

FLORIDA A&M UNIVERSITY

# Laboratory Efficacy & Duration of Two New CDC Recommended Repellents Compared to DEET Against the Southern House Mosquito, *Culex quinquefasciatus*

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## ABSTRACT

Two commercial formulations of picaridin [Cutter Advance® (7% picaridin) and Cutter Advance Sport® (15% picaridin)] and one formulation of oil of lemon eucalyptus (Repel Lemon Eucalyptus® 40%) were evaluated *in vivo* against *Culex quinquefasciatus* using a modification of the K&D module technique developed by Klun & Debboun (2000). Comparisons were made with two standard DEET repellents [Off! Insect Repellent® (14%) and Off! Skintastic® (7%)] and a non-treated control. Complete protection (i.e., 100% repellency) was provided by both the 15% picaridin and 14% DEET for 6 hrs post-treatment. Repellency was also similar between the 7% formulations of picaridin and DEET, although complete protection extended for only 2 hrs post-treatment. The botanical repellent, Repel Lemon Eucalyptus 40% provided complete protection for 4 hrs post-treatment.

## INTRODUCTION

The Centers for Disease Control and Prevention (CDC) recently added two new ingredients, picaridin and oil of lemon eucalyptus (p-menthane 3,8-diol), to the agency list of recommended repellents. This was based on efficacy data published in the literature for a limited number of mosquito species. This study was performed to evaluate three new, commercial products containing these ingredients against *Culex quinquefasciatus*, the southern house mosquito, a major vector species in the southern U.S. Neither these products, nor this species have been tested to date.

## OBJECTIVES

1. Evaluate the repellency and duration of commercial formulations of picaridin and oil of lemon eucalyptus against *Cx. quinquefasciatus*.
2. Compare repellency with standard commercial formulations containing DEET (N,N-diethyl-meta-toluidide).

## MATERIALS & METHODS

1. 10 starved female *Cx. quinquefasciatus* were aspirated into each of 6 chambers within K&D repellent test modules (Fig. 1).
2. Clear packing tape was applied to the base of the modules and cut open to expose the sliding doors. The tape was removed and replaced after the module was alcohol swabbed between assays to reduce contamination.
3. Six randomly assigned treatments were applied at 28.6 µl to 12 cm<sup>2</sup> rectangles drawn on the skin surface of the upper legs with a ball-point pen and template matching the door openings.
4. Treatments were separated by one chamber to reduce repellent interaction so that three treatments were tested per leg. The three remaining treatments were tested by rotating the chamber 180° to the opposite leg, thus utilizing all six chambers.
5. Two-minute biting counts were performed for each of the six treatments consisting of five test repellents (Fig. 2) and a non-treated control.

6. Three replicate assays were performed by each of three evaluators utilizing multiple modules placed in turn on the top and both sides of the upper legs.
7. Assays were repeated at 0, 1, 2, 4 & 6 hrs. post-treatment with freshly stocked mosquitoes and cleaned modules between time intervals.
8. Percent repellency was calculated by subtracting the number of bites in treatment from control divided by control multiplied by 100.
9. Each evaluator completed an informed consent form and the studies were approved by the FAMU IRB for human subjects testing.

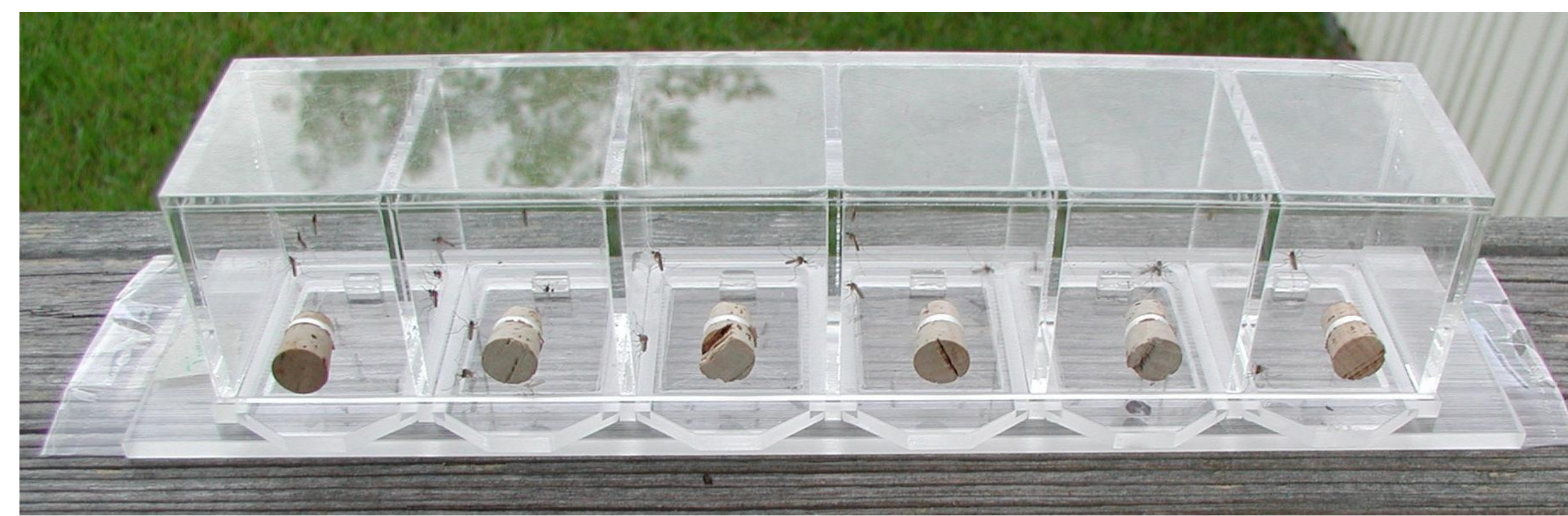


Fig. 1. K&D Plexiglas repellent test module equipped with 6 mosquito-holding chambers and sliding doors to expose mosquitoes to treated skin surface.



Fig. 2. Test products from left to right – 2 DEET standards, 2 picaridin formulations and 1 botanical oil.

## RESULTS & DISCUSSION

Fig. 3 presents the biting counts by treatment for each of the post-treatment time intervals. As expected, biting counts in the non-treated control (blue bars) were consistently higher than the repellent treatments. Biting pressure occurred throughout the day, increasing later in the day. Biting counts for the repellents did not occur until the 4 hr time interval and then only in the lower concentration DEET and picaridin formulations. Biting counts also occurred at the 6 hr interval for the oil of lemon eucalyptus. There were no bites in the higher concentration DEET or picaridin formulations.

Fig. 4 converts biting counts to % repellency for each product by time interval. Complete protection (100% repellency) was provided by the higher DEET and picaridin formulations (Off! Insect Repellent® and Cutter Advance Sport®). The lower DEET and picaridin formulations (Off! Skintastic® and Cutter Advance®) also performed similarly with 100% repellency out to 2 hrs post-treatment. The botanical repellent (Repel Oil of Lemon Eucalyptus®) provided complete protection for 4 hrs post-treatment and performed closer to the higher concentration DEET and picaridin formulations.

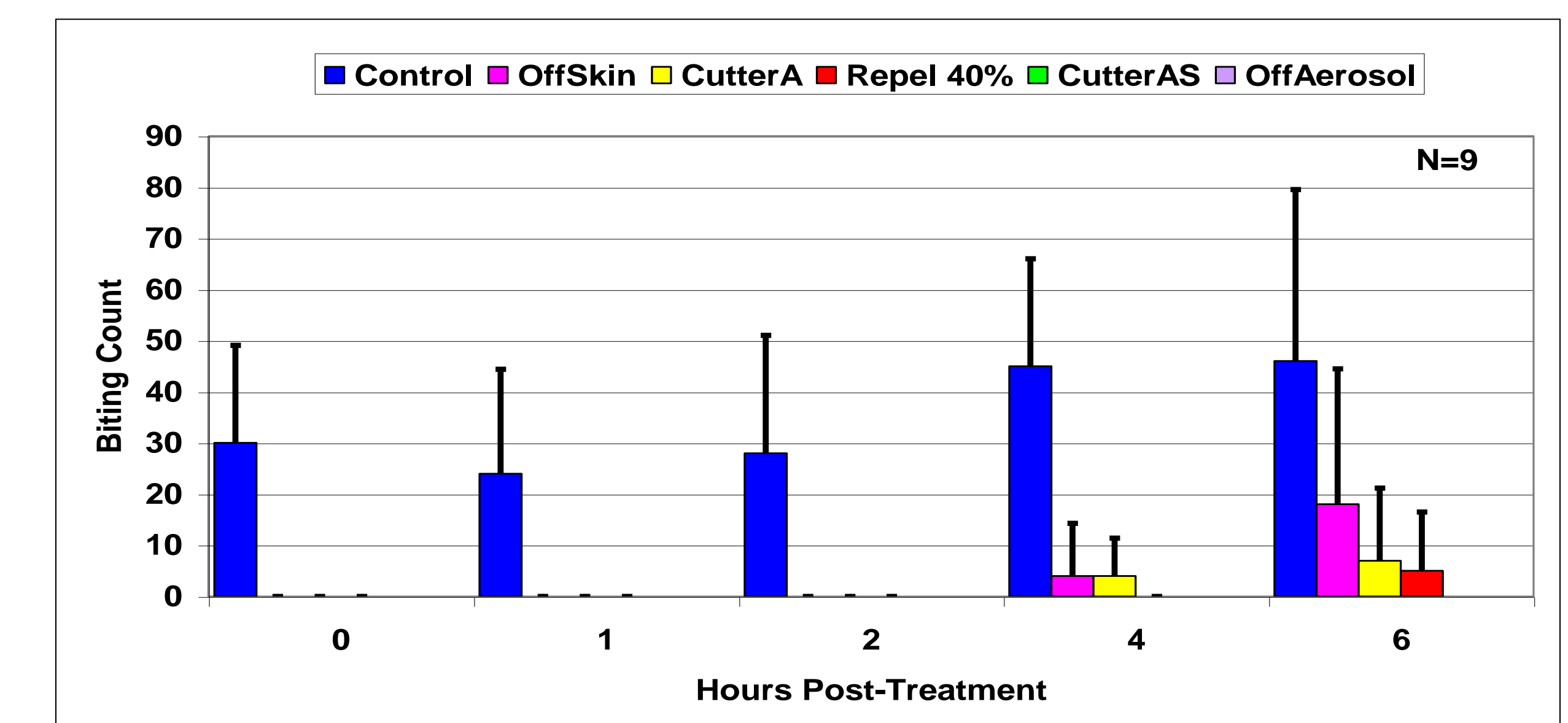


Fig. 3. Comparative biting counts for each treatment by time interval.

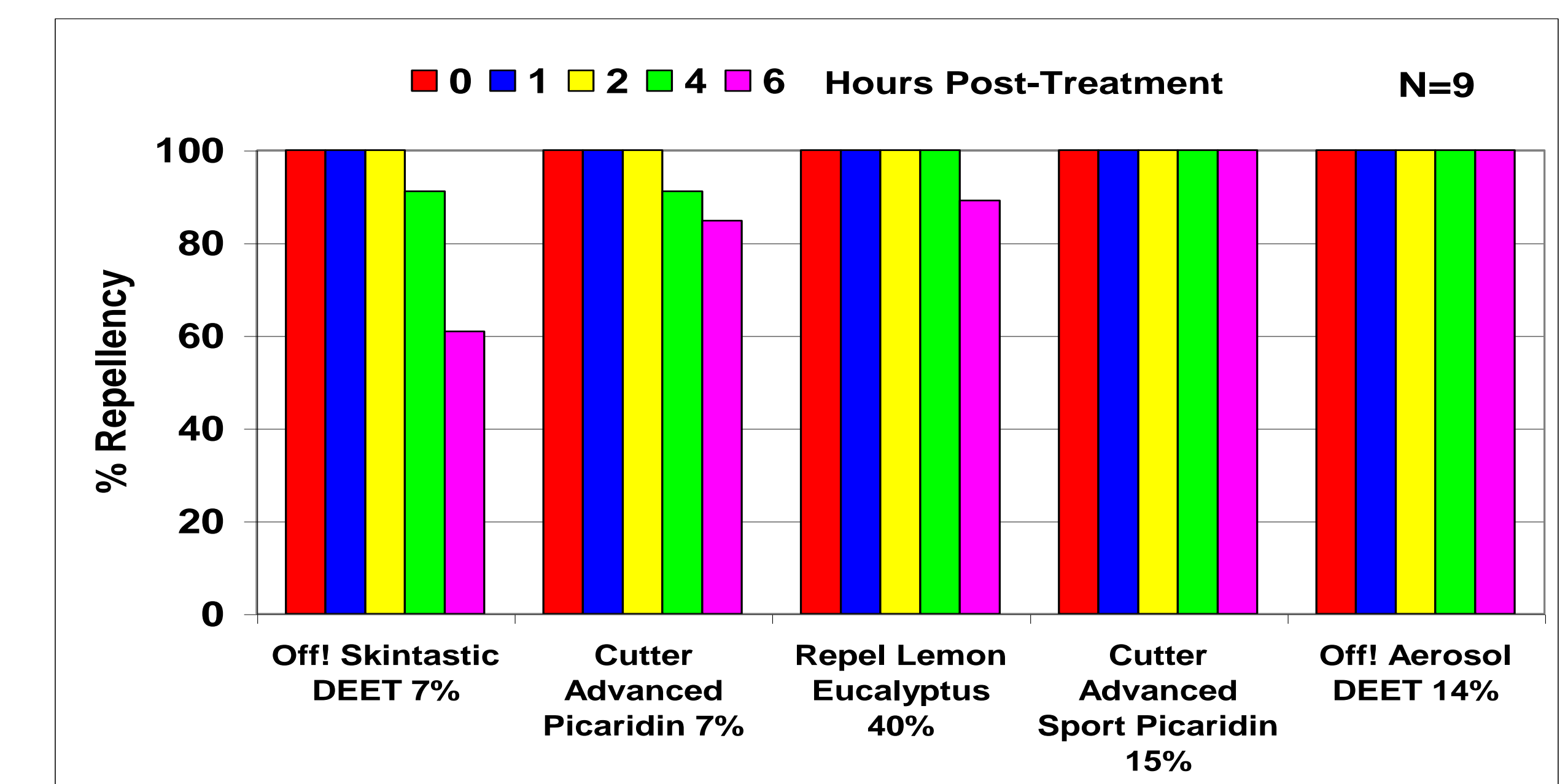


Fig. 4. Percent repellency by time interval for each product.

## CONCLUSIONS

Picaridin performed as well as DEET against *Cx. quinquefasciatus*. Repel Lemon Eucalyptus 40% appears to be a good repellent for persons interested in a plant-based alternative. It outperformed both the lower DEET and picaridin formulations.

## LITERATURE CITED

Klun, J. A. & M. Debboun. 2000. A new module for quantitative evaluation of repellent efficacy using human subjects. *J. Med. Entomol.* 37(1): 177-181.