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Larvicidal effect of some natural products on mosquito and some aquatic predators in Gezira State, Sudan: Field assessment

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Abstract

There are many methods used for mosquito control. Depending on the situation, source reduction (removing stagnant water), bio-control (importing natural predators), trapping, and insecticides to kill larvae or adults may be used. Some aquatic predators were reputed as biological control agents for mosquito larvae. Hence they have to be considered when experimenting on the lethal effects of any material on mosquito larvae. The objectives of this study were to study the effects of neem leaves and usher latex against *Anopheles* and *Culex* larvae and some of their aquatic predators (hemipteran boatman (HB), tadpole (T), swimming beetle larvae (SBL) and adult (SBA) and mayfly naiad (MF)) in some breeding sites around Wad Medani Town, Gezira State, Sudan. Two villages were selected for conducting this study. The count of the mosquito larvae and the aquatic predators continued for four days from applying natural products. The results showed that, mosquito's larvae were affected more than the aquatic by Neem leaves and Ushar latex. The study of the microclimates in the breeding sites will help to correlate toxicity to any level of any environmental factor.

Keywords: Neem; Ushar; Neem; Mosquito; Aquatic predators; Gezira State- Sudan

1. Introduction

Mosquitoes are small insects belong to the family Culicidae; order Diptera. Mosquitoes have one pair of wings, three pairs of long hair-like legs, slender segmented body, feathery antennae, and elongated mouthparts (called a proboscis) that can pierce the skin of a host and feed on blood. Mosquitoes go through four stages in their life cycle: egg, larva, pupa, and adult or imago [1]. The first three stages are aquatic and last for 5–14 days, depending on the species and the ambient temperature. Adults live for 4–8 weeks. Mosquito species feeds on the blood of various hosts, including most vertebrates and some invertebrates, primarily other arthropods [2, 3].

The mosquito's saliva which transferred to the host during the bite, can cause an itchy rash, and transmit some pathogens (such as malaria parasites [4], yellow fever, Chikungunya, West Nile, dengue fever, filariasis, Zika and other arboviruses. By transmitting diseases, mosquitoes can cause the deaths to human and some vertebrates more than any other animal taxon [5].

In order to predict mosquito-borne disease spread in relation to climate, two types of models are used: correlative models and mechanistic models. These models have been used to predict the potential risk of a vector-borne disease based on an areas forecasted climate [6].

Insecticides resistance in *Anopheles arabiensis* population from Gezira, Sudan has produced strains showing very low mortality when exposed to malathion (the same dose and exposure time resulted in 100% mortality in other

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populations of the species of *A. gambiae*). Resistance to fenthion detected in *Culex quinquefasciatus* was also reported [7]. One of the general measures to counteract resistance and environmental pollution caused by insecticides is by using natural products, which are, cheap, available, easily applied and relatively safe.

Neem (*Azadirachta indica*) is a tree in the mahogany family Meliaceae. and is native to India Subcontinent, growing in tropical and sub-tropical regions in alluding Sudan [8]. Neem oil can cause some forms of toxicity if consumed in large quantities [9]. Imaranet *al.* [10] studied the neem leaves phytochemistry.

Ushar (*Calotropis procera*) is a species of flowering plant in the dogbane family, Apocynaceae, which is native to North Africa, tropical Africa, Western Asia, South Asia, and Indochina. It grows all over the Sudan. Both Neem and Usher preparation were reacted to give promising result in insect pest control in finding [11]. The milky exudation from the plant is toxic. Calotropin, a compound in the latex, is more toxic compound. The latex is also harmful to the eyes [12].

This study aims to evaluate the effects of neem (*A. indica*) leaves and usher (*C. procera*) latex against mosquito's (*Anopheles* and *Culex*) larvae and some of their aquatic predators in some breeding sites around Wad Medani City (Karkoug and Barakat villages), Gezira State, Sudan.

2. Material and methods

2.1. Study area

The breeding sites of Barakat and Karkoug villages were selected for testing the potentiality of the some natural products and sampling mosquitoes (*Anopheles* and *Culex*) larvae and aquatic predators. These villages were more or less located to the west (Karkoug) and south (Barakat) of Wad Medani City, Gezira State, Sudan.

2.2. Materials

The leaves of neem (*A. indica*) and the latex of Ushar (*C. procera*) plant used as basic materials in this study, were collected from the gardens of the University of Gezira, main campus. The Ushar latex was collected from the aerial parts of the plant. The plant stems and leaves were cut by using a sharp small knife and the flowing latex was then sucked by 5 ml syringe and then the samples were transferred into small, cleaned glass containers.

The collected neem leaves were immediately cleaned then dried at room temperature under shade away from the direct sunlight. The dried leaves were crushed to fine particles using a mortar. The plant materials were then ready for the field assessment of their potentialities in the breeding sites of the study area.

2.3. Field application of plant products

The volume of breeding water in each selected site was estimated just before the potentiality test was run, then 10 g of the dried sample of the neem leaves were added to each breeding site per liter water (10 g/L).

The raw usher latex was tested as 50% aqueous latex (1 ml latex: 1 ml water). The aqueous Ushar latex was applied at a concentration of 10 ml/L breeding water. The prepared mixtures were tested immediately and never stored for a while.

2.4. Counting of mosquito larvae and the aquatic predators

Sampling from breeding sites of each village was done daily for successive four days for each breeding site. Larvae of *Anopheles* (An) and *Culex* (CL) mosquitoes, great diving beetles (larvae (SBL) and adults (SBA), hemipteran boatman (HB), mayfly naiads (MF) and tadpoles (T) that were collected during sampling were immediately separated, counted and discarded.

3. Results and discussion

3.1. The effect of neem leaves powder

In Karkoug breeding sites, the reduction of (An) and (CL) reached 100% after 72 hours (from 854 to 52, 4 and 0 for (An) and from 220 to 19, 3 and 0 for (CL). The aquatic predators also deteriorated against neem leaves (NL) product; (MF) was completely disappeared (from 6 to 3, 3 and 0 after 72 hours), while (SBA) and (HB) were slightly affected (from 4 to 2 after 72 hours), whereas, (SBL) and (T) were not seen in these breeding sites (Table, 1).

In Barakat breeding sites, the reduction of (An) and (CL) also reached 100% after 72 hours. The aquatic predators were slightly affected with (NL) product; the (MF), (SBA) and (SBL) lost not more than two individuals, whereas (HB) was not affected, while (T) was not found at that period (Table, 1).

Kehail [13] found that, neem leaves powder resulted in 100% mortality in *Anopheles* larvae, while the highest mortality in *Culex* larvae occurred at the first day, but it did not reach 100%. The potentiality of neem leaves powder against *Anopheles* and *Culex* mosquitos' larvae, were reviewed by some researchers e.g., AbdAldafae [14], and Osman [15]. The important constituents in neem are margostic acid, the alkaloid azadirachtin, margaspierine and margosine [16], which were seemed to be responsible for death in larval populations.

Table 1 Count of *Anopheles* and *Culex* larvae and some of their aquatic predators in Karkoug and Barakat breeding sites treated with *A. indica* leaves powder at 10 g/L breeding water

Site	Day	HB	T	SBL	SBA	MF	CL	An
Karkoug	1	4	0	0	4	6	220	854
	2	3	0	0	3	3	19	52
	3	3	0	0	2	3	3	4
	4	2	0	0	2	0	0	0
Barakat	1	2	0	4	3	8	67	351
	2	2	0	3	3	7	4	15
	3	2	0	2	3	6	0	1
	4	2	0	2	2	6	0	0

MF= mayfly naiads; SBA= swimming beetle (adult); SBL= swimming beetle (larvae); T = tadpole; HB = hemipteran boatman

3.2. The effect of aqueous Ushar latex

Table (2) showed that, the aqueous ushar latex (AUL) mixture as a control material, decreased the density of (An; 600 larvae) and (CL; 400 larvae) to reached 99.5% and 100%, respectively, after 72 hours. The aquatic predators were also affected with AUL; 58% of (MF), 50% of (SBA) and (SBL), 100% of (HB), while 43% of (T) were controlled at that period, considering that, their densities did not exceed 20 individuals, except (T).

Table 2 Count of *Anopheles* and *Culex* larvae and some of their aquatic predators in Karkoug breeding site treated with aqueous ushar latex at 10 ml/L breeding water

Site	Day	HB	T	SBL	SBA	MF	CL	An
Karkoug	1	2	30	4	20	12	400	600
	2	1	21	3	14	9	54	80
	3	1	16	3	12	8	11	12
	4	0	13	2	10	7	0	3
Barakat	1	3	5	4	6	4	40	100
	2	1	4	3	4	3	12	20
	3	2	3	2	3	2	4	4
	4	1	2	3	2	2	0	1

MF= mayfly naiads; SBA= swimming beetle (adult); SBL= swimming beetle (larvae); T = tadpole; HB = hemipteran boatman

At Barakat area, using the AUL mixture, the reduction of (An) and (CL) reached 100% just after 48 hours (from 100 to 20, 4 and 0 for (An) and from 40 to 12, 4 and 0 for (CL)). The aquatic predators were also affected with AUL mixture; 50% of (MF), 67% of (SBA), and (HB) population were controlled, while 25% of (SBL) and 60% of (T) were also lost.

Ushar is rich in different chemical compounds. The active principles of the juice were calctin, calotropin, calotoxin and uschardin which are poisonous in nature [17]. The plant contains a very toxic glycoside [18].

NL produced 100% control in (An) and (CL) larvae, while not more than 50% of the aquatic predators submitted to this material were killed. AUL mixture showed relatively similar control percentage (more than 97%) against mosquito's larvae, while the aquatic predators showed different sensitivities to AUL ranged between 25% to 100%.

The means percentages control for NL and AUL showed that, these natural products produced more mortality in mosquito's larvae, and less mortality in their aquatic predators. This finding reflected the advantage of using natural products in comparison to the considerably high cost, more hazardous, resistible and imported insecticides.

4. Conclusion

The densities of (An) and (CL) and their aquatic predators seemed to be more in Karkoug breeding sites than Barakat breeding sites.

(SBL) and (T) were not noticed in some breeding sites in Karkoug, while in Barakat breeding sites (T) sometime were not noticed.

Neem leaves and usher latex preparations affected mosquito's larvae more than the aquatic predators in the study areas.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors (Abdelmonem E. H. Ali and Mutaman A. A. Kehail) declare no conflicts of interest regarding the publication of this paper.

Statement of ethical approval

The present research work does not contain any studies performed on animals/humans subjects by any of the authors'.

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