Efficacy of Selected Compounds on *Thermocyclops oblongatus*, one of the Main Intermediate Hosts of Guinea Worm in Africa

Wirksamkeit ausgewählter Verbindungen auf *Thermocyclops oblongatus*, einen der wichtigsten Zwischenwirte des Medinawurms in Afrika

J.-P. Chippaux*, K. P. Yovo, Y. Soakoudé**, and M. Akogbéto*****

Keywords: Cyclopidae, *Thermocyclops oblongatus*, Vector Control, Guinea Worm, West Africa, Temephos, Pesticides

Summary: Ten selected compounds were tested on *Thermocyclops oblongatus* to determine their ability to be used for treatment of drinking water sources. None were shown to be interesting for individual application in household water tanks. Tested compounds, such as potassium permanganate or chlorine-releasing products, were ineffective or affected dramatically the taste or colour of the water. For collective application in water sources, temephos appeared to be the most valuable pesticide because it was effective against cyclops and harmless for environment. Other pesticides should be proposed as substitutes in case of cyclops resistance to temephos.

Schlagwörter: Cyclopidae, *Thermocyclops oblongatus*, Bekämpfung der Übertragung, *Dracunculus medinensis*, Westafrika, Temephos, Pestizide

Zusammenfassung: Die Wirksamkeit von zehn ausgewählten Verbindungen auf *Thermocyclops oblongatus* wird getestet, um ihre Anwendbarkeit für die Behandlung von Oberflächenwasser als Trinkwasserquelle zu bestimmen. Kaliumpermanganat und chlorfreisetzende Präparate erweisen sich als unwirksam, bzw. sie beeinflussen in den notwendigen Konzentrationen Geruch oder Färbung des Wassers erheblich. Für die Anwendung in Gewässern erweist sich Temephos mit einer $LC_{99,24h}$ von 420 µg/L als das geeignetste Pestizid auch wegen seiner sonstigen Umweltverträglichkeit. Im Falle einer Resistenzentwicklung erscheinen Deltamethrin, Cypermethrin, Cyfluthrin und Ziram als geeignete Ersatzsubstanzen.

1 Introduction

Strategies for guinea worm eradication program are based on health education and water supply. Vector control could be a complementary way to reduce incidence of guinea worm in hyperendemic regions. Use of pesticides or antiseptics is restricted by toxicity to non-target organisms and implementation. Ten compounds (Table 1), available in Bénin, were tested. Eight could be employed in water bodies (collective application), and four might be used in household water tank (individual application).

2 Material and Methods

Cyclops were collected from a natural pond in an endemic village near Cotonou (Southern Bénin). Cyclops colonies were maintained in aquarium with filtered water obtained from the same pond. Tanks were aerated six hours per day using electric aerator. More than 95% of specimens were *Thermocyclops oblongatus*, however, species of cyclops used in experiments were confirmed by dissection after each test. *T. oblongatus* is one of the most important intermediate hosts of *Dracunculus medinensis* in wet savannah region of Africa (Steib and Mayer [1]), especially in Bénin (Chippaux [2]).

Efficiency tests were done on adults and stage V copepodites isolated by filtration on nylon monofilament sieve of 100 µm mesh size. Batches of about 30 specimens were transferred by tapered pipette into disposable cups. Each batch was put in a total amount of 200 mL of filtrated pond water.

Mortality was determined after one hour contact with antiseptics used for individual treatment. We used chloramine T (*N*-chloro-4-methylbenzenesulfonamide sodium salt), chloroxylenol (4-chloro-3,5-dimethylphenol), niclosamide (2′,5-dichloro-4′-nitrosalicylanilide), and potassium permanganate ($KMnO_4$). Mortality was determined after 24 hours contact with insecticides used for collective treatment. We tested cypermethrin (3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylic acid cyano(3-phenoxyphenyl)methyl ester), *Bacillus thuringiensis* H-14, chloroxylenol, cyfluthrin (3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylic acid cyano(4-fluoro-3-phenoxyphenyl)-methyl ester), deltamethrin (3-(2,2-dibromoethenyl)-2,2-dimethylcyclopropanecarboxylic acid cyano(3-phenoxyphenyl)methyl ester, niclosamide, temephos (*O,O′*-thiodi-*p*-

* Dr. Jean-Philippe Chippaux, Antenne ORSTOM auprès du Centre OCCGE de Cotonou, Bénin
** K. P. Yovo, Y. Soakoudé, Centre Polytechnique Universitaire, Université Nationale du Bénin, Abomey-Calavi, Bénin
*** M. Akogbéto, Centre OCCGE de Cotonou, Bénin
Correspondence to J.-P. Chippaux, CERMES, B. P. 10887, Niamey, Niger

Table 1: *Thermocyclops oblongatus* sensitivity to tested compounds

Sensitivität von *Thermocyclops oblongatus* gegenüber den getesteten Verbindungen

DP: dustable powder; EC: emulsifiable concentrate; TG: technical grade; WP: wettable powder

	Formulation	LC_{50} mg L^{-1}	LC_{90} mg L^{-1}	LC_{99} mg L^{-1}
1 hour contact				
chloramine T	25 WP	>1000	–	–
chloroxylenol	4.5 EC	0.19	0.42	0.81
niclosamide	70 WP	33.8	290	>1000
potassium permanganate	crystal	2.82	6.04	11.46
24 hours contact				
cypermethrin	20 EC	0.029	0.11	0.36
Bacillus thuringiensis H-14	DP	>1000	–	–
chloroxylenol	4.5 EC	0.17	0.25	0.35
cyfluthrin	20 EC	0.051	0.13	0.28
deltamethrin	25 EC	0.021	0.117	0.49
niclosamide	70 WP	1.057	3.29	8.51
temephos	20 EC	0.073	0.189	0.419
ziram	TG	0.02	0.04	0.075

phenylene diphosphorothioic acid *O,O,O′,O′*-tetramethyl ester), and ziram (bis(dimethyldithiocarbamato-*S,S′*)zinc). Formulations and the content of active substances in the formulations are given in Table 1. After contact time, the cyclops were discharged in a Petri dish and examined for numeration and identification under a dissecting stereoscopic microscope.

Various lethal concentration values (LC_{50}, LC_{90}, and LC_{99}) were calculated using log-probit analysis. All compounds were tested on five separate occasions to average the toxicity. Mortality in control was fewer then 10%.

3 Results

Results are presented in Table 1. Toxicity of cypermethrin, cyfluthrin, deltamethrin and temephos was very high for *T. oblongatus*. Observed lethal concentrations were similar to those claimed in literature (Muller [3]; Sastry et al. [4]; Manonmani et al. [5]). Toxicity of ziram seemed to be higher than described by Grétillat [6]. Niclosamide was not very toxic for cyclops, and *Bacillus thuringiensis* H-14 appeared to be clearly ineffective.

Only chloroxylenol should be regarded as a slightly interesting antiseptic for individual treatments. All other tested compounds of this group must be rejected because ineffective or giving bad taste or bad colour to water.

4 Discussion

Although these compounds are generally harmless for human at the doses used for these essays, some could be more toxic for other organisms such as frogs, toads or non-target-arthropods. Toxicity of selected compounds for mammals and fishes are given in Table 2 for comparison. However, the half-life period of each of these substances in water is short, less than 5 days for temephos (Chippaux and Coustard [7]) which is a very stable pesticide. None of the tested materials are known to produce bioaccumulation nor are recorded as carcinogenic. Considering toxicity for cyclops and safety for environment, deltamethrin, cypermethrin, cyfluthrin, and ziram should be considered as potential substitutes if cyclops resistance to temephos arises. But fishes and batrachians, potentially sensitive to such pesticides, may live in ponds where dracunculiasis transmission occurs. We did not test combination of these substances which could be synergetic and more potent when associated.

Table 2: Toxicity (LD_{50}) of selected compounds for rats and fishes, given by manufacturers

Toxizität (LD_{50}) ausgewählter Verbindungen gegenüber Ratten und Fischen (nach Herstellerangaben der Präparate)

	Rats, mg kg^{-1}	Fish, mg L^{-1}
niclosamide	>5000	0.235
potassium permanganate	1.09	?[1]
cypermethrin	251...4123	0.0028
cyfluthrin	500...800	?[1]
deltamethrin	135...5000	0.0001...0.01
temephos	8600...13000	31.8
ziram	1400	?[1]

[1] no data available

Mehta et al. [8] and Mehta and Srivastava [9] reported promising results under laboratory and field conditions with chlorine water and potassium permanganate. Our results did not confirm these results and showed that practical interest of antiseptics was poor and they should not be recommended. Only chloroxylenol showed a rather good efficacy. However, the toxicity of chloroxylenol is ten times fewer than that of the other pesticides, and the cost would limit its use.

Trials of temephos in natural water bodies have been done previously with success (Muller [3]; Lyons [10]; Sastry et al. [4]; Ripert et al. [11]; Chippaux et al. [12]; Kaul et al. [13]). Good results must not mask the two main problems of vector control strategies: i) identification of every potential focus is rather impossible, and ii) resistance apparition is foreseeable.

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