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SUSCEPTIBILITY OF SCHISTOSOMAISIS SNAILS (*BIOMPHALARIA PFEIFFERI*) TO AGRICULTURAL PESTICIDES (MALATHION, CARBARYL)

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ABSTRACT

Background: Snail control is one of the methods of choice for the control of transmission of schistosomaisis. **Objective:** This study aimed to determine the susceptibility of *Biomphalaria* snails to agricultural pesticides (Malathion and Carbaryl). **Methodology:** Field surveys were conducted for collection of *Biomphalaria* snails, from the irrigation canals of El-Selait agricultural schems in El-Faki Hashim area, Khartoum State. In the laboratory, the snails were divided into control group and study groups, the control group were not exposed to any pesticides except water, and the study groups were exposed to different concentrations of Malathion and Carbaryl pesticides. The results recorded after 24h. **Results:** The study revealed that there is difference in snail's mortality for the same dose, in the trials of Malathion, the higher concetration that achieved 100% kill is $1.5x10^{-4}$ %, (1.5 mg/L). While in the trials of Carbaryl, the higher concetration that achieved 100% kill is $4.25x10^{-4}$ %, (4.25 mg/L). The study revealed that the lethal concentration LC_{50} for Malathion and Carbaryl is $1x10^{-5}$ %, (0.1 mg/L) and $6x10^{-5}$ %, (0.6 mg/L) respectively. Malathion more toxic for snails as compared with Carbaryl. **Conclusion:** Both Malathion and Carbaryl have toxic effect on snails. There should be co-ordination between ministry of health and ministry of agriculture to control of schistosomiasis snails and agricultural pests together.

KEYWORDS: Susceptibility, Snails, Malathion, Carbaryl.

INTRODUCTION

Schistosomiasis, or bilharziasis, is a chronic debilitating disease with significant morbidity and mortality. It affects more than 200 million people in 74 countries worldwide and is second only to malaria in socioeconomic and public health importance in tropical and subtropical areas.[1] Freshwater aquatic and amphibious snail intermediate hosts transmit schistosomaisis. Aquatic snails of the genus *Biomphalaria* transmit *S. mansoni*. The extensive transport of freshwater plants either commercially or privately, or for exchange between botanical gardens, has often resulted in snail species passing natural barriers.[2] Snail habitats include almost all types of freshwater bodies ranging from small temporary ponds and streams to large lakes and rivers. Within each habitat, snail distribution may be patchy and detection requires examination of different sites. Moreover, snail densities vary significantly with the season. In general, the aquatic snail hosts of schistosomes occur in shallow water near the shores of lakes, ponds, marshes, streams and irrigation channels.[3] Snail control is one of the methods of choice for the control of transmission of schistosomaisis, and may entail the use of molluscicides, plant molluscicides, biological agents and environmental management.[2] In the past, molluscicides were often applied on an area-wide basis as a chemical control for snails. This costly and environmentally harmful method has been replaced by focal application.[4,5] There has been limited use of molluscicides in recent years and hence little concern about the development of resistance to niclosamide.[6]

Malathion is an insecticide in the chemical family known as organophosphates. Products containing Malathion are used outdoors to control a wide variety of insects in agricultural settings and around people's homes. Malathion has also been used in public health mosquito control and fruit fly eradication programs. Malathion may also be found in some special shampoos for treating lice.[7]

Carbaryl is the common name for a chemical known as 1-naphthyl methylcarbamate. Carbaryl belongs to a family of chemicals that kill or control insects (insecticides) known as carbamates.[8] Carbaryl is used to control a wide variety of pests, including moths, beetles, cockroaches, ants, ticks, and mosquitoes. Products with carbaryl can be formulated as dusts, wettable powders, liquid concentrates, granules, or baits. Carbaryl products are used on fruits, vegetables, rangeland, lawns, ornamental plants, trees, and building foundations.[9]

This study aimed to determine the susceptibility of schistosomaisis snails to agricultural pesticides (Malathion and Carbaryl)

MATERIALS AND METHODS

Study area: El-Faki Hashim area located in the East Nile locality, an area of about 8000 km^2 located in the north-eastern part of Khartoum state, Sudan. Even though Khartoum is the smallest state in the country by area (22,142 km^2), it is the most populous (5,274,321 in 2008 census). The state is geographically divided intoblocks (or clusters), which are further subdivided into localities. There are a total of three blocks and seven localities. Khartoum has a semi-arid climate, where the rainfall is usually 150–250 mm per year. The mean monthly temperature varies from 25 °C in December to 45 °C in May. The River Nile flood season coincides with the rainy season, peaking in August. Due to low rainfall and the short rainy season, agriculture is mainly of the irrigated type. Agricultural schemes are distributed along the banks of the River Nile and its tributaries; 50 % of the cultivated areas are in the East Nile locality. There are two seasons in Sudan: summer (May to September) and winter (October to April). Rain falls during the summer season from June to September, which is followed by a long dry season, extending from October to May.[10]

Collection of snails: Field surveys were conducted for collection of *Biomphalaria pfeifferi* snails, from the irrigation canals of El-Selait agricultural schems in El-Faki Hashim area, Khartoum State. The collection process was performed using a scoop made of an iron frame supporting a wire mesh. The sampling technique was conducted by taking many dips, verticaly to the border of the canal along to the bottom, for the distance of about 1.5 to 2 meter towards the depth of the canal. The collected snails were pooled in plastic containers, supplied with water and lettuce vegetable (for feeding of snails) found in the natural habitat of snails. Within two hours after collection, all sampled snails were transported to medical entomology laboratory, Faculty of Public and Environmental Health, University of Khartoum, in order to carry the experiments.

Snails in the Laboratory

In the laboratory, the snails let to spend 72 hours to avoid any external effect on the experiments, and the snails were maintened in room temperature, in a good ventilation.

Test procedures

Insecticides: Susceptibility tests were conducted with two standard solutions of Malathion, and Carbaryl.

Preparing of exposure containers: About 10-test container were used for each solution, and labeled carefully. The label show the type of insecticide and its concentration. In addition, there is a control container for each test labeled carefully. An amount of water free from chlorine were added to all exposure containers according to quantity of insecticides, for example; 98ml of pure water added to 2ml of insecticide, 97ml of pure water added to 3ml of insecticide until complete the test.

We placed 15 snails for each exposure container that contain solution (water and insecticides), the sanils leaved of 24h and then we calculate mortality.

Mortality and adjustment calculations

The mortality of the test sample is calculated by summing the number of dead snails across all exposure replicates and then expressing this as a percentage of the total number of exposed snails.[11]

$$\text{Observed mortality} = \frac{\text{Total number of dead snails}}{\text{Total sample size}} \times 100$$

A similar calculation should be made in order to obtain a value for the control mortality. If the control mortality is ≥20%, the tests must be discarded. When control mortality is <20%, then the observed mortality must be corrected using Abbott's formula, as follows.[12,13]

$$\text{Corrected mortality} = \frac{(\%\text{observed mortality} - \%\text{ control mortality})}{(100 - \%\text{ control mortality})} \times 100$$

If the control mortality is <5%, no correction of test results is necessary, whereas mortality of ≥5% requires correction.

DATA ANALYSIS

The bioassay with snails was analyzed for the 24h. LC_{50} for each test was determined by probit analysis.[14] This was calculated by finding the probit value of the percentage mortality from the probit table and plotting it against the logarithm of different concentrations. A horizontal line was drawn from the 50% (5% probit value) to meet the line graph. The intersection point on the abscissa corresponded to the 24h LC_{50}.[15]

RESULTS AND DISCUSSION

In this study, we conducted four trails for each concentration for both Malathion and Carbaryl in the same conditions. The mortality of snails appear in real form because there is no mortality in control group.

Mortality was determined after 24h from exposure to insecticides (Malathion, Carbaryl), the average of four trails was taken. The study revealed that there is difference in snail's mortality for the same dose, and this may be due to variations of some morpho-physiological characteristics, or may be due to cross resistance, which is produced by insecticides belonging to the same group of studied pesticides.[12]

In This study, the trials conducted with Malathion found that the higher concetration that achieved 100% kill is $1.5x10^{-4}$ %, (1.5 mg/L), (table.1), which is less than that found in similar study conducted in ricelands of Cameroon, which revealed that the concentrations of Malathion resulting in 100% kill of adult snails after 24 h exposure were 1,200 mg/l.[16] While in trials conducted with Carbaryl found that the higher concetration that achieved 100% kill is $4.25x10^{-4}$ %, (4.25 mg/L), (table.2).

The trails excuted with Malathion and Carbaryl revealed that the lethal concentration LC_{50} for Malathion is $1x10^{-5}$ %, (0.1 mg/L), and for Carbaryl is $6x10^{-5}$ %, (0.6 mg/L), (table.3). The LC^{50} of Malathion and Carbaryl in this study is more than that found in similar study which revealed that the LC_{50} of Temephos on *Bulinus globossus* was 0.021 mg/L[17], this indicate that temephos is more toxic to snails as compaire with Malathion and Carbaryl. The trails revealed that Malathion is more toxic for snails as compared with Carbaryl, because the LC_{50} of Malathion is lower than LC_{50} of Carbaryl, this relationship proved by (University of Minnesota) which said that ″the lower the LC_{50} the more toxic the chemical″.[18] Thus the possibility of developing resistance is more in Carbaryl than Malathion, because Carbaryl is more used in agricultural pests control, thereby snails may be exposed to small doses of Carbaryl frequantly, which contribute in developing of resistance.

Table. 1: The average of four trials of Malathion toxicity on schistosomiasis snails for 24 hours.

Concentration %	Log of concentration	Log of Concentration +6	% of corrected mortality in tests (experiments)				Average of corrected mortality of 4 trails	Probit
			Trail 1	Trail 2	Trail 3	Trail 4		
$1.5x10^{-4}$	-3.8239	2.1761	100%	100%	100%	100%	100%	7.33 ≈
$1x10^{-4}$	-4.0000	2.0000	100%	100%	93.3%	93.3%	96.6%	6.75
$5x10^{-5}$	-4.3010	1.6990	93.3%	86.6%	80%	86.6%	86.6%	6.08
$2.5x10^{-5}$	-4.6020	1.3980	86.6%	80%	86.6%	80%	83.3%	5.95
$2x10^{-5}$	-4.6989	1.3011	73.3%	66.6%	73.3%	73.3%	71.6%	5.55
$1.5x10^{-5}$	-4.8239	1.1761	66.6%	60%	53.3%	60%	59.9%	5.23
$1x10^{-5}$	-5.0000	1.0000	40%	33.3%	40%	46.6%	39.9%	4.72
$2.5x10^{-6}$	-5.6020	0.3980	26.6%	20%	20%	20%	21.6%	4.19
$2x10^{-6}$	-5.6989	0.3011	20%	6.6%	6.6%	6.6%	11.6%	3.77

Table. 2: The average of four trials of Carbaryl toxicity on schistosomiasis snails for 24 hours.

Concentration %	Log of concentration	Log of Concentration +6	% of corrected mortality in tests (experiments)				Average of corrected mortality of 4 trails	Probit
			Trail 1	Trail 2	Trail 3	Trail 4		
$4.25x10^{-4}$	-3.3716	2.6248	100%	100%	100%	100%	100%	7.33 ≈
$2.55x10^{-4}$	-3.5934	2.4066	93.3%	86.6%	93.3%	86.6%	89.9%	6.23
$1.7x10^{-4}$	-3.7695	2.2305	86.6%	80%	86.6%	73.3%	81.6%	5.88
$8.5x10^{-5}$	-4.0705	1.9295	66.6%	60%	60%	53.3%	59.9%	5.23
$4.25x10^{-5}$	-4.3716	1.6284	60%	53.3%	46.6%	46.6%	51.6%	5.03
$3.4x10^{-5}$	-4.4685	1.5315	46.6%	40%	40%	33.3%	39.9%	4.72
$2.55x10^{-5}$	-4.5934	1.4066	33.3%	26.6%	20%	20%	24.9%	4.29
$1.7x10^{-5}$	-4.7695	1.2305	20%	13.3%	13.3%	13.3%	14.9%	3.92
$8.5x10^{-6}$	-5.0705	0.9295	6.6%	0%	6.6%	6.6%	4.9%	3.25

Table. 3: The lethal concentration LC_{50} of the Malathion and Carbaryl for snails.

Insecticides	Lethal Concentration LC_{50}	
	%	mg/L
Malathion	$1x 10^{-5}$	0.1
Carbaryl	$6x10^{-5}$	0.6

CONCLUSION

Both Malathion and Carbaryl have toxic effect on snails, but the Malathion is more toxic than Carbaryl. There should be co-ordination between ministry of health and ministry of agriculture to control of schistosomiasis snails and agricultural pests together.

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