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PLANTS EXTRACTS AS AN EFFECTIVE CONTROLLING AGENT AGAINST MOSQUITO: A REVIEW

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ABSTRACT

Different plant extracts and their oils can be used to jurisdiction different species of mosquitoes. Mosquitoes causes many life threatening disease like malaria, zika virus and dengue, so it is crucial to control it by using some biological ways instead of chemical ways. As there are many chemicals to control it but it's better to use biologicals ways to control the pest as plant extract are ecofriendly to use so using plant extracts is safe to control the pest. Garlic (*Allium sativum*), *Momordica charantia*, and Black pepper (*Piper nigrum*) was found to be effective against different mosquitoes. *Allium sativum* contain some compounds having ajoene, diallyl polysulfides, allicin, S-allylcysteine, and enzymes like saponins, flavonoids, and Maillard reaction products, These phytochemicals fabricated by garlic are the major contributors to the characteristic odor of garlic, has bactericidal properties, interfere and restrict the synthesis of parasite cell membranes and causes lysis, and helps in killing mosquitoes by blocking their respiratory system and even *Momordica charantia* leaves have flavonoids, alkaloids, saponins and terpenoids they will enter into the digestive tract of the mosquito larvae and then got absorbed by the intestinal wall of the tract and then after that will circulate all along the blood that will interfere with the metabolism of body of the mosquito and kills them. *Piper nigrum* also have compound Piperine which is very pungent and a very strong alkaloid. It also contains some compound like sabinene, safrol, pinene, limonene, caryo-phyllene and linaonol. It exhibited good larvicidal and mortality activities and showed abnormal behavior and became restless in mosquitos then muscle contraction seize which lead to paralysis and eventually mosquito dies so the extract of these species basically attack on the neuromuscular system of the mosquito and the anal gill membrane also shrinks. So these can be used to kill mosquito using the biological ways.

Keywords: *Piper nigrum*, *Momordica charantia*, *Allium sativum*, neuromuscular, phytochemicals.

INTRODUCTION

Garlic (*Allium sativum*): This is a perennial flowering plant that grows from a bulb. It is having a tall and a erect flowering stem that grows up to 1 m (3 ft). This plant is from the lily family Amaryllidaceae. The leaf blade of *Allium sativum* is flat, solid, linear and approximately 1.25–2.5 cm width. In the Northern Hemisphere this engender pink to purple flower from July to September. Garlic is basically the edible bulb which contains 10 to 20 cloves that are asymmetric in shape and the bulb is odoriferous and contains outer layers of thin sheath of leaves surrounding an inner sheath that encloses the clove. The flowers produced by this are hermaphrodite. It was widely used in ancient times for various health purposes by people in different parts of the world, including the Egyptians, Greeks, Romans, Chinese, Japanese, and Native Americans. Garlic can be grown and cultivated easily in many different regions in different climatic regions specially in mild climates. Sexual propagation can be seen in garlic but usually all the cultivation of garlic is propagated asexually by planting only single clove in the ground which further gives rise to others. *Allium sativum* contain some compounds having sulfur like ajoene, diallyl polysulfides, allicin, S-allylcysteine, and enzymes like saponins, flavonoids, and Maillard reaction products, which do not contain sulfur compounds. These phytochemicals produced by garlic are the major contributors to the characteristic odor of garlic, has

bactericidal properties, interfere and restrict the synthesis of parasite cell membranes and causes lysis, and helps in killing mosquitoes by blocking their respiratory system.

***Momordica charantia*:** it comes under order cucurbitales and family Cucurbitaceae. It is commonly known by different names some of them are bitter gourd, Kerala, bitter melon ; bitter apple ; bitter squash etc. As one of its name is bitter gourd perfectly defines its taste it is very bitter to eat but is having lots and lots of health benefits. It comes under the category of climbers as it need support to grow so its vine grows upto 5 m and have simple and alternate leaves. This plant have many distinct species, different shapes and sizes. The male and female flowers of this plant are yellow in color and the fruit is light green to dark green and whitish in color. If the fruit ripen up it will turn into yellow and the seeds will turn into red color. Fruit is long with some irregular ridges on it inside the fleshy layer seeds are also present and the end is tapering with pointed ends. The whole fruit of this plant is edible including the flesh and seeds also. It is used in many medicines to cur different diseases like it prevent cancer, helped in treatment of diabetes, fever, HIV and AIDS, and many other infections also. It was originated from India and now cultivated in other countries also. *Momordica charantia* leaves have flavonoids, alkaloids, saponins and terpenoids they will enter into the digestive tract of the mosquito larvae and then got absorbed by the intestinal wall of the tract and then after that will circulate all along

the blood that will interfere with the metabolism of body of the mosquito and kills them.

Black pepper (*Piper nigrum*): It's from the family of *Piperaceae* which contains approximately 2,000 species, which are widely grown and are very commonly used in tropical regions as medicines, spice, and condiments in different cuisine. Mostly the fruit part is used and the fruits of this family is known as peppercorn. The plant is a woody climber having a heights of 10 meters (33 feet) with aerial roots. Leaves of this plant are broad and green and they are alternately arranged. The flowers are small and with slender spikes. The size of fruits are about 5 mm (0.2 inch) in diameter. They become yellowish red when they attain maturity with bearing a single seed. Its odor is very strong penetrating and very aromatic. The taste is hot seems like spicy, bitter and very pungent. It contains compounds like piperine, and its seeds contain chavicine, piperidine, and piperettine. The fruits are picked and collected after they turned up red. After collecting the fruits they are put into the boiling water for almost about 10 minutes, which leads them to turn dark brown or black in color after about hour. Then they are allowed to dried in the sun for three or four days. *Piper nigrum* is having a compound Piperine which is very pungent and a very strong alkaloid. It also contains some compound like safrol, linaonol, limonene, sabinene, caryo-phyllene and pinene,. It showed good larvicidal and mortality activities and showed abnormal behavior and became restless in mosquitos then muscle contraction seize which lead to paralysis and eventually mosquito dies so the extract of these species basically attack on the neuromuscular system of the mosquito and the anal gill membrane also shrinks. Piperonaline, extracted from the hexane fraction of pepper was very effectful and showed great larvicidal activities against *Aedes aegypti*.

The essential oils extracted from garlic and asafoetida are combined and showed very good level of toxicology was checked in case of larvae of *Culex pipiens Linnaeus* and *Culex restuans Theobald*. 10 compounds were present in garlic essential oil and 12 compounds were present in asafoetida essential oil. The five most extreme compounds acquired in garlic essential oil were allyl methyl trisulfide, allyl disulfide, diallyl trisulfide, diallyl tetrasulfide, and allyl methyl disulfide out of these five diallyl trisulfide and Allyl disulfide were the most ample compounds extracted from garlic. For asafoetida essential oil, the five most acquired compounds were butyl propenyl disulfide, (Z) butyl propenyl disulfide, disulfide, methyl 1-(methylthio) propyl, allyl disulfide, and diallyl trisulfide out of these five butyl propenyl disulfide, (Z) butyl propenyl disulfide, and disulfide, methyl 1-(methylthio) propyl were the most abundant compounds extracted from asafoetida (Muturi *et al.*, ; 2018). The essential oils from these two plants were extracted to kill mosquitoes and it was found that essential oil extracted from garlic showed more toxicity than asafoetida. The combination of these two plant extracts showed adverse effects like when the culex eggs are exposed to the essential oils of garlic and

asafoetida these oils failed to hatch the eggs and larvae of mosquitos but the few that have hatched mostly died at the stage of first instar larvae. Allyl disulfide showed the best capability of killing eggs and larvae of mosquitoes and hence contributed greatly to the overall toxicity of the two essential oils.

Ethanollic garlic bulb extract was also very effective against *C. quinquefasciatus* mosquito larvae (Eroegbusi *et al.*, ; 2010) The effect of this extract was noticeable after 24 hours and that results in increases in the mortality rate for the mosquito which helped in killing the 2nd, 3rd, 4th instar larvae. In this whole process garlic bulb and leaves were taken and were grinded properly and mixed with ethanol extract. So ethanol garlic bulb extract can be considered as a natural way to kill mosquitos.

Garlic contain Allicin, and diallyl sulfide which has bactericidal properties. Allicin interfere and restrict the synthesis of parasite cell membranes and causes lysis so that eventually parasites can't grow more and it is also toxic to the parasite and bacterial cells these oils change the surface tension of water so larvae was not able to take enough oxygen. So larvae will not get enough oxygen to grow, and eventually larval death takes place. Flavonoid is the another constituent that is also present in garlic and act as a respiratory inhibitor of insects and blocks the respiratory system by interfering in energy metabolism and electron transport system that will prevent ATP production and then causes decrease in oxygen consumption by mitochondria (Rahmal *et al.*, ; 2019) An experimental studies was performed with *Aedes aegypti* larvae in which different concentration of garlic solution were taken The concentrations were as follow 10%, 15%, 20%, 25%, 30%,. And 6 groups were taken and each of them contains 20 larvae observed at different time interval. At concentration of 10% mortality rate was 30%, at concentration of 15% mortality rate was 45%, at concentration of 20% mortality rate was 75%, at concentration of 25% mortality rate was 85%, and at final concentration of 30% mortality rate was 90% so with the increase in the concentration of garlic extract the mortality rate was also found to be increased.

In a study seven easily available plants were used against *Culex quinquefasciatus* which include Aloe vera, *Allium cepa*, *Datura alba*, *Allium sativum*, *Zingiber officinale*, and *Ocimum basilicum*, *Cinnamomum tamala* (Iqbal *et al.*, ; 2018). The different parts of these plants used were Dried leaves of *Cinnamomum tamala*, *Ocimum basilicum* and Aloe vera, Dried fruits of *Datura alba* and *Zingiber officinale*, Dried bulbs of *Allium sativum* and *Allium cepa* were taken and mixed with water to make aqueous extract of them. Different concentration of these extract were taken and their larval mortality effects were checked after 1 and 2 days of exposure. garlic were found to be the most effective, then taiz pat and aloe vera at 24 h and at 48 h showed aloe vera followed by garlic and taiz pat were found to be effective. The effectiveness of other plants were onion < datura < niazbo < ginger after 1 day and datura < niazbo < onion < ginger after 2 days. So the aqueous extracts of



Plate-1: Garlic (*Allium sativum*)



Plate-2: *Momordica charantia*

these plants showed good efficacy against the larvae of *Culex quinquefasciatus* and can be used as natural larval killing agents. Use of just a simple aqueous extract of these easily available plants is very useful and inexpensive method to control mosquitoes. These plants have different phytochemicals and insect killing properties, which are the important reason for the highest larval mortality rate. They makes changes in developmental stages and in the midgut epithelium of in mosquito vectors to eventually kill them. As the aqueous extracts were taken so we can easily kill the mosquitoes in stagnant water also.

Essential oils were extracted from some commonly available plants that are used in kitchen to check there larvicidal and pupicidal actions against *Culex* mosquito. Different parts of plants were taken like leaves, branches and rhizome. Plants used were Ginger, peppermint, basil, garlic and neem. (Nasir *et al.*, ; 2015) Higher mortality rate was found in case of 2nd & 3rd instar larvae and in case of 4th instar larvae and pupae very less mortality rate was found. The highest mortality rate was seen in case if ginger and less motility rate was seen in basil in immature stages. Ginger oil was more dominant after 12 and 24 h against all life stages of 2nd, 3rd, 4th instar larvae & pupae followed by peppermint, basil, garlic and neem. The incompletely purified plant extract were found

to be more cheap and effective in studies. These plants are rich in bioactive compounds to helped in increasing the mortality rate and mortality rate also increases with increase in concentration of plant extracts.

Leaf of *Momordica charantia* are also very useful to kill mosquitoes. Leaf extract of *Momordica charantia* contain some toxic components like n-hexane fraction extract, ethanol, ethyl acetate fraction extract and n-butanol fractions extract which are used to kill *Culex pipiens* larvae (Annisa *et al.*, ; 2017). Third instar larvae was used as they are more physiological and morphological stable ones. Then these extracted extracts are tested individually by putting them in different vials with third instar mosquito larvae and covered them with foil papers, to check there killing potential and mortality rate. It was found that when the concentration of the leaf extract was increased that

eventually resulted in increasing the mortality rate of the mosquito larvae. As the concentration of extract was having different toxic compounds increased mosquito will consume it more and that toxic compounds will interfere with the metabolism of mosquito larvae. *Momordica charantia* leaves have flavonoids, alkaloids, saponins and terpenoids they will enter into the digestive tract of the mosquito larvae and then got absorbed by the intestinal wall of the tract and then after that will circulate all along the blood that will interfere with the metabolism of body of the mosquito larvae *Culex pipiens* that results in decrease in the energy and eventually Mosquitoes finally dies. So these compounds act as *stomach poisoning* compounds and therefore can be used to kill mosquito larvae.

Leaf extracts of *Momordica charantia* and *Bacillus thuringiensis* together also shows good larvicidal activities against *Anopheles stephensi* (Subramaniam *et al.*, ; 2012). Methanol extract that is extracted from the leaf *Momordica charantia* showed good mortality rate as it interfere in the functioning of mosquito. So leaf *Momordica charantia* in this study was found to be effective against the first- to fourth instars larvae of *Anopheles*. In first instar larvae 48 % mortality was observed then it increases by 94 % in *B. thuringiensis* it was observed 41% in initial stage and then increased by 89%. *B. thuringiensis* is having some crystal



Plate-3: Black pepper (*Piper nigrum*)

toxins which goes into the midgut of the mosquito and damages the epithelium of gut and thus leads to the death of the mosquito.

Combination of *Tithonia diversifolia* and *Momordica charantia* against *Anopheles gambiae* is also effectful (Ileke *et al.*, ; 2019). Different phytochemicals are found in the methanol extract and aqueous extract of *Tithonia diversifolia* and *Momordica charantia* having high toxicity which leads to higher mortality like Alkaloids, Tanins, Saponins, Flavonoids, Cardiac glycosides, Steroids. are found. After 24 hours it was observed that mortality rate of *Tithonia diversifolia* was higher as compared to *Momordica charantia* as it was also having strong and pungent odor. Many other researches through their studies have found that plants with strong and pungent odor have higher biological activity against insect pest then others. *T. diversifolia* have more alkaloids, this compound is known to possess a high level of biological activity against different insect vectors and therefore making it more stronger than *Momordica charantia* against development stages of mosquito. *Anopheles gambiae* showed high mortality as the used plant extracts was having the ability decrease or block the oxygen supply to the initial or developmental stages in the water which also decreases the swimming ability of mosquitoes and then leads to the blockage of

the spiracle which will further leads to the suffocation and death of mosquito . *M. charantia* sowed lesser potency as compared to *T. diversifolia*, but it was also having high toxicity against the mosquito.

Momordica charantia was also taken with other 14 plant extracts and sowed a great mortality rate. Stem of *Abutilon indicum*, *Achyranthes aspera*, *Allium sativum* and *Zingiber officinale*, leaves of *Cassia occidentalis*, *Lantana camara*, *Ricinus communis*, *Putranjiva roxburghii*, *Chrysanthemum indicum*, *Bauhinia tomentosa*, and *Melaleuca bracteata* and fruit of *Phyllanthus emblica*, *Momordica charantia*, *Trachyspermum ammi* and *Myristica fragrans* was taken (Kumar *et al.*, ; 2012). Only 10 species out of these 15 showed 100% mortality rate and *Momordica charantia* was one of them but Other plant extracts resulted only from 0–25% mortality rate and because of their less mortality rate these species was rejected for further bioassays.

Because of the hexane leaf extract present in the *Lantana camara* it was the most effective but *Phyllanthus emblica* fruit extract was observed to be the least effective. These plants showed mortality rate because of different bioactive fractions and phytochemicals present in them which increase toxicants and helps in killing mosquitoes. The 10 species which shows great mortality rate were having more hexane extract and ethanol in them.

M. charantia seeds have some active toxic compounds in them and were tested against *Aedes aegypti* (Khoirunnisa *et al.*, ; 2019). Screening was done and showed the presence of some compounds having insecticidal and larvicidal properties which causes the mortality of the mosquito those compounds were flavonoids, saponins, alkaloids, and triterpenoids in the seeds extract of *Momordica charantia*. The seeds were extracted, dried and then treated with ethanol and different concentrations of extract were taken and tested on *Aedes aegypti* and the best larval mortality was observed in the third larval stage the mortality rate was 100%. Increasing the extract concentration increased the mortality rate which shows the effectiveness of the seed extract of the *Aedes aegypti*. Due to these bioactive compounds larvae undergo starvation and dies they becomes transparent in color due the presence of alkaloids as they damages the cell membrane and flavonoids makes the digestive hormones inactive and after it get interacted with saponins it produces poison in stomach and also removes the cuticle layer of larvae as this cuticle layer disintegrate it allows the triterpenoids to get in larval body and effects the functioning of metabolism and digestive system.

Piper nigrum (black pepper) is also very easily available and cheap thing that is found in each and every house that can kill mosquitos. Some essential oils, some aqueous extract and methanolic extracts extracted from *Piper nigrum* and *Curcuma longa* and were tested against larvae, pupae and adults species of *Anopheles gambiae* mosquito. (Kemabonta *et al.*, ; 2017) *Piper nigrum* showed better mortality rate then *Curcuma longa* so was more effective to kill mosquitoes. The coils of these extracts showed different mortality rate like approx. 95% mortality was observed in *Piper nigrum* and approx. 76% mortality was observed in *Curcuma longa* which increases further after 1 day. *Piper nigrum* is having a compound Piperine which is very pungent and a very strong alkaloid. It also contains some compound like sabinene, safrol, pinene, limonene, caryo-phyllene and linaonol. *Curcuma longa* (Turmeric) have some phenolic compounds and terpenoids.

Alkaloid of *Piper nigrum* have piperine, which have shown good larvicidal properties and was tested against third and fourth instar *Anopheles* larvae. (Samuel *et al.*, ; 2016) The extract of the black pepper was added into the water in which larvae were present to check the efficiency of the extract firstly lumps were forms then it dissolved further with time. The effect of piperine is very less toxic to *An. funestus*. But piperine was proved very toxic to the other members of the *An. gambiae* species which were more complex than to *An. funestus*. Piperamides present in black pepper are best for larval control as they act as neurotoxins and blocks the sensory system and kill the mosquito.

Methanol extract of 19 species of different plants were taken to check there larvicidal activity. The different plants and their parts used were pericarp of *Zanthoxylum limonella*, seed of *Pipernigrum*, leaf of *Spilanthes acmella*,

seed of *Piper longum*, peel of *Citrus aurantifolia*, leaf of *Mentha arvensis*, flower of *Tagetespatula*, leaf of *Lippia nodiflora*, *Calotropis gigantea*, *Hibiscus rosa sinensis*, *Leucas linifolia*, *Lantana camara*, *Ocimum sanctum* and *Chrysanthemum Cinerariifolium*, fruit of *Capsicum annum*, root of *Moringa oleifera*, rhizome of *Zingiber officinalis* and *Curcuma amada*, seed of *Adnentera pavonia* was tested against *Aedes(s)albopictus* and *Culex quinquefasciatus* (Nath *et al.*, ; 2006). Out of all these plants pericarp of *Zanthoxylum limonella* and extract of *Piper nigrum* was found to be the most effective and extract of *Calotropis gigantea* was found to be the least effective among the all. Methanol, ether, alkaloids, bioactive fractions and some toxic elements present in them showed larvicidal activities and interfere with the different system of mosquitos.

In a study fruit part of three different species of pepper were taken which were *Piper longum*, *P. nigrum*, and, *P. nigrum* these are commonly known as long pepper, black pepper and white pepper these three species were tested against *Aedes aegypti* (Kumar *et al.*, ; 2011). Among all these species the hexane extract of black pepper was found to be the most effective against the fourth instar larvae of *Aedes aegypti* followed by long pepper and white pepper. Initially the larvae showed abnormal behavior and became restless then muscle contraction seize which lead to paralysis and eventually mosquito dies so the extract of these species basically attack on the neuromuscular system of the mosquito and the anal gill membrane also shrinks. The extract and oil of these species should be used as soon as possible because there toxicity will start decreasing after some time. Pipernonaline, extracted from the hexane fraction of pepper was very effectful and showed great larvicidal activities against *Aedes aegypti*.

Ethyl acetate and methanol extracts of nine plants and there different parts like leaf of *Nelumbo nucifera*, *Cassia siamea*, *Phyllanthus amarus*, *Lantana camara*, seed of *Acacia concinna*, *Piper nigrum*, *Coriandrum sativum*, *Cuminum cyminum* and *Trachyspermum ammi* were taken and there larvicidal activities were check against *Anopheles stephensi* and *Culex quinquefasciatus*. (Kamaray *et al.*, ; 2011) All plant extracts are tested and observed after 24 h and 48 h of exposure that study concluded and the results showed that the highest activity was observed in leaf extract of *Nelumbo nucifera* and in the methanolic seed extract of *Piper nigrum*. Other plants also show good mortality rate but they took some time to show the effect so all of them showed almost 100% mortality rate but in different time period.

CONCLUSION

The three plants which were Garlic (*Allium sativum*), *Momordica charantia*, and Black pepper (*Piper nigrum*) was found to be effective against different mosquitoes and showed great mortality rate because of the presence of different toxic compounds in them like *Allium sativum* contain some compounds having ajoene, diallyl polysulfides, allicin, S-allylcysteine, and enzymes like

saponins, flavonoids, and Maillard reaction products, *Momordica charantia* leaves have flavonoids, alkaloids, saponins and terpenoids, and *Piper nigrum* have Piperine which is very pungent and a very strong alkaloid. It also contains some compound like sabinene, safrol, pinene, limonene, caryo-phyllene and linaonol. The presence of all of all these chemicals and compounds release toxins and interfere with the functioning of the different systems of mosquito body like they block the respiratory system, disturb the functioning of neuromuscular system, cause lysis in different membranes, disturb the functioning of circulatory system and digestive system which eventually lead to mosquito death. Using the extract of these three plants is very safe as it is completely the natural and biological way to kill mosquitoes and it will not affect humans in any case moreover these plants are cheap and are very easily available.

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