# EXPLORING THE POTENTIAL USE OF CHALCONES IN AGRICULTURE

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***Abstract****. Chalcones are naturally occurring flavonoid compounds and have recently been elucidated to display a vast spectrum of biological activities such as antifungal, antibacterial, herbicidal, and insecticidal activities. Due to their α, β-unsaturated carbonyl system their structure forms a basis for several bioactivities making them ideal in crop protection. This short review aims at discussing modern agricultural application of chalcones including synthesis and biological impact as well as the potential application in the future. As demand for environment friendly approaches to control pests and diseases are on the rise, chalcones offers a good chance of developing green agrochemicals.*

***Keywrods****: crop protection, green agrochemicals, organic farming methods.*

## Introduction

The requirement for green and organic farming methods is more crucial than before due to the increase in food production globally and the impacts of inorganic farming fertilizers on the environment. Chalcones belong to the flavonoids group and concerns have been raised based on the chemical constituents credited for various biological functions such as herbicidal, antifungal and insecticidal activities. Chalcones contain an aromatic ketone group with α, β–unsaturated carbonyl that enables the compound the flexibility of engaging with other biological systems.

Initially, chalcones were known and used for their pharmacological activities while current studies have revealed their vast prospect in the area of agriculture. The toxicity observed in chalcones on weeds and ability to inhibit fungal growth and also in controlling insect pests provide it as a promising agrochemical. Their availability in plant, biodegradable nature and non hazardous effect on other organisms is advantageous compared to synthetic pesticide and herbicides.

Modern practices in agriculture, especially in developed countries, use synthetic forms of chemicals to guard crops against from pests, diseases and competition from weed. But the onset of these chemicals has resulted in some complications such as pollution of the environment, destruction of species in the ecosystem, emergence of species that are resistant to the chemicals besides adverse effects on the health of both humans and animals. This driven the researchers to look for better and safer form of agricultural use from natural products like chalcones.

Although the biological activities of chalcones are well documented, the potentials of chalcones in agriculture have not been fully harnessed. Some of the concerns that have been raised include the lack of field studies to determine their effectiveness, toxicity effects on organisms other that pests and diseases that can be controlled by the fungicides and the costly synthesis and application of the fungicides.

The following are the potential application of chalcones.

Herbicidal Activity: Chalcones have been demonstrated to possess huge prospects in the formulation of herbicides mainly for weeds. They are known to interfere with cell processes including microtubule polymerization and mitochondrial function and therefore their modes of inhibiting plant growth. Chalcones have been known to cause plant PCD, a phenomenon that kills

weeds without affecting crop plants. They are also biodegradable since they are selective intheir action to the weed species hence reducing the impact of other non-target organisms.

Antifungal Properties: The antifungal properties of chalcones are highly effective in controlling crop diseases caused by fungi. Some research conducted have indicated that chalcones possess the ability to reduce germination of the spore of the fungi such as Fusarium and Phytophthora besides interrupting synthesis of cell wall in the fungi. It mitigates the use of synthetic fungicides which poses threat to the environment and increases the chances of developing resistant fungal species.

Insecticidal Applications: Chalcones also has insectical activity, they affect various insect pests by modulating the nervous system or the reproductive apparatus. Among chalcone derivatives, some compounds possess acetylcholinesterase inhibitory effect, which is crucial for regulation of insect nervous systems. This results into stinging, paralysis and lastly death of the pest making it an organic solution to synthetic insecticides.

Antibacterial Effects: The antibacterial activity of chalcones can also be applied in agriculture to combat bacterial pathogens responsible for diseases in crops. Chalcones interfere with bacterial cell walls and metabolic pathways, effectively inhibiting the growth of harmful bacteria. This provides an alternative to synthetic bactericides, which often contribute to environmental toxicity.

The table 1 shows the chemical structure and biological activities of some important chalcones.

| Chalcone Name | Chemical Name | Biological Activities | Reference |
|---|---|---|---|
| Licochalcone A | 3-[4-(2,2-Dimethylpyran-5-yl)oxy]phenyl-1-(2,4-dihydroxyphenyl)propenone | Antifungal, antibacterial, insecticidal activity | (1) |
| Xanthohumol | 3-[3,4-(Dimethoxyphenyl)]-1-(4-hydroxyphenyl)propenone | Antimicrobial, antiviral, anti-inflammatory, and herbicidal effects | (2) |
| Isobavachalcone | 2'-Hydroxy-4',6'-dimethoxychalcone | Insecticidal, fungicidal, and plant growth regulation | (3) |
| Cardamonin | 2′,4′-Dihydroxy-6′-methoxychalcone | Antifungal, antibacterial, antioxidant, herbicidal | (4) |
| Butein | 3,4,2′,4′-Tetrahydroxychalcone | Antioxidant, antifungal, insecticidal activity | (5) |
| Flavokawain A | 4′-Hydroxy-6′-methoxychalcone | Antifungal, antibacterial, insecticidal, and nematicidal activity | (6) |

| | | | |
|---|---|---|---|
| Echinatin | 4,4′-Dihydroxy-2′-methoxychalcone | Antioxidant, antibacterial, insecticidal | (7) |
| Chalcone-4-Methyl Ether | 4′-Methoxy-1-phenyl-3-(4-methoxyphenyl)propenone | Herbicidal, antifungal, and insecticidal | (8) |

***Table 1 Chemical structure and biological activities of some important chalcones.***

Future Aspects

The future of chalcones in agriculture appears promising, but several research gaps need to be addressed. Key areas for future exploration include:

Field Trials: While chalcones have shown bioactivity in laboratory conditions, field trials are necessary to validate their efficacy in real-world agricultural environments. This would help determine optimal concentrations, application methods, and the persistence of their bioactive effects.

Formulation Development: Developing stable formulations that enhance the bioavailability and stability of chalcones is crucial for their practical application in agriculture. Encapsulation technologies, such as nanoparticles, could improve their solubility and reduce degradation in field conditions..

Toxicity Studies: Comprehensive toxicity assessments are needed to ensure that chalcones do not adversely affect non-target organisms, such as beneficial insects, soil microbes, and humans. Understanding their environmental impact and biodegradability is critical for their approval as sustainable agrochemicals.

Cost-Effective Synthesis: Although chalcones can be synthesized relatively easily, large-scale production for agricultural use will require cost-effective and environmentally friendly synthesis methods. Advances in green chemistry and biotechnology could provide solutions to this challenge

Conclusion

Chalcones offer a sustainable and eco-friendly alternative to synthetic agrochemicals in agriculture. Their diverse bioactivities, including herbicidal, antifungal, antibacterial, and insecticidal properties, make them versatile agents for crop protection. However, further research is necessary to optimize their use, ensure their safety, and develop effective formulations for large-scale application. With continued development, chalcones could become an integral part of future agricultural practices, contributing to global food security and environmental sustainability.

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