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An Overview: The Utilization Of Plant Extracts As Botanical Insecticides For Brown Planthopper Control

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Abstract– Farmers commonly rely on chemical insecticides for pest control in agricultural practices. However, the continuous use of such insecticides without adherence to proper application standards can negatively affect human health and the environment, and also contribute to the development of pest resistance. Therefore, alternative pest control methods that are both environmentally friendly and safe for human health are urgently needed. The findings indicate that plant extracts contain active compounds such as phenols, alkaloids, flavonoids, rotenone, tephrosin, deguelin, saponins, polyphenols, cyanides, and limonoids (triterpenoids). These compounds can be effectively utilized for botanical pest control. Suitable plants for botanical insecticide development should be readily available, non-toxic to the environment and non-target organisms, and should exhibit both high effectiveness and efficiency.

Key words: Botanical insecticides, Brown planthopper, Concentration, Plant extracts

I. INTRODUCTION

Pests are organisms that cause harm to crops and agricultural systems, capable of damaging plants either directly or indirectly, thereby reducing crop yields. Infestations caused by pests can result in significant economic losses. Common types of pests that frequently attack agricultural crops include rodents, fruit flies, stink bugs, Artona caterpillars, and planthoppers. Among these, planthoppers have long posed a major challenge for farmers. Their ability to reproduce rapidly and cause extensive damage, even leading to plant death, makes them a particularly serious threat. Therefore, rapid and effective pest control measures are essential.

Farmers typically rely on chemical insecticides for pest control. These insecticides contain chemical compounds specifically designed to eliminate pests. However, continuous use without following application standards can result in serious consequence. The including the development of pest resistance and health risks for farmers such as shortness of breath, skin disorders, headaches, nausea, muscle pain, diarrhea, and back pain [6]. Prolonged use of chemical insecticides can also result in environmental pollution, pest resistance, pest resurgence, and other detrimental effects on human health. Thus, alternative pest control methods that do not pose adverse impacts on health and the environment are urgently needed.

One such alternative is the use of botanical insecticides. Botanical insecticides are biodegradable, reduce the risk of resistance, and are safe for the environment, human health, and livestock. These insecticides can be derived from plants that contain secondary metabolites such as flavonoids, saponins, and terpenoids, which act as natural pest control agents. As a result, botanical insecticides are environmentally friendly, cost-effective, easy to prepare, and serve as an ideal solution for sustainable agriculture [18]. Additionally, botanical insecticides can improve productivity and contribute to food security [20]. This literature review

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aims to provide references regarding the potential of various plant extracts as botanical pesticides for sustainable agricultural practices.

II. RESULT AND DISCUSSION

Plant extracts contain various active compounds that function as botanical insecticides by disrupting pest hormonal activities, inhibiting feeding, functioning as repellents or attractants, and serving as neurotoxins. The active constituents include phenols, alkaloids, flavonoids, saponins, polyphenols, cyanides, and limonoids (triterpenoids), as illustrated in Table 1. To be considered suitable for botanical insecticide development, plants must meet several criteria: they should be readily available, environmentally safe for non-target organisms, and demonstrate both efficacy and efficiency [15].

A. Types of Plant Extracts

Table 1. Active Compounds in Plant Extracts Used as Botanical Insecticides

No	Plant Extract	Active Compounds	Target Pest	Reference
1	*Nothaphoebe coriacea* Kosterm	Alkaloids, pyrethrins, resins, and tannins	Brown planthopper	[12]
2	*Discorea hispida* Dennst	Saponins and cyanides	Brown planthopper	[22]
3	*Ageratum conyzoides* L.	Alkaloids, flavonoids, saponins, polyphenols, and essential oils	Brown planthopper	[2]
4	*Cymbopogon nardus* L.	Flavonoids, saponins, terpenoids, triterpenoids, and tannins	Brown planthopper	[1]
5	*Artocarpus altilis*	Tannins, saponins, and flavonoids	Brown planthopper	[24]
6	*Orthosiphon aristatus*	Flavonoids and saponins	Brown planthopper	[11]
7	*Tinospora crispa* L. Miers.	Alkaloids, saponins, tinocrisposide, triterpenoids, and tannins	Brown planthopper	[21]
8	*Azadirachta indica*	Limonoids (triterpenoids)	Brown planthopper	[23]
9	*Derris elliptica*	Tephrosin and toxicarol	Brown planthopper	[16]
10	*Syzygium aromaticum* L. and *Alpania galangal* L.	Terpenoids, alkaloids, and phenols	Brown planthopper	[17]

Alkaloids are secondary metabolites derived from plants that can inhibit enzyme activity in the nervous system of insect larvae. These compounds are generally unpalatable to insects, making them effective repellents and inhibitors of insect development. Alkaloids act as toxins once ingested by insects, they can impair and paralyze the digestive and nervous systems, leading to rapid insect mortality [22].

Flavonoids function as natural defense compounds in plants, exhibiting toxic properties and inhibiting insect feeding behavior. When flavonoids are ingested by insects or target pests, they interfere with digestion by blocking gustatory receptors in the insect's olfactory system, ultimately causing the insect to stop feeding and die of starvation. Flavonoids also disrupt respiratory function. Rotenone, a derivative of flavonoids, inhibits respiratory enzymes and causes respiratory failure in insects [8]. Phenols are secondary plant metabolites that act as stomach poisons by inhibiting insect development.

Saponins have a bitter taste, when consumed by insect nymphs, these compounds may corrode the mucosal lining of the digestive tract and inhibit growth hormones [11]. Saponins also interfere with digestive enzyme activity, when absorbed through the insect cuticle, they can cause respiratory disturbances, intestinal damage, and nutrient absorption disruption, all of which can ultimately lead to insect death.

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Tannins are found in all woody plants and serve as a defense mechanism by inhibiting the digestive processes of herbivorous insects. These compounds are bitter in taste and possess the ability to precipitate, shrink, and bind proteins. Tannins function as anti-nutritional factors and enzyme inhibitors, reducing glycemic response in animals due to limited starch hydrolysis. Their bitter taste discourages insect feeding; if ingested, tannins disrupt both digestion and nutrient absorption in insects [9].

Hydrocyanic acid (cyanide) is one of the most toxic and fast-acting compounds, exhibiting rapid effects on animal physiology. This compound plays a crucial role in plant defense mechanisms against herbivorous animals [3]. Plants containing cyanogenic compounds can kill insects by disrupting their nervous systems. Secondary metabolites derived from plant extracts can be effectively utilized as insecticides. Compound groups such as terpenoids, alkaloids, tannins, and steroids show high potential as natural pest control agents. Several plant species identified as potential sources for botanical insecticides against brown planthoppers include *Nothaphoebe coriacea* Kosterm, *Dioscorea hispida* Dennst, *Ageratum conyzoides* L., *Cymbopogon nardus* L., *Artocarpus altilis*, *Orthosiphon aristatus*, *Tinospora crispa* L. Miers, *Azadirachta indica*, *Derris elliptica*, *Syzygium aromaticum* L., and *Alpinia galangal* L.

B. Concentration of Plant Extracts

Table 2. Various Concentrations of Plant Extracts as Botanical Insecticides Against Brown Planthopper

No	Plant Extract	Target Pest	Concentration	Potential (Effect)	Reference
1	*Tithonia diversifolia*	Brown planthopper	0%, 1%, 3%, 5% and 7%	7% concentration inhibited feeding activity within 24 hours of treatment	[10]
2	*Derris elliptica*	Brown planthopper	2,5%, 5%, 7,5% and 10%	7.5% concentration resulted in 82.50% mortality	[16]
3	*Lansium domesticum* Correa	Brown planthopper	0,25%, 0,50%, 0,75% and 1%	0.75% concentration resulted in 62% mortality	[5]
4	*Derris elliptica*	Brown planthopper	1%	1% concentration applied weekly was effective in reducing nymph population	[14]
5	*Citrofortunella microcarpa*	Brown planthopper	2%, 4% and 6%	6% concentration increased mortality by 43%	[4]
6	*Anredera cordifolia*	Brown planthopper	0,5%, 0,75%, 1%, 1,5% and 2%	2% concentration resulted in 63.75% mortality on the 14th day	[18]

The variation in plant extract concentrations significantly affects pest mortality. Higher concentrations result in greater levels of active compounds, increasing toxicity and maximizing insecticidal effectiveness, which in turn leads to a higher number of brown planthopper deaths. It has also been reported that elevated levels of active compounds produce stronger toxic effects against brown planthoppers [2]. The concentration of plant extracts used in pest control directly influences mortality rates, with botanical insecticides demonstrating superior potential compared to chemical insecticides, as they can be applied at concentrations up to ten times higher [7].

In addition to concentration, environmental factors such as temperature and humidity can inhibit the growth and development of brown planthoppers. Extract concentration also impacts the extent of plant damage, as the active compounds in plant extracts are capable of suppressing pest feeding activity. Therefore, understanding the appropriate concentration levels of botanical insecticides is essential to ensure their optimal effectiveness in controlling pests in agricultural crops.

III. CONCLUSION

The active compounds found in plant extracts such as phenols, alkaloids, flavonoids, rotenone, tephrosin, deguelin, saponins, polyphenols, cyanides, and limonoids (triterpenoids) can be utilized as environmentally friendly botanical insecticides. Their use can help enhance crop productivity and resilience, offering a sustainable solution for modern agriculture. One of the key factors influencing pest mortality is extract concentration; the higher the concentration used, the greater the resulting mortality rate. Therefore, the application of botanical insecticides for pest control must involve precise concentration formulations to ensure optimal and efficient pest elimination. Several plant species have demonstrated potential as sources of botanical insecticides, including *Nothaphoebe coriacea* Kosterm, *Dioscorea hispida* Dennst, *Ageratum conyzoides* L., *Cymbopogon nardus* L., *Artocarpus altilis*, *Orthosiphon aristatus*, *Tinospora crispa* L. Miers, A*zadirachta indica*, *Derris elliptica*, *Syzygium aromaticum* L., and *Alpinia galangal* L

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