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A survey on the feeding of competition horses and perceptions of forage in the UK and Sweden

Auriane Hurtes

Examensarbete / SLU, Institutionen för husdjurens utfodring och vård, **536**

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Handledare:
Supervisor: Malin Connysson, SLU, Department of Animal Nutrition and Management
Examinator:
Examiner: Anna Jansson, SLU, Department of Animal Nutrition and Management
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Abstract

Classical feeding practices of the performance horse have included the necessity for energy-dense concentrates that are rich in starch in order to meet its' high energy requirements. Such diets have been associated to numerous health problems. Moreover, access to forage is traditionally limited due to time constraints and perceptions of it hindering athletic performance. The aim of the present study was to assess the current feeding practices and perception of forage within the competition industry. This was done through an online survey for harness racing trainers and elite level 3-day event riders in the UK and Sweden. Results indicated that feeding practices varied between the disciplines and countries. Hay (45%) and haylage (42%) were the main forages fed. Respondents fed on average 3.6 kg of concentrates daily and most reported turning out their horses on pasture. Less concentrate and more forage was fed in Sweden compared to the UK (p<0.001). Health was selected as the most important factor determining their horses' feed, more so than performance. Most respondents reported a nutritionist was their main source of nutritional advice. Perceptions of forage in the UK reflected the traditional view that forage cannot meet the high energy requirements of the athletic horse. On the other hand, perceptions of forage in Sweden reflected the findings of research. Overall, respondents were open-minded to a forage-only diet for their athletic horses.

Keywords: Horse; Performance; Feeding practices; Forage

Foreword

This thesis was written as part of the Animal Science Masters at the Swedish University of Agricultural Sciences (SLU). I would like to thank the following people for their help and support throughout this degree project. First and foremost, thanks to my supervisor Malin Connysson for her advice, encouragements and guidance in writing this thesis, as well as her help in translating and distributing the survey. I am very grateful to Nina Lloyd-Jones, Michelle Graham, Wiveka Lundh and Kirsty Lee for their assistance in forwarding the survey to the members of the national governing body for elite level three-day-eventing and harness racing. Last but not least, I would like to thank Sara Rottensteiner for her cosmic support throughout the whole process including baketales therapy.

Contents

Introduction

Nutrition is a key component of equine health and performance. Horses have evolved as grazers adapted to high fiber diets, feeding continuously over long periods of time. However, through domestication horses have commonly been stabled and fed high concentrate diets. This is particularly true of the performance horse that has high energy requirements that are traditionally met with energy-dense cereal grains rich in starch, fed over two or three meals a day, and has restricted access to forage (Jansson & Harris, 2013). As horses' small intestine has a limited capacity to digest starch, high-starch low-forage diets have been associated to adverse clinical consequences. These include multiple nutritional disorders such as gastric ulcers, endotoxemia, colic and laminitis. Furthermore, there has been a fear of decreased athletic performance due to high-forage diets increasing gut fill and body weight. Several studies have shown that the high energy requirements of competition horses can be met with high quality forage-only diets and this benefits their health (Connysson, 2009; Jansson & Lindberg, 2008; Jansson & Lindberg, 2012; Muhonen, 2008; Muhonen et al., 2009; Ringmark, 2014; Ringmark & Jansson, 2011).

The aim of this paper is to review the current feeding practices of competition horses and in particular the inclusion of forage. The hypothesis is that competition horses are fed differently depending on the country where they are stable and the discipline they perform in.

The horse (*Equus Caballus)* as a grazing animal

Evolution/feeding behavior

The horse (*Equus Caballus*) is a herbivorous ungulate that evolved as a grazer. Its upper and lower incisors enable it to graze closely by shearing off forage. Free-ranging-horses spend the majority of the day, between 16-18h, grazing. They graze in small bouts of uninterrupted feeding separated by non-feeding intervals (Duncan, 1992). They are highly suited to temperate grasslands and cover 10-20 km per day, generally at a slow and steady walk (Duncan, 1980). Horses are social animals that live in (family) bands with a constant social hierarchy.

Digestion

The horse's gastrointestinal (GI) tract is adapted to a fibre-rich-diet and the horse has developed a symbiosis with the hindgut (caecum and colon) microbiota. The horse gut microbiota is composed of protozoa, fungi, archeabacteria, bacteria and viruses. As non-ruminant herbivores, horses utilize both enzymatic digestion and microbial fermentation to break feedstuffs down into smaller particles for absorption into the bloodstream and for metabolism. Enzymatic digestion occurs primarily in the small intestine and microbial fermentation takes place in the large intestine. To efficiently utilize the fiber-rich part of the diet and to avoid digestive disturbances, proper function of the hindgut is necessary (Sadet-Bourgeteau & Julliand, 2010). Microbial hindgut digestion provides a substantial part of the dietary energy in the horse (Glinsky et al., 1976).

Starch is broken down in the small intestine by α-amylase to the disaccharide maltose which is further digested to simple sugars by the enzyme maltase that has a high activity in the horse. The production of α-amylase is limited in the horse thereby affecting starch digestion. Furthermore, monosaccharides glucose, fructose, galactose, are absorbed and transported in the blood to tissues for energy metabolism or storage. Glucose and galactose transporter SGLT-1

is expressed mainly in the small intestine and has a limited capacity for these sugars (Dyer et al., 2002). At high levels of grain intake sugar digestion and absorption may therefore exceed the capacity of the small intestine and these carbohydrates may pass to the large intestine (Potter et al., 1992). This occurrence may contribute to digestive disturbances associated with high grain intake (Dyer et al., 2002).

Energy and Nutrient requirements

To maintain their health and activity, horses require adequate and balanced intake of energy, protein, vitamins, minerals (macro and micro) and water. Horses require energy for maintenance, to maintain their body at rest, as well as for any additional activity such as growth, gestation, lactation and physical work.

The heat produced from the complete oxidation of food is expressed as gross energy (GE). The GE is not completely utilized by the animal since some of the feed leaves the body as faeces. The GE minus the energy lost in the faeces is called digestible energy (DE). Energy is also lost in the urine and through gases; this energy substracted from the DE is the metabolizable energy (ME). Furthermore, energy is released in the form of heat, called heat increment, as food is ingested and absorbed. The remaining energy, GE minus energy lost in faeces, urine, gases and heat increment, is called the net energy (NE). There are two main systems used to express horses' energy and nutrient requirements; the DE system and the NE system. Different countries use different feeding systems; the U.K use the National Research Council (NRC)'s DE system and megajoules (MJ) as units. In Sweden requirements are expressed as MJ of ME and derived from the NRC and NE feeding system developed by INRA in France (Jansson et al., 2004; Martin-Rosset, 2008).

Sources of dietary energy are structural carbohydrates found in forages (cellulose), simple carbohydrates found in forages and cereals (starch), fats and proteins. Carbohydrates are the major source of energy and may constitute by weight two thirds of a horse's diet. Glucose and acetic, propionic and butyric volatile fatty acids (VFA) are the main products of carbohydrate digestion and fermentation. A forage-only diet increases plasma acetate concentrations compared to a forage-concentrate diet (Connysson, 2009; Jansson and Lindberg, 2012). Glucose and propionate contribute to liver glycogen reserves, and acetate and butyrate support the fat pool. Horses rely mainly on stored energy when exercising, in the form of glycogen-blood glucose reserves- and fat.

Protein is primarily required for tissue building and replacement and is an expensive source of energy. As a dietary energy source, protein is important in providing essential amino acids although it is metabolized to net energy less efficiently than starch or fat. Furthermore, adequate nitrogen is required by the microbial population of the large intestine for optimal function. Protein content can be expressed as crude protein (CP) or as digestible crude protein (dCP) which is a coefficient for the amount of protein that is digestible.

Fat supplementation of diets for athletic horses has been of increasing interest in the last few decades (Jansson & Harris, 2013). As well as providing fatty acids, fat is very energy dense, palatable and easily absorbed. It contains more energy than grains (3 times as much as oats) and thus increases the DE intake of horses when added to the diet, without increasing the amount of grain.

The Competition Horse

Since their domestication 5000 BP, horses have been used for meat, warfare, transportation, agriculture and leisure. The latter includes sports events such as 3-day-events, endurance riding, and harness-racing. Horses have a huge capacity for physical work and athletic potential for speed, endurance, and agility. The success of a performance horse relies to a great extent on its conditioning/fitness and on its nutrition/energy metabolism. Feeding the equine athlete should aim at providing the necessary nutrients in optimal amounts to allow maximal health and performance. 80-90% of the performance horse's feed is used for energy metabolism. The high performance horse such as that participating in elite-level-3-day-events has nutritional requirements 1.5-2.0 times that of a horse at maintenance (NRC, 2007). The energy required for work depends on a multitude of factors including the time and intensity of the exercise and may vary as much as 30% between individuals (Lawrence, 1992). The highest nutritional requirement category includes horses competing in endurance riding, 3-day-eventing, polo and Thoroughbred/Standardbred/Quarter-Horse racing (NRC, 2007).

Athletic disciplines: Three-Day-Eventing and Harness Racing

Three-Day-Eventing is a competition that takes place over three days and consists of three phases: dressage, cross-country and show jumping. It requires a large variety of skills from the horse as well as from the rider. They must possess the training and riding discipline of the dressage phase; the endurance and speed required for the cross-country phase; and the obedience and soundness to jump a show jumping course.

Harness racing is a form of horse racing where the horse races at a specific gait usually pulling a two-wheeled cart called a sulky where a driver is sat. Main breeds in harness racing include the Standardbred, the French trotter, and the coldblood trotter. There are two kinds of harness racing horses, differentiated by gait: the pacing horse moves both legs on one side of its body at the same time; the trotting horse strides with its front left and rear right leg moving forward simultaneously, and then front right and rear left together.

Traditional Nutrition of competition horses

To meet the energy demands of the performance horse large amounts of energy-dense cereal grains that are high in starch and low in fiber have traditionally been included in their diet (Jansson & Harris 2013). High-levels of starch fed in a single meal result in excess starch entering the hind-gut due to the limited capacity of the horse's small intestine to digest starch (Kienzle, 1994). This favors the proliferation of Gram positive lactic acid producing bacteria at the expense of Gram negative fiber-degrading bacteria in the hindgut. Feeding high starch diets results in increased lactate, decreased [(acetate+butyrate)/propionate] ratio and thereby decreased gut pH which can cause a number of intestinal and metabolic disorders in horses such as gastric ulcers, colic and laminitis (De Fombelle et al, 2001; Rowe et al., 1994). Such health problems can reduce athletic performance (Clarke et al., 1990). Furthermore, it is accepted that high amounts of concentrates interfere with the microbial ecosystem and the digestibility of feed components in the horse's large intestine (Goodson et al., 1988). A starch intake of $\leq$1 g/kg BW per meal has been recommended by several authors (Harris & Geor, 2013; Lindberg & Jansson, 2010).

The traditional feeding management of the performance horse is single-stall housing with short eating times and restricted access to high-fiber forage. Concentrates enable horses to meet their energy requirements in a much shorter time since they are much more calorically dense feeds than most forage. As a result, horses spend less time feeding and more time standing. This lack

of possibility to perform natural behaviors is believed to be connected to the development of abnormal behaviors and stereotypies such as crib-biting, wind-sucking and weaving (McGreevy et al, 1995; Willard et al., 1977). Furthermore, it has been suggested that reduced hindgut pH may increase horses' motivation to chew wood, eat bedding material and exhibit restlessness, nervousness and aggressive behavior (Zeyner et al., 2002). Increased time at pasture is associated with a lower risk of developing stereotypies (Bachmann et al., 2003).

Forage

Forage is the primary source of fiber for horses. Most competition horses have restricted access to pasture which leads to the use of conserved forages as hay, haylage or silage. The difference between these three conservation methods is the moisture content of the forage. The dry matter (DM) content is highest for hay, lowest for silage and in-between for haylage. Haylage or silage can generally be harvested and stored at conditions favoring a higher nutritive value than hay. Furthermore, the digestibility of silage was shown to be higher than that if hay in horses in training (Muhonen et al., 2009). The type of forage used generally depends on the climate and growing conditions of the geographic area where it is available. Conserved forage should be of high quality: clean and as free from contaminants such as mold and dust as possible. Forage plants can be divided into two categories: grasses such as timothy and legumes such as lucerne. The latter usually have a higher DE, protein and mineral (particularly calcium) content than the former (Harris & Geor, 2013). However, this can vary greatly depending on soil fertility, growing conditions and the stage of maturity of the plant at the time of harvest.

Forage Nutrient Content

The fiber content and digestibility of the fiber fraction are the main factors determining if forage can contribute to a great extent to the energy intake. Cell contents such as protein, fat and soluble carbohydrates, and cell walls including cellulose, hemicellulose and lignin, are components of forages and vary in their relative proportions. The cell content is highly digestible (80-100%) whereas the true digestibility of the cell wall is more limited (40-50%) (Fonnesbeck, 1968). The proportion of cell contents decrease while cell walls increase with increasing plant maturity. As the fiber content increases, this lowers the organic matter digestibility and consequently the digestible energy content of the forage. Energy and nutrient content of forage is therefore affected by the stage of plant maturity. Offering high energy forage to horses with high energy requirements can be favorable with regards to voluntary intake and digestive functions, whilst meeting their requirements (Willard et al., 1977).

Chemical composition of forages can vary a great deal, depending on the maturity of forage plants, botanical composition, fertilization and local conditions such as the weather (Ragnarsson, 2009). As Jansson et al. (2012) suggested forages should be analyzed for their nutritive value with appropriate assessment methods since visual appraisal is more indicative of cleanness than nutritional quality.

Effects of forage-only diets vs. traditional forage:concentrate diets

Horses spend more time chewing when fed forage compared to concentrates (Harris & Arkell, 1999). The proper chewing of food is very important; digestion is more efficient with smaller particles as it provides an increased surface area upon which digestive enzymes and microbes can act (Mueller et al., 1998). Chewing also stimulates saliva production which delivers bicarbonate, a buffering agent, to the gastrointestinal tract. This could partly explain the lower prevalence of problems related to acidosis, such as gastric ulcers, in horses fed high-forage diets.

A study by Elia et al. (2010) measured faecal pH in mares fed two different diets in counterbalanced order: *ad libitum* orchard grass hay and a complete pelleted feed, which mainly consisted of soybean hulls, wheat middlings and lucerne meal. Both diets had similar protein content. The pellets probably contained a much higher amount of soluble carbohydrates than the hay, to exemplify the effects of concentrates, which are high soluble carbohydrates feeds, versus forages, which are low soluble carbohydrates feeds. The faecal pH was more acidic when the horses were fed the pelleted feed. The authors suggested this was due to the increased fermentation of the soluble carbohydrates of the pelleted diet, caused by the increased rate of passage of the small pelleted particles. The overflow of concentrates into the hindgut affects the efficiency of the microbes for fibre fermentation (Elia et al., 2010).

Willing et al. (2009) compared faecal microbiota of Standardbred horses fed either a forage-only diet or a traditional forage:concentrate diet, with a starch intake of <1g/kg BW per day. They found that horses showed lower counts and relative abundance of specific bacterial populations that have been associated with the initiation of laminitis when they were fed the forage-only diet. Furthermore, they found a consistently low relative abundance of *Streptococcus bovis/equines* on the forage-only diet, suggesting that such diets may be preventive of gastrointestinal disorders in horses. They concluded that a forage-only diet is a viable means to improve equine health by inducing greater microbial stability, while reducing representation of members associated with gastrointestinal disorders (Willing et al., 2009).

Julliand et al. (2001) studied the effect of three hay:barley ratios on microbial and biochemical characteristics in caecal and colonic digesta samples from ponies. In accordance with previous studies with high concentrate diets, they found that feeding barley led to an increase of total bacteria in the colon, particularly due to higher concentrations of amylolytic bacteria. Lactobacilli and streptococci are major starch utilizers that grow under acid conditions and are enriched by fermentable carbohydrates at low pH (Julliand et al., 2001). The increase of these amylolytic populations is associated with the accumulation of lactate, which is the main end product of their fermentation. The study showed that as the proportion of barley in the diet increased, so did the lactate concentration and the concentration of cellulolytic bacteria was depressed in the colon. Furthermore a decrease in the [(acetate+butyrate)/propionate] ratio was simultaneously observed and indicated a depression of the fibrolysis (Julliand et al., 2001).

Another study comparing a forage-only diet with a forage:concentrate diet looked at the effect on the metabolic response of horses in training (Jansson & Lindberg, 2012). The authors reported an altered metabolic response, including a higher plasma acetate concentration and increased lactate threshold, during exercise in horses fed the forage-only diet compared to horses on the forage:concentrate diet. Furthermore, they suggested that the observed increase in venous pH during exercise in horses on the forage-only diet could counteract the acidosis induced by the exercise typically performed by racehorses.

Forage for the competition horse

Traditional perspective

Many authors have asserted that the high energy requirements of the athletic horse cannot be met by forage alone and providing a large amount of concentrate is necessary (Harris & Geor, 2013; Hoskin & Gee, 2004; Lawrence, 1992; Leahy et al., 2010; Pratt-Phillips & Lawrence, 2013). This reflects the traditional perspective in equine nutrition. Harris & Geor (2013) suggested that the main reason for the reluctance to feed high-forage diets is that for every kg of dry hay, around 2.5-3.5 kg of water may be consumed which will add to the weight of the horse and may negatively affect athletic performance. As such, high-forage diets can be associated with increased gut fill and increased body weight (BW) which may disadvantage

performance horses (Ellis et al., 2002). Moreover, Werhahn et al. (2012) reported that the most frequent reason for not increasing turnout time and allowing free exercise on pasture is the risk of injury since competition horses can be worth a lot of money.

Traditional feeding practices, especially those that are perceived to be of value, are difficult to change. Results from a bibliometric review on the nutrition of the performance horse between 1970 and 2010 show a tendency for a higher forage allowance and a reduction in concentrate allowance over time (Jansson & Harris, 2013). Assuming the horses' energy requirements have not decreased over the years, the authors suggest this could be due to an increase in forage allowance or to an increase in the energy density of feedstuffs used. It is possible to use forages with increased energy content, especially when haylage or silage is used instead of hay. However, it is most likely that the energy density of the concentrates fed has increased, probably due to the inclusion of fat (Jansson & Harris, 2013).

Forage-only diets

Several studies have shown that high-energy forage-only diets can be an alternative to conventional high-grain diets for performance horses (Connysson, 2009; Jansson & Lindberg, 2008; Jansson & Lindberg, 2012; Muhonen, 2008; Muhonen et al., 2009; Ringmark, 2014; Ringmark & Jansson, 2011).

Jansson & Lindberg (2008) studied the effect of a high-energy forage-only diet on BW in Standardbred horses in training. Results indicated that BW tended to be higher pre- and post-exercise on the forage-only diet compared to a traditional forage-concentrate diet. However, the increase was slight (<1% of BW) and did not seem to have an effect on performance. Connysson (2009) reported similar findings in Standardbred horses fed an early cut high-energy forage-only diet compared to a concentrate diet. These studies differed from Ellis et al (2002)'s finding a higher BW and heart rate during exercise and recovery in riding horses fed a low-energy forage-only diet compared to a forage-concentrate diet. These studies indicate that feeding horses a high-energy forage-only diet will result in a smaller BW increase than if fed a low-energy forage-only diet. Moreover, the difference in BW compared to feeding a traditional forage-concentrate diet will disappear after transportation, to a competition for instance.

It has been shown that Standardbred yearlings can grow and train on a forage-only diet (Jansson & Lindberg, 2008; Ringmark, 2014). Furthermore, adult Standardbred trotters in training were able to maintain body condition (BC) on a forage-only diet (Connysson, 2009; Muhonen et al., 2009), and even perform at a comparable level to those fed a typical forage:concentrate diet (Jansson & Lindberg, 2008; Ringmark, 2014). This indicates that using forage of high nutritional quality such as early cut grass hays/silage can meet most of athletic horses' requirements and the need for concentrates or other supplements is minimized. However such diets should be supplemented with mineral supplements when the forage does not meet the horse's mineral requirements (Jansson et al., 2012). Feeding mixed forages, including legume and grass species, can provide higher protein and mineral contents than grass forages only. Moreover, forage-only diets are the best way to promote natural feeding behavior (Jansson et al., 2012).

Materials and Methods

Participants

This study involved a survey designed to review how competition horses are currently fed and how forage-only diets are viewed within the competition industry. An online survey was intended for professional three-day-event riders and trainers of harness racing competition horses. This referred to the person having the daily responsibility for the horses' care and feeding.

Survey Design

An online survey was created using the web-based survey software Netigate. It consisted of demographics, current feeding practices, and knowledge and perceptions of equine nutrition, particularly related to forage (see Appendix 1). The survey consisted mainly of questions with a number of fixed alternatives where the respondent could choose one or more. Several questions included ranging the alternatives from most to least important. A number of questions were similar to those asked by Hoffman et al. (2009) in their survey of horse owners' feeding practices and knowledge of equine nutrition. As the study population was in Sweden, the U.K, and Australia the survey was made both in English and in Swedish to avoid the impact of differences in language within the survey results (Lietz, 2010). Furthermore, the survey questions were kept short with extra information when necessary to ensure their clarity and increase participant understanding and response rates (Holbrook et al., 2007). As recommended by Dillman (2000), vague terms such as 'probably' and 'maybe' were avoided to improve clarity and validity of answers. Pretesting was carried out via a pilot survey in Swedish on 3 trainers not familiar with the survey, none of which were included in the final survey. The final Survey comprised of 27 questions, mainly multiple-choice type, and a link was emailed to contacts in the Swedish, British and Australian national federations for 3-day-eventing and harness racing. These contacts acted as mediators forwarding the link to professional riders and trainers in 3-day-eventing and harness racing, respectively. The survey was accessible between March and April 2015.

Data Analyses

Data were collected in the Netigate Online Survey tool and downloaded as raw data into an Excel spreadsheet and as reports into Excel and Power Point. Data were manually transcribed to create four categories, comparing disciplines in both countries and within each country: harness racing in Sweden and the UK; eventing in Sweden and then UK, harness racing and eventing in Sweden/the UK. Quantitative data were analyzed for descriptive statistics. Differences between Sweden and the UK were determined by independent *t* test using SPSS software. Furthermore, some data were examined using binary test. A value of $p < 0.05$ was considered statistically significant for all analyses.

Results

Demographics

The survey was taken by harness racing trainers and 3-day-event riders in the United Kingdom (26; 13), Sweden (452; 3) and Australia (1; 0), respectively. Due to the lack of response Australia was excluded from the study. The average age was 42 and 46 for trainers and 47 and 32 for eventers in the UK and Sweden, respectively. Respondents were primarily men among British trainers (85%) and women among British (77%) and Swedish (67%) eventers. Both genders were equally represented for harness racing in Sweden (50% women and 50% men).

The educational background of participants was mostly in high school and higher education for trainers and eventers in both countries, respectively. Most Swedish (81%) and British (69%) trainers had the daily responsibility for 1-10 horses, as did British eventers (69%). Swedish eventers had the daily responsibility for more than 20 horses (67%). The average weight of British and Swedish horses was 427 ±60 kg and 550 ±63 kg for harness racing and eventing, respectively ($p<0.01$).

Current feeding practices

As Figure 1 shows, hay was the most popular type of forage fed by Swedish eventers (60%) and British trainers (44%). Haylage was fed by most of the Swedish trainers (50%) and British eventers (46%). Other types of forage fed included mainly chaff and bagged forage, and silage and straw in the UK and Sweden, respectively.

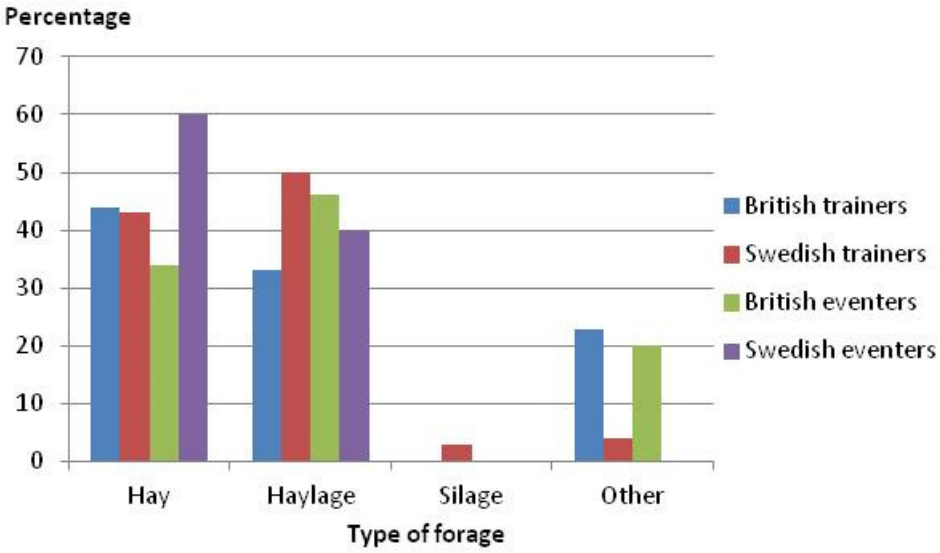

Figure 1. Type of forage fed by trainers/eventers in the UK/Sweden.

Grass was the most popular main forage component fed, followed by lucerne (alfafa), by trainers (97%; 83%) and eventers (100%; 85%) in the UK and Sweden, respectively. Respondents were asked to rank factors affecting their choice of forage from most (1) to least (6) important. Results (Table 1) show that the nutritional content/quality was the most important factor in how participants choose the forage they feed their horses in both countries. Swedish trainers were the exception having selected good feed hygiene as the most important. "Other" factors included mostly trainers and eventers' own production of forage but also price and feed analysis. The selection criteria of nutrient content from most to least popular were high protein content, high energy, low protein, low starch, high DM content, and balance of fiber, vitamins and minerals.

Table 1. Factors affecting how trainers/eventers choose the forage they feed.

	1	2	3	4	5	6

British eventers	Nutritional content/quality	Personal recommendation	Good feed hygiene	Looks appetizing	Good internet reviews	Other
Swedish eventers	Nutritional content/quality	Good feed hygiene	Personal recommendation	Other	/	/
British trainers	Nutritional content/quality	Personal recommendation	Looks appetizing	Good feed hygiene	Good internet reviews	Other
Swedish trainers	Good feed hygiene	Nutritional content/quality	Personal recommendation	Good internet reviews	Looks appetizing	Other

Most horses were fed 0-10 kg of forage in harness racing in the UK. Feeding >10 kg of forage was more popular in Sweden (70%) than in the UK (31%) ($p<0.001$) (Figure 2).

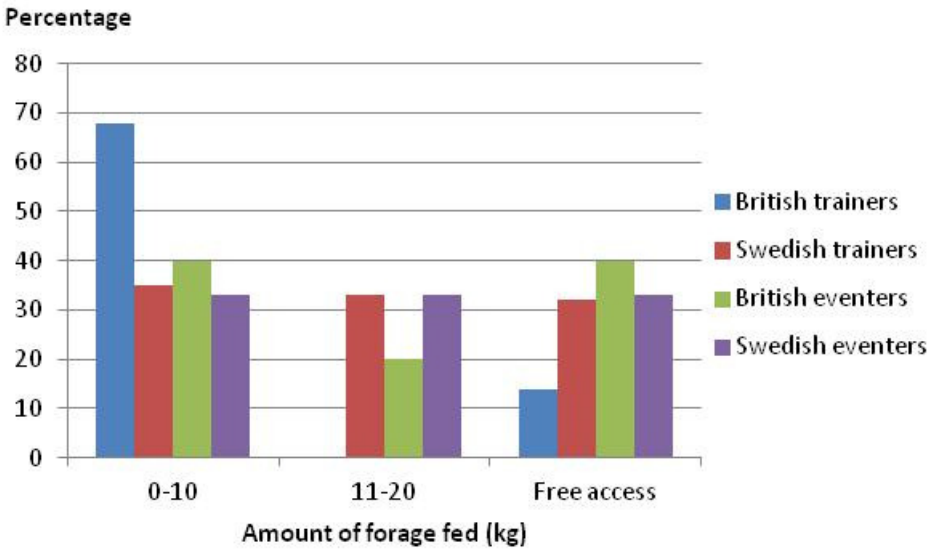

Figure 2. Amount of forage (kg) fed by trainers/eventers in the UK/Sweden.

Although most horses had access to pasture in both disciplines in the UK and Sweden, this was most popular in the former (60%) compared to the latter (40%) ($p<0.001$) (Figure 3). Most horses in eventing had access to pasture for 10 hours or less both in Sweden (100%) and the UK (75%). The same was true for harness racers in the UK whilst most in Sweden had access for 11-24 hours ($p<0.01$) (Figure 4).

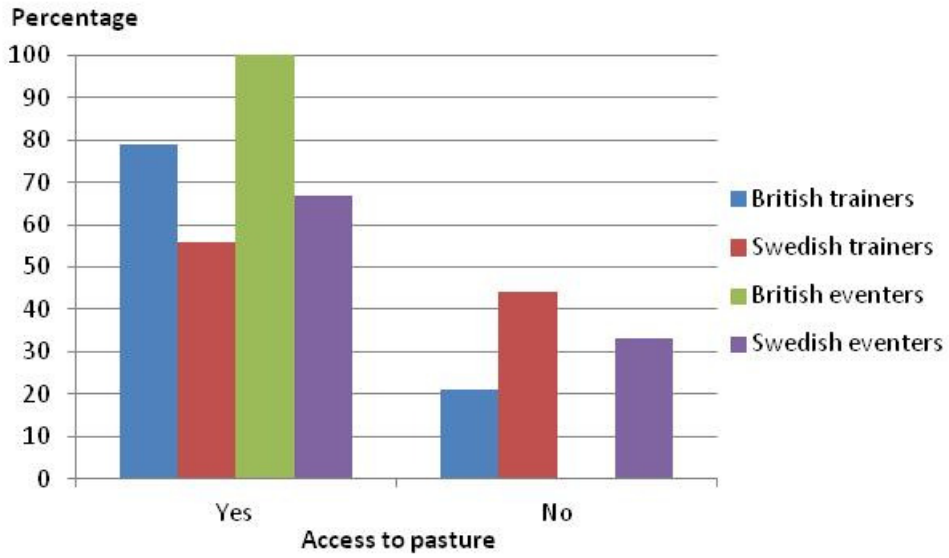

Figure 3. Percentage of trainers/eventers putting their horses out on pasture.

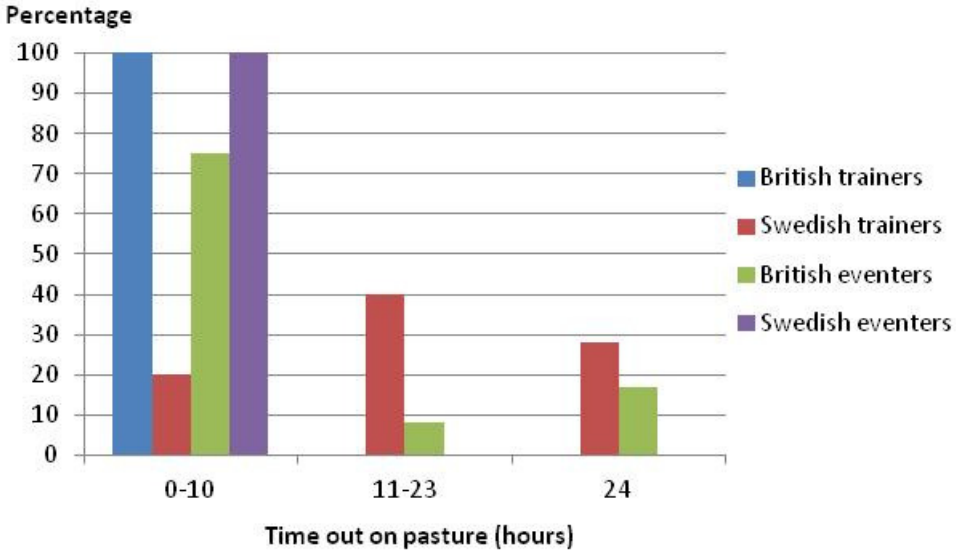

Figure 4. Numbers of hours that horses are out on pasture.

Most Swedish respondents analyzed the forage they feed their horses (59% trainers, 67% eventers). Although in the UK most eventers also had their forage analyzed (67%), this was not the case of trainers (38%). The mean nutritional content of the forage fed by Swedish trainers was 77% DM, 8.7 MJ/kg DM, and 61 g/kg digestible crude protein and 82% DM, 10 MJ/kg DM, and 7.5% crude protein for the forage fed by British eventers. Data was not provided for the nutritional content of the forage fed by British trainers in harness racing except for crude protein (14%). Moreover, data was only provided by one respondent in Swedish eventing and excluded for being unrealistic.

The most popular brands of concentrate fed were Krafft (66%) and St. Hippolyt (22%) in Sweden and Spillers (29%), Baileys (23%), and Dobson and Horrel (19%) in the UK. Feeding 1-3 kg of concentrates was most popular in Sweden both in harness racing (54%) and eventing (100%). Most Swedish trainers fed 3.5-5 kg of concentrates (37%). In the UK the same number of eventers (40%) fed 1-3 kg and 3.5-5 kg of concentrates while the majority of trainers fed 5.5-8 kg (44%). Overall, respondents fed less concentrate (2.9 ±1.4 kg) in Sweden than in the UK

(4.4 ± 2.1 kg) ($p<0.001$)._Most trainers fed 3 meals per day in both Sweden (42%) and the UK (56%). Feeding 2 (60%) and 4 (67%) meals per day was the most popular in British and Swedish eventing, respectively.

The supplements most commonly fed were electrolytes, vitamin/mineral supplements, fatty acids/oils, and herbs. Other supplements in harness racing included rosehip, algae, linseed, and lime. Chondroprotectives were more popular in eventing and other supplements included gastric protectant, joint supplement, blood tonic and probiotic.

Perceptions and Knowledge

British respondents from both disciplines and Swedish trainers rated their knowledge on nutrition as adequate (70%) or very good (30%). On the other hand Swedish eventers rated their knowledge on nutrition as adequate (90%) or poor (10%). British and Swedish respondents ranked their interest to research conducted on various nutrition fields (Table 2). Trainers in both countries ranked research on supplements as being of highest interest. Research on forage-only diets was ranked as being of 2nd and 4th highest importance in Sweden and in the UK, respectively. British and Swedish eventers ranked research on feed timing as being of highest interest along with research on forage-only diets for the latter.

Table 2. Topics of interest to do research on.

	1	2	3	4	5
British eventers	Feed timing	Supplements	Forage-only diets	Laminitis	Feed hygiene
Swedish eventers	Feed timing/ Forage-only diets	Supplements	Feed hygiene	/	/
British trainers	Supplements	Feed timing	Feed hygiene	Forage-only diets	Laminitis
Swedish trainers	Supplements	Forage-only diets	Feed hygiene	Feed timing	Laminitis

Other nutrition fields of interest for research included disorders such as gastric ulcers, cheap automatic feeding systems and the impact of the feed on the horse and of its' production on the environment, from the use of fertilizers for instance.

Health was agreed by all participants to be the most important factor determining the horses' feed. Body condition was ranked the second and performance the third most important factor in Sweden and British eventing whilst the contrary was observed in British harness racing.

Sponsors included Spillers, Red Mills and Baileys in the UK and Krafft, St. Hippolyt and RS Mustang in Sweden.

As shown by Figure 5, most trainers (80%) and eventers (90%) in the UK calculated the feed rations for their horses whilst this was not the case in Sweden (47%; 33%, respectively).

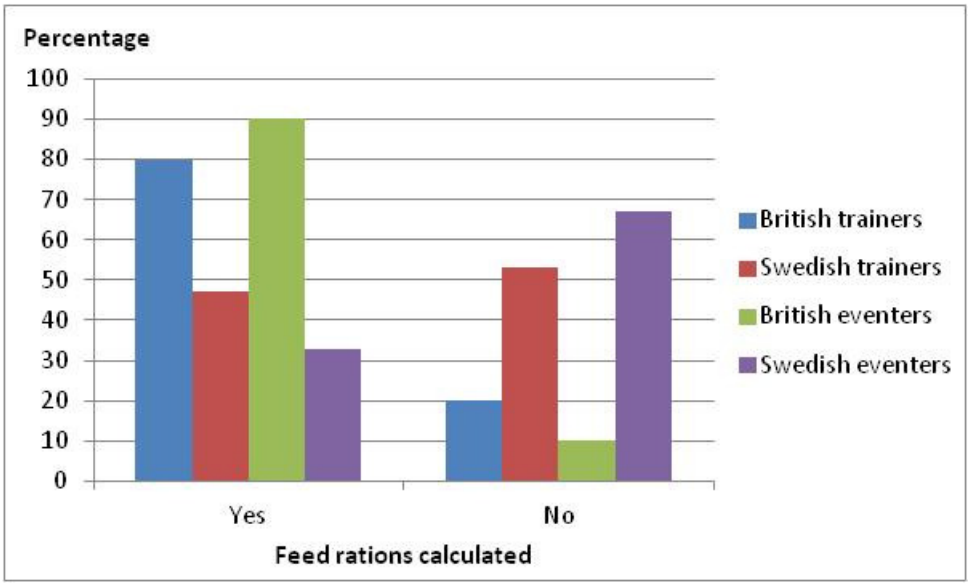

Figure 5. Percentage of trainers/eventers calculating their horses' feed rations.

Respondents in Sweden (40%) and British eventers (89%) rated a nutritionist as their main source of advice on nutrition, followed by a veterinarian. The same percentage of British trainers (31%) rated a veterinarian and a nutritionist as their main source of advice on nutrition. Trainers, sponsors and the internet were the other 3 primary sources of information, respectively. Other sources included themselves, literature, and family members.

The most popular statements were "forage cannot meet my horses' high energy requirements" and "more forage in the diet is good for my horse" in the UK and Sweden, respectively (Figure 6).

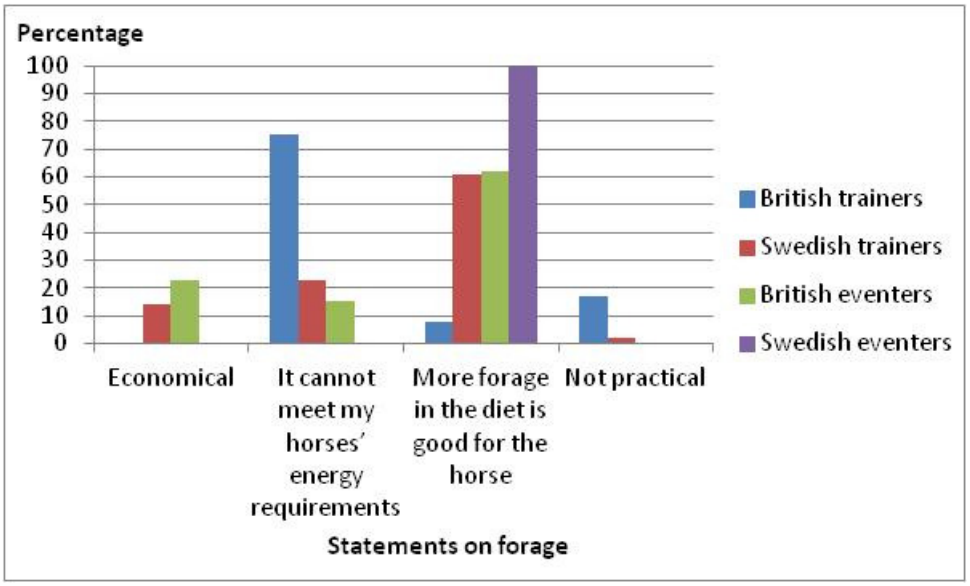

Figure 6.2 Percentage of trainers/eventers agreeing with statements about forage.

British trainers' willingness (92%) to adopt a forage-only diet for their horses was low whilst relatively high among eventers (60%). Swedish participants' willingness was relatively high in harness racing (56%) and eventing (67%) (Figure 7).

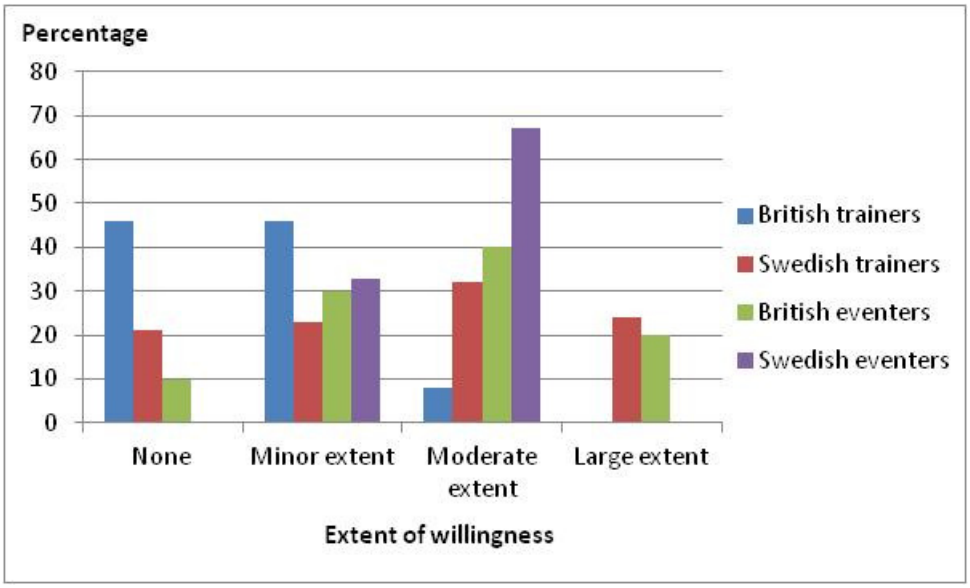

Figure 7. Trainers/eventers' willingness to put their horses on a forage-only diet.

Discussion

The aim of this study was to review the current feeding practices within the competition industry, and notably the inclusion and perception of forage. Data was collected via an online survey intended for harness racing trainers and elite level 3-day-event riders in the United Kingdom and Sweden.

Demographics

In eventing, respondents were primarily female which coincides with the high number of females in the equine industry generally, which have been reported as 85% in Sweden (Anon-Ridsportförbundet, 2013) and 73% in the UK (Anon-BETA, 2011). However, this was not the case for current findings on harness racing in the UK, where there was a majority of male respondents. The gender neutrality represented in harness racing in Sweden is interesting considering the fact that gender equality is an important ideology in the country, which has been placed for many years among the top five countries by the global gender gap indexes (Svensson & Gunnarsson, 2012). Nevertheless, this is not representative of Swedish Harness Racing since 61% of licensed trainers are men (Svensk Travsport, 2015). This could have been due to women being more willing than men to participate in the current survey. Furthermore, this could be related to a possible difference in feeding practices between both genders. It has been suggested that women are more emotional/affectionate than men to their horses (Robinson, 1999). Horses were larger for elite 3-day-eventing than harness racing. This is not surprising considering most horses in harness racing are Standardbreds which according to the breed characteristics weigh 400-550 kg (Staples, 2007) whilst Warmbloods are most popular in eventing and weigh 470-650 kg (Anon, 2015).

Current feeding practices

Hay was the main forage fed to horses in eventing in Sweden and in harness racing in the UK. This is similar to findings in previous studies on feeding practices in the UK and US (Hoffman et al., 2009; Hotchkiss et al., 2007; Mellor et al., 2001; Wylie, et al., 2013). On the other hand, haylage was most popular in harness racing in Sweden and in eventing in the UK. Furthermore,

Swedish trainers were the only group to report feeding silage. This reflects the popularity of ensiled forages in Scandinavia, where these have partially or completely replaced hay in the last decade (Müller, 2012). In Sweden, conserving forage as hay, haylage or silage has been compared to study horses' preference (Müller & Udén, 2007), and the effects on performance (Muhonen, 2008; Muhonen et al., 2009).

Grass and lucerne were the first and second main forage component in both disciplines and countries in this study. This coincides with the findings of surveys in the US (Burk & Williams, 2008; Hoffman et al., 2009) and the UK (Wylie et al., 2013).

The results of the present study indicate that feeding horses forage with free access was more popular in Sweden than in the UK. This could be attributed to the high amount of research in Sweden on forage for athletic horses (Connysson, 2009; Connysson et al., 2010; Jansson & Lindberg, 2012; Jansson et al., 2012; Lindberg & Jansson, 2010; Muhonen, 2008; Ringmark, 2014 ; Ringmark et al., 2013).

In accordance with previous studies, turn-out on pasture was popular in the UK, on average 4.6 hours per day (Hotchkiss et al., 2007; Walters et al., 2008). Interestingly, current results show that turnout was more popular in the UK than in Sweden yet most Swedish trainers reported a daily turnout time of 11-24 hours. The lower popularity of access to pasture in Sweden could be due to the climate and amount of daylight in the country, where there is an average of 6 hours of daylight in the winter. Turnout times have previously been reported as being limited for the elite horse in the Northern hemisphere (Brunner et al, 2012; Hoskin & Gee, 2004; Verhaar et al., 2014; Werhahn et al., 2012). As such, some respondents may have considered "access to pasture" as a few hours out on paddock rather than 11-24 hours per day at pasture. Moreover, this difference in turnout times could be attributed to the status of respondents, whether 'professionals' as were the 3-day-eventers or 'amateurs' as were the trainers. The latter tend to have more time than the former to take care of their horses.

The finding that the majority of respondents in both disciplines and countries analyzed the forage they feed their horses was reassuring since the nutritional content of forage can vary so greatly. Changing between forage batches with unknown chemical composition can induce gastrointestinal disturbances (Tinker et al., 1997). Hoffman et al. (2009) reported that horse owners in the US did not analyze the forage they fed.

Less concentrate was reportedly fed in Sweden than in the UK. Among the latter, trainers fed the highest amount. Once again the lower quantity of concentrate fed in Sweden could be a result of research on forage, promulgating the detrimental effects of concentrates on equine health. Nevertheless, in the present study respondents on average fed 3.6 kg concentrate per horse and day which is much less than 13.7 kg and 10 kg reported by previous studies on elite 3-day-eventing horses in the U.S and Australia, respectively (Leahy et al., 2010; Owens, 2005). Jansson & Harris (2013)'s review of nutritional studies in Standarbred and Thoroughbred training stables in various countries from 1979 to 2007 showed an average allowance of 6.7 kg concentrate per horse. The current findings agree with their finding less concentrate fed in Swdeden than in the other countries, namely the UK in this study. The amount of concentrate previously reported in studies indicate a higher allowance in eventing than in racing, which differs from present findings.

Electrolytes and vitamin/mineral supplements were reportedly the most common types of supplements fed by respondents in this study. This concurs with Williams et al. (2009)'s finding that electrolytes were the most common supplement used by elite 3-day-eventers. On the other hand, it differs from Hoffman et al. (2009) that reported chondroprotectives to be most popular in their study.

Perceptions and knowledge

The results of the present study indicate that research on supplements and feed timing was of biggest interest to trainers and eventers, respectively, in both Sweden and the UK. Forage-only diets were reported as the other main and second research topic of interest by Swedish eventers and trainers, respectively.

All respondents agreed on health being the most important factor determining the nutrition of their horses. Such a finding is reassuring since when it comes to competition, performance can be at the expense of health (McLean & McGreevy, 2010; Murray et al., 2006; Vigre et al., 2002). Except for British trainers, respondents selected body condition and performance as the 2nd and 3rd most important factor, respectively. British trainers reported a higher importance of performance, ranking it 2nd and body condition 3rd. Overall, this reflects why there is a huge market for supplements claiming to improve health.

Most respondents in the UK reported calculating the feed rations for their horses whilst this was not the case in Sweden. The latter coincides with findings from Murray et al. (2015) who reported that most respondents did not calculate their horses' feed rations. A nutritionist was the main source of advice on nutrition as reported by British eventers and Swedish respondents. A nutritionist and a veterinarian were reported equally as a main source of advice for British trainers. This varies from Hoffman et al. (2009)'s findings, where a nutritionist was not among the three most popular sources on nutrition. This present finding is encouraging since nutritionists are best suited to give horse owners sound nutritional advice and a recent study has shown veterinarians do not feel confident to do so (Roberts & Murray, 2013). Furthermore, this coincides with Murray et al. (2015)'s recommendation to shift the responsibility of nutritional advice away from the veterinarian to the nutritionist.

This study's results indicate that the predominant perception of forage is that it cannot meet athletic horses' high energy requirements and more forage in the diet is good for horses in the UK and Sweden, respectively. The former reflects the traditional perspective in equine nutrition whilst the latter is encouraging considering this is probably a reflection of the ongoing high activity of research on forage-only diets in Sweden. Respondents' willingness to adopt a forage-only diet was reflective of this.

Limitations

The present study has several limitations. It comprised of a survey which was accessible to trainers and professional eventers in the UK, Sweden and Australia. The survey was accessible online in order to facilitate data collection and management. A contact within the national governing body of each discipline and country acted as a mediator in order to elicit greater compliance. Due to very few respondents (0 and 1 for eventing and harness racing, respectively) Australia was excluded from the study. Furthermore, the targeted elite-3-day-eventers were challenging to get responses from for various reasons such as the fact that the survey was not face-to-face but accessible online. This might have led to the small sample size in the UK (n=13) and particularly in Sweden (n=3). Although online administration of surveys is efficient, a face-to-face survey might improve the response rate, specifically for professional event riders. Moreover, many respondents did not specify the units of the nutrient content of their forage or it varied between per kg feed or kg DM, indicating a lack of knowledge on how to read the feed analysis. This led to having to exclude these answers from the survey. A possible improvement could be to ask for a photo of the nutrient analysis of their feed.

Conclusion

Results indicate that concentrates were fed to a much lesser extent than previous studies reported. Furthermore, this was even stronger in Sweden where feeding forage seemed to be reflective of research, indicating a small gap between research and practice. It appears the responsibility of nutritional recommendations has shifted away from the veterinarian to the nutritionist. Perceptions of forage reflected the traditional perspective and research in the UK and Sweden, respectively. However, respondents were to a great extent open-minded to have their athletic horses on a forage-only diet. This study is encouraging in regards to a change in the feeding practices of the performance horse, where less concentrate is being fed and forage is gaining popularity. Furthermore, the impact of national research on feeding practices in the country seems promising.

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