients	Hay	Alfalfa	Oat	Barley	Soybean Meal
Moisture, %	8.1	9.1	9.3	9.4	8.7
ME MJ/kg	6.2	6.9	12.7	12.5	12.6
Crude protein, %	3.6	16.4	8.5	8.4	46.7
Crude fat, %	1.1	2.4	4.0	1.9	1.6
Crude fiber, %	37.2	29.5	15.4	5.6	4.0
Ash, %	8.2	9.2	2.9	2.2	6.7

Abbreviations: ME, metabolizable energy; MJ, megajoule.

3.1. Forage and Concentrate Consumption

None of the racing stables has access to any pasture. Grass (meadow) hay is the most common hay fed to horses, followed by alfalfa. Grass hay is grown in all regions and is widely available in Turkey. The use of grass hay in the diet was 99.2%, and only 2.2% of the horses were fed ad libitum. A total of 61% of the horses consumed alfalfa hay together with grass hay in the ration. Three horses did not consume any concentrate feed and were only fed forage. The median number of concentrates fed was 2 but ranged from 1 to 5. The estimated amounts of forages and concentrates fed are provided in Table 2. The feeding schedule did not show variations for the majority of horses, with hay (97%), alfalfa (90%), and concentrates (92%) being fed two times daily. The percentage of concentrate feeds consumed by racehorses is shown in Table 3. Seventy-nine percent of the horses' diets contained grain, with 30% fed only oats; 22% only barley; 45% oats and barley together; and 3% linseed, soybean meal, rice bran meal, and cracked corn in addition to oats and barley. Oats were by far the most common grain fed, and the mean oat intake was 3.5 ± 1.5 kg/d. Only 3.6% of the horses' diet contained commercial feed balancer providing essential nutrients such as protein, vitamins, minerals, and trace elements.

3.2. Supplements

Forty-nine percent of the total number of horses was fed supplements, with 35% of them fed one supplement, 32% two supplements, 14% three supplements, 18% more than three supplements, and 1% received seven supplements. The mean number of supplements used was 2.3 ± 1.5, and the median was 2 (range, 0–7). The supplement use percentages are summarized in Table 3. The most commonly used supplements were chondroprotectives, multivitamins, and gastrointestinal protectives. The most commonly used vitamin-mineral mixtures were calcium, phosphorus, and complete premixes.

Table 2
The mean amount of forages and concentrate fed (% of BW/d).

Feed Intakes (Mean ± SD)	All Horses	Thoroughbreds	Arabians
Total forage	1.09 ± 0.42	1.06 ± 0.44	1.17 ± 0.36
Alfalfa	0.30 ± 0.30	0.29 ± 0.30	0.32 ± 0.31
Grass hay	0.79 ± 0.31	0.77 ± 0.32	0.85 ± 0.28
Total concentrate	1.20 ± 0.46	1.24 ± 0.48	1.09 ± 0.38
Grain	0.80 ± 0.55	0.81 ± 0.57	0.79 ± 0.50

Abbreviation: SD, standard deviation.

Oil was also used as a supplementary energy source, but only 12% of the horses were supplied with oil, mostly corn oil or sunflower oil and the average amount of oil fed was 90 mL/d. Salt was often available as free-choice salt blocks containing trace minerals in many horses' stalls and was useful to provide the Na and Cl needs of the horse, especially those which sweat extensively and regularly. All horses were fed succulents, and 92% of these were carrots, apples, and parsley. Garlic powder, molasses, dried grapes, honey, and mint were also used as treats.

3.3. Nutrient Analyses

Thoroughbred horse trainers fed their horses an average of 97.8 ± 25.3 MJ ME/d. The energy intakes varied in comparison to requirements, 31% of thoroughbreds had higher intakes than required with a further 23% of thoroughbreds fed under the recommended energy levels. Trainers of Arabians fed their horses an average of 80.9 ± 17 MJ ME/d. For 45% of the Arabians, the energy intake was within the requirements, with 20% fed less and 35% fed higher than the recommended energy levels.

Eighty-eight percent of the horses were fed normal levels of crude protein, and the intake was 2.2 ± 0.6 g/kg BW, which was within the range of NRC recommendations [18]. The crude protein intake was higher in 7.4% of the cases and lower in 4% of the horses [18]. The estimated lysine intake was within the normal range for 91% of the horses, with the remaining horses receiving less than recommended [18].

Mean crude fiber intake was 3.1 ± 1.5 g/kg BW, and crude fat intake was 0.7 ± 0.3 g/kg BW, both being within NRC recommendations [18]. However, average starch intake was 5.0 ± 2.1 g/kg BW, and sugar intake was 1.2 ± 0.4 g/kg BW, both of which were high compared to the NRC recommendations [18].

The comparison of macromineral and micromineral intakes with the NRC recommendations is shown in Table 4. In addition to the mineral contents of the diets, some of the mineral ratios are also important. The mean calcium: phosphorus ratio was 1.6:1 ± 0.8 and the zinc:copper ratio was 4.2:1 ± 1.0. Forty-two percent of the horses were fed with either calcium- or phosphorus-deficient, or both deficient diets, and 53% of the horses were fed with either zinc- or copper-deficient diets. Fifty-eight percent of the horses were fed Ca-, P-, Zn-, Cu-, Se-, I-, or Mg-deficient diets.

The horses were fed with acceptable vitamin levels except vitamin E. The vitamin E intake was less than the NRC recommendations for 54.4% of the horses. However, in 71.4% of the horses, at least one of the vitamins or macromineral or micromineral intakes was outside of the NRC recommendations [18].

4. Discussion

Equine nutrition plays a critical role in equine health. However, many owners have an inaccurate understanding of equine nutrition [1], and decisions regarding nutrition are often based on "folklore, tradition, and misinformation" [19].

Table 3
Concentrate feed intakes and combination with supplements.

Concentrate	Horses, %	Supplement Use, %	Vitamin and Mineral, %	Other Supplements, %
Grain	38	47	79	21
Commercial feed	19	56	50	50
Grain and commercial feed	41	56	42	58

Two percent of the horses consumed only forage.

4.1. Forage

Grass (meadow) hay is the most common hay fed to horses in Turkey, which is similar to other European countries. Laboratory analysis of grass hay revealed a lower crude protein (3.6%) and a higher crude fiber content (37.2%) compared to NRC levels provided for this feedstuff. The ME content of the hay was low (6.2 MJ/kg) in comparison to NRC data provided for this forage, which is likely due to the maturity of the forage. The digestibility of hay depends on maturity at harvest, leaves to stem ratio, crude fiber content, and storage conditions. As hay matures, leaves to stem ratio declines and neutral detergent fiber (NDF) in stem tissue increases, although the NDF in grass leaves is more digestible than the NDF in stem tissue [18]. Because of the relationship between NDF and energy supply, mature hay provides less energy than immature hay. Consequently, a hay-only diet of this nature would not meet the energy requirements of a racehorse. The inclusion of alfalfa did increase the protein content of the ration; however, alfalfa hay is not as commonly provided in Turkey as in countries such as the United States [7], Australia [10], and the UK [9] because it is generally more expensive.

The average grass hay intake was higher (3.4 kg), and alfalfa hay intake was lower (1.2 kg) in Turkey compared to Australia (2.5 kg grass or alfalfa hay [10]). However, the average daily forage intake was higher (4.7 kg) for thoroughbreds in Turkey than in Australia (3.3 kg) [10] but was lower than in many other countries. However, it is approximately 1% of the BW on a dry matter basis which is the NRC absolute minimum intake. Furthermore, 10% of the trainers feed less than 2 kg forage/d, and it should not be surprising that many of these trainers complain about the difficulties in getting horses to eat well enough. This could relate to gastric ulcers, hindgut disturbances, or B vitamin deficiencies due to abnormal hindgut function of low forage diets.

In this study, straw was the most frequently used bedding material (88%). The preference of straw may be attributed to its availability, relative low cost, and relative ease of disposal, as well as providing a deep, warm, and comfortable bed. However, straw is believed to increase the risk of impactions and inflammatory airway disease in horses [9]. On the other hand, straw can replace hay when it is ingested by the horses, and low hay provision could be balanced by the intake of straw.

Table 4
The macromineral and micromineral intake (% of horses) compared to NRC recommendations.

Minerals and Vitamins	Very Low	Low	Normal	High
Ca	18.6	11.1	69.4	0.9
P	0.9	15.6	83.5	
Mg	2.7	5.9	90	1.4
Fe			100	
Cu	35.2	11.9	52.9	
Mn	4.4	23.1	72.5	
Zn	34.3	14.1	50.7	0.9
Se	38.2	11.1	50.7	
Co		0.8	99.2	
I	30.7	32.8	36.5	
Vitamin A	12.8	5.2	82	
Vitamin D	2.9	10.4	85	1.7
Vitamin E	37.3	17.1	45.6	
Vitamin B1	11.9	26.8	61.3	
Vitamin B2			100	

Very low 0%–50%, low 50%–80%, normal 80%–150%, high 150%–250% of the requirement compared to NRC recommendations.

4.2. Concentrate

Turkish trainers have traditionally fed more “straights” than premixed feeds, although this pattern appears to have changed because 60% of the horses in this study were fed a ration that contained a commercial feed preparation. This study illustrated that 41% commercial feeds were not used according to instructions but are diluted with other grains, which diminishes the value of the vitamin and mineral premixes in the feeds. These feeds are a simple and economic method of feeding but still give the user control over grain and energy intakes. Unfortunately, most horse owners ignore the feeding instructions and feed these products at lower than recommended levels, so they do not provide an adequate diet. In contrast to our study, Huntington [10] showed that the average amount of concentrate fed was 7.8 kg by Thoroughbred and 7.7 kg by Standardbred trainers compared to 5 kg by Thoroughbred trainers and 4.3 kg by Arabian trainers in Turkey. This might be due to the smaller size, higher forage intakes, and lower training loads in Turkey. Small amounts of other straight grains or grain by-products and proteins are also given in Turkey, like in other countries [7]. The oat, barley, and soybean meal in this study had typical nutrient profiles for these feed types, albeit the protein levels for oats and barley were slightly lower than the NRC values [18]. The range and quality of commercial feeds available in Turkey have increased dramatically in recent years. However, there is still a substantial prejudice against pellets by trainers.

4.3. Supplements

The results of this study also demonstrated the widespread use of supplements. A large amount of supplementation can sometimes lead to increased costs of

feeding and oversupply of certain vitamins and minerals, with possible interactions and interferences.

Various feed additives and supplements can be given to horses. In accordance with our study, approximately 84% of owners reported including at least one dietary supplement in their performance horse's daily feed in New England [1]. The most commonly used supplements were chondroprotectives, electrolytes, and multivitamins.

Despite widespread use of fortified commercial feed and supplements, our study has shown that 71% of the horses had at least one of the vitamin, macromineral, or micromineral intakes lower than recommended by the NRC [18], copper, zinc, selenium, iodine, and vitamin E deficiencies were the most common. In contrast, Honore [15] reported that horses receiving some type of nutritional supplements were twice as likely to have excessive dietary levels in at least one nutritional category compared with nonsupplemented horses, increasing the likelihood of an improperly balanced ration. Most trainers have little concept of the mineral and vitamin needs of their horses and what is supplied by commercial feeds and supplements; hence, the choice of supplements becomes difficult. Causes of deficiencies can include low specifications of certain nutrients in feeds and supplements, and lower supply of commercial feeds and supplements than recommended. In particular, dilution of commercial feeds with straight grains leads to lower nutrient intakes than the nutritionist intended when the feed was designed. Trainers and owners need to use a commercial feed at recommended amounts, if they feed lower amounts they should use a more concentrated commercial feed such as a semiconcentrate or a ration balancer. Therefore, the use of feed supplements without proper guidance and education could prove detrimental to the horse. This demonstrates the importance of a careful diet history and in-depth communication between the equine nutritionist and the client regarding the horse's diet in relation to any medical problems and the concurrent use of any form of nutritional supplement.

Carrots and apples are the most commonly given succulents in Turkey, as in the UK and Germany [9] and other countries. Supplemental vegetable oil is often given as an alternative or additional energy source [20]. The average amount of oil given was less than 100 mL (3.5 MJ energy) in our study, whereas it was less than 125 mL in the study of Huntington [10]. However, the fat addition as an oil should not be taken into account as a single parameter because some high energy supplements and the new premixed feeds for racehorses also contain considerable quantities of added fat.

4.4. Nutrition Analyses and Diseases

Thoroughbred trainers fed an average of 22 MJ/100 kg BW which is a lower energy intake than the energy intakes (26 MJ/100 kg BW) of horses in Australia [10] and many other countries. The size and BW of the horses in Turkey is smaller than in Australia and some other countries; thus, the lower energy intake is acceptable. Furthermore, there is a significant variation in daily intake that presumably relates to workload and individual metabolism.

Racehorses are performance horses and most are not growing; therefore, they do not need a high protein level. In our study, most of the trainers fed a normal amount of crude protein with an average intake of 969 g; however, in Australia, most of the trainers fed more crude protein than recommended by the NRC with an average of 1,450 g. The low protein grass hay and low concentrate amounts led to this overall lower intake.

The starch (mean 5 g/kg BW) and sugar intake (2 g/kg BW) were higher than the NRC 2007 recommendations [18]. This may be correlated with the most commonly reported diseases of internal medicine. This group included gastric ulcers (equine gustric ulcer syndrome [EGUS]), poor body condition, or weight loss and was similar to the study of Hoffman et al [1]. Additionally, the trainers often complain about lower performance than the horse's ability or capacity. EGUS has a multifactorial ethology with several potential risk factors. High starch intake of >2 g/kg BW/feeding time was associated with an approximately twofold increase in the likelihood of EGUS in Denmark [2].

In 71% of the horses, at least one of the vitamin, macromineral, or micromineral intakes, particularly Ca, P, Zn, Cu, Se, I, Mg, and vitamin E intake, was deficient. In contrast, Harris [9] showed that most of the horses were being fed very high amounts of Ca, P, Mg, K, Cu, Fe, I, Co, and vitamins A and D in the UK and Germany. Orthopedic problems were the second most common disease group in this study and that might be related to deficiencies of calcium and phosphorus which constitute the major part of the mineral content of the bone.

As in Australia [10], the UK, and Germany [9], a Thoroughbred in race training is likely to be kept in an individual stall over 20 hours/d, and there was no access to grazing in Turkey. Previous studies have found correlations between increased visual horizons, social contact, and reductions in stereotypic behavior [13]. The occurrence of stereotypies or other unusual behaviors in this survey is similar compared to previous surveys [21,11]. The frequency of the most common abnormal behavior of wood chewing was 8.2% in the present survey, whereas it was reported as 0.9% by Sondergaard and Christensen [11] and 11.8% by Nicol [21]. However, in our experience, stereotypic behavior is more common than was reported here. The low percentage recorded in this study might be due to Turkish trainers or owners being unaware that their horse is performing a stereotypy or that they do not want to admit behavioral problems in their stable.

Consequently, nutrition is a critical component of equine health. Although there is considerable variation in the management and feeding practices of the domestic horse across the world, feeding practices of racehorses in Turkey were consistent with the feeding practices across the world apart from lower intake of ME and lower quality ingredients. Horse trainers' lack of knowledge and decisions regarding nutrition often are based on tradition. It is difficult to understand that more feed does not necessarily mean horses will run faster [10]. Proper communication between horse owners and equine nutritionist is needed with regard to formulating a proper diet for each patient. This is also true for supplement use and how it may interact with other medications being administered to an individual animal.

Thus, the equine veterinarians and horse trainers need to be prepared to discuss ideal nutritional practices with an equine nutritionist.

References

[1] Hoffman CJ, Costa LR, Freeman LM. Survey of feeding practices, supplement use and knowledge of equine nutrition among a subpopulation of horse owners in New England. J Equine Vet Sci 2009; 29:719–24.

[2] Luthersson N, Nielsen KH, Harris P, Parkin TDH. Risk factors associated with equine gastric ulceration syndrome (EGUS) in 201 horses in Denmark. Equine Vet J 2009;41:625–30.

[3] Valle E, Gandini M, Bergero D. Management of chronic diarrhea in an adult horse. J Equine Vet Sci 2013;33:130–5.

[4] Kaya G, Sommerfeld-Stur I, Iben C. Risk factors of colic in horses in Austria. J Anim Physiol Anim Nutr 2009;93:339–49.

[5] Bruynsteen L, Janssens GPJ, Harris PA, Duchateau L, Valle E, Odetti P, Vandevelde K, Buyse J, Hesta M. Changes in oxidative stress in response to different levels of energy restriction in obese ponies. Br J Nutr 2014;112:1402–11.

[6] Brosnahan MM, Paradis MR. Assessment of clinical characteristics, management practices, and activities of geriatric horses. J Am Vet Med Assoc 2003;223:99–103.

[7] Duren S. Feeding practices in the United States. In: Advances in equine nutrition II. Proceedings from the KER equine nutrition Conference. 2001; 453–460.

[8] Harris PA. Feeds and feeding in the United Kingdom. In: Robinson NE, editor. Current therapy in equine medicine. Washington: W.B. Saunders; 1997. p. 121–4.

[9] Harris PA. Feeding practices in the UK and Germany. In: Advances in equine nutrition II. Proceedings from the KER equine nutrition Conference. 2000; 429–452.

[10] Huntington P. Feeding practices in Australasia. In: Advances in equine nutrition II. Proceedings from the KER equine nutrition Conference. 2001; 461–472.

[11] Søndergaard E, Christensen JW. A survey of housing and management conditions for horses in Denmark. Proceedings of the Havemeyer Workshop on horse Behaviour and Welfare. 2002; 10–15.

[12] Townson J, Dodd VA, Brophy PO. A survey and assessment of racehorse stables in Ireland. Irish Vet J 1995;48:364–72.

[13] Cooper JJ, Mason G. The identification of abnormal behavioral problems in stabled horses and their relationship to horse welfare: a comparative review. Equine Vet J 1998;27:5–10.

[14] Demirel G. Feeding practices for racehorses in Turkey. J Fac Vet Med Istanbul Univ 2006;32:79–86.

[15] Honore EK. Equine feeding practices in Central North Carolina: a preliminary survey. J Equine Vet Sci 1994;14:424–9.

[16] Henneke DR, Potter GD, Kreider JL, Yeates BF. Relationship between condition score, physical measurement and body fat percentage in mares. Equine Vet J 1983;15:371–2.

[17] Kienzle E, Zeyner A. The development of a metabolizable energy system for horses. J Anim Physiol Anim Nutr 2010;94:231–40.

[18] NRC (National research council). 6th revised edition of “the nutrient requirement of horses”. Washington, USA: National academic press; 2007.

[19] Martin O. Feeding horses at the winter equestrian festival: a review of common practices. In: Proceedings of the 17th Kentucky equine research nutrition Conference: feeding and veterinary management of the Sport horse. Lexington, Kentucky: Kentucky Equine Research, 2010; 127–130.

[20] Harris PA. Energy sources and requirements of the exercising horse. Annu Rev Nutr 1997;17:185–210.

[21] Nicol CJ. Stereotypies and their relation to management. In: Harris PA, Gomarsall G, Davidson HPB, Green R, editors. Proceedings BEVA Specialist Days on behavior and nutrition, equine Vet J; 1999. p. 11–4.