Introduction

- Biological hazards such as exposure to ticks and mosquitoes can affect worker health.
- Permethrin is a repellant/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.

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% light)
  - 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 [WHOPECS]); 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 Aedes albopictus at 2 hpe (knockdown) and 24 hpe (mortality) to fabric type, light exposure, pesticide treatment, temperature, and number of washes.

<table>
<thead>
<tr>
<th>Variable</th>
<th>2 hpe</th>
<th>24 hpe</th>
</tr>
</thead>
<tbody>
<tr>
<td>df</td>
<td>χ²</td>
<td>P</td>
</tr>
<tr>
<td>Fabric</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>5.61</td>
<td>0.061</td>
</tr>
<tr>
<td>1</td>
<td>6.86</td>
<td>0.009</td>
</tr>
<tr>
<td>Pesticide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>80.85</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1.93</td>
<td>0.165</td>
</tr>
<tr>
<td>Washes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>66.89</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Likelihood ratio</td>
<td>8</td>
<td>217.29</td>
</tr>
</tbody>
</table>

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.

Figure 2. Proportion of Aedes 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.