

MOSQUITO REPELLENT ACTION OF NEEM (*AZADIRACHTA INDICA*) OIL

V. P. SHARMA, M. A. ANSARI AND R. K. RAZDAN

Malaria Research Centre, 22 Sham Nath Marg, Delhi 110 054, India

ABSTRACT. Two percent neem oil mixed in coconut oil, when applied to the exposed body parts of human volunteers, provided complete protection for 12 h from the bites of all anopheline species. Application of neem oil is safe and can be used for protection from malaria in endemic countries.

Mosquito coils and mats containing synthetic pyrethroids have been employed in many areas of the world for protection against mosquito bites. The relative efficacy of each method varies considerably (Curtis et al. 1987). Prolonged use of insecticides in repellents may also produce harmful results (Liu et al. 1987) and requires standardization and quality control (Coene et al. 1989), which is seldom the case. A variety of natural and synthetic repellents have been used for protection from biting insects (Curtis et al. 1989). We report the results of field studies on the repellent action of neem oil in India. This is the first report of the repellent action of neem oil (extracted from the seeds of *Azadirachta indica* A. Juss [Meliaceae]) on mosquitoes.

The repellent action of neem oil was tested in the villages of Ramgarh and Bhel-Akbarpur, which are about 30 km east of Delhi. These experimental villages have a high malaria transmission rate, with many larval mosquito habitats producing large anopheline populations. *Anopheles culicifacies* Giles is the vector of malaria in this area and it has been incriminated again in recent years (Subbarao et al. 1988). In this region, the vector has become resistant to DDT and HHC and there are no practical and sustainable methods for vector control. Baseline data collected during 1991 on the mosquito fauna of Ramgarh and Bhel-Akbarpur villages revealed that it comprised 7 species of anophelines (65%) and 2 culicines (35%). Mosquito densities were monitored at fortnightly intervals by hand catching methods in 8 rooms and 8 cattle sheds. Based on these data, the yearly average man-hour densities of anophelines and culicines were 183 (range 39-641) and 137 (range 69-210), respectively. Among the anophelines, 60-70% of the specimens were *An. culicifacies*, 20-35% were *Anopheles subpictus* Grassi and 10-15% were *Anopheles annularis* Van der Wulp. Other anophelines, viz., *Anopheles stephensi* Liston, *Anopheles aconitus* Dönitz, *Anopheles pulcherrimus* Theobald and *Anopheles nigerrimus* Giles, were encountered only occasionally.

Neem oil was mixed at 0.5, 1.0 and 2.0% strength in coconut oil. Three to 5 ml of this oil mixture was applied to the face, arms and legs

of the volunteers between 1745 and 1800 h, and simultaneously other volunteers applied coconut oil alone for comparison as a control. Mosquitoes were collected from 1800 to 0600 h for 5 nights each in Ramgarh and Bhel-Akbarpur villages. For an all-night collection, a volunteer served as bait from 1800 to 2400 h and was replaced by another volunteer until 0600 h. For each dosage of neem oil and coconut oil, volunteers occupied a separate room and were allowed to lie on a cot. Mosquitoes landing on the exposed body were collected by another person (untreated, without any oil) using a flashlight and a suction tube. Volunteers, insect collectors and experimental rooms were randomized each night and collections were made on the treated and control volunteers concurrently on 10 different nights in September-October 1992. Results of these observations and percentage protection from mosquito biting are given in Table 1. The percentage protection from man-mosquito contact was calculated by subtracting the total number of mosquitoes in the experimental group from the control, divided by mosquitoes in the control and multiplied by 100.

Neem oil produced a strong repellent action on *An. culicifacies* (the major vector of rural malaria in India) and other nuisance anopheline mosquitoes even at concentrations as low as 0.5 and 1.0%. At a concentration of 2%, there was no anopheline biting and the protection provided was 100% during a 12-h period.

Neem is an insect antifeedant that has been tested against at least 26 species of insects (Ladd et al. 1978). A wide range of developmental and behavioral changes are also induced by neem alkaloids (Kubo and Kloche 1982). Neem oil is extracted from seeds mechanically using a crusher and is marketed throughout the country at a price of about U.S. \$1.00-3.00/kg. Neem alkaloids are safe to humans (Bhide et al. 1958, Gaitonde and Bhide 1959) and neem oil is edible after processing (Rukmini 1987). It can be mixed in coconut or any other oil for application on the skin to repel mosquitoes.

Malaria is endemic in India with at least 2 million cases reported each year. In most areas the mosquito nuisance is unbearable. Although

Table 1. Results of neem oil mixed in coconut oil and applied on the exposed body parts of volunteers in relation to the biting rate of mosquitoes.

Neem oil (%) mixed in coconut oil	Total no. of mosquitoes landing in indoor human baits in 10 nights during September–October 1992					
	<i>An. culicifacies</i>			Total anophelines		
	Neem oil	Control	Percent protection	Neem oil	Control	Percent protection
0.5	11	74	85.1	14	87	83.9
1.0	10	167	94.0	30	408	92.6
2.0	0	48	100.0	0	144	100.0

residual spraying of insecticides is the mainstay of malaria control, there are epidemics in areas undergoing spraying. Malaria control has become highly complex and problematical, *inter alia*, due to vector resistance, exophilic or exophagic vector behavior, widespread chloroquine resistance in *Plasmodium falciparum*, operational failures and financial constraints (Sharma and Mehrotra 1986). In this context, the repellent activity of neem oil in providing complete protection from the bite of *Anopheles* mosquitoes can be of great help in our fight against malaria.

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