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Research Article

STUDY OF PLANT REGULATORY ACTIVITY OF 2-METHOXY-6-[(1-NAPHTHALEN-1-YL-ETHYLIMINO)-METHYL]-PHENOL AND ITS TRANSITION METAL COMPLEXES ON *TRIGONELLA FOENUM-GRAECUM*, *TRITICUM AESTIVUM* AND *BRASSICA NIGRA*

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ABSTRACT

A Schiff base ligand and its transition metal complexes were synthesized. Plant growth regulating activity on seeds of *Trigonella foenum-graecum* (methi), *Triticum aestivum* (wheat) and *Brassica nigra* (black mustard) has been studied using standard Blotter method for evaluation of inhibitory or stimulatory effects of the synthesized compounds. The plant growth analysis was decided by measurement of parameters like percentage of germination, shoot length, root length, root/shoot ratio and vigor index. The values of these parameters have been used to make a conclusion about plant growth regulating activity of ligand and its complexes.

Keywords: Schiff bases, Metal Complexes, Plant growth studies, Standard Blotter method

1. INTRODUCTION

Agricultural research involves production of new and better varieties of crop plants, plant protection against insects and weeds, manage soil fertility. Many natural and synthetic substances are found to induce same plant responses. In this context coordination chemistry plays a significant role. Many transition metal complexes are been used to produce new varieties of crops, control soil fertility, protect the plants from insects, diseases and weeds [1-3]. Plant growth regulating activity of complexes of transition metal ions [4, 5] and inner transition metal ions [6] has been reported. The effect of Chromone complexes have been studied on germination, survival, seedling height action spinach plant [7]. Schiff bases are versatile ligands and therefore their compounds and metal complexes hold lot much of promise in various fields including agrochemicals [8, 9]. The biological properties of some rare earth complexes and physiological effects of transition metal complexes on *Hordeum vulgare* [10] have been reported. The effect of Benzothiazolyl hydrazones and naphtha thiazolyl hydrazones on seed germination was studied for the seeds of various plants [11]. The metal complexes of a few substituted isoxazolines and pyrazolines with transition metals have been studied for their plant growth regulatory activity for *Cicer arietinum* and *Hibuscus esculentus* [12] *Triticum aestivum* (wheat) and *Trigonella foenum-graecum* [13, 14]. Transition metal complexes are used to produce new varieties of crops, improve the quality of plants, and protect the plants from insects, diseases and weeds [15]. Schiff base complexes of transition metals were shown to have plant regulatory activity for *Triticum aestivum* and *Trigonella foenum-graecum* [16].

2. MATERIAL AND METHODS

2.1. Chemicals and reagents

The chemicals used are 1-Naphthalen-1-yl-ethylamine (Merck, AR grade) and o-Vanillin (Merck, AR grade), Ethyl alcohol (Merck, AR grade), Cobalt (II) chloride dihydrate (Sigma Aldrich), Nickel(II) chloride hexahydrate (Sigma Aldrich), Copper(II) chloride dihydrate (Sigma Aldrich), Zinc (II) chloride (Sigma Aldrich), Manganese (II) chloride tetrahydrate (Sigma Aldrich)

2.2. Synthesis of Ligand

The Schiff Base ligand 2-Methoxy-6-[(1-naphthalen-1-yl-ethylimino)-methyl]-phenol (Fig. 1) was synthesized by condensing amine 1-Naphthalen-1-yl-ethylamine with o-Vanillin in equimolar proportions. To an ethanolic solution (10 ml) of the amine (0.01 mole) was added o-Vanillin (0.01 mole) in ethanol (10 mL) with stirring. The mixture was then refluxed for 30 mins. The reaction mixture was then cooled which immediately gave a precipitated product. The product then obtained was filtered, washed with ethanol and then dried. The crude product was then crystallized from aqueous ethanol to give a yield of 86%.

2.3. Synthesis of metal complexes:

The ligand and metal salt in the molar ratio of 2:1 was dissolved in ethanol and the reaction mixture was heated on water bath for about one hour. It was then cooled when colored solid separated out which was washed with ethanol and dried. This is the general method employed for the synthesis of metal complexes of ligand with metal chlorides viz Ni(II), Cu(II), Co(II), Mn(II) and Zn(II) (Fig. 1).

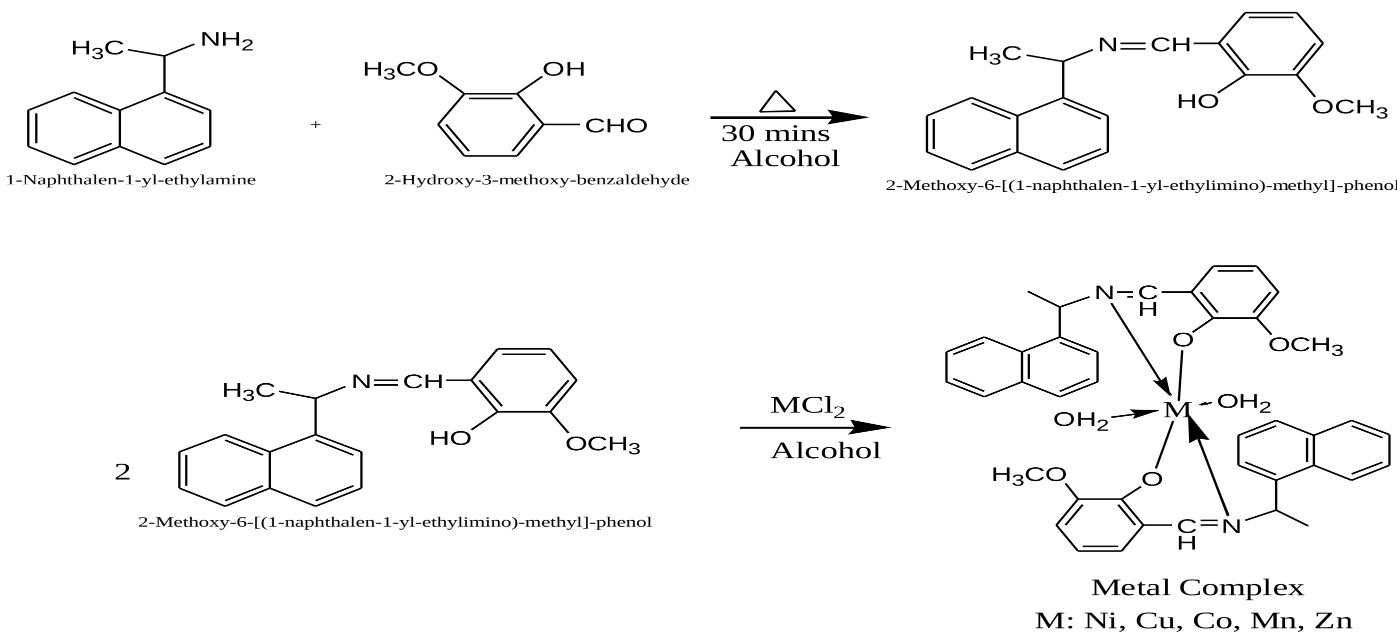

Fig. 1: Synthesis of ligand and metal complex

3. RESULTS AND DISCUSSION

In NMR spectra, formation of ligand was confirmed by presence of CH=N peak at δ 8.7 and OH at δ 5.5 [17]. The IR spectra of the metal complexes [17] show considerable shift in the νC=N of extra nuclear C=N linkage from 1642.09 cm-1 to 1615-1632 cm^{-1}, which indicates the involvement of the same in the bonding. All complexes showed bands 3300 cm^{-1} to 3400 cm^{-1} indicating coordinated H_2O moiety in the complexes and medium to weak intensity bands in the regions 505-673 cm^{-1} and 437-486 cm^{-1} which may be attributed to M-N and M-O stretching vibrations respectively confirming the bonding through azomethine nitrogen and oxygen atom of the deprotonated -OH groups on the Schiff base. The electronic absorption spectra of the Schiff base in DMSO solution in the ultraviolet range show two high intensity peaks at 35842 cm^{-1} and 30211 cm^{-1} due to intra ligand transitions assignable most probably to $n \rightarrow \pi^*$ and $\pi \rightarrow \pi^*$ electronic transitions. The shift in position of intra ligand transitions and d-d transitions in all these complexes shows that there is π interaction between the metal and the ligand orbitals. Conductivity measurements indicate that the complexes are non-electrolytic nature [18]. The Molar conductance values for all the newly synthesized complexes were in the range 30 mhos cm^2 mol^{-1} to 85 mhos cm^2 mol^{-1}, indicating very low conductance. The XRD of the complexes [18] gave different crystal lattices where the Ni (II) complex, Cu (II) complex, Mn (II) complex and Zn (II) complex shows orthorhombic crystal system whereas Co (II) complex shows a cubic crystal system.

3.1. Plant Growth Activity study

The seeds of equal size of the three plants *Trigonella foenum-graecum* (Methi), *Triticum aestivum* (wheat) and *Brassica nigra* (black mustard) were selected. Further metal complex solutions (5 ppm) and ligand solution (5ppm) were prepared using 20% DMSO solution in doubly distilled water. Approximately 80 to 100 seeds were soaked in water and for 4 hours; from these, healthy seeds of equal size were chosen, out of which 20 seeds each were immersed in distilled water, DMSO, complex solutions. Healthy seeds of equal size were chosen, and then immersed in distilled water, 20 % DMSO solution, ligand solution and complex solutions for 6 hours. The soaked seeds were further washed thoroughly with distilled water. All the seeds were planted using standard Blotter method with 20 seeds per plate in Petri plate containing moistened blotters. The plates were observed for germination, % survival, and root length, shoot length, root/shoot ratio and vigor index for 10 days. The results of the plant growth activity are summarized in Table 1 for *Trigonella foenum-graecum*, Table 2 for *Triticum aestivum* and Table 3 for *Brassica nigra* (black mustard) plant.

Table 1: Growth parameters for *Trigonella foenum-graecum* (Methi)

Treatment	% Germination	Fresh Wt. (gm)	Dry Wt. (gm)	Shoot Length (cm)	Root Length (cm)	Vigor index	Protein (μg/ml)	Carboh -ydrate
Ligand	85	0.51	0.018	2.8	4.0	578	400	17.0
NEMP-Ni	60	0.47	0.016	2.0	3.5	330	370	18.0
NEMP-Cu	60	0.46	0.014	2.3	3.0	318	375	14.0
NEMP-Co	55	0.47	0.017	2.0	2.8	264	370	15.0
NEMP-Mn	55	0.50	0.018	2.3	2.9	286	355	17.0
NEMP-Zn	60	0.48	0.014	2.0	2.7	240	400	16.0
Water	90	0.65	0.018	3.0	4.4	666	500	19.0
Cytokinin	80	0.53	0.016	3.7	5.1	792	600	14.2
Gibberellic acid	90	1.13	0.020	4.2	3.7	711	600	18.0
Indole acetic acid	60	0.71	0.021	5.1	3.4	510	450	20.0

Table 2: Growth parameters Triticum aestivum (wheat)

Treatment	% Germination	Fresh Wt. (gm)	Dry Wt. (gm)	Shoot Length (cm)	Root Length (cm)	Vigor index	Protein (μg/ml)	Carboh-ydrate
Ligand	90	0.52	0.015	2.1	3.5	504	430	19.0
NEMP-Ni	85	0.37	0.014	1.7	3.4	357	360	17.0
NEMP-Cu	70	0.44	0.013	1.9	3.2	382	385	14.0
NEMP-Co	85	0.45	0.014	1.3	3.3	391	375	16.0
NEMP-Mn	75	0.51	0.017	1.5	3.1	345	350	16.0
NEMP-Zn	65	0.38	0.015	1.0	3.2	273	420	15.0
Water	100	0.60	0.018	2.8	4.5	730	490	18.0
Cytokinin	100	0.54	0.015	2.7	5.2	790	550	14.0
Gibberellic acid	90	0.62	0.021	4.3	4.2	765	610	18.0
Indole acetic acid	80	0.68	0.022	4.1	3.6	616	550	19.0

Table 3: Growth parameters for *Brassica nigra* (black mustard)

Treatment	% Germination	Fresh Wt. (gm)	Dry Wt. (gm)	Shoot Length (cm)	Root Length (cm)	Vigor index	Protein (μg/ml)	Carboh-ydrate
Ligand	80	0.45	0.018	3.2	1.7	392	420	19.0
NEMP-Ni	75	0.37	0.017	2.4	1.1	265	360	18.0
NEMP-Cu	75	0.46	0.017	2.0	1.2	240	385	14.0
NEMP-Co	80	0.45	0.016	1.2	0.8	160	375	16.0
NEMP-Mn	85	0.48	0.014	1.8	1.0	238	350	16.0
NEMP-Zn	70	0.45	0.015	1.9	1.2	217	420	15.0
Water	95	0.68	0.017	3.6	2.2	551	490	18.0
Cytokinin	90	0.63	0.014	3.5	2.2	513	550	14.0
Gibberellic acid	90	0.54	0.019	4.0	3.2	648	610	18.0
Indole acetic acid	80	0.64	0.019	3.8	2.6	512	550	19.0

4. CONCLUSION

The carbohydrate content for the three plant seeds was comparatively similar to the standards. Ligand showed higher carbohydrate content for all the three plant seeds as compared to the standards. The complexes followed a similar pattern. It was observed that the root: shoot ratio for the ligands is higher than the complexes for all the three seeds under investigation. The ligands showed better activities than the complexes. This could be concluded that the synthesized complexes have plant inhibitory activity. However, this property of the synthesized compounds was obtained under the controlled conditions of the laboratory; and there is always a scope of verifying the activities in open field.

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