Wash-off Potential of Pyrethroids after Use of Total Release Foggers

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Introduction

Total release foggers (also known as "bug bombs") are available for the general public's use. In California, more than 60 products are registered for this particular type of formulation, commonly utilizing pyrethroids as an active ingredient. These products are often used to target bed bugs, fleas, or cockroaches. However, the efficacy of these fogger products to control insects in harborage sites has been brought into question [1].

Pyrethroids are frequently detected in wastewater effluent, representing a source of toxicity to the waters into which they discharge [2]. One recent study [3] suggested that pyrethroid inputs from indoor cleaning activities within residential areas is a significant source of pyrethroids in wastewater. With an estimated use of 50 million total release foggers used annually [4], these products represent a significant release of pyrethroids into households. This represents a potential source of pyrethroids entering the municipal water system, through the washing of contaminated surfaces and items.

This study investigates this potential by determining how much cypermethrin is removed from various surfaces after the activation of a total release fogger and how effective water is at removing these insecticides after fogger use.

Materials and Methods

A 10 × 10 ft tent (Ozark Trail 6-Person ConnecTent) was set up with interconnecting foam floor tiles (≈9 × 9 ft; Cap Barbell, Inc.) and covered with butchers' paper. A fogger (Hotshot Fogger with Odor Neutralizer, 0.05% tetramethrin, 0.75% cypermethrin) was centrally placed and elevated (0.5 m) on a leveled plastic cylinder. The fogger was activated and the tent immediate sealed. The tent remained sealed overnight to allow for complete settling of the product.

Eight filter paper squares (5 × 5 cm) were evenly spaced in a square (1.66 × 1.66 m) surrounding the central fogger. Tile, vinyl, and wood squares were arranged 5 cm around each filter paper. The filter paper was extracted by cutting out 1 × 1 cm square from top left corner, placing into a vial and adding 200 µl hexane before vortexing. To extract each material, a clean 1 × 1 square of filter paper was placed on the top left corner and 20 µl deionized water was applied to the paper before dragging down the left edge of the square for 10 cm. These papers were then extracted with 200 µl hexane.

Twenty-four points were evenly arranged in a square (1.66 × 1.66 m) surrounding the central fogger. A 5 × 5 cm piece of filter paper and a 5 × 5 cm piece cotton fabric were placed 1 cm on each side of the point. After fogger settling, three 1 × 1 cm squares were cut out of the top left corner of each material and placed into separate vials.

Three extractions methods, using hexane, water, and water + detergent (1% liquinox), were conducted on each material. To extract with hexane, 200 µl was added to the vial and then vortexed. Water extraction was done by adding 200 µl of deionized water to vial and removing the square before adding 200 µl hexane. Water + detergent extraction was done by adding 200 µl of a 1% liquinox solution to the vial. After vortexing, the filter paper or fabric square was removed and 200 µl hexane added. After vortexing, the samples were frozen to separate liquinox from the hexane layer. 40 µl of the hexane layer was removed and placed into a new vial containing a glass insert for analysis.

Quantification of all samples was done using an automatic liquid sampler (ALS) device injecting 2 µl of the hexane extract onto an Agilent 7890 gas chromatograph equipped with a DB-5 column (30 m × 0.25 mm inner diameter) and a flame ionization detector. Helium was used as the carrier gas and samples were injected in splitless mode, with a temperature program of 50°C for 1 min and then 10°C min^{-1} to 300°C with 10-min hold. The quantities of cypermethrin were determined by running a series of eleven standards of technical grade cypermethrin in concentrations ranging from 70 µg/ml to 0.3125 µg/ml that were regressed through the origin. The amount of cypermethrin was determined for each sample and statistical analyses were done using R version 3.6.1.

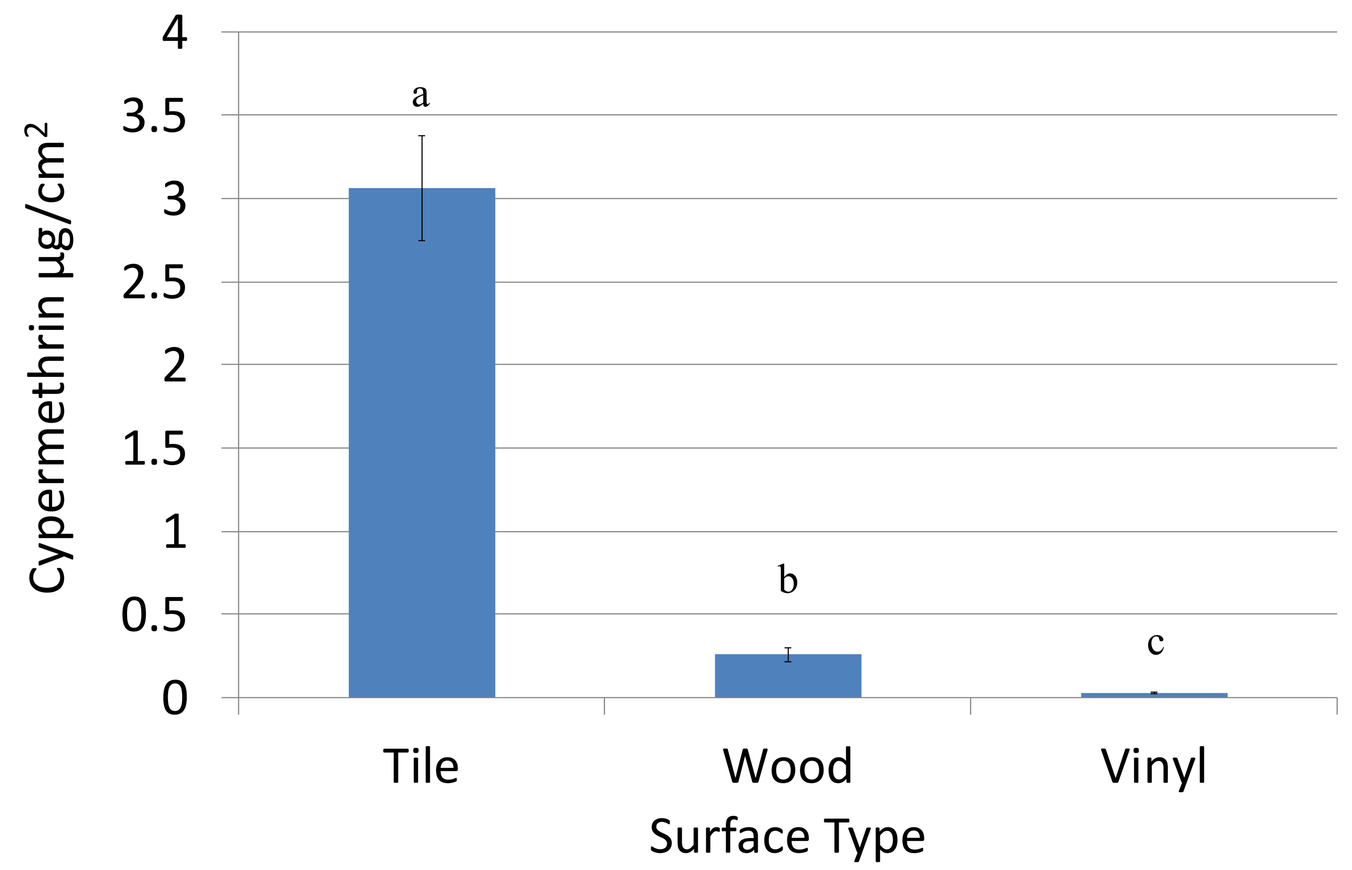

Fig. 1. Average amount of cypermethrin removed (n = 8) from various surfaces. Error bars represent standard error. Letters represent significant differences (Dunn's Multiple Comparisons; $P < 0.05$).

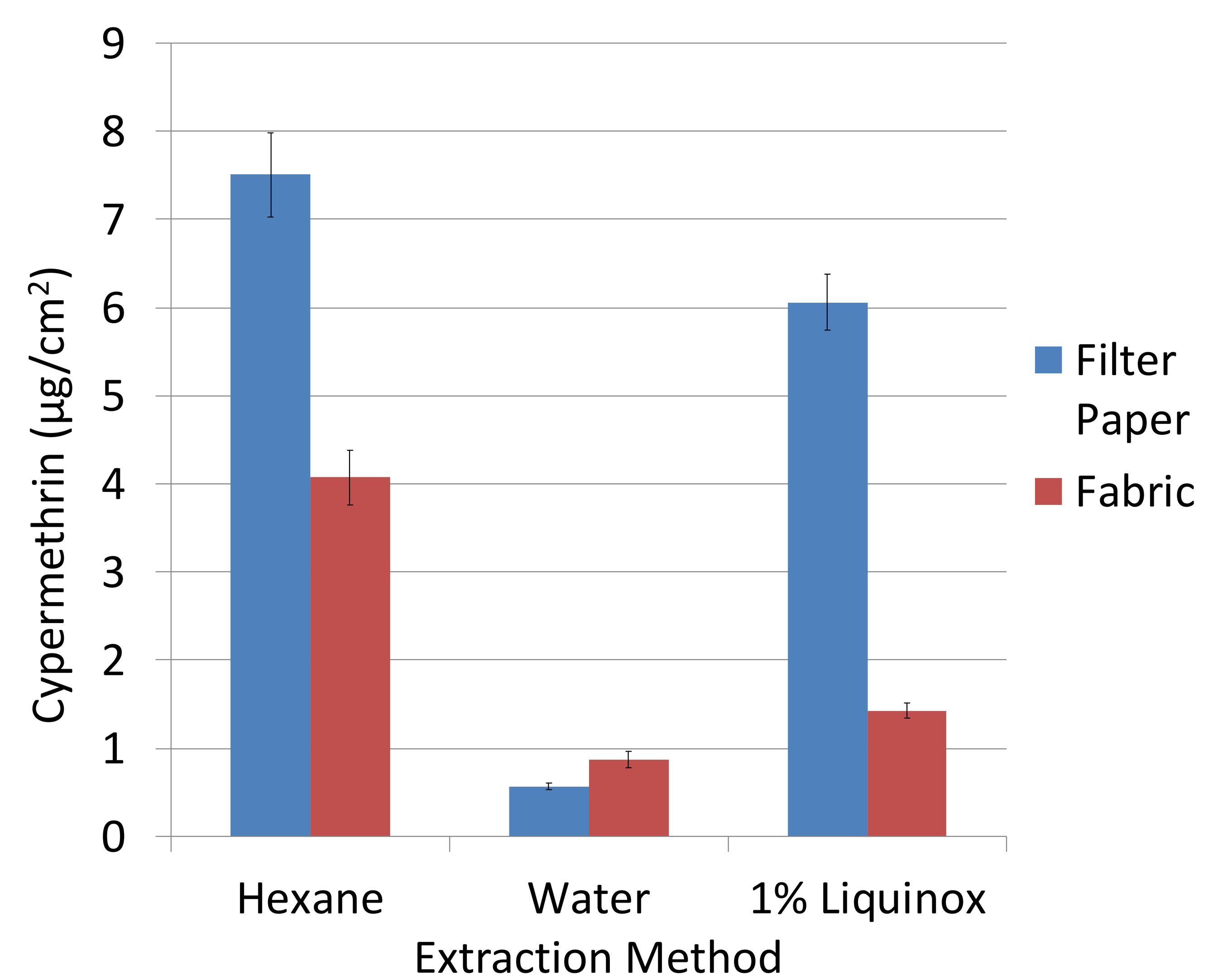

Fig. 2. Average amount of cypermethrin recovered (n = 24) using various solvents. Error bars represent standard error.

Results

The amount of cypermethrin recovered from the filter paper (6.29 ± 0.57 µg/cm^2) provides an estimate for the total amount deposited onto each surface. The type of material had a significant effect on the amount of cypermethrin removed from each surface, $H(3) = 20.5$, $P < 0.001$. The amount recovered from tile, vinyl and wood were all significantly distinct (Dunn's Multiple Comparisons; $P < 0.05$, Figure 1).

There was a significant main effect of extraction method $F(2, 138) = 169.1$, $P < 0.001$ and material $F(1, 138) = 130.6$, $P < 0.001$ on the amount of cypermethrin removed (Figure 2). There was also a significant interaction between the extraction method and type of material $F(2, 138) = 43.1$, $P < 0.001$ on the amount of cypermethrin removed (Figure 2).

Conclusion / Future Directions

Our results suggest that relatively large fractions of insecticides deposited by total release foggers can be removed from some materials. This suggests several possible ways that insecticides from foggers can enter the municipal water supply, such as the cleaning of exposed surfaces or the washing of contaminated clothing. This provides circumstantial evidence that some pyrethroids entering municipal wastewater likely originates from fogger products.

Additional work will investigate the deposition pattern of total release foggers, how well the insecticides are recovered from carpeting, and the effectiveness against insecticide resistant urban pests.

References

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