Field trial on the spatial repellency of metofluthrin-impregnated plastic strips for mosquitoes in shelters without walls (*beruga*) in Lombok, Indonesia

Hitoshi Kawada, Yoshihide Maekawa, and Masahiro Takagi

Department of Vector Ecology and Environment, Institute of Tropical Medicine, Nagasaki University, Nagasaki, Nagasaki 852-8523, Japan

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ABSTRACT: Field trials on the spatial repellency of metofluthrin-impregnated plastic strips for mosquitoes present in shelters without walls (*beruga*) were carried out in Lombok, Indonesia. A major reduction in the incidence of human biting by *Culex quinquefasciatus* was achieved, and the use of two strips per *beruga* repelled >60% of the mosquitoes for at least 11 wk while four strips repelled >60% of the mosquitoes for more than 15 weeks. The technique was found to be a practical long-term solution for the prevention of mosquito bites without using electricity or heat to evaporate the metofluthrin. ***Journal of Vector Ecology* 30 (2): 181-185. 2005.**

Keyword Index: Metofluthrin, plastic strip, spatial repellency, *Culex quinquefasciatus.*

INTRODUCTION

Metofluthrin, (2,3,5,6-tetrafluoro-4-methoxymethyl-benzy1 (E,Z)(1R,3R)-2,2-dimethyl-3-(prop-1-enyl) cyclo-propanecarboxylate) (S-1264) is a newly-synthesized pyrethroid produced by Sumitomo Chemical Co. Ltd., Osaka, Japan (Ujihara et al. 2004). Metofluthrin belongs to the relatively safe pyrethroid group (Shono et al. 2004) and has already been registered in several Asian countries such as Singapore, Indonesia, Myanmar, and Vietnam. We reported in our previous papers that metofluthrin impregnated into multilayer paper strips is a promising spatial repellent for mosquitoes under laboratory and field conditions (Kawada et al. 2004a, 2004b). It was proven that mosquitoes were repelled by airborne metofluthrin vapor for 4 weeks in simulated outdoor conditions (Kawada et al. 2004a). The field tests also indicated the effectiveness of metofluthrin against mosquito bites in shelters without walls (*beruga*), which people in Lombok Island, Indonesia, use for resting, praying, and evening conversations with neighbors. During such occasions there is a high risk of transmission of malaria at a *beruga* (Kawada et al. 2004b).

The above preliminary investigations were carried out using the prototype paper devices, which were prepared in the laboratory. A more advanced technology is required for mass production of these devices, which should be economical, easy to handle, and long-lasting so that their use can be feasible. Therefore, a plastic strip impregnated with metofluthrin was produced on a trial basis. In this paper, we report the residual spatial repellency of this formulation for mosquitoes in the field conditions existing in Lombok, Indonesia.

MATERIALS AND METHODS

Formulation of metofluthrin-impregnated strips

Metofluthrin-impregnated multilayer paper strips (similar to the devices used by Kawada et al. (2004a, 2004b)) and plastic strips were supplied by Sumitomo Chemical Co., Ltd. (Takatsukasa 4-2-1, Takarazuka, Hyogo, 665-8555 Japan). Metofluthrin, 200 mg, diluted with acetone was uniformly applied to the paper strip (tissue paper, 25g/m^2 in density, 0.06-0.07mm in thickness), which is multilayered and foldable, and the acetone was allowed to evaporate. The plastic material had a folded cylindrical-shaped network structure (11.5 cm in width, 3-4 mesh) composed of polyethylene impregnated with 5% (w/w) metofluthrin. The plastic material was cut into a strip weighing 20 g (11.5 by 37 cm) (Figure 1).

Field evaluation of repellency

The field evaluation was carried out at Presak located in the coastal area ca. 7.5 km northwest of Mataram. The dominant mosquito species in the area, which were collected by human baited collection, were *Culex quinquefasciatus* Say. The mean numbers of outdoor mosquito bites were >300 per man per night (Kawada et al. 2004b). Four *beruga* (floor areas, 4.4 to 6.2 m^2) were chosen as the test sites. The *beruga* is a simple hut made of wood and palm leaves and has no walls or may have simple screens on one or two sides. The people on Lombok Island use the *beruga* for resting, praying, and during evening conversations with neighbors. The trials for metofluthrin-impregnated paper strips and plastic strips were carried out from September 29 to October 3, 2003 and from December 8, 2003 to March 17, 2004, respectively. The former period was the relatively dry season and latter was the rainy season. Two treatment regimes were rotated on a daily basis (four replications for the four different *beruga*) among the *beruga*; a) four-paper strip treatment regimes and b) untreated control for the paper strip trial and three treatment

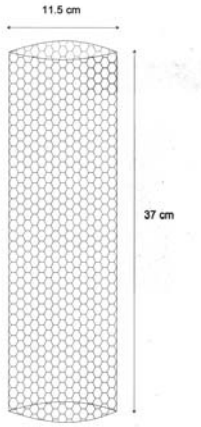

Figure 1. Metofluthrin-impregnated plastic strip used in the study.

regimes were rotated on a daily basis (three to four replications for the four different *beruga*); a) four plastic strips, b) two plastic strips and c) untreated control for the plastic strip trial, respectively. Two humans (males aged 20 to 30, 50 to 60 kg weight) laid in a bed net (ca 2 by 2 by 2 m), which was hung in each *beruga*, during the test as human bait, and mosquitoes were collected outside the net by a person with an aspirator. This person stayed outside the bed net throughout the trial. Strips were hung below the ceiling of the *beruga* outside the bed net (Figure 2). The distance between the strips and the humans inside the bed net was 1 to 1.5 m. Mosquitoes were collected from 1800 h to 2400 h, as described above. Strips were maintained, as mentioned earlier, outside the *beruga* throughout the trial and the same evaluation was carried out at one to four-week intervals. Percent repellency was calculated based on the average number of mosquitoes per hour collected at a strip-treated *beruga* and at an untreated *beruga*. Ambient temperature during the tests ranged from 24°C to 28°C.

RESULTS AND DISCUSSION

Spatial repellency of metofluthrin-impregnated paper strips and plastic strips for mosquitoes at *beruga* are shown in Table 1 and 2. The dominant mosquito species was *Cx. quinquefasciatus*, followed by a small number of *Anopheles sundaicus* (Rodenwaldt). The repellency of the strips was evaluated based on the effect on the total number of mosquitoes of both species. The number of mosquitoes collected at the untreated control *beruga* fluctuated, ranging from 19.9 to 43.5 per h, but it was maintained at a constantly high value throughout the trials (Figure 3). High spatial repellent effect was observed in the *beruga* that was treated with four metofluthrin-impregnated paper strips on the day of treatment, as previously reported by Kawada et al. (2004b). The repellency, however, decreased rapidly in less than one week (Table 1). This rapid reduction in efficacy is attributable to the rapid decrease in the active ingredient in the paper strip due to degradation and the rapid loss by vaporization since no protective measure against photo degradation and oxidation or against excess loss by vaporization was incorporated into the device. In the case of metofluthrin-impregnated plastic strips, on the other hand, high spatial repellency was

Figure 2. Field test with four plastic strips in a beruga. Arrows indicate the plastic strips treated.

Table 1. Numbers of mosquitoes collected in the metofluthrin-impregnated paper strips at treated and untreated collection sites.

Sample	No. of devices per beruga	Weeks after treatment	Replications	Average number collected/h *Anopheles sundaicus*	Average number collected/h *Culex quinquefasciatus*	Average number collected/h Total[2] (SD[3])	% Repellency[4]
Metofluthrin-impregnated paper strip[1]	4	0	4	0	2.7	2.7a (1.8)	89.0
		1	4	0.17	16.0	16.2a (9.3)	40.7
		2	4	0.04	17.4	17.5a (11.2)	12.2
Untreated	-	0	4	0.13	24.5	24.6b (8.3)	0
		1	4	0.21	27.1	27.3a (9.8)	0
		2	4	0.29	19.6	19.9a (4.9)	0

[1]200 mg metofluthrin was impregnated in a device.
[2]Same letters in the same week indicate that there was no significant difference between the number of collection ($P > 0.05$, Tukey's HSD Test).
[3]Standard deviation.
[4]% Repellency = (1 - No. treated/No. untreated) x 100.

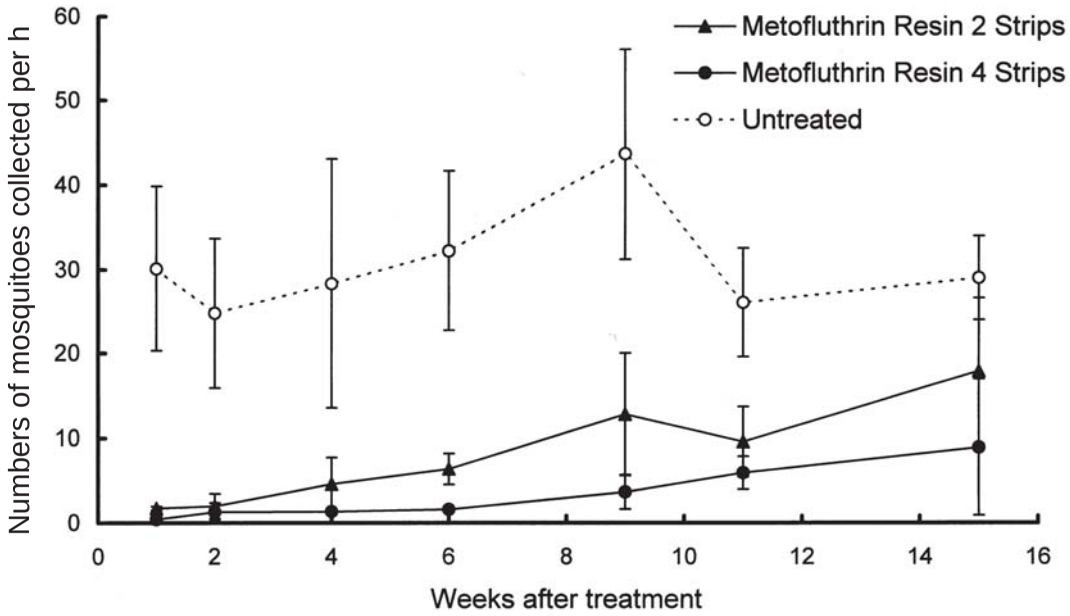

Figure 3. Changes in the total number of mosquitoes collected per h during the trial for plastic strips. Bars indicate the standard deviations.

Table 2. Number of mosquitoes collected in the metofluthrin-impregnated plastic strips treated and untreated collection sites.

Sample	No. of devices per beruga	Weeks after treatment	Replications	Average number collected/h *Anopheles sundaicus*	Average number collected/h *Culex quinquefasciatus*	Total[2] (SD[3])	% Repellency[4]
Metofluthrin-impregnated plastic strip[1]	2	1	4	0.04	1.7	1.8a (0.2)	94.2
		2	4	0	2.0	2.0a (1.5)	91.9
		4	4	0.04	4.6	4.6a (3.1)	83.7
		6	3	0.06	6.3	6.4a (1.8)	80.2
		9	3	0	12.8	12.8a (7.2)	70.6
		11	3	0	9.6	9.6a (4.2)	63.2
		15	3	0.11	17.9	18.0b (8.7)	38.2
	4	1	4	0	0.4	0.4a (0.4)	98.6
		2	4	0	1.3	1.3a (1.1)	94.7
		4	4	0.04	1.3	1.4a (0.3)	95.2
		6	3	0	1.6	1.6a (0.2)	95.0
		9	3	0.06	3.6	3.7a (2.0)	91.6
		11	3	0	5.9	5.9a (2.0)	77.2
		15	3	0	9.0	9.0a (8.1)	69.2
Untreated	-	1	4	0.13	30.0	30.1b (9.8)	0
		2	4	0.21	24.6	24.8b (8.9)	0
		4	4	0.04	28.3	28.3b (14.7)	0
		6	3	0	32.2	32.2b (9.5)	0
		9	3	0.17	43.5	43.7b (12.4)	0
		11	3	0.06	26.1	26.1b (6.5)	0
		15	3	0	29.1	29.1b (5.0)	0

[1]1000 mg metofluthrin was impregnated in a device.
[2]Same letters in the same week indicate that there was no significant difference between the number of collection ($P > 0.05$, Tukey's HSD Test).
[3]Standard deviation.
[4]% Repellency = (1 - No. treated/No. untreated) x 100.

maintained much longer than that for the paper strips. A significantly higher (>60%) spatial repellency ($P < 0.05$; Tukey's HSD test) than that observed in the untreated control, lasted for at least 11 weeks with the two-strip treatment and for >15 weeks with the four-strip treatment (Table 2, Figure 3).

We could confirm the effective, long-lasting efficacy of the repellent against mosquitoes by using metofluthrin-impregnated plastic strips in outdoor conditions. However, the effective duration in the present result appears to be insufficient with regard to the practical use of the devices, from the viewpoint of cost of the treatment. The plastic strips examined in the present study were only a prototype that requires further improvement. The long-term effectiveness might be achieved by the further formulation studies that work towards optimizing the release speed of the active ingredient, such as the investigation for the optimum density of plastic polymer. The more improved measures for manufacturing plastic will provide an improved formulation that result in a longer effective duration period of the repellent.

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