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Horse behaviour: Comparative study of different bedding materials

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Abstract This research was conducted to compare various types of bedding commonly used for sport horses housed in stables in Italy. The main objective of this study was to evaluate how different bedding materials affect the well-being of horses, as these animals spend a significant amount of time in their stalls. A lack of soft material covering the stall floor can lead to serious injuries, respiratory issues, and behavioural problems in horses. During the trial, the four types of bedding were tested with six subjects, all of whom were kept under similar conditions. The materials, which are easily found in Italy and commonly used in stables, were examined over two weeks each: dedusted wood chips, sawmill shavings, straw pellets, and coconut fibres. To evaluate the effectiveness of these materials, we assessed their impact on behavioural aspects. The horses were monitored with infrared cameras, and their actions were categorized into seven different categories . Statistical analysis were performed using ANOVA and post hoc Bonferroni correction to assess differences in the duration of actions performed by horses across different types of bedding. The analysis revealed that straw pellets were the most used bedding material among the six subjects, particularly for the sternal decubitus (SR) and lateral decubitus (LR) positions, both in terms of duration and frequency of use. In conclusion, straw pellets are the most used material, followed by coconut fibres. Further research is needed to evaluate the chemical aspects of each bedding material and analyse how each material reacts chemically during use in stalls.

Keywords: equine, substrate, responses

1. Introduction

The most common housing system for horses is single stalls , and the widespread use may be explained by tradition, safety, space savings, the use of old buildings, and cost considerations . Box housing allows for comfort when resting and prevents fighting between horses and the resulting injuries (Jovanović et al., 2024). Equine management systems often involve horses being housed inside for most of the day throughout their lives (Mönki et al., 2021), and, according to many authors, the negative aspects of single box housing are the absence of movement and exercise, lack of social relationships, and unnatural feeding behaviour (Jovanović et al., 2024). The use of bedding in the stable is a traditional practice that has recently received more attention due to its reported positive and negative effects on horses . In general, environmental enrichment aims to improve the biological functioning of an animal by adjusting the artificial environment (Greening et al., 2013). The type and quality of bedding significantly influence the health and welfare of horses, including those that are kept in stables for a short period during the day (Kwiatkowska-Stenzel et al., 2017). In fact, bedding material serves consistent ethological and practical. functions. According to Werhahn et al. (2010), Garlipp et al., (2011), and Kwiatkowska-Stenzel et al. (2016), the choice of bedding material has an impact on two important factors: (i) the behaviour of horses and (ii) the quality of the air (Prišenk et al., 2017). Bedding materials serve several purposes, including the absorption of excrement, protection from mechanical insult, cushioning of the horse's legs against concussion, improvement of skid and slip resistance (Werhahn et al., 2010), prevention of the development of abnormal behaviours, thermal insulation , and prevention of drafts; in fact, bedding material reduces heat loss through the floor and by horses through thermal conduction (Kwiatkowska-Stenzel & Sowinska, 2016, Whisher et al., 2011). It is also a source of occupation for horses during their long hours of standing in stalls: the horses that nose, shift, and eat bedding spend less time inter alia standing still (Greening & McBride, 2022, Baumgartner et al, 2019). A lack of bedding on concrete flooring can cause slipping and discomfort, especially for horses with musculoskeletal problems such as laminitis (Smith et al., 2017). In addition, horses may roll in stable boxes, especially after exercise, and bedding materials cushion them to prevent injury. Common plant-based bedding materials used in horse stalls include wood residues, hulls, and straw. The selection of bedding materials for horses mainly depends on their availability and price, absorptive capacity, ease of clean up and disposal, fertility values, and biodegradability. However, horse managers should also consider equine welfare as an important factor when picking bedding material (Pedersen et al., 2004).

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1.1. Hoof health related with bedding choice

The hooves bear the entire weight of the horse, and thus, even minor problems have a lasting effect on performance: the adage “no hoof, no horse” remains relevant. The equine foot is a complex biological structure of functional significance to the integrity and well-being of the horse (Fürst & Lischer, 2021). Therefore, it is necessary to determine the prevalence of hoof abnormalities and to emphasize the importance of maintaining hoof health to ensure equine soundness and overall welfare (Thirkell, 2017). Some hoof disorders may be caused by a single incident (e.g., a nail in the sole of the hoof), but most cases are considered multifactorial and, ultimately, of management origin (Holzhauer et al., 2017). The physical properties of bedding materials, such as absorbency and retention of urine, and manure, are crucial for maintaining a dry and hygienic environment for horses (Zailani et al., 2024). As expected , bedding that is not consistently dry is associated with a higher risk of thrush than consistently dry bedding. The most prevalent hoof diseases are thrush, superficial hoof wall cracks, growth rings, sole bruises, white line diseases, perforating hoof wall cracks, and widening of the white line (Holzhauer et al., 2017).

1.2. Sleep environment and equine stereotypic behaviors

The characteristics of the sleep surface in the stable have also been shown to influence sleep-related behaviour (Garlipp et al., 2011). Hunter and Houpt (1989) reported that horses kept in stalls with bedding rest in a recumbent position, and when there is no bedding, the animals do not lie down at all or reluctantly do it (Kwiatkowska-Stenzel & Sowinska, 2016). Moreover, some bedding substrates are associated with higher proportions of recumbency as part of the nocturnal time budget than others are (Garlipp et al., 2011), even if excessive bedding may cause discomfort due to a lack of a firm base (Guay et al., 2019). The depth of the bedding substrate within the stable layer also has a significant effect on nocturnal behaviour. The central premise in the relationship between sleep and welfare is that sleep deprivation has the potential to diminish animal welfare (Garlipp et al., 2011). Thus, horses living under inappropriate environmental conditions were observed to have a decreased duration of rest (including sleep). In such situations, a lack of rest/sleep favours the expression of stereotypic behaviors (Lesimple, 2020). Stereotypies are characterized by regular, periodic, and predictable behaviours, repeated in the same manner, such as oral stereotypies (Arena et al., 2021). Equine behaviour scientists define 28 simple forms of compulsive behaviours or abnormal repetitive behaviours (ARB) in horses, which are categorized into 4 groups: abnormal oral activities in horses, abnormal ingestion in horses, abnormal actions in stable horses and abnormal reactions in horses (Kádár et al., 2023). The most common stereotypies are crib biting and windsucking. Crib biting is an oral stereotypy in which the animal grasps a surface at the height of the chest with the incisors, pulling back and arching the neck , accompanied by air being sucked into the proximal oesophagus (Roberts et al., 2017). The air may be expelled or, when food is eaten while the air is still in the oesophagus, pushed into the stomach (Zailani et al., 2024). Weaving is a type of locomotor stereotypy, defined as the repetitive weight shift from one forelimb to the other, often combined with lateral swaying of the head (Roberts et al., 2017).

Stereotypies may function to cope with elevated levels of frustration (Freymond et al., 2015) since Briefer et al. (2017) showed that engaging in stereotypic behaviour can function as a coping strategy to prevent stress (Freymond et al., 2020). Horse owners and veterinarians are often concerned that stereotypic behaviours may reduce performance, decreas monetary value of the animal, and the develop secondary pathologies, such as gastric ulcers and colic syndrome (Cunha et al., 2023).

The purpose of this study was to investigate how different types of commonly used equine bedding materials affect the well-being of stabled sport horses in Italy. Specifically, this research aimed to assess the behavioural responses of horses to four different bedding types, with a focus on identifying which material offers the most comfort and welfare benefits during prolonged stall confinement.

2. Materials and Methods

2.1. Location of the study

The trial was conducted at the equestrian center "La Valle Equitazione", which is located in Serpiolle, within the municipality of Florence. The stalls where the horses were housed, each 3 × 3 m in size, are located inside a stable with a central aisle (Figure 1) oriented east–west. The walls are constructed of wood, while the flooring is made of concrete flooring. The roof consists of a sandwich board that is 2.70 m high at the ridge and 2.20 m high in eaves. The solid wooden partitions between adjacent stalls were approximately 1.5 m high, with the upper 0.7 m being made of steel grill to allow ventilation and visual contact.

The boxes were identical and in the same condition. The air exchange was ensured by a space of 10 cm between the end of the back wall and the roof and by the stall door, which had a lattice and hinged window. The horses were provided with hay through a window overlooking the aisle, and each stall was equipped with a feeder for concentrates and an automatic drinking trough. The stalls were cleaned twice a day by the stableman : in the morning at approximately 10:00 in a more thorough way and in the afternoon at approximately 3 pm. Each day, the six subjects were taken outside for several hours, varying according to the weather conditions. On rainy days, the time they spent outside significantly decreased.

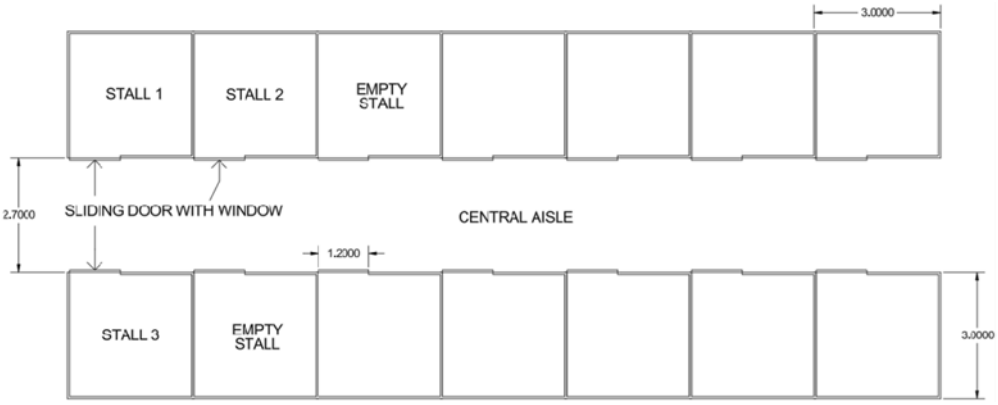

Figure 1 Layout of the stable where the experiment took place.

To avoid confounding variables, adjacent stalls were left unoccupied throughout the study.

2.2. Animals

For this study, we selected six geldings: three Italian-breed horses, aged 9, 7, and 13 years (housed in stalls number 1, 5, and 6, respectively), and three Maremma horses, aged 6, 18, and 10 years (housed in stalls number 2, 3, and 4, respectively). All were similar in size, measuring approximately 175 cm at the withers.

2.3. Bedding materials and feed

The bedding materials were sourced from reliable local suppliers:

• Dedusted wood chips were purchased pre-packaged in compressed 20 kg bags. They were obtained from a commercial supplier in Italy and consisted of softwood material subjected to a dedusting process to reduce airborne particles. The product is specifically intended for use as equine bedding.

• Wood waste chips were acquired fresh from a local sawmill and stored in polypropylene 'Big Bags' (200 kg each) in a dry, ventilated storage area to prevent moisture accumulation.

• Straw pellets were also obtained from the sawmill and were stored similarly in 500 kg 'Big Bags'.

• Coconut fibre was bought in compressed 26 kg packages and stored indoors in a dry environment. The material was sourced from an Italian distributor and derived from mechanically shredded and compressed coconut husks. It is marketed for use as horse bedding and is characterized by high absorbency, low dust production, and good storage stability under dry conditions.

For feeding, the horses were given high-quality grass hay sourced locally and stored in a clean, dry barn loft to preserve its nutritional value. Each horse received 8 kg of high-quality grass hay daily, which was divided into three meals (morning, midday, and evening) supplemented with 1.5 kg of corn flakes . Water was provided ad libitum throughout the trial. The feeding methods and quantities remained consistent during all bedding trials.

2.4. Experimental design

The study was split into four experimental periods, each of which lasted two weeks. At the beginning of each series, the horse stalls used as study subjects were emptied and filled with new bedding material. Every three days, bedding was topped up as needed for a total of three additions. In the first two weeks, dedusted bedding was used. Throughout the second two weeks, wood waste chips, which were obtained from a local sawmill, were used. During the fifth and sixth weeks, straw pellets were tested, and in the last two (weeks seven and eight), coconut fibres were tested (Table 1).

Table 1 Summary table of bedding used per type.

type of bedding	size	starting ammount (kg)	kg added every three days	total weight used (kg)
de-dusted brand chips	60	60	20	120
wood waste chips	66	66	66	264
straw pellets	130	130	22	226
coconut fibre	68	78	32	117

Before the trial began, infrared cameras were installed to record the behaviour of each horse continuously throughout each period as the type of bedding was changed. At the conclusion of the study, we reviewed the recordings for every day of the trial. From the video footage captured by the digital infrared video system, we were able to collect data on the general behaviour of each horse, which varied between individuals. This allowed us to evaluate the horses' preferences for each beddin

type on the basis of changes in the frequency and duration of their activities. In the first week, the subjects had time to become accustomed to the new material, while the second week was essential for assessing the rating of each bedding by the horses examined. The actions observed over the 24 hours were categorized into seven subgroups (Table 2):

- Feeding time of the horse.
- Time spent in the window.
- Hours during which the animal was removed from the stall.
- Time spent exploring the bedding.
- Time spent in a sternal recumbency position (denoted as "SR").
- Time spent resting moments in a lateral recumbency position (noted as "LR").
- Time spent standing.

These seven defined categories result from subdividing the actions performed by the horses throughout the day.

Table 2 Description of the seven subgroups created.

OBSERVATION SUBGROUPS						
"FEED" feeding time of the horse	"WINDOW" time spent at the window	"LEAVING" hours the horse left the stall	"BEDDING" time spent exploring the bedding	"SR" resting periods in sternal recumbency	"LR" resting periods in lateral recumbency	"STANDING" time spent standing

2.5. Measustment techniques

Three infrared cameras, designed by Arm Electronics in Cambridge, UK, were used for video recording, each connected to a 2TB video recorder, capturing 24-hour videos for all six subjects seven days a week (Figure 2).

Figure 2 a: Infrared camera. b: Monitor and video recorder.

2.6. Statistical analysis

The statistical evaluation of the data obtained from the video footage of the cameras was performed via the Microsoft Excel program. Analysis of variance (ANOVA) is a series of statistical tests that determine whether the means of at least two data groups are different. This analysis was performed using the calculation functions available in the program, with a significance level of P = 0.05. The Bonferroni correction was therefore applied to identify differences between groups. For this test, the significance level was set at P = 0.0125, calculated by dividing the variance analysis significance level by the number of groups (four), corresponding to the number of weeks in which the trial was conducted. This level of significance is called the adjusted P value.

3. Results

For each horse, graphs summarizing the average behaviour in terms of minutes and frequencies over the four weeks of observation (eight weeks in total, with 4 observations, one for each bedding), were created. These graphs allow us to assess the habits of individual animals, regardless of the type of bedding material used. The different behaviours of each horse can influence the test results, so it is important to analyse these differences carefully (Figure 3).

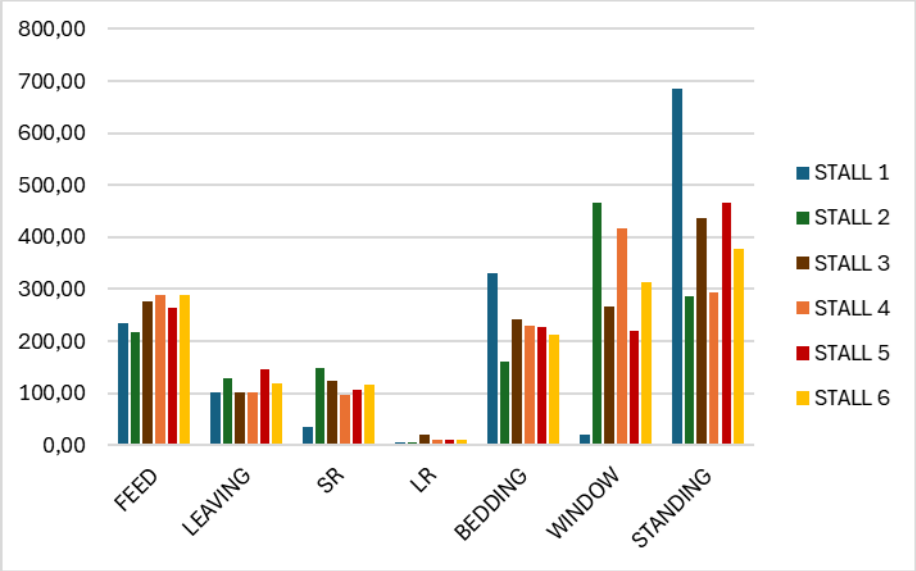

Figure 3 Average behaviour of each horse recorded in minutes.

The graph illustrates the time spent by six horses in various behaviours. Notably, the first horse shows a strong interest in exploring the bedding but tends to spend less time in two positions of lying down (decubitus). This horse was not frequently observed at the window. As reported in a study by Lesimple et al. (2019), allowing some horses to put their heads out has been associated with increased indicators of stress and compromised welfare. This horse became very agitated when given the chance to look out of the window, which is why the window remained closed for nearly the entire duration of the experiment. The second horse spends more time at the window but investigates the bedding less, and primarily adopts a sternal decubitus position. The third horse is distinguished by its tendency to lie primarily in the lateral decubitus position. The fourth horse spends considerable time at the window and prefers sternal decubitus. The fifth and sixth horses do not exhibit any notable differences from one another (Figure 4).

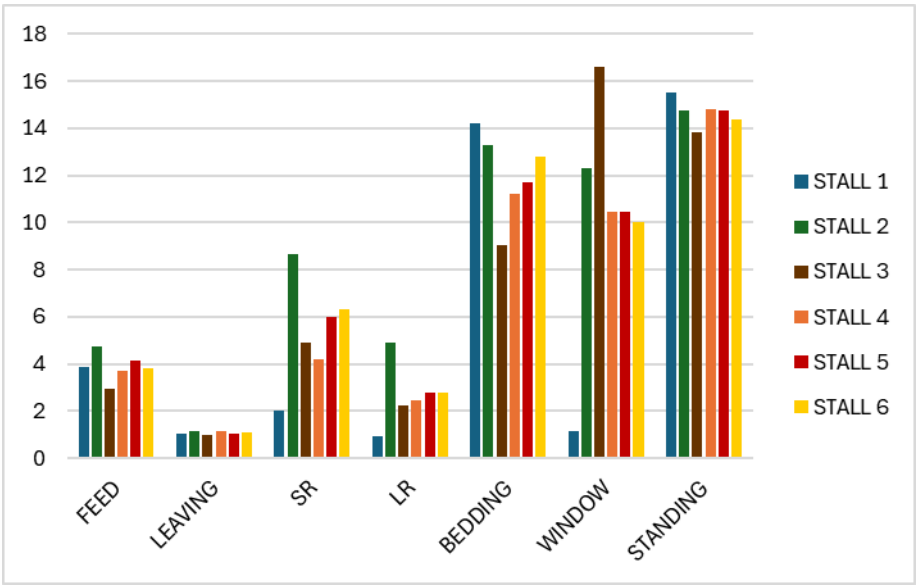

Figure 4 Average frequency of behaviour of each horse.

The following section describes the frequency trends of the six horses. With respect to their positions when lying down, specifically in the decubitus sternal and lateral positions, horse 2 is the most likely to assume these positions, whereas horses 5 and 6 follow closely behind. In contrast, horse number 1 rarely takes either position. As illustrated in the previous graph, horse number 1 investigates the bedding most frequently, whereas horse 3 does so the least. Additionally, horse 3 stands out because this horse faces the window more often than the others .

3.1. Statistical analysis: percentage minutes

3.1.1. P value

After the average behaviour of each subject , graphs showing the percentage of time (in minutes) spent by the six horses in different activities, categorized by type of bedding, were generated. Analysis of variance (ANOVA) (P value analysis) was performed on these data with significance assessed using P values. Significance testing using P value (level of significance), allows us to determine which activities, in terms of duration, were influenced by the type of bedding. Categories with $P < 0.05$ were considered significantly affected by the change in material and are marked with the letter "S" in the legend. Categories with $P > 0.05$ were considered not significant and are marked with the abbreviation "N.S." .

The categories of lateral recumbency “LR” and sternal recumbency “SR” are important for this subject (Figure 5).

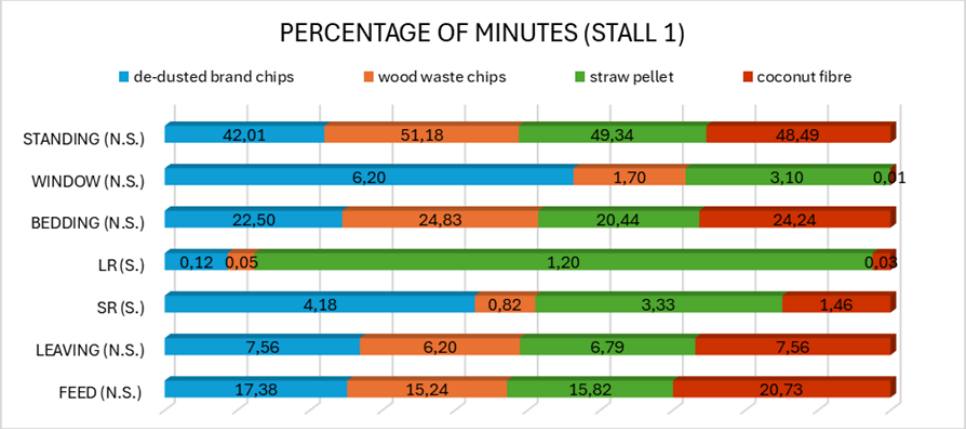

Figure 5 Percentage of actions performed by horse 1 in minutes.

For the second element, the P value is less than 0.05 for the category of sternal recumbency "SR" (Figure 6).

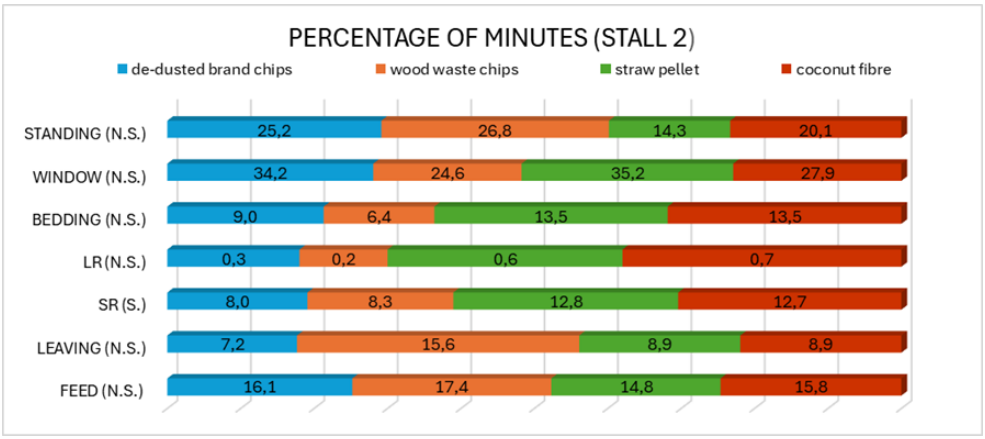

Figure 6 Percentage of actions performed by horse 2 in minutes.

This subject showed a significant effectonly for the "BEDDING" category, regarding the time spent investigating the material (Figure 7).

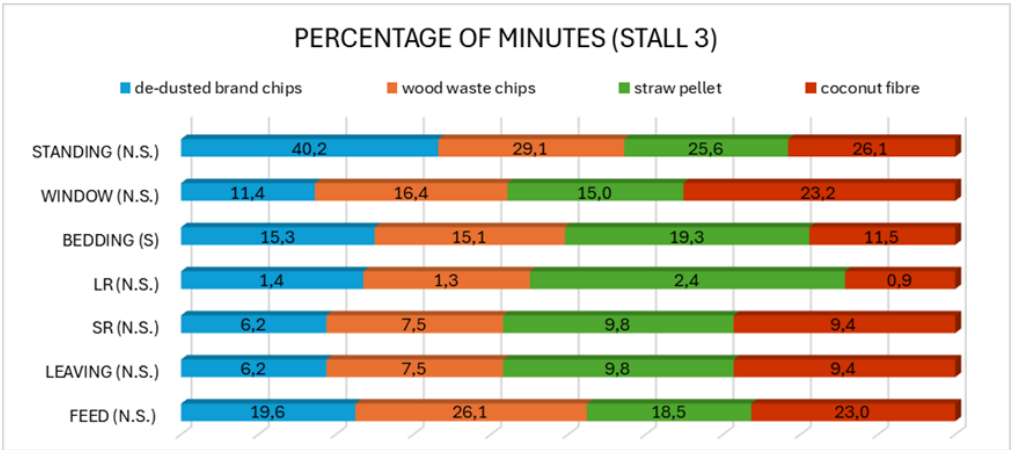

Figure 7 Percentage of actions performed by horse 3 in minutes.

The category sternal recumbency “SR” is important for the fourth subject (Figure 8).

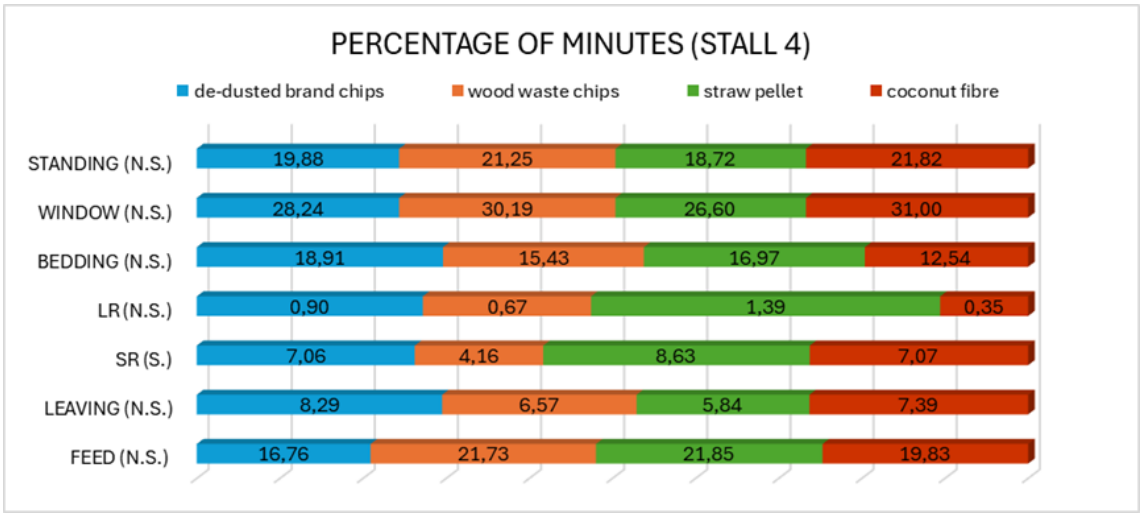

Figure 8 Percentage of actions performed by horse 4 in minutes.

For the fifth element, the P value is less than 0.05 for the categories “SR” and “BEDDING” (Figure 9).

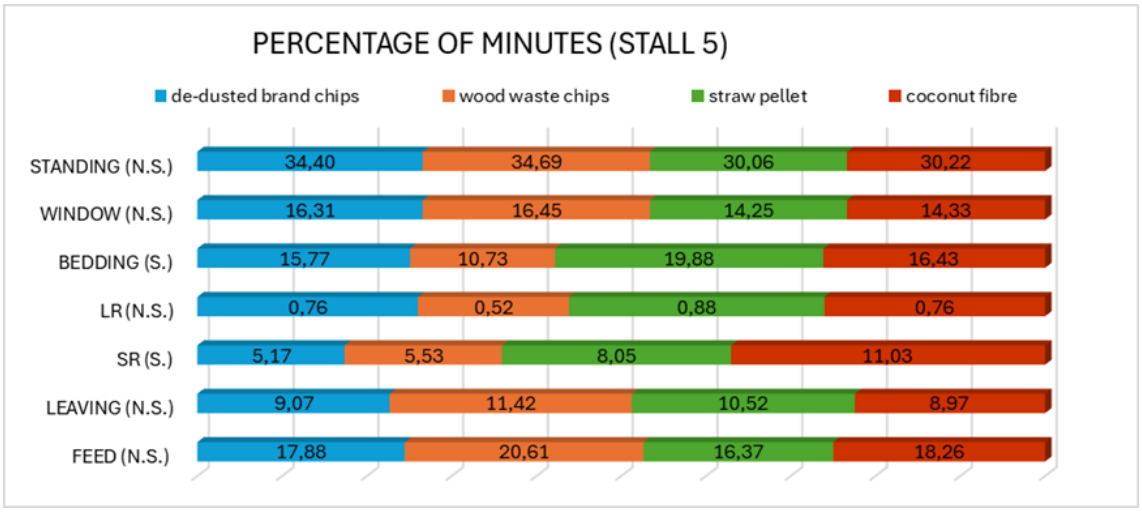

Figure 9 Percentage of actions performed by horse 5 in minutes.

The last subject shows a significant P value for the categories “SR” and "BEDDING" (Figure 10).

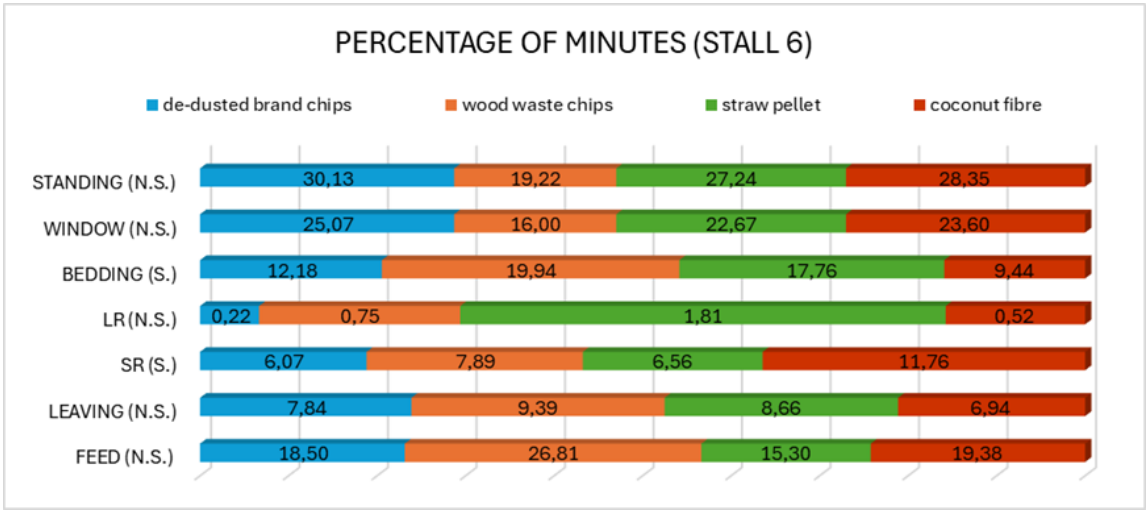

Figure 10 Percentage of actions performed by horse 6 in minutes.

3.1.2. Adjusted p-value

For each horse, it is essential to identify the categories influenced by the type of bedding. To further analyse this relationship, we conducted a Bonferroni correction with an adjusted P value of 0.0125. This allows us to compare pairs of the four materials studied and determine which materials the subjects prefer.

To further analyse this relationship, we conducted a Bonferroni correction(adjusted P value = 0.0125) to compare pairs of the four bedding materials and determine the subjects preferences.

Table 3 presents values that are either above or below the significance level. Values above the significance level indicate no statistically significant difference between the two bedding types, meaning that the subjects show no preference . In contrast, values below the significance level suggest a preference for one bedding material over another, with lower values indicating a stronger preference. In particular, in the category "SR" (sternal decubitus), the horse in stall 1 showed a preference for the first bedding material (de-dusted brand chips) over the second (wood waste chips) and the fourth (coconut fibre). Compared with the other horses, the horses in stall 4 preferred the third bedding (straw pellets). The horse in stall 5 favoured the fourth material, coconut fibre, which was also the preference of the horse in stall 6. Horses in stalls 2 and 4 did not express a preference in this category. In terms of "LR" (lateral decubitus), the horses in stall 1 preferred the third bedding over the others. Similarly, the horses in stall 2 also showed a preference for the third bedding, followed closely by the fourth one. The horses in the remaining four stalls did not demonstrate a preference in this category. Finally, in relation to the category "BEDDING," the horses in stall 1 preferred the third bedding, followed by the fourth bedding. This preference was also observed in stalls 3 and 5. In stable 6, the preferred bedding was the second-highest, followed by the third highest. Horses in stables 2 and 4 did not show a preference in this category.

Table 3 Results of the Bonferroni correction relating to minutes.

MINUTES						
STALL 1	BEDD. 1-2	BEDD. 1-3	BEDD. 1-4	BEDD .2-3	BEDD.2-4	BEDD. 3-4
SR	0,0047	> 0,0125	0,0063	0,0084	> 0,0125	0,0120
LR	> 0,0125	0,0005	> 0,0125	0,0004	> 0,0125	0,0005
STALL 2	BEDD. 1-2	BEDD. 1-3	BEDD. 1-4	BEDD .2-3	BEDD.2-4	BEDD. 3-4
LR	> 0,0125	0,0061	0,0101	0,0046	0,0064	> 0,0125
STALL 3	BEDD. 1-2	BEDD. 1-3	BEDD. 1-4	BEDD .2-3	BEDD.2-4	BEDD. 3-4
BEDDING	> 0,0125	0,0037	0,0042	0,0033	0,0049	0,0010
STALL 4	BEDD. 1-2	BEDD. 1-3	BEDD. 1-4	BEDD .2-3	BEDD.2-4	BEDD. 3-4
SR	0,0057	> 0,0125	0,0013	0,0026	0,005	0,0009
STALL 5	BEDD. 1-2	BEDD. 1-3	BEDD. 1-4	BEDD .2-3	BEDD.2-4	BEDD. 3-4
BEDDING	0,0020	0,0029	> 0,0125	0,0007	0,0018	0,005
SR	> 0,0125	0,0058	0,0018	0,0073	0,002	0,0085
STALL 6	BEDD. 1-2	BEDD. 1-3	BEDD. 1-4	BEDD .2-3	BEDD.2-4	BEDD. 3-4
BEDDING	0,0010	0,0017	0,008	> 0,0125	0,0005	0,0008
SR	> 0,0125	> 0,0125	0,0021	> 0,0125	0,0048	0,0025

3.2. Statistic analysis of frequencies

The same graphs, obtained for the percentage distribution of minutes spent indifferent activities by the six horses, were also generated for the frequency percentages , representing the number of times each horse engaged time in one of the seven categories.

3.2.1. P value

The horses in the first stall showed statistically significant frequencies, with a P value < 0.05, in the categories of sternal recumbency "SR" and lateral recumbency "LR" (Figure 11).

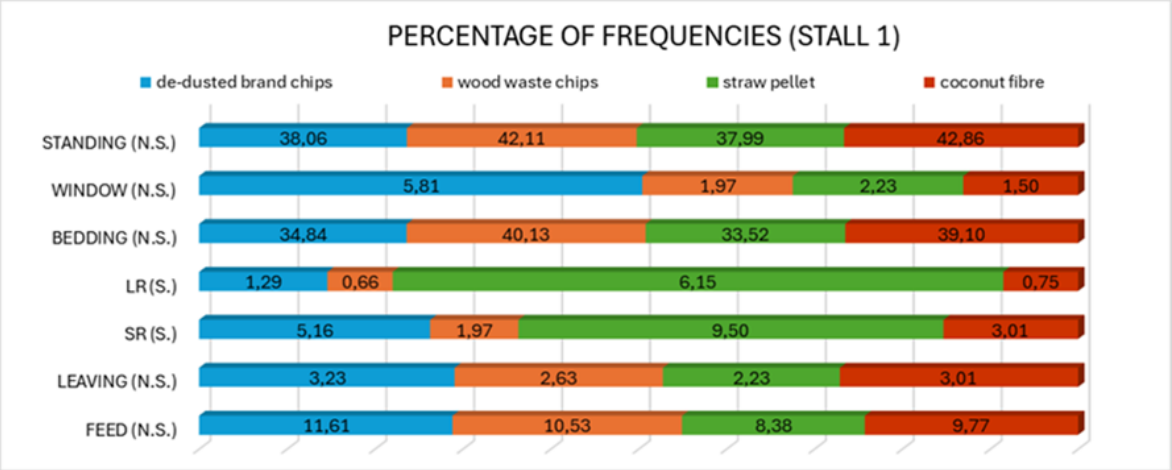

Figure 11 Frequencies of actions performed by horse 1.

For the second subject, statistically significant frequencies were also observed for "SR" and "LR" categories (Figure 12).

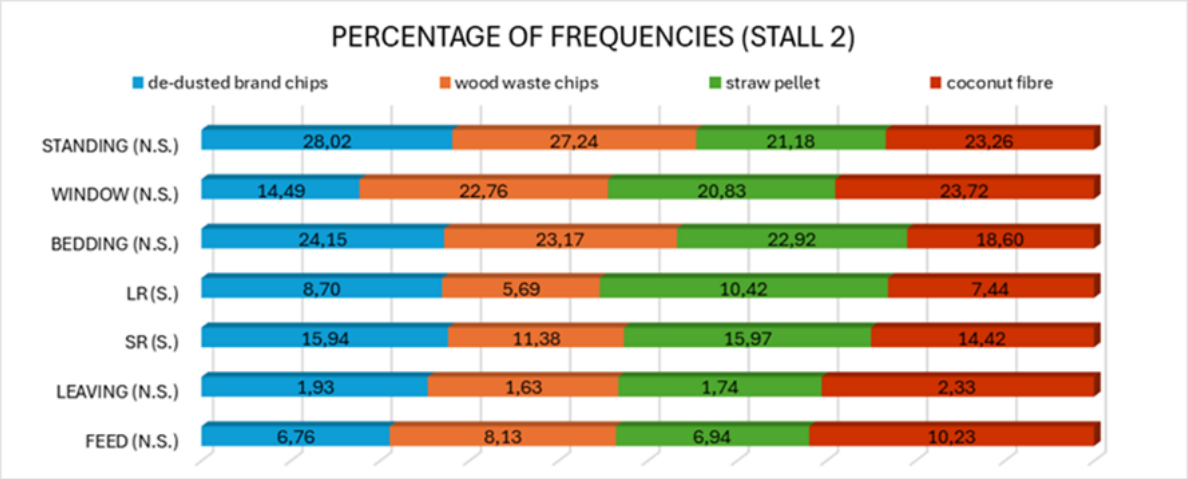

Figure 12 Frequencies of actions performed by horse 2.

This subject showed a significant P value for “BEDDING”, “LR”, and “SR” categories (Figure 13).

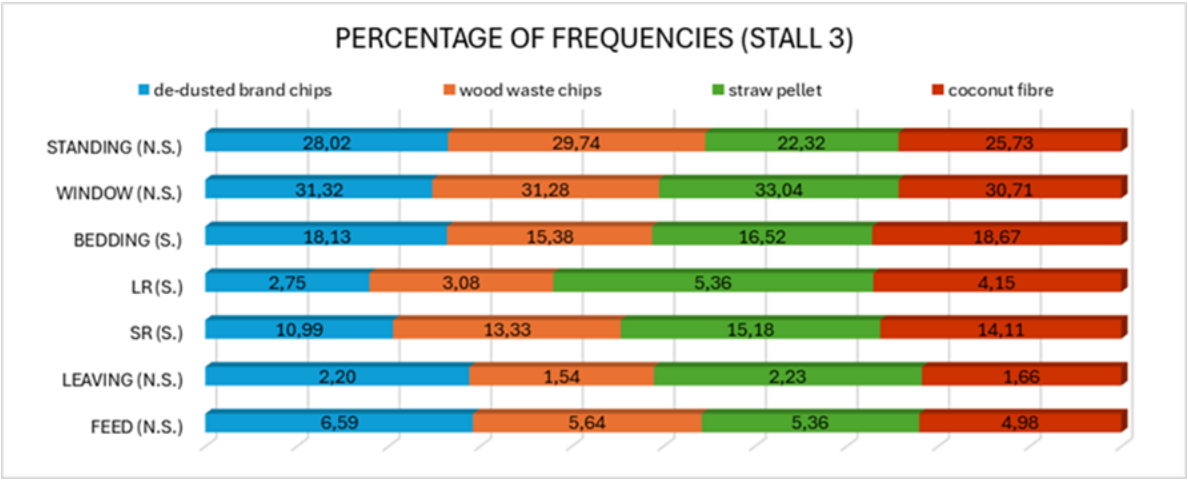

Figure 13 Frequencies of actions performed by horse 3.

The categories “LR” and “SR” are important for the fourth subject (Figure 14).

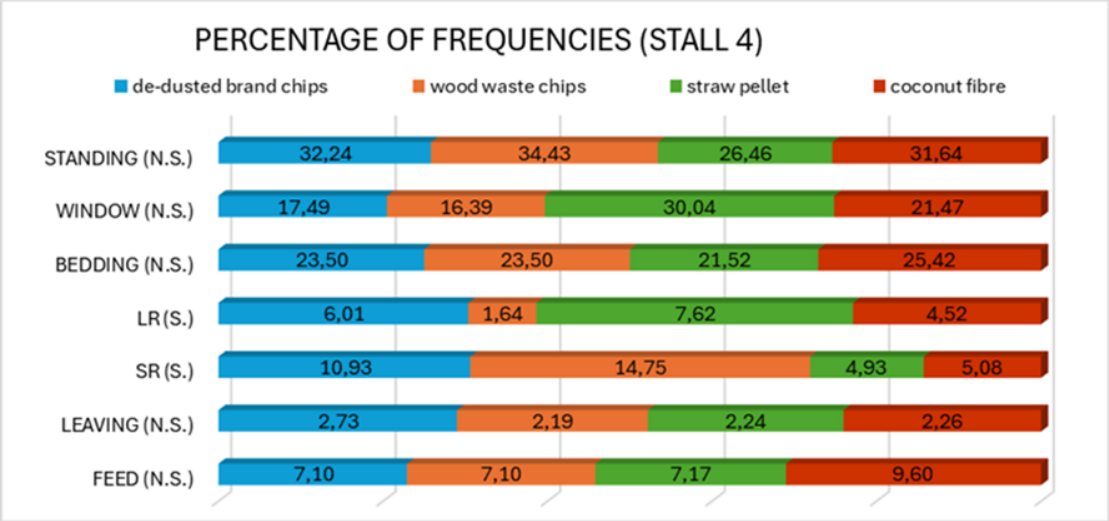

Figure 14 Frequencies of actions performed by horse 4.

Even this subject shows a significant P value for the categories “BEDDING” and “LR” (Figure 15).

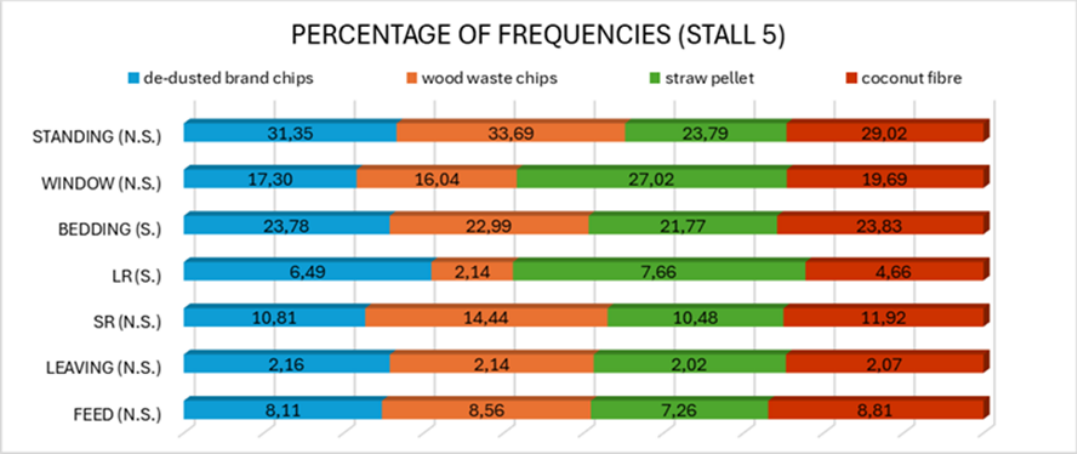

Figure 15 Frequencies of actions performed by horse 5.

The last subject, like the third and fifth ones, showeda significant P value for "BEDDING", “LR” and “SR” categories (Figure 16).

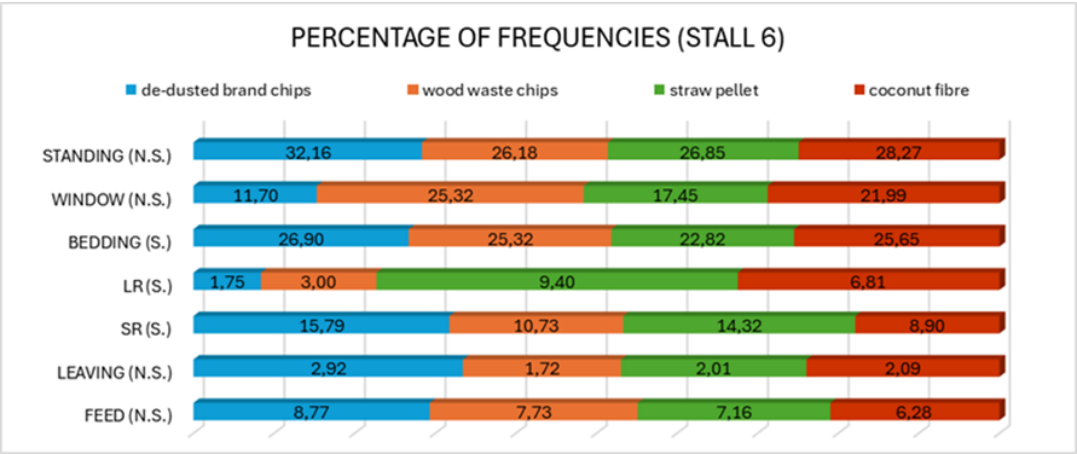

Figure 16 Frequencies of actions performed by horse 5.

3.2.2. Adjusted p-value

The Bonferroni correction was conducted for frequencies, using an adjusted P valueof 0.0125, based on the results of variance analysis (Table 4).

Table 4 Results of the Bonferroni correction relating to the frequencies.

FREQUENCIES						
STALL 1	BEDD. 1-2	BEDD. 1-3	BEDD. 1-4	BEDD .2-3	BEDD.2-4	BEDD. 3-4
SR	> 0,0125	> 0,0125	> 0,0125	0,0077	> 0,0125	0,0116
LR	> 0,0125	0,0050	> 0,0125	0,0049	> 0,0125	0,0049
STALL 2	BEDD. 1-2	BEDD. 1-3	BEDD. 1-4	BEDD .2-3	BEDD.2-4	BEDD. 3-4
SR	> 0,0125	0,0090	> 0,0125	0,0061	> 0,0125	0,0068
LR	> 0,0125	0,0101	> 0,0125	0,0077	> 0,0125	0,0101
STALL 3	BEDD. 1-2	BEDD. 1-3	BEDD. 1-4	BEDD .2-3	BEDD.2-4	BEDD. 3-4
SR	> 0,0125	0,0077	0,0101	> 0,0125	> 0,0125	> 0,0125
BEDDING	> 0,0125	> 0,0125	0,0101	> 0,0125	0,0068	> 0,0125
STALL 4	BEDD. 1-2	BEDD. 1-3	BEDD. 1-4	BEDD .2-3	BEDD.2-4	BEDD. 3-4
SR	> 0,0125	> 0,0125	0,0116	0,0077	0,0061	> 0,0125
LR	> 0,0125	> 0,0125	> 0,0125	0,0101	> 0,0125	> 0,0125
STALL 5	BEDD. 1-2	BEDD. 1-3	BEDD. 1-4	BEDD .2-3	BEDD.2-4	BEDD. 3-4
LR	> 0,0125	> 0,0125	> 0,0125	0,0088	> 0,0125	> 0,0125
BEDDING	> 0,0125	> 0,0125	> 0,0125	0,0116	> 0,0125	> 0,0125
STALL 6	BEDD. 1-2	BEDD. 1-3	BEDD. 1-4	BEDD .2-3	BEDD.2-4	BEDD. 3-4
SR	> 0,0125	> 0,0125	> 0,0125	> 0,0125	> 0,0125	0,0068
LR	> 0,0125	0,0061	> 0,0125	0,0077	> 0,0125	> 0,0125
BEDDING	0,0088	> 0,0125	> 0,0125	> 0,0125	> 0,0125	> 0,0125

The table of adjusted P values for frequencies shows both significant and non-significant values. P value greater than 0.0125 indicates no significant difference, whereas values below 0.0125 suggest a preference for one bedding type over another. Upon detailed analysis, we can evaluate the frequency of different beddings for the category "SR" (sternal decubitus) as follows:

- In stall 1, the third bedding was more common than the second and fourth types.
- In stall 2, the third bedding type presented the highest frequency of all bedding types.
- In stall 3, the third bedding predominates over the fourth and first .
- In stall 4, the second bedding is the most common, followed by the first.
- In stall 6, the third bedding is more common than the fourth.

Notably, the horses in stall 5 did not show any predominant frequencies for this category.
Next, examining the "LR" (lateral decubitus) category, we observe the following:

- In stalls 1 and 2, the third bedding had a greater frequency than did the other three beddings.
- In stalls 4 and 5, the third bedding prevails over the second.
- In stall 6, the third bedding is more common than the second and the first types.

However, the horse in stall 3 exhibited no particular differences in frequency for "LR."
Finally, significant differences in frequencies are noted in the "BEDDING" category:

- In stall 4, the fourth bedding is more common than the first and second bedding.
- In stall 5, the third bedding is more common than the second.
- In stall 6, the second beddingis more common than the first.

Horses in stalls 1, 2, and 3 showed no preference in this category.

4. Discussion

Each horse exhibits unique behavioural characteristics, reflected in its daily activities in both quantity and frequency. This variability significantly influenced the study, revealing different responses for each horse; consequently, bedding selection is often based on subjective preference, without fully assessing both short-term and long-term effects of bedding materials (Pedersen et al., 2004). However, the results of this study demonstrated that bedding type significantly affected three of the seven behavioural categories analyzed. To organize the collected data, two summary tables were created: one for duration (minutes) and the other for frequency of behaviours. These tables illustrate, when possible, the preferences of the six horses for different bedding types across behavioural categories. For each category, the preferred bedding, when identifiable, was marked with an 'X', providing a clear overview of the horses' choices.

Pelleted straw emerged as the most preferred bedding type in this study. Horses showed longer and more frequent resting behaviors on pelleted straw, and previous studies indicate that this material can positively influence respiratory

indicators, such as tracheal mucus scores and breathing rate, compared to other bedding types (Mönki et al., 2021; Bambi et al., 2018). These findings suggest that pelleted straw not only provides behavioural comfort but also supports respiratory health. Coconut fibre was also preferred by several horses and offers additional benefits. It produces very low ammonia concentrations, reducing respiratory stress (Masebo et al., 2025), and its low dust and microbial contamination levels make it favorable for maintaining respiratory health (Kwiatkowska-Stenzel et al., 2017). While not as strongly preferred as pelleted straw in this study, coconut fiber still represents a high-quality bedding option that supports both welfare and health. In contrast, traditional wood shavings were less favoured by the horses. Research has shown that this material can result in higher ammonia levels and greater dust exposure, which may negatively affect respiratory health and overall welfare (Mönki et al., 2021; Saastamoinen et al., 2015). These findings highlight that bedding choice impacts not only behavioural preferences but also physiological well-being in stabled horses. Overall, the results indicate that bedding type significantly influences both behaviour and welfare. Pelleted straw appears to provide the highest comfort and health benefits, while coconut fibre is also advantageous. Wood shavings, on the other hand, may be less suitable for promoting optimal welfare. These findings underscore the importance of considering both behavioural and health factors when selecting horse bedding (Table 5-6).

Table 5 Summary of bedding preferences in minutes.

	MINUTES	DE-DUSTED BRAND CHIPS	WOOD WASTE CHIPS	STRAW PELLTS	COCONUT FIBRE
STALL 1	SR	X			
	LR			X	
	BEDDING	no preference			
STALL 2	SR	no preference			
	LR				X
	BEDDING	no preference			
STALL 3	SR	no preference			
	LR	no preference			
	BEDDING			X	
STALL 4	SR			X	
	LR	no preference			
	BEDDING	no preference			
STALL 5	SR				X
	LR	no preference			
	BEDDING			X	
STALL 6	SR				X
	LR	no preference			
	BEDDING			X	

Table 6 Summary of bedding preferences according to frequency.

	FREQ.	DE-DUSTED BRAND CHIPS	WOOD WASTE CHIPS	STRAW PELLETS	COCONUT FIBRE
STALL 1	SR			X	
	LR			X	
	BEDDING	no preference			
STALL 2	SR			X	
	LR			X	
	BEDDING	no preference			
STALL 3	SR			X	X
	LR	no preference			
	BEDDING				X
STALL 4	SR		X		
	LR			X	
	BEDDING	no preference			
STALL 5	SR	no preference			
	LR			X	
	BEDDING			X	
STALL 6	SR			X	
	LR			X	
	BEDDING		X		

5. Conclusions

In conclusion, the most favoured bedding among the six subjects was straw pellets. Most subjects showed a preference for this bedding when the two positions of decubitus were assumed, both in terms of duration and frequency. Among the six horses that preferred investigating the bedding, all demonstrated a longer duration (in minutes) for the third type of bedding, straw pellets. The second material that showed a preference was the fourth type, which was coconut fibre.

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6. Declarations

6.1. Ethical considerations

All experimental procedures were performed in accordance with standard ethical guidelines for animal care and use.

6.2. Use of artificial intelligence (AI)

The authors declare that no generative artificial intelligence (AI) tools were used in the preparation, analysis, or writing of this manuscript.

6.3. Conflict of interest

The authors declare no conflict of interest.

6.4. Funding

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