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

Dr. Mohammed Ismail Humaida* and Dr. Ahmed Subahi Ahmed

Department of Public and Environmental Health, Faculty of Medicine and Health Sciences, University of Kordofan, Sudan.

*Corresponding Author: Dr. Mohammed Ismail Humaida
Department of Public and Environmental Health, Faculty of Medicine and Health Sciences, University of Kordofan, Sudan.

ABSTRACT
Background: Snail control is one of the methods of choice for the control of transmission of schistosomiasis. 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 schemes 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 concentration that achieved 100% kill is 1.5x10^-5 %, (1.5 mg/L). While in the trials of Carbaryl, the higher concentration that achieved 100% kill is 4.25x10^-6 %, (4.25 mg/L). The study revealed that the lethal concentration LC50 for Malathion and Carbaryl is 1x10^-3 %, (0.1 mg/L) and 6x10^-3 %, (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 schistosomiasis. 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 schistosomiasis, 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 schistosomiasis 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 km² located in the north-eastern part of Khartoum state, Sudan. Even though Khartoum is the smallest state in the country by area (22,142 km²), it is the most populous (5,274,321 in 2008 census). The state is geographically divided into blocks (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 schemes 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, vertically 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 into 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 maintained 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 snails 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. \textit{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 \textit{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 concentration that achieved 100% kill is $1.5 \times 10^4 \%$, (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 concentration that achieved 100% kill is $4.25 \times 10^5 \%$, (4.25 mg/L), (table 2). 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 globosus was 0.021 mg/L.[17], this indicate that temephos is more toxic to snails as compare 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 frequently, which contribute in developing of resistance.

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

<table>
<thead>
<tr>
<th>Concentration</th>
<th>Log of concentration</th>
<th>Log of Concentration +6</th>
<th>% of corrected mortality in tests (experiments)</th>
<th>Average of corrected mortality of 4 trails</th>
<th>Probit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1.5 \times 10^4$</td>
<td>-3.8239</td>
<td>2.1761</td>
<td>100% 100% 100% 100%</td>
<td>100% 6.75</td>
<td>7.33</td>
</tr>
<tr>
<td>$1 \times 10^4$</td>
<td>-4.0000</td>
<td>2.0000</td>
<td>93.3% 86.6% 80% 80%</td>
<td>86.6% 6.08</td>
<td>5.95</td>
</tr>
<tr>
<td>$5 \times 10^3$</td>
<td>-4.3010</td>
<td>1.6990</td>
<td>86.6% 80% 80% 80%</td>
<td>83.3% 5.95</td>
<td>4.72</td>
</tr>
<tr>
<td>$2.5 \times 10^3$</td>
<td>-4.6020</td>
<td>1.3980</td>
<td>73.3% 66.6% 73.3% 73.3%</td>
<td>71.6% 5.55</td>
<td>4.19</td>
</tr>
<tr>
<td>$1 \times 10^3$</td>
<td>-4.8239</td>
<td>1.1761</td>
<td>66.6% 60% 53.3% 60%</td>
<td>59.9% 5.23</td>
<td>3.77</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Concentration</th>
<th>Log of concentration</th>
<th>Log of Concentration +6</th>
<th>% of corrected mortality in tests (experiments)</th>
<th>Average of corrected mortality of 4 trails</th>
<th>Probit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$4.25 \times 10^4$</td>
<td>-3.3716</td>
<td>2.6248</td>
<td>100% 100% 100% 100%</td>
<td>100% 6.23</td>
<td>7.33</td>
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<tr>
<td>$2.55 \times 10^4$</td>
<td>-3.5934</td>
<td>2.4066</td>
<td>93.3% 86.6% 93.3% 86.6%</td>
<td>89.9% 5.88</td>
<td>4.72</td>
</tr>
<tr>
<td>$1.7 \times 10^4$</td>
<td>-3.7695</td>
<td>2.2305</td>
<td>86.6% 80% 86.6% 73.3%</td>
<td>81.6% 5.23</td>
<td>4.19</td>
</tr>
<tr>
<td>$8.5 \times 10^3$</td>
<td>-4.0705</td>
<td>1.9295</td>
<td>66.6% 60% 53.3% 60%</td>
<td>59.9% 5.23</td>
<td>3.77</td>
</tr>
<tr>
<td>$4.25 \times 10^3$</td>
<td>-4.3716</td>
<td>1.6284</td>
<td>60% 53.3% 46.6% 46.6%</td>
<td>51.6% 5.03</td>
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</tr>
<tr>
<td>$3.4 \times 10^3$</td>
<td>-4.4685</td>
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<td>3.25</td>
</tr>
<tr>
<td>$2.55 \times 10^3$</td>
<td>-4.5934</td>
<td>1.4066</td>
<td>33.3% 26.6% 20% 20%</td>
<td>24.9% 4.29</td>
<td>3.92</td>
</tr>
<tr>
<td>$1.7 \times 10^3$</td>
<td>-4.7695</td>
<td>1.2305</td>
<td>20% 13.3% 13.3% 13.3%</td>
<td>14.9% 4.29</td>
<td>3.25</td>
</tr>
<tr>
<td>$8.5 \times 10^2$</td>
<td>-5.0705</td>
<td>0.9295</td>
<td>6.6% 0% 6.6% 6.6%</td>
<td>4.9% 3.25</td>
<td>4.29</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Insecticides</th>
<th>Lethal Concentration $LC_{50}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malathion</td>
<td>$1 \times 10^3$ mg/L</td>
</tr>
<tr>
<td>Carbaryl</td>
<td>$6 \times 10^3$ mg/L</td>
</tr>
</tbody>
</table>

### 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.

### REFERENCES


