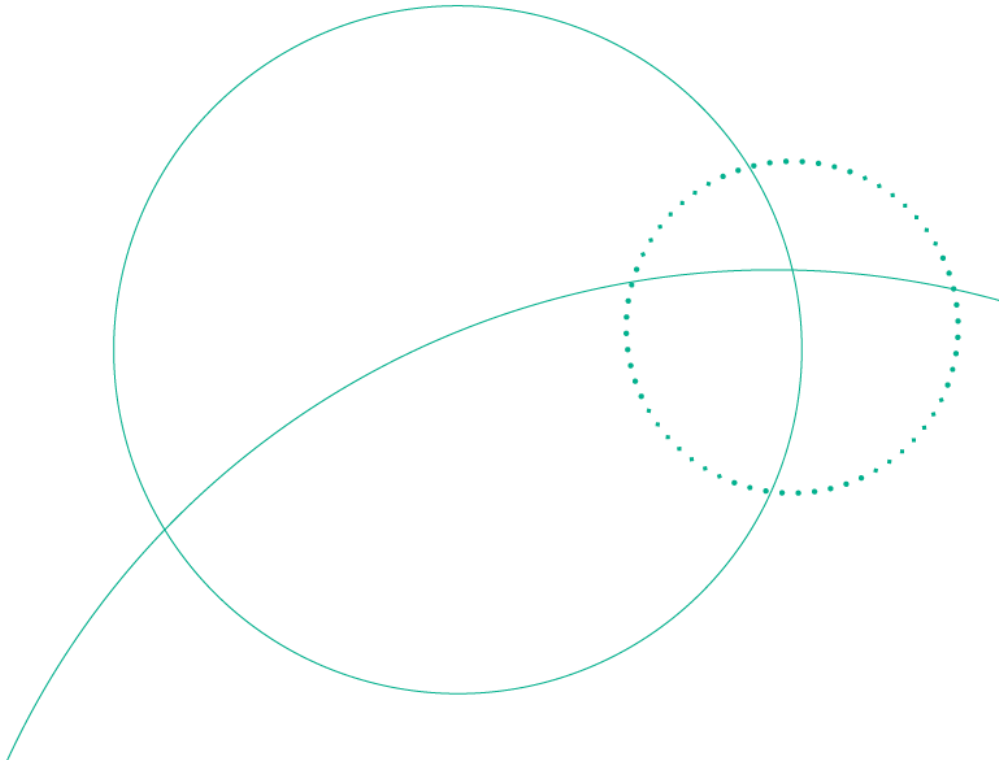
World Health Organization

WHO Prequalification Programme / Vector Control Product Assessment

WHO Public Assessment Report: WHOPAR Part 5

Vectron T500 (Mitsui Chemicals Crop & Life Solutions, Inc.) P-03226

Efficacy Assessment



Contents

1 Introduction

The primary purpose for the use of a pesticide is the control of a pest, including disease transmitting vectors. Vector control tools, including formulated pesticides, which provide effective management or control of vectors, may be used as part of a resistance management programme. Vector control products for use in public health are a component of Integrated Vector Management (IVM), which is a programme that relies on a suite of diverse interventions and implementations of best practices to manage the vector and chemical/behavioural resistance.

VECTRON T500 is a wettable powder formulation containing 50% broflanilide that is intended to be used for the control of Anopheline mosquitoes as an indoor residual spray. The insecticidal mode of action on mosquitoes is through binding to the inter-subunit allosteric site on the insect γ-aminobutyric acid (GABA) receptor gamma aminobutyric acid (GABA) receptor and thus inhibiting neurotransmission.

Semi-field studies to characterize the performance of VECTRON T500 and the residual efficacy on wall surfaces in experimental huts and community studies on the performance of VECTRON T500 and the residual efficacy on wall surfaces were submitted to WHO as part of the prequalification dossier.

2 Semi-field studies

Studies conducted in the semi-field setting often include the investigation of endpoints other than mortality and blood-feeding inhibition. Examples of these include, entry rate, exit rate, and deterrence, as well as analyses for non-standardized calculations of “personal protection.” Based on the existing requirements and established decision framework, mosquito mortality is considered the primary endpoint for assessment. Therefore, results for these are included within the summaries of these studies. Calculations of blood feeding inhibition or results for blood feeding rate were also included for further characterization of the entomological impact of the product.

2.1 Experimental hut trials

Data on the semi-field performance of VECTRON T500 and the residual efficacy on concrete/cement and mud wall surfaces were provided. These data were obtained from studies conducted according to established standards and/or Good Laboratory Practices (GLP).

Three semi-field studies were presented to evaluate the efficacy and residual activity of VECTRON T500. The negative control/s used in each study were untreated huts with cement/concrete or mud walls, and the positive control was a prequalified product containing 300 g AI/L of pirimiphos methyl applied at 1,000 mg AI/m^2, hereafter referred to as PC1.

The product was tested against pyrethroid resistant natural populations of: i) *An. arabiensis* in Lower Moshi, Tanzania, carrying *kdr* gene frequencies of 100% SSe; ii) *An. gambiae* s.l. in Covè, Benin, carrying *kdr* gene frequencies of >90% L1014F and metabolic resistance through over-expression of CYP6P3; iii) *An. gambiae* s.l. in Vallee du Kou, Burkina Faso, carrying *kdr* and metabolic resistance mechanisms. VECTRON T500 was applied at 100 and 150 mg AI/m^2.

Supplementary bioassays using WHO cone tests were used to characterize the bioavailability of the active ingredients on the wall surfaces of the treated huts. The *An. gambiae s.s.* Kisumu strain was used as an insecticide susceptible test system in all sites. The pyrethroid resistant test systems used were *An. gambiae* s.s. Muleba-Kis in Tanzania, *An. gambiae* s.l. in Benin, and *An. coluzzii* in Burkina Faso.

The duration of the free-flying mosquito studies was 12 months in all sites. In Tanzania and Burkina Faso, cows were used as the attractant in the experimental huts and in Benin, human volunteers were used. The results from the free-flying mosquito studies are presented in Table 6. Over 12 months, VECTRON T500 induced a minimum of 56% mortality in concrete/cement huts and 46% mortality in mud huts.

Supplementary bioassays were carried out for 12 months in Tanzania and Burkina Faso and 18 months in Benin. The results from supplementary bioassays are presented in Table 7. In concrete/cement huts, 72-hour mortality greater than 80% was recorded in WHO cone tests using the *An. gambiae* Kisumu system to 12 months (Tanzania), 18 months (Benin) and nine months (Burkina Faso). In mud huts, 72-hour mortality greater than 80% was recorded in WHO cone tests using the *An. gambiae* Kisumu system to nine months (Tanzania), 18 months (Benin) and 12 months (Burkina Faso). In WHO cone tests using pyrethroid resistant test systems, 72-hour mortality greater than 80% was recorded in concrete/cement huts to 12 months (Tanzania), 18 months (Benin) and one month (Burkina Faso); in mud huts, 72-hour mortality greater than 80% was recorded to three months (Tanzania), 18 months (Benin) and eight months (Burkina Faso).

Table 6. Mortality and blood feeding inhibition of free-flying wild *An. arabiensis* and Pyrethroid resistant *An. gambiae s.l.* in three experimental hut trials

Product	Hut surface	Treatment concentration (mg AI/m2)	% M72 (95% CI/SEM)	% Blood feeding inhibition (Tanzania, Benin) % Blood feeding (Burkina Faso)	Sample size
Tanzania (*An. arabiensis*)					
Total number of mosquitoes collected = Not provided			Compliant with power calculation? Not provided		
Control	Concrete	N/A	2 (1.0-4.0)	-	
Control	Mud	N/A	3 (2.0-4.5)		
VECTRON™ T500	Concrete	100	62.2 (59.8-64.5)	6.3	
VECTRON™ T500	Mud	100	46.4 (43.8-49.1)	19.0	
PC1	Concrete	1,000	30.5 (27.3-33.9)	14.4	
PC1	Mud	1,000	34.6 (31.5-37.9)	18.3	
Benin (*An. gambiae* s.l.)					
Total number of mosquitoes collected = 23,171			Compliant with power calculation? Yes		
Control	Cement	N/A	2 (0 – 5)	99 (99 – 100)	4,627
Control	Mud	N/A	2 (0 – 5)	99 (99 – 100)	4,462

Table 6. Mortality and blood feeding inhibition of free-flying wild *An. arabiensis* and Pyrethroid resistant *An. gambiae s.l.* in three experimental hut trials

Product	Hut surface	Treatment concentration (mg AI/m2)	% M72 (95% CI/SEM)	% Blood feeding inhibition (Tanzania, Benin) % Blood feeding (Burkina Faso)	Sample size
VECTRON™ T500	Cement	100	56 (54 – 58)	98 (97 – 98)	3,981
VECTRON™ T500	Mud	100	60 (58 – 62)	97 (96 – 98)	4,117
PC1	Cement	1,000	53 (51 – 56)	98 (98 – 99)	2,540
PC1	Mud	1,000	53 (51 – 56)	98 (98 – 99)	3,444
Burkina Faso (*An. gambiae* s.l.)					
Total number of mosquitoes collected = 19,552			Compliant with power calculation? Not provided		
Control		N/A	5.6	-	3,453
VECTRON™ T500	Concrete	100	60.4	0.71	3,546
	Concrete	150	70.0	0.6	4,330
	Mud	100	55.5	4.5	3,498
	Mud	150	73.2	0	3,190
PC1	Concrete	1,000	100	0	1,535

Table 7. Control corrected 72-hour mortality (%, Tanzania) and observed 72-hour mortality (%, Benin, Burkina Faso) for WHO cone tests conducted in experimental huts treated with 100 or 150 mg AI/m² of VECTRON T500 or 1,000 mg AI/m² of PC1

Treatment	Substrate	Dose (mgAI/m2)	Month															
			0.25	0.5	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18
Tanzania *An. gambiae* s.s. (Kisumu)																			
VECTRON T500	Concrete	100		99.5	100.0	100.0	100.0	100.0	100.0	99.0	99.5	100.0	100.0	100.0	100.0	97.4			
PC1	Concrete	1,000		82.4	100.0	57.5	25.0	12.8	17.2	2.0	9.4	2.1	14.6	34.0	56.3	24.0			
VECTRON T500	Mud	100		100.0	95.4	96.8	98.4	93.6	99.0	67.9	37.0	33.0	22.9	32.6	61.7	33.5			
PC1	Mud	1,000		94.6	59.8	58.8	28.8	6.4	39.6	20.4	0.0	0.0	16.0	22.1	41.5	23.7			
Tanzania *An. gambiae* (Muleba-Kis)																			
VECTRON T500	Concrete	100		100.0	100.0	96.9	100.0	100.0	98.4	94.8	95.3	92.6	100.0	98.4	100.0	91.2			
PC1	Concrete	1,000		90.2	87.2	15.1	29.7	24.0	18.8	1.0	4.2	13.7	20.6	30.2	32.3	23.7			
VECTRON T500	Mud	100		97.3	90.1	92.3	94.6	57.1	62.4	15.4	17.6	21.2	13.7	27.4	30.0	22.9			
PC1	Mud	1,000		89.0	30.8	14.9	8.1	5.7	25.8	2.1	6.4	11.1	7.4	20.0	24.2	12.5			
Benin *An. gambiae* s.s. (Kisumu)																			
Control	Cement	N/A	0		0	2	0	0	0	0	0	0	0	4	0	0	2	0	4
Control	Mud	N/A	0		0	2	0	0	0	0	0	4	0	2	0	0	2	0	2
VECTRON T500	Cement	100	100		98	100	100	100	100	100	100	100	100	98	100	100	100	100	100
VECTRON T500	Cement	100	100		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
VECTRON T500	Mud	100	100		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
VECTRON T500	Mud	100	100		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
PC1	Cement	1,000	100		100	100	100	100	100	98	46	65	30	8	N/A	15	26	48	15
PC1	Mud	1,000	100		100	100	100	100	100	100	89	79	30	30	N/A	38	37	55	58

Table 7. Control corrected 72-hour mortality (%, Tanzania) and observed 72-hour mortality (%, Benin, Burkina Faso) for WHO cone tests conducted in experimental huts treated with 100 or 150 mg AI/m² of VECTRON T500 or 1,000 mg AI/m² of PC1

Treatment	Substrate	Dose (mgAI/m2)	Month																
			0.25	0.5	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18
Benin *An. gambiae* s.l. (Covè)																			
Control	Cement	N/A	0		0	4	0	0	0	0	0	0	0	8	0	2	0	0	2
Control	Mud	N/A	0		0	4	0	0	0	0	0	2	0	6	0	2	2	0	0
VECTRON T500	Cement	100	100		85	90	100	100	100	100	100	100	100	100	100	83	100	100	100
VECTRON T500	Cement	100	96		100	100	100	100	100	100	100	98	100	100	100	96	100	100	100
VECTRON T500	Mud	100	100		100	100	100	100	100	100	100	96	100	100	100	100	100	100	100
VECTRON T500	Mud	100	100		100	100	100	100	100	100	98	95	100	96	100	94	100	98	98
PC1	Cement	1,000	100		100	98	100	100	100	100	58	28	20	12	14	22	11	15	33
PC1	Mud	1,000	100		92	86	100	100	100	100	90	58	22	53	32	26	32	12	21
Burkina Faso *An. gambiae* s.s. (Kisumu)																			
Control	Concrete	N/A	5.3 (2.0)		6.0 (2.5)	20.6 (6.5)	15.7 (3.6)	10.7 (3.0)	17.5 (5.4)	8.3 (3.3)	7.0 (2.9)	2.8 (1.8)	6.8 (2.5)	3.7 (1.8)	8.2 (3.0)	5.2 (2.2)			
VECTRON T500	Concrete	100	100		100	100	100	88.8 (6.5)	100	94.9 (2.2)	100	100	100						
VECTRON T500	Concrete	150	100		100	100	100	100	98.7 (1.6)	100	100	97.9 (1.8)	100	53.1 (12.1)	57.5 (13.4)	52.7 (13.9)			
VECTRON T500	Mud	100	100		100	100	100	100	100	98.8 (1.0)	100	100	100						
VECTRON T500	Mud	150	100		100	100	100	100	100	100	100	100	100	96.4 (3.8)	100	100			
PC1	Concrete	1,000	100		100	100	94.9 (3.3)	55.7 (5.5)	93.1 (3.7)	53.8 (4.6)	100	68.5 (8.6)	100						
Burkina Faso *An. coluzzii*																			
Control	Concrete	N/A	2.6 (2.7)		4.9 (1.9)	13.0 (3.3)	2.1 (2.5)	9.8 (4.3)	12.1 (2.6)	2.2 (2.1)	5 (2.0)	9.6 (3.8)	4.6 (3.6)	2.2 (1.3)	8.2 (2.3)	2.4 (1.5)			

Table 7. Control corrected 72-hour mortality (%, Tanzania) and observed 72-hour mortality (%, Benin, Burkina Faso) for WHO cone tests conducted in experimental huts treated with 100 or 150 mg AI/m² of VECTRON T500 or 1,000 mg AI/m² of PC1

Treatment	Substrate	Dose (mgAI/m2)	Month															
			0.25	0.5	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18
VECTRON T500	Concrete	100	100		100	64.8 (9.5)	94.3 (5.8)	71.2 (7.2)	77.3 (7.3)	100	90.2 (3.6)	76.9 (9.3)	23.8 (5.3)	-	-	-			
VECTRON T500	Concrete	150	100		98.8 (1.1)	100	75.0 (10.4)	87.3 (9.7)	100	74.4 (7.5)	86.2 (6.0)	98.8 (1.0)	15.4 (3.4)	17.3 (8.0)	53.0 (8.4)	8.9 (3.4)			
VECTRON T500	Mud	100	100		100	84.9 (11.4)	97.8 (2.1)	100	93.5 (5.5)	100	100	98.8 (1.3)	91.7 (4.5)	-	-	-			
VECTRON T500	Mud	150	100		100	100	100	98.1 (1.8)	100	100	100	100	73.9 (10.8)	84.2 (9.6)	79.6 (7.0)	37.2 (7.6)			
PC1	Concrete	1,000	100		100	98.8 (1.4)	98.1 (1.7)	45.6 (7.2)	97.5 (1.5)	45.5 (13.6)	100	34.5 (5.1)	4.6 (4.2)	-	-	-			

2.2 Semi-field studies conclusions

The submitted semi-field studies demonstrate the bioavailability of broflanilide on concrete, cement and mud surfaces using WHO cone bioassays and the impact of VECTRON T500 on the mortality of free-flying mosquitoes. Based on the submitted studies, following a single application of VECTRON T500 at 100 mg AI/m^2, the bioavailability of broflanilide can be sustained for up to 12 months on concrete against pyrethroid susceptible *An. gambiae* Kisumu and against two pyrethroid resistant strains of the *An. gambiae* complex. Against a highly resistant strain of *An. coluzzii*, bioavailability was sustained for three months. On mud surfaces, the bioavailability of broflanilide was sustained for five months against pyrethroid susceptible *An. gambiae* Kisumu and three months against pyrethroid resistant *An. gambiae* complex strains.

There was a consistent effect of VECTRON T500 on the mortality of free-flying mosquitoes in concrete, cement and mud huts up to 12 months after a single application at 100 mg AI/m^2.

3 Community studies

Data on the community performance of VECTRON T500 and the residual efficacy on concrete/cement, mud and painted cement wall surfaces were provided. These data were obtained from studies conducted according to established standards and/or Good Laboratory Practices (GLP).

Three community studies were presented to evaluate the efficacy and residual activity of VECTRON T500, conducted in Benin, Burkina Faso, and Tanzania. Each community study measured the impact of VECTRON T500 on the density of *An. gambiae* s.l. mosquitoes, and residual efficacy using WHO cone bioassays. The control in the Benin study was a prequalified product applied at 200 mg (clothianidin) and 25 mg (deltamethrin) AI/m^2, hereafter referred to as PC2; the control in the study in Burkina Faso was PC1, applied at 1,000 mg AI/m^2; the control in the Tanzania study was PC2, applied at 200 mg (clothianidin) and 25 mg (deltamethrin) AI/m^2. VECTRON T500 was applied at 100 mg AI/m^2.

The product was tested against pyrethroid resistant natural populations of i) *An. gambiae* s.l. in Covè, Benin, with an approximate species distribution of 45% *An. coluzzii* and 55% *An. gambiae* s.s. carrying *kdr* gene frequencies of >80%; ii) the multi-resistant *An. gambiae* s.l. in Vallee du Kou, Burkina Faso, carrying *kdr* gene frequencies of 80-90% L1014F and ace-1 frequencies of 3-40%; iii) *An. gambiae* s.l. and *Anopheles funestus* in Muheza, Tanzania, with an *Anopheles* species distribution of 61% *Anopheles gambiae* s.l. and 38% *An. funestus* (insecticide resistance data were not provided for *An. funestus*). The resistance intensity to deltamethrin of the *An. gambiae* s.l. population was measured in Benin and mortality did not exceed 98% at 10X the diagnostic dose in any of the study villages. No resistance to broflanilide or clothianidin was observed either prior to IRS or at 10 months after IRS.

Supplementary bioassays using WHO cone tests were used to characterize the bioavailability of the active ingredients on the wall surfaces of the treated structures. The *An. gambiae* s.s. Kisumu strain was used as an insecticide susceptible test system in all sites. The pyrethroid resistant test system used in Benin was the *An. gambiae* s.l. Cové strain. In Burkina Faso, two pyrethroid resistant test systems were used: i) *Anopheles coluzzii* VKPer strain and ii) *An. gambiae* s.l. wild type strain collected from the study area as larvae and reared to adults. In Tanzania, the pyrethroid resistant

test systems were *An. gambiae* s.l. Muheza (month 6) and *An. gambiae* s.s. Muleba Kis (months 11 and 12) strains.

The duration of the free-flying mosquito studies was 18 months in Benin, 12 months (results for nine months reported to date) in Burkina Faso and 12 months in Tanzania. In Benin, 88% (11,336/12,933) of eligible structures in the study villages were sprayed with coverage rates of 83% and 93% respectively, in the VECTRON T500 and PC2 arms. There was a discrepancy between the two methods used to quantify the amount of product applied to sprayable surfaces. HPLC analyses of filter papers from houses suggested that treatments were applied within the WHO-indicated target dose deviation of 50% in a total of six clusters of which two clusters were in the VECTRON T500 arm and 4 clusters were in the PC2 arm of the trial. Estimations of application rates based on the average wall area of houses in a village cluster, the number of houses in a cluster and the number of sachets of IRS product used, indicated that the actual quantities of insecticide applied as required by the number of sprayable structures in each village was within target in 80% of the villages (12 out of 15). Spray applications were within an overall acceptable deviation from target of 31% for the PC2 arm and 20% for the VECTRON T500 arm. This discrepancy was investigated and found to be associated with sprayers and spraying process.

In Burkina Faso, 30 houses each with concrete, mud, and painted cement walls for selected for use in each arm of the study (VECTRON T500, PC1, unsprayed negative control). HPLC analysis of filter papers from 16 houses in each of the VECTRON T500 and PC1 arms indicated that 38% (3/8 in each arm) of houses were over-sprayed beyond the ±50% acceptable WHO range.

In Tanzania, the overall spray coverage in the study clusters was 96% (95% CI 94-98%). A total of 844 and 916 houses, respectively, were sprayed in the VECTRON T500 and PC2 arms. HPLC analyses of filter papers from houses suggested that treatments were applied in excess of the WHO-indicated target dose deviation of 50% in every cluster in the study. Estimations of application rates based on the volume of IRS solution sprayed per unit wall area indicated that the actual quantities of insecticide applied as required by the number of sprayable structures in each village was within target in 50% of the clusters (4 out of 8) in the VECTRON T500 arm and 88% of the clusters in the PC2 arm (7 out of 8).

The results of the community performance and the impact on free-flying mosquito are presented in Tables 8, 9 and 10. In Benin, the impact on vector density of VECTRON T500 applied at 100 mg AI/m^2 was non-inferior to the impact on vector density of PC2 both indoors and when the indoor and outdoor collection data were combined (Table 8). In Burkina Faso, there was a 2-fold reduction in the *An. gambiae* s.l. density in the areas that received IRS treatment compared to the unsprayed control sites (RR = 0.3, 95% CI = [0.2 – 0.38], P = 0.0001), and there was no significant difference in the mean indoor resting density between the VECTRON T500 and the PC1 arms (RR = 0.88, 95% CI = [0.65 – 1.20], P = 0.63). In Tanzania, the impact on vector density of VECTRON T500 applied at 100 mg AI/m^2 was non-inferior to the impact on vector density of PC2 (Density ratio 0.92, 95% CI 0.36 – 2.35, P = 0.86, Table 10).

Supplementary bioassays were carried out for 18 months in Benin, nine months (to date) in Burkina Faso and 12 months in Tanzania. In structures with concrete/cement walls, 72-hour mortality greater than 80% was recorded in WHO cone tests using the *An. gambiae* Kisumu system to 18 months (Benin), nine months (Burkina Faso) and 12 months (Tanzania). In structures with mud walls, 72-hour mortality greater than 80% was recorded in WHO cone tests using the *An. gambiae* Kisumu system to 18 months (Benin), nine months (Burkina Faso) and 12 months (Tanzania). In houses with

painted cement walls in Burkina Faso, 72-hour mortality greater than 80% was recorded in WHO cone tests using the *An. gambiae* Kisumu system to nine months.

In WHO cone tests using pyrethroid resistant test systems, 72-hour mortality greater than 80% was recorded in structures with concrete/cement walls to 18 months (Benin), nine months (Burkina Faso, VKPer and wild type strains), and 12 months (Tanzania); in structures with mud walls, 72-hour mortality greater than 80% was recorded to 18 months (Benin), nine months (Burkina Faso, VKPer and wild type strains) and 12 months (Tanzania). In houses with painted cement walls in Burkina Faso, 72-hour mortality greater than 80% in the VKPer and wild type strains was recorded in WHO cone tests to nine months.

3.1 Community studies conclusions

The results from the supplementary bioassays demonstrate that the bioavailability of broflianilide is sustained on concrete, cement, mud and painted cement surfaces for up to nine months following a single application at 100 mg AI/m^2. The duration of the residual effect was the same for the pyrethroid susceptible and the pyrethroid and multi-resistant strains of *An. gambiae* s.l. that were used as test systems in the bioassays. The duration of the bioavailability may be revised upwards following the submission of the final report from the study in Burkina Faso.

Table 8. Results from multi-level mixed effects negative binomial regression analysis of *An. gambiae s.l.* vector density in a community trial of VECTRON T500 in Benin

Phase	Arm	Total collected	Man nights	HBR	Rate ratio (95% CI)	P value	Marginal predicted HBR (95% CI)
Benin (*An. gambiae* s.l.) indoor collections							
Total number of mosquitoes collected = 3,005				**Compliant with power calculation? Yes**			
Before IRS	PC2	726	288	2.52	0.98 (0.32 – 2.98)	0.97	3.19 (0.322 – 6.05)
	VECTRON™ T500	908	288	3.15			3.12 (0.32 – 5.92)
After IRS	PC2	731	864	0.85	0.64 (0.29 – 1.45)	0.28	1.04 (0.40 – 1.69)
	VECTRON™ T500	640	864	0.74			0.67 (0.26 – 1.08)
Benin (*An. gambiae* s.l.) outdoor collections							
Total number of mosquitoes collected = 2,392				**Compliant with power calculation? Yes**			
Before IRS	PC2	599	288	2.08	0.91 (0.34 – 2.41)	0.85	2.42 (0.57 – 4.27)
	VECTRON™ T500	686	288	2.38			2.21 (0.52 – 3.89)
After IRS	PC2	597	864	0.69	0.85 (0.45 – 1.59)	0.61	0.68 (0.37 – 1.00)
	VECTRON™ T500	510	864	0.59			0.58 (0.31 – 0.85)
Benin (*An. gambiae* s.l.) indoor and outdoor collections combined							
Total number of mosquitoes collected = 5,397				**Compliant with power calculation? Yes**			
Before IRS	PC2	1,325	576	2.30	0.94 (0.33 – 2.64)	0.90	2.81 (0.50 – 5.12)
	VECTRON™ T500	1,594	576	2.77			2.64 (0.47 – 4.80)
After IRS	PC2	1,328	1,728	0.77	0.76 (0.39 – 1.48)	0.42	0.83 (0.42 – 1.24)
	VECTRON™ T500	1,150	1,728	0.67			0.63 (0.32 – 0.94)

Table 9. Mortality and blood feeding inhibition of free-flying pyrethroid resistant *An. gambiae s.l.* in Burkina Faso

	Wall substrate	Treatment concentration (mg AI/m2)	Number collected	% M72 (95% CI)	Total number of females examined for blood feeding status (all substrates combined)	% Blood feeding inhibition
Control	Concrete	N/A	2,179	29.6 (27.7 – 31.6)	4,567	-
	Mud	N/A	2,395	19.11 (17.5 – 20.7)		
	Painted cement	N/A	2,472	21.3 (19.7 – 22.9)		
VECTRON T500	Concrete	100	778	75.7 (72.7 – 78.7)	1,646	64.01
	Mud	100	778	74.7 (71.6 – 77.7)		
	Painted cement	100	727	75.9 (72.8 – 79.0)		
PC1	Concrete	1,000	502	47.8 (43.4 – 52.2)	985	34.14
	Mud	1,000	731	35.6 (32.1 – 39.0)		
	Painted cement	1,000	613	35.6 (31.8 – 39.4)		

Table 10. Results from non-inferiority assessment of mosquito density between VECTRON T500 and PC2 in Muheza, Tanzania

Phase	Arm	Total collected	Mean number per house per night (95% CI)	Density ratio (95% CI)	P value
Total number of mosquitoes collected = 6,030			Compliant with power calculation? Yes		
Before IRS	PC2	1,835	17.4 (0.86 – 33.9)	1 (Ref)	0.84
	VECTRON T500	1,476	15.4 (0.50 – 30.3)	0.89 (0.27 – 2.86)	
After IRS	PC2	1,793	1.6 (0.2 – 3.0)	1 (Ref)	0.86
	VECTRON T500	926	1.5 (0.03 – 2.9)	0.92 (0.36 – 2.35)	

4 Efficacy conclusions

Based on the studies and information provided, all data requirements for the prequalification assessment of product efficacy have been satisfied. These data have been relied upon to assess the bioavailability and the impact on free-flying mosquitoes of the proposed product for the purpose of characterising the biological impact and residual efficacy of the product on wall substrates.

The efficacy component of the dossier is considered complete, and the assessment of the submitted information on efficacy supports prequalification of the product.

Table 11. List of efficacy studies submitted to WHO as part of the prequalification dossier

Studies that were relied upon for decision making	
Study number	**Study title**
2016/04	Evaluation of VECTRON™ T500 efficacy as indoor residual spraying (IRS) product against malaria vectors, in Burkina Faso
26B006-P	Evaluating VECTRON™ T500, broflanilide 50WP, on different substrates in Hurusini experimental huts
1904 CREC/LSHTM	Experimental hut evaluation of VECTRON™ T500, broflanilide (Mitsui Chemicals Agro, Inc.) for indoor residual spraying against pyrethroid resistant *Anopheles gambiae* s.l. in Covè, Southern Benin
CREC/LSHTM 2004	Community (Phase III) evaluation of VECTRON™ T500 for Indoor Residual Spraying against pyrethroid-resistant malaria vectors in the Za-Kpota District of Southern Benin
15-2021	Community (Phase III) trial of residual effect and efficacy of a new IRS product VECTRON™ T500 (broflanilide) against susceptible and pyrethroid-resistant *Anopheles gambiae* s.l. populations from rural Burkina Faso
26C001	Community (Phase III) evaluation of VECTRON™ T500 (Broflanilide 50WP) for indoor residual spraying for malaria vector control in Muheza, N.E. Tanzania
Studies that were not used to inform decision making	
Study number	**Study title**
26B001-P and 26B003-P	Determining the optimal concentration and formulation of broflanilide in two hut studies in Moshi, Tanzania
1605/6.2	Experimental hut evaluation of VECTRON™ T500 (broflanilide WP) by Mitsui Chemicals Agro, Inc. for indoor residual spraying against pyrethroid resistant *Anopheles gambiae* s.l. in Covè, Benin
041/20-21	Semi-field trial of VECTRON™ T500 in comparison to Sumishield™ 50WG against susceptible and resistant field *Anopheles gambiae* s.l. in Odumse, Dodowa, Southern Ghana