

Can diet impress horse behaviour?

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ABSTRACT

Along with domestication, various changes in nutrition and digestion have occurred in horses as well as in all species. Our review aims to compile existing studies examining the role of nutrition and digestion in the emergence of undesirable behaviours in domestic horses. The success achieved in species with high adaptability has not been sustained by the change in breeding purposes over the years. Welfare, defined as the physical and mental health of animals. The responses of animals to various stimuli are defined as behaviour. Since the behaviour of animals plays a primary role in monitoring welfare, studies on animal behaviour have intensified. The development of undesirable behaviours complicates the care and management practices and negatively affects the welfare of the animals in the following periods, resulting in negative consequences for both the animal and its environment. Stereotypes, which are among the unwanted behaviours and exhibited in the form of purposeless, repetitive movements, are one of the biggest behavioural problems of horse breeding. Oral stereotypes impede food intake, locomotor stereotypes impede mobility and are instrumental in the emergence of chronic and more complex health problems. Other undesirable behaviours may also harm the horse's keeper and other horses kept together in the same box, resulting in serious injury. It is known that nutrition and nutrients affect the development of undesirable behaviours in horses. It is known that anticipatory behaviour creates a basis for repetitive behaviours as a result of inhibition when feeding time and nutrient content are out of preference or insufficient. The effect of nutrition and nutrient content on the emergence of stereotypes and undesirable behaviours has not been fully addressed and the subject remains up-to-date. The purpose of this paper is to provide a brief discussion of studies conducted to assess the effect of nutritional imbalances on stereotypic behaviour in horses. The PRISMA 2020 guidelines were applied to the review using systematic review rules

Keywords: animal nutrition, behaviour, feed, stereotypes, horse.

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Introduction

Horses have played an important role in human history for many years. After the industrial revolution, horse breeding evolved for sports and hobby purposes. Also, horses breed for meat and labour, but their share is small. In present conditions, it is important to have well-developed behavioural characteristics as well as physiological health in horse breeding, which is carried out with special care and feeding. In order to maintain continuity of growth and development and vital activities within physiological limits, nutrition and nutrient composition are of great importance. Diet varies according to species, breed, age, physiological

phase and individual preferences are also important. Sensory factors such as taste and smell are known to vary between individuals. It is also thought that diets that are disliked or not enjoyed sensually can cause restlessness. Housing problems are one of the main causes of stress in horses and are the main cause of undesirable behaviour. However, the fact that similar behavioural problems are observed in equestrian horses reared in good conditions and away from the stress of transport suggests that factors other than housing may also cause behavioural problems.

Behaviour of animals is used to provide environmental

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control and to develop a rapid adaptation (Kappeler, 2010). Behaviours can be examined under many titles such as social behaviours, species/breed-specific behaviours, and reproductive behaviours. Behaviours that are outside of normal behaviours, aimless and repeated are defined as stereotyped behaviours. It is known that poor welfare and poor management conditions are effective in the occurrence of undesirable behaviours and stereotypes in horses (Waters et al. 2010; Sarrafchi and Blokhuis, 2013).

Repetitive behaviours are frequently observed in individuals or group stabled horses, especially due to lack of space and nutrients (Johnson et al. 2010). The most common of these behaviours are crib biting and pawing, which can occur at a very young age as a result of nutritional deficiencies and stress. Crib-biting behaviour can be caused oral cavity injuries and colic pains that may develop due to air swallowing, can be economic damage to the stable equipment also negatively affect animal health and welfare (Eser and Erat, 2022). This situation also leads to poor performance in horses used for equestrian.

Feeding times are defined as periods of over excitement and frustration because the arrival of feed is a very exciting and gratifying event for the horses as same as other animals (Mills and Clarke, 2002). Many concentration feeds' delectable flavour and unusually high energy content can operate as super stimulants, raising anticipation before feeding (Goodwin et al. 2005). This anticipation can be shown through stereotypic behaviours like pawing and circling, repetitive behaviour like kicking the stable door, and behaviour showing enthusiasm and arousal (van den Berg et al. 2016a; Eser and Erat 2022; Hockenhull and Creighton, 2023).

While examining the effects of nutrients on horses, studies were conducted on the reactivity, temperament and preferences of horses, but the direct effects of nutrients were not mentioned. Although it is known that preference orientations are not only affected by organoleptic characteristics, few studies showing that they are affected by some behavioural patterns.

This study aims to evaluate the studies examining the effects of feeding and nutrient contents on horse behaviour as a systematic review.

The literature review procedure (review, inclusion criteria, and data acquisition) was prepared according to the PRISMA-2020 guidelines (Page et al. 2020). The relevant diagram is given in Figure 1.

In the study, the literature was searched in both Turkish and English languages using the keywords "horse", "stereotypes in horses", "nutrition in horses",

and "nutrition and stereotype relationship" in the databases of Elsevier, Wiley and Google Scholar. Since there are not many studies on the subject, the year range is not specified. The researches obtained from the databases included in the study consisted of 3 compilations, 2 printed book chapters, 1 pre-rehearsal article, 3 conference proceedings and all the remaining 41 were original research articles. No ethical permission is required for the study.

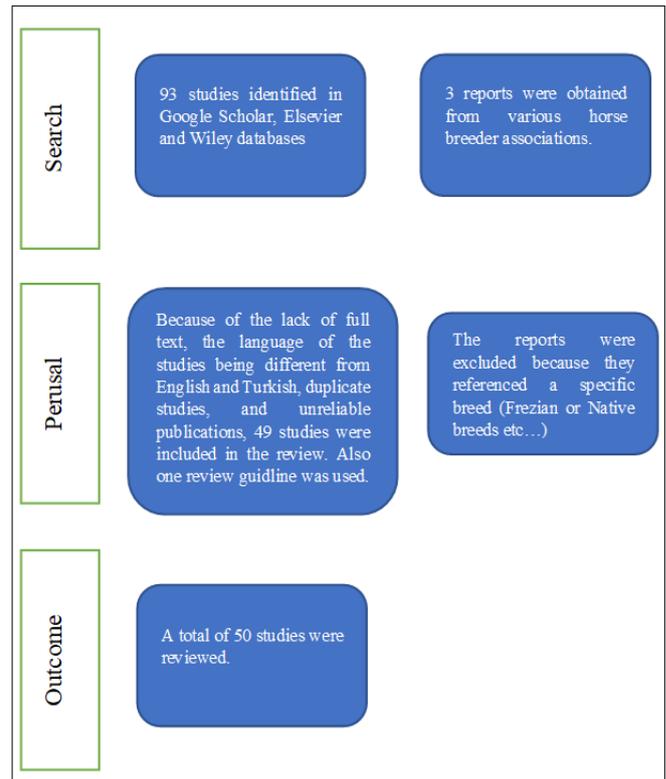


Figure 1. The PRISMA procedure followed in obtaining and using the literature reviewed in the study (Page et al. 2020).

Feeding Behaviour and Food Preferences in Horses

Feeding behaviours studies in herbivores have focused heavily on ruminants. However there are limited studies on food preferences in horses according to nutrient content (van den Berg et al. 2016b).

It has been observed that herbivores with grazing behaviours increase their bite size as the differences in grass height discrepancies grow. Foraging models indicate that herbivores should prefer long grass to short grass. Furthermore, the feeding region can be identified by intermediate biomass for optimal digestible nutrient intake, although there may be a trade-off between forage quality and quantity. The foraging models propose that herbivores should select tall grass over short grass. However, the feeding area can be characterized by intermediate biomass to optimize the uptake of digestible nutrients due to the trade-off between forage quality and quantity

(Catanese et al., 2013). This behaviour has been observed in studies on sheep (Naujeck et al., 2005) and cattle (Ungar et al., 2001), but few studies have investigated the feed preferences of horses (Naujeck et al., 2005; Ellis et al., 2005; Hanis et al., 2020a).

Horses get their food in small chunks and graze at short intervals without going too far from the area. Some studies reported that horses prefer foods with lower indigestible carbohydrate content (Naujeck et al. 2005; Ellis et al. 2005; Hanis et al. 2020b). In addition, feeds with high energy content are preferred; in the absence of this type of feed in the environment that the energy need is met by increasing the amount and frequency of food intake (van den Berg et al. 2016c).

Physiologically, horses have evolved to consume structural plants that take significantly longer to chew than grains or processed feeds. Since chewing is the main stimulus for saliva production in the horse, the amount of saliva produced can also be compromised when feeding concentrates, which can affect subsequent digestion as well as buffering in the colon. The inclusion of dried shredded fodder or straw is becoming increasingly common. However, there are few studies on the effects of straw length or inclusion ratio on feeding behaviour (Ellis et al. 2005).

Horses graze for 12 to 18 hours a day in their natural habitat, but the amount of food and time they consume it in the shelter is often limited (Ellis, 2010 and 2012; Harris et al. 2017; Raspa et al. 2017). According to Burla et al. (2016), agonistic behaviour was generally reported to be more intense at feeding times in group bred horses. Additionally, horses fed at timed feeding intervals exhibited more locomotor activity prior to feeding than horses fed at untimed intervals, although no difference was seen during feeding. Regardless of the feeding arrangement, it is strongly advised from an ethological perspective to supply not just grass but also hay. In another study, Cooper et al. (2005) revealed that the frequency of feeding in horses causes an overall increase in stereotypic behaviours. The study concludes that splitting up concentrated rations for barn horses into smaller meals may be an effective strategy to eliminate oral stereotypes, but pre-feeding stereotypes may still exist and practise may make stereotyped behaviours more frequent. Horses in visual contact but not fed.

Regardless of the preferred flavour, Cairns et al (2002) reported that horses preferred higher energy diets to lower energy diets. However, it has been hypothesised that ruminal fermentation, particularly when multiple feeds are provided at the same time, may make it difficult for horses to associate the chosen

feed with the post-digestion results. Redgate et al. (2014), compared the effect of selecting three roughages in a simultaneous preference study when horses consumed a single type of feed rich in water-soluble carbohydrates, lipids or protein. In the study, it was observed that feeds rich in water-soluble carbohydrates or protein were preferred, and it was concluded that the macronutrients in the diets triggered a response in the horses and activated the feedback mechanisms.

Nutrient Composition and Behaviour Relationship in Horses

Animal behaviour and its evaluation by various methods has become a popular topic in the scientific community in recent decades. As the general definition of behaviour, it is seen that there are many factors that have an effect. Although it is known that the most influential factor on behaviour is breeding and husbandry conditions and care, recent studies have tried to reveal that nutrient contents also lead to the development of undesirable behaviours through various physico-chemical pathways or habits (Gillham et al. 1994; Holland et al. 1996a; b; McBride and Hemmings, 2009; Ellis, 2010 and 2012; Hemmings and Hale, 2013; Roberts et al. 2015; Moore-Colyer et al. 2016; Hanis et al. 2020b). Since nutrient intake is also driven by preferences, we cannot make a strong generalization about the effect of nutrient content on behaviour due to the influence of individual factors. Therefore, a conclusive statement similar to housing and care conditions has yet to be clarified.

Although there are intensive studies on roughage in animal nutrition, there is no comprehensive explanation. In general, there is limited research in other species on the carbohydrate and roughage components of rations, which are essential in ruminant diets. On the other hand, in studies with increasing descriptive features, roughages are mentioned as components that are not easily degraded with the enzymes, and their effects on physical satiety are continuing to be demonstrated (De Leeuw et al. 2008). In addition to physiological satiety, roughage should also be considered in terms of the animal busy with mastication, reducing stress and preventing the development of abnormal behaviours (Paintal, 1954; Rolls and Rolls, 1997; Cummings and Overduin, 2007; De Leeuw et al. 2008).

It is known that there is a connection between stereotypic behaviours and endogenous opioids in many species, especially horses (Gillham et al. 1994). According to Albright et al. (2017), one of the most effective crib-biting triggers, mediated by the opioid

and dopaminergic systems, is a highly appetising meal. Extremely appetising taste is still a potential contributing component to the concentrated diet, despite the possibility of gastric and post-gastric repercussions.

The effects of roughage and plain oat consumption on the crib-biting behaviour were examined and it was determined that they were not at the same level of effect in the studies. Studies have determined that as the preferability of the diet increases, endogenous opioids are released and the opioid, dopaminergic and glutaminergic neural systems are fed by feedback mechanisms (Albright et al. 2017). It has been observed that in horses fed alfalfa pellet, the crib-biting stereotype begins within 10 minutes after feed intake, similar results are seen in horses fed with cereal grains with high carbohydrate content, and the stereotype is exhibited for 30 minutes (Gillham et al. 1994).

To prevent obesity and weight gain in horses, hay intake is restricted. Ellis (2010), reported that horses exhibit food intake behaviour of 12.5±2.5 hours a day and this is necessary to protect both digestive system health and mental health. It is known that both physiological and mental balance is impaired in case of restriction of time or food intake (Ellis, 2012). A parallel study found that in Thoroughbred horses receiving less than 6.8 kg of fibre per day, stereotypic behaviour and feed limitation were positively correlated. After weaning, foals fed concentrated feed showed a 4 times higher incidence of crib-biting behaviour than other foals (Waters et al. 2002). According to Roberts et al. (2015), concentrated feed-induced increases have been associated with dopamine neurotransmission and more intricate changes in neuroactive molecules including leptin and ghrelin (Hemmann et al. 2013; Hanis et al. 2020b). On the contrary side, bait reduces the intensity of crib-biting (Hemmings and Hale, 2013), but the feeding time has no impact on locomotor activity in terms of typical or stereotypic behaviour over the course of a 24-hour period (Piccione et al. 2013). For this reason, it is recommended to progressively introduce roughage to horses displaying crib-biting behaviour in order to prevent the onset of the behaviour and lower the frequency of stereotyped behaviour.

It is thought that dopamine released during the performance of oral stereotypes such as biting the wood and wind sucking the perpetuation of the stereotypes. For this reason, giving adequate feed and some substance for chewing or occupy the oral cavity in indoor horses is a great solution to prevent the formation of behavioural disorders (Moore-Colyer et

al. 2016).

Foals supplied with a diet of fat and fibre were less stressed than those fed a diet of starch and sugar, according to Nicol et al. (2005). Horses' reduced responsiveness can be ascribed to high blood sugar levels following meals when they consume a lot of starch (Bulmer et al. 2015). If we evaluate the effects of macronutrients on horses diet choices, horses prefer protein and hydrolyzed carbs over fats, according to Redgate et al. (2014). The energy content has no bearing on the horses' preferred feed, according to van den Berg et al. (2016c). Similar to wild horses, it has been reported that they have complicated dietary habits and consume a variety of plant species that are high in fibre and low in calories. Additionally, it was proposed by van den Berg et al. (2016a; b) that organoleptic signals including taste and smell might affect nutritional choice. For instance, it has been said that silage preferred by horses than hay or straw. (Müller and Uden, 2007). According to a recent study, feed preferences in ponies are influenced by lateralization, smell, and excitability (Vinassa et al. 2020). Mares given hay continuously have better bodily conditions and higher reproductive rates than mares fed the same amount of roughage exclusively at night, according to reports. This is also effects to their well-being and behavioural patterns (Benhajali et al. 2013).

Limited studies have been conducted on the impact of nutrition on normal behaviour, reactivity, or stress reaction in horses, despite mounting evidence linking starch-rich diets to abnormal behaviour. Although commercial feed supplements that promise to lower general reactivity are frequently employed, there hasn't been much evidence of them having a detrimental impact on reactivity. There is, however, little proof that dietary lipids influence reactivity. Holland et al (1996a) reported that, horses were fed test diets with additional fat, observed lower sensitivity to pressure, auditory, and visual stimuli as well as decreased locomotion. Foals fed a diet high in fat and fibre had lower pre-weaning cortisol levels than foals fed a diet high in starch and sugar, according to Holland et al. (1996b). In the study, which also examined at the weaning behaviour of foals, it was discovered that, at least in part of the observed weaning groups, foals that got fat and fibre supplements demonstrated increased grazing behaviour and seemed less agitated.

Non-structural carbohydrates are prevalent in meals made of grains, which are frequently offered two or three times per day. However, high grain consumption is not compatible with the

gastrointestinal system of horses, and according to George and Harris (2007), this feeding method is linked to the emergence of gastrointestinal issues, including gastric ulcer disease and colic linked to hindgut dysfunction. Additionally, research on horses indicates that low-fibre diets put animals at a higher risk of exhibiting abnormal behaviours like stereotypes, potentially as a result of shortened eating intervals and visceral disturbance (George and Harris, 2007).

Hanis et al. (2020), examined the frequency of locomotor or oral stereotyped and directed behaviours as well as their connection to regular management and feeding practises. Horses that are utilised for riding, equestrian, polo, endurance, and patrolling were chosen for the study and are housed in a variety of ways. Oral stereotypic behaviour was found to be most prevalent in the study. It has been found that the number of straws used, the concentration level, and the amount of time spent working all have a substantial impact on oral stereotypic behaviour. Another finding of the study was that the quantity and frequency of feedings had an impact on both locomotor stereotyped and redirected behaviours. The study's findings indicated that consistent management and feeding techniques can influence the frequency of various abnormal behaviours in the majority of working horses.

In a study that investigated the relationship between high-fibre diets and high-starch diets and behaviour of horses, behavioural activities connected to feeding a diet rich in fibre produced better results than providing a diet high in Fstarch. Giving horses a diet high in fibre is beneficial for their welfare and profitable from an economic standpoint, allowing the animals to express their feeding behaviour more fully. Animals that are excited or triggered have been observed to consume less feed with high energy content. It has been proven that fiber-based diets can be utilised to stop horses from acting out in undesirable behaviours in this way (Raspa et al. 2022).

The display of oral stereotypic behaviour has been shown to depend on meal times. Horses with the crib-biting had a significant plasma ghrelin peak before a concentrated feed, according to Hemmann et al. (2012 and 2013). After feeding, plasma leptin levels in crib-biting horses were considerably lower than those in healthy horses. These results imply that more study is required to determine how nutrition affects ghrelin, leptin, and abnormal oral behaviour. Another study found that among the horse population under investigation, directed behaviour and oral stereotypes were the most common abnormal oral behaviours

(Hanis et al. 2021). Both behaviours were found to be strongly related to nutritional qualities like dietary fibre and low straw content (Hanis et al. 2020 and 2021). In other study suggests that, persistent observation of abnormal oral behaviours following meals may point to a lack of postprandial satiety (Hanis et al. 2023).

Conclusion

It is a well-known that poor care conditions and management lead to stress and low welfare in all animal species. The absence of suitable housing and management, which are key factors contributing to inadequate care, results in animal distress and undesirable behaviours. However, the lack of sheltering space restricts the normal behaviour, and increases the development of abnormal behaviours and stereotypes. Reproduction and feeding conditions, which are the leading environmental factors in horses, are of great importance on behaviours as well as quantitative characteristics. Inadequate and unhealthy feeding, which is one of the care deficiencies, causes both physical and physiological problems in animals and negatively affects welfare. Although there are many studies on animal welfare care conditions and shelter characteristics, the effect of nutrition and nutritional characteristics on welfare indicators has not been fully explained. Studies have shown that feeding time and frequency can affect behavioural patterns in animals. It has also been reported that diet can lead to various repetitive behaviours in animals and trigger abnormal behaviours, often referred to as stereotypes. The feed preferences, which are thought to have developed in the evolutionary process depending on the digestive physiology of the horses, were determined as the feeds containing carbohydrates with high digestibility. Considering the energy intake, it has been obtained as a result of the studies that the energy is kept in balance by increasing the amount of feed. Considering the nutrient content, it was found that malnutrition in animals caused oral stereotypes; it was concluded that deficiencies in the ration structure, depending on the rearing purpose and activity, may trigger other abnormal behaviours. In horses, preoccupation has been identified as a method of coping with the stress of individual housing and has been reported to account for a large proportion of chewing behaviour. It has been reported that horses whose chewing behaviour is restricted by feeding low roughage diets become mentally fatigued and increase undesirable behaviours. Although there are many issues to investigate regarding the effect of diet composition on behaviour, the number of available

studies is relatively small. The limited number of studies on the identification of secondary factors in the development of stereotypic behaviour in horses has meant that the subject under discussion in this review has not been supported by sufficient literature. Although many titles on the effect of diet composition on behavioural patterns need to be examined, the number of available studies is very few. Considering the developments in the field of animal nutrition and behaviour, it is clear that more multidisciplinary studies investigating the effects of diet and nutrient content on equine behaviour are needed.

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