EFFECT OF WATER QUALITY ON THE EFFICACY OF WATER-BASE SUSPENSIONS OF AROSURF® MSF AGAINST LARVAE OF *AEDES TAENIORHYNCHUS*: BIOASSAY EVALUATIONS[1,2]

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Technical and water-base formulations of Arosurf® MSF have been shown to be effective for controlling the larvae and pupae of various species of mosquitoes (Anonymous 1984). The choice of formulation is usually based on the type of application (i.e., ground or aerial), the availability of agitation within the spray system, and/or on the density of vegetation or debris in the mosquito habitat.

Recently, preliminary field observations and bioassays by Levy et al. (1986) have indicated that faster kill of larvae of *Aedes taeniorhynchus* (Wiedemann) can be obtained with water-base Arosurf MSF than with the technical material when applied at equivalent active application rates. We speculated that the formation of micelles of Arosurf MSF in water during vigorous agitation is responsible for the enhanced larvicidal action of water-base Arosurf MSF when compared to the larvicidal response of the technical material. Water quality is one of the parameters that is known to effect the critical micelle concentration in aqueous solution (Fendler 1982).

To date, bioassays with water-base Arosurf MSF have only been performed with Arosurf MSF that was formulated with well water purified by reverse osmosis filtration (R.O.). However, on an operational basis unfiltered well water is usually used as the diluent for Arosurf MSF for ground and aerial application. In addition, previous bioassays against *Ae. taeniorhynchus* were mainly conducted in 12.5% artificial seawater (Instant Ocean®; Aquarium Systems, Mentor, OH 44060); however, *Ae. taeniorhynchus* habitats are known to vary greatly in salinity. To simulate a variety of natural field and operational conditions, bioassays were conducted to determine if the type of water in the water-base Arosurf MSF suspension and/or the type of water in which the Arosurf MSF formulation is applied (i.e., the mosquito habitat) would effect the rate of larvicidal action of Arosurf MSF against *Ae. taeniorhynchus*. Bioassay data could then be used to evaluate the relationship between water quality and the efficacy of water-base Arosurf MSF against larvae of *Ae. taeniorhynchus*.

A few thousand eggs of *Ae. taeniorhynchus* were hatched in 5.0 gal plastic buckets containing each type of water to simulate the mosquito habitat, and the resultant larvae were reared in these containers until being transferred to beakers for testing. Bioassays were conducted in 400 ml glass beakers containing 250 ml of various concentrations of Instant Ocean artificial seawater ranging from 6.25 to 100% (Table 1) and 10 early to late 3rd or 4th instar larvae of laboratory-reared *Ae. taeniorhynchus*. Tests were replicated 3 times and monitored at 24 hr intervals in a room maintained at ca. 27°C (ambient) and ca. 80% RH.

Four types of water (Table 1) were evaluated in the Arosurf MSF formulations. Arosurf MSF was suspended in a 100 ml glass medicine bottle in each of these types of water at a 5.2% level by vigorous hand-shaking for 1 min. The resultant milky suspensions were then pipetted into beakers containing the 3rd or 4th instar larvae of *Ae. taeniorhynchus* at a total volume of 5.0 gal/surface acre of water (i.e., 0.26 gal Arosurf MSF/surface acre of water). Technical Arosurf MSF was applied to the surface of the water with a micropipette at a rate of 0.26 gal/acre in all tests. The recommended label rates for larviciding with Arosurf MSF generally range from 0.3 to 0.5 gal/acre (Anonymous 1984). Larvae in beakers were fed a few drops of a ground rabbit chow–R.O. water suspension prior to application of the Arosurf MSF formulations.

Larvicidal efficacy was evaluated at 24 hr intervals. Results were statistically analyzed using "z" and "t" tests. The formulation and habitat water quality parameters and the range of values obtained for these waters are presented in Table 1.

Comparative bioassays against 4th instar larvae of *Ae. taeniorhynchus* in 12.5–75% artificial seawater with Arosurf MSF water-base formulations composed of well, tap, R.O., and distilled water (Table 2) indicated that there was no significant correlation between the water quality of the habitat or formulation and the general mosquito-controlling efficacy of the water-base

[1] Arosurf® MSF is a mosquito larvicide and pupicide manufactured by Sherex Chemical Company, Inc., P.O. Box 646, Dublin, OH 43017.

[2] Mention of a brand name or proprietary product does not constitute a guarantee or warranty by Lee County Mosquito Control District and does not imply it is approved to the exclusion of other products that may also be suitable.

Table 1. Formulation and habitat water quality analyses.

Water type	Parameters analyzed: Hardness (mg/l) $CaCO_3$	Hardness (mg/l) Mg	Hardness (mg/l) Total	Salinity (o/oo)	Conductivity (μmhos/cm)	pH
			Formulation water			
Well	150	190	340	0.1–0.7	520–890	7.5–7.85
Tap	230	160	390	0.1–0.2	680–720	7.4–7.95
Reverse osmosis	0	5	5	0–0.1	370–580	6.85–6.95
Distilled	0	0	0	0	10–18	6.9–6.95
			Habitat water			
6.25% seawater	—	—	—	2.1–2.3	3,250–4,400	6.9–6.95
12.5% seawater	—	—	—	4.0–4.7	6,000–6,400	6.8–6.95
25.0% seawater	—	—	—	8.0–8.8	11,000–13,200	6.8–7.0
50.0% seawater	—	—	—	17.1–17.4	22,000–25,000	6.9–7.0
75.0% seawater	—	—	—	25.8–27.0	32,000–42,000	6.85–6.95
100.0% seawater	—	—	—	34.1–34.4	— —	7.0–7.25

Table 2. Effect of formulation and habitat water quality on the efficacy of technical and/or water-base Arosurf® MSF against fourth instar larvae of *Aedes taeniorhynchus*.[1,2]

Test no.	Habitat water quality (% seawater)	Formulation	Cumulative percentage mortality of larvae, pupae, and/or emerging adults at indicated posttreatment time period (hours). 5	24	48	72	96	120
1a	12.5	Well water + Arosurf MSF	—	83.3	96.7	100	—	—
		Tap water + Arosurf MSF	—	83.3	86.7	96.7	100	—
		R.O. water + Arosurf MSF	—	100	—	—	—	—
		Distilled water + Arosurf MSF	—	90	100	—	—	—
		Control	—	0	0	0	0	—
1b	25	Well water + Arosurf MSF	—	93.3	96.7	100	—	—
		Tap water + Arosurf MSF	—	100	—	—	—	—
		R.O. water + Arosurf MSF	—	96.7	100	—	—	—
		Distilled water + Arosurf MSF	—	100	—	—	—	—
		Control	—	6.7	10	10	—	—
1c	50	Well water + Arosurf MSF	—	93.3	96.7	100	—	—
		Tap water + Arosurf MSF	—	100	—	—	—	—
		R.O. water + Arosurf MSF	—	96.7	100	—	—	—
		Distilled water + Arosurf MSF	—	100	—	—	—	—
		Control	—	0	3.3	3.3	—	—
1d	75	Well water + Arosurf MSF	—	96.7	96.7	100	—	—
		Tap water + Arosurf MSF	—	96.7	100	—	—	—
		R.O. water + Arosurf MSF	—	96.7	100	—	—	—
		Distilled water + Arosurf MSF	—	96.7	100	—	—	—
		Control	—	3.3	6.7	6.7	—	—
2	12.5	R.O. water + Arosurf MSF	—	90	96.7	96.7	100	—
		Distilled water + Arosurf MSF	—	90	100	—	—	—
		Tap water + Arosurf MSF	—	90	96.7	100	—	—
		Well water + Arosurf MSF	—	90	96.7	100	—	—
		Arosurf MSF	—	26.7	53.3	60	100	—
		Control	—	0	3.3	3.3	6.7	—
3	12.5	R.O. water + Arosurf MSF	77.7	90	100	—	—	—
		Distilled water + Arosurf MSF	47.7	86.7	86.7	86.7	90	100
		Tap water + Arosurf MSF	77.7	97.7	100	—	—	—
		Well water + Arosurf MSF	93.3	97.7	100	—	—	—
		Arosurf MSF	0	66.7	83.3	93.3	96.7	100
		Control	0	0	6.7	6.7	6.7	6.7

[1] Arosurf MSF in water-base and technical formulations applied at a rate of 0.26 gal/surface acre of water; total application rate of all water-base formulations was 5.0 gal/surface acre of water.

[2] Larvae 7–8 days old at time of testing.

Arosurf MSF formulations. The data indicated that water-base Arosurf MSF formulations killed 83.3–100% of the 7–8 day old 4th instar larvae within 24 hr posttreatment, with the remaining larvae, pupae, and/or emerging adults being killed within 48–120 hr posttreatment. The results of tests 2–3 (Table 2) at 5 and 24 hr posttreatment confirmed earlier observations (Levy et al. 1986) that the rate of kill of 4th instar larvae of *Ae. taeniorhynchus* was significantly faster with water-base Arosurf MSF than with technical Arosurf MSF.

Although variations in the daily kill rate were observed within and among tests 1–3 (Table 2), no consistent trend was observed. Differences in the age of the larvae at the time of testing and fluctuations in various water quality parameters within a test as well as among the test series, were presumed to have contributed to variations in the delayed larvicidal action of *Ae. taeniorhynchus* over the 5 day test period (Levy et al. 1981).

In general, comparative bioassays against 5–6 day old larvae of *Ae. taeniorhynchus* in 6.25–100% of artificial seawater with R.O. and well water formulations of Arosurf MSF and technical Arosurf MSF indicated that no significant differences in kill over the 120 hr test period could be related to habitat or formulation water quality (Table 3). With the exception of test 2b, well water-base formulations of Arosurf MSF killed faster than R.O. water-base formulations or technical Arosurf MSF at 24 hr posttreatment; however, this was not as apparent at 72–96 hr posttreatment, with all formulations producing 100% mortality of larvae, pupae, and/or emerging adults within 72–120 hr posttreatment.

Results of tests between R.O. water-base Arosurf MSF and technical Arosurf MSF for 3rd instar larvae of *Ae. taeniorhynchus* (Table 3) were consistent with earlier reports which indicated that 3rd instar larvae showed comparable sensitivity to the 2 formulations (Levy et al. 1986); however, with the exception of tests in 12.5% seawater, enhanced larvicidal action was observed at 24 hr posttreatment when well-water Arosurf MSF formulations in tests 2a and 2c–e were compared to technical Arosurf MSF (Table 3). This is interesting since this well water is used to formulate water-base Arosurf MSF in our operational program. Variations in the 24 hr rate of kill over the 5 day test period for 3rd instar larvae were also related to the aforementioned parameters for 4th instar larvae.

Results of bioassays against 3rd and 4th instar larvae of *Ae. taeniorhynchus* in several simulated aquatic habitats with agitated water-base formulations of Arosurf MSF varying in water

Table 3. Effect of formulation and habitat water quality on the efficacy of technical and water-base Arosurf ® MSF against third instar larvae of *Aedes taeniorhynchus*.[1,2]

Test no.	Habitat water quality (% seawater)	Formulation	Cumulative percentage mortality of larvae, pupae, and/or emerging adults at indicated posttreatment time period (hours).				
			24	48	72	96	120
2a	6.25	R.O. water + Arosurf MSF	40	40	56.7	96.7	100
		Well water + Arosurf MSF	73.3	73.3	83.3	100	—
		Arosurf MSF	46.7	56.7	86.7	100	—
		Control	0	0	0	3.3	3.3
2b	12.5	R.O. water + Arosurf MSF	46.7	66.7	70	93.3	100
		Well water + Arosurf MSF	26.7	56.7	73.3	90	100
		Arosurf MSF	40	60	83.3	93.3	100
		Control	0	0	0	3.3	3.3
2c	25	R.O. water + Arosurf MSF	13.3	23.3	56.7	76.7	100
		Well water + Arosurf MSF	70	83.3	86.7	100	—
		Arosurf MSF	26.7	60	93.3	93.3	100
		Control	0	0	0	3.3	3.3
2d	50	R.O. water + Arosurf MSF	53.3	56.7	63.3	100	—
		Well water + Arosurf MSF	80	86.7	90	100	—
		Arosurf MSF	46.7	80	100	—	—
		Control	0	0	0	0	—
2e	100	R.O. water + Arosurf MSF	40	56.7	73.3	96.7	100
		Well water + Arosurf MSF	76.7	76.7	83.3	100	—
		Arosurf MSF	40	46.7	83.3	100	—
		Control	0	0	0	3.3	3.3

[1] Arosurf MSF in water-base and technical formulations applied at a rate of 0.26 gal/surface acre of water; total application rate of all water-base formulations was 5.0 gal/acre.

[2] Larvae 5–6 days old at time of testing.

quality have suggested that no detrimental or inhibitory effects on the mosquito-controlling efficacy should result when Arosurf MSF is suspended in a variety of water types at 5% by volume with vigorous agitation and applied to a variety of aquatic habitats at a total application rate of 5.0 gal/acre (i.e., 0.26 gal Arosurf MSF/surface acre of water).

For the most part, the data has also suggested that agitated water-base formulations of Arosurf MSF will kill certain larval stages of *Ae. taeniorhynchus* faster than technical Arosurf MSF (Levy et al. 1986). However, both formulations appear to provide effective delayed control of larvae of this species.

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