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MIXED LIGAND COMPLEXES OF ZINC AND THEIR ENTOMOLOGICAL STUDIES

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ABSTRACT
The current manuscript summarizes the insect toxicology and entomological efficacy of some newly synthesized mixed ligand complexes of Zinc against *Spodoptera litura* and *Tetranychus sp.* The results clearly indicate them as potential insecticidal agents.
Keywords: Mixed Ligand, Zinc, Toxicological, and Entomological Activities.
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INTRODUCTION

The study on insect and pest management is an important area with a perspective to saving crops from insects, pests, and mites.[1] They affected society by spreading a number of diseases like malaria, dengue, and cholera in addition to painful bites.[2] Sometimes they may be beneficial such as honey bees which give us honey and silkworm which provide us with silk. Insecticide is mainly a substance intended for killing, repelling, or otherwise preventing treated surfaces from insects.[3] The use of insecticides started with the discovery of Paris green[4] and other inorganic chemicals.[5] There are a large number of organic[6] and metal organic[7] compounds that made a revolutionary change in insect and pest management like phenolics[8] and carbamates[9] but later on, metal-based insecticides made a new revolution in entomology.[10] The current manuscript summarizes the insect toxicology and entomological efficacy of some newly synthesized mixed ligand complexes of Zinc against *Spodoptera litura* and *Tetranychus sp.*

EXPERIMENTAL

The mixed ligand complexes of Zinc were synthesized and characterized by sophisticated instrumental analysis[11] for their toxicology and entomological activities.

Insect Toxicological Studies

Contact Toxicity

The topical application method[12] was applied for contact toxicity against larvae of *Spodoptera litura*. The test complexes were dissolved in acetone followed by the preparation of different concentrations *viz*., 0.06%, 0.12%, 0.25%, 0.50%, and 1.00%, which were applied on the dorsal surface of the larvae. Some larvae of insects were treated by acetone alone works as a control. The mortality data recorded after 24 hrs were used for the calculation of LC_{50}/LD_{50} using the Maximum Likelihood program MLP 3.01.

Stomach Toxicity

The leaf dip method[13] was used to study against larvae of *Spodoptera litura* by maintaining three replications for each concentration in acetone *viz*. 0.06%, 0.12%, 0.25%, 0.50%, and 1.00%. The discs of caster leaf dipped in various concentrations of the test compounds were used. The mortality data recorded after 24 hrs were used for the calculation of LC_{50}/LD_{50} using the maximum likelihood program, MLP 3.01.

Antifeedant Activity

The leaf dip method[13] was used to study against larvae of *Spodoptera litura* by maintaining three replications for each concentration in acetone *viz*. 0.06%, 0.12%, 0.25%, 0.50%, and 1.00%. The discs of

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caster leaf dipped in various concentrations of the test compounds were used. The insects were allowed to feed for 24 hrs, after that area uneaten was measured by a leaf area meter. The difference in leaf area provided and uneaten is taken as the amount of leaf area consumed. The feeding inhibition was used for the calculation of effective concentration (EC_{50}/LD_{50}) using the maximum likelihood program, MLP 3.01.

Acaricidal Activity

This activity was carried out by leaf dip method[13] wherein different concentrations of complexes were prepared *viz*. 0.001%, 0.005%, 0.05%, 0.1%, 0.5% using 0.2% tween 20 as emulsifier. Leaf discs dipped in different concentrations were placed over wet cotton in Petridis. The mites were released on treated leaf discs followed by the calculation of mortality data after 48 hrs, which was used for the calculation of LC_{50}/LD_{50} using the maximum Likelihood Programme (MLP). 3.01.

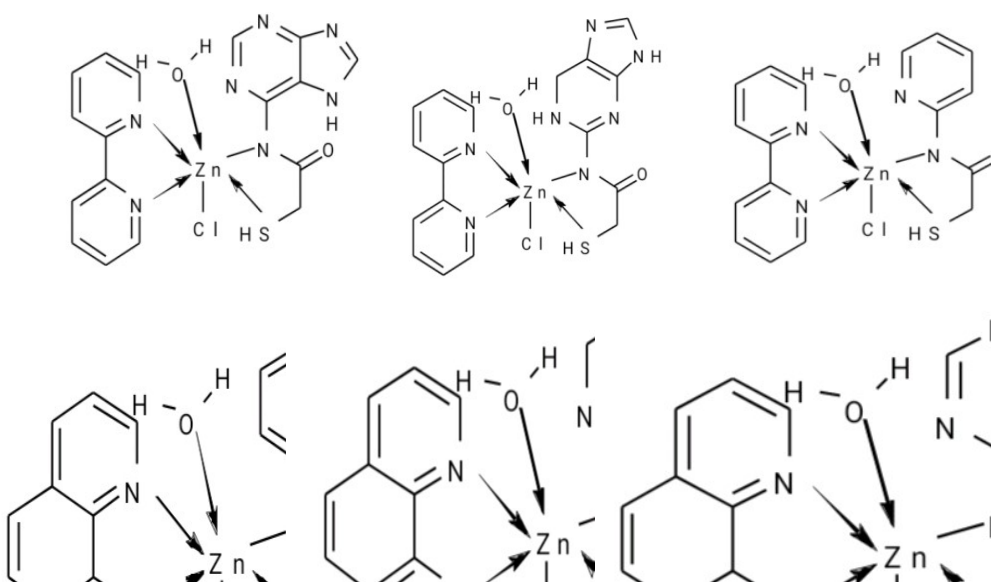

Fig-1: Structure of Mixed Ligand Complexes of Zinc

RESULTS AND DISCUSSION

The newly synthesized complexes were soluble in organic solvents, dissolve readily in acetic acid and decompose above 150°C.

Contact Toxicity

The toxicity results show that complex 3, 4, and 5 have higher efficacy against the larvae while the rest of the complexes have moderate efficacy. The variation in toxicity is generally reported on the basis of ligands. The freshly prepared emulsion by adding *tween-20* affects the nervous systems of the insect and causes the death of the insects.

Stomach Toxicity

The stomach toxicity of the mixed ligand complexes shows that complexes 3, 4, and 8 show low values of toxicity while the rest of the compounds show high toxicity against the insect. The presence of different moieties as ligands alters the activity and ultimately changes the toxicity against the insect by affecting the mucosal lining of the stomach.

Antifeedant Activity

The mixed ligand complexes of Zn were found highly effective against the *Spodoptera litura* in different concentrations. The variation in antifeedant activity is generally found due to variation in ligands.

Acaricidal Activity

The acaricidal efficacy was found greater in complexes 4 and 7 while the rest of the complexes show moderate activity. The variation in the acaricidal activity of these compounds is generally based on the nature of the ligand. Some of the ligands lower the toxicity of the metal ion. In this case, the compounds were used as emulsions by adding tween 20 as an emulsifier.

Table-1: Contact Toxicity on Insect

S. No.	Compounds	Fiducial Limits	Slop ±	Chi. Sq. (3)	LC_{50}/LD_{50} at 24 hrs.
1.	$C_{17}H_{17}ClZnN_4O_2S$	1.61–2.54	1.17±0.19	0.22(3)	2.37
2.	$C_{17}H_{16}ClZnN_7O_2S$	0.92–2.60	11.11±0.16	0.26 (3)	1.36
3.	$C_{17}H_{18}ClZnN_7O_2S$	0.41–0.61	1.63±0.15	1.84 (3)	0.49
4.	$C_{16}H_{16}ClZnN_5O_3S$	0.40–0.60	1.58±0.15	0.72 (3)	0.48
5.	$C_{19}H_{17}ClZnN_4O_2S$	0.69–1.32	1.40±0.67	1.67(3)	0.90
6.	$C_{19}H_{16}ClZnN_7O_2S$	1.72–7.94	1.31±0.21	0.16 (3)	2.93
7.	$C_{19}H_{18}ClZnN_7O_2S$	2.37–32.67	0.95±0.19	0.61(3)	5.38
8.	$C_{18}H_{16}ClZnN_5O_3S$	0.41–0.61	1.63±0.15	0.26 (3)	1.36

Table-2: Stomach Toxicity

S. No.	Compounds	Fiducial Limits	Slop ±	Chi. Sq. (3)	LC_{50}/LD_{50} at 24 hrs.
1.	$C_{17}H_{17}ClZnN_4O_2S$	1.65–6.93	1.35±0.21	0.29 (3)	2.75
2.	$C_{17}H_{16}ClZnN_7O_2S$	1.69–7.75	1.28±0.21	0.38 (3)	2.89
3.	$C_{17}H_{18}ClZnN_7O_2S$	0.44–0.67	1.65±0.16	3.89 (3)	0.53
4.	$C_{16}H_{16}ClZnN_5O_3S$	0.44–0.67	1.69±0.16	3.30 (3)	0.53
5.	$C_{19}H_{17}ClZnN_4O_2S$	2.49–3.65	0.93±0.18	0.501 (3)	5.88
6.	$C_{19}H_{16}ClZnN_7O_2S$	1.47–5.17	1.38±0.21	0.35 (3)	2.33
7.	$C_{19}H_{18}ClZnN_7O_2S$	1.88–14.44	1.01±0.18	1.06 (3)	3.70
8.	$C_{18}H_{16}ClZnN_5O_3S$	0.45–1.09	0.87±0.13	1.71 (3)	0.64

Table-3: Antifeedant Activity

S. No.	Compounds	Fiducial Limits	Slop ±	Chi. Sq. (3)	LC_{50}/LD_{50} at 24 hrs.
1.	$C_{17}H_{17}ClZnN_4O_2S$	0.32–0.53	1.15±0.14	7.53 (3)	0.40
2.	$C_{17}H_{16}ClZnN_7O_2S$	0.25–0.40	1.17±0.14	7.23 (3)	0.31
3.	$C_{17}H_{18}ClZnN_7O_2S$	0.64–1.16	1.47±0.16	3.73 (3)	0.83
4.	$C_{16}H_{16}ClZnN_5O_3S$	0.37–0.63	1.18±0.14	2.36 (3)	0.47
5.	$C_{19}H_{17}ClZnN_4O_2S$	0.21–0.32	1.31±0.14	5.70 (3)	0.25
6.	$C_{19}H_{16}ClZnN_7O_2S$	0.33–0.61	1.00±0.13	0.68 (3)	0.43
7.	$C_{19}H_{18}ClZnN_7O_2S$	0.45–1.09	0.87±0.13	1.71 (3)	0.64
8.	$C_{18}H_{16}ClZnN_5O_3S$	0.68–1.72	1.03±0.14	0.66 (3)	0.98

Table-4: Acaricidal Activity

S. No.	Compounds	Fiducial Limits	Slop ±	Chi. Sq. (3)	LC_{50}/LD_{50} at 24 hrs.
1.	$C_{17}H_{17}ClZnN_4O_2S$	0.12–0.30	0.78±0.88	1.70 (3)	0.18
2.	$C_{17}H_{16}ClZnN_7O_2S$	0.14–0.31	0.96±0.09	7.52 (3)	0.20
3.	$C_{17}H_{18}ClZnN_7O_2S$	0.12–0.30	0.80±0.08	6.91 (3)	0.18
4.	$C_{16}H_{16}ClZnN_5O_3S$	0.01–0.02	1.03±0.07	25.30 (3)	0.02
5.	$C_{19}H_{17}ClZnN_4O_2S$	0.10–0.23	0.88±0.08	2.14 (3)	0.15
6.	$C_{19}H_{16}ClZnN_7O_2S$	0.03–0.06	0.76±0.07	15. 89 (3)	0.40
7.	$C_{19}H_{18}ClZnN_7O_2S$	0.06–0.10	1.24±0.10	14.27 (3)	0.08
8.	$C_{18}H_{16}ClZnN_5O_3S$	0.16–0.37	0.09±0.09	8.28 (3)	0.23

CONCLUSION

The toxicological efficacy of mixed ligand complexes of Zinc was found potentially effective against insects, pests, and mites using *tween-20* as an emulsifier. The result indicates their potential applications in the protection and management of Indian crops.

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CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest.

AUTHORS CONTRIBUTION

All the authors contributed significantly to this manuscript, participated in reviewing/editing, and approved the final draft for publication. The research profile of the authors can be verified from their ORCID ids, given below:

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