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Ethological investigation of hayracks in equine husbandry

Regarding the species horse, an appropriate supply of roughage should take into account the need to chew as well as the need for occupation. In this context, and due to the current cost pressure for hay, the interest in roughage racks increases. It is assumed that roughage racks could help to extend the feeding time and reduce food losses.
The present study places the emphasis on the observation of the feeding behaviour of eight horses in single horse boxes. Three different roughage racks are compared to traditional feeding on the floor. On the basis of the results it may be concluded that the use of roughage racks extends the feeding time and thus ensures longer occupation. In one of the three roughage racks investigated the horses mainly eat in a natural posture of their head and neck.

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Abstract
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Horses in the wild feed on grasses and herbs mainly. 50–80 % of their daily time is spent seeking and consuming feed [1]. The equine digestion tract is adapted for high-roughage, low-energy feed and continuous feeding. Hunger periods of over four hours do not represent normal feeding behaviour for the horse. Species-appropriate feeding must fulfil anatomical, physiological and ethological requirements. It therefore follows that the daily time for feed consumption should be at least 12 hours (50 % of time budget). Recommended is a daily minimum amount of chewable material (structure material length of at least 4–5 cm) representing 1.5 % of liveweight (600 kg LW = 9 kg roughage/day) [2]. Along with nutritional-physiological aspects, the occupation of the horse plays a big role. A horse requires 40–50 minutes to consume 1 kg of hay or straw. [3; 4]. With a daily ration of 9 kg hay for a 600 kg horse, this represents a feeding time of 360 to 450 minutes per day. Accordingly, the horse with unrestricted feeding is occupied for a quarter of the day with hay feeding. Chewing occupation and saliva production are encouraged through feeding. If the supply of chewable material is too low this can lead to problems in the digestion tract, but also to insufficient wearing of the teeth, stomach ulcers, and colic symptoms. Behaviour abnormalities caused by a too short occupational time in feed seeking and consumption can have further consequences. Studies confirm that such behaviour increasingly occurs in stables where less roughage such as hay or silage is fed and where horses are not bedded with long straw [1]. The chewing of box walls can also be associated with insufficient duration of feeding and associated lack of occupation. Hayracks or hay nets can lead to a doubling of feed consumption time to 86 min/kg hay [5].

The challenge for horse farms comprises provision of feed of hygienic quality and application of economic management towards optimising the increasing costs for roughage. Further, care must be taken in the use of automatic feeders, hayracks and hay nets so that horses using them can consume their feed while expressing natural feeding behaviour. In nature, horses feed from the ground, i. e. with lowered head and in normal grazing stance. Recommended is a grazing level based on withers height x 0.3 [6]. Vertical grid bars on feed racks lead to fears by horse keepers of negative effects on horse health in that the animal has to pull its feed out with angled head or neck. Up until now, this aspect has not been scientifically investigated. Using racks instead of on-ground feeding lowers the risk of reinfection with endoparasites through dirty litter [7].

Within the present study the feeding speed, the total feeding time, the duration of individual feeds, and the amount of feed consumed within defined periods of time after feed provision, were all to be observed. Additionally, recorded were head-neck movements and the body posture in association with the natural grazing position of the horse.

Material and methods

The investigation was conducted on a farm with 45 pension horses. Trial subjects were 6 warmblood horses and 3 riding ponies. The animals were from 8 to 22 years of age. During the trial period one of the horses had to be moved to an outer box

Fig. 1

a) Trough rack *b) Conical rack* *c) „Hay Bar“ (Photos: Sulzberger)*

for health reasons and was thus precluded from the study. The horses were housed in similar single boxes (3 x 3.5 m) with long straw litter. Feeding comprised concentrate feed 2 x day (7.00 am and about 10.00 pm) and 2 x day an individual ration of between 2.5 and 3.5 kg hay (10.00 am and 10.00 pm). Calculation of the hay ration was based on the formula 0.5–1.0 kg hay per 100 kg liveweight [3]. Additionally taken account of was the feed condition of the horses. All horses were out to grass for an average 3.5 hours per day. Within the trial, feed intake amount, feed consumption time and feeding behaviour of every horse were recorded by video (T/N-IR colour dome camera with LED lighting; type: VFKUP-600/3-11IR, manufacturer VC). Three different hayracks were alternated for every horse (**Figure 1**, a) trough rack, b) conical rack, c) “Hay Bar”, all from Sulzberger), arranged so that every horse could be observed with every type of rack. The order of rack and horse was arbitrarily selected. Behaviour was filmed over a seven-day period after a three-week familiarisation period. An arbitrarily selected 24-hour period was chosen for evaluation of each feeder type.

The distance between grid bars with all racks was 5 cm. The trough rack and the Hay Bar conformed to guidelines, mounted at a height equal to withers height x 0.3. With the ponies, this gave a feeding height of approx. 40 cm above ground, with the horses approx. 50 cm. The upper part of the conical rack was clad with sheet metal, forcing the horses to feed from below.

Data collection

Speed of feeding was calculated taking into account the animal-individual feed rationing (5–7 kg/day). A feed was recognised as ended when the feeding action was interrupted for more than 2 minutes. Short pauses, e. g., for swallowing or drinking, were not regarded as interruptions. Recording differentiated between feeding periods and the pauses within. Total feeding time was calculated from the total of the individual feeds.

The study focused on the occupation potential of roughage feeding over the day. For this reason, the observation period was divided into four time sectors starting from the point of hay provision:

- I: ≤ 1 hour after hay provision
- II: 1–2 hours after hay provision
- III: > 2–6 hours after hay provision
- IV: > 6 hours after hay provision

The feed consumption time was calculated independently from the length of feeds within a time sector.

In order to clarify whether certain head-neck posture or positions occurred especially frequently, the frequency of those was counted over 24 hours. Hereby, the duration of the respective postures positions was not analysed. The assessment of head-neck posture (KHH) took place based on three categories:

- Category 1 (KHH1): Neutral posture of head and neck
- Category 2 (KHH2): Bent posture of head and neck
- Category 3 (KHH3): Bent posture of head and neck

The horses’ standing position to the rack was also listed under three categories:

- Category 1 (Position “frontal“): Horse head-on to rack
- Category 2 (Position “parallel“): Horse standing parallel to rack
- Category 3 (Position “angled“): Horse standing at an angle to rack

Data analysis

Statistical analysis used the program R 386 3.01 i [8]. In that several data sets showed no normal distribution and also featured small sample sizes, non-parametric tests were used for sample analysis (Wilcoxon pair comparison test, Friedman test, for very small samples with the option ”exact“). The Spearman-Rank correlation test was applied for correlation analyses. Significance level was established as 0.05. All tests were bilateral.

Results and discussion

Total feeding time

The installation of the different roughage racks was shown to have significant effects on total feeding time. The influence of the racks on feeding duration was highly significant (Friedman-Exact test: n = 8; χ^2_3 = 19.05; p = 0.000). A pair comparison test showed that the total feeding time at the trough rack and the Hay Bar was extended highly significantly compared with the result from on-ground feeding (**Table 1**).

The longest feeding time was recorded at the trough rack (**Table 1**). Observations showed that this was due to the horses

Table 1

*Total feeding time depending on feeding system (Wilcoxon-Exact-Test: n = 8; p < 0.05 significant *, p < 0.01 very significant **, p < 0.001 most significant ***, p > 0.05 not significant n.s.)*

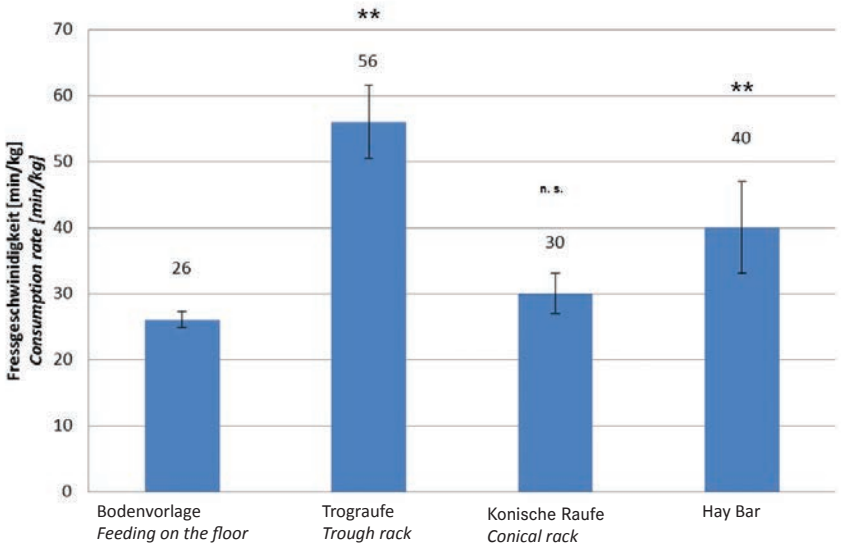
	Median [min]	Minimum [min]	Maximum [min]	N	Signifikanz/*Significance*
Bodenvorlage *Feeding on the floor*	148	124	187	8	
Trograufe *Trough rack*	318	196	407	8	p-value = 0.014 ***
Konische Raufe *Conical rack*	172	107	226	8	p-value = 0.195 n. s.
Hay Bar	220	138	360	8	p-value = 0.016 ***

having to pull all the hay out through the grid bars without any exception. While the grid fixed on top of the trough did shift with feeding, it still pressed down on the hay with its weight and in this way slowed down the feeding action. The comparatively small increase in feeding time at the conical rack could be explained by the horses being able to pull out the hay in bunches of stalks together. With the Hay Bar, the weight of the grid had a limited effect compared to the trough rack, in that it was attached on one side and only lay over the hay at an angle. The form of the Hay Bar meant enclosure of the hay was incomplete over the form of the container, so that the horses were able to pull the feed past the feed grill.

Calculation of the resultant feeding times in duration per kg of hay enabled comparison with values from other studies (30–40 minutes/kg roughage from on-ground feeding with loose hay [6; 9]). The partaking horses in the present study recorded a faster feeding speed with an average 26 min/kg loose hay from on-ground feeding. Compared with on-ground feeding, the trough rack very significantly slowed down feeding (Wilcoxon-Exact test: n = 8; p = 0.014) and Hay Bar (Wilcoxon-Exact test: n = 8; p = 0.016) (**Figure 2**).

Duration of individual feeds (within total feeding time) with the different feed racks were also of interest. Average feed duration with on-ground feeding was 53 minutes (min. = 35 min/max. = 90 min). With the trough rack, the feeds were significantly longer in duration compared with on-ground feeding with 95 minutes (min. = 46 min/max. = 163 min) and compared with the Hay Bar (52.5 min, min. = 40 min/max. = 68 min) (Wilcoxon-Exact test: n = 8, p = 0.008). The conical trough also achieved significantly longer feeds (66 min, min. = 52/max. = 115 min) than on-ground feeding (Wilcoxon-Exact test: n = 8, p = 0.001) and than the Hay Bar (Wilcoxon-Exact test: n = 8, p = 0.004). The feeds were longest in duration with the trough rack. Total feeding times were longer here too (+115 % over on-ground feeding). Although the Hay Bar lengthened the total feeding time overall by 48 % compared with on-ground feeding, the individual feeds with both systems were similarly short. Regarding lengthening of duration of total feeding time,

Fig. 2



*Consumption rate per kg roughage depending on feeding system (p < 0.05 significant *, p < 0.01 very significant **, p < 0.001 most significant ***, p > 0.05 not significant n.s.)*

Table 2

Feeding time over time after feed provision

	≤ 1 h nach Futtervorlage *≤ 1 h after feed provision* **[min]**		**1–2 h nach Futtervorlage** *1–2 h after feed provision* **[min]**		**> 2–6 h nach Futtervorlage** *> 2–6 h after feed provision* **[min]**		**> 6 h nach Futtervorlage** *> 6 h after feed provision* **[min]**	
Bodenvorlage *Feeding on the floor*	Median		Median		Median		Median	
	46		**18**		**8**		**0**	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
	32	58	10	28	0	34	0	2
Trograufe *Trough rack*	Median		Median		Median		Median	
	55		**37**		**50**		**16**	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
	47	60	16	57	9	95	8	30
Konische Raufe *Conical rack*	Median		Median		Median		Median	
	53		**27**		**4**		**0**	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
	43	60	0	50	0	29	0	0
Hay Bar	Median		Median		Median		Median	
	52		**19**		**35**		**5**	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
	29	60	3	38	17	82	0	8

Table 3

*Head and neck posture depending on different roughage racks [%] ($p < 0.05$ significant *, $p < 0.01$ very significant **, $p < 0.001$ most significant ***, $p > 0.05$ not significant $^{n.s.}$)*

	Kopf-Hals-Haltung gerade (KHH 1) *Neutral posture of head and neck (KHH1)* **[%]**	**Kopf oder Hals gebogen (KHH 2)** *Bent posture of head or neck (KHH2)* **[%]**	**Kopf und Hals gebogen (KHH 3)** *Bent posture of head and neck (KHH3)* **[%]**	**Signifikanz** *Significance*
Trograufe *Trough rack*	33,95	45,96	20,09	Wilcoxon-Exact-Test: n = 8, p = 0,023 *
Konische Raufe *Conical rack*	19,87	69,88$^{a\ 1)}$	10,25$^{b\ 1)}$	Friedman-Exact-Test: n = 8; χ^2_2 = 13,067; p = 0,002 **
Hay Bar	99,55^{a}	0,45^{b}	0	Friedman-Exact-Test: n = 8; χ^2_2 = 15,44; p = 0,000 ***

[1)] Unterschiedliche Buchstaben kennzeichnen signifikante Unterschiede/Different letters indicate significant differences

the conical trough ended in last place with 16 % over on-ground feeding. At the same time, individual feeds with the conical trough were second-longest in duration.

Results from total feeding time, speed of feeding and duration of individual feeds only allowed a conditional conclusion regarding occupational potential of the respective feed provision systems. Feed consumption time within defined periods, however, determined how long the horses fed split up over the day (**Table 2**). This permitted the observation that feeding with all rack types was almost continual over the first hour following feed provision. With the trough rack and Hay Bar, it was clear that the total feeding time lengthened and that the feed consumption lasted over a period of six hours after feed provision.

Feeding posture

In the context of using feed racks, not only feed consumption behaviour was investigated. The question was also followed as to whether horses were able to adopt a species-appropriate head-neck posture or body position with regard to the feeding rack.

With the trough rack, the horses fed much more often with KHH2 than with KHH3. This also applied to the conical rack, whereby the proportion of KHH2 was much higher. It was shown with the Hay Bar that horses fed significantly more often with KHH1 than with KHH2 and that KHH 3 did not occur (**Table 3**).

Analysis of head-neck posture did not permit an investigation of how long the horses remained in the respective postures, but instead only how often the postures occurred. From

an ethological point of view, the head-neck posture with the Hay Bar could be classified as almost natural, because the horses fed almost completely with neutral head posture and outstretched neck. With the trough rack, the critically viewed category 3 head-neck posture occurred most often. However, it was seen that the horses remained in this posture no longer than 40 seconds. The proportion of neutral head-neck postures was lowest with the conical rack. Based on the special design of this rack, this result is possibly not to be judged too critically, as described by Geuder [10]. The upper half of the rack is clad with sheet metal and the feeding level with 0.3 x withers height is thus according to the guidelines. This means that the head-neck posture deviating from natural head posture could only occur near the ground level. With all racks, a large proportion of feeding time was taken up with the chewing/grinding of roughage so that the unnatural head posture only took place during pulling or plucking hay out of the racks. So far, there has been no scientific investigations into whether this leads to health problems. The different horse positions with respect to the racks were categorised into "frontal", " parallel" and "angled". The trough rack was the only one where all three positions occurred. Hereby, the horses stood for one third of the observations frontal, 12.2 % parallel and 56.5 % – the significantly longest time – angled to the rack (Friedman-Exact test: n = 8; χ^2_2 = 5.871; p = 0.053). Only frontal and angled position were observed with the conical trough, whereby the horses' positions to the rack were easily most often angled (64.2 %) than frontal (35.8 %) (Friedman-Exact test: n = 8; χ^2_2 = 4.5; p = 0.034). The construction of the Hay Bar required that the horses stood exclusively frontal to the rack. Horses on pasture graze in forward motion. Their posture is thereby always straight. It can, therefore, be assumed that the horses with an angled position react to the more difficult accessibility of the hay in racks. Possibly the horses try first to overcome this through first altering the natural body position thus avoiding an angled head-neck, or they vary their positions.

Additionally of interest was whether the hayracks can allow the natural grazing position of the horse. With the trough and conical racks, 6 from 8 horses stood in the grazing position and with the Hay Bar, all 8 of the horses. However, the grazing position was not so clearly expressed in the first two racks as with the Hay Bar.

Not systematically investigated in the present study were feed losses with hayracks. However, no significant feed losses were observed during the assessments. This aspect is of economic interest and leaves room for further investigations.

Conclusions

In horse keeping, feeding serves not only nutritional but also occupational requirements of horses. A continual moderate intake of structured roughage feed encourages healthy support of the sensitive digestion system. Through using hayracks the risks of colic, stomach ulcers, and of reinfection by endoparasites through dirty litter are sustainably reduced. Horses display behavioural anomalies such as cribbing and weaving all the more often, the shorter the feeding time is.

The types of racks investigated here are effective in prolonging total feeding time and occupation time by up to 6 hours from feed deposition. Depositing the feed twice offers the possibility of prolonging feed intake to nearly 12 hours, which represents the initially mentioned target of 50 % of daily time budget.

With the Hay Bar, the horses mainly fed with a natural head posture. With conical rack and trough rack there was frequent observation of bent head or neck posture. However, this only occurred in combination for a low percentage of the time. The grazing position was observed with all racks. Further aspects such as, e. g., the avoidance of feed losses, could make the application of feed racks in single box housing additionally interesting.

References

[1] Pirkelmann, H.; Ahlswede, L.; Zeitler-Feicht, M. (2008): Pferdehaltung. Stuttgart, Ulmer Verlag, S. 11

[2] Zeyner, A., Kienzle, E.; Coenen, M. (2011): Artgerechte Pferdefütterung. Landbauforschung-vTI Agriculture and Forestry Research, Sonderheft 353, S. 164–187

[3] Meyer, H.; Coenen, M. (2002): Pferdefütterung. Berlin, Parey Verlag, S. 19

[4] Gieselmann, A. (1994): Nutritive Anamnese bei Kolikfällen des Pferdes. Diss. Med. vet., Tierärztliche Hochschule Hannover

[5] Zeitler-Feicht, M.; Margit, H.; Walker, S. (2005): Zum Einsatz eines speziellen Heunetzes in der Pferdefütterung aus ethologischer Sicht. Pferdeheilkunde 21, S. 229–233

[6] BMELV (2009): Leitlinien zur Beurteilung von Pferdehaltungen unter Tierschutzgesichtspunkten, vom 9. Juni 2009, Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz

[7] Menzel, M. (2013): Zum Heu raufen. Cavallo 02, S. 111

[8] R Development Core Team (2013): R: A Language and Environment for Statistical Computing. http://www.R-project.org, Zugriff am 28.5.2014

[9] Zeitler-Feicht, M.; Walker, H.; Buxade, C. und K. Reiter (2005): Untersuchungen verschiedener Formen der Heuvorlage bei Pferden unter ethologischem Aspekt. KTBL-Schrift 437, Landwirtschaftsverlag GmbH, Münster-Hiltrup, S. 209–216

[10] Geuder, U. (2004): Eignung von Heuraufen für eine bedarfs- und verhaltensgerechte Vorlage von Raufutter bei der Boxenhaltung von Pferden. Bayerische Landesanstalt für Landwirtschaft, Jahresbericht, S. 24

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