بسم الله الرحمن الرحيم

Sudan University of Science and Technology

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A project submitted as to complete the requirements of a B. Sc. (honor) degree in scientific laboratories-physics.

The effect of the ultrasound waves on mosquitoes

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الآيـة

قَالَ تَعَالَىٰ:

بسم الله الرحمن الرحيم

﴿ قَالُواْ سُبۡحَٰنَكَ لَا عِلۡمَ لَنَآ إِلَّا مَا عَلَّمۡتَنَآۖ إِنَّكَ أَنتَ ٱلۡعَلِيمُ ٱلۡحَكِيمُ ٣٢ ﴾

صدق الله العظيم

سورة البقرة الآية (32)

Dedication

To My

Parents, brothers and sisters

Teachers

Friends

All those

Whom I love

Acknowledgements

This project wouldn't be possible without many people. The first is Dr. Loai Mohammed Elamin who helped us by anything and without him support we couldn't do this project in this form, and we also thanks prof. Mubarak Dirar Abd-Alla for his kind support .Thanks also extend to Dr. Nodar Osman Khalifa and Sudan University of Science and Technology College of Science Department of Scientific Laboratories-Physics.

All our thanks for Allah

Abstract

This project aimed to define the ultrasound waves and evaluate are effect on the mosquitoes. The practical work has been conducted in JICA laboratory at Sudan University of Science and Technology College of Agriculture, a number of around 300 larvae, and 180 pupae and initial experience of adult were treated at different interval time by exposing them to the ultrasound waves, the death percentage of the larvae was 100% and 98% on the pupae.

المستخلص

هذا المشروع يهدف إلي تعريف الموجات فوق السمعية وتقييم أثرها علي البعوض . تم اجراء التجارب العملية بمعمل جايكا كلية الزراعة جامعة السودان للعلوم والتكنولوجيا . عولج تحت تأثير الموجات فوق الصوتية ما يقارب عدد 300 يرقة و 180 شرنقة مع الحشرة الكاملة للبعوض في فترات زمنية مختلفة وتم الحصول على نسبة موت 100% في طور اليرقة و 98% في طور العذراء .

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Chapter One

Introduction

Mosquitoes are by far the most important of the blood -sucking arthropods worldwide giving annoyance and transmit dangerous diseases in humans. About 3500 species of mosquitoes have been described worldwide. Generally mosquitoes are important vectors of malaria, filariasis, yellow fever, dengue fever and other many other viral diseases.

Malaria is a major health problem in the tropical countries especially sub-Saharan Africa where about 90% of the clinical cases occur .There are nearly 500 million clinical cases of malaria worldwide each year and 1.1 to 2.7 million people die annually. It is estimated that 7.5 - 10 million cases of malaria occur in Sudan every year and 35000 deaths every year. Anopheles arabiensis is the major malaria vector reported from all parts of the Sudan .

Lymphatic filariasis(LF) is an important public health and socio-economic problem worldwide. It affects 120 million people in over 80 countries. Lymphatic filariasis is endemic in Sudan based on published and unpublished data from scattered spot surveys and hospital records. Several species of genera *Culex*, *Anopheles*, *Aedes* and *Mansonia* are known as vectors of lymphatic filariasis.

The objectives of this Study is the effect of the ultrasound waves on the mosquitoes.

1.1: The main objectives of the project

A deeper understanding of ultrasound waves and identify it is effect on mosquitoes.

1.2: The assumptions of the project

The ultrasound waves have significantly effect on mosquitoes and it can be used as new and safety way of controlling mosquitoes.

1.3: Problem of the project

The mosquitoes are significant vectors of human disease, however the mosquito transmitted disease problem worldwide.

The currently controlling methods unfortunately caused undesirable side effects, including environmental pollution.

1.4: Contents of the project

In this project the study of ultrasound waves and it is effect on mosquitoes is the main task.

Chapter one show the introduction ,objective ,assumption and problem of the project, in chapter tow introduced the waves and mosquitoes in details, in chapter three we present the experiment and result also the discussion, and finally in chapter four the conclusion and reference.

Chapter Two

Theoretical Background

Introduction

This chapter will introduce some physical background about the waves and the mosquitoes.

2.1: The waves

The waves are a disturbance that moves through matter or space .It is carry energy and information from one place to another through a medium, but the medium itself is not transported[1].

2.1.1: Types of waves

There are two major types of the waves

2.1.1.1: Electromagnetic waves: no medium is needed for the motion of electromagnetic waves. They all travel though space at the speed of light $3x10^8$ m/s. for examples Light waves, radio wave and x- ray[2].

2. 1.1.2: Mechanical waves: mechanical wave motion requires a material medium. Water, air and springs or ropes are the materials that carry the energy of these mechanical waves. For examples water waves, sound waves, and the waves that travel along a spring or rope [2].

Mechanical waves can be classified by the way in which they displace the medium through which they travel. There are three general types of mechanical wave transverse wave, longitudinal wave and surface waves:

(i)Transverse waves: in a transverse waves the vibration of the individual particles of the medium is perpendicular to the direction of waves propagation. In the examples of it water waves, the particle in this type move up and down [3].

(ii) Surface waves: are mixture of transverse and longitudinal waves [2].

(iii)Longitudinal waves: in longitudinal waves the vibration of individual particles moves in a determined direction which is parallel to the direction of wave's propagation. This type generally consists of a series of condensations and rarefactions [3].

Condensations is the compressed region and rarefaction is the low- pressures region[4].

The examples of longitudinal waves are sound waves [2].

2.1.2: The Sound Waves

Sound waves are longitudinal mechanical waves. They can be propagated in solid, liquids and gases. The material Particles transmitting such as a waves oscillate in the direction of propagation of the wave itself[5].

The sound waves have many different properties:

2.1.2.1: Properties of sound waves

Sound waves are characterized by the following parameters:

Period (*T*): the shortest time interval during which the motion repeats itself [2].

Frequency (*f*) :the number of waves passing a given point per second [3].

Amplitude (A): the maximum displacement of any particle from its equilibrium position [6].

Wavelength (λ): the distance between two adjacent crests or troughs of the waves[2].

$\lambda = \upsilon T$. ………………………………………………………… (2.1)

Velocity(V) :the distances a wave moves per second[3].

$V = f\lambda$. ………………………………………………………… (2.2)

Intensity (I): the average power per unit area carried by the wave past surface perpendicular to the waves direction of propagation[6].

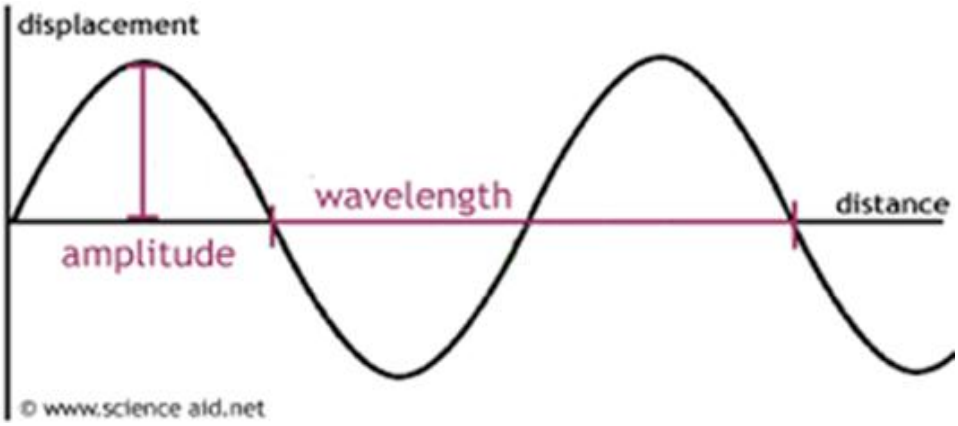


Figure (1.1) shows the properties of sound waves

2.1.2.2: Types of sound waves

By using frequency range sound waves divided in to:

(i) Infrasound waves: are longitudinal mechanical waves whose frequency is below the audible range (less than 20 Hz), of interest are usually generated by large sources, earthquake waves being an example [5].

(ii) Audibled waves: are being confined to the frequency range which can stimulate the human ear and brain to the sensation of hearing, is longitudinal waves whose frequency ranges from about 20 Hz to about 20 KHz [5].

(iii) Ultrasound waves: are longitudinal mechanical waves with frequencies above the human audible range [8].

2.1.3: Ultrasound waves

2.1.3.1: Production Of ultrasound waves

Ultrasonic waves are produced by the following methods [9].

Magnetostricion Generator

Principle: Magnetostricion effect when a ferromagnetic rod like iron or nickel is placed in a magnetic field parallel to its length, the rod experiences a small change in its length. This is called Magnetostricion effect[9].

Piezo Electric Generator or Oscillator:

Principle: Inverse Piezo electric effect.

If mechanical pressure is applied to one pair of opposite faces of certain crystals like quartz, equal and opposite electrical charges appear across its other faces. This is called as Piezo-electric effect. The converse of Piezo electric effect is also true. If an electric field is applied to one pair of faces, the corresponding changes in the dimensions of the other pair of faces of the crystal are produced. This is known as inverse Piezo electric effect or electrostriction [9].

2.1.3.2: The effect of ultrasound noise on human body

Ultrasonic noise may affect hearing and non-hearing parts of the body. Because audible noise is also present in industrial conditions, it is difficult to interpret the results of environmental studies on the effects of ultrasounds on hearing Furthermore, the age of study participants and the potential presence of chemical factors in the working environment are also important.

Nevertheless, some reports indicated that components with ultrasonic frequencies may cause sound sensations associated with hearing defects within the high frequency range, which audiometric tests do not always taken into account. Subjective symptoms like headache and dizziness, tinnitus, balance disturbances and nausea are typical for

workers exposed to ultrasounds of low frequencies. Health standards are to prevent Subjective effects of exposure to ultrasonic noise and hearing damage. Proposals of these standards were based on two basic assumptions:

(a) high audible frequencies may cause annoyance, tinnitus, headache, fatigue and nausea.

(b) ultrasound Components with high sound pressure level may cause hearing damage[10].

2.1.3.3: Applications of Ultrasound

Ultrasounds are used extensively in industries and for medical purposes. As mentioned above, Ultrasounds are high frequency waves (higher than 20kHz). Even in the presence of obstacles, they are able to travel along well defined paths.

1. To detect cracks and flaws in metal blocks[8].
2. Doctors use the technique called Echocardiography in which ultrasonic waves are made to reflect from various parts of the heart and form image of the heart[9].

3. Doctors also use an instrument called ultrasound scanner for getting images of internal organs such as kidney, gall bladder, uterus, liver etc.[8].
4. Another use of ultrasound is to break small stones formed in the kidneys into fine grains[8].
5. Another use of ultrasound is in the Sound Navigation and Ranging (SONAR) it is a device that uses ultrasonic waves to measure the speed, direction and distance of an underwater object[8].
6. To clean parts located in hard to reach places by advice called ultrasonic bath and we used it in our experiment [11].

2.1.4: Ultrasonic bath

It is a device that uses ultrasound wave and cleaning solution for cleaning sensitive stuff. It uses cavitations bubbles to penetrate holes and cracks.

Figure (1.2) shows ultrasound bath device Ultra wave precision ultrasonic cleaning equipment[11].

2.1.4.1: The device components:

1.ultra-Analogue Bench top ultrasonic bath.

2.basket.

3. lid.

4. 2m length of drain hose (U500H).

5.hose tail (U500).

6.ultraclean detergent sample.

7.timer.

8.heater.

9. 5A fuse.

2.1.4.2 : The mechanism of work

This device works at generated frequency ranged between(32-38 KHz), it runs on AC power source whether it has working on 220 or 110 volt to feeds the converter in order to reduce the voltage and current of the source and then sent it to the unification circle that convert alternating current to direct and deliver it again to the circle of pulse generator which contain transistors, integrated revolving crystals and capacitor to produce ultrasound frequency, then transferred to the water inside the device and generated a very high energy density in the sound field that able to occur voids on mosquito's body because of high pressure and the collapse of these bubbles in the mosquito cells leading it to death. This phenomenon called capitation[11].

2.2: Mosquitoes

Mosquitoes are by far the most important of the blood -sucking arthropods worldwide giving annoyance and transmit dangerous diseases in humans, other mammals and birds. About 3500 species of mosquitoes have been described worldwide[12].

2.2.1 : Classification of mosquitoes

Class: Insect

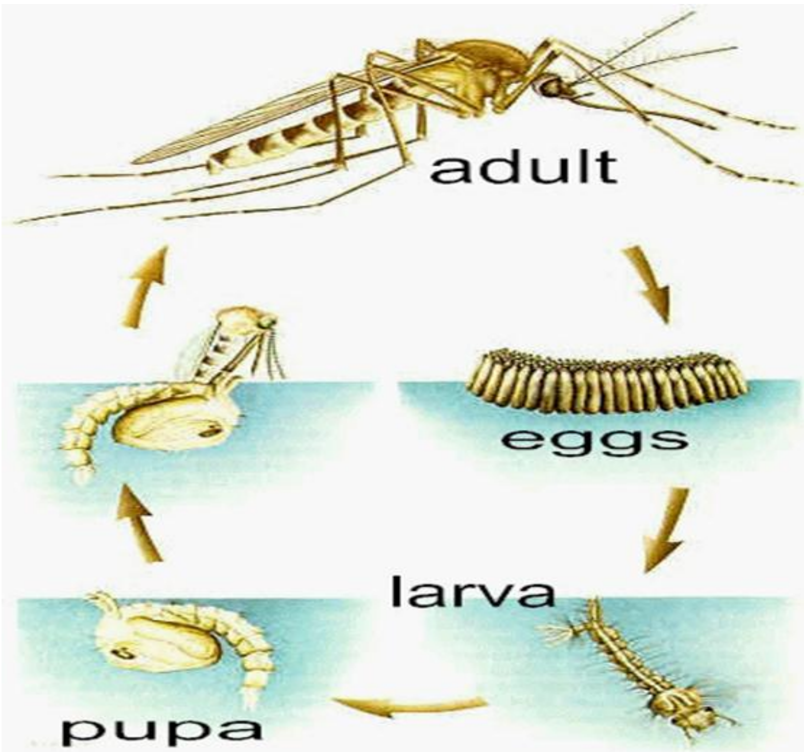
Order: *Diptera*

Sub-Order: *Nematoceran*

Family: *Culicidae*

Sub-Family: *Culicinae -Anophelinae-Toxorhynchitinae*[13]

2.2.2 : Description and life cycle



Figure(2.3): shows the mosquitoes life cycle[7] .

Mosquitoes undergo complete memorphosis, having egg, larval, pupae, and adult stages. Larval are commonly referred to as wigglers and pupae as tumblers [12].

Eggs are laid either singly on vegetation near the edge of the water or in rafts on the surface of the water. Female mosquitoes usually lay between 50 and almost 500 eggs, two to four days (even more in cool temperate climates) after the blood meal.[14] .

Larvae have a well-developed head bearing a pair of antennae and a pair of compound eyes. Prominent mouth brushes are present in most species and serve to sweep water containing minute food particles into the mouth . The thorax is roundish and has unbranched and branched hair, which are usually long and conspicuous. The 10-segmented abdomen has nine visible segments, most of which have unbranched or branched hairs. The last segment, which differs in shape from the preceding eight segments, has two paired groups of long hairs forming the caudal setae, and a larger fan-like group comprising the ventral brush. This last segment ends in two pairs of transparent, sausage-shaped anal papillae, which although often called gills are concerned not with respiration but with osmoregulation .

Mosquito larvae, with the exception of Mansonia and Coquillettidia species (and a few other spies), must come to the water surface to breath.

Atmospheric air is taken in through a pair of spiracles situated dorsally on the ninth abdominal segment . They feed on yeasts, bacteria protozoans, and numerous other micro-organisms, as well on decaying plant and animal material found in the water . There are four larval instars and in tropical countries larval development that is time from egg hatching to pupation can be as 5-7 days but many species require about 7-14 days. In temperate areas the larval period may last several weeks or months and several species overwinter as larval[13].

Pupae all mosquito pupae are aquatic and coma-shaped. The head and thorax are combined to form the cephalothoraxes, which dorsally has a pair of respiratory trumpets. The abdomen is 10-segmented, although only eight segments are visible.

Pupae do not feed but spent most of their time at the water surface taking in air through the respiratory trumpets. If disturbed they swim up and down in the water

in a jerky fashion . In the tropics the pupae period lasts only 2-3 days but in cooler temperate regions pupae development may take 9-12 days or longer. At the end of pupae life the skin on the dorsal surface of the cephalothoraxes splits and the adult mosquito struggles out[13].

Adults the adult mosquito that emerges from the pupa has three main parts- head thorax and abdomen. The head has eyes, antennae, palps and mouth parts or proboscis. Only the female mosquito feeds on blood. A 3-9 mm length, wing scales, and prominent elongated proboscis clearly differentiate them from similar forms of dipteral .The easiest way to distinguish male from female mosquitoes is by looking at the antennae, which are feathery in males [14].They have long , 15-segmented antennae, a long proboscis for bloodsucking, and scales on the wing fringes and wing veins[11].

Females of most mosquito species require a blood-meal before the eggs can develop, and this is taken either before or more usually after mating [13].

Once the blood-meal is digested and the eggs have developed, the female mosquito finds a suitable place to lay the e.g.In favorable conditions, female adult mosquitoes live an average of 10-14 days, although some live much longer. The lifespan of the male adult mosquito is shorter[14].

Generation times for mosquitoes vary from several weeks to a year[12].

2.2.3 : Medical importance of mosquitoes

Although in several temperate countries mosquitoes may be of little or no importance in transmitting diseases to humans they can, nevertheless, cause considerable annoyance because of their troublesome bites. The greatest numbers of mosquitoes are found in the northern areas of the temperate regions, especially near or within the Arctic Circle, where the numbers biting can be so great at certain times of the year as to make almost any outdoor activity impossible. Because of their elongated mouthparts female mosquitoes can easily bite through clothing such as socks, shirts, blouses, trousers and woolen garments, but clothing with a much closer weave may prevent biting. Mosquitoes are important as vectors of malaria, various forms of filariasis and numerous arboviruses such as dengue, yellow fever and West Nile virus[15].

2.2.4 : Mosquito control

Control campaigns can be directed against larvae or adults[16].

Immature stages control

2.2.4.1: Biological control

Aquatic predators, both naturally occurring and introduced, include the mosquito

fish (Gambusia affinis) and killifish (Fundulus spp)[14]. Invertebrate predators include the predatory mosquito *toxorhynchites* , several families of aquatic bugs and beetles , predatory copepods hydras ,and turbellarianflatworms ; however , none has been implemented with great success, 2002).

Bacillus*thuringiensis* var. Israelensis (Bit) is undoubtedly the most useful pathogen, as it can be easily mass-produced, is toxicologically safe to humans and wildlife, and is more or less specific in killing mosquito larvae [13].

2.2.4.2: Genetic control

Several genetic methods of mosquito control are being studied under laboratory conditions. A few, including the release of sterile males to reduce fertility, have been tested in field trials[14].

2.2.4.3: Physical control and chemical control

Generally earlier attempts to control mosquitoes were directed towards drainage and treatment of breeding sites with suffocating agents like mineral and toxic substances such as Paris green and chemical emulsions. Oil-based insecticides will kill larvae and pupae of all surface-breathing culicids. Surface-applied dusts would selectively target Anopheles larvae[17]. Recommended chemicals for larviciding include Malathion, Pirimiphos-methyl, Chlorpyrifos, Function and Temephos. In Sudan Temephos is applied all the year round in Khartoum and Northern State as an ant larval measure . Insect growth regulators (IGRs) these are compounds, such as Methoprene and Pyriproxyfen, that arrest larval development of insects, or compounds, like Diflubenzuron, which inhibit chitin formation in the immature stages[13].

In this Study the ultrasound waves is used as a physical control against mosquitoes.

Chapter Three

Results and Discussion

3.1: Introduction

This experiment was conducted in JICA laboratory on Sudan University of science and technology, collage of agriculture. In this chapter the effect of ultrasound wave on mosquitoes has been studied. Mosquito samples are obtained in a pool Burri east Khartoum it was contained two type of mosquito (*Anopheles* and *Culex*). Three different phases are separated then each phase placed in deferent container each container contains 20 samples of mosquito amount of water ranging from (30-50 ml).

Figure (3.1): shows mosquito's larvae on contenders

Figure (3.2): shows mosquito's on countenancers'

3.2: The device

Ultrasonic bath device is used to conduct experiment saluting. The mosquito samples were exposed for wave from the device with frequency ranged between (32-38 kHz). Ultrasound used only without heating. We poured hand warm water into the bath until it's at least 3/4 full or the fluid level reaches the lip of the tank and we operated the ultrasonic by turning the timer dial to required time and pressing the sonic button and turning the heater's switch off.

3.3: Experiment

This experiment performed in tow stage and each stage has different phase and exposure occur in the fallowing manners:

Firstly: larvae

We placed the three larvae's containers inside the device for 30 second in order to observe the effect of the ultrasonic wave. The experiment is repeated for different series of time (60-120-180 second) as shown on table (3.1) below.

Secondly: pupae

We placed the three pupae's containers inside the device for 60 second in order to observe the effect of the ultrasound wave. The experiment is repeated for different series of time (120-180 second) as shown on table (3.2) below.

Table (3.1): shows the results of Larvae treatment

Time/sec	Dead number on containers			The death average	Percentage
	C_1	C_2	C_3		
30	13	16	14	14.33	71.66
60	18	20	18	18.66	93 33
90	18	19	20	19.00	95.00
120	20	19	19	19.33	96.66
180	20	20	20	20.00	100.00

The result in the table above showed that the ultrasound wave effective against
mosquito larvae. Only after 60 second, the mortality reaches over 90% (93.3) and after 180 secant caused 100% mortality. This result indicates that the larvae of mosquito were very sensitive to ultra-wave and the mortality was increased gradually by increasing of exposure time. There significant different in all treatment when compared to control. .

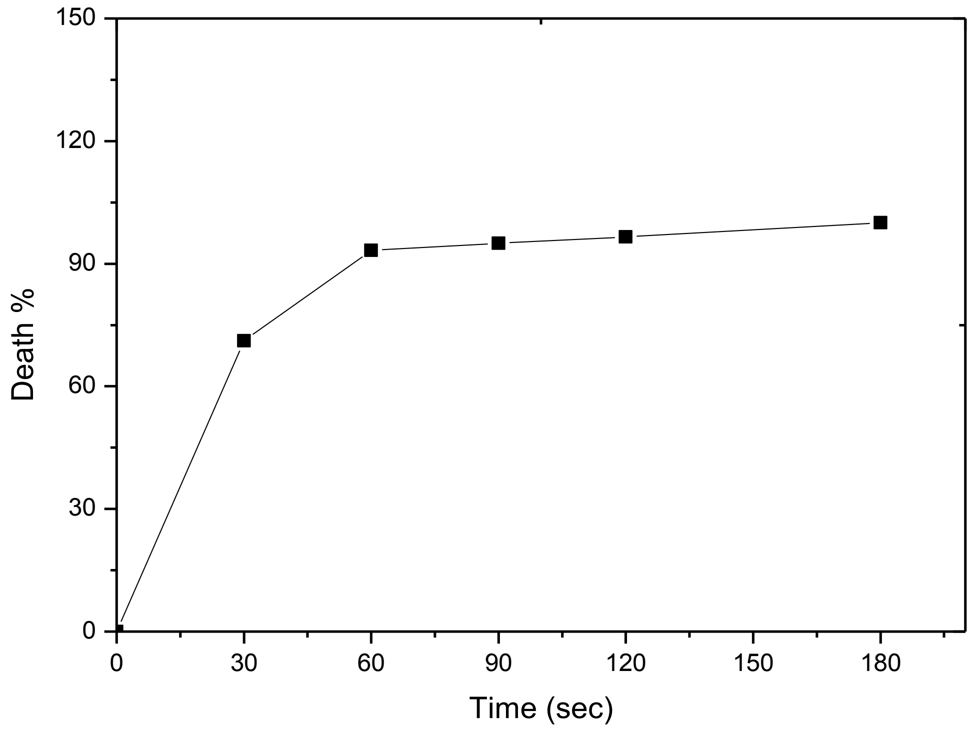


Figure (3.3) Shows the larvae results

Table (3.2) shows the results of Pupae treatment:

Time/sec	Dead number on containers			The death average	Percentage
	C_1	C_2	C_3		
60	6	10	5	7.00	35.00
120	15	14	12	10.30	51.66
180	20	20	19	19.66	98.33

The result presented in the table above showed that there is a significant different between the treated containers and the control. After 60 sec past exposure the mortality was 35% and after 120 sec the mortality was approximately 2 times that means every 60 sec the mortality in caused by about 35%.

From the above mentioned results we conclude that ultrasonic waves were effective against both larvae and mosquito pupae but we observed that larvae were using sensitive than pupae.

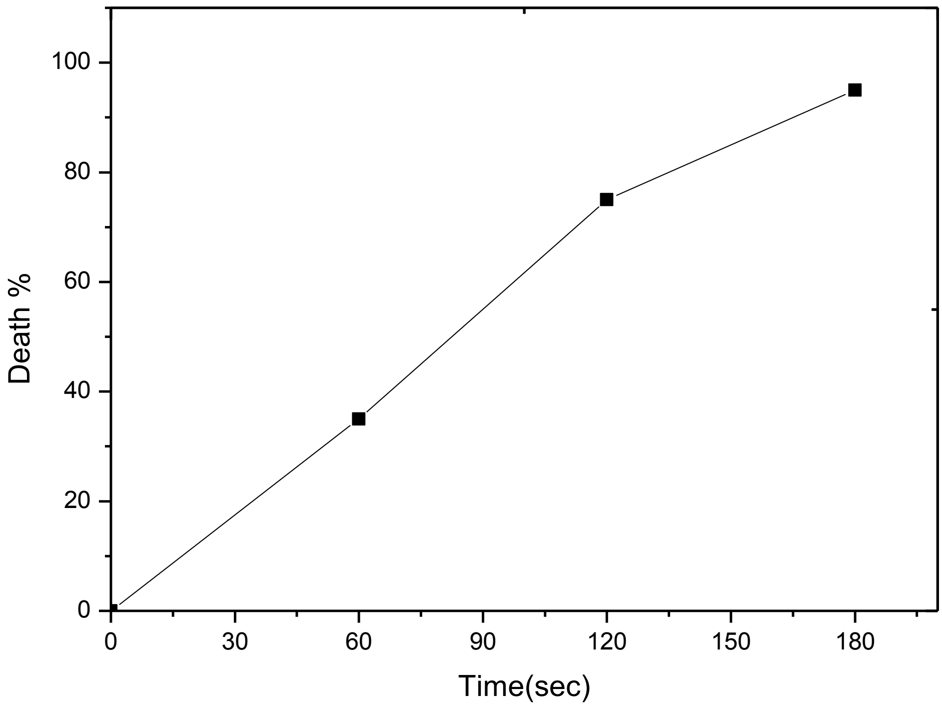


Figure (3.2) shows the pupae results

Chapter Four

Conclusion & Recommendations

Conclusion

We showed that the ultrasound waves have great impact on mosquitoes especially at larvae and pupae phases it can kill them at short exposure time, and the used frequency does not have any side effect on human and environmental health.

Recommendations

Exertion more from the experiments by used different interval time and above frequencies on the adult phase.

Design device works by this technique and using in kill the mosquitoes to being new control method.

Pursuance research and developing in this sphere.

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