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# Activity of Newly Synthesized Inorganic Complexes against Pathogenic Bacteria

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## Abstract

Four inorganic complexes, namely, nickel, iron, manganese and chromium with N, N'-ethylene-bis (3-carboxypropenamide) [EBCPH2] and N,N'-Phenylene-bis(3-carboxypropenamide) [PBCPH2] ligands were newly synthesized and their structures were confirmed by UV-Visible and IR spectrum. They show high antibacterial activity against the human pathogenic bacteria, *Shigella dysentriae* and *Salmonella typhi*.

**Keywords:** antibacterial activity, inorganic complexes, *Shigella, Salmonella*

## INTRODUCTION

Bacteria are one of the interesting and important groups of microorganisms. The major infections caused by human pathogenic bacteria are tetanus, typhoid fever, diphtheria and syphilis. Information regarding inhibition of the activity of the bacteria, *Shigella dysentriae* and *Salmonella typhi* by synthesized inorganic complexes are scanty even though literature abounds with antibacterial activities of phytochemicals (Madsen and Pates, 1952; McCleary *et al.*, 1960; Banerjee and Sen, 1978; Latiff *et al.*, 1989; Basile *et al.*, 1999). Recently several scientists have reported various compounds such as unsaturated lipids, fatty acids, esters, phenolic etc., involved in antibacterial activity (Bergsson *et al.*, 1999; Inouye *et al.*, 2001). This paper describes the antibacterial activity of some newly synthesized inorganic complexes against selected Gram-positive (*S. dysentriae)* and Gram-negative (*S. typhi)* bacteria.

## MATERIALS AND METHODS

### Preparation of ligands

The ligands used for the syntheses of nickel, iron, manganese and chromium complexes were prepared by the following procedure.

### N, N'-ethylene-bis (3-carboxypropenamide) [EBCPH2]

Maleic anhydride (0.1 mole) was dissolved in glacial acetic acid (50 ml) and kept overnight. Ethylenediamine (0.05 mole) was then added dropwise with constant stirring under ice-cold condition. The white solid formed was filtered, washed several times with acetone, dried in air and recrystallised in aqueous ethanol.

### N,N'-Phenylene-bis(3-carboxypropenamide) [PBCPH2]

Maleic anhydride (0.1 mole) was dissolved in glacial acetic acid (50 ml) and kept overnight. 1,3-phenylenediamine (0.05 mole) was then added dropwise with constant stirring under ice-cold condition. The white solid formed was filtered, washed several times with acetone, dried in air and recrystallised in aqueous ethanol.

### Preparation of nickel(I), iron(II), manganese(III) and chromium(IV) complexes of [EBCPH2] and [PBCPH2]

An aqueous methanolic solution of 0.01 mole sodium salt of the ligand was added to 0.01 moles of nickel, iron, manganese and chromium salt solution. The resulting solution was refluxed on a water bath for about an hour. By cooling, the solid complex was separated and dried over calcium chloride.

### Isolation of Bacteria

The bacteria which are used for the inhibition studies were cultured from the human excreta of the persons affected with diarrhoea and typhoid in nutrient broth for 15 days. The serial dilution of the sample was made using sterile distilled water, the suspension was plated using nutrient agar (NA) medium and the plates were incubated at $37^0$C for 24 hours. The bacteria were isolated and identified from the plates.

### Antibacterial susceptibility assays

The newly synthesized inorganic complexes were tested against the 15 days batch cultured pathogenic bacteria, *Shigella dysentriae* and *Salmonella typhi* by disc diffusion method (Bauer *et al.* 1966). The observed zone of inhibition was compared with the zone of inhibition formed by standard antibiotic drug ciprofloxacin. This test is to find out whether both Gram-positive and Gram–negative organisms are equally susceptible to these compounds.

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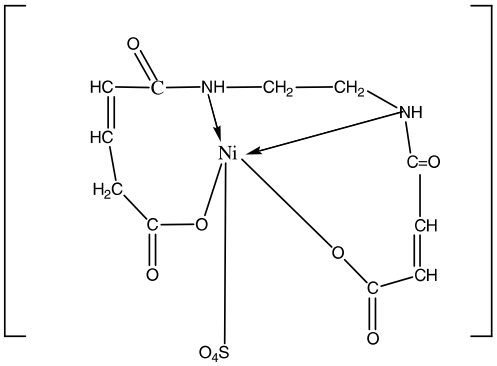
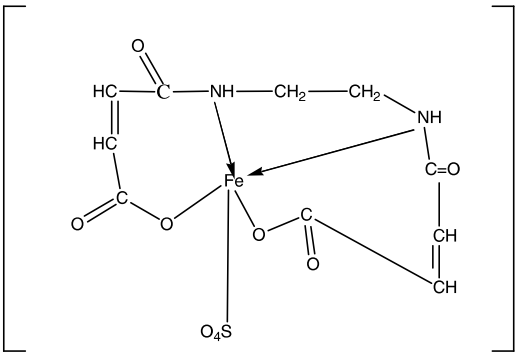
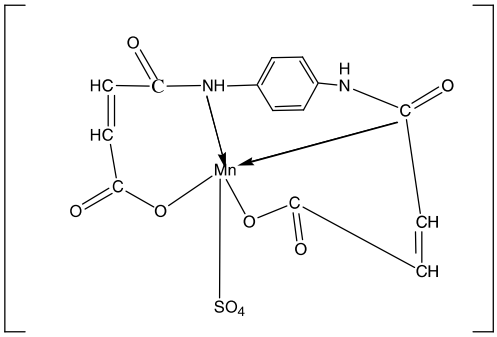


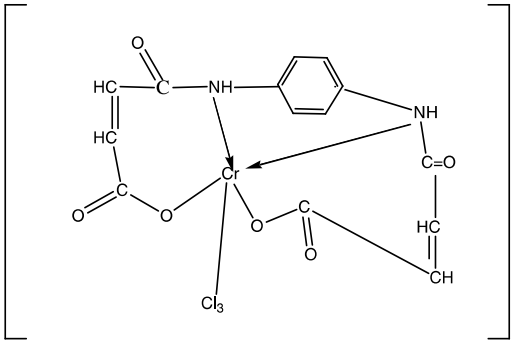
**Complex I**



**Complex II**



**Complex III**



**Complex IV**

**Figure 1.** Structures of newly synthesized complexes

**Table 1.** Antibacterial activity of the synthesized complexes

| S. No | Bacteria | Zone of inhibition in mm (mean values) (n=3) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Complex I (µg/ml) | | Complex II (µg/ml) | | Complex III (µg/ml) | | Complex IV (µg/ml) | | Ciprofloxacin | Control (Solvent ethanol) |
| | | 25 | 50 | 25 | 50 | 25 | 50 | 25 | 50 | 25 µg/ml | |
| 1. | *Shigella dysentriae* | 11 | 14 | 12 | 15 | 14 | 11 | 13 | 14 | 17 | 03 |
| 2. | *Salmonella typhi* | 15 | 19 | 12 | 15 | 12 | 13 | 13 | 15 | 19 | 03 |

## RESULTS AND DISCUSSION

The structures of the newly synthesized inorganic complexes (Fig. 1) were confirmed by UV-Visible and IR spectral studies.

The UV spectral λmax values assign the presence of the following groups in the complex (IV). The λmax value around 193 nm shows the presence of –CH=CH-COOH group. The λmax value around 260-280 nm shows the presence of benzene ring with –NH-CO linkage. The λmax value around 215 nm shows the presence of chromophores like -COOH, -CO, -OH groups. The λmax value around 360 nm confirms the presence of chromium complex (IV), which is formed by the strong ligand.

The IR spectrum of the chromium complex of [PBCPH2] (IV) shows a band 3413 $cm^{-1}$ and 989 $cm^{-1}$ indicating the presence of benzene ring. A band at 2365 $cm^{-1}$ shows the –NH stretching frequency. A band at 1567 $cm^{-1}$ is assigned for the –CO group of amide. Bands at 1240 $cm^{-1}$ and 1107 $cm^{-1}$ show the stretching –CO group. Above all, the bands at 1101, 1636, 3428 show the presence of chromium and chloride ion in the complex.

Thus the newly synthesized complexes were confirmed by UV-Visible and IR spectra data. For biological interest, the synthesized complexes were subjected to antibacterial screening by a disc diffusion method. All the four newly synthesized inorganic complexes, *viz.*, I, II, III and IV have been found to have antibacterial activities, as there were significant inhibition zones by their treatments against both Gram-positive and Gram-negative bacteria (Table 1).

All the synthesized complexes had more or less equal inhibition zones to the tested bacteria *viz., Shigella dysentriae* and *Salmonella typhi.* The antibacterial activity increased with the increase in the concentration of the complexes used (Table 1).

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