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Original Research

Effect of Crumb Rubber Made From Recycled Tires on Air Quality in an Indoor Riding Arena: A Pilot Study

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ABSTRACT

Our hypothesis was that recycled crumb rubber can significantly decrease air particulate matter when applied on the top of existing arena sand, and the objective of our study was to test this hypothesis. Treatments were as follows: A (control—existing sand floor), B (recycled rubber 1.5″), and C (recycled rubber 3″). Air quality was measured using three DC1100 monitors (Dylos Corporation; Riverside, CA). Data collections occurred during advanced riding classes twice per week for 3 weeks using randomly assigned horses and riders. Data were analyzed as a three-way analysis of variance with fixed effects using a Tukey post hoc test with SAS (version 9.4; SAS Institute Inc) and significance established at $P < .05$. Application of the recycled rubber material significantly reduced air particulate matter in both treatments B and C for particles measured at 0.5 μm and 2.5 μm. We observed no significance associated with monitor or time. We observed no difference between treatments B and C. Recycled rubber material significantly reduced particulate matter in the air during an indoor riding class when applied over existing arena sand flooring.

1. Introduction

Dust levels in indoor arenas have long been an issue for horses, riders, and equine professionals. This problem has long been associated with symptoms including cough, itchy eyes, and, when chronic exposure occurs, even respiratory diseases such as asthma [1]. In a survey conducted by Kollar et al (2005), data indicated that riding instructors have a significantly higher rate of diagnosis for chronic bronchitis, rhinitis, and asthma as compared with the general population. Although most equestrian facilities use dust control methods such as watering, the use of alternate footings is beginning to be explored.

Horses and humans are exposed to much higher levels of dust in indoor riding arenas for a myriad of reasons. For the equine athlete, this is due in part to the physical demands placed on them. Quite simply, animals breathe more deeply when they are hard at work. During breezing, a common equine exercise regimen, the average horse breathes at a rate of about 1,500 L per minute, as opposed to 60 while at rest [2]. This natural increase in respiratory rate necessarily facilitates greater intake of atmospheric contaminants.

Indoor arenas are also, by necessity, enclosed spaces, which can drastically increase the concentration of particulate matter encountered [1]. Few are well ventilated, which may result in similar negative impacts on air quality and may further exacerbate issues with air particulate matter [1]. The footing used is also a concern. One study demonstrated that “any riding surface, regardless of material, may eventually result in air pollution with dust” [1]. Riding in arenas generally produces large amounts of both small and large particulates, and in a study by Millerick-May [3], it was found that dust concentrations tend to rise progressively during a riding session and settle only when arena activity ceased.

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Table 1
Weather conditions during particulate matter measurement of air during riding class.

Treatment	Atmospheric Conditions				
	Date	Temperature (°C)	Humidity (%)	Barometric Pressure (in Hg)	Wind (km/hr)
Sand	8/26/14	32.2	61	761.9	4.8
Sand	8/28/14	28.8	69	761.9	0
1.5″ Rubber	9/2/14	27.2	76	759.4	11.2
1.5″ Rubber	9/4/14	30.5	67	761.9	19.3
3.0″ Rubber	9/9/14	26.1	60	761.9	14.4
3.0″ Rubber	9/11/14	27.7	59	761.9	12.8

Mazan and Hoffman (2006) state that there are three general types of particles that affect air quality. The first and largest is the inhalable particle category and consists of those particles that are 100 μm or less in diameter. Although, as the name suggests, these particles can be inhaled, they generally do not make it past the upper airways. Thoracic particles describe those that are 30 μm and below; these are small enough to reach the thorax.

The particles that are of most concern to air quality researchers are called respirable particles. These are particles that are ≤4 μm. These may reach the alveoli and are thought to be the major cause of particulate-based lung damage. Smaller 2.5-μm particles are commonly measured. At this diameter, the smallest of the alveoli can be reached; consequently, particles of this size are being acknowledged as a major contributor to the aforementioned lung damage [2].

Our study was designed to test the hypothesis that recycled crumb rubber can significantly decrease air particulate matter when applied on the top of existing arena sand. Such a decrease could have significant health effects for many equestrians and their horses.

2. Materials and Methods

This study was conducted using an advanced riding class at Southern Illinois University Carbondale. Six horses and riders were in the class, and they rode for approximately 1 hour per session. Samples were taken on the existing sand flooring (control/sample group A), the sand covered in 1.5″ of recycled crumb rubber (sample group B), and the sand covered in 3″ of recycled crumb rubber (sample group C). This material was chosen because of interest in using recycled materials and for its shock absorptive characteristics. Each flooring was tested for 1 week of class time (two riding class sessions in each week). Total data collection occurred over a 3-week period.

Three Dylos DC1100 air quality monitors (Dylos Corporation; Riverside, CA) were placed at the points of an isosceles triangle around the arena, where the short side measured 18.3 m and the long two, 25.6. Monitor A was placed 1.359 m off the ground; monitor B, 0.423; and monitor C, 0.356. The monitors were placed off the ground at varying heights to be representative of the entire breathing zone relative to head position. Horses hold their heads at many different levels when under saddle based on many variables, so having the monitors at varying heights allowed us to get a fair representation of how much particulate matter, on average, the horses were exposed to. The levels were varied intentionally, but they were chosen based on the availability of surfaces to place the monitors on. The arena measured 30.25 m by 21.50 m (air volume) and had 10 open windows measuring 2.33 m for ventilation. There were two double doors on either side of the arena that were open before class for air flow, but they were closed while the students were riding. Three hours before each class, the arena was watered for 25 minutes because of the anticipation of extremely high dust levels.

Weather measurements (temperature, humidity, barometric pressure, and wind direction/speed) were recorded from the Yahoo! weather application before each ride and are shown in Table 1. Readings from the air quality monitors were taken at 0, 30, and 60 minutes into the rides, and data for both 2.5-μm and 0.5-μm particle sizes were recorded. Statistical analysis was conducted as a three-way analysis of variance with fixed effects using a Tukey post hoc test with SAS (version 9.4; SAS Institute Inc), and significance was established at $P < .05$.

3. Results and Discussion

Application of the recycled rubber material significantly reduced air particulate matter in both treatments B and C for particles measured at 0.5 μm and 2.5 μm. We observed no significance associated with monitor or time. We observed no difference between treatments B and C. Recycled rubber material significantly reduced particulate matter (Fig. 1) in the air during an indoor riding class when applied over existing arena sand flooring. However, we observed no difference between an application of recycled crumb rubber at a depth of 1.5″ as compared with an application of 3″ in depth.

The objective of our study was to test our hypothesis that applying crumb rubber to existing arena sand would significantly reduce particulate matter in the air. We successfully completed this objective. The first treatment, an application of 1.5″ of crumb rubber to the sand, significantly reduced particulate matter in the indoor arena. However, when compared with the 3″ application, we saw no additional benefit. Therefore, we concluded that although the product is effective at improving air quality relative to particulate matter, there does not appear to be additional benefit from having a deeper application.

Various studies have asserted the negative effects of particulate inhalation, and the application of crumb rubber to existing arena flooring could vastly improve air quality in indoor riding arenas. Such improvements could create a healthier environment for horses, riders, and instructors alike. The negative effects of dust inhalation have been well chronicled in many species and situations. In swine, decreased growth rate has been as a concern [2]. In