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## REPELLENT ACTIVITY OF A PROPRIETARY BATH OIL (SKIN-SO-SOFT®)<sup>1</sup>

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**ABSTRACT.** A proprietary bath oil (Skin-So-Soft®) containing mineral oil, isopropyl palmitate, diisopropyl adipate, fragrance, dioctyl sodium sulfosuccinate and benzophenone was tested on the forearm for re-

pellency to the yellow fever mosquito, *Aedes aegypti*. The median effective dosage (ED50) and effective half-life ( $t_{1/2}$ ) of the product were estimated at 0.09 mg/cm<sup>2</sup> and 1.6 hours, respectively.

Recently we have learned through person-to-person channels that a commercial product, Skin-So-Soft® bath oil (Avon Products, Inc., New York), is widely used as a mosquito repellent. According to the label this product contains mineral oil, isopropyl palmitate, diisopropyl adipate, fragrance, dioctyl sodium sulfosuccinate and benzophenone-11.

fever mosquito, *Aedes aegypti* (Linn.). These tests were terminated in October 1979 for reasons of "economy," but during the period of testing we were able to establish that Skin-So-Soft bath oil is a true repellent for *Ae. aegypti* and to obtain some indication of its relative persistence on the skin.

Schreck and Kline (1981) tested Skin-So-Soft bath oil for repellency against several species of *Culicoides* (Diptera, Ceratopogonidae). They reported that Skin-So-Soft bath oil did not repel these insects but did trap them in the film formed by the material on the skin and prevent them from biting.

### MATERIALS AND METHODS

In July 1979 we initiated a series of tests of Skin-So-Soft bath oil against the yellow

**TEST INSECTS.** The University of California at San Francisco (UCSF) strain of *Ae. aegypti* was used in the tests. These were reared and maintained as described previously (Rutledge et al. 1978).

**TEST MATERIAL.** The material tested was a commercial sample of Skin-So-Soft bath oil.

**TEST METHODS.** The median effective dosage (ED50) of Skin-So-Soft bath oil for *Ae. aegypti* was determined by a modification of the method of Buescher et al. (1982a). Five circular test areas (29 mm diam) were outlined on the flexor region of the forearm with a plastic template and a fine-tipped felt pen. The 5 test areas were then treated at random with 0.0625,

<sup>1</sup> Use of trade names in this report does not imply official approval or indorsement of the items mentioned. Opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the Department of the Army or the Department of Defense.

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0.125, 0.25 and 0.5 mg/cm<sup>2</sup> of Skin-So-Soft bath oil in ethanol and ethanol only, as a control. Five minutes after application of the test material a test cage (see Buescher et al. 1982a for illustration) containing 15 nulliparous female *Ae. aegypti* (age range 5 to 15 days) was fastened to the treated forearm and a slide was withdrawn to permit the mosquitoes access to the 5 circular test areas through matching cutouts in the cage floor. The number of mosquitoes feeding on each of the 5 test areas was recorded 1.5 min after the slide was withdrawn. This procedure was replicated 26 times over a period of 7 days using 3 volunteers. A new mosquito test population was used for each replicate. The ED<sub>50</sub> of the test material was determined from the test data by the maximum likelihood method of probit analysis (Finney 1947).

The 4-hour ED<sub>50</sub> of Skin-So-Soft bath oil was determined in the same way, except that the test cage was not applied to the forearm until 4 hours after application of the test material. The 4 dosages of Skin-So-Soft bath oil applied were 0.5, 1, 2 and 4 mg/cm<sup>2</sup>. The test procedure was replicated 10 times over a period of 4 days using the same volunteers as before.

The effective half-life ( $t_{1/2}$ ) of Skin-So-Soft bath oil was determined by similarly testing a high dosage (3.9 mg/cm<sup>2</sup> Skin-So-Soft bath oil) and a control (3.9 mg/cm<sup>2</sup> ethanol) at 0, 2 and 4 hours post-application, replicated 24, 16 and 16 times, respectively, using 3 volunteers. The  $t_{1/2}$  of the test material was graphically estimated from the test data (Axtell 1967).

The volunteers participating in this study gave free and informed voluntary consent, and the investigators adhered to Army regulation 70-25 and Army Medical Research and Development Command regulation 70-25 governing the use of volunteers in research.

## RESULTS AND DISCUSSION

The results obtained in the ED<sub>50</sub> and 4-hour ED<sub>50</sub> tests are shown in Fig. 1.

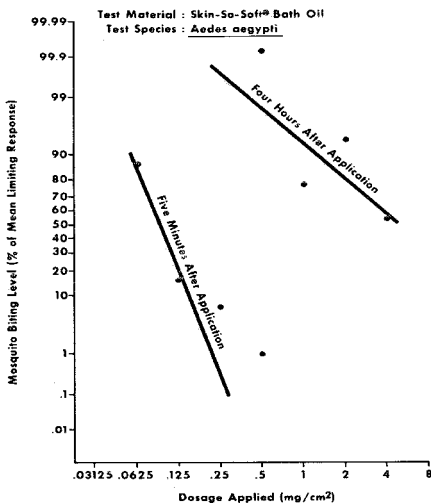


Fig. 1. Dose-response regression lines for repellency of Skin-So-Soft® bath oil to *Aedes aegypti* at 5 minutes and at 4 hours post-application. The ordinate of the point at (0.5, 99.92) was plotted as the working probit because the mean number of mosquitoes biting at that dosage (4.20 bites per replicate) was greater than the mean limiting response (4.04 bites per replicate) and the empirical probit could not be calculated.

The maximum likelihood estimate of the ED<sub>50</sub> of Skin-So-Soft bath oil for *Ae. aegypti* was 0.09 mg/cm<sup>2</sup> (95% confidence limits 0.05 to 0.13 mg/cm<sup>2</sup>). For comparison, the ED<sub>50</sub> of *N,N*-diethyl-*m*-toluamide (deet) for *Ae. aegypti*, as determined by the same method on the same strain, is 0.003 mg/cm<sup>2</sup> (Buescher et al. 1982b). On the basis of these figures it can be concluded that *Ae. aegypti* is about 30 times more sensitive to deet than to Skin-So-Soft bath oil.

When tested against *Ae. aegypti* 4 hours after application, Skin-So-Soft bath oil provided less than 50% protection, even at maximal dosages (Fig. 1). The highest dosage tested (4.0 mg/cm<sup>2</sup>) is the approximate runoff dosage for this material. For comparison, the 4-hour ED<sub>50</sub> of deet for *Ae. aegypti*, as determined by the

same method on the same strain, is 0.2 mg/cm<sup>2</sup> (Buescher et al. 1982b). Thus, although our data are not definitive, it seems clear that Skin-So-Soft bath oil would be less effectual than equimolar deet for long-term protection from *Ae. aegypti*.

The results obtained in the effective half-life tests are shown in Fig. 2. The effective half-life of Skin-So-Soft bath oil on the skin was estimated from this graph to be approximately 1.6 hours. No strictly comparable figure for deet is available for comparison.

The foregoing data demonstrate that Skin-So-Soft bath oil is an effective repellent for *Ae. aegypti*, although it is not as active or persistent on the skin as deet. The repellent activity of Skin-So-Soft bath oil is not surprising, since it has been known for many years that two of its ingredients, diisopropyl adipate and benzophenone, are repellent to *Ae. aegypti* (King 1954). It is possible that the fragrance of Skin-So-Soft bath oil may have repellent and/or fixative properties as well (Khan et al. 1975, Novak and Paulova 1977). However, it is not possible to determine from our data alone whether any of the separate ingredients of Skin-So-Soft bath oil might be more effective or more persistent than deet or other standard repellents if tested on an equimolar basis.

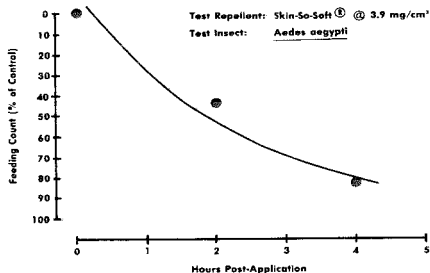


Fig. 2. Persistence of Skin-So-Soft® bath oil on the skin as measured by its residual repellency to *Aedes aegypti*. The curve was sketched to represent a first order decay process.

Although Skin-So-Soft bath oil is not, gram for gram, as effective or persistent as native deet, it may well be competitive with many commercial insect repellent formulations that contain only small amounts of deet or other repellents. This can, of course, be determined only by direct comparison, and this is evidently occurring in the marketplace and field at the present time. The relative costs of Skin-So-Soft bath oil and the available commercial repellents will no doubt play an important part in the outcome of this process. Our information in this regard is that, although prices vary widely, commercial insect repellents are usually several times more expensive than Skin-So-Soft bath oil on a unit cost basis.

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