The Use of White Fir Shavings as Bedding for Laboratory Animals

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Abstract

White tir is an underutilized species found in southwestern Colorado. In this research. the suitability of white fir for use as laboratory animal bedding was investigated. White fir was selected for evaluation because of its neutral color, relatively low specific gravity (good absorbency properties), and lack of distinct odor. In addition, white fir wood is nonresinous and is used for food applications, including fruit and vegetable containers. A toxicology analysis was conducted prior to use with laboratory animals. Results indicated that the white fir shavings did not contain any toxins that might have posed an immediate health risk to the laboratory animals. Contact studies conducted with laboratory animals suggest that the bedding performed well. The animals did not show any adverse effects from the bedding. The bedding had good absorbency properties and did not develop objectionable

odor after exposure to moisture. Generally, white fir shavings exhibited desirable characteristics similar to aspen that is the preferred wood species for laboratory animal bedding.

Introduction

White fir (Abies Concolor) is found in southwestern Colorado and throughout the Four Corners Region growing in a variety of climatic conditions ranging in elevation from 2,000 to 11,000 feet. Over the past decades since settlement, white fir has become a predominant understory species to ponderosa pine and Douglas-fir in the region. With efforts underway to restore these forests to stand composition and density that existed historically prior to settlement, significant volumes of white fir could potential1~ be removed during implementation of restoration projects.

In the Southwest, mature white fir trees up to 300 years old average about 50 inches in diameter and 135 feet tall (10). However, the average size of trees removed during forest restoration efforts will be considerably smaller. Data collected by Lynch (6) from a forest restoration sale in southwestern Colorado indicated that 49.1 percent of the white fir trees harvested had diameters of less than 3 inches and were unmerchantable. The remaining 50.9 percent of white fir trees harvested were merchantable. However, only 18.3 percent of white fir trees harvested were greater than 12 inches in diameter. Therefore, 81.7 percent of the trees harvested from this restoration sale would be characterized as small diameter.

In the Rocky Mountains and Southwest, white fir can be characterized as an

underutilized species, particularly with respect to value-added products. Although white fir can be used for a range of products, including plywood and pulpwood. the majority of white fir harvested in the region is being manufactured into 2x4 studs and other dimension lumber. Gorman et. al. (4) tested the mechanical properties of white fir studs from southwestern Colorado. Generally, because white fir wood has low specific gravity, it has correspondingly low strength values. There is a need to look at the potential for manufacturing other products from white fir. One possibility is bedding and litter for small laboratory animals, including rats, mice, hamsters, guinea pigs, rabbits, and cats.

Aspen is currently the preferred wood species utilized as bedding for small laboratory mammals. Aspen is preferred because it is lightweight, with good absorbency properties, lacks characteristic odor, and has neutral color. Considerable quantities are utilized at research facilities throughout Colorado. Laboratory Animal Resources at Colorado State University utilizes an estimated 26 tons of aspen shavings and between 50 to 85 tons of chips annually. Virtually all of the aspen utilized at CSU and other laboratory facilities located in Colorado come from out-of-state (7).

Generally, the wood of white fir has the same desirable properties for bedding that aspen has. White fir wood is light in weight, ranging in color from white to reddish brown. There is little difference between heartwood and sapwood. The annual growth rings show a distinct delineation in color between earlvwood and latewood of the preceding year. However, the transition from earlywood to latewood is gradual. The wood has a medium to somewhat coarse texture. The wood has no characteristic taste or odor and resin canals are normally absent. It is generally straight grained and relatively easy to work with. White fir wood is also approved for food applications including fruit

and vegetable containers.

The objective of this research was to evaluate the potential use of white fir shavings as laboratory animal bedding. Included as part of this research is a toxicology study conducted on the white fir to determine if biological pathogens, pesticides, and/or heavy metals are present in the wood. Contact studies conducted using rats and mice were also conducted. A comparison of white fir with other wood bedding products on the market is also presented

Methodology

Air-dried white fir lumber (2x4's) was obtained from a primary wood processor in Southwestern Colorado and transported to the Colorado State Forest Service Nursery located on the Foothills Campus of Colorado State University. The 2x4's had been manufactured from debarked logs, so the wood was relatively free of bark. Prior to manufacturing shavings, wood stained by fungi attack was discarded. The remaining wood was manufactured into shavings using a jointer. Approximately *50* to 60 lbs of shavings were manufactured. They were screened to remove fines, placed in plastic bags and labeled. Wood samples were taken to determine moisture content and specific gravity. Moisture content was measured using ASTM standard test method D 4442, Method A *(3),* oven-drying, and specific gravity was determined using ASTM standard test method D *2395* (Method A), volume by measurement (2).

The shavings were than taken to the Painter Center (Laboratory Animal Resources) on the CSU campus for evaluation. A preliminary toxicology study was conducted by Environmental Health Services at Colorado State University. This study involved analyzing membrane filter coliforms, standard plate counts, and fungus present in the

bedding prior to and after being autoclaved. A subsequent toxicology study performed by Warren Analytical located in Greeley, Colorado was done to determine the levels of pesticides and heavy metals present in the white fir bedding.

Contact studies were performed on rats and mice. Two rat cages and 3 mouse cages were used. Two rats were housed per each rat cage. The dimensions of the rat cages were *8.5* inches wide by 12.125 inches long by 9 inches high and the rats shared 78 square inches of floor surface. Five mice were housed in each mouse cage. Mouse cage dimensions were *7.5* inches wide by 12.125 inches long by *5* inches high and the mice shared 63 inches of floor space. White fir shavings were autoclaved and then metered into trays using a MTP Model 1742 automatic bedding dispenser. The depth of bedding put in the trays was *0.5* inches. Contact testing extended over a period of 10 days. Bedding was changed at a rate of twice a week or three times over the test period.

Results

A sample of the white tir bedding utilized in this research is shown in Figure 1. The bedding was light brown and had no characteristic odor prior. The mean moisture content of the air-dried wood was 9.1 percent. The wood was relatively light with a specific gravity of 0.36 based on air-dried (9.1 percent moisture content) volume. This compares to a specific gravity of 0.39 based on volume at 12 percent moisture content reported in the Wood Handbook (1 1).

A summary of microbiological tests conducted on the white fir shavings is presented in Table 1. Results of these studies indicated that autoclaved bedding had less than I fungus per ml, less than 1 aerobic plate count per ml, and 0 coliform per 100 ml. Results from pesticide and heavy metal tests are summarized in Table 2. No detectable levels of

the pesticides evaluated were present in the wood. Heavy metals evaluated (arsenic, mercury, cadmium, and lead) were present at levels of less than 0.1 parts per million.

Results of contact studies are summarized in Table *3.* The rats and mice didn't show any adverse respiratory effects resulting from contact with the white fir wood. No ocular or nasal discharge from test animals was observed. There were also no adverse skin effects such as rashes or scratching. The bedding exhibited good absorbency properties and no distinct odors were detected after exposure to urine (moisture).

Discussion

Although some pet suppliers and owners do not recommend wood shavings and chips (particularly cedar and to a lesser extent pine) for small mammal bedding under any circumstance, wood bedding is generally considered acceptable when manufacturer recommendations are followed. Recommended usage guidelines for wood bedding and litter products are presented in Table 4 (8). With the exception of ferrets, pine is generally favored over cedar. Chlorophyll pine does not offer significant advantage compared to ordinary pine bedding. Aspen is considered superior to both cedar and pine.

Generally, cedar and pine bedding products are not normally used for laboratory animals. Although widely available in retail pet stores, cedar and pine are not used because of health issues that can potentially influence experimental results. Extended exposure to plicatic acid found in cedar and abeitic acid found in pine can potentially harm mammals, including humans (6). These aromatic hydrocarbons can contribute to a variety of respiratory diseases such as asthma and liver or kidney disease. Small mammals housed in relatively small enclosures with poor ventilation are particularly at risk. Warm, moist conditions typically found in these enclosures enhance the aromatic

properties of wood. Although changing bedding and litter often, as recommended by manufacturers, can reduce problems associated with odor, less aromatic woods such as aspen are preferred for laboratory animal bedding.

Aspen shavings and chips are considered an excellent choice of bedding and litter for all varieties of small laboratory mammals. In addition to having no distinct odor, aspen is desirable because it has relatively low density and good absorbency properties. Aspen also has a neutral color. Curiously, while aspen is the bedding and litter of choice for small laboratory animals, this wood is not readily available in retail pet stores. Although the reason for this is uncertain, raw material cost relative to cedar and pine, and lack of available resource probably account for this phenomenon. Aspen shavings and chips are desirable for a variety of products, including OSB and pulpwood.

The performance of the white fir shavings used in this research was very comparable to aspen bedding products currently used by Lab Animal Resources at Colorado State University. This was expected. Even though these woods are anatomically different. white fir is a softwood and aspen a diffuse-porous hardwood, as noted in the introduction. in terms of important properties that affect the performance of animal bedding, these woods are very similar. The specific gravity of white tir shavings used in this research 0.36 air-dried basis is very comparable to the value reported for aspen (0.38 at 12 percent moisture content basis) in the Wood Handbook (1 1). They both have good absorbency properties. Both white fir and aspen have a relatively neutral color and lack of distinct odor. White fir, like aspen. is generally approved for a variety of food applications.

There were no handling problems encountered while using the white fir shavings. The shaving size provided worked well in the automatic bedding dispenser. There was no

dust buildup on the dispenser indicating that screening and autoclaving successfully removed the majority of fines. Handling the white fir shavings was comparable to aspen shavings. Aspen chips (sawdust) have more fines (dust) that tend to build up on the dispensing machine even after autoclaving.

The results from toxicology studies for white fir were very comparable to results reported by manufacturers of aspen bedding products (1, 9). The rats and mice showed no adverse reactions to the white fir wood during contact studies, results typical of tests conducted with aspen bedding. The good absorbency properties and lack of distinct odor experienced during contact tests are comparable to aspen.

Conclusion

White fir is an underutilized species found in throughout the Southwest. The objective of this research was to investigate the suitability of white fir shavings for laboratory animal bedding. The bedding size provided worked well in the automatic bedding dispenser. A toxicology study was done on the white fir to determine if there were any toxins present in the wood that could potentially hurt laboratory animals. Levels of fungi, aerobic plate counts, and coliform were not significant. No significant levels of pesticides or heavy metals were present in the wood. No adverse respiratory or skin effects were observed during contact studies conducted using rats and mice. These results are comparable to aspen bedding products currently available on the market.

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Table 1. Summary of Results from MicrobiologicalTests Conducted on White Fir Bedding.

Specimen ID	Total Fungi/ml	Aerobic Plate Count/mi	Total Coiiform/100 ml
Unautoclaved bedding	<1	15	0
Autoclaved Bedding	<1	<1	0

Note: Testing conducted by Colorado State University Environmental Quality Laboratory.

Table 2. Summary of Results from Pesticides & Heavy Metal Tests Conducted on White Fir Shavings.

Type	Level Detected	Type	Level Detected
Pesticide:			
Alpha-HCH	**ND**	**Aidrin**	**ND**
Beta-HCH	**ND**	**Delta-HCH**	**ND**
Dieldrin	**ND**	**Endrin**	**ND**
HCB	**ND**	**Heptachior Epoxide**	**ND**
Heptachior	**ND**	**Lindane**	**ND**
Methoxychior	**ND**	**Mirex**	**ND**
4,4-DDD	**ND**	**4,4-DDE**	**ND**
4,4-DDT	**ND**	**Chlorpyrifos**	**ND**
Diazinon	**ND**	**Disyston**	**ND**
Ethyl Parathion	**ND**	**Ethion**	**ND**
Malathion	**ND**	**Methyl Parathion**	**ND**
Ronnel	**ND**	**Trithion**	**ND**
Arochlor 1221	**ND**	**Arochlor 1232**	**ND**
Arochlor 1242	**ND**	**Arochlor 1248**	**ND**
Arochlor 1254	**ND**	**Arochlor 1260**	**ND**
Aflatoxin	**<0.5 ppb**		
Heavy Metal:			
Arsenic	**<0.1 ppm**	**Cadmium**	**<0.1 ppm**
Mercury	**<0.1**	**Lead**	**<0.1**

Notes: 1. ND = None Detected
ppm = parts per million
ppb = parts per billion

2. Detection Limits:

Organochlorine Pesticides	**0.0! ppm**
Organophosphorous Pesticides	**0.05 ppm**
Arochlors	**0.05 ppm**

3. Testing conducted by Warren Analytical Laboratory, P.O. Box G, 650 **"0" Street, Greeley, Colorado 80632-0350**

Table 3. Summary of Contact Studies Conducted with Rats and Mice.

Factor	24 Hour Exposure	10 Day Exposure
Rats:		
Respitory Effects	**ND**	**ND**
Skin Irritations	**ND**	**ND**
Odor	**ND**	**ND**
Mice:		
Respitory Effects	**ND**	**ND**
Skin Irritations	**ND**	**ND**
Odor	**ND**	**ND**

ND - None Detected

Table 4. Recommended Usage Chart for Wood Bedding & Litter Products.

Type of Pet	Cedar	Pine	Chlorophyll Pet	Aspen
Rabbits	**NR S**	**NR - S**	**NR**	**NR - G**
Guinea Pigs	**NR**	**NR - G**	**NR - S**	**G**
Ferrets	**NR G**	**NR-S**	**NR-S**	**NR-G**
Hamsters	**NR**	**NR-G**	**NR-S**	**G**
Gerbils	**NR- S**	**NR-G**	**NR-G**	**G**
Other Rodents	**NR**	**NR -**	**NR s**	**G**

Notes: **1. NR** Not Recommended

S - Satisfactory

G- Good

2. Recommendations often ranged considerably and this is reflected in notations. For example, “NR - G” means that recommendations varied from not recommended to good.