SYNTHESIS AND CHARACTERIZATION OF MIXED LIGAND COMPLEXES OFCOBALT WITH 1,10- PHENANTHROLINE AND SARCOSINE

***Samia Nawab, *Ammara Nazir, Yasra Naseer[3],Talib Hussain, Rana Amir Maqbool, Mohsin Rana**
Department of Chemistry, Minhaj University, Lahore, Pakistan.
*Corresponding author: samianawab@yahoo.com, ammara_nazir9@yahoo.com

ABSTRACT: *Two new coloured mixed ligand complexes of transition metal Cobalt ($_{27}Co$) with 1,10 – phenanthroline and Sarcosine (N – methyl glycine – an amino acid) as ligand have been prepared, using Methanol or Ethanol as a solvent in mole ratio (1: 2: 1) respectively, at room temperature. The complexes were synthesized by two methods, by magnetic stirring and by direct heating respectively. All the prepared complexes were characterized by analytical techniques i.e. UV / Visible spectroscopy and FTIR. The λ max was found to be 390 nm. FTIR spectral data suggested that bands due to (C = N) ring vibrations of 1,10 - phenanthroline appeared at 1515 $cm^{-1}$and 1514cm^{-1}respectively for complex –I and Complex – II. Stretching vibrations of (N – H) bond appeared at 3189-3152 for complex –I and 3046-3019cm^{-1} for Complex –II. Absorption bands due to $\upsilon(COO)^{-}_{sym}$ appeared at 1220cm^{-1} for Complex –I and at1217cm^{-1} for Complex –II . The bands due to (Co – N) bonds appeared for complex –I and Complex –II at 486cm^{-1} and 476cm^{-1} respectively, and (Co – O) bands for complex -I and Complex –II appeared at 514cm^{-1} and 520cm^{-1}respectively. The proposed geometry for both the complexes is octahedral.*

Key Words: Mixed - Ligand complexes, 1,10 – Phenanthroline, Sarcosine, Magnetic Stirring, FT – IR, spectral studies etc.

INTRODUCTION

The formation of mixed ligand complexes of certain transition metal ions like Cobalt, Nickel, Manganese, Zinc etc. with 1,10- phenanthroline and some biologicaly important amino acids like glycine, L-Valine and Sarcosine (N-methyl glycine) as lignds have great socio economic importance and unique significance in the field of biochemistry. The study of co-ordination chemistry of amino acids with transition metal ions like (Co^{+2}, Ni^{+2}, Zn^{+2}, Cu^{+2}, and Fe^{+2}) can evaluate the effects of substituent's on the α – carbon atoms of the amino acids, providing the information about anti-microbial and anti-bacterial activities of amino acids e.g. as it is evident from Sarcosine complexes with Cobalt and Zinc.**[1, 2]**

1,10 – Phenanthroline is a poly aromatic hetro cyclic compound.1,10- Phenanthroline (Phen) is a classic ligand in co-ordination chemistry, which couples in a very versatile manner with different metal atoms/ions to give different peculiar characteristics to the metal complexes formed by it e.g. metal complexes with (Phen) can be viewed to develop new molecular " Chromo sensors" for metal cations & anions, ionophores as well as new intercalating agents for polynucleotide's especially in case of DNA cleavage. It is widely used in analytical applications of metal complexes and acts as an efficient bidentate ligand with two donor Nitrogen atoms to form metal complexes.**[3,4]**

Sarcosine also known as (N - methyl glycine) is a natural amino-acid found in muscles and other body tissues. It is a weak acid having PKa value 2.36. Sarcosine is an intermediate and by-product in glycine synthesis and degradation. Sarcosine in the presence of an enzyme, Sarcosine dehydrogenase is converted into glycine, while another enzyme, Glycine - N- methyl transferase generates Sarcosine by degradation of glycine. Sarcosine is sweet in taste and can be dissolved in water however for laboratory purposes; it is preferred to dissolve in Methanol or aqueous Ethanol. It is found in biological materials and some foods like egg yolks, ham, legumes and vegetables in some animals like turkeys etc. Inside the human body sarcosine can be formed by the dietary intake of choline and by metabolic degradation of glycine. The concentration of sarcosine in blood serum of normal human beings is in the range of 1.4- ± 0.6 micro mol. It is very significant from clinical point of view. It is evident that sarcosine can increase intelligence, improve brain injury, muscle strength, athletic performance, power and shorten muscle recovery time.

Sarcosine is also used in the treatment of Schizophrenia and is also supposed to be a biomarker in the early diagnosis of human prostate cancer. **[5, 6, 7]**

This article deals with the synthesis and characterization of transition metal cobalt complexes with 1,10-phenanthroline as a primary ligand while sarcosine (N-methyl glycine) as a secondary ligand.

MATERIAL AND METHODS

a.) All the chemicals used metal salt (Cobalt Nitrate), 1, 10-phenanthroline and sarcosine were of Analytical grade (BDH). These were used without further purification.

b.) **Instruments:** FTIR spectra were recorded as Potassium bromide discs using Fourier transform Infrared Spectrophotometer Shimadzu 24 FTIR 8400s. These spectra were recorded in the range of (400 – 4000 cm^{-1}). Electronic spectra of the prepared complexes were measured in the region of (200 – 1100 cm^{-1}) with UV – visible spectro photometer.

c.) **General Synthesis of Mixed Ligand Metal Complexes by magnetic stirring:**

Solution of metal salt (Cobalt Nitrate) (1 mmol) and ligands - Sarcosine (1 mmol) and 1,10- phenanthroline (2 mmol) were prepared. 10 mL of metal solution was mixed with 1,10-phenanthroline (20 mL) as primary ligand with continuous stirring with the help of magnetic stirrer for (1 - 1.5) hours. pH of the solution was checked, it was found to be alkaline. Then Sarcosine solution (10 mL) was added to it as a secondary ligand and the mixture was stirred again (1 – 1.5) hours to accomplish complexation. pH of the solution was checked again. It was found to be slightly acidic or neutral. The whole procedure was carried out at room temperature. After magnetic stirring, the solution was cooled at room temperature and was left over-night for evaporation of the

solvent. The product thus formed was filtered off, washed with methanol and dried in air and analyzed by employing standard methods. Orange coloured amorphous solid obtained was assigned as complex-I. **[8, 9, 10]**

d.) Complex Formation by Direct Heating:

10 mL (1 mmol) solution of metal salt ($Co(NO_3)_3.6H_2O$) was taken in a beaker. Then, added (10 mL, 2 mmol) solution of ligand 1, 10-phenantroline and mixed it well. Then added 10 mL (1 mmol) solution of other ligand Sarcosine to it with continuous stirring with the help of stirrer. Then it was heated on a water bath at temperature not less than 50 ^{0}C, till the mixture was super saturated. It was first cooled at room temperature and then in ice bath. Solution was then filtered and crystals obtained were recrystallized with Methanol. Dark yellow precipitates were obtained on drying. The product thus obtained was labeled as complex-II.

Results and Discussion

a.) Characterization of metal – ligand complexes

Based on physical properties it was observed that all the complexes were coloured, amorphous solids, non-hygroscopic and stable at room temperature. The solubility of the complexes was studied in various solvents. It was observed that complexes were soluble in water, Methanol or aqueous Ethanol at room temperature.

b.) FT – IR spectral studies and mode of co-ordination

IR spectral band due to υ (C = N) ring vibrations of uncon-ordinated 1,10 – phenanthroline in free ligand was appeared at 1590cm^{-1}.The peaks for υ (C = N) in complex 1 was 1515 cm^{-1} and 1514cm^{-1} in complex -II. The decrease in the frequency was 75 cm^{-1} in complex - I and 76 cm^{-1} in complex -II. This shift showed that 1,10 – phenanthroline was co-ordinated to the metal center. The spectra arising from the complexes revealed that the absorption bands belonging to the stretching vibrations of υ(N – H) of amino (NH) group have been found in the range between (3503 – 3325) cm^{-1} shifted to lower frequency in complex-I at 3189-3152 and in complex-II at 3046-3019cm^{-1} suggesting co-ordination of the ligand (Sarcosinate) through Nitrogen atom. Absorption assigned to υ $(OCO)_{sym}$ in free sarcosine ligand was noticed at 1313 cm^{-1}. Peaks corresponding to these in complex - I and II were 1220 cm^{-1} and 1217 cm^{-1} respectively. This decrease in the frequency value was an indication of co-ordination of (COO) group to the central metal atom. Free lattice H_2O molecules showed bands in the range of (3500–3631cm^{-1}).

(Co – N) bands appeared at 486 cm^{-1} and 478 for complex - I and II respectively. The bands for (Co – O) appeared at 514 cm^{-1} for complex - I and 478cm^{-1} for complex -II.

c.) U.V/Visible or Electronic spectral studies

The electronic spectral studies based on U.V / Visible Spectroscopic techniques of the newly synthesized mixed ligand complexes of Cobalt showed maximum absorbance at wave length 390 nm

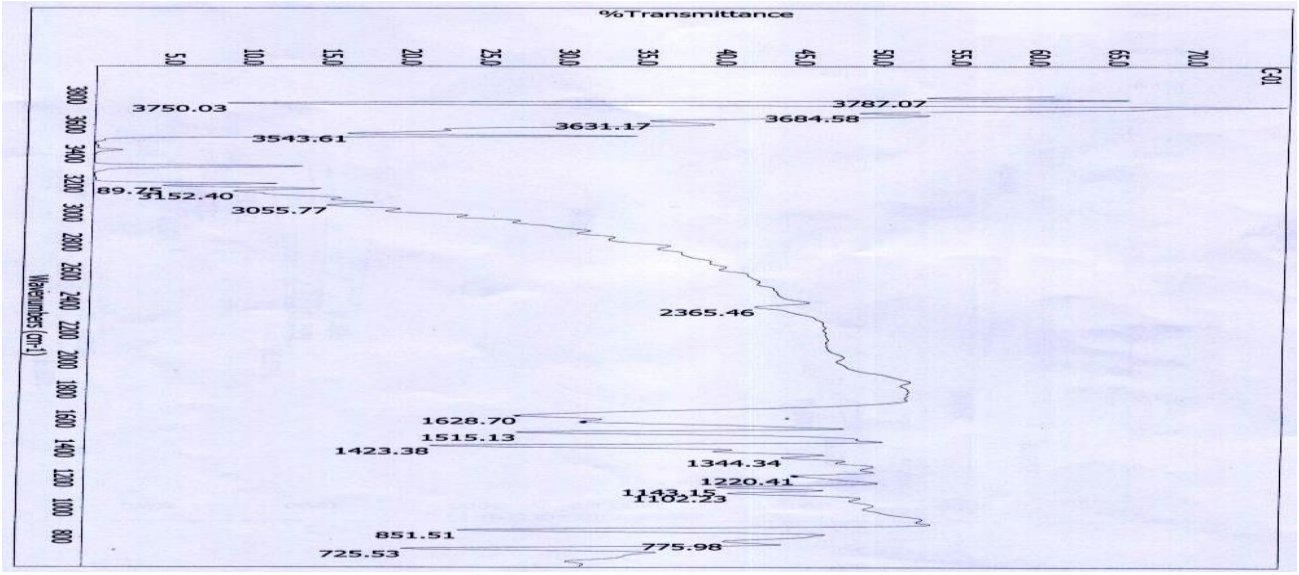
Absorption bands in this range are consistent and comparable to six co-ordinated cobalt (III) complexes, suggesting an octahedral geometry for the newly synthesized complexes.**[11]**

Table # 1: Characterization of Complexes Prepared

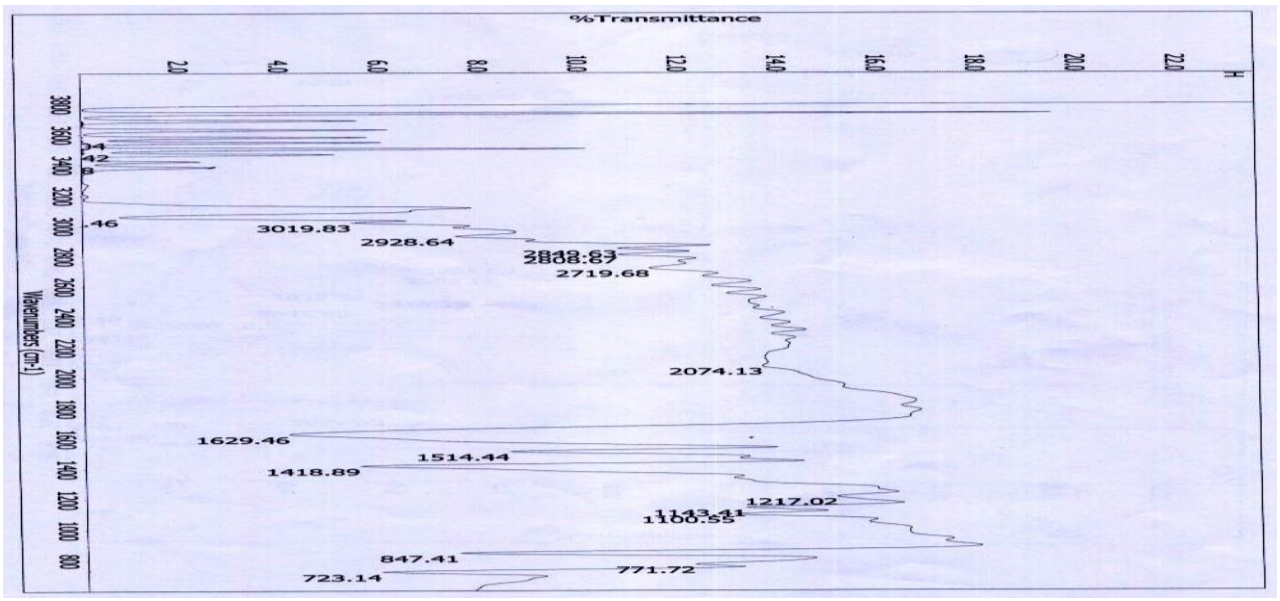
S.No	Complexes	State / Colour	λ max (nm)
1	Complex - I	Amorphous / Orange	390
2	Complex – II	Amorphous/Dark Yellow	390

Table # 2: I.R Frequencies (cm^{-1}) of Cobalt (III) Complexes

S.No	Complexes	N – H	C = N	$(COO)^-$ asym	$(COO)^-$ sym	Co - N	Co - O
1	Complex - I	3189-3152	1515	1628	1220	486	514
2	Complex – II	3046-3019	1514	1629	1217	478	520



FT – IR Spectrum of Mixed Ligand Complex – I



FT – IR Spectrum of Mixed Ligand Complex - II

REFERENCES:

[1] Majid, A. Y., Sarhan, M.B., Al. Najjar, A.N. (2008). Stability constant of some metal ion complexes (4 Amino Hippuric acid) in aqueous Solutions. *Journal of Al. Nahrain University*. **11:** 1-8.

[2]. Arafat. Y., Ali, S., Shahzadi, S.,Shahid, M. (2013). Preparation, Characterization, and Anitimicrobial activities of Bimetalic Complexes of Sarcosine with Zn(II) and Sn(IV)*Bioinorganic Chemistry and application,* **7**.

[3]. Agwara, O.M., Nidofone, T.P., Nidsori, N.B., Paboudam, G.A., Yafanyi, M.D.,Mohamadou, A. (2010) Synthesis characterization and anti micro biological activities ofCobalt(II) and Zinc(II) mixed ligand complexes containing 1,10 phenonthroline and 2,2, bipyridine. *Bull.chem. society*, *Ethiope*, **24 (3)**: 383 - 389.

[4]. Co-Ordination Chemistry Reviews. (2010). Vol: **254(17)**. pp.2096 - 2180.

[5]. Allen, R. H., Stabler, S. P. Linden baum, J. (1993). Serum betaine, N, N-dimethyl glycineand N-methyl glycine levels in patients with cobalamin and folate deficiency and related in born errors in metabolism. **42(11)**: 1448 -1460.

[6]. Agrwal, N., Gupta, R., Gupta, K.C. (2011). Stability of Zn^{+2}, Mn^{+2}, Co^{+2} binary andternary complex with 2,3 - DMSO as a primary ligand and some biologically importantamino acids as secondary ligands. *International Journal of Chemical Society*, **9**:1035 - 1044.

[7]. Cernei, N., Heerm, Z., Guwlec, J., Zitka, O., Masarik, M., Babula, P., Eckshlager, T., Stiborva, M.,Kizek, R., Adam.V. (2013). Sarcosine as Potential prostate Cancer Biomarker. A Review. *Int. J. Mol. Sci*, **14**:13893 - 13908.

[8]. Fayad, K.N., Al-Noor,H.T., Mahmood, A.A., Malih,K.I. (2013). Synthesis, characterization and antibacterial studies of Mn(II), Fe(II), Co(II), Ni(II), and Cd(II) mixed – ligand complexes containing amino acid (L-valine) and (1, 10 – phenanthroline).*Chemistry and Material Research*, **3(5)**:.

[9]. Agrawal, N., Gupta, R., Gupta, K.C. (2011). Stability of **(**Zn^{+2}, Mn^{+2}, VO^{+2} and Co^{+2}) Binary and Ternary complexes with 2,3 – DMSA. As a primary ligand and someBiologically important amino acids as secondary ligands. *Int J. Chem Sci*, **9(3)**: 1035 – 1044.

[10]. Marchi, L.E. (1967). Inorganic synthesis, Vol: II, pp.10, Mc Graw Hill Company, N.Y.

[11]. Mrinalini, L., Manihar Singh, A. K. (2011). Mixed ligand Cobalt(III) complexes with 1 – Amidino -O-Methyl urea and Amino Acids. *Research Journal of Chemical Sciences*, **2(1)** 45 - 49.