IRJIF. I.F. : 3.821

North Asian International Research Journal of Sciences, Engineering & I.T.

ISSN: 2454-7514 Vol. 4, Issue-7 July -2018

Index Copernicus Value: 52.88

GARLIC AS A NATURAL PESTICIDE | EXPERIMENT

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Abstract

This experiment was designed to investigate and compare the effectiveness of garlic as the natural larvicide and Abate as the chemical larvicide against mosquito larvae. The effectiveness of the larvicides was determined by the time taken for all the mosquito larvae to be killed. The mosquito larvae were placed in separate plastic cups containing garlic extract and Abate respectively. They were monitored at fixed time intervals and the time taken for all the mosquito larvae to die was recorded. The experiment was repeated with different concentrations of garlic extract and Abate. A two-way ANOVA statistical test showed that Abate is more effective against mosquito larvae at 5% significance level compared to garlic, corresponding to the experimental hypothesis.

Keywords: Garlic, Pesticide, Natural, Experiment, ANOVA.

Research and Rationale

Mosquitoes originate from the family Culicidae.13 Like many other insects, they go through a life cycle from egg to larva, pupa and finally adult. They are generally well-known as blood-sucking insects to human and they are responsible for many fatal diseases such as dengue, malaria and yellow fever. Some commonly known genera are Aedes, Culex and Anopheles. Usually, mosquitoes breed in stagnant water like ponds, marshes and swamps and they thrive in warm climates.9

In order to control mosquitoes, chemical larvicides are used. One commonly used larvicide, Abate is applied to stagnant water to kill larvae of a wide range of pathogen-carrying vectors (mosquitoes) to hinder their development into adult mosquitoes.2 Consequently, this prevents disease-carrying mosquitoes from hatching and transmitting the pathogens to human via bites. Although the active ingredient of Abate, temephos is said to be effective against mosquito larvae (affects the nervous system by inhibiting cholinesterase enzyme), it has its downsides.

Research has shown that certain mosquito species (Aedes albopictus and Aedes aegypti) have developed resistance for Abate.4 In addition, rats exposed to temephus showed organic phosphorus poisoning while some fish are vulnerable to temephus. Temephus also harm inverterbates such as shrimps and crabs. Accumulation of temephus may also cause drastic impacts on cholinesterase activity involved in nerve signal transmission.6

Plant extracts such as those of garlic are potential alternatives to Abate. Crushing garlic releases thiosulfinates which convert into diallyl disulfide and diallyl trisulfide if mixed with water.10 these two products formed are effective against mosquito larvae. Trials conducted in Bombay have shown that several species of mosquito larvae are susceptible to garlic extracts. Allicin helps to curb malaria by preventing the formation of circumsporozoite protein (CSP) of Plasmodium sporozoites to infect host cells.10 They are effective, safe, environmental-friendly and economical.

The objective of this experiment was to investigate and compare the effectiveness of garlic as the natural larvicide and Abate as the chemical larvicide against mosquito larvae. The results from this experiment indicate that the spread of pathogen-causing diseases by mosquitoes can be curbed by using natural substances such as garlic as well as chemical larvicide like Abate. Garlic is a potential alternative to Abate as it is effective, easily available and eco-friendly. Although it might not be as fast-acting as chemical larvicides, garlic has none of the downsides of Abate such as accumulating in the environment and killing other invertebrates. Thus, more research is being conducted to investigate the efficiency of garlic as a larvicide.

Statistical Analysis

Two-way ANOVA test was used to analyse the data to show whether there is a significant difference between the two larvicides. The Columns P-Value (8.58E-24) is less than the significance level (α = 0.05). There is a significance difference between the larvicidal properties of Abate and garlic. Abate is a stronger larvicide than garlic. Therefore, the experimental hypothesis is accepted and the null hypothesis is rejected.

From the analysis also, the calculated Sample P-value (3.62E-22) is less than the significance level tested as well (α = 0.05). This shows that there are statistically significant differences between different concentrations of garlic and Abate. The Interaction P-Value (3.01E-19) indicates that there was a statistical significant interaction between the larvicides and the concentrations used. Higher concentrations of both larvicides are more effective against the mosquito larvae compared to lower concentrations.

The two-way ANOVA test revealed that Abate is a stronger larvicide than garlic. The Columns P-value is less than the significance value (α = 0.05), which indicated that Abate and garlic are significantly different in terms of larvicidal properties. This supports the experimental hypothesis that the effectiveness of Abate is greater than that of garlic.

Table 4 shows that for all Abate concentrations, the mean time taken for all the mosquito larvae to die are shorter compared to that of garlic. For both larvicides, as their concentrations increased, the mean time decreased. From the data in Table 4, it can be evaluated that there is a bigger percentage difference in the mean time taken between garlic and Abate for the first two concentrations (about 75%). For 3%, 4% and 5% concentrations, the percentage differences in mean time range from 54% to 58%. This is illustrated in Figure 1. It clearly suggested that Abate is much more effective than garlic.

Abate is a chemical larvicide while garlic is a natural larvicide. Both contain the active substances which are capable to kill mosquito larvae. Within 24 hours, all mosquito larvae would have died in Abate as well as garlic solutions. It was therefore not practical to calculate the number of live mosquito larvae after 24 hours. Hence, the

time taken for the mosquito larvae to die was used as a measure of the substance's effectiveness. The shorter the time taken, the more effective the compound is. Dead larvae can be identified by touching them with the tip of a rod or dropper. They cannot be induced to move.

Abate contains temephos which is an organophosphate compound.11 It is able to inhibit acetylcholinesterase enzyme which is required to stop a nerve impulse after it has crossed the synapse. As a result, there is a continuous stimulation of the nerve, resulting in tremors and uncoordinated movement.11 Garlic, when crushed and mixed with water, will convert thiosulfinates to diallyl disulfide and diallyl trisulfide,10 both which are organosulfur compounds. They are effective against mosquito larvae.

The experiment showed that Abate is a more effective larvicide compared to garlic. Both organophosphorus and organosulfur compounds worked against mosquito larvae. This explains that during the trial experiment, after allowing both solutions to sit for 24 hours, all mosquito larvae died. Nevertheless, the experimental results showed that Abate which contains organophosphorus compounds took a shorter time to kill all the mosquito larvae compared to garlic (organosulfur compound), implying that organophosphorus compounds are more effective against mosquito larvae. However, this may also be due to the purity of the active substances. The industrially-produced Abate contain pure temephos, whereas allicin found in garlic is impure. For an active ingredient to work effectively, it has to be extracted and processed to give optimum results.

Although results showed that Abate is a more effective larvicide, it should be noted that Abate is harmful to certain animals such as mice and fish, as well as to some invertebrates. Abate is also liable to accumulate within the natural environment, posing risks to human health. Garlic is an option to replace Abate as it is easily obtainable, cheap and does not pose harm to the environment. Nevertheless, garlic takes a longer time to kill mosquito larvae compared to Abate. Time is a crucial factor when dealing with disease-carrying mosquitoes such as Aedes aegypti. Therefore, although garlic might be effective against mosquito larvae, it may not be practical to use such a time-consuming substance to alleviate the problem with mosquito larvae.

Evaluation

To increase the accuracy, the base of the garlic, together with its skin was removed before the garlic cloves were weighed using an electronic balance. The garlic cloves were pounded lightly using a mortar and pestle to prevent heat from destroying the chemical contents of garlic, which might decrease the effectiveness of garlic. Disposable droppers were used to avoid contamination of substances being tested and in the container used to collect mosquito larvae. Besides, plastic cups were used instead of laboratory glassware in order to prevent contamination as well. Each cup was closed with a perforated cover to ensure that air flows into the cup. The cup was covered as a precaution to prevent the introduction of any mosquito into the environment in case any larvae managed to complete its life cycle.

Results from the trials showed that all mosquito larvae were killed by the larvicides within 24 hours. Therefore, if the number of live mosquito larvae were noted after 24 hours, there would not be any significant differences. As an alternative, the time taken for the mosquito larvae to be killed was measured. It was also impossible to run a stopwatch to measure the time as it would be difficult to estimate when to stop it. Instead, the mosquito larvae were observed every five minutes and any dead larva was noted. Hence, the time measured was

estimation as it would be hard to check on the larvae every minute for hours. To increase the precision of results, the experiment was repeated twice to obtain an average time.

It was also impossible to differentiate the types of mosquito larvae. Different larvae species might have different response towards larvicide. However, in this experiment, they were assumed to be of the same species. The larvae were also of different days old. Larvicides might have different effects on larvae of different days old. Besides, the solutions might not contain the exact concentration which was supposed to be tested. This is because garlic juice might not be able to be extracted and dissolve in distilled water completely. Abate granules also did not dissolve completely in distilled water.

An ethical issue that may be questioned is the accidental introduction of mosquitoes into the environment. In this experiment, mosquito larvae are collected from ponds, which are mosquito breeding grounds. These mosquito larvae are actually prevented from turning into adult mosquitoes, which may transmit certain diseases. Larvae collected are placed in a covered container and are monitored to prevent accidental introduction of mosquitoes in case any larva managed to complete its life cycle.

This investigation could be modified by grinding the garlic cloves and dissolve it in ethanol to form garlic solution of a particular concentration. This would increase the reliability of the results. Besides, mosquito larvae of the same species could be used to ensure that the effects of larvicides on that particular type of mosquito larvae only are determined. This reduces the probability of results occurring by chance. Mosquito larvae of a specific species could be cultured rather than collecting them from a pond. The number of mosquito larvae could also have been increased to obtain a more reliable result.

Conclusion

Chemical larvicide, Abate is significantly more effective than garlic in killing mosquito larvae. This was determined by the notably shorter time taken by Abate to kill all the mosquito larvae than shown by garlic.

Source Evaluation

Source 2 contains information on agricultural products such as vector control by BASF, the world's leading chemical company and a corporate group. Hence, it is trustable and reliable.

Source 4 is a journal, so contains sound scientific information. It contains a research note written by authors from several research universities. Therefore, it should be trustable and reliable.

Source 6 is a data sheet on temephos, the active ingredient in Abate. The data sheet is provided by IPCS INCHEM, cooperation between International Programme on Chemical Safety (IPCS) and the Canadian Centre for Occupational Health and Safety (CCHOS). IPCS INCHEM compiles information regarding management of chemicals and their risks based on data from World Health Organization (WHO) and Food and Agriculture Organization (FAO). Therefore, this source is reliable and not biased.

Sources 8 and 13 are published books. Therefore, they are credible sources with reliable contents written by notable experts in the respective fields.

Source 10 is a trustable review as it is written by credible experts in the particular area.

Source 12 is a reliable and credible governmental website by the U.S. Environmental Protection Agency in regulating pesticides; therefore, all facts and information provided are updated.

Source 14 is guidelines for laboratory and field testing of mosquito larvicides by World Health Organization, so should contain sound scientific information.