

## SHORT COMMUNICATION

**Preliminary field trials of personal protection against  
Mosquitoes in The Gambia using deet or permethrin in soap,  
Compared with other methods**

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A current trend in the control of disease in developing countries is to use methods which are cheap and can be operated effectively by local communities. Insect repellents may fulfil these criteria; they act as a last line of defense against blood-seeking mosquitoes, including those which are vectors of disease.

Deet (diethyltoluamide) and permethrin in a soap formulation (U.K. Patent Application GB 2160216 A) proved effective against mosquitoes in Malaysia (Yap, 1986) and Australia (Frances, 1987). We attempted to determine how suitable this soap would be for protecting individuals against attack from mosquitoes in the early evening in The Gambia. Preliminary tests were undertaken to evaluate whether deet, permethrin or a combination of both chemicals in a soap formulation applied to human skin would reduce the rates of attack by wild mosquitoes under field conditions. Having demonstrated this, the repellent activity of soap containing both chemicals was compared with other methods of personal protection practiced in The Gambia. The present paper pays no attention to mosquito bednets, the efficacy of which has been evaluated recently in The Gambia by Lindsay *et al.* (1989<sup>a</sup>) and Snow *et al.* (1989) for permethrin-impregnated bednets and by Snow *et al.* (1988) and Lindsay *et al.* (1989b) for untreated bednets.

At the beginning of the rainy season in 1987, two field trials were carried out in The Gambia at Balingho and Banjul. Catches of mosquitoes were made at Balingho along a bush-lined road between the village and River Gambia. On one side of the road was an area of brackish swamp, on the other a high bank. The catching site at Banjul was on the outskirts of this coastal city on the banks of an open canal fringed with reeds.

Repellency was assessed using man-biting catches. Ten male volunteers sat in pairs facing each other. The pairs were positioned 10 m apart in a straight line. Each catcher sat on a chair with his arms and legs exposed and collected mosquitoes landing on his body using a torch and aspirator.

In the first trial at Balingho, all men applied one of the following five treatments; water only soap only, soap with 20% deet, soap with 0.5% permethrin, soap with 20% deet plus 0.5% permethrin (Simmons Pty Ltd, P.O. Box 107, Vic. 3148, Australia). As recommended by the manufacturers, approximately 2.3 g of soap was applied all over the wetted body at 18.00 hours and then left to dry without being washed off. The type of soap treatment was unknown by the investigators or by each individual subject until after the catches had been made. Catches of mosquitoes were made between 19.30 and 22.00 hours for five consecutive nights. Dusk was around 19.45 hours. The five treatments used at Banjul during the second trial were: (i) soap with 20% deet and 0.5% permethrin, (ii) approximately 60 g of 'santango', i.e. bark and resin from the local tree *Daniella oliveri* (Rolfe) Hutchinson and Dalziel, burnt on charcoal in a small brazier, (iii) a pyrethroid coil containing 0.25% allethrin (Yotox, Italy), (iv) sitting with the feet up off the ground on chairs, and (v) no protection. Both the santango and the pyrethroid coil were burnt within a distance of 1 m of a pair of catchers seated outdoors. The wind was light or absent, so that neighbouring pairs of catchers seldom detected the smell of smoke from santango or pyrethroid coil. Mosquito collections were made between 19.30 and 20.30 hours for five consecutive nights.

Both trials were performed using a 5X5 Graeco-Latin design (Fisher, 1492) to compensate for the variation in number of mosquitoes caught between treatments, pairs of catchers, seating position and on different nights. This allowed each pair to experience each chair position only once and each treatment only once. Statistical analysis was with a four-way ANOVA based on log values of the number of mosquitoes.

In the primary comparisons between soap formulations, plain soap gave no reduction in the mosquito attack rate compared with water treatment only (351 v. 350 bites), whereas soap containing deet with permethrin (mean reduction=62%, 95% C.I. 50-75%,  $t=6.68$ , d.f.=8,  $P<0.001$ ), deet alone (mean reduction=70%, 95% C.I. 60-78%,  $t=8.24$ , d.f.=8,  $P<0.001$ ) and permethrin alone (mean reduction=29%, 95% C.I. 6-47%,  $t=2.37$ , 8 d.f.,  $P<0.05$ ) significantly reduced the mean number of mosquito bites received by individuals.

There was no significant difference between the number of mosquitoes caught on different nights (variance ratio, VR=2.96, d.f.=4, n.s.), by pairs of collectors (VR=3.06, d.f.=4, n.s.) or chair positions (VR=2.26, D.f. =4, n.s.). Totals of 546 *Culex thalassius* Theobald, 324 *Cx neavei* Theobald, 146 *Cx tritaeniorhynchus* Giles, 102 *Aedes simpsoni* Theobald, 45 *Ae. Longipalpis*, 31 *Ae. irritans* Theobald, 25 *Ae. Luteocephalus* Newstead, 4 *Ae. Furcifer/taylori* Edwards and 19 *An. Melas* Theobald were captured during the trial. As a cautionary note, it should be appreciated that these results from The Gambia concern predominantly culicine mosquitoes, not anophelines, and the behaviour of mosquitoes in contact with a repellent can vary between species. For instance, Curtis *et al.* (1987) tested deet-impregnated anklets on subjects sitting on chairs in Tanzania and found little tendency for anophelines or *Cx quinquefasciatus* to be diverted to upper parts of the body. In contrast, we found that, in general, mosquitoes simply fed on an area of skin where there was little or no repellent.

Numbers of mosquitoes caught by pairs of men testing the various types of personal protection at Banjul (Table 2) demonstrated significant reductions in the mosquito attack

rates compared with unprotected controls. The use of repellent soap (deet+permethrin) (78% reduction, 95% C.I.=70-83%,  $t=10.42$ , d.f.=8,  $P<0.001$ ), burning santango (77% reduction, 95% C.I.=70-81%,  $t=10.21$ , d.f.=8,  $P<0.001$ ), burning a mosquito coil (71% reduction, 95% C.I.=61-78%,  $t=8.54$ , d.f.=8,  $P<0.001$ ) and raising the feet off the ground (32% reduction, 95% C.I.=9-48%,  $t=2.63$ , 8.d.f.,  $P<0.05$ ) significantly reduced the landing rate of blood-seeking mosquitoes. There was a highly significant difference in the number of mosquitoes collected by different pairs (VR=8.65, d.f.=4,  $P<0.01$ ) and a significant difference in the number of mosquitos caught on different nights (VR=4.13, d.f.=4,  $P<0.05$ ). Totals of 2439 *Cx thalassius*, 51 *Cx neavei*, 17 *Cx quinquefasciatus* Wiedemann and 1 *Aedes aegypti* (L.) were captured during the trial.

TABLE 1. Numbers of mosquitoes captured by pairs of seated individuals receiving different treatments over five consecutive nights at Balingho, The Gambia.

Night	Treatment					Total
	Soap with deet and Permethrin	Soap with deet	Soap with permethrin	Soap only	Water only	
1	32	4	18	21	112	187
2	15	28	27	180	25	275
3	26	23	179	37	97	362
4	36	44	51	65	84	280
5	12	15	29	48	32	136
Total	121	114	304	351	350	1240

TABLE 2. The number of mosquitoes captured by pairs of catchers using different methods of personal protection on five consecutive nights at Banjul.

Night	Treatment					Total
	Soap with Deet and permethrin	Burning santango	Burning allethrin coil	Raising the feet	Unprotected	
1	19	10	28	26	351	434
2	51	26	22	294	143	536
3	27	32	9	108	216	392
4	28	132	207	200	110	677
5	71	55	176	87	80	469
Total	196	255	443	715	900	2508
Cost/night (U.S.A. cents)	25*	4-14	5-11	0	0	

\* Price from yap (1986)

The three soap formulations of deet and permethrin, separately or together, reduced the mean number of mosquito bites an individual receives under field conditions. Deet was 57% more repellent than permethrin (95% C.I.=44- 68%,  $t=5.89$ ,  $P<0.001$ ). Although deet does not repel all species of mosquito equally (Curtis *et al.*, 1987) it is generally effective against all species of mosquitoes, midges, other haematophagous arthropods and even leeches (Sharma, 1969).

Soap formulation provided a simple and efficient method of covering the body with a thin film of deet. When applied to the skin, repellents have the advantage of giving mobile protection, although there may be some disadvantages or side-effects of regularly treating the skin with repellent soap formulation and not washing off for many hours. Also, if kept out of its protective box, the soap turns gelatinous, which may present problems of acceptability. Cropped hair should be treated with the soap to avoid insects biting on the scalp. However, dense hair is protective and has been shown to reduce feeding by *Ae. Aegypti* (Lindsay & Denham, 1985). The addition of permethrin to the soap could contribute to a reduction in lice and other ectoparasites.

Locally-produced santango proved to be a cheap and effective repellent under field conditions. Laboratory failure to demonstrate such protection from mosquitoes (C. Curtis and N. Hill, unpublished) may have been because feeding inhibition rather than repellancy was being measured. Santango is typically burnt indoors at irregular intervals, often of many days, which probably accounts for the unreduced malaria morbidity among children living in houses where this repellent is used (Snow *et al.*, 1987).

The burning of pyrethroid coils protected individuals outdoors. Similar reductions have been reported by other workers in Africa (Hudson & Esozed, 1971; Smith *et al.*, 1972) and in Papua New Guinea (Charlwood & Jolley, 1984).

Elevating the fee onto raised platforms reduced the number of mosquitoes landing on an individual, but only by 32%. Even so, Charlwood *et al.* (1984), working in Papua New Guinea, suggested that protection conferred by being raised off the ground may be particularly beneficial to children placed upon elevated beds.

In summary, soap with deet (with or without permethrin), burning santango or a mosquito coil all provided reasonable degrees of protection from the bites of blood-seeking mosquitoes in the early evening. The choice between these treatments is primarily a question of convenience and cost.

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