Lowering the Volatility of Lindane Cattle Sprays by Addition of Film-Forming Material

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Approximately 20 grams of lindane per animal was safely applied to cattle in a chlorinated terphenyl mixture with a pressurized sprayer. This contrasts with application of emulsion at the rate of approximately 2 grams, normally considered safe when lindane is applied alone. Fly control was good for at least 4 weeks after one application of the mixture. The lindane concentration in whole milk was 8.4 p.p.m. on the first day and dropped to 0.1 p.p.m. by the 42nd day. Lindane absorption persisted for at least 1 week, but for the next 3 weeks low lindane absorption was accompanied by good insect control.

LINDANE HAS BEEN SPRAYED ON CATTLE to control livestock pests, but there are three drawbacks to its use. Toxic effects have been reported when sprays exceeding 0.1% have been used (*3*, *5*), and it is so volatile that frequent applications are necessary, and milk contamination results when it is sprayed on dairy cows (*1*, *2*).

The volatility of lindane can be materially lowered by incorporating it in a film-forming mixture of isomeric chlorinated terphenyls (Aroclor 5460, available from Monsanto Chemical Co., St. Louis, Mo.) (*4*, *8*). It therefore seemed probable that applying it in such a mixture without thoroughly wetting the animal—e.g., as a pressurized spray in a volatile solvent—would give an adherent deposit on the tips of the hairs, which would have little tendency to volatilize or be absorbed by the animal. Thus, higher dosages of longer lasting lindane might be safely applied.

In tests at the Kerrville, Tex., laboratory such a mixture was applied as a pressurized spray and compared with conventional applications of lindane emulsions. The entomological data and the results of chemical analyses for lindane in the milk of treated cows are presented below.

Entomological Data

A spray pressurized to 100 pounds per square inch with carbon dioxide and containing 454 grams each of lindane and the chlorinated terphenyl in 1 liter of methyl ethyl ketone was applied at the rate of approximately 20 grams of lindane per animal. One Jersey yearling was treated in mid-August. At various intervals thereafter 100 stable flies and 100 horn flies were released on the animal, which was caged in the insectary, and the time when all the flies were down was noted. Another animal was treated 5 weeks later, but because cold weather interfered with fly activity the duration of insecticidal effect could not be checked. However, neither of the cattle showed any symptoms of poisoning from the lindane. The results with the first animal were as follows:

Days after Treatment	Time for Complete Knockdown
1	20 min.
7	28
18	32
25	120
36	24 hours
44	24
50	24
54	48

For comparison, a Jersey yearling was treated with approximately 2 grams of lindane, normally considered a safe dosage, in a 0.05% emulsion. The animal was thoroughly wet with 2 quarts of the spray applied with a garden-type sprayer. The toxicity to insects was tested in the same way as on the animal receiving the pressurized spray. After 1 day all the flies were down in 20 minutes, but after 2 days the treatment was not effective.

The marked increase in the duration of effectiveness of the chlorinated terphenyl mixture over the emulsion was due in part to the ability to apply greater amounts of lindane without apparent injury to the animal. To compare the duration of similar deposits of lindane from the two treatments, two Jersey yearlings were sprayed over the entire body with lindane-chlorinated terphenyl as before and two other yearlings with a 1% lindane emulsion over an area 18 inches square until it was thoroughly wet. After 1 week and at various intervals thereafter hair was clipped from a 2-inch square on each animal and placed in a Petri dish with 20 heavily engorged stable flies. The results given in Table I again indicate that the lindane-chlo-

Table I. Comparative Duration of Effectiveness of Lindane-Chlorinated Terphenyl Pressurized Spray and Lindane Emulsion against Stable Flies on Cattle

	Chlorinated Terphenyl Pressurized Spray		Emulsion	
Weeks after Treatment	Min. for complete knockdown	% mortality in 24 hours[a]	Min. for complete knockdown	% mortality in 24 hours
1	14	100	25	100
	15	100	29	100
2	15	100	203	100
	15	100	235	100
3	18	100	...	85
	24	100	...	70
4	44	100	...	20
	51	100	...	25

[a] 70 and 75% after 6 weeks and 30% after 9 weeks.

rinated terphenyl mixture is more enduring than lindane alone.

Chemical Data

As it had been reported that lindane appears in the milk when it is sprayed directly on dairy cows (*1, 2*), lindane-in-milk concentrations were determined for both the chlorinated terphenyl and emulsion treatments.

At the Kerrville laboratory one cow was treated with each spray. The emulsion was applied to give approximately 2 grams of lindane, and the pressurized spray to give 20 grams each of lindane and chlorinated terphenyl. At appropriate intervals duplicate 475-ml. samples of whole milk were taken, preserved by the addition of 1 ml. of formaldehyde, packed in dry ice, and shipped by air to the Beltsville, Md., laboratory for analysis.

On arrival at Beltsville the milk samples were refrigerated for 48 hours, and then the cream layer was separated from the aqueous phase. The butterfat in turn was separated from the cream, by a modification of the detergent method for determining butterfat (*6*). The cream layer was poured into a 500-ml. Erlenmeyer flask, and 300 ml. of an aqueous solution containing 21 grams of sodium tetraphosphate and 9 grams of Triton X-100 was added. The flask was heated on a steam bath until the butterfat cleanly separated, and then the contents were poured into a 500-ml. separatory funnel. The butterfat rapidly rose to the top of the mixture, and was drained into a tared 250-ml. Erlenmeyer flask having a standard-taper 24/40 neck. The aqueous phase was discarded. The weight of the butterfat was recorded and 125 ml. of glacial acetic acid added. Twenty-five milliliters of the acid was distilled out to remove any volatile impurities that might interfere in the lindane determination (*7*). In this procedure the lindane is dechlorinated to benzene by means of zinc in acetic acid, and the benzene is nitrated to *m*-dinitrobenzene. In the presence of methyl ethyl ketone and strong alkali, *m*-dinitrobenzene gives a red color measurable at 565 mμ. As little as 5 γ of lindane can be determined in this manner.

Table II. Lindane in Milk from Two Cows Treated with Lindane (P.P.M.)

Days after Treatment	Emulsion	Chlorinated Terphenyl Mixture
1	0.85	8.4
2	0.41	6.0
3	0.27	4.6
5	0.21	5.2
7	0.10	2.7
14	0.05	0.74
21	0.03	0.44
28	...	0.19
35	...	0.18
42	...	0.10
49	...	0.05

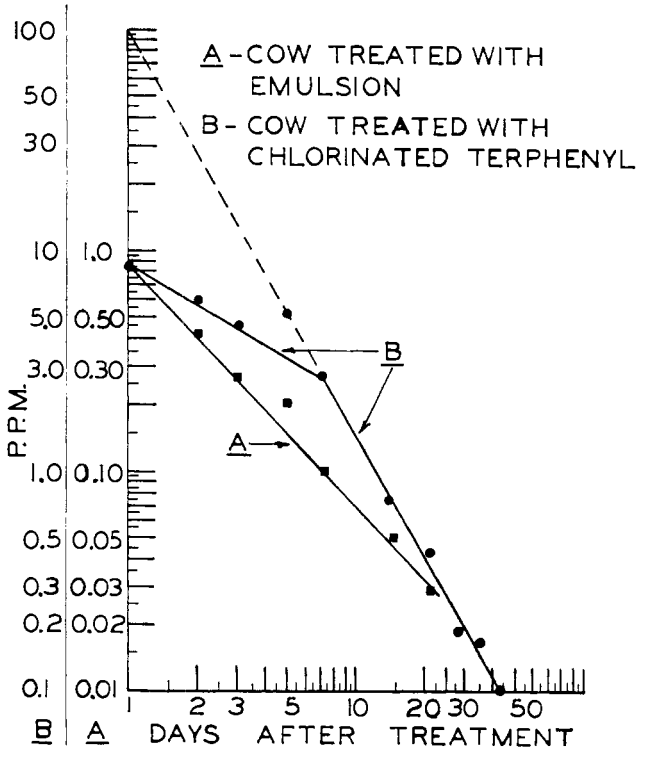
Milk samples from both cows prior to treatment were also analyzed for lindane. Blanks of less than 0.005 p.p.m. on a whole-milk basis were found; therefore, all values obtained are considered significant. The analytical results are presented in Table II.

When plotted on log-log paper (Figure 1), the data for the emulsion (curve *A*) yield the straight line and those for the chlorinated terphenyl mixture are shown in curve *B*. If that part of curve *B* having the sharper slope is extrapolated back to the 1-day intercept, an apparent value of nearly 100 p.p.m. of lindane in milk is obtained instead of the 8.4 p.p.m. actually found. This curve may therefore be interpreted as indicating that lindane was being absorbed from this deposit until about the seventh day, for thereafter the lindane concentration decreased rapidly as in curve *A*.

The high initial concentration of lindane in milk and the continued absorption for the first week may be due to the fact that in the mixture selected the solubility of lindane in the chlorinated terphenyl deposit is exceeded, and there is an initial needlelike lindane "bloom," which readily volatilizes and causes rapid insect kill. These lindane vapors very close to the animal's skin may have been readily absorbed. Furthermore, there may have been a more thorough wetting of the animal than anticipated.

Although lindane absorption slowed down appreciably after 1 week, its toxicity persisted for at least 4 weeks—that is, insect control was maintained without appreciable lindane absorption. Increasing the ratio of chlorinated terphenyl to lindane would eliminate crystal formation and might minimize lindane absorption.

Figure 1. Lindane in milk from two cows treated with lindane



Conclusion

Lindane dosages 10 times normal were applied to cattle without harmful effects by using a lindane-chlorinated terphenyl mixture in a pressurized spray. Fly control was good for 4 weeks after only one application. The high initial concentration of lindane in milk requires further work before this type of treatment can be recommended for use on dairy or beef cattle.

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