

Effects of Different Bedding Materials on the Behavior of Horses Housed in Single Stalls

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ABSTRACT

The effects of three different bedding materials (straw, wood shavings, and straw pellets) on the behavior of six warmblood horses (four mares, two of them with foals) housed in single stalls were analyzed. Each material was used for 2 weeks in three consecutive runs. The behavior of the horses was videotaped and analyzed on the first and last 3 days for each bedding alternative in the last of the three runs. The time budgets for the behaviors including standing, eating, lying, occupation with bedding material, and other were generated. Compared with straw pellets and wood shavings, the application of straw bedding led to a significantly higher frequency and longer duration of occupation with bedding material and in turn, shorter fractions of standing and other behaviors. The total duration of lying was significantly longer on straw than on straw pellets. Straw pellets resulted in the least mean recumbency duration per occurrence of this behavior. Because occupation is one of the important functions that bedding material is supposed to fulfill, we concluded that in regard to horse behavior, straw bedding was the best among the three materials analyzed. Further investigations with a more homogeneous group of probands are necessary to verify the observed behavioral reactions.

Keywords: Horse; Bedding material; Behavior; Single stalls

INTRODUCTION

In Germany, most riding horses are housed in single stalls.¹ In this housing system, animals are directly subjected to the influences of the stable environment for the major part of the day (often up to 23 hours). In addition to other factors, the bedding material has a decisive influence on the stable environment. The functions of the bedding material

include the absorption of excrement, protection from mechanical insult, cushioning the horse's legs against concussion, thermal isolation, prevention of draft, improvement of skid and slip resistance, and the occupation of the horses.² Preference research conducted by Hunter and Houpt³ revealed that horses favor lying down in areas having bedding material as compared with areas without it. Therefore, a dry and soft floor seems to have a positive influence on horse welfare. Moreover, bedding material influences the development of noxious gases and dusts significantly, and consequently, the air quality within a stable. It is well-known that contamination of the stable air can cause severe respiratory diseases,^{4,5} and that inadequately maintained bedding material can lead to hoof problems such as thrush.⁶ However, few investigations have been conducted on how and to what extent the type of bedding influences horse behavior. McGreevy et al⁷ reported that bedding materials other than straw increase the risk of abnormal behavior. Another study⁸ reported that horses kept on straw bedding spend more time lying in a lateral recumbent position. This is important for a complete sleeping cycle and the essential deep sleep phase showing rapid-eye-movement (REM)-sleep phases.⁹ Housing systems are supposed to provide conditions that help maintain natural behavior as much as possible. The comparison between the behavior of horses in the wild and domesticated horses in a housing system gives an indication of the animal welfare inherent in a system.¹⁰

In Germany, the most commonly used bedding materials for horses housed in single stalls are straw (wheat and barley) and wood shavings. Straw is comparatively low-priced and easy to buy in bales of different sizes. Its absorbent characteristics are good and it can be disposed off easily. Its disadvantages include dust exposure and the fact that it can harbor spores (considerable quality differences in different batches). Wood shavings are often used as an alternative for straw. Because of the standardized processing methods used to manufacture wood shavings, they are of a consistent quality, more absorbent, less dusty, and harbor conspicuously fewer allergens than straw. However, shavings are more expensive and more difficult to dispose off. Another material with similar characteristics to wood shavings is straw pellets, which have the advantage that it can be easily disposed off.¹¹

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For keeping the bedding clean and dry, different types of mucking out regimes are commonly used. Carrying out complete mucking on a daily basis is labor intensive and involves a high material consumption. One way to save time and reduce material consumption is to remove only the feces on a daily basis. This method has been recommended, for example, for wood shavings and straw pellets by the manufacturers. For the most labor-saving regime, only new material is added on a daily basis and complete mucking out takes place in intervals of several weeks.¹²

The present investigation is based on the results that originated from an experiment the main focus of which was on the effect of popular bedding materials on the stable climate.^{13,14} Our objective was to determine whether and to what extent the bedding material affects the behavior of horses housed in single stalls.

MATERIALS AND METHODS

Location of the Study

The research project was undertaken in a stable in Lönningen (county of Cloppenburg, Lower Saxony, Germany) in the period between January 26 and September 4, 2006. Four warmblood mares (two of them with foals) were housed in single stalls within the stable. Figure 1 shows the layout of the stable. The four windows were always kept closed; one of the doors was kept half open and the other completely open. The single stalls were separated by stone walls (height = 1.3 m), with a wooden section (height = 1.2 m) placed on the upper surface of the walls. In the direction of the aisle, the wall consisted of a 0.8-m stone wall with 1.4-m wooden paneling on top. Stalls 1, 3, and 4 had spaces in their wooden walls, which allowed the horses to look into the aisle. These horses were also fed (hay) from the aisle. The horses in stall 2 were fed inside the stall. Each stall was equipped with feeders for concentrates and automatic drinking troughs.

Animals

A 7-year-old warmblood mare (dam, D1) with foal (F1) was housed in stall 1. Stall 2 housed a 6-year-old warmblood mare (D2) with foal (F2), stall 3 housed a 5-year-old riding horse (warmblood mare; R1), and stall 4 an 18-year-old riding horse (warmblood mare; R2). The height of the adult horses ranged between 1.65 and 1.70 m. The dams weighed about 650 kg, the riding horses about 600 kg, and the foals about 230 kg.

Bedding Materials and Feed

The two most common bedding materials in Germany were selected for this study: wheat straw (unchaffed, length 20–30 cm, dry matter content 89%, water binding capacity 321%) and dust-free wood shavings (spruce wood; Goldspan, Brandenburg Com., Goldenstedt, Germany; dry matter content,

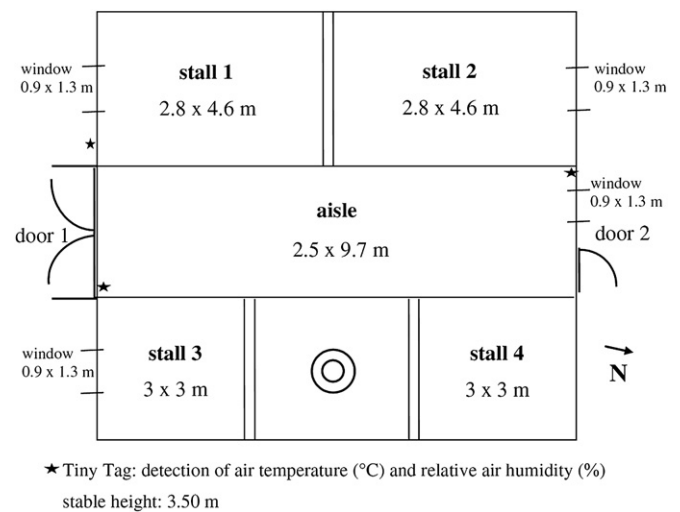


Figure 1. Plan of the stable.

86%; water binding capacity, 316%). Additionally, use of wheat straw pellets (straw ground and made into pellets; Biolan, RWZ Rhein-Main Com., Cologne, Germany; dry matter content, 87%; water binding capacity, 419%) as a bedding material was also investigated, as it is known to cause particularly small amounts of dust¹³ and ammonia emissions¹⁴ under environmentally-controlled conditions. Further information on the bedding materials investigated by Fleming et al has been previously published.¹⁴

On a daily basis, the horses were fed with hay (6 kg/[mare and day]), pellets (3 kg/[mare and day]), and oats (1 kg/[mare and day]) once at 8 AM and then again at 6 PM. The pellets (Derby Zucht Derby Spezialfutter Com., Germany) contained 12.5 MJ metabolic energy (ME)/kg and 15% crude protein (CP). The oats contained 11.5 MJ ME/kg and 8.5% CP. Hay (8 MJ ME/kg and 5.4% CP) was placed inside the stall for D2 and on the floor of the aisle for the remaining three horses. The feed quality and type remained constant over the course of the experiments. The foals were nursed by their dams. Water was available at all times.

Measurement Techniques

Four video cameras (Panasonic CCTV WV-BP 310), each with an infrared light source, were fixed on top of the wooden paneling at the back of the stalls to record the behavior of the horses. A long time recorder (Time Lapse Video Recorder AG-6040, Panasonic), multiplexer (Video Multiplexer WJ-FS 116, Panasonic), and a monitor screen to control the records were placed in a room outside the stable.

Experimental Design

The basic study was split into three runs, each run lasting for 6 weeks. The behavior measurements were recorded

in the last run, by which time the horses were already used to the change of bedding material. In each run, the bedding materials were used for 2 weeks. In this study, when straw was used (between August 9 and 21, 2006), it was necessary to add new material daily¹²; 11 kg of straw per stall was strewn on a daily basis in this study. Following the manufacturers' instructions, the bedding made of straw pellets (between July 26 and August 6, 2006) was kept about 5 cm deep and the bedding of wood shavings (between August 23 and September 4, 2008) about 25 cm deep. The manufacturers also suggest adding new material in intervals of 2 weeks; therefore, no new material was added within the 2 weeks of the experiment. The total amount of bedding material placed in the four stalls was as follows: straw, 225 kg in stalls 1 and 2, 150 kg in stalls 3 and 4 (plus 11 kg daily); straw pellets 33 kg in stalls 1 and 2, 22 kg in stalls 3 and 4; shavings 150 kg in stalls 1 and 2, 120 kg in stalls 3 and 4.

The behavior of the horses was observed and analyzed continuously by an individual on the first (period 1) and last 3 days (period 2) of each bedding alternative in the last of the three runs (6 days for each of the three bedding alternatives for six horses, 108 data sets in total). Because the horses spent 6 to 7 hours a day out at the pasture, the behavioral observations for each horse were carried out daily for 15 hours (6 PM–11 AM). The observations were noted when the horses returned to the stable from the pasture. The frequency, mean duration per appearance, and total duration within 15 hours were documented for each behavior type. The 20 observed behavior types were grouped into the following five categories: eating (including eating hay and concentrates), standing (including dozing and watching with their head out), lying (including sternal recumbency and lateral recumbency), occupation with bedding material (including eating, nuzzling, and investigating the material), and other (including behaviors of short duration and/or little frequency; eg, locomotion, drinking, rolling, and grooming).

Statistical Analysis

The statistical evaluation of the data was carried out with the software program SAS 9.1 (SAS Inst. Inc, Cary, NC, USA). The following behavior data had to be logarithmically transformed into Gaussian distribution: frequency of occupation with bedding, lying, sternal recumbency, and lateral recumbency; mean duration of eating, standing, occupation with bedding and lateral recumbency; and total duration of occupation with bedding, and lateral recumbency.

The analysis of variance was computed using the GLM procedure with the significance level at $P \leq .05$. Probability values between .05 and .1 were noted as tendencies (t -test). For all behaviors, the fixed effects of the bedding alternative (straw pellets, straw, and wood shavings), the

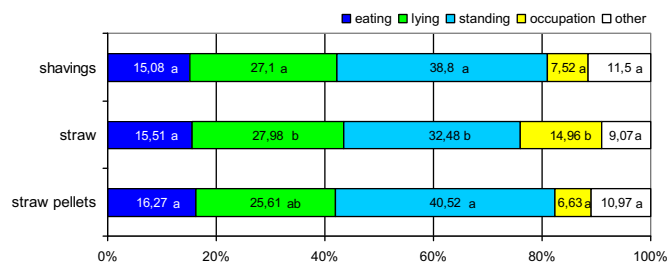


Figure 2. Determined time budgets of the behavior inside the stall subdivided according to bedding materials (observation period 15 hours; $n = 108$; a, b = least squares means within a behavior with different letters are significantly different [$P < .05$]).

observation period (period 1 = days 1–3; period 2 = days 11–13), and the horse were considered. Additionally, for the two behaviors “standing” and “occupation with bedding,” the interactions between the bedding alternative and the horse and between the bedding alternative and the observation period were also considered. Moreover, for the behavior “lying,” the fixed effect of the observation day (within the period) and the interactions between bedding alternative and horse, bedding alternative and observation period, observation period and horse, bedding alternative and observation day, were also taken into account.

RESULTS

Time Budgets

For the daily observation time of 15 hours, the time budgets for the total duration of the five main behavior groups—standing, eating, lying, occupation with bedding, and other—were generated (mean values of all horses and observation days; Fig. 2, Table 1). The bedding material had a significant influence on the frequency, mean duration per appearance, and total duration of occupation with bedding ($P < .0001$). In all cases, compared with other materials, the horses spent more time occupying straw bedding than on the other materials. In contrast, the behavior “standing” was performed in a lower frequency and in a shorter total duration ($P < .0001$). Straw bedding also caused a significantly longer total duration of lying than straw pellets ($P = .0094$; Table 1).

Influence of the Individual Horse

Each horse had a highly significant influence on all the observed behaviors with respect to frequency, mean duration per appearance, and total duration ($P < .0001$). Figure 3 presents this influence using the example of total duration of the behavior “occupation with bedding.” D2 spent the longest time occupied with the bedding and the two foals spent more time occupied with the bedding than the riding

Table 1. Total duration, frequency, and mean duration of the behaviors standing, eating, lying, and occupation subdivided according to bedding materials (n = 108)

| | n | Standing | | Eating | | Lying | | Occupation | |
|----------------------|----|----------------------|------|--------------------|------|---------------------|------|--------------------|------|
| | | LSM | SE | LSM | SE | LSM | SE | LSM | SE |
| Total duration (hrs) | | | | | | | | | |
| Straw pellets | 36 | 6.08 ^a | 0.14 | 2.44 ^a | 0.10 | 3.84 ^a | 0.09 | 0.99 ^a | 0.11 |
| Straw | 36 | 4.87 ^b | 0.14 | 2.33 ^a | 0.10 | 4.20 ^b | 0.09 | 2.24 ^b | 0.11 |
| Shavings | 36 | 5.82 ^a | 0.14 | 2.26 ^a | 0.10 | 4.06 ^{a,b} | 0.09 | 1.13 ^a | 0.11 |
| Frequency | | | | | | | | | |
| Straw pellets | 36 | 37.75 ^a | 1.41 | 21.72 ^a | 1.01 | 22.47 ^a | 0.91 | 15.31 ^a | 1.12 |
| Straw | 36 | 30.00 ^b | 1.41 | 19.44 ^a | 1.01 | 22.00 ^a | 0.91 | 24.25 ^b | 1.12 |
| Shavings | 36 | 37.89 ^a | 1.41 | 19.42 ^a | 1.01 | 21.11 ^a | 0.91 | 17.11 ^a | 1.12 |
| Mean duration (mins) | | | | | | | | | |
| Straw pellets | 36 | 10.75 ^a | 0.47 | 7.19 ^a | 0.45 | 11.62 ^a | 0.61 | 3.47 ^a | 0.23 |
| Straw | 36 | 10.27 ^{a,b} | 0.47 | 7.40 ^a | 0.45 | 13.58 ^b | 0.61 | 5.65 ^b | 0.23 |
| Shavings | 36 | 9.73 ^b | 0.47 | 7.78 ^a | 0.45 | 13.06 ^b | 0.61 | 3.35 ^a | 0.23 |

n, number of values; LSM, least squares means; SE, standard error.

^{a,b} Least squares means within a variable with unlike superscripts are significantly different ($P < .05$).

horses and D1. All the horses showed the longest time occupied on straw bedding; in three of the cases it was significantly different from the other two materials ($P < .05$) and in one case, it was significantly longer than on straw pellets ($P = .0312$). No significant differences between the bedding materials could be found in D2 and F2 (Table 2). These horses were fed hay inside their stall.

Influence of the Observation Period on the Time Spent Lying

In some cases, the observation period influenced the behavior “lying” either in tendency or significantly. In Table 3, the behavior “lying” in periods 1 and 2 is presented, subdivided into sternal and lateral recumbency on the basis of type of bedding material. When the bedding consisted of wood shavings, the phases spent lying in sternal recumbency in period 1 were significantly shorter than in period 2 ($P = .0464$). The results from the other two materials reported the same tendency but they were not statistically significant. In contrast, the phases spent lying in lateral recumbency in period 1 were significantly longer than in period 2. These results were also not statistically significant, but tendencies could be recognized for straw ($P = .0620$) and straw pellets ($P = .0792$). In most cases, the phases of sternal recumbency are clearly longer than phases in lateral recumbency. No differences could be found in total duration and frequency of lying between periods 1 and 2 (Table 3).

DISCUSSION

When kept on straw bedding, the horses spent the maximum time with the behavior “occupation with bedding”

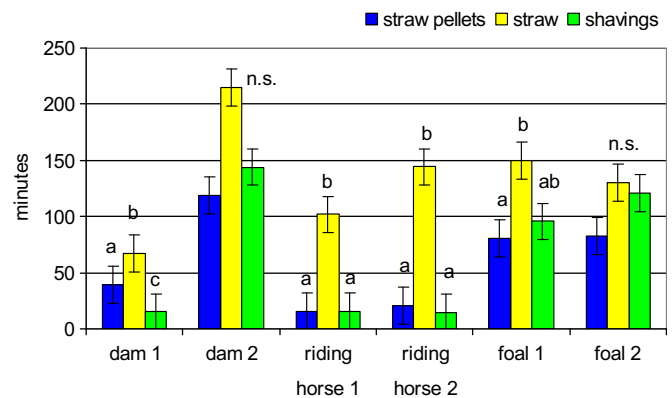


Figure 3. Least squares means and standard error of total duration of occupation with bedding subdivided according to horses and bedding materials (observation period 15 hours; n = 108; n.s. = not significant; a, b, c = least squares means within a horse with different letters are significantly different [$P < .05$]).

and the shortest with the behavior “standing.” It is known that horses in the wild are occupied with finding feed for about 60% of the day.^{10,15} In contrast, horses housed in stables usually spend a lot more time standing without occupation (upto 65%) and only about 15% of the day eating.¹⁵ This situation can lead to the development of stereotypic behavior.⁷ Providing horses with a possibility to occupy themselves with bedding material should have an important influence on how animal-friendly the housing system is.² On the basis of this, compared with wood shavings and straw pellets, straw as a bedding material seems to meet the requirements of the horses in terms of occupation

Table 2. Total duration, frequency, and mean duration of the behavior occupation with bedding subdivided according to bedding materials and horses (n = 108)

| | n | Total duration (hrs) | | Frequency | | Mean duration (mins) | |
|----------------|---|----------------------|------|----------------------|------|----------------------|------|
| | | LSM | SE | LSM | SE | LSM | SE |
| Dam 1 | | | | | | | |
| Straw pellets | 6 | 0.65 ^a | 0.27 | 14.17 ^{a,b} | 2.74 | 2.46 ^a | 0.56 |
| Straw | 6 | 1.12 ^b | 0.27 | 18.66 ^a | 2.74 | 3.46 ^b | 0.56 |
| Shavings | 6 | 0.25 ^c | 0.27 | 9.83 ^{a,b} | 2.74 | 1.33 ^c | 0.56 |
| Dam 2 | | | | | | | |
| Straw pellets | 6 | 1.99 ^a | 0.27 | 19.00 ^a | 2.74 | 6.71 ^a | 0.56 |
| Straw | 6 | 3.58 ^a | 0.27 | 24.33 ^a | 2.74 | 8.48 ^a | 0.56 |
| Shavings | 6 | 2.40 ^a | 0.27 | 17.33 ^a | 2.74 | 8.09 ^a | 0.56 |
| Riding horse 1 | | | | | | | |
| Straw pellets | 6 | 0.26 ^a | 0.27 | 9.00 ^a | 2.74 | 1.48 ^a | 0.56 |
| Straw | 6 | 1.70 ^b | 0.27 | 20.00 ^b | 2.74 | 5.22 ^b | 0.56 |
| Shavings | 6 | 0.26 ^a | 0.27 | 9.33 ^a | 2.74 | 1.65 ^a | 0.56 |
| Riding horse 2 | | | | | | | |
| Straw pellets | 6 | 0.35 ^a | 0.27 | 8.00 ^a | 2.74 | 2.47 ^a | 0.56 |
| Straw | 6 | 2.40 ^b | 0.27 | 20.00 ^b | 2.74 | 7.09 ^b | 0.56 |
| Shavings | 6 | 0.24 ^a | 0.27 | 9.00 ^a | 2.74 | 1.61 ^c | 0.56 |
| Foal 1 | | | | | | | |
| Straw pellets | 6 | 1.35 ^a | 0.27 | 20.17 ^a | 2.74 | 3.91 ^a | 0.56 |
| Straw | 6 | 2.50 ^b | 0.27 | 27.17 ^a | 2.74 | 5.82 ^b | 0.56 |
| Shavings | 6 | 1.59 ^{a,b} | 0.27 | 26.33 ^a | 2.74 | 3.37 ^a | 0.56 |
| Foal 2 | | | | | | | |
| Straw pellets | 6 | 1.38 ^a | 0.27 | 21.50 ^a | 2.74 | 3.78 ^a | 0.56 |
| Straw | 6 | 2.17 ^a | 0.27 | 35.33 ^b | 2.74 | 3.81 ^a | 0.56 |
| Shavings | 6 | 2.02 ^a | 0.27 | 30.83 ^a | 2.74 | 4.05 ^a | 0.56 |

n, number of values; LSM, least squares means; SE, standard error.

^{a,b,c}Least squares means within the horse with unlike superscripts are significantly different ($P < .05$).

most suitably and in turn improves their welfare. These findings concur with the results from a study by Mills et al¹⁶ regarding preferences between bedding materials in Thoroughbred horses. On the basis of the fact that horses also eat some bedding material while they are occupied with it, the present study proves the hypothesis that time spent standing is reduced when horses in single stalls spend more time eating.¹⁷

In comparison, Mills and McDonnell reported that the time spent lying is not influenced by the time spent eating.¹⁷ In general, this hypothesis can also be supported by the present results, even though the straw bedding led to a 3% increase in lying behavior than straw pellets. This might indicate that beddings made of straw pellets are less comfortable than straw and even wood shavings. In fact, the straw pellet mattress was (in adherence to the manufacturers' instructions) only 5-cm deep. Possibly, this depth is not enough to create a comfortable bed for the horses. In contrast to the present study and Mills and McDonnell,¹⁷ Fader¹⁸ observed more occurrence of the

“lying” behavior on shavings than on straw in open housing systems and less “lying” when horses were fed additional roughage.

Considerable differences were observed between the individual horses. This result was expected because the group was small and very heterogeneous with respect to age (foals, adults between 5 and 18 years) and physiological condition (dams, foals, and riding horses). All the horses spent most of their time occupied with bedding made of straw. However, for D2 and F2, the time spent occupied with bedding was not significantly different between the materials. This latter result was considered to be because of the fact that these horses (living in stall 2) were fed with hay *within* their stall, whereas all the other horses had their hay placed in the aisle. Because of the presence of the hay within the stall, there was mixing of the feed and bedding. Therefore, when the horses are provided with their ration within their stalls (as was the case in this study), the behavior “occupation with bedding” is prolonged because the horses have to search for bits of hay

Table 3. Total duration, frequency, and mean duration of the behavior lying subdivided according to sternal, lateral, and total recumbency, bedding materials, and periods (n = 108)

| | n | Total duration (hrs) | | Frequency | | Mean Duration (mins) | |
|--------------------|----|----------------------|------|--------------------|------|----------------------|------|
| | | LSM | SE | LSM | SE | LSM | SE |
| Sternal recumbency | | | | | | | |
| Straw pellets | | | | | | | |
| Period 1 | 18 | 2.61 ^a | 0.12 | 13.44 ^a | 0.68 | 12.75 ^a | 0.92 |
| Period 2 | 18 | 2.83 ^a | 0.12 | 14.06 ^a | 0.68 | 13.65 ^a | 0.92 |
| Straw | | | | | | | |
| Period 1 | 18 | 3.08 ^a | 0.12 | 13.83 ^a | 0.68 | 14.94 ^a | 0.92 |
| Period 2 | 18 | 3.06 ^a | 0.12 | 13.11 ^a | 0.68 | 16.79 ^a | 0.92 |
| Shavings | | | | | | | |
| Period 1 | 18 | 2.91 ^a | 0.12 | 13.50 ^a | 0.68 | 14.76 ^a | 0.92 |
| Period 2 | 18 | 3.14 ^a | 0.12 | 12.39 ^a | 0.68 | 17.40 ^b | 0.92 |
| Lateral recumbency | | | | | | | |
| Straw pellets | | | | | | | |
| Period 1 | 18 | 1.19 ^a | 0.08 | 8.28 ^a | 0.64 | 6.14 ^a | 0.52 |
| Period 2 | 18 | 1.05 ^a | 0.08 | 9.17 ^a | 0.64 | 4.74 ^a | 0.52 |
| Straw | | | | | | | |
| Period 1 | 18 | 1.26 ^a | 0.08 | 9.17 ^a | 0.64 | 5.99 ^a | 0.52 |
| Period 2 | 18 | 0.99 ^a | 0.08 | 7.89 ^a | 0.64 | 4.55 ^a | 0.52 |
| Shavings | | | | | | | |
| Period 1 | 18 | 1.19 ^a | 0.08 | 8.44 ^a | 0.64 | 5.98 ^a | 0.52 |
| Period 2 | 18 | 0.89 ^a | 0.08 | 7.89 ^a | 0.64 | 5.35 ^a | 0.52 |
| Total recumbency | | | | | | | |
| Straw pellets | | | | | | | |
| Period 1 | 18 | 3.80 ^a | 0.13 | 21.72 ^a | 1.29 | 11.61 ^a | 0.88 |
| Period 2 | 18 | 3.88 ^a | 0.13 | 23.22 ^a | 1.29 | 11.62 ^a | 0.88 |
| Straw | | | | | | | |
| Period 1 | 18 | 4.34 ^a | 0.13 | 23.00 ^a | 1.29 | 12.89 ^a | 0.88 |
| Period 2 | 18 | 4.06 ^a | 0.13 | 21.00 ^a | 1.29 | 14.27 ^a | 0.88 |
| Shavings | | | | | | | |
| Period 1 | 18 | 4.10 ^a | 0.13 | 21.94 ^a | 1.29 | 12.90 ^a | 0.88 |
| Period 2 | 18 | 4.03 ^a | 0.13 | 20.28 ^a | 1.29 | 14.31 ^a | 0.88 |

n, number of values; LSM, least squares means; SE, standard error.

^{a,b}Least squares means within behavior and material with unlike superscripts are significantly different ($P < .05$).

within the bedding. In contrast, only minor differences in occupation would be expected if the horse's roughage ration was fed *ad libitum*.

Among the foals, the time spent being occupied with bedding did not differ as much between the materials as compared with the adult horses (apart from D2). They probably spent more time exploring their environment in general than the adult horses because of their natural curiosity at that age.

When horses are occupied with bedding, they have their head facing downward. This position is the physiologic posture for more than half of the day in the wild² and for that reason is considered to be positive for horse welfare.

The differences between periods 1 and 2 in mean duration per lying down episode reported only tendencies,

and therefore did not allow a clear interpretation. We hypothesized that the total time spent lying would be shorter in period 1 than in period 2 because horses need to get used to a changed environment—in this case bedding material—before they perform normal lying behavior.^{19,20} However, we did not obtain this expected result. No significant difference or tendency in total recumbency between periods 1 and 2 was reported. However, when the mean duration of recumbency was divided into sternal and lateral recumbency, some differences between period 1 and 2 could be registered (Table 3). To explain this observation further investigations are necessary because the differences are still not quite clear. Pedersen et al⁸ observed that horses kept on straw bedding spent three times more time in lateral recumbency than those kept on wood shavings. Our

studies could not confirm these results because no differences in time spent in a lateral recumbent position were detected between the straw bedding and the other materials.

In conclusion, the results of this study show that bedding material does influence horse behavior in occupation with bedding, standing, and lying. On the basis of the longest time spent occupied, straw seems to support the welfare of the horse better than wood shavings or straw pellets. Because of the highly significant influence of each horse, further investigations with a larger and more heterogeneous horse group are necessary to verify the observed reactions. Because providing roughage *ad libitum* to horses housed in single stalls is not always possible, it is advised—with regard to the behavior of the horse—to place the rationed diet *inside* the stall, thereby enabling an extension of their time spent occupied.

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