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Heavy Metal and Hydrocarbon Residues in Tissue and Blood of Beef Steers Bedded on Waste Newspapers

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There are over 3 million tons of waste newspaper generated annually in Pennsylvania alone. This provides a significant disposal problem for many municipalities who are confronted with dwindling options for solid waste disposal. Previous studies have identified several of the potential advantages of the material as a bedding material for livestock. With over 1 million beef and dairy cattle in the state, the potential use of newspaper as bedding is important. Of concern, however, is the effect of the chemical composition of the paper on animals which have the opportunity to consume it, and subsequent entry of undesirable residues into the food chain. Metals such as cadmium, lead, mercury and copper are known to exist in relatively high quantities in newsprint from the ink used in printing. Napthalene and other aromatic hydrocarbons which are found in coal tar and synthetic and natural crude oils are known to accumulate in marine life and are absorbed by humans after consumption (Eisele, 1985.) A preliminary report (Comerford, 1990) indicated beef steers bedded on newspaper did consume varying amounts of the material. Few studies have determined if residues of heavy metals or organic compounds are found in the carcasses of animals continuously bedded on newspaper. The objectives of this study were to determine the levels of cadmium, copper, lead, mercury and certain aromatic hydrocarbons in the blood and liver of feedlot cattle bedded continuously on waste newspaper or sawdust.

MATERIALS AND METHODS

The cattle were maintained in pens with concrete flooring (approximately 14 ft X 32 ft in size) until slaughter (average length of feeding period = 140 days and average slaughter weight=1120 lbs.) The cattle had ad libitum access to a ration that was 40% corn silage and 60% grain, minerals and protein on a dry matter basis.

Half of the area in each pen was bedded with either sawdust purchased from a local vendor (n=8 steers), or with bales of shredded newspaper purchased from the Centre County (PA) Solid Waste Authority (n= 8 steers). The newspaper was first sorted to remove magazines and colored materials, shredded into strips 1 in X 18 in in size, and then baled with a conventional hay baler.

Approximately 350 lbs of sawdust and 180 lbs of paper were used each time the pens were bedded. Pens were cleaned and rebedded on the average of every 10 days. Samples of both newsprint and sawdust were retained and subjected to laboratory analysis. At slaughter a 1L sample of venous blood and a 100g sample of liver were collected from each animal and frozen. Eisele (1985) determined the liver was one of the major tissues of deposition for chronic doses of napthalene in dairy

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cattle. The samples were sent to a local analytical laboratory for analysis when all of the cattle had been slaughtered. The analysis procedures used by the laboratory are described in Table 1.

Table 1. Methods of analysis of four metals and sixteen aromatic hydrocarbons in blood and liver tissue of feedlot cattle.

Item		Analysis Method	Detectable Level
		(Dry Matter Basis)	
Hydrocarbons			
Acenaphthene		EPA 8100	330 ug/kg
Acenaphthylene		EPA 8100	330 ug/kg
Anthracene		EPA 8100	330 ug/kg
Benzo (a) anthracene		EPA 8100	330 ug/kg
Benzo (b) fluoranthene		EPA 8100	330 ug/kg
Benzo (k) fluoranthene		EPA 8100	330 ug/kg
Benzo (a) pyrene		EPA 8100	330 ug/kg
Benzo (ghi) perylene		EPA 8100	330 ug/kg
Chrysene		EPA 8100	330 ug/kg
Dibenzo (a,h) anthracene		EPA 8100	330 ug/kg
Fluoranthene		EPA 8100	330 ug/kg
Fluorene		EPA 8100	330 ug/kg
Indeno (1,2,3-cd) pyrene		EPA 8100	330 ug/kg
Napthalene		EPA 8100	330 ug/kg
Phenanthrene		EPA 8100	330 ug/kg
Pyrene		EPA 8100	330 ug/kg
Metals			
Cadmium	blood	EPA 6010	.02 mg/L
	liver	EPA 6010	.36 mg/kg
Copper	blood	EPA 6010	.08 mg/L
	liver	EPA 6010	1.42 mg/kg
Lead	blood	EPA 6010	.20 mg/L
	liver	EPA 6010	3.57 mg/kg
Mercury	blood	EPA 7471	.10 mg/L
	liver	EPA 7471	.60 mg/kg

RESULTS AND DISCUSSION

The analysis of the newsprint and sawdust samples showed there were no detectable levels of any of the 16 hydrocarbons. Newsprint contained .68 mg/kg cadmium, 17.2 mg/kg copper, 2.10 mg/kg lead and undetectable levels of mercury. The sawdust contained 3.31 mg/kg copper, and undetectable levels of cadmium, lead and mercury. There were no detectable levels of any of the 16 hydrocarbons in either the blood or liver samples (Tables 2 and 3.) The levels of napthalene were lower than those reported by Eisele (1985) in poultry, swine and dairy cattle livers after receiving chronic and acute doses. There were no detectable levels of these materials in the newsprint itself, indicating the inks present probably did not contain detectable amounts of coal tar, synthetic crude oils or other carriers containing napthalene.

Table 2. Hydrocarbons and heavy metals in blood of feedlot cattle bedded on newspaper and sawdust

	Newspaper	Sawdust
Hydrocarbons		
Acenaphthene	ND[1]	ND
Acenaphthylene	ND	ND
Anthracene	ND	ND
Benzo (a) anthracene	ND	ND
Benzo (b) fluoranthene	ND	ND
Benzo (k) fluoranthene	ND	ND
Benzo (a) pyrene	ND	ND
Benzo (ghi) perylene	ND	ND
Chrysene	ND	ND
Dibenzo (a,h) anthracene	ND	ND
Fluoranthene	ND	ND
Fluorene	ND	ND
Indeno (1,2,3-cd) pyrene	ND	ND
Napthalene	ND	ND
Phenanthrene	ND	ND
Pyrene	ND	ND
Metals (mg/L)		
Cadmium	ND	ND
Copper	.69	.72
Lead	ND	ND
Mercury	ND	ND

[1]ND=non-detectable amount.

The report from Eisele (1985) indicated the possibility of retention of napthalene in the milk and milk fat of dairy cattle after both acute and chronic doses. However, this author also reported the compound rapidly disappeared from the tissue after doses were discontinued. It appears from the present study that napthalene and 15 other aromatic hydrocarbons are not present in the paper at detectable levels, and, if minute amounts are present, there is no significant retention of them for at least 140 d after exposure to the bedding by beef cattle. While liver and blood are not usually consumed by humans, Puls (1988) indicated the liver would normally be the source for most of the deposition of these compounds.

Analysis for copper, cadmium, lead and mercury indicated the only detectable level was for copper in both blood and in liver tissue (Table 4.) There was a higher level found in the sawdust-treated cattle, and both were well below the toxic level in the liver of cattle of 250-800 mg/kg as defined by Puls (1988.) The liver is the site for accumulation of copper from any source in cattle, so the copper residue could have originated from any combination of feed, water, or bedding material. Retail cuts of beef normally come from steers and heifers that are less than 20 mon of age, and these cattle have been fed in confined pens that would require bedding for 200 days or less. In the case of dairy cattle that have been bedded for a more extensive period and enter the food chain as ground beef, the possibility exists that higher levels of copper may be retained in the tissue.

It should be noted the paper used in this experiment was primarily "black-on-white"

TABLE 3. Hydrocarbons and heavy metals in liver of feedlot cattle bedded on newspaper and sawdust

	Newspaper	Sawdust
Hydrocarbons		
Acenaphthene	ND[1]	ND
Acenaphthylene	ND	ND
Anthracene	ND	ND
Benzo (a) anthracene	ND	ND
Benzo (b) fluoranthene	ND	ND
Benzo (k) fluoranthene	ND	ND
Benzo (a) pyrene	ND	ND
Benzo (ghi) perylene	ND	ND
Chrysene	ND	ND
Dibenzo (a,h) anthracene	ND	ND
Fluoranthene	ND	ND
Fluorene	ND	ND
Indeno (1,2,3-cd) pyrene	ND	ND
Napthalene	ND	ND
Phenanthrene	ND	ND
Pyrene	ND	ND
Metals (mg/kg, wet basis)		
Cadmium	ND	ND
Copper	28.7	38.8
Lead	ND	ND
Mercury	ND	ND

[1]ND=non-detectable amount.

newsprint and contained a very limited amount of colored inks. There is a difference in the heavy metal content of certain colored inks in comparison to the standard black ink (Shipp and Baker, 1989.) Sorting of the newspapers for colored material and "slick" magazines appears to be essential in exposing cattle to lower levels of copper, cadmium, lead and mercury in the bedding.

The importance of the results in the present study is twofold. First, the use of waste newspapers as animal bedding provides an invaluable source of disposal for this material and redirects it from the conventional solid waste stream for many communities. Secondly, the freedom from contamination of animal products from undesirable compounds for animals bedded on newspaper is essential for this use. It appears from these data that using waste newspapers for bedding in beef feedlots for 140 d or less will not sigificantly alter beef products that enter the food chain.

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