Metabolism of Xenobiotics in Ruminants

Use of Activated Carbon as an Antidote for Pesticide Poisoning in Ruminants

K. A. Wilson and Robert M. Cook

Activated carbon when given to ruminants at the level of 2 to 4 g per kg of body weight prevented the normal absorption of HEOD (1,2,3,4,10, 10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-*endo-exo*-5,8-dimethanonaphthalene) the major component of dieldrin from the rumen as evidenced by lower levels of blood HEOD, and a three- to tenfold increase in HEOD excretion in the feces over that for control animals. Granular activated carbon (20 × 40 Darco) can be fed free choice or mixed with the grain ration. Finely powdered activated carbon can be mixed with an equal weight of water and then added to the daily grain ration for lactating cows. Activated carbon is an effective antidote for dieldrin poisoning in ruminants. This provides the animal husbandryman with a technique to increase the rate of excretion of dieldrin from contaminated animals.

An antidote for dieldrin poisoning in cattle is needed that will not only relieve toxicity symptoms but increase the rate of clearance of dieldrin from the body. One such antidote would be an inert compound that could be fed to cattle poisoned with a pesticide, bind the pesticide, and prevent its absorption from the gut.

We have studied several materials to determine their effectiveness as an adsorbent of 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-*endo-exo*-5,8-dimethanonaphthalene (HEOD), the major component of dieldrin. These materials included pectin, lignin, liquid-phase activated carbon, and diatomaceous earths. Of these materials, lignin and activated carbon were good adsorbents for HEOD. Activated carbon was chosen for *in vivo* trials because it is inert, whereas lignin can be fermented to a limited extent by rumen microorganisms. This paper reports results of experiments designed to test the use of activated carbon as an adsorbent for dieldrin in ruminants. This work was reported in a preliminary communication (Wilson *et al.*, 1968).

EXPERIMENTAL PROCEDURE

Wether goats and sheep and Jersey heifers were used as experimental animals and were fitted with rumen cannulae (Table I). Total feces were collected from goats and sheep by sealing a plastic bag over the rump. The heifers were placed in digestion stalls for total collection of feces. Blood samples were taken using indwelling jugular cannulae. The animals were fed alfalfa hay free choice.

HEOD was added to the rumen approximately 1 hr after activated carbon was added to the rumen. Feces were collected at approximately 12-hr intervals. Serial samples of blood and rumen fluid were taken. One gram portions of the samples were analyzed for HEOD as previously described (Cook, 1970). The dry matter in feces from sheep and goats was determined by heating in a forced air oven first for 24 hr at 50° C and then 24 hr at 100° C. The dry matter in feces from heifers was determined by heating in a forced air oven for 24 hr at 100° C. HEOD concentrations in feces are expressed on a dry matter basis.

Dairy Department, Michigan State University, East Lansing, Mich. 48823

Table I. Experimental Treatments

Animal	Body wt, kg	HEOD added to rumen mg/kg body wt	Activated carbon[b] added to rumen, g/kg body wt
Sheep	37.7	15.40	...
Sheep	49.0	15.40	4.08
Goat	56.3	8.80	...
Goat[c]	57.2	8.70	3.40
Heifer	296.0	5.07	...
Heifer[a]	296.0	5.07	2.30

[a] Heifer 2 was given an additional 681 g of activated carbon at 2.0 days.
[b] The activated carbon was a finely powdered Norite.
[c] Goat 2 was given an additional 100 g of carbon at 2.5 days.

RESULTS AND DISCUSSION

Activated carbon prevents the normal rise in blood HEOD levels after HEOD is added to the rumen (Figures 1 and 2). The levels of HEOD in rumen fluid from animals treated with carbon are higher than control animals for some time, but eventually decline below the control values (Figures 3 and 4). These results are consistent with the adsorption of HEOD by activated carbon.

The concentration of HEOD is higher in feces from carbon-treated animals than in control animals (Figures 5, 6, and 7). When sheep were treated with activated carbon, the maximum concentration of HEOD in feces occurred after 36 hr. The maximum concentration of HEOD in feces from control sheep occurred after 48 hr. A similar pattern was observed with goats and Jersey heifers.

The concentration and total excretion of HEOD in the feces for the various collection periods are shown in Figures 8, 9, and 10. The pattern for total HEOD excretion is similar to

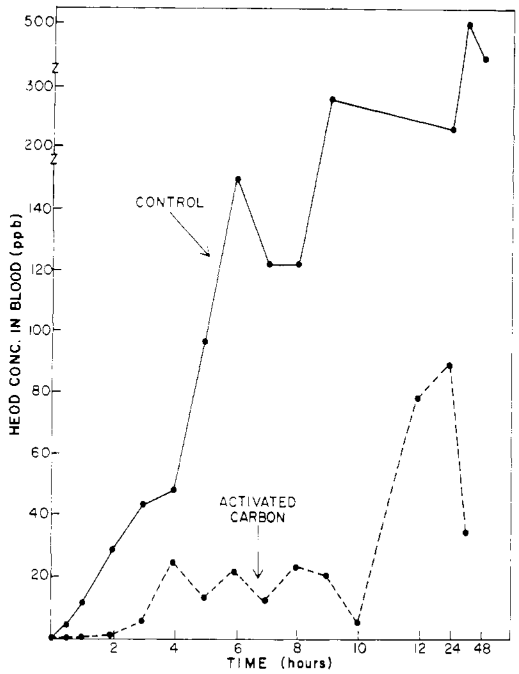

Figure 1. Effects of activated carbon on HEOD concentration in jugular blood of sheep

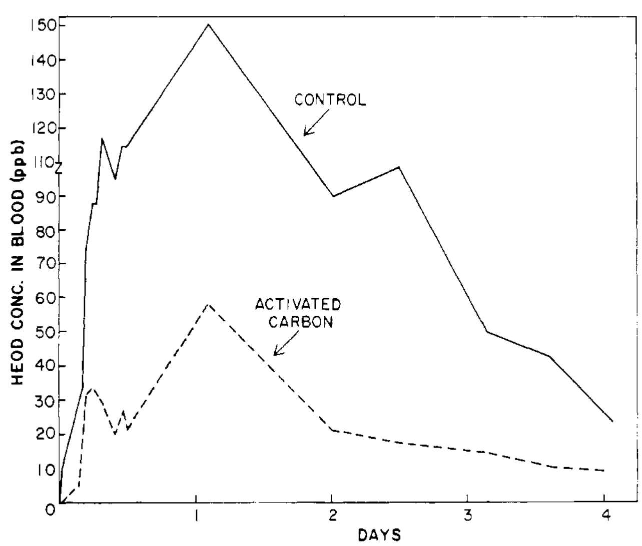

Figure 2. Effect of activated carbon on HEOD concentration in jugular blood of goats

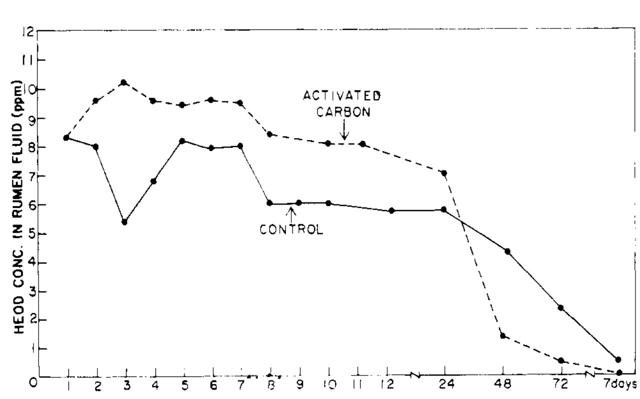

Figure 3. Effect of activated carbon on HEOD concentration in rumen fluid of sheep

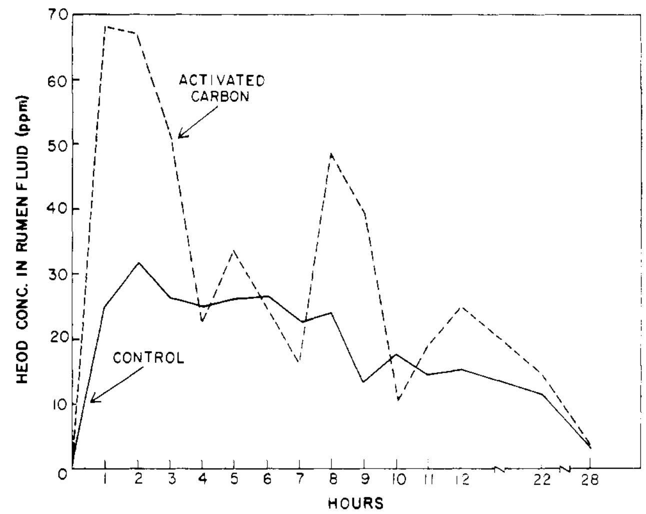

Figure 4. Effect of activated carbon on HEOD concentration in rumen fluid of goats

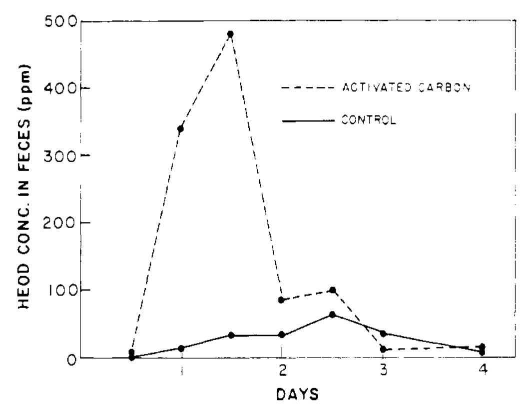

Figure 5. Effect of activated carbon on HEOD concentration in the feces of sheep

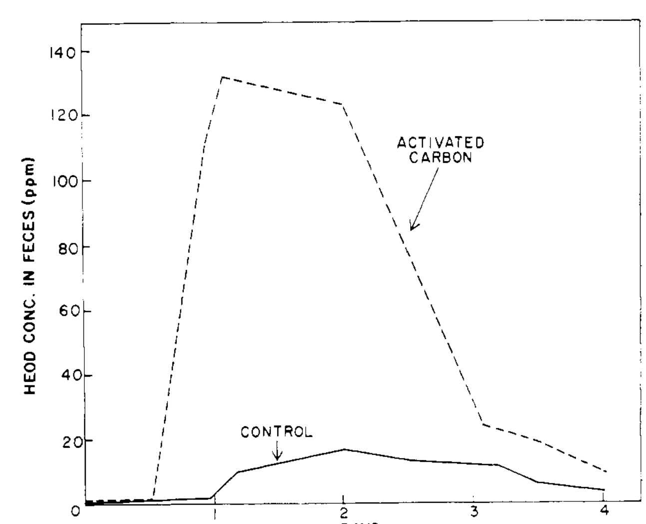

Figure 6. Effect of activated carbon on HEOD concentration in the feces of goats

that for HEOD concentration in the feces. These similar patterns are the results of the constant feed intake during the treatment periods.

Figure 11 shows the total excretion of HEOD in the feces after 4 days, expressed as percent of the total HEOD dose. Heifers were given the lowest amount of activated carbon in terms of grams of carbon per kg of body weight. In this case,

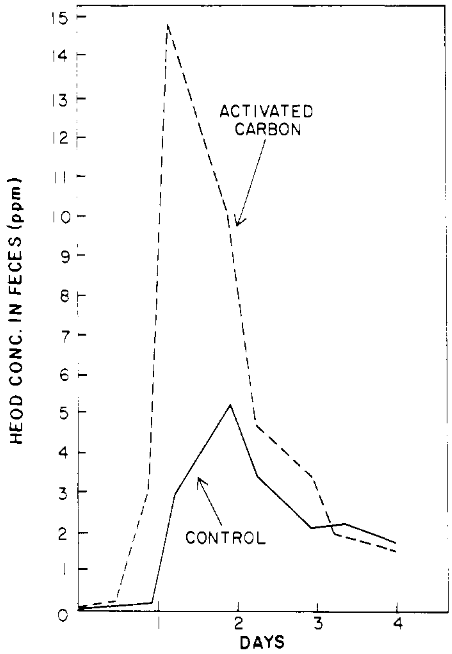

Figure 7. Effect of activated carbon on HEOD concentration in the feces of heifers

the active carbon gave a three-fold increase in HEOD excretion. When the amount of activated carbon was doubled in the sheep trial, HEOD excretion in the feces was 10 times greater than the control. Goats were intermediate with respect to carbon treatment and effects of carbon on HEOD excretion in the feces. Although comparison of the effects of levels of activated carbon may reflect some species variation, the results show that activated carbon treatment at approximately 2 g per kg body weight is much less effective in trapping HEOD than activated carbon treatment at 4 g per kg body weight.

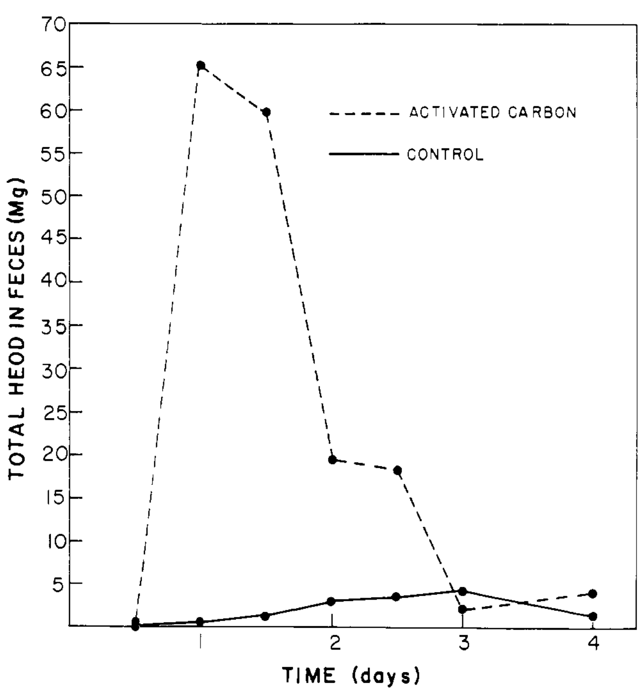

Figure 8. Effect of activated carbon on total HEOD excretion in the feces of sheep

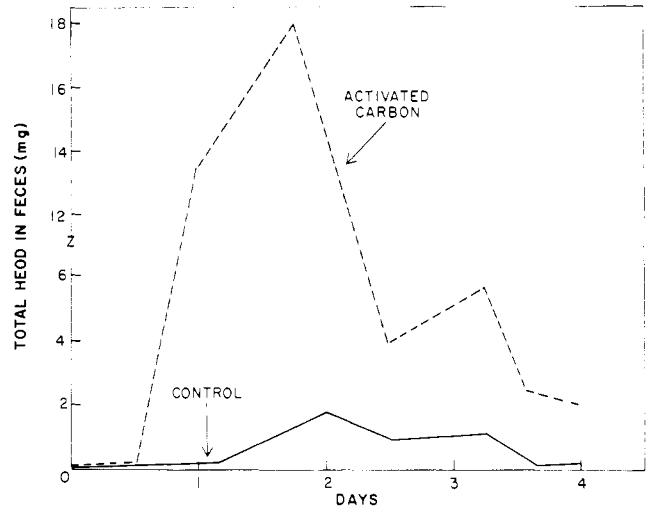

Figure 9. Effect of activated carbon on total HEOD excretion in the feces of goats

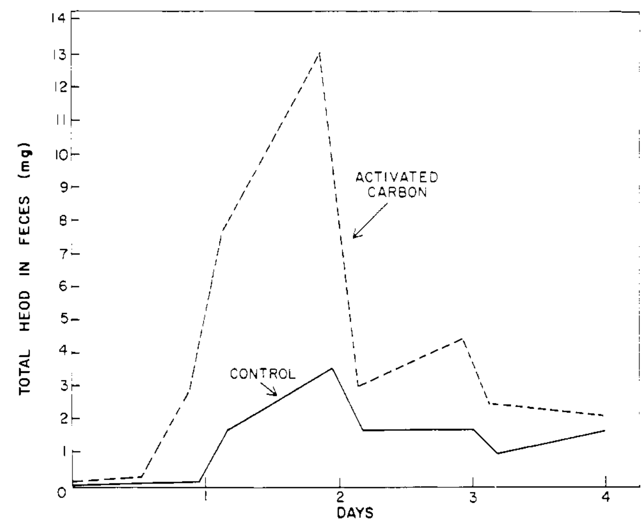

Figure 10. Effect of activated carbon on total HEOD concentration in feces of heifers

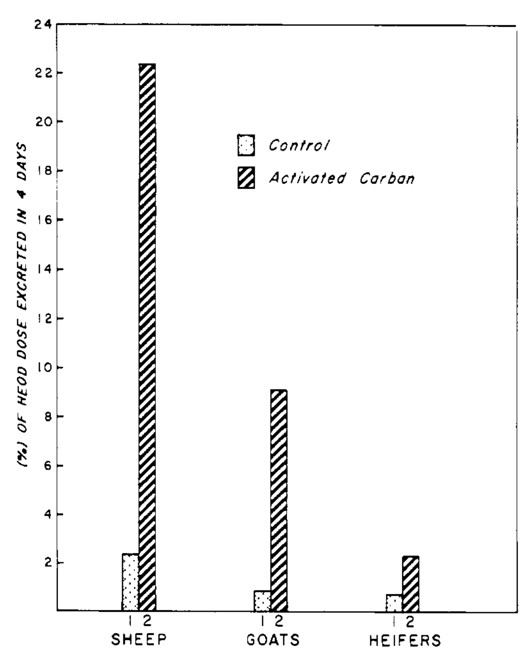

Figure 11. Percent of the total HEOD added to the rumen that was excreted in 4 days

Activated carbon has been shown by others to be a good antidote for poisons. Holt and Holz (1963) have presented a literature review on the use of activated carbon as an antidote. Decker *et al.* (1968) have shown that activated carbon will adsorb several drugs and poisons, including malathion, DDT, and *N*-methylcarbamate. Also, Picchioni *et al.* (1966) have shown that activated carbon adsorbs pentabarbital, strychnine, and malathion, and is an effective antidote for these drugs and poisons in rats.

Our experience with dairy herds show that Holstein cows will consume about 2 lb per head daily of 20 × 40 Darco activated carbon (Atlas Chemical Industries) when the carbon is fed free choice. Holstein cows have been fed 20 × 40 Darco in the grain mixture at approximately the rate of 1 lb per head daily for a period of 8 mo without adversely affecting milk production or health of the cows. Finely powdered activated carbon can be mixed with an equal weight of water and then successfully fed by mixing with the grain ration at the time of feeding. For cases of severe acute poison, it would be advantageous to drench cows with 3 to 4 lb of activated carbon and then feed as much carbon as the animal will consume.

Regardless of whether activated carbon is given at 2 or 4 g per kg of body weight, the data show that carbon is a good agent for binding HEOD in the gut. In cases of severe accidental contamination of cattle with HEOD, activated carbon can be an effective antidote, particularly if administered soon after contamination. Also, since HEOD is recycled from the blood to the gastrointestinal tract (Cook, 1970), carbon feeding beginning several weeks after contamination should be effective in increasing the rate of HEOD excretion in the feces.

ACKNOWLEDGMENT

The technical assistance of Betty Jean Zinn is gratefully acknowledged.

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Received for review September 9, 1969. Accepted February 2, 1970. Published with the approval of the Director of the Michigan Agricultural Experiment Station as Journal Article No. 4843.