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RESEARCH ARTICLE

THE LETHAL IMPACT OF *IXORA* LEAVE AND FLOWER'S AQUEOUS AND ETHANOL EXTRACTS ON SOME AQUATIC PREDATORS OF *ANOPHELES* LARVAE

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Abstract

The use of insecticides in Gezira Scheme resulted in many environmental problems (especially on aquatic predators that naturally controls mosquitoes larvae) in addition to that, many strains of mosquitoes developed resistance to these insecticides. This study aimed to investigate the impact of *Ixora* leave and flowers aqueous and ethanol extracts on the aquatic predators of mosquitoes and *Anopheles* Larvae. The mosquitoes larvae were collected from temporary aggregated water at Wad Medani City, Gezira State. The selected aquatic predators: Hemipteran boatmen, great diving beetle adults and larvae, dragonfly naiads were collected during the collection of mosquitoes, whereas, *Gambusia* fish were brought from the Blue Nile National institute for Training and Research, University of Gezira. *Anopheles* larvae were applied during bioassay test to prevent the aquatic predators of die starved. The results showed the respective LC_{50} and LC_{95} for Hemipteran boatman were 43.22 and 261.66, for swimming beetle larvae were 29.47 and 202.36, for dragonfly naiad were 25.27 and 84.43, for *Gambusia* fish were 70.95 and 545.13. The LC_{50} and LC_{95} 's of the aquatic predators seemed to be relatively high compared to that of mosquitoes' larvae (LC_{50} between 14.24 and 36.96 for *Anopheles* larvae; 46.04). The ethanol extracts of *Ixora* leaves and flowers were more potent than the aqueous extracts and both can play an important role in *Anopheles* control with slight effects on these aquatic predators. The study recommend running more further researches to be sure of no environmental problems are resulted from using the extracts of *Ixora* leaves and flowers for mosquitoes larval control.

Key Words: *Anopheles*.. Aquatic predators.. Lethal Impact.. Aqueous and Ethanol Extracts

المستخلص

أدي إستخدام المبيدات في مشروع الجزيرة إلي العديد من المشاكل البيئية (خصوصاً علي المفترسات المائية والتي تقضي بصورة طبيعية علي يرقات البعوض) بالإضافة لذلك, طورت العديد من سلالات البعوض مقاومة لهذه المبيدات. هدفت هذه الدراسة للتحقق من المردود القاتل للمستخلصات المائية والإيثانولية لأوراق وأزهار الإكسورا علي يرقات بعوض الانوفلس و بعض المفترسات المائية . شمل العمل التأثير القاتل لمستخلصات أوراق وأزهار الإكسورا علي بعض المفترسات المائية. تم جمع يرقات الأنوفلس والكيولكس من المياه المؤقتة المتجمعة في مدينة ود مدني, ولاية الجزيرة. تم جمع المفترسات المائية التي تم إختيارها: نصفيات الأجنحة المائية, بالغات ويرقات الخنافس المائية الكبيرة, حوريات الرعاشات إثناء جمع يرقات البعوض, في حين تم إحضار أسماك القمبوزيا من معهد النيل الأزرق القومي للتدريب والبحوث, جامعة الجزيرة. تم إضافة يرقات البعوض خلال تطبيق التجربة لمنع المفترسات المائية من الموت بسبب الجوع. أوضح النتائج أن قيم LC50 و LC95 علي التوالي لنصفيات الأجنحة المائية هي 43.22 و 261.66, وللخنافس المائية الكبيرة كانت 29.47 و 202.36, ولحوريات الرعاشات كانت 25.27 و 8.43, ولأسماك القمبوزيا كانت 70.95 و 545.13. يبدو أن قيم التراكيز الكافية للقضاء علي 50% و95% من المفترسات المائية نسبياً عالية مقارنة مع يرقات البعوض (تراوحت LC50 بين 14.24 و 36.96 ليرقات الأنوفلس و 46.04 . كانت مستخلصات أوراق وأزهار نبات الإكسورا أكثر فعالية من المستخلصات المائية وهما معاً يمكنهما لعب دور في مكافحة بعوض الأنوفلس مع تأثير طفيف علي هذه المفترسات المائية. توصي الدراسة بإجراء المزيد من الأبحاث اللاحقة للتأكد من عدم حدوث مشاكل بيئية يمكن أن تنتج من إستخدام مستخلصات أوراق وأزهار نبات الإكسورا لمكافحة يرقات البعوض.

الكلمات المفتاحية: أنوفلس.. المفترسات المائية.. التاثير القاتل.. المستخلصات المائية والايثانولية.

INTRODUCTION

Mosquitoes are important vectors of several tropical diseases; including malaria, filariasis, and numerous viral diseases, such as dengue, Japanese encephalitis and yellow fever, in countries with a temperate climate they are more important as nuisance pests than as vectors. There are about 3000 species of mosquitoes, of which about 100 are vectors of human diseases**.** Human malaria is transmitted only by females of the genus *Anopheles*. Of the approximately 430 *Anopheles* species, only 30-40 transmit malaria (vectors) in nature (Abdullah and Merdan, 1995).

The introduction of irrigation in the arid areas of Gezira state produced drastic changes in the ecology. As a result of these changes, Gezira is currently the largest area in Sudan with the highest number of permanent mosquitoes breeding sites. Thirty one *Anopheles* species were identified from different areas of Sudan. *Anopheles arabiensis* is the main vector of malaria throughout the Gezira State.

Insecticides were used in Gezira state for many years for controlling mosquitoes and other agricultural pests. The use of insecticides resulted in many ecological and environmental problems (Abdel Karim *et al*., 1985) in addition to that many strains of mosquitoes developed resistance to these insecticides.

Efforts are directed towards finding some natural products alternatives to the use of conventional insecticides. The use of some natural products against mosquitoes has been discussed by several scientists (e.g. Abd Aldafae, 2009; Kehail, 2004)

Some garden plants naturally repel mosquitoes. Rose-scented geraniums contain the natural insect repellents citronellal and geraniol. Some gardeners report swishing their hands through the leaves is enough to deter mosquitoes. Lemon balm (*Melissa officinalis*), which is easy to grow from seed, contains the repellents citronellal, geraniol and geranial. And the essential oil in catnip (*Nepeta cataria*), nepetalactone, was found to be about 10 times more effective at repelling mosquitoes than DEET (Beaty and Miller, 1999).

This study aimed to investigate the impact of *Ixora* leave and flowers aqueous and ethanol extracts on the aquatic predators of mosquitoes and *Anopheles* Larvae.

MATERIALS AND METHODS

The study area

Gezira State is located in the eastern central region of Sudan. It lies between latitudes (13 – 32 and 12 -30) North and longitudes (22 -32 and 20-34) East. The introduction of irrigation in the arid areas of Gezira state produced drastic considerable changes in ecology. As a result of these changes; Gezira state is considered as the largest area in Sudan with the highest number of permanent mosquito breeding sites and the malaria transmission changed from seasonal to perennial and malaria endemicity from mesoendemic to hyperendemic. The Gezira irrigation scheme is the main economic activity in the state and a major challenge for malaria control as it contributes to the accumulation of water resulting in both permanent and temporary breeding sites for mosquitoes and other vectors that cause water-borne diseases. Different localities within and around Wad Medani (the capital of Gezira State) were selected for sampling mosquitoes and their aquatic predators.

Materials

Samples

Anopheles larvae were collected from temporary aggregated water around Alkaraiba neighborhood, Wad Medani, Gezira State, using network made of special cloth and long iron stick,

the sample were then placed in labeled dishes containing 200 ml of water. Hemipteran boatmen (*Corixa*) great diving beetle adults and larvae (Coleoptera) and Mayfly naiads (Odonata) were caught during the collection of mosquitoes using the same procedures. Each test repeated 2 times. *Gambusia affinis*, fish were brought from the Blue Nile National institute for Training and Research, University of Gezira. Rearing and maintenance of mosquito larvae followed the instructions of WHO (1980). The collected samples were immediately transferred to the Biology Laboratory, University of Holy Quran, Wad Medani, where the phytochemical and toxicity tests were run.

Preparation of *Ixora* aqueous and ethanolic extracts

Ixora leaves and flowers were collected from Alnishaishiba area, Wad Medani, Gezira State; the collected samples were then let to dry in the shade under the room temperature away from the direct sun light. Ten grams of each dried product was placed in a 500 ml beaker, and 500 ml of tap water or 500 ml l alcohol were added. The beaker was then covered and kept under the room temperature. After 24 hours the mixtures were filtered in a clean, 500 ml conical flask, using filter papers, the component of the beaker was filtered. The filter paper with its un-dissolved components was dried in the oven under 160^{o}C for two hours, and then weighed so as to calculate the actual quantity of each plant product that was dissolved in the final volume of each solvent, the stock solvents. From each *Ixora* aqueous or alcoholic leaves and flowers extracts: 0.5, 1, 1.5, 2, 2.5 ml extract/ 250 ml tap water were added. The tested concentrations of aqueous leave extracts were (12.71, 25.42,38.13,50.84 and 63.55 mg/l) and the ethanolic leave extracts were (6.69, 13.38, 20.07, 26.76 and 33.45 mg/l), while the tested concentrations for aqueous flowers extracts were (15.15, 30.10,45.45,60.60 and 75.75 mg/l), and the flower ethanolic extracts were (5.18, 10.36,15.54, 20.72 and 25.89 mg/l).

Preparation and dilution of Malathion

Malathion EC insecticide (production date: September 2012; Eias Industrial Groups of Company-Germany; Ex date: September 2016; Concentration (57%) 57 g/L; 57000 mg/L) was used as positive control. One ml of the original concentration was dissolved in 250 ml tap water to form the stock solution (concentration = 228 mg/L). Each of 0.2, 0.4, 0.6, and 0.8 ml from this stock solution were added to 500 ml tap water and accordingly the corresponding concentrations were 0.0912, 0.1824, 0.2736, and 0.3648 mg/L, respectively. These concentrations were used to test the susceptibility of *Anopheles* larvae and some of their aquatic predators.

Methods

Toxicity test

Experiments were started by preparing a number of (45) plastic cups (250 and 500 ml), filled with tap water. Randomly 20 individuals of each of the *Anopheles* or of the selected aquatic predators were gently added to those cups. A series of the prepared concentrations were applied to test their toxicity against *Anopheles* larvae and the aquatic predators. Three replications were used to conduct the experiments, and 24 hours was the submission period. Each plastic cup of the aquatic predators was supplied with some of the *Anopheles* larvae during the toxicity test procedure, so as to exclude the death resulted of starvation. Control batches were also designed. The mortalities were accounted according to Busvine (1957).

3.5 Statistical analysis

Mortality of *Anopheles* larva and the tested aquatic predators were plotted in special tables designed to present the data and its corresponding analysis. The obtained data were submitted to a simple regression analysis and ANOVA analysis by using Excel program 2007. The used

concentrations were transformed to as log, whereas the resulted mortalities were transformed to as probit by using Finney's (1925) probit transformation table. The Log-concentration and the probit data were used to run a regression analysis so as to calculate the LC_{50} and LC_{95} from the resulted intercept (a) and x-coefficient (b); the element of the regression equation. The correlation (R^2) was also obtained to detect the level of homogeneity in any single test.

RESULTS AND DISCUSSION

Toxicity test on mosquito larvae and some aquatic predators

The effect of ethanol extract of *Ixora* leaves on *Anopheles* larva and some aquatic predators.

The present investigations involved an attempt to determine the potential role of *Ixora* extracts as natural products to control mosquito larvae and also to assess their effects on their aquatic predators. Five different concentrations of ethanol extract of *Ixora* leave were applied against the tested organisms. The tested concentrations ranged between 6.69 to 33.45 mg/L. These concentrations resulted in 20% to 95% mortality in *Anopheles* larvae. 5.9% to 45.5 mortality in Hemipteran boatman,12.5% to 60% mortality in swimming beetle larvae, 7.5% to 69.5% mortality in Dragonfly naiad, 5% to 40% mortality in Gumbosia fish shown in table (1)

The LC_{50} and LC_{95} were 14.24 and 36.96 mg/L, for *Anopheles* larvae The LC_{50} and LC_{95} for the aquatic predators were 43.22 and 261.66 for Hemipteran boatman, 29.47 and 202.36 for swimming beetle larvae, 25.27 and 84.43 for Dragonfly naiad, 70.95 and 545.13 for *Gambusia* fish, following the same order. The LC_{50} and LC_{95}'s of the aquatic predators seemed to be relatively high compared to that of mosquitoes' larvae. This finding indicated that, the ethanol extract of *Ixora* leaves can play an important role in *Anopheles* control with slight effects on the aquatic predators.

The regression analysis reflected that, the R^2's were 0.75 for *Gumbosia* fish, 0.79 for Dragonfly, 0.93 for swimming beetle larvae, 0.93 for Hemipteran boatman, while it was 0.88 in *Anopheles* larvae.

In a similar research, El Mahi (2014) found that, *Ixora* extracts were toxic against mosquito larvae, also the *Anopheles* larvae were more susceptible to ethanol extract of *Ixora* leaves than *Culex* larvae.

Table (1): Percentage mortality of ethanolic extract of *Ixora* leave on *Anopheles* Larvae and some aquatic predators.

Mortality (%)					**Concentration (mg/L)**
Anopheles	Hemipteran Boatman	Swimming beetle Larvae	Dragonfly Naiad	Gumbosia Fish	
20	5.9	12.5	5.7	5	6.69
25	10	20	5	5	13.38
65	20	40	40	10	20.07
85	35	40	60	20	26.76
95	45.5	60	69.5	40	33.45
0	0	0	0	0	Control
Probit transformation					**Log-concentration**
4.16	3.45	3.82	3.59	3.36	0.825
4.33	3.72	4.16	3.36	3.36	1.126
5.39	4.16	4.75	4.75	3.72	1.303
6.08	4.61	4.75	5.25	4.16	1.427
6.64	4.90	5.25	5.52	4.75	1.524
Regression analysis					
0.88	**0.93**	**0.93**	**0.79**	**0.75**	**R^2**
0.78	**1.57**	**2.12**	**0.61**	**1.572**	**A**
3.66	**2.097**	**1.96**	**3.13**	**1.852**	**B**
0.996	**0.43**	**0.39**	**1.19**	**0.789**	**SE-Y**
0.787	**0.34**	**0.31**	**0.94**	**0.624**	**SE-X**
14.24	**43.22**	**29.47**	**25.27**	**70.95**	**LC50 (mg/L)**
39.96	**261.66**	**202.36**	**84.43**	**545.13**	**LC95 (mg/L)**

1.2 The Effect of ethanol extract of *Ixora* flower on *Anopheles* larva and some aquatic predators.

The ethanol extract of *Ixora* flowers was tested at concentrations ranged between 5.18 to 25.89 mg/L. These concentrations resulted in 40.5% to 95% mortality in *Anopheles* larvae, 10.8% to 60% mortality in Hemipteran boatman, 20.5% to 65% mortality in swimming beetle larvae,10.5% to 65.7% mortality in Dragonfly naiad, 7.5% to 70% mortality in Gumbosia fish shown in table (2).

The LC_{50} and LC_{95} were 6.63 and 32.37 mg/L, for *Anopheles* larvae, . The LC_{50} and LC_{95} for the aquatic predators were 23.43 and 167.48 for Hemipteran boatman, 18.03 and 170.66 for swimming beetle larvae, 17.65 and 88.04 for Dragonfly naiad, 17.10 and 66.13 for Gumbosia fish. The LC_{95} of the aquatic predators seemed to be high compared to that of mosquitoes' larvae. This finding indicated that, the ethanol extract of *Ixora* flower extracts can play an important role in mosquito control with slight effects on the aquatic predators.

The regression analysis revealed that, the R^2's were 0.88 for *Gumbosia* fish, 0.99 for Dragonfly, 0.93 for swimming beetle larvae, 0.95 for Hemipteran boatman, while 0.94 in *Anopheles* larvae.

Table (2): Percentage mortality of ethanol extract of *Ixora* flowers on *Anopheles* Larvae and some aquatic predators .

Mortality (%)					**Concentration (mg/L)**
Anopheles	Hemipteran Boatman	Swimming beetle Larvae	Dragonfly Naiad	Gumbosia Fish	
40.5	10.8	20.5	10.5	7.5	5.18
65	25	30	30	20	10.36
75	35	40	40	45	15.54
85	40	55	60	60	20.72
95	60	65	65.7	70	25.89
0	0	0	0	0	**Control**
Probit transformation					**Log-concentration**
4.77	3.77	4.19	3.77	3.59	**0.71**
5.39	4.33	4.48	4.48	4.16	**1.02**
5.67	4.61	4.75	4.75	4.87	**1.19**
6.04	4.75	5.13	5.25	5.25	**1.32**
6.64	5.25	5.39	5.41	5.52	**1.41**
Regression analysis					
0.94	**0.95**	**0.93**	**0.99**	**0.98**	**R^2**
2.94	**2.37**	**2.89**	**2.07**	**1.47**	**a**
2.45	**1.92**	**1.68**	**2.35**	**2.84**	**b**
0.42	**0.29**	**0.30**	**0.18**	**0.29**	**SE-Y**
0.37	**0.25**	**0.26**	**0.15**	**0.25**	**SE-X**
6.63	**23.43**	**18.03**	**17.65**	**17.10**	**LC50 (mg/L)**
32.37	**167.48**	**170.66**	**88.04**	**66.13**	**LC95 (mg/L)**

1.3 The effect of aqueous extract of *Ixora* leaves on *Anopheles* Larvae and some aquatic predators.

The aqueous extract of *Ixora* leaves was tested at concentrations ranged between 12.71 to 63.55 mg/L. These concentrations resulted in 7.5% to 95.7% mortality in *Anopheles* larvae, 20% to 70.5% mortality in Hemipteran boatman,7.5% to 70.5% mortality in swimming beetle larvae, 10% to 80% mortality in Dragon fly naiad, 5.5% to 65.5% mortality in Gumbosia fish shown that in table (3).

The LC_{50} and LC_{95} were 12.9 and 33.0 (mg/L) for *Anopheles* larvae. The LC_{50} and LC_{95} for the aquatic predators were 36.92 and 226.87 for Hemipteran boatman, 39.51 and 139.10 for swimming beetle larvae, 32.48 and 113.89 for Dragon fly naiad, 119.84 and 703.33 for Gumbosia fish. The LC_{50} and LC_{95} of the aquatic predators seemed to be very high compared to that of mosquitoes' larvae. This finding indicated that, the aqueous extract of *Ixora* leaves can play an important role in mosquito control with slight effects on the aquatic predators.

The regression analysis revealed that, the R^2's were 0.99 for *Gumbosia* fish, 0.99 for Dragonfly 0.94 for swimming beetle larvae, 0.94 for Hemipteran boatman, while 0.987 in *Anopheles* larvae.

Table (3): Percentage mortality of aqueous extract of *Ixora* leaves on *Anopheles* Larvae and some aquatic predators.

Mortality (%)					**Concentration (mg/L)**
Anopheles	Hemipteran Boatman	Swimming beetle larvae	Dragonfly Naiad	Gumbosia Fish	
7.5	20	7.5	10	5.5	**12.71**
20	30	20	40	20	**25.42**
35	45	60	60	40	**38.13**
65	65.5	62.5	70.5	60	**50.84**
95.7	70.5	70.5	80	65.5	**63.55**
0	0	0	0	0	**Control**
Probit transformation					**Log-concentration**
3.59	4.16	3.59	3.72	3.45	**1.104**
4.16	4.48	4.16	4.75	4.16	**1.405**
4.61	4.87	5.25	5.25	4.75	**1.580**
5.39	5.41	5.33	5.55	5.25	**1.706**
6.75	5.55	5.55	5.84	5.41	**1.803**
Regression analysis					
0.82	**0.94**	**0.94**	**0.99**	**0.99**	**R^2**
0.52	**1.74**	**0.21**	**0.45**	**0.12**	**a**
4.03	**2.08**	**3.00**	**3.01**	**2.29**	**b**
0.52	**0.49**	**0.66**	**0.18**	**0.27**	**SE-Y**
0.05	**0.32**	**0.43**	**0.12**	**0.17**	**SE-X**
12.9	**36.92**	**39.51**	**32.48**	**119.84**	**LC50 (mg/L)**
33.0	**226.87**	**139.10**	**113.89**	**703.33**	**LC95 (mg/L)**

1.4 The effect of aqueous extract of *Ixora* flower on *Anopheles* Larvae and some aquatic predators.

The aqueous extract of *Ixora* flowers was tested at concentrations ranged between 15.15 to 75.75 mg/L. These concentrations resulted in 30.5% to 95.5% mortality in *Anopheles* larvae, 10% to 67.5% mortality in Hemipteran boatman,7.5% to 45.7% mortality in swimming beetle larvae, 5% to 65% mortality in Dragonfly naiad, 5% to 60% mortality in Gumbosia fish shown that in table (4).

The LC_{50} and LC_{95} were 17.88 and 104.10 (mg/L) for *Anopheles* larvae. The LC_{50} and LC_{95} for the aquatic predators were 138.71 and 1012.19 for Hemipteran boatman, 106.39 and 810.22 for swimming beetle larvae, 53.49 and 210.12 for Dragonfly naiad, 61.28 and 250.76 for Gumbosia fish. The LC's of the aquatic predators seemed to be high compared to that of mosquitoes' larvae. This finding indicated that, the aqueous extract of *Ixora* flower extracts can play an important role in mosquito control with slight effects on the aquatic predators.

The regression analysis revealed that, the R^2's were 0.88 for *Gumbosia* fish, 0.88 for Dragonfly 0.89 for swimming beetle larvae, 0.75 for Hemipteran boatman, while in *Anopheles* larvae it was 0.71.

Table (4): Percentage mortality of aqueous extract of *Ixora* flowers on *Anopheles* and *Culex* Larvae and some aquatic predators.

Mortality (%)					Concentration (mg/L)
Anopheles	Hemipteran Boatman	Swimming beetle larvae	Dragonfly Naiad	Gumbosia Fish	
30.5	10	7.5	5	5	**15.15**
40	15	10	10	7.5	**30.298**
50	20	25	20	20	**45.45**
70	35	30	40	40	**60.597**
95.5	67.5	45.7	65	60	**75.75**
0	0	0	0	0	**Control**
Probit transformation					**Log-concentration**
4.50	3.72	3.59	3.36	3.36	**1.18**
4.75	3.96	3.72	3.72	3.59	**1.48**
5.00	4.16	4.33	4.16	4.16	**1.66**
5.52	4.61	4.48	4.75	4.75	**1.78**
6.75	5.47	4.90	5.39	5.25	**1.88**
Regression analysis					
0.71	**0.75**	**0.89**	**0.88**	**0.88**	**R^2**
0.96	**0.93**	**1.23**	**0.23**	**0.21**	**a**
2.72	**1.90**	**1.86**	**2.76**	**2.68**	**b**
1.6	**1.15**	**0.61**	**0.93**	**0.92**	**SE-Y**
1.0	**0.72**	**038**	**0.58**	**0.57**	**SE-X**
17.88	**138.71**	**106.39**	**53.49**	**61.28**	**LC50 (mg/L)**
104.10	**1012.19**	**810.22**	**210.12**	**250.76**	**LC95 (mg/L)**

2. The effect of Malathion insecticide on *Anopheles* Larvae and some aquatic predators.

The Malathion insecticide was tested at concentrations ranged between 0.046 to 0.3648 mg/L. These concentrations resulted in 60% to 95% mortality in *Anopheles* larvae, 10.7% to 90% mortality in Hemipteran boatman, 25% to 80% mortality in swimming beetle larvae, 40 % to 92% mortality in Dragon fly naiad,10% to 80% mortality in Gumbosia fish shown that in table (5).

The LC_{50} and LC_{95} were 0.79 and 40.26 mg/L, for *Anopheles* larvae. The LC_{50} and LC_{95} for the aquatic predators were 11.94 and 49.04 for Hemipteran boatman, 11.21 and 94.43 for swimming beetle larvae, 3.47 and 41.04 for Dragon fly naiad, 16.41 and 90.43 for Gumbosia fish The LC_{50} and LC_{95} seemed to be very high compared to that of mosquitoes' larvae. This finding indicated that, the Malathion insecticide can play an important role in mosquito control with more effects on the aquatic predators.

The regression analysis revealed that, the R^2 were 0.98 for *Gumbosia* fish, 0.98 for Dragonfly 0.91 for swimming beetle larvae, 0.97 for Hemipteran boatman, while 0.98 in *Anopheles* larvae.

Results of this study showed that, Malathion was more toxic to *Anopheles* larvae and the aquatic predators compared to *Ixora* extracts. This result was in agreement with Kehail (1995) who found that, Malathion was more toxic against *Anopheles* than *Culex*. The United States Environmental Protection Agency (2006) found that Malathion is highly toxic to insects, including beneficial insects such as honeybees, and it is toxic to aquatic organisms, including fish and invertebrates.

Table (5): Percentage mortality of Malathion insecticide on *Anopheles* Larvae and some aquatic predators.

Mortality (%)					Concentration (mg/L)
Anopheles	Hemipteran Boatman	Swimming beetle larvae	Dragonfly Naiad	Gumbosia Fish	
60	10.7	25	40	10	**0.0456**
80	20	25	70	20	**0.0912**
85	65	65	85	45	**0.1824**
90	80	75	90	65	**0.2736**
95	90	80	92	80	**0.3648**
0	0	0	0	0	**Control**
Probit transformation					**Log-concentration**
5.25	3.77	4.33	4.75	3.72	**-1.34**
5.84	4.16	4.33	5.52	4.16	**-1.04**
6.04	5.39	5.39	6.04	4.87	**-0.74**
6.28	5.84	5.67	6.28	5.39	**-0.56**
6.64	6.28	5.84	6.41	5.84	**-0.44**
Regression analysis					
0.98	**0.97**	**0.91**	**0.98**	**0.98**	**R^2**
4.38	**1.67**	**2.87**	**3.65**	**2.04**	**A**
1.39	**2.91**	**1.9**	**1.83**	**2.34**	**B**
0.203	**0.35**	**0.42**	**0.19**	**0.26**	**SE-Y**
0.17	**0.29**	**0.35**	**0.16**	**0.21**	**SE-X**
0.79	**11.94**	**11.21**	**3.47**	**16.41**	**LC50 (mg/L)**
40.26	**49.04**	**94.43**	**41.04**	**90.43**	**LC95 (mg/L)**

CONCLUSION AND RECOMMENDATIONS

Conclusion

1- The ethanolic and aqueous extracts of *Ixora* leaves and flowers have a considerable lethal effect on *Anopheles arabiensis* larvae but with varying effects on the aquatic predators.

2- Dragon fly naiads showed more susceptibility to ethanolic and aqueous extracts of *Ixora* leaves and flowers than Gumbosia fish, hemipteran boatman, and swimming beetle larvae.

3- *Anopheles* larvae and the tested aquatic predators different in their susceptibilities towards different doses of the ethanol and aqueous extract of Ixora flower**.**

4- The Malathion insecticide was more toxic than ethanolic and aqueous extracts of *Ixora* leaves and flowers.

5- Gumbosia fish was the most resilient predators to both extracts.

Recommendations

1- According to the lethal effect exerted by the extract of *Ixora* leaves and flowers on *Anopheles* larvae it can be recommended to use these preparation as methods to control mosquitoes

2- Malathion was found to be more toxic to both mosquito larvae and its predators and it should be for their tested in very low concentrations.

3- Small scale field triads could be carried out to test the efficacy of Ixora leaves and flowers extracts in controlling *A. arabiensis* larvae under field conditions.

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