

Duration of Effectiveness of Permethrin-Treated Clothing to Prevent Mosquito Bites Under Simulated Conditions

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Introduction

- Biological hazards such as exposure to ticks and mosquitoes can affect worker health.
- Permethrin is a repellent/insecticide approved for human use by the Environmental Protection Agency.
- Permethrin-treated clothing is commercially available to the public.
- Permethrin-treated clothing (50% cotton/50% nylon) has been shown to retain repellency through 70 washings.
- Work attire differs between state and consulting foresters, park rangers, etc.; hence, variation in protection from vector borne disease may exist and affect risk assessments.

Objective

- Evaluate the extent to which pesticide treatment, fabric type, light, temperature, and number of washes impacts permethrin content and mosquito knockdown / mortality rates.



Aedes albopictus

Materials and Methods

- We evaluated the extent to which:
 - Fabric type (100% cotton denim jeans, 100% polyester work shirt, 35% cotton/65% polyester United States Forester uniform work shirt)
 - Light exposure (0 or 100%)
 - Temperature (18°C, 32°C)
 - Number of washes (0, 3, 12, 36) affected mosquito knockdown two hours post-exposure (hpe), mosquito mortality 24 hpe, and permethrin content.
- Each group was replicated once (N = 96 fabric swatches; 5 cm²).
- Mosquitoes (N ≈ 10 female *Aedes albopictus*) were transferred to funnels placed over fabric swatches for 3 min (adapted from World Health Organization Pesticides Evaluation Scheme [WHOPES]); transferred to separate cages; provided 20% sucrose.
- Knockdown (2 hours post-exposure; hpe) and mortality (24 hpe) were categorized prior to statistical analyses: a) $x < 0.20$, b) $0.40 > x > 0.19$, c) $0.60 > x > 0.39$, d) $0.80 > x > 0.59$, e) $x > 0.79$.
- Permethrin extracted from fabric swatches; quantified using gas chromatograph (GC-FID).
- Logistic regression to predict the likelihood of knockdown/mortality.
- Analysis of variance to evaluate differences in permethrin content.

Acknowledgements

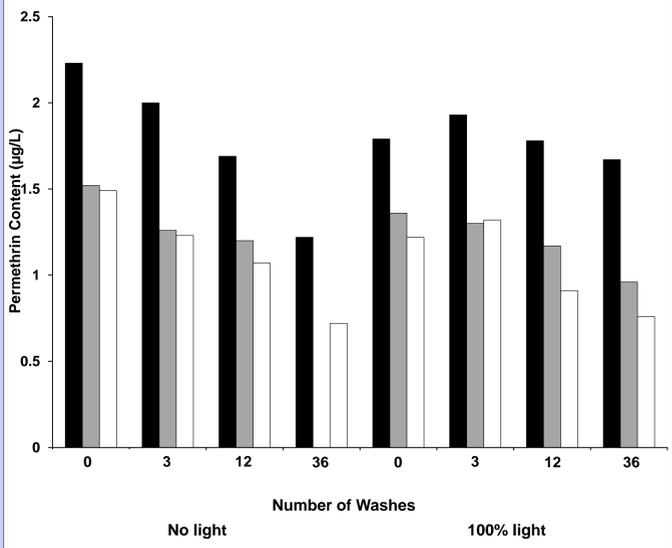
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Results

Table 1. Logistic regression testing the relationships of categorized proportions of *Ae. albopictus* at 2 hpe (knockdown) and 24 hpe (mortality) to fabric type, light exposure, pesticide treatment, temperature, and number of washes.

Variable	2 hpe			24 hpe		
	df	χ^2	P	df	χ^2	P
Fabric	2	5.61	0.061	2	3.08	0.214
Light	1	6.86	0.009	1	26.50	< 0.0001
Pesticide	1	80.85	< 0.0001	1	57.39	< 0.0001
Temperature	1	1.93	0.165	1	3.62	0.057
Washes	3	66.89	< 0.0001	3	28.28	< 0.0001
Likelihood ratio	8	217.29	< 0.0001	8	108.76	< 0.0001

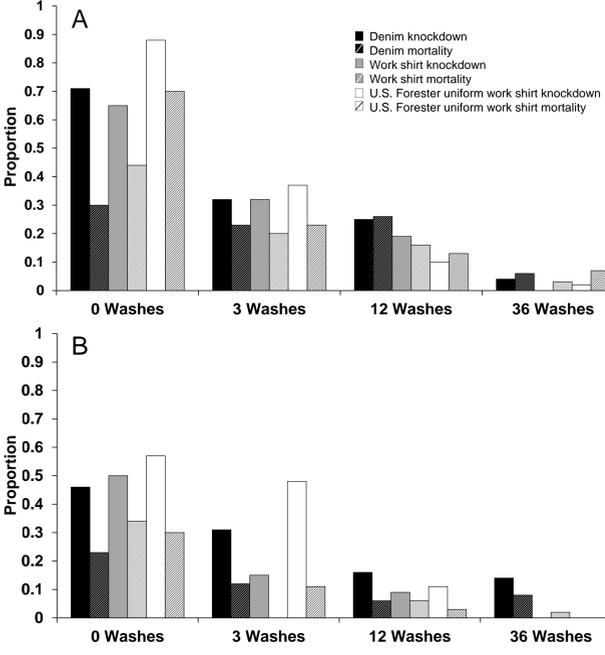
Figure 1. Permethrin content ± standard error in fabrics experiencing different numbers of washes and light exposure.



- Permethrin content was significantly impacted by fabrics (highest in denim), light exposure (highest in no light group), and numbers of washes (highest in 0 wash group).
- Temperatures tested here did not affect permethrin content.

Results

Figure 2. Proportion of *Ae. albopictus* experiencing knockdown (2 hpe) or mortality (24 hpe) after being exposed to different fabrics for 3 min with no light (A) or 100% light (B) exposure.



- Washing and light exposure, but not temperature, significantly reduced the ability of permethrin-treated fabric to induce mosquito knockdown and/or mortality.

Observations and Conclusions

- Washing fabrics reduced permethrin content and mosquito effects.
- Denim (100% cotton) exhibited higher permethrin content than the work shirt (100% polyester) and the U.S. Forester uniform shirt (35% cotton, 65% polyester); however, mosquito knockdown and mortality was not different between fabrics.
- Mosquito knockdown did not always lead to mortality at 24 hpe.
- Long-lasting impregnation of uniforms protects against biological hazards such as mosquito bites under simulated laboratory conditions employed here for < one year.
- Employers and employees should recognize occupational health risks and consider using permethrin-impregnated clothing in addition to daily repellent sprays.