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The effect of stable bedding materials on dust levels, microbial air contamination and equine respiratory health

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ABSTRACT

The choice of bedding material affects the quality of air in a stable and, consequently, the respiratory health of horses and humans. The risk of respiratory problems can be mitigated by improving the quality of air in the stable. The choice of bedding material is particularly important in cold climate conditions where horses are kept indoors throughout the year. This study examined the impact of three bedding materials: straw (S), peat with shavings (PS), and crushed wood pellets (CWP). The investigated factors were air contamination, including dust contamination and microbial (bacterial and fungal) contamination, and the condition of the equine respiratory tract. The condition of the respiratory tract was evaluated based on the results of arterial blood biochemistry tests and endoscopic evaluations of the upper respiratory tract. Mechanical dust contamination was lowest for PS (1.09 mg/m^3) and highest for CWP (4.07 mg/m^3). Bacterial contamination (in CFU – colony forming units) was highest for PS (5.14 $\log_{10}$ CFU/m^3) and lowest for CWP (4.81 $\log_{10}$ CFU/m^3). Fungal air contamination was lowest for CWP (4.54 $\log_{10}$ CFU/m^3) and highest for S (4.82 $\log_{10}$ CFU/m^3) and PS (4.88 $\log_{10}$ CFU/m^3). An analysis of physiological indicators revealed that all horses were clinically healthy regardless of the type of applied bedding. The type of bedding material did not exert a clear influence on arterial blood biochemistry or the results of endoscopic evaluations of the respiratory tract; however, the use of alternative for straw bedding materials improved endoscopy results.

1. Introduction

Bedding material is an indispensable item for stable maintenance. The primary function of bedding is to absorb moisture, keep the stable floor dry and produce a healthy microclimate in the stable (Airaksinen et al., 2005; Elfman et al., 2009). The bedding material is also crucial to provide comfort to the horses and allows them to manifest their natural behavior (Werhahn et al., 2010). Cushioning properties of bedding materials are very important during horses' lying, standing up and lying down (Hunter and Houpt, 1989; Raabymagle and Ladewig, 2006). Straw is the most popular bedding material in Poland (Housing Systems for Horses, Farm Standards, 2004) and in other countries in the world (Pedersen et al., 2004). The insulation layer of good quality straw encourages horses to lie down and provides them an occupation (Mills et al., 2000; Werhahn et al., 2010). Due to the specific microclimate of horse stables, straw has many defects, including low absorption of water and ammonia (Airaksinen et al., 2001; Kwiatkowska-Stenzel et al., 2014) and high dust emissions (Fleming et al., 2008). In stables with straw bedding, dust levels can be two- or even three-fold higher than in facilities with alternative bedding materials (Banhazi et al., 2002). Compared to many other bedding materials straw also revealed higher levels of endotoxin contamination (Tanner et al., 1998). Those drawbacks have prompted the search for alternative bedding materials to straw. For example, straw pellets offer an attractive alternative to straw in stables. Straw pellets produce less dust than straw and wood shavings (Fleming et al., 2008). Their production technology also reduces microbial air contamination in comparison with straw. Peat is also increasingly used in stables. This bedding material is characterised by high water absorption (Airaksinen et al., 2001), but it creates a favourable environment for the development of pathogens.

The type and quality of bedding significantly influence the health and welfare of horses, including animals that are kept in stables for a short period during the day. The bedding material may cause the increase of dust concentration. Another serious risk factors to horses' respiratory tract, associated with the use of bedding material, are bacteria and fungal spores (Tanner et al., 1998; Fleming et al., 2008). Dusty and contaminated environments increase the risk of equine respiratory diseases such as Recurrent Airways Obstruction (RAO),

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Chronic Obstructive Pulmonary Disease (COPD) and Small Airway Inflammatory Disease (SAID), and compromise the overall health status of animals (Kirschvink et al., 2002; Saastamoinen et al., 2015). For this reason, the choice of high-quality bedding material improves hygiene and microclimate conditions in stables. It can thus be hypothesized that stalls bedded with materials that minimize dust and microbial contamination contribute to the optimal parameters of respiratory function in horses. The aim of this study was to determine the influence of three bedding materials on dust levels and microbial air contamination in stables and the respiratory health of horses kept in individual boxes.

2. Material and methods

2.1. Stable

The experiment was carried out in a box stable in the north-eastern part of the Region of Warmia and Mazury in Poland (20°41′E, 53°50′N). The stable was designed to accommodate 9 horses. It featured an attic and 2 utility rooms. Total floor area (excluding the utility room) was 178.76 m^2, and cubic capacity was 575.29 m^3. Every box had an area of 10.06 m^2. Every long wall in the stable was fitted with three windows. The stable had two double-leaved doors (2.60 m × 2.66 m each), one in the central wall and one in the long wall. The stable was not equipped with a mechanical ventilation system, and the exchange of air was accomplished naturally (periodic ventilation). The experiment was conducted in autumn – winter season and was divided into three directly following stages of three weeks each, with different bedding materials use: straw (S), peat with shavings (PS), crushed wood pellets (CWP). The experimental design is presented in Table 1. During the whole experiment microclimate conditions were monitored (Table 2). Temperature (°C) and relative humidity (%) of air were recorded continuously every 30 min with the use of an LB 520 thermohygromether (LAB-EL, Poland) outside and in the stable. No significant differences in average aerial temperature and humidity were observed between experimental stages. Relative humidity of bedding materials was analysed at the beginning (fresh) and at the end (spent) of each stage. 10 samples were taken in each measurement. The analyse was conducted by the classic loss on drying method (PN ISO 6496 Standard, 1999). The dry matter content of each (fresh and spent) bedding material differed statistically (Table 2).

2.2. Animals

During the experiment, the stable was occupied by 8 horses (4 mares and 4 geldings) which participated in show jumping competitions. The animals were adult (4–13 years of age) Polish half-bred horses. They were fed crushed oats three times a day and hay twice a day in their stalls. During the whole experiment the type of forage and the way of feeding were the same. All horses grazed on pasture for 4 h every day. The animals remained in good health throughout the experiment, and their health parameters were monitored. The following parameters were evaluated at the beginning of the study and at the end of each stage: venous blood morphology (WBC – white blood cells, RBC – red blood cells, HGB – haemoglobin concentration, HCT – haematocrit level, PLT – platelet count and leucogram), body temperature (*per rectum*), pulse, respiratory rate and auscultatory findings. Blood samples were collected before the morning feeding. A total of 24 blood samples were collected in all stages of the study. Blood samples were transported to the laboratory at 6 °C. Hematological evaluations were performed with the ADVIA 2120i Siemens (Germany) haematology analyser and the appropriate reagents (PEROX and BASO – Siemens). The study was approved by the Local Ethics Committee under Resolution No. 105/2011.

2.3. Bedding materials

2.3.1. Straw (oat) – stage I (S)

Straw bedding was used in stage I of the study. Straw is the most popular type of stable bedding, and it constituted the control group in the experiment. Straw was produced locally in the farm were the investigated stable and horses were located. It was stored in a dry barn, in round bales with a diameter of 150 cm and average weight of 200 kg. Ten kilograms of straw were used per stall (approx. 1 kg/m^2). Bedding was replaced in its entirety every 4 days. Faeces and wet straw were removed from stalls twice a day, and fresh material was added.

2.3.2. Peat with shavings (Torvströ, RSProducter AB, Sweden) – stage II (PS)

Peat with shavings was used in stage II of the study. This bedding material was composed of dedusted peat mixed with fir and spruce chips. In line with the manufacturer's recommendations, every box was supplied with 3.5 cubes (35 kg per cube) of peat with shavings (11.6 kg/m^2 of floor area). Fresh material was supplemented according to need throughout the study. Faeces and wet material were removed twice a day. Peat with shavings was stored in original plastic packaging in a dry barn.

2.3.3. Crushed wood pellets (Equisoft, Agromed, Austria GmbH) – stage III (CWP)

The pellets were used in stage III of the study. This natural bedding material was obtained from wood, which was processed into pellets and crushed. Pellets were enriched with herbal extracts. In line with the manufacturer's recommendations, every box was supplied with 5 cubes (25 kg per cube) of crushed pellets (11.8 kg/m^2 of floor area). Fresh material was supplemented according to need throughout the study. Faeces and wet material were removed twice a day. Crushed wood pellets were stored in original packaging in a dry barn.

Table 1
Experimental design.

General experimental design[a]																							
S							PS							CWP									
Terms and hours of air contamination measurements[b]																							
Wk 1			Wk 2	Wk 3			Wk 1			Wk 2	Wk 3			Wk 1			Wk 2	Wk 3					
D 1	D 4	D 7	n.m.[c]	D 1	D 4	D 7	D 1	D 4	D 7	n.m.	D 1	D 4	D 7	D 1	D 4	D 7	n.m.	D 1	D 4	D 7			
5:00; 13:00; 21:00				5:00; 13:00; 21:00			5:00; 13:00; 21:00				5:00; 13:00; 21:00			5:00; 13:00; 21:00				5:00; 13:00; 21:00					
Terms of physiological indicator measurements																							
Wk 1			Wk 2	Wk 3			Wk 1			Wk 2	Wk 3			Wk 1			Wk 2	Wk 3					
n.m.			n.m.	Clinical study, blood sampling, endoscopy			n.m.			n.m.	Clinical study, blood sampling, endoscopy			n.m.			n.m.	Clinical study, blood sampling, endoscopy					

[a] S – straw; PS – peat with shavings; CWP – crushed wood pellets.
[b] Wk – week; D – day.
[c] n.m. – no measurements (stabilization period).