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Original Research

Water Absorption Capacity of Flax and Pine Horse Beddings and Gaseous Concentrations in Bedded Stalls

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ABSTRACT

It can be a challenge to find suitable horse bedding materials that provide higher moisture absorption, better animal comfort, greater fertilizer values, and improved indoor environment. Our first objective was to determine the water absorption capacity (WAC) of two bedding materials, flax shive (FS) and pine wood shavings (PWS), commonly used by equine facilities. The second objective was to measure ammonia (NH_3), hydrogen sulfide (H_2S), and greenhouse gas (GHG) concentrations emitted from these bedded stall surfaces. In this study, the WAC of bedding materials were measured at 0.5, 1, 2, 3, 4, 6, 8, 12, and 24 hours in the laboratory. A total of eight horses were used for a 14-day study period. Of these, four horses (group-1) were bedded with FS and the other four (group-2) were bedded with PWS for week-1. In week-2, bedding materials were switched between the two groups. Ammonia and H_2S were measured in situ. For GHG measurement, air samples (methane [CH_4], carbon dioxide [CO_2], and nitrous oxide [N_2O]) were collected 152 mm above the bedded stall surface in Tedlar bags using a vacuum chamber and analyzed for GHG using a gas chromatograph. The WAC of FS was 56% greater than the PWS. There were no significant differences in NH_3, H_2S, CH_4, CO_2, and N_2O concentrations between the two bedding materials ($P > .05$). Nutrient contents between fresh and soiled bedded samples for each bedding type were different ($P < .05$). Measured nutrient contents between fresh FS and PWS and bedded FS and PWS bedding materials were similar ($P > .05$).

1. Introduction

Ideally, bedding provides a clean, dry, and comfortable environment for the horse, allowing for maximum absorption of urine. Additionally, a dry pen means a lower pathogen environment with reduced hoof infections and ammonia (NH_3) emissions [1,2]. Different types of materials are available and currently used as bedding. Bedding needs to absorb maximum amounts of urine, be easily biodegradable and able to be converted into organic fertilizer and recycled back to the environment [3]. Emissions of NH_3 from manure are the predominant source of atmospheric NH_3 [1], and the choice of bedding material affects the air quality in horse stables [1,2]. Therefore, bedding materials are widely used not only for the comfort of the animal but also to reduce environmental impacts and thus to improve indoor environment.

Common plant based bedding materials used in horse stalls include wood residues, seed hulls, and straws [4]. The selection of bedding materials for horses mainly depends on availability and price, absorptive capacity, ease of clean up and disposal, fertility values, and biodegradability [4]. Wood residues such as wood shavings, sawdust, and wood chips are relatively inexpensive bedding materials and widely used in equine facilities. However, their physical

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characteristics make them difficult to handle and dispose of, and they are less biodegradable because of high levels of lignin and high C:N ratios [5,6].

Therefore, horse and stable owners are looking for alternate bedding materials that are economical, have greater water absorbance capacity, dust free, and degrade easily during composting. In North America, flax is grown as an oilseed crop. Harvesting and processing of the stem create shive, which can be potentially used as a horse bedding material. However, no information is available on water absorbance capacity, manure characteristics, and air emissions from stalls using flax shive (FS) as a bedding material.

A typical 455-kg horse produces 0.023 m^3 of manure per day that weighs >22.7 kg [7, 8]. If manure is not managed properly, it may contribute to gaseous emissions in the atmosphere. Emissions of NH_3 from soiled bedding are the predominant source of atmospheric NH_3 [1]. It is reported that a 455-kg horse may generate 0.14 kg of nitrogen and 0.033 kg of phosphorus per day [9]. Most nitrogen may be lost as NH_3, whereas phosphorus may end up in surface water because of runoff [10]. Therefore, if manure is not managed properly, it may pose environmental concerns [9].

Fleming et al [1] compared the gaseous emission of six bedding materials in a controlled environment condition, where known ratios of horse manure–urine mix were added daily for a 14-day period. They observed considerable variations in NH_3, carbon dioxide (CO_2), and nitrous oxide (N_2O) concentrations among bedding materials. In contrast, Elfman et al [11] found that there were no significant differences in dust emissions and CO_2 concentration in the stable environment, when wood pellets and peat moss were used as bedding. Wartell et al [12] observed that softwood bedding was barely degradable, and it did not cause inhibition of methane (CH_4) production from manure [12].

Because of the previously mentioned concerns, horse owners are always looking for alternate bedding materials that will help to keep stall surfaces dry, pathogen levels low, and reduce NH_3 levels in a cost effective manner. Thus, this study focused on evaluating two bedding materials, flax shive and pine wood shavings (PWS) for water absorbency, manure nutrient content, and gaseous emissions from stall surfaces. The specific objectives were to (1) determine the size fractions and water absorption capacity (WAC) of two bedding materials (FS and PWS); (2) quantify NH_3, H_2S, CH_4, CO_2, and N_2O concentrations in stalls; and (3) quantify and compare the nutrient contents of FS and PWS bedding materials under fresh and bedded conditions.

2. Materials and Methods

2.1. Particle Size of Bedding Materials

In this study, two bedding materials, PWS (Swan river, MB, Canada) and FS (SWM International, Winkler, MB, Canada), were analyzed for particle sizes following a standard procedure described in the study of Fleming et al [2]. Briefly, approximately 100 g of each material was weighed, sieved through six different sieves (>9.5 mm, 9.4-6.3 mm, 6.2-4.75 mm, 4.65-3.35 mm, 3.25-2.0 mm, 1.9-1 mm, and <1 mm), and retained materials on each sieve were weighed. The procedure was repeated three times for each bedding material. The percentage of respective particle size fractions was calculated with respect to initial weight. A photographic view of bedding materials used in this study is presented in Figure 1.

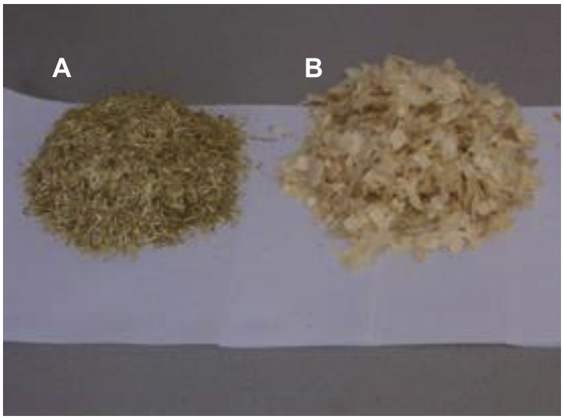

Fig. 1. Photographs of two bedding materials: (**A**) Flax shive and (**B**) Pine wood shavings.

2.2. Determination of the WAC

To determine the WAC, bedding materials were subsampled and oven dried at 105°C for 24 hours. After oven drying, approximately 30 g of oven-dried bedding material was placed in a hydrophobic (nylon) single knee high pantyhose. Three sample replicates were immersed in water for 0.5, 1, 2, 3, 4, 6, 8, 12, and 24 hours. After each time interval, immersed replicate samples were removed from the water, suspended, and allowed to drain excess water for 30 minutes (Fig. 2). Materials were reweighed when samples ceased dripping. The WAC was calculated based on the following equation:

$$W = \frac{W_t - W_0}{W_0} \times 100$$

where, W_t is the weight of a bedding material at a given immersion time after excess water is drained and W_o is the weight of oven-dried sample.

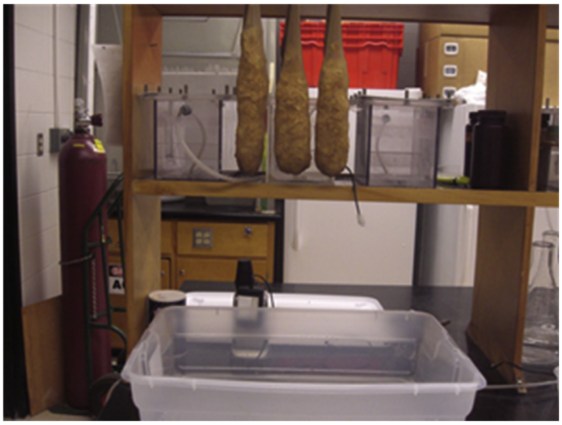

Fig. 2. Draining off excess water from bedding material after immersing for predetermined time.