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CHEMICAL COMPONENTS OF *ALOE VERA* AND THEIR EFFECTS ON INSECTS

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Introduction:

The well-known medical plant *Aloe vera* (L.) is found in tropical and subtropical areas. It is a member of the Asphodelaceae family and has long been prized for its many medicinal uses in herbal medicine. The plant can store a lot of water and bioactive phytochemicals in its thick, succulent leaves, and it is ideally suited to hot, dry climates. These substances are crucial to the plant's natural defence systems in addition to adding to its therapeutic effect.

Aloe vera includes a variety of physiologically active substances, such as alkaloids, amino acids, proteins, vitamins, polyphenols, saccharides, organic acids, and many secondary metabolites, according to phytochemical research. Phenolic chemicals, anthraquinones, glycosides such aloin A and B, aloe-emodin, β-1,4-acetylated mannan, mannose phosphate, glycoproteins, and saponins are important components. Among these, aloin A is regarded as one of the main bioactive substances found in *Aloe vera* gel and is linked to both insecticidal and antibacterial qualities.

Concerns about the effects of synthetic pesticides on the environment and human health have led to a rise in interest in plant-derived insecticides in recent years. *Aloe vera* and other botanical extracts are becoming more popular as environmentally friendly pest control options. *Aloe vera* extracts have been shown in studies to have insecticidal, larvicidal, antifeedant, and repellent properties against a variety of insect pests. Anthraquinones, phenolic compounds, and other bitter phytochemicals that obstruct insect feeding, growth, and development are primarily responsible for these effects.

Effects on Insects

Aloe vera can amass a variety of bioactive chemicals in its leaves due to its special adaptation to hot, dry regions. It is abundant in phytochemicals including

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alkaloids, amino acids, vitamins, hormones, proteins, polyphenols, saccharides and organic acids as a result of this adaptation (Zayed *et al*., 2012). Phenolic substances, glycosides such as aloins (Aloin A and B), anthraquinones like aloe-emodin, β-1,4-acetylated mannan, mannose phosphate, alprogen glycoproteins, and saponins are the main phytochemical components of *Aloe vera* (Hirat *et al*., 1983). Aloin A, which was extracted via column chromatography from methanolic preparations of *Aloe vera* gel is thought to be the main bioactive molecule among these substances (Mallavadhani *et al*., 2016).

Aloe vera has been shown in numerous research to have insecticidal and repellant properties. Crude methanolic aloin extracts have demonstrated notable mortality against insect larvae due to their larvicidal action. As an illustration of aloin's potential as a botanical pesticide, larval mortality of 70–80% was noted at a concentration of 0.5%, whereas no mortality occurred in control treatments (Pugazhendhi *et al*., 2021).

For mosquito control, plant-based larvicides, such as extracts from Aloe species, have also been investigated. According to Al-Jabr, 2004, these extracts have repulsive properties and may disrupt insect's development by interfering with their juvenile hormone system.

Plant extract's antifeedant qualities have also been investigated in comparative research. *Tephrosia vogelii, Nicotiana tabacum,* and *Aloe secundiflora* leaf extracts were evaluated against fall armyworm larvae. Aloe extracts provided moderate larval mortality and high repelling effects while having a lower insecticidal activity than *N. tabacum* and *T. vogelii.*

Plant-based *Aloe vera* gel's repelling properties are partly due to its bitter taste. Insects like ants, bedbugs, and houseflies can be repelled by this bitterness. Aloe extracts can operate as natural insect repellents on surfaces like windows, doors, and clothing. Furthermore, saponins have antibacterial and cleaning qualities that may help deter insect activity inadvertently (Hirat *et al*., 1983). *Aloe vera*'s potential utility as a natural pest management solution is further supported by India's long history of employing plant-based pest control techniques (Rajasekhar *et al*., 2012).

Studies have also evaluated the effectiveness of *Aloe vera* extracts against mosquito larvae particularly Culex species. The plant consists of about 99.5% water along with vitamins, minerals, enzymes, sugars and secondary metabolites such as anthraquinones, saponins, flavonoids and tannins. These compounds are known to exhibit toxic effects on mosquito larvae.

Aloe vera extract's efficacy against mosquito larvae especially Culex species, has also been assessed in studies. Along with vitamins, minerals, enzymes, carbohydrates, and secondary metabolites including anthraquinones, saponins, flavonoids, and tannins, the plant is composed of around 99.5% water. It is well known that these substances have harmful effects on mosquito larvae. The toxicity of secondary metabolites including alkaloids, saponins, tannins, and flavonoids can kill mosquito larvae by interfering with their physiological functions. Studies using phytochemical screening have verified that *Aloe vera* contains these substances. These tests aid in pinpointing the precise secondary metabolites that have insecticidal properties. The results reported by Weni *et al*. (2018) confirmed the presence of alkaloids, glycosides, saponins, tannins and flavonoids in *Aloe vera*, supporting earlier findings by Ramesh *et al*. 2012

Ways to Enhance the Efficacy of Botanicals

There are a number of ways to increase the efficacy of botanical insecticides, but each strategy has drawbacks. Using synergists is one popular tactic. For instance, research has demonstrated that neem oil and *Prosopis juliflora* aqueous extracts can complement each other. The primary active ingredient in neem, azadirachtin, can be stabilized and enhanced by adding *P. juliflora* extract to a neem oil microemulsion (Sharma *et al*., 2019).

To enhance the durability and efficacy of botanical insecticides, advanced formulation technologies are also being investigated. Plant-based pesticides can be made more effective by preventing photodegradation through methods such microencapsulation, nanoencapsulation, and the application of ultraviolet (UV) protectants (Sarmah *et al*., 2024). These methods have potential, however there are issues with cost, formulation stability, and large-scale implementation. Thus, it is crucial to comprehend both the benefits and drawbacks of these methods. Future studies should concentrate on enhancing the stability, distribution, and field performance of current plant-based pesticides in addition to finding novel botanical pesticides.

Conclusion

Aloe vera is a significant medicinal plant with a variety of phytochemical components that support its biological functions. Its antibacterial, insecticidal, and repellent qualities are mostly due to compounds like aloin, anthraquinones, phenolics, and saponins. *Aloe vera* extracts have been demonstrated in numerous experiments to lower feeding activity, repel insects, and cause larval mortality,

underscoring the plant's promise as a natural pest management technique.

Aloe extracts are a possible substitute for synthetic insecticides due to their strong repelling activity and environmentally friendly nature, even though their insecticidal effectiveness may be mild when compared to some other botanical pesticides. *Aloe vera*'s potential use in integrated pest management and sustainable agriculture is further supported by the conventional application of plant-based pest control techniques. *Aloe vera*'s promise as a safe and sustainable botanical pesticide will be further enhanced by future research that focuses on the separation of active components, the creation of better formulations, and field testing.

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