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Professional paper

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Abstract

The paper aimed to define frequency of feeding (frequency of rations) "modern" horse, regarding the physiological and ethological aspects of horse. From an evolutionary and physiological point, the horse was built for constant feeding. The rations have to provide an adequate supply of energy and nutrients and largely affect the horses' ethology. The management of feeding and quality of ration affects the horses' health and welfare. Today horses are far less physically active than before. The frequency of rations affects the physiological parameters of digestion and the aetiology of the horse. How to balance the appropriate ration frequency considering the physiological and ethological aspects, and the usage of the horse itself depends primarily on the daily amount and quality of feed required for the horse to remain fit. Usually, adult horses have two rations a day with a 10-hour daily interval and 14-hours nightly interval between rations. The frequency of a horses' ration varies depending on the way of keeping, category, physiological condition and usage. The effect of feeding on the health and welfare of horses is mainly focused on the appropriate intake of energy and nutrients and on the consideration of the aetiology of feeding, limiting concentrates to specific needs, availability of water and hygienic correctness of feed and water. Knowledge of the specific feeding needs of horses in physiology and aetiology should be considered an essential part of preserving the horses' welfare.

Key words: feeding, horse, feeding frequency

Introduction

Looking ago 100 years when horses were used in agriculture, transportation and the army, they were fed four to five times a day. The horses from the ration had to obtain enough

energy for their daily work. This fact was applied by horse traders and buyers because horses were healthier at that time and they found a buyer faster. The "modern" horse is faced with completely different conditions (Davidson and Harris 2007). The work is less physically strenuous and horses move considerably less than before (Sakač et al., 2011). The frequency of feeding (number of rations per day) should be harmonized with the usage of horses since it simultaneously affects the physiological parameters of digestion, especially the stomach and the rest of the digestive tract, as well as the aetiology of horses. The impact of feeding on the health and well-being of horses includes in particular an adequate supply of energy and nutrients. The understanding of horse feeding is obtained by considering the physiological behaviour (ethology) of feed intake, especially voluminous feed, limiting the intake of concentrated feed that depends on work, water quality and availability and hygienic feed. Typical stereotypes in horses, such as swallowing air or knitting, indicate a limited sense of well-being, and feeding errors can contribute to the development of stereotypes. According to Ellis (2010), the "biological basis of behaviour" includes physiological mechanisms that direct and control the body (nervous and endocrine systems), which adapt, change due to genetics, but also due to adaptation to breeding that allows interaction, perception and experience within the environment.

According to Benz et al. (2014) in horse breeding, feeding is not only for feeding horses but also for their occupation. Continuous, moderate consumption of voluminous feed enables the maintenance of a healthy digestive system. Voluminous feed plays an important role in feeding horses, not only from a nutritional point of view. Horses have an instinctive need to constantly move and "bite" because of their bent development. Because the horse is constantly eating in the wild, the horse's stomach is constantly producing stomach acid, which can only neutralize saliva. Saliva is excreted only when chewed. If the stomach is at rest for more than four hours, it continuously produces stomach acid which irritates the mucous membranes. The consequences of inappropriate feeding can be a stomach ulcer or colic. Inadequate feed intake is described as an important factor in many horse behavioural disorders. In addition to stereotypes, some health disorders such as gastrointestinal disorders, muscle damage or obesity are caused by nutritional errors that seriously impair the well-being and development of the disease, such as the occurrence of laminitis that accompanies obesity. In most cases, feeding errors occur due to insufficient knowledge of the specific needs of horses, and only in a few cases intentional errors can be assumed. Davidson and Harris (2007) warn of a discrepancy in horse feeding with two large rations a day. These modern practices have advantages but also potential disadvantages for the horse, (nutritional and

ethological) which can affect well-being. The growing interest in animal welfare and knowledge of the physiological and ethological needs of horses has led to the development of different types of horse management and housing systems (Marliani et al., 2021). According to Placci et al. (2020) in the equestrian world, two different types of management can be distinguished: traditional management and natural boarding, each of which has its advantages and disadvantages.

The paper aimed to define frequency of feeding (frequency of rations) "modern" horse, regarding the physiological and ethological aspects of horse.

Physiology of horse digestion

According to Ellis (2010), food intake is controlled by multiple energy-related homeostatic signals (such as the hormones ghrelin and leptin) as well as somatosensory (taste, touch, smell) and motivational stimuli across the peripheral and central nervous systems. Free-range horses tend to eat 10-15 different feeds in 24 hours and are fed for about 10-14 hours a day. Voluntary dry matter intake ranges between 1.3-1.7% body weight (BW) for straw, 1.9% BW for hay and 2.6% BW for fresh grass. Chewing one kilogram of fresh matter in an adult horse ranges around 3400 for straw, 2700 for hay and 1800 chewing for chopped fodder with corresponding swallowing times of 45-35-20 minutes/kg (Ellis, 2010). The chewing rhythm (chewing/min) remains mostly constant for each animal, while intake rates (g / min) vary according to moisture content, fracture properties, teeth, and organoleptic perception of feed (Ellis, 2010). Consumption of concentrated food takes about 18 minutes/kg (for oats). Adding chopped fodder for concentrated food by a rate of 20-38% increases the time of food intake by 50-100%. Furthermore, adding oil to animal feed increases feed intake time.

Irregularities in the feeding and/or well-being of horses indicate atypical reaching for food such as geophagy (eating earth or sand), chewing wood and coprophagy. According to Ellis, (2010) for atypical food reach, a ration for horses enriched with structural fibres is suggested. According to Wyss et al. (2016), the distribution of meals up to twelve times in 24 hours significantly contributes to feeding adjusted to the physiology of horse digestion.

Voluminous food in horse feeding

Voluminous feed, whether it is in form of grazing, fresh green mass or hay, should always be available. This method of feeding management is not possible in all breeds and in all horses (overweight). Furthermore, the increased hay intake increases water consumption, which should always be available. The preparation of quality hay is laborious (DLG-verlag, 2003) and is exposed to a high weather risk when drying on the ground which can lead to large changes in the quality itself. The optimal time to cut the grass to produce hay to feed the

horses would be from the beginning (about 30% of the grass blooms) to the middle of flowering. During this phase, the metabolic energy level is 7-8 MJ ME / kg dry matter (DM), the crude fibre content of about 27% or more and crude protein below 12% in DM (DLG-verlag, 2003). A healthy horse should be able to get as much energy as possible from the voluminous fodder (hay). Hay quality should be medium to good and consumed in the amount of 2 kg / 100 kg BW. Horses consume hay at a different rate than concentrated feed. For the same amount of feed, horses consume hay four times longer. Horses graze on pasture for 12 to 20 hours. Since grass contains a lot of water (70-90%), more grass must be eaten until as much weight as dry hay is absorbed (water content 10-15%) (Lüem, 2021). Adult horses that eat six to eight hours of voluminous feed meet 80% of the nutrients per day, and 20% should be provided from a concentrated feed. If horses are deprived of a concentrated portion of a ration, the daily intake of voluminous feed is extended to 12-16 hours (Lüem, 2021). The time of intake of voluminous feed can be extended with automatic feeders. Automatic feeders are suitable for horses with low energy requirements or horses on a diet. Intake of voluminous feed is slightly more frequent in daylight, while at night it is slightly less. The frequency of feeding affects the intake of voluminous feed. When horses receive 8 small concentrated feed rations, they consume more voluminous food than if they receive only two concentrated rations. If a horse needs to eat more hay, it is often given small amounts of concentrated feed. According to Benz et al. (2014), the period of consumption of voluminous feed is greatly influenced by the characteristics of the feeder (extends the consumption time by 50%). Furthermore, Clegg et al. (2008) found that feeder characteristics did not affect horse physiology (digestibility, plasma or pulse cortisol concentration).

Concentrated feed in horse feeding

Concentrated food can be offered through 3-4 rations in the amount of 0.3 kg / 100 kg BW per ration. Vegetable oils can be supplemented in the amount of 20-50 ml / 100 kg BW daily after a period of adaptation. Complex foods with increased protein content (about 12%) and soy meal (10-20 g / 100kg / BW) can be used for protein supply. An increased proportion of crude fibre in a ration can be achieved with foods that contain pectin such as beet pulp (0.2 kg / 100 kg BW) (Lüem, 2021). Furthermore, in adult horses, excessive mineralization with calcium (Ca) and phosphorus (P) and vitaminization with vitamins A and D should be avoided. A positive effect on the horses' welfare has an increase in the number of concentrated feed rations and at the same time a decrease in the amount of feed in the ration. The advantage is the glycemic response of the meal and its consequences. The glycemic response changes significantly when the daily amount of feed is given in one, two or more

meals (Philippeau et al., 2014). One meal leads to a higher glycemic index and as a result higher insulin secretion (Harris and Geor, 2009). The glycemic response to a morning meal is strongest, no matter how many feed rations are given during the day. This should be considered in horses where the glycemic response plays a role and should be controlled (e.g. endurance). Furthermore, the order of feeding also affects the glycemic response. For horses receiving only one concentrated ration, the glycemic response is higher when hay is given 15 minutes before the concentrated feed, and lower when hay is given 15 minutes after a concentrated feed (Rodiek and Stull, 2007, Lüem, 2021). This is not noticed when horses receive several concentrated feed rations a day. Horses that receive concentrated feed before voluminous often bite the wood. Feeding concentrated feed also affects air swallowing, knitting and other stereotypes in horse behaviour. Stereotypical behaviours such as chewing wood or swallowing air are the result of boredom but can be caused by inflammation, ulcers, or abnormal stomach acidity.

Number of rations per day

According to Davidson and Harris (2007) and Meyer and Coenen (2014), adult horses are typically fed twice daily. During the day they have an interval between rations of 10 hours and at night 14 hours. In addition to the mentioned glycemic index, the capacity of the digestive tract should be taken into account when administering large amounts of concentrate (Harris and Geor, 2009). Large amounts of concentrated food can overcome the small intestine's ability to break down grains and absorb starch. Too much undigested grain reaches the back of the intestine. The consequences of microbial fermentation or non-fermentation can range from diarrhea, colic to laminitis. As a general rule, no more than 500 g of cereal concentrate (> 30% starch) should be given per ration per 100 kg of body weight (Lüem, 2021). For larger quantities, it should be divided into several smaller rations. If the starch content is higher, the recommendations for the amount per ration are even lower as shown in the table below (Table 1).

Table 1. Maximum mass of ration for optimal starch digestion in the small intestine (Lüem, 2021)

Body weight (BW)	< 30%	30 – 40 %	> 40 %
400 kg	2.00 kg	1.20 kg	1.00 kg
450 kg	2.25 kg	1.35 kg	1.125 kg
500 kg	2.50 kg	1.50 kg	1.25 kg
550 kg	2.75 kg	1.65 kg	1.375 kg
600 kg	3.00 kg	1.80 kg	1.50 kg
650 kg	3.25 kg	1.95 kg	1.625 kg
700 kg	3.50 kg	2.10 kg	1.75 kg

Rations with more than 1.1 g of starch per 1 kg of body weight increase the risk of stomach ulcers. Gastric ulcer is also closely associated with malnutrition. In horses that do not have access to feed for 12 hours, the pH in the stomach drops to 2 (Lüem, 2021) creating conditions for stomach ulcers. The lowering of the pH in the stomach is often noticed even after the feeding of concentrate or pure cereals. In horses kept on pasture, the pH in the stomach is between 4 and 6. Increased frequency of rations is also very important if horses have certain diseases, such as hyperkalemic periodic paralysis. An approach with two large rations a day leads to nutritional imbalances and a negative effect on horses' well-being (Davidson and Harris 2007).

Horse management and housing systems

In the equestrian world, two different types of horse breeding management can be distinguished: traditional management and natural boarding. According to Placci et al. (2020) horses kept in natural boarding have the most favourable endocrine framework (determine DHEA (dehydroepiandrosterone) and cortisol concentration through RIA). This research suggests that this management best suits the ethological and physiological needs of the horse. The results of Marliani et al. (2021) related to the ethological barn model, showed that horses spent most of their time searching for food, followed by behaviours at rest and movement. Social behaviours (e.g., allogrooming, olfactory research) were rare, and stereotypical behaviours (e.g., oral and locomotor stereotypes) accounted for 2.74% ± 2.74% of total time. The percentage of time spent searching for food, resting and moving reflects the calculation of activity observed in wild horses that roam freely. However, the rare occurrence of positive social interactions and the presence of some stereotypes could be aspects for improvement. This kind of ethological barn housing could be considered a good alternative to traditional horse management and could offer a better compromise between horse needs and human management goals.

Conclusion

The appropriate frequency of feeding (frequency of rations), taking into account physiological and ethological aspects, depends on the daily amount of feed necessary for a horse to stay in shape. Frequent and constant access to feed either grass or hay is a key point of optimized feeding technology. Adequate rations of concentrate affect the glycemic response, avoid overuse of the digestive tract, and will affect horse behaviour. If a lot of calories are needed and starchy foods are used, the frequency of meals needs to be adjusted.

Presumably not every horse needs four rations as their hard-working ancestors do. The frequency of rations during the day is equally important in optimized horse feeding as the quality of ration. The ethological and physiological needs of horses are largely met in the natural boarding system of horse breeding management. Today in the equestrian world there is a growing interest in animal welfare. Therefore, it is necessary to modify the management and housing systems following the physiological and ethological needs of horses.

References

Benz, B., Münzing, C., Krüger, K., Winter, D. (2014) Ethological investigation of hayracks in equine husbandry. landtechnik, 69, 5.

Clegg, H. A., Buckley, P., Friend, M. A., McGreevy, P. D. (2008) The ethological and physiological characteristics of cribbing and weaving horses. Applied Animal Behaviour Science, 109(1), 68-76.

Davidson, N., Harris, P. (2007) Nutrition and welfare. In The welfare of horses (pp. 45-76). Springer, Dordrecht.

DLG-verlag (2003) Deutsche Landwirtschafts-Gesellschaft e.V. - Arbeiten der DLG / Band 198: Praxisgerechte Pferdefütterung; Eine Information des DLG-Arbeitskreises Futter und Fütterung; DLG-Verlags-GmbH, Eschborner Landstraße 122, 60489 Frankfurt am Main

Ellis, A.D. (2010) Biological basis of behaviour in relation to nutrition and feed intake in horses. European workshop on equine nutrition; The impact of nutrition on the health and welfare of horses: 5th European workshop equine nutrition, Cirencester, EAAP Publication No. 128, 53–74

Harris, P., Geor, R. J. (2009) Primer on dietary carbohydrates and utility of the glycemic index in equine nutrition. Veterinary Clinics of North America: Equine Practice, 25(1), 23-37.

Lüem S. (2021) Fütterungsfrequenz. (11/12/2021). https://www.optimera.ch/

Marliani, G., Sprocatti, I., Schiavoni, G., Bellodi, A., Accorsi, P. A. (2021) Evaluation of Horses' Daytime Activity Budget in a Model of Ethological Stable: A Case Study in Italy. Journal of Applied Animal Welfare Science, 24(2), 200-213.

Meyer, H., Coenen, M. (2014) Pferdefütterung. (Horse feeding and nutrition) 5. Auflage, Berlin: Enke Verlag. [Google Scholar]

Philippeau, C., Varloud, M., Julliand, V. (2014) Mobile bag starch prececal disappearance and postprandial glycemic response of four forms of barley in horses. Journal of animal science, 92(5), 2087-2093.

Placci, M., Marliani, G., Sabioni, S., Gabai, G., Mondo, E., Borghetti, P., Accorsi, P. A. (2020) Natural horse boarding vs traditional stable: A comparison of hormonal, hematological and immunological parameters. Journal of Applied Animal Welfare Science, 23(3), 366-377.

Rodiek, A. V., Stull, C. L. (2007) Glycemic index of ten common horse feeds. Journal of equine veterinary science, 27(5), 205-211.

Sakač, M., Baban, M., Antunović, B., Mijić, P., Bobić, T., Ivanković, A., Ramljak, J. (2011) Review of basic equine ethology in natural and controlled conditions. In 4th International Scientific/Professional Conference, Agriculture in Nature and Environment Protection, Vukovar, Croatia, 1st-3rd June 2011 (213-218).

Wyss C., Gerster G., Zollinger A., Schneider L., Bachmann I. (2016) Slow-feeding-Systeme für Pferde: Fresszeiten und Liegeverhalten.Nutztiere, Agrarforschung Schweiz 7 (11–12): 490–495.

Fiziološki i etološki aspekti hranidbe konja

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Sažetak

Cilj rada bio je prikazati optimalan broj obroka „modernog“ konja tijekom dana uzimajući u obzir fiziološke i etološke aspekte konja. S evolucijske i fiziološke točke, konj je izgrađen za stalno hranjenje. Obroci moraju osigurati odgovarajuću opskrbu energijom i hranjivim tvarima i uvelike utječu na etologiju konja. Upravljanje hranidbom i kvalitetom obroka utječe na zdravlje i dobrobit konja. Danas su konji daleko manje fizički aktivni nego prije. Učestalost obroka utječe na fiziološke parametre probave i etiologiju konja. Kako uravnotežiti odgovarajuću učestalost obroka s obzirom na fiziološke i etološke aspekte, te korištenje samog konja ovisi prvenstveno o dnevnoj količini i kvaliteti hrane koja je potrebna da konj ostane u formi. Odrasli konji obično imaju dva obroka dnevno s 10-satnim dnevnim intervalom i 14-satnim noćnim intervalom između obroka. Učestalost obroka konja varira ovisno o načinu držanja, kategoriji, fiziološkom stanju i korištenju. Učinak hranidbe i kvalitete obroka na zdravlje i dobrobit konja uglavnom je usmjeren na odgovarajući unos energije i hranjivih tvari te na razmatranje etiologije hranjenja, ograničavanje koncentrata na specifične potrebe, dostupnost vode i higijensku ispravnost hrane i vode. Poznavanje specifičnih hranidbenih potreba konja u fiziologiji i etiologiji treba smatrati bitnim dijelom očuvanja dobrobiti konja.

Ključne riječi: hranidba, konji, frekvencija hranjenja