**THE HYPOXIC ACTIVITY OF CHARCOAL IN MOSQUITO LARVAE CONTROL**

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**ABSTRACT**

The females of many species of mosquitoes are [blood-](http://en.wikipedia.org/wiki/Hematophagy)sucking pests. Some mosquitoes that bite humans routinely act as [vectors](http://en.wikipedia.org/wiki/Vector_(epidemiology)) for a number of infectious diseases affecting millions of people per year, with malaria disease being the greatest killer of man. Mosquitoes are very widespread, occurring in all regions of the world except for Antarctica. In warm and humid tropical regions, they are active for the entire year, but in temperate regions, they hibernate over winter. Charcoal was introduced into three different containers with stagnant water containing mosquito larvae and pupae to test its efficacy in controlling mosquitoes, as a cheap alternative to other conventional eco-friendly control methods or agents. The charcoal used was prepared locally by burning hard wood in limited supply of oxygen and the mosquitoes were bred by exposing water in plastic containers. The average means of the larvae and pupae used in the course of the experiment were 5 and 4 respectively, and they all died after the introduction of charcoal in the water containing them. Mosquitoes are found in virtually all the climes and biomes of the world, except in Iceland. Some authors arguably have considered mosquitoes to be the number one killer insects in the world, this is of great concern, particularly to developing countries, hence, the need to cheaply and effectively control, while at the same time safe-guarding the environment. Charcoal was proved to be efficient in tackling this, through the laboratory and a specific environmental test study carried out.

**Keywords**: Charcoal, Mosquito larvae, Blood-sucking, Oxygen, Eco-friendly

**INTRODUCTION**

The mosquitoes are a [family](http://en.wikipedia.org/wiki/Family_(biology)) of small, [midge](http://en.wikipedia.org/wiki/Midge)-like [flies](http://en.wikipedia.org/wiki/Fly): the *Culicidae*. Although, a few species are harmless or even useful to humanity, most are a nuisance because they consume blood from living [vertebrates](http://en.wikipedia.org/wiki/Vertebrates), including [humans](http://en.wikipedia.org/wiki/Human). The females of many species of mosquitoes are [blood-eating](http://en.wikipedia.org/wiki/Hematophagy) pests. In feeding on blood, some of them transmit extremely harmful human and [livestock](http://en.wikipedia.org/wiki/Livestock) diseases, such as [malaria](http://en.wikipedia.org/wiki/Malaria), [yellow fever](http://en.wikipedia.org/wiki/Yellow_fever) and [filariasis](http://en.wikipedia.org/wiki/Filariasis). Some authorities argue accordingly that mosquitoes are the most dangerous animals on Earth (MMCO, 2013).

Potential transmission of [HIV](http://en.wikipedia.org/wiki/HIV) was originally a public health concern, but practical considerations and detailed studies of epidemiological patterns suggest that any transmission of the HIV virus by mosquitoes is at worst extremely unlikely (CDC, 2006).

Over 3,500 species of mosquitoes have already been [described](http://en.wikipedia.org/wiki/Alpha_taxonomy) from various parts of the world (Liesnham, 2013). Some mosquitoes that bite humans routinely act as [vectors](http://en.wikipedia.org/wiki/Vector_(epidemiology)) for a number of infectious diseases affecting millions of people per year (Afshin, 2003). Others that do not, routinely bite humans, but are the vectors for animal diseases, may become disastrous agents for [zoonosis](http://en.wikipedia.org/wiki/Zoonosis) of new diseases when their habitats are disturbed, for instance by sudden deforestation (Wilcox and Ellis, 2006).

Like all flies, mosquitoes go through four stages in their lifecycles: [egg](http://en.wikipedia.org/wiki/Egg_(biology)), [larva](http://en.wikipedia.org/wiki/Larva), [pupa](http://en.wikipedia.org/wiki/Pupa), and adult or [imago](http://en.wikipedia.org/wiki/Imago). In most species, adult females lay their eggs in stagnant water; some lay eggs near the water's edge; others attach their eggs to aquatic plants. Each species selects the situation of the water into which it lays its eggs and does so according to its own ecological adaptations (Wigglesworth, 1933). Mosquitoes are very widespread, occurring in all regions of the world except for Antarctica (Mullen and Durden, 2009).

A larvicide (alternatively larvacide) is an [insecticide](http://en.wikipedia.org/wiki/Insecticide) that is specifically targeted against the [larval](http://en.wikipedia.org/wiki/Larva) life stage of an [insect](http://en.wikipedia.org/wiki/Insect). Their most common use is against [mosquitoes](http://en.wikipedia.org/wiki/Mosquito). Larvacides may be contact poisons, stomach poisons, growth regulators (methprene), or (increasingly) [biological control](http://en.wikipedia.org/wiki/Biological_control) agents e.g. [*Bacillus thuringiensis*](http://en.wikipedia.org/wiki/Bacillus_thuringiensis), also known as *Bt*, which is a [bacterial](http://en.wikipedia.org/wiki/Bacteria) disease specific to [Lepidopteran](http://en.wikipedia.org/wiki/Lepidoptera) [caterpillars](http://en.wikipedia.org/wiki/Caterpillar), [*Bacillus thuringiensis israelensis*](http://en.wikipedia.org/wiki/Bacillus_thuringiensis_israelensis), also known as *Bti*, and [*Bacillus sphaericus*](http://en.wikipedia.org/wiki/Bacillus_sphaericus), which affect larval mosquitoes and some [midges](http://en.wikipedia.org/wiki/Midges) (Lawniczak *et al*., 2010).

Charcoal is a light black residue consisting of [carbon](http://en.wikipedia.org/wiki/Carbon), and any remaining [ash](http://en.wiktionary.org/wiki/ash), obtained by removing water and other volatile constituents from [animal](http://en.wikipedia.org/wiki/Animal) and [vegetation](http://en.wikipedia.org/wiki/Vegetation) substances. Charcoal is usually produced by slow [pyrolysis](http://en.wikipedia.org/wiki/Pyrolysis), the heating of [wood](http://en.wikipedia.org/wiki/Wood) or other substances in the absence of [oxygen](http://en.wikipedia.org/wiki/Oxygen). It is usually an impure form of [carbon](http://en.wikipedia.org/wiki/Carbon) as it contains ash (Smith and Voreacos, 2007).

Mosquitoes and the diseases they spread, mosquitoes-transmitting malaria kill 2-3 million people and infect another 200 million or more every year. Today, however, the threat of developing encephalitis from mosquitoes’ bites carrying certain viruses is far greater than even the threat of malaria in the world. This study was therefore undertaken to determine the efficacy of the indigenous charcoal usage, as a cheaper alternative to the commercial use of eco-friendly insecticides (both chemical and biological) in the control of mosquito larvae and pupae and also to determine the form in which the charcoal is more effective (whole or powdered).

**MATERIALS AND METHODS**

**Breeding of Mosquitoes**

The study was carried out at The Federal Polytechnic, Ilaro, Ogun state, Nigeria. Three fairly large transparent plastic containers containing water were left outside the laboratory for some few days to naturally encourage and enable female mosquitoes to lay eggs. Afterwards, they were monitored until the eggs developed into larvae.

**Local Production of Charcoal**

Charcoal is got from hard wood i.e. the incomplete combustion of hard wood in limited air.

The hard wood used was got from a local sawmill in Ilaro, Ogun State. Outside of the laboratory, kerosene was amply sprinkled on the hard wood obtained, it was thereafter set off with fire. The hard wood burned gradually and after a while, the fire was put off by sprinkling copious quantity of water on it to prevent the charcoal obtained from burning into ashes. The charcoal was obtained in pieces of varying sizes, allowed to cool and then kept in a polythene bag in the laboratory, for subsequent use.

**Charcoal Introduction**

The transparent plastic containers containing the visible larvae were then brought in into the laboratory for further studies. The first container, labeled A, was left to allow the larvae to further develop into pupae, and the adults, in the absence of charcoal. This serves as a control experiment.

The second container, labeled B, was treated with two pieces of charcoal at the larval stage of the metamorphosis of the laid eggs. The charcoal pieces were introduced by using a pair of forceps, while wearing a hand glove.

The third container, labeled C, was also treated with two pieces of charcoal, but at the pupal stage of the metamorphosis of the larvae.

All the containers were then observed for some days for any appreciable activities, including the eventual deaths of the larvae and pupae.

**Charcoal Mass Appreciation**

The charcoal pieces were weighed, using a weighing balance, before their introduction into the water in the container (anhydrous) and also at the end of the experiment (hydrated). This is to probably suggest a kind of activity between the charcoal pieces and water.

**Comparative Test Study**

A comparative test study was carried out to find out which was more effective between whole charcoal pieces and the powdered charcoal. Two pieces of charcoal were ground using a pestle and mortar, the powder was then introduced into a fresh container containing mosquito larvae, labeled D. It was then observed for some days to determine how long it took for the larvae to probably die, as against the containers treated with whole charcoal pieces.

**Environmental Test Study**

Charcoal pieces were introduced, at strategic points, into an open drainage containing stagnant water with noticeable and appreciable number of mosquito larvae and pupae. This was then observed for some days to determine if the larvae and pupae will eventually die.

**RESULTS**

The three plastic containers containing water were observed daily for mosquito larvae, an indication that female mosquitoes could have laid eggs in them.

The containers were observed daily for days for likely deaths, which could have been noticed by either the larvae or pupae showing no sign of movement or activity, basically, by not swimming back and forth between the bottom and surface of the water at intermittent intervals.

In the course of the experiment, it took roughly about a week before the onset of mosquito larvae in each of the container, from the day they were left in the open outside of the laboratory. They were then brought into the laboratory for further studies.

After the introduction of charcoal in containers B and C, it took about four days before the deaths of the larvae and pupae were confirmed, respectively.

**Table 1: Number of live and killed larvae/pupae in each container**

|  |  |  |
| --- | --- | --- |
| Sample | No. of larvae/pupae | No. of deaths |
| A | 15 (larvae) | Nil |
| B | 17 (larvae) | All |
| C | 14 (pupae) | All |

**Table 2: Masses of Charcoal used in Samples B and C**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Sample | Charcoal designate | Anhydrous (g) | Hydrated (g) | Mean anhydrous (g) | Mean hydrated (g) |
| B | X1 | 0.98 | 36.9 | 0.80 | 33.8 |
|  | X2 | 0.62 | 30.7 |
| C | X3 | 0.79 | 34.3 | 0.81 | 34.9 |
|  | X4 | 0.83 | 35.5 |

**Table 3: Number of live and killed larvae/pupae in an open drainage**

|  |  |  |
| --- | --- | --- |
| Sample | No. of larvae/pupae | No. of deaths |
| Open drainage | Indeterminate | Appreciable |

**DISCUSSION**

In this investigation, it was observed from the result from table 1 that charcoal is indeed cheaply effective in controlling mosquitoes, by targeting them either at the larval or pupal stage. From the table, sample A recorded the occurrence of fifteen larvae which remained viable throughout the course of the experiment. Being control experiment, the larvae were left to develop into pupae and then adult mosquitoes. Subsequently, the immature adult mosquitoes floated on the surface of the water for some days before they became mature enough to fly off. Sample B recorded the occurrence of seventeen larvae which all died upon the introduction of charcoal. Sample C recorded the occurrence of fourteen larvae which were left to develop into pupae. The pupae too all died after the introduction of charcoal!

An extra sample (D), containing mosquito larvae and powdered charcoal, showed the pulverized charcoal to be a little more effective, as the larvae all died about three days from the day the charcoal powder was introduced, as against the four-day-death duration obtained with the whole charcoal pieces in samples B and C.

Table 2 shows the hydrated pieces weighed more than the anhydrous piece. The mean anhydrous masses recorded for the two samples (B and C) were 0.80g and 0.81g while the mean hydrated masses recorded were 33.8g and 34.9g respectively.

Although, charcoal is insoluble in water, it is remarkable for its porosity. This clearly explains why the charcoal pieces sank i.e. due to the anhydrous pieces imbibing water leading to a significant increase in their masses. As ordinarily prepared charcoal is full of air held in the pores, which so reduces its apparent density that it floats on water but if the charcoal is placed on water in a vacuum, the air is extracted and the charcoal sinks (Durrant, 1964).

To further test the effectiveness of charcoal against mosquitoes, four whole pieces were strategically placed into an open drainage, off the Polytechnic community, with appreciable number of mosquito larvae and pupae and then monitored for days. It was observed by the fifth day that all the larvae and pupae in the drainage had died!

No literature is available yet on the control of mosquito larva using charcoal, hence, the novelty of this study was to determine the efficacy of charcoal in terminating mosquito larvae; thus showing a larvicidal activity.

Malaria is a predominant deadly disease across the world, particularly, West Africa and some other developing countries, with their attendant poor environmental sanitation practices. Little wonder, mosquitoes, the carriers of *Plasmodium*, have been considered the number one killer insects, which is a reason for serious concern because of their despicable menace and their being vectors to some other fastidious and health-challenging diseases, hence, the need to take the issue of their control very seriously too. But for poverty, tackling mosquitoes in these endemic areas remains a Herculean task, let alone their elimination, hence, the need to search for cheap, environment-friendly and yet effective control measures.

**CONCLUSION**

By this investigation, the use of charcoal has showed to be slow, but highly effective in tackling the menace mosquitoes constitute by ensuring their deaths at either the larval stage or pupal stage. According to Durrant (1964), charcoal exhibits in a unique degree the property (which is shared to some extent by all solids) of adsorbing gases to which it is exposed. The process of adsorption consists of the condensation of a layer of molecules of the adsorbed substance on the surface of the solid. The nature of the attractive forces which hold the adsorbed gas molecules on the surface is not fully understood; the mode of adherence of a gas molecule to the surface of the solid appears to be intermediate between simple physical cohesion and a true chemical link. This may suggest the water environment becoming hypoxic or anoxic, leading to the asphyxiation and then consequently, the deaths of the mosquito larvae and pupae

**RECOMMENDATIONS**

Because of the relative ease of the usage and availability of charcoal, its application in open drainages or anywhere stagnant water is deliberately or spontaneously collected, that could aid the breeding of mosquitoes, besides the other control measures aimed at reducing the population of mosquitoes in the immediate environment, should be encouraged and promoted.

Further studies could be carried out to actually determine the exact mechanism of action of charcoal in water against mosquito larvae and pupae.

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