A DELTAMETHRIN TABLET FORMULATION FOR THE TREATMENT OF BEDNETS

HEIKO DIEHLMANN AND JOHN INVEST
Hoechst Schering AgrEvo GmbH
Höchst Industriepark, H872, D-65926 Frankfurt am Main, Germany

Abstract - There is an increasing trend to use insecticide impregnated bednets for major interventions in malaria programs today. Deltamethrin has proved to be one of the most effective insecticides for vector control, especially under varying climatic conditions, and is already the most widely used insecticide for impregnating bednets for effective long term control of malaria. Four experiments are described, evaluating efficacy, wash-fastness, and user-acceptability. The first three methods describe different bednet laboratory tests with or without washing against *Anopheles arabiensis* and *Culex quinquefasciatus*. The fourth describes a field trial evaluating the user-acceptability of the new tablet formulation of deltamethrin for insecticide treatment of bednets. The tests show that the new tablet formulation containing 25% deltamethrin has the same or better efficacy than the current SC 1% formulation of deltamethrin for insecticide treatment of bednets, even after repeated washing. The assessment of user-acceptability of the tablet formulation has shown a good acceptance by the population in a malaria-endemic region, mainly due to of ease of use and safety of storage. Overall it can be said that the new tablet formulation of deltamethrin is a good and acceptable alternative to the currently available liquid formulations used for impregnating bednets.
Key words - Malaria control, mosquitoes, WHO cone test, bednets, deltamethrin

INTRODUCTION

There is an increasing trend to use insecticide impregnated bednets for major interventions in malaria programs today. The World Health Organization, recognizing impregnated bednets to be the first new tool against malaria for many years, has conducted large scale trials in several African countries to evaluate if insecticide treated bednets have an impact on child mortality under varying climatic and sociological conditions. Subsequently, it was shown that the use of insecticide treated bednets could save the lives of as many as 500,000 African children between the ages of zero and five each year. The results of their studies showed a reduction in child mortality (1-4 years) of 17-33% with a mean of 25% reduction (WHO, 1998). Economic advantages have also been attributed to treating bednets. In the Gambia for example, where treating bednets with low doses of a pyrethroid were considerably less expensive than spraying the houses with DDT (Curtis, 1993).

Deltamethrin has proved to be one of the most effective insecticides, especially under varying climatic conditions, and is already the most widely used insecticide for impregnating bednets for effective long term control of malaria (Lengler, 1998). Further advantages are the efficacy against other types of mosquitoes including *Culex* spp.; efficacy against other nuisance insects (*e.g.* bedbugs, lice and ticks); and durability on bednets (up to twelve months or three washes).

Until recently, only liquid insecticide formulations were available to treat bednets. The logistics of using liquids to treat bednets have some disadvantages. The development of a tablet formulation (K-Otab®, AgrEvo GmbH, Frankfurt, Germany) containing 25% deltamethrin has all the advantages of a suspension concentrate (SC) formulation with the additional advantages of a simple presentation which has real benefits in terms of ease of use, packaging, transport to the consumer, and minimal storage requirements. The tablet provides a simple-to-use product which is a unit dose and therefore assists people in villages *etc*. in vector-borne disease areas of the world where the measurement of liquid pesticide formulations can be both hazardous and inaccurate.

The results of a series of laboratory tests and field trials are presented which demonstrate the efficacy of deltamethrin-treated bednets against *C. quinquefasciatus* and *A. arabiensis*, and assess the

Proceedings of the 3rd International Conference on Urban Pests.
Wm H. Robinson, F. Rettich and G.W. Rambo (editors). 1999.

impact of repeated washings on durability of the treatment. The user acceptance trial was initiated to compare the efficacy and ease-of-use of the tablet formulation with a conventional formulation under "real conditions": *i.e.* a population in a malaria infested region (near Dar Es Salaam, Tanzania).

MATERIALS AND METHODS

Comparison of K-O Tab® and K-Othrine Moustiquaire® 1% SC on bednets

Squares of polyester multi-filament 75 denier bednet material measuring 12 x 15 cm were used. For each dose rate and each washing regime three samples were prepared. Washing followed a standard procedure, using natural soap flakes and hot water at 40 ºC. Total immersion time in hot water was 12 minutes followed by two rinsings in cold water. Mosquitoes were exposed to the nets for exactly three minutes using WHO mosquito test kit cylinders in which the nets were attached to plain papers. The technique varies from the WHO cone test and is used by AgrEvo EH laboratories because it allows a much quicker transfer of mosquitoes onto and off the impregnated netting. This means that exposure time is more exact than with the cone test. Mosquitoes were held for 24 hours following exposure in clean paper cups and provided with 5% sugar water for sustenance. Batches of 20 female mosquitoes of two species were used: *C. quinqefasciatus* and *A. arabiensis.*

Comparison of effectiveness of K-O Tab® and K-Othrine Moustiquaire® 1% SC against *A. arabiensis*

Bednets were treated with both products at an application rate of 25 mg/m^2 active ingredient (AI). Ten pieces of cardboard of 0.5 cm thickness had rectangular holes measuring 12 x 10 cm cut in the middle. Pieces of treated and untreated netting were pinned on one side of the cardboard. The cardboard was fixed horizontally and test insects exposed to the netting using WHO bioassay cones. Insects were exposed for 30 minutes with knockdown (KD) counts taken at 10, 20 and 30 minutes. At 30 minutes the insects were transferred to clean containers and supplied with 5% sugar solution. Mortality was assessed at 24 hours post exposure.

Deltamethrin bednet trials with WHO cylinders

A susceptible strain of *A. arabiensis* was used. The bednets used were multi-filament polyester nets, 75 denier. The target dose of a.i./m^2 was 20-25 mg/m^2 (experimental procedure confirmed by chemical analysis of the bednets). The bednets were washed after each exposure using a detergent. The mosquitoes were exposed to the treated netting for the standard three minute exposure using WHO cylinders with the netting stapled to card and rolled into the test cylinder. After exposure the insects were removed and observations were made at 15, 30 and 60 minutes. Mortality was assessed 24 hours after exposure.

Field trial studies

A large scale field trial involving 220 people was done in Tanzania, investigating the user-acceptability and efficacy of K-O Tab® for insecticide treatment of mosquito nets. In addition people were surveyed on their opinions of the efficacy of the new product and how long it lasted. The tablet was compared to sachets containing lambda-cyhalothrin (2.5% CS).

The participants for the study were people who regularly used a net and were willing to answer questions on the net treatments. A total of 220 people were recruited for the trial in Tanzania. They were requested to dip their own bednets using the two products so that they had full experience of advantages and disadvantages of both products.

RESULTS

Comparison of K-O Tab® and K-Othrine Moustiquaire® 1% SC on bednets (from Duffield and Hordle, 1997)

The bioassays showed that both formulations provided good biological control. The water dispersible tablets gave equivalent results with unwashed nets, although after washing, the tablets gave equivalent

Proceedings of the 3rd International Conference on Urban Pests.
Wm H. Robinson, F. Rettich and G.W. Rambo (editors). 1999.

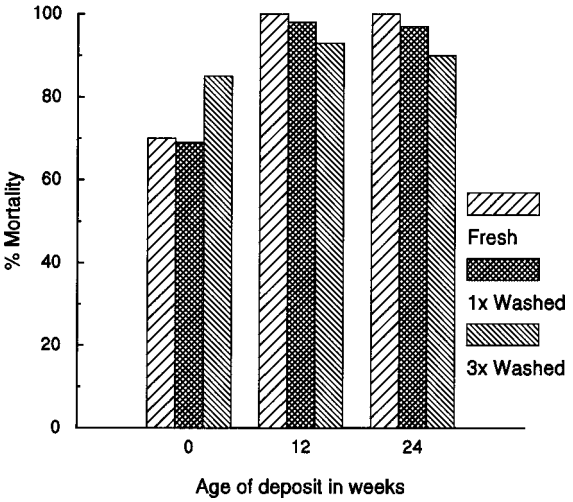

Figure 1. Efficacy of K-Othrine Moustiquaire® SC 1% against *C. quinquefasciatus* at 20 mg/m², after 0,1, and 3 washes.

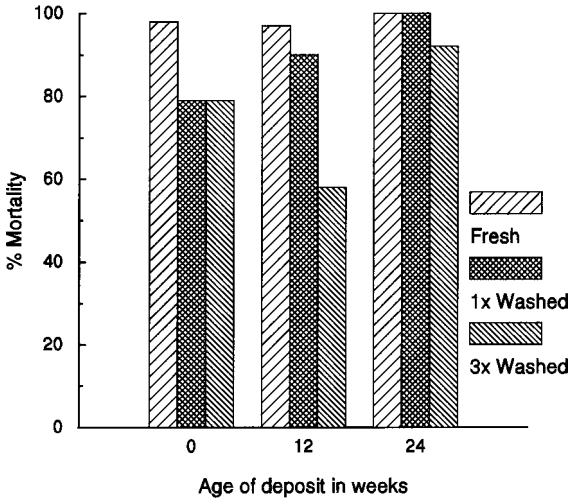

Figure 2. Efficacy of K-Otab® 25% against *C. quinquefasciatus* at 20 mg/m², after 0,1, and 3 washes.

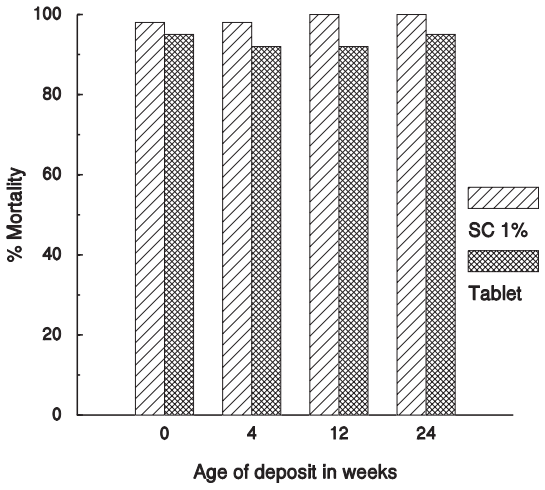

Figure 3. Efficacy of K-Otab® 25% compared with K-Othrine Moustiquaire® SC 1% against *A. arabiensis*, both at 20 mg/m², unwashed.

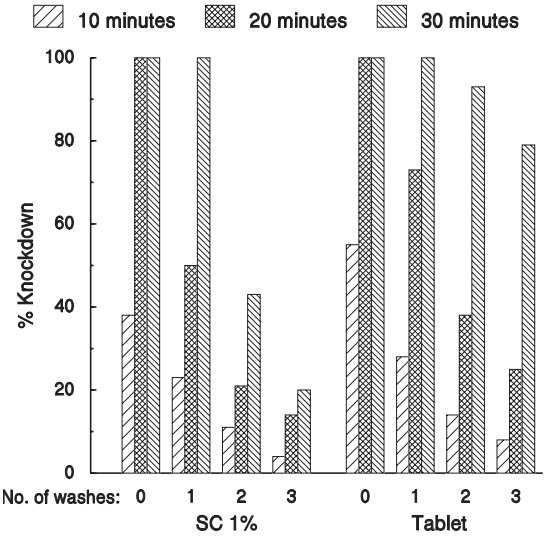

Figure 4. Knockdown efficacy of bednets treated with K-Othrine Moustiquaire® SC 1% compared with KOtab® 25% against *A. arabiensis*, both at 25 mg ai/m², unwashed, and washed 1, 2, or 3 times.

Proceedings of the 3rd International Conference on Urban Pests.
Wm H. Robinson, F. Rettich and G.W. Rambo (editors). 1999.

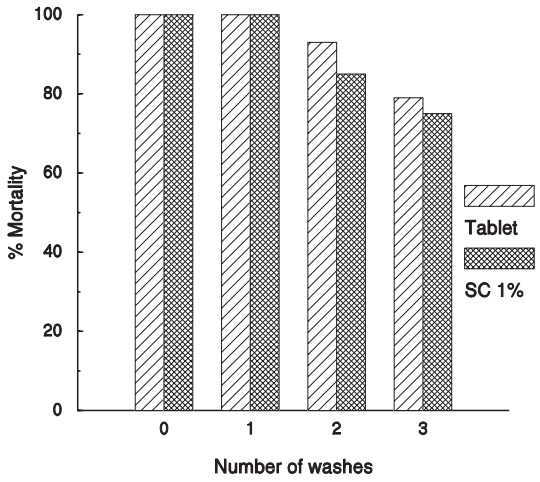

Figure 5. Mortality of mosquitoes held for 24 hours after exposure to bednets treated with K-Othrine Moustiquaire® SC 1% compared with KOtab® 25%, against *A. arabiensis*, both at 25 mg ai/m^2.

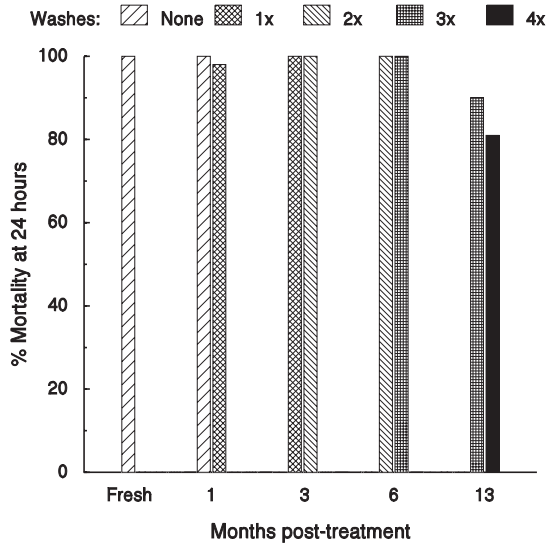

Figure 6. Efficacy of K-Otab® 25% treated bednets against *A. arabiensis*, at approx. 25 mg ai/m^2, unwashed, and washed one to four times, at varying intervals from fresh to 13 months.

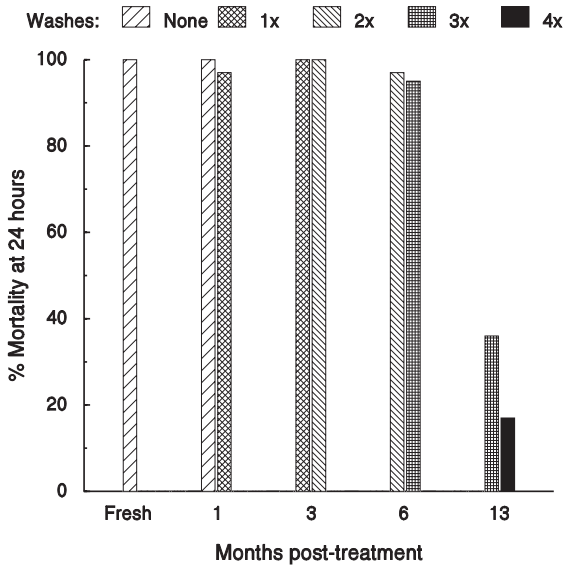

Figure 7. Efficacy of K-Othrine Moustiquaire = AE SC 1% treated bednets against *A. arabiensis*, at approx. 25 mg ai/m^2, unwashed, and washed one to four times, at varying intervals from fresh to 13 months.

Proceedings of the 3rd International Conference on Urban Pests.
Wm H. Robinson, F. Rettich and G.W. Rambo (editors). 1999.

or superior biological control compared to bednets treated with K-Othrine Moustiquaire 1% SC, throughout a 24 week test period (Figures 1-3).

Comparison of effectiveness of K-OTab® with K-Othrine Moustiquaire® 1% SC against *A. arabiensis* (from Zimba, M., 1996)

In a direct comparison of both formulations, the knockdown of K-O Tab was superior to the SC formulation, although the impact of washing became significant after one wash. Comparing mortality of mosquitoes after 24 hours, there was only a small difference between the two formulations (Figure 4). It is interesting to note that mortality was still high even after 3 washes (Figure 5).

Deltamethrin bednet trials with WHO cylinders (from Hunt, 1998)

Tablet treated bednets gave 100% kill for 6 months (Figure 6). At 13 months post-treatment, the nets washed three times gave 90% kill and 81% after the 4th wash. The SC formulation gave similar results up to 13 months when the net washed 3 times gave 36% kill and nets washed four times gave 17% kill (Figure 7). Both formulations gave a good kill of *A. arabiensis*. However, it was clearly demonstrated that although the SC formulation gave very good long-term performance, the K-O tab gave superior long-term efficacy and wash fastness.

Field trial studies (from Jones and Miller, 1997)

The trial confirmed that the people noticed the benefits of insecticide treated nets in keeping with WHO's own observations. The majority of people washed their nets at least once in three months. Increased washing resulted in a noticeable decrease in efficacy with both products. People understood the safe handling of insecticides and stored them correctly out of the reach of children. The people preferred the tablet to the sachet presentation based on its, ease of use and safety of storage.

DISCUSSION

The aim of the new tablet formulation of deltamethrin was to obtain an equivalent bioefficacy to that of the commonly available formulations for treatment of bednets, while adding the. advantages of handling, ease of use, packaging, and minimal storage requirements. The different laboratory bednet tests have clearly shown that the new tablet formulation has the same or better efficacy than the SC 1% formulation of deltamethrin for insecticide treatment of bednets. Even after washing the bednets, the bioefficacy was still high in KD and mortality. The assessment of user acceptability of the tablet formulation showed a good acceptance by the population in malaria afflicted region. The people were happy with the new advantages of the tablet especially because of its ease of use and safety. Overall the tablet formulation reached the set aims and is a good alternative to insecticide formulations for bednet treatments that are currently available.

REFERENCES CITED

Curtis C. F. 1993. Alternatives to conventional insecticides for urban vector and pest control. In: Proceedings of the 1st International Conference on Insect pests in the Urban Environment. eds. K.B.Wildey and W. H.Robinson July 1993, Cambridge, UK.

Duffield L. Z. and A. Hordle A. 1997. Comparative evaluation of K-Othrine water dispersible tablets and K-Othrine Moustiquaire 1% SC treated bednets against *Culex quinquefasciatus* and *Anopheles arabiensis*. AgrEvo Internal Report BG97-0012

Hunt, R. 1998. Deltamethrin bednet trials. Commissioned report conducted on behalf of AgrEvo, S. A.

International Conference on bednets and other insecticide treated materials. 1997. A selected bibliography on bednets and other insecticide treated materials. Prepared by EHP and BASICS.

Jones, C. O. H. and J. E. Miller. 1998. Field trial on the acceptability and efficacy of the K-O Tab for the insecticide treatment of mosquito nets. *The Malaria Consortium*, London School of Hygiene & Tropical Medicine. Commissioned by AgrEvo UK Ltd (Unpublished).

Proceedings of the 3rd International Conference on Urban Pests.
Wm H. Robinson, F. Rettich and G.W. Rambo (editors). 1999.

Lengler, C. 1998. Insecticide treated bednets and curtains for malaria control (Cochrane Review). The Cochrane Library, Issue 3, 1998. Oxford.

World Health Organization - Division of control of Tropical Diseases. 1998. Turning malaria around. WHO/CTF/MAL/98.6

Zimba, M. 1996. Evaluation of the effectiveness of deltamethrin Tab-treated bednets against *Anopheles arabiensis.* Study commissioned by AgrEvo S. A. in Zimbabwe.