A FIELD TRIAL WITH ETOFENPROX (OMS 3002) AS A RESIDUAL INSECTICIDE AGAINST MALARIA VECTORS, IN TANJUNG BUNGA DISTRICT, EAST FLORES, INDONESIA

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Abstract. An operational trial of Vectron (Etofenprox, OMS 3002) was conducted in East Flores Regency, Nusa Tenggara Timur Province. The compound (Etofenprox 10EW) was applied as indoor residual spray and as an impregnation treatment for bednets in two separate areas. Dosage in both cases was 0.2 g/m². A third area, designated as control, was untreated. In bioassay tests, bamboo surfaces gave 100% mortality for 150-160 days post spray, while wooden surfaces and treated bednets both gave complete mortality for at least 120 days. Malaria cases monitored by successive malariometric surveys showed steady declines in positivity rates, particularly in children.

INTRODUCTION

Etofenprox (OMS 3002), known also as Vectron or Trebon, is a recently developed non-ester pyrethroid insecticide that has similar properties to other pyrethroids (Kamiya *et al,* 1987). It is found to be effective as a contact and stomach insecticide. Toxicological studies have shown that etofenprox has a low oral toxicity for mammals, the LD50 for rats being greater than 10,000 mg/kg according to the WHO "Recommended classification of pesticides by hazard" which classifies etofenprox as "Unlikely to present acute hazard in normal use" (WHO, 1996). Fish are also unaffected by this insecticide (MTCI, 1991). Moreover, no phytotoxicity has been observed in most kinds of crops at the recommended dosages (Udagawa, 1988). Cross-resistance studies showed no effect of carboxylesterase, elevated esterases, altered acetylcholin-esterase or glutathione-S-transferase-based resistance mechanisms on etofenprox toxicity (Hemingway, 1995).

Laboratory bioassays carried out by Mitsui Toatsu Chemicals Incorporation (MTCI) indicated that etofenprox possesses a residual effect against mosquitos when sprayed on brick, wood or mud walls (MTCI, 1991). Asinas *et al* (1991), in an unpublished report (1991) refer to a village scale trial in Quezon, Philippines, where dosages of 0.2 and 0.1 g/m² remained effective against *Anopheles flavirostris* for 7 and 6 months respectively, accompanied by a drop of 72.3% in the malaria parasite rate. Rohani *et al* (1993) found a good residual effect of 0.2 g/m² etofenprox when sprayed on bamboo, wood and cement surfaces against the malaria vectors *An. dirus* and *An. maculatus* in Malaysia.

The present trials were conducted in East Flores, Indonesia, to investigate the efficacy of etofenprox in reducing malaria transmission. Malaria vectors present in the area included *An. sundaicus, An. barbirostris, An. subpictus, An. flavirostris* and *An. maculatus*. The first trial was started in 1992, however in December 1992 a tidal wave devastated the trial area and the trial had to be discontinued. After restoration of the villages in 1993 the trial was redesigned and recommenced. The present report describes the results of investigations during a 16 month period, up to 5 months after the 3rd round of indoor residual spraying with 0.2 g/m² and three impregnations of bednets with 0.2 g/m².

MATERIALS AND METHODS

Trial area

The Tanjung Bunga district was selected for the trial based on its malaria endemicity. In addition, the district had not been sprayed with insecticides, and the only malaria control measure applied was drug administration to suspected cases. The town of Tanjung Bunga is located approximately 30 km east of Larantuka.

The district is arid, and vegetation consists of

shrubs, dry cultivation such as coconut, cashew nuts and secondary forest. During the monsoon, rainfall ranges from 1,052-2,010 mm with rainy days ranging from 0-30 per month. This season extends from November till April, the dry season extending from May till October. Crops are planted during the rainy season only.

After the tidal wave of December 1992, and reconstitution of the villages, the trial was pursued as follows:

Area A consisted of two villages, namely Riankoli and Ratulodong where etofenprox was sprayed at a dosage of 0.2 g/m^2.

Area B included the village of Bahinga, and here bednets impregnated with etofenprox at a dosage of 0.2 g/m^2 were issued to the inhabitants.

Area C, the control area, consisted of the village Ebak.

Geographical reconnaissance

The district of Tanjung Bunga extends over an area of 1,560 km^2, with a total population of 9,081. The percentage of the population in the current trial area was 36. 7%. Geographical reconnaissance was first carried out in July 1993 and was repeated prior to every subsequent spray round. Random samples of 10-20% of the houses in each village were measured. Houses were classified as small (70-100 m^2), medium (100-150 m^2) and large (> 150 m^2).

Spraying operations

The first spray round of 0.2 g/m^2 started on 27 September 1993, followed six months later (27/3/94) by the second round, and four months after that (17/7/94) by the third round. Before every spraying round all spraymen were given a 5-day training period. Training for bednet impregnation was also conducted before the first impregnation. After the operational training a health education program was launched to explain safety measures and precautions to be taken by the health workers and the population. Spraymen were provided with uniforms and gloves to protect themselves against any possible contact with the insecticide.

Bednet trial

A distribution was made of 578 impregnated family-size bednets to 179 houses in the village of Bahinga, covering 100% of the residents. The surface area of each bednet was 19.52 m^2, requiring a total of 3.904 g/net of etofenprox active ingredient. The total number of nets distributed corresponded with the total number of beds present in the village. The first impregnation and distribution of the bednets was effected on 25 October, 1993. Reimpregnation of bednets was carried out by the community under direct supervision of the malaria staff.

Entomological evaluation

Baseline entomological information was collected routinely, on a biweekly basis, during 18 weeks prior to the first spray round and followed through until the end of the trial. Day resting densities and man-vector contact were assessed on the basis of hand collections and the numbers collected per man-hour, indoors and outdoors. Manlanding collections were carried out from sunset to midnight, and four houses were selected and fixed for this purpose in each indicator village.

Bioassay tests

Contact biossay tests were conducted on sprayed wood and bamboo surfaces at regular intervals after the first and subsequent spray rounds using laboratory colonies of *An. aconitus* and *An. barbirostris*. Three cone sites were selected and used on each surface. Into each cone, 15 mosquitos were introduced and given half an hour exposure before being removed to clean paper cups for 24 hour observation and record of final mortality.

Standard bioassays were also conducted on the impregnated bednets.

Epidemiological evaluation

Epidemiological evaluation was based on malariometric surveys which started in August 1993, followed by surveys in January, June and December 1994. The samples of blood slides collected in these surveys were tabulated after examination into two age groups, below 10 years and above ten years of age.

RESULTS

Geographical reconnaissance

Geographical reconnaissance results with information on the number of houses and population figures within the trial area are presented in Table 1. The drastic effects of the tidal wave on the number of houses and remaining population are reflected in the sharp decrease to half of the original numbers within a period of one year.

Operational results

Spray coverage ranged from 66% to 94%, averaging 81.6%. The average sprayable surface per house varied between 185 and 201 m^2, and the average dosage of etofenprox varied between 0.2 and 0.22 g/m^2.

Out of a total of 578 bednets impregnated initially and distributed, 537 (92.9%) turned up for the first reimpregnation and 389 (67.3%) for the second reimpregnation.

Residual effect

The results of bioassay tests are given in Tables 2 and 3. After the first round of spraying, bamboo surfaces gave 100% mortality up to five months after spray. Wood surfaces gave complete mortality for four months. Similarly, the residual effect of etofenprox on nylon bednets was evident at the 100% mortality level for 4 to 5 months.

Impact on day resting vector densities

Mosquito densities in general were relatively low in all areas, even before the application of etofenprox. This may have been due to the dry environment existing in the areas utilized for the trial. The average indoor day resting densities were slightly higher in the control area (C) where an average of 1.06 mosquitos per man-hour were recorded in the baseline period.

Area A: (residual tratment, 0.2 g/m^2)

The indoor resting density in Area A averaged 0.91 per man/hour pre-spray. This dropped to 0.11 after the first round, and was nil after the second and third rounds.

Area B: (impregnated bednets, 0.2 g/m^2)

Averaging 0.39 per man/hour pretreatment, the indoor day resting density was undetectable after the first two impregnations, but averaged 0.06 mosquitos per man/hour during the five and a half months following the third impregnation.

Area C: (control, untreated)

Mosquito density was also low during the whole period of observation (July 1993 to December 1994) but was never zero, averaging 1.06 initially, then 0.37,0.32 and 0.23 mosquitos per man/hour over successive periods.

Impact on man/vector contact

Area A: From an initial average of 0.91, the

Table 1

Geographical reconnaissance data for trial areas.

Date	Population in areas			Houses in areas		
	A	B	C	A	B	C
a. Before the tidal wave						
20/8/92	4,059	2,159	704	764	701	177
b. After the tidal wave						
5/8/93	2,004	1,010	319	507	202	66
15/2/94	2,080	970	329	499	194	65
15/6/94	2,111	753	335	448	180	67

Table 2

Bioassay results, wood and bamboo surfaces.

Date of spray	Days after spraying	% mortality control		% mortality sprayed surfaces	
		wood	bamboo	wood	bamboo
27/9/93	15	0.0	0.0	100	100
	30	0.0	0.0	100	100
	45	0.0	0.0	100	100
	60	0.0	0.0	94	100
	75	0.0	0.0	83	100
	90	0.0	0.0	100	100
	120	0.0	0.0	78	100
	150	0.0	0.0	23	100
27/3/94	32	0.0	0.0	100	100
	61	0.0	0.0	91	98
	91	0.0	0.0	100	100
17/7/94	30	0.0	0.0	100	100
	67	0.0	0.0	100	100
	96	0.0	0.0	100	100
	124	0.0	0.0	100	100
	160	0.0	0.0	42	100

Table 3

Bioassay results, impregnated bednets.

Days after impregnation	% mortality control	% mortality impregnated nets
1	00.00	100
8	00.00	100
15	00.00	100
30	1.00	100
60	00.00	100
90	00.00	100
120	00.00	100
150	00.00	70

indoor man -biting density averaged 0.23, 0.004 and then fell to zero after the first, second and third spray rounds respectively. Similarly, the outdoor biting density dropped from an initial average of 1.32 to 0.38, 0.03 and 0.01 respectively.

Area B: The indoor biting density decreased from an initial average of 0.29 to 0.22, 0.05 and 0.1 after the first second and third impregnations. The corresponding figures for outdoor biting were 0.54, 0.34, 0.13 and and 0.43.

Area C: In the control area biting levels fluctuated, both indoors and outdoors, showing no apparent trends over the observation period, the records corresponding to those of the other two areas being

0.24, 0.47,0.20 and 0.12 for indoor biting and 0.36,0.62, 0.45 and 0.23 for outdoor biting.

Impact on the parasite rate

Table 4 summarizes the results of 4 malariometric surveys conducted in areas A, B and C in 1993 and 1994. In the initial survey, one month before treatment coverage in the first two areas, the parasite rate was 30.6%, 13.28% and 14.11% respectively, with an overall average of 19.33%. The *Plasmodium falciparum* rate averaged 13.2%. Three successive surveys were conducted at 5, 5 and 6 monthly intervals and showed reductions on the pretreatment figures from 30.6% to 30.00%, 20.98% and 8.39% in area A, and from 13.28% to 19.23%, 15.98% and 10.20% in area B. Comparative results for the control area C were 14.11%, 34.15%, 32.74% and 33.00%.

The impact of residual spraying and impregnated bednets on *P. falciparum* in areas A and B was also demonstrated. The results show a reduction of the slide falciparum rate from a pretreatment level of 20.86% to levels of 13.00%, 6.20% and 3.39% in area A and from a pretreatment level of 10.16% to successive levels of 12.82%, 6.15% and 4.20% in area B. In area C the corresponding *P. falciparum* levels were 8.56%, 24.39% 18.58% and 18.19% respectively.

Child parasite rates

The results of the malariometric surveys pertaining to children below ten years of age were extracted and recorded separately (Table 4). From an initial rate of 31.00% in area A the child parasite rate dropped to 20.7%, 15.21% and 9.43% after the first, second and third sprayings respectively. In area B the child parasite rate dropped from 53.84% pretreatment to 33.33%, 17.39% and 9.30% successively. In area C no progressive decrease in the child parasite rate was apparent, the corresponding figures being 53.57% pretreatment, followed by 63.15%, 37.50% and 44.00%.

Toxicity

No adverse effects were observed or reported by field supervisors, spraymen or members of the community who came in direct contact with the insecticide. Moreover, samples of 20 houses in each village were selected and the inhabitants questioned on any adverse affects or toxic symptoms

Table 4

Malariometric survey data before and after application of etofenprox.

Dates of survey	Area	Slides	SPR	SFR	Children		
					Slides	Pos	%
28/8/93	A	163	30.60	20.86	42	13	30.95
23/1/94		100	30.00	13.00	29	6	20.68
26/6/94		143	20.98	6.20	46	7	15.21
26/12/94		152	8.39	3.39	53	5	9.43
31/8/93	B	128	13.28	10.16	26	14	53.84
26/1/94		78	19.23	12.82	18	6	33.33
29/6/94		244	15.98	6.15	69	12	17.39
27/12/94		142	10.20	4.20	43	4	9.30
25/8/93	C	163	14.11	8.56	28	15	53.57
28/1/94		82	34.15	24.39	19	12	63.15
24/6/94		113	32.74	18.58	24	9	37.50
29/12/94		111	33.00	18.19	25	11	44.00

experienced during or after spraying with the new insecticide. No complaints or negative comments were received.

DISCUSSION

The results of this trial, under fairly severe operational conditions demonstrate a good epidemiological impact of etofenprox against malaria vectors under the climatological and topographical conditions prevailing in the East Flores region of Indonesia. Despite operational setbacks, such as those due for example to the earthquake and tidal wave which devastated the original trial area in December 1992, the succeeding trial results have confirmed the efficacy of etofenprox as an insecticide for malaria control, both in terms of residual persistence and epidemiological impact.

This was demonstrated not only by the residual qualities on bamboo, wood and nylon bednet substrates, as monitored by regular bioassay, but was also indicated by mosquito density indices.

The main drive of the trial, however, was epidemiological, and here the impact on disease transmission was good as measured by successive malariometric surveys, with progressive reductions both in overall slide positivity rate and *P. falciparum* rate. This was true both for the area under residual spray and for the impregnated bednet area. The SPR and SFR showed declines over the 16 month trial period of 72.6% and 88.0% respectively in the sprayed area, and 23.2% and 60.0% in the bednet area. The parasite rate for children under 10 years of age similarly decreased in both treated areas, whereas parasite indices showed an increase in the untreated control area over the same period.

Bednet impregnation, while affecting transmission, did not appear to afford as good protection as the indoor residual spraying. The reasons for this may be twofold; firstly, the nets protected children more than adults, who presumably spent more time outside the nets in the evening, and, secondly, while a large proportion of nets (92.9%) received a second impregnation, this fell to 67.3% for the third impregnation.

With a compound of such low basic mammalian toxicity no problems were anticipated in this regard, and none were detected despite specific attention being paid to safety aspects in relation both to spraymen and local inhabitants. The high acceptability by householders confirms the suitablilty of etofenprox for use in vectorborne disease control programs.

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