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Physiochemical Studies and the effect of Fe (III) Schiff base chelate on the Germination of the Ggazone (Cynadon) seeds

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Abstract: Iron (III) chelate of a Schiff base formed from the condensation of salicylaldehyde and threonine amino acid has been synthesized in excellent yield and characterized by using different physiochemical tools in terms; CHN elemental analysis, molar conductivity, infrared, electronic and electron paramagnetic resonance spectra. The CHN elemental analysis data showed the formation of 1:1 [M:L] ratio. The molar conductivity value revealed the existence of this chelate in non-electrolytic nature. The infrared spectral data displayed the coordination sites of the Schiff base under investigation towards Fe(III) ion. The electronic spectral results exhibited the $\pi \rightarrow \pi^*$(phenyl ring), $n \rightarrow \pi^*$ (HC=N) transition and the obtained results confirmed the presence of an octahedral structure for the chelate. The electron paramagnetic resonance spectral data supported the results which obtained from the electronic transitions. The synthesized free Schiff base, Fe (III) ion and Fe (III) chelate affected on germination of the root and shoot lengths of gazone (Cynadon) seeds.
Keywords: F(III) ion, salicylaldehyde, threonine, Schiff base, chelate, germination.

Introduction

Salicylaldehyde compound has many applications in chemistry and medicine, and it has a good ability to form large number of chelates with most non-transition and transition metal ions.(1) The complexes of Mn(III) with Schiff bases obtained by condensation of 2-hydroxynaphthaldehyde with glycine, L-alanine, L-phenylalanine, L- histidine, L-tryptophan and threonine have been synthesized and characterized by different physiochemical techniques.(2) The synthesis and characterization of La(III) and Y(III) ions benzimidazole-2-acetic acid are reported and characterized by different physical tools. The effect of La(III) complex on germination, coleoptite and root length of two local varieties of wheat DWR-195 and GW-349 for different treatment periods has been investigated. The complex was found to exhibit enhanced activity, compared to the free ligand or La(III) salt alone at lower treatment periods has been investigated.(3)

This study aims to synthesis, characterization of the Schiff base and its iron (III) chelate. Also to show the effect of the chelate on the germination of gazone seeds.

Experimental

All chemicals and reagents used in this investigation are of pure grade.

Synthesis of the Schiff base

The amino Schiff base was synthesized as following : NaOH (10 mmole;0.4 g) was dissolved in 30 cm^3 of methanol and threonine (10 mmol; 1.2 g) was added to it, and then the mixture was stirred magnetically at room temperature. When the mixture becomes homogenous, a solution of salicylaldehyde (10 mmole; 1.22 g) in 30 cm^3 of ethanol was added. After 2 minutes, the solution was evaporated by 20% of its original volume and 1 cm^3 of acetic acid was added immediately. After two hours, yellow crystals appeared. The crystals were filtered, washed, dried and recrystallized from hot methanol to give pure yellow crystals in excellent yield of 86%.

Synthesis of iron (III) chelate

The threonine (1.20 g) was dissolved in 30 cm^3 of methanol containing NaOH (0.4 g) in conical flask and strirred at ambient temperature. A solution of salicylaldehyde (1.22 g) in 30 cm^3 of ethanol was added to the mixture, and then 30 cm^3 of ethanolic $FeCl_3.6H_2O$ (2.71 g) solution was added to the mixture and stirred for three hours at 80 ^{0}C. The obtained precipitate was then filtered off, washed with water and hot ethanol. The precipitate was dried in a vacuum dessicater.

Measurements

The melting points of the synthesized Schiff base and the iron (III) chelate are 267 and >250^0 C, respectively. The Schiff base and its chelate were subjected to elemental analysis using 2400 CHN elemental analyzer. The molar conductivity of the chelate was measured in DMSO solvent using digital conductivity meter CMD 650, at chemistry department, Garyounis University, Benghazi, Libya. The infrared spectra of the Schiff base and its chelate were carried out applying KBr disc technique using IFS-25 DPUS/IR spectrometer (Bruker). The electronic spectra of the Schiff base and its chelate were measured in $CHCl_3$ solvent by using a Perkin-Elmer lambda 4β spectrophoto meter. The electron paramagnetic resonance spectrum of the chelate was recorded by using EMX ESR spectrometer (Bruker) 1998Y. Elemental analysis, infrared, electronic and electron paramagnetic spectra were done at micro analytical centre, Cairo University, Giza, Egypt.

Germination assay

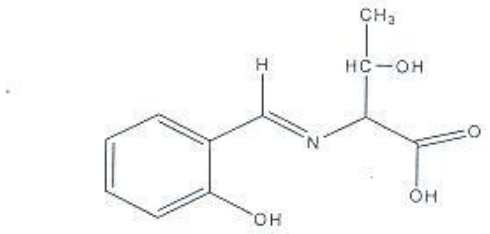
Gazone (Cynadon) seeds were arranged on petridishe contain two layers of filter paper (No.1), different concentrations (0.001, 0.01, 0.1 and 0.2 g/20ml of the Schiff base, Fe(III) ion and Fe(III) chelate were added to the seeds on the filter paper. The control seeds were irealid with distilled water. At the end of the experiment, the number of seed germination was counted and compared with control. Both length of root and shoot were measured and compared with the reference of root and shoot growth control.

Statistical analysis

The statistical evaluation of the results was conducted with use of SPSS (Statistical Package for Social Science; Windows version 6.0) packed program. One-way analysis of variance (ANOVA) used to analyze the results. The level of statistical significance was set up at $p < 0.05$.

Results and Discussion

The condensation of salicylaldehyde and threonine in methanol yields one amino acid Schiff base compound. The chemical equation concerning the formation of the compound represented as follows:



Elemental analysis and molar conductivity

The elemental analysis data of the synthesized Schiff base [C% 59.19 (60.65), H% 5.82 (6.10 and N% 6.27 (6.22)] and its Fe(III) chelate [C% 39.89 (39.84), H% 5.49 (5.70) and N% 4.27 (4.55)] reveal that the calculated values are in a good agreement with the experimental values. The low molar conductivity value of the chelate (16.00 Omh^{-1} cm^2 mol^{-1}) indicates a non-electrolytic nature.[4]

Infrared spectrum of the Schiff base and its Fe(III) chelate

The infrared spectrum of the Schiff base shows three bands at 1597, 1505 and 3108 cm^{-1} attributed to ν(HC=N), ν (COO-) and νOH vibrations.[5-7] Meanwhile, the spectrum of the chelate exhibit a band at 3222 cm^{-1} which could be due to the existence of water molecules as coordinated bonding.[8] Two bands at 1608 and 1645 cm^{-1} assigned to ν(HC=N) and ν(COO^-) vibrations, respectively. This shift of these bands to higher frequency compared to the free Schiff base indicating the involvement of nitrogen atom of azomethine and oxygen atom of carboxylic acid of the threonine in chelation with Fe(III) ion. The bands at 433 and 575 cm^{-1} which are not present in the free Schiff base are due to the existence of vibrations ν (M-N) and ν (M-O), respectively,[9] supporting the participation of both nitrogen and oxygen atoms in complexation.

Electronic and electron paramagnetic resonance spectra

The spectral data of the Schiff base show two bands at 280 and 345 nm (35714 and 28985 cm^{-1}), indicating the presence of $\pi \rightarrow \pi^*$ and $n \rightarrow \pi^*$ transitions, respectively.[10] During the formation of the Fe(III) chelate, two new bands are observed at 450 and 520 (22222 and 19230 cm^{-1}) corresponding to ^2A_2g (F)$\rightarrow$ ^2T_2g (F) and ^2A_2g (F)$\rightarrow$ ^2T_1g (F) transitions, and these transitions are consistent with an octahedral geometry.[11] The electron paramagnetic resonance spectral data of the Fe(III) chelate exhibit g_{eff} value of 2.020 which is deviated from the ideal value (2.0023) confirming the existence of an octahedral geometry.[12,13] This value supports the data which obtained from the electronic spectrum.

Seed germination, root and shoot growth

The Schiff base caused an increase of seed germination, root and shoot growth at concentration of 10^{-3} g/20ml) (Fig.1) compared to the control which caused growth all of the seeds after three days, and means of the root and shoot lengths were after six days reach to 7.292 and 5.100 cm, respectively. The Fe(III) chelate has no effect on the seed germination. Whereas, there is partially inhibition of the chelate on the root and shoot growths (plate). The statistical analysis shows significant results except when p = 0.85 at 0.001 g/ 20ml, fig.2.

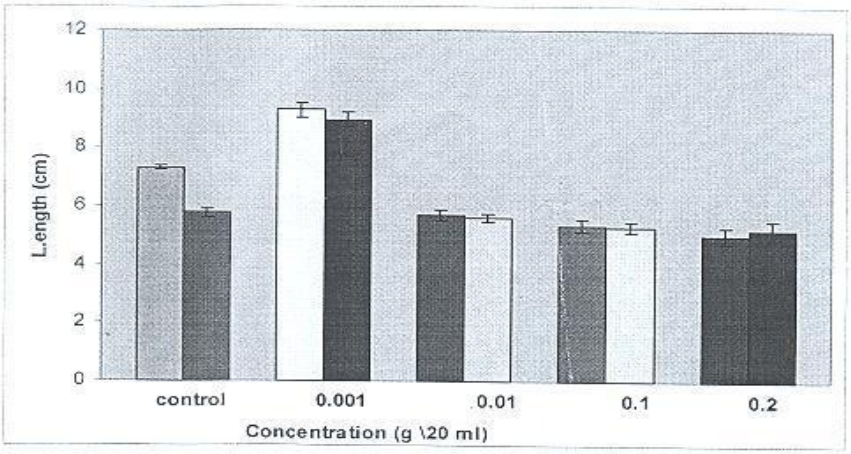


Fig. (1): Effect of Schiff base L_3 on gazone seeds at different concenrations. The data are means at 12 root and shoot lengths (cm) of each treatment and the bars are (SD). Note concentration (0.001 g\ 20ml) caused stimulation of root and shoot lengths compared with control.

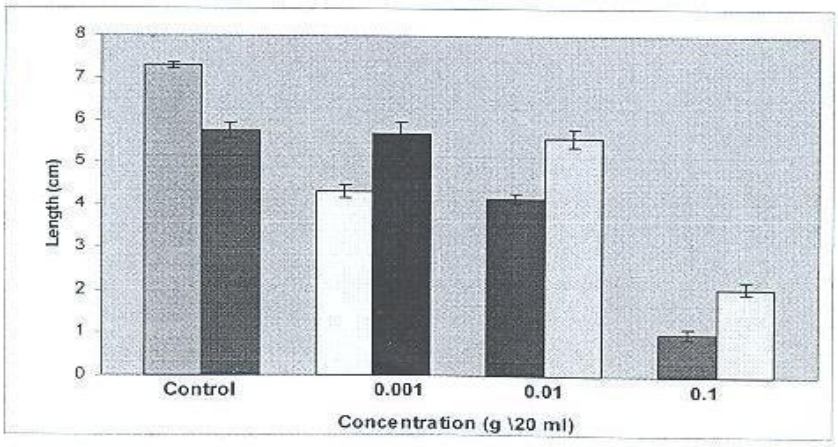
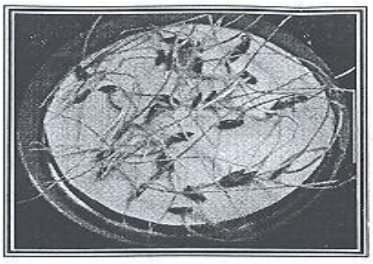
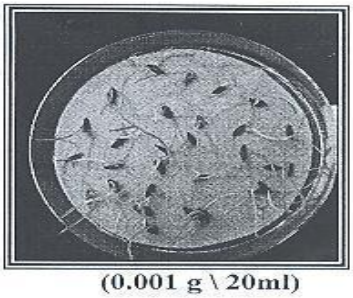


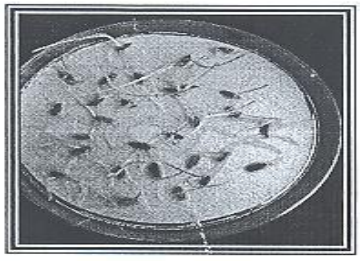
Fig. (2): Effect of Fe(III)-L_3 complex on gazone seeds at different concentrations. The data are means of 12 root and shoot lengths (cm) of each treatment bars are (SD). Note the extent of inhibition increased with rise of concentrations between (0.001, 0.01g\20ml) did not show any difference



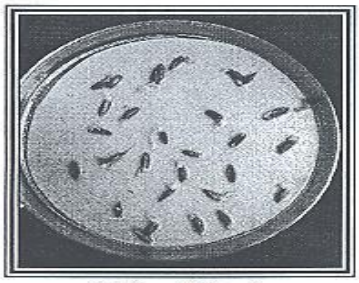
Control



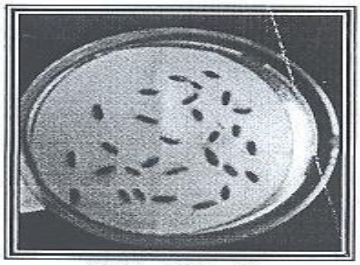
(0.001 g \ 20ml)



(0.01 g \20 ml)



(0.1 g \ 20ml)

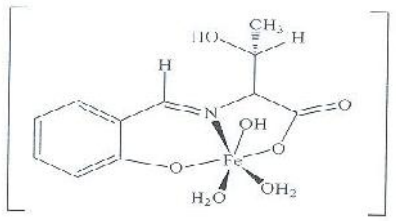


(0.2 g \20 ml)

Plate Effect of Fe(III)-L_3 complex on gazone seeds at different concentrations. Note the extent of the inhibition is increased with rise of concentration.

Conclusion

The above data suggest an octahedral geometrical structure for the synthesized Fe(III) Schiff base chelate. Also, there is an effect for free Schiff base on both Gazone (Cynadon) seeds, root and shoot growths. Whereas, the chelate has no effect on the germination of Gazone (Cynadon) seeds, but it has partially inhibition on the root and shoot growths. This is due to the nature of the free Schiff base and the Fe(III) chelate.



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