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# Synthesis and Characterization of Ternary Complexes of Cu (II) ion with Drug Dapsone and Different Amino Acids.

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**ABSTRACT**

The synthesis of ternary complexes of transition metals with amino acids and drugs was carried by the precipitation technique. In this synthesis drug is used as primary ligand and amino acids are as secondary ligand. The characterization of these complexes are done by elemental analysis, UV-visible spectroscopy, IR spectroscopy, ESR spectroscopy and magnetic measurement etc. The uv-visible spectra of all these complexes will obtained to find out geometry of complexes.IR spectral studies of complexes will be modle of establish bonding modes of the ligand molecule with metal ion.

**Keywords:** Mixed-ligand complexes, spectral analysis, dapsone complexes.

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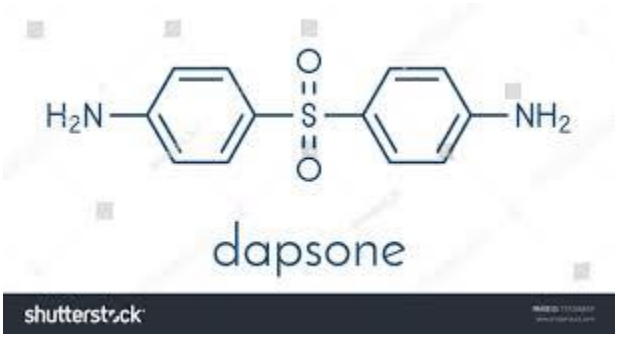
## INTRODUCTION

The ternary complexes of transition metals with amino acids and drugs has played an important role in pharmaceutical and biological sciences. Complexes of some transition metal ions can be used as modle to study pharmacodynamic effects of drugs or for increasing the bio-compatibility and minimize the toxic effects of metal ions [1-3]. Transition metal ions define the number of reactive sites available. Metal ion can induce toxicity in humans and plants [4].Complex tendency of transition metals like copper is very high ,this factor contributes to much more noble character of copper to make compound more valent [5, 6].The amino acids and their compounds are used in biology ,pharmacy ,industry and laboratory reagents. Amino acids with one or more than one co-ordination site along with different functional groups has a significant role in chemical and biological systems [7].Dapsone is an antibiotic sulpha drug that is commonly used to treat leprosy ,dermatitis ,herpetiformis and pnemocytic carinii pneumonia. It shows efficient pharmacological activity[8].




The literature reveals that very limited work on the study of ternary complexes of transition metals with drug dapsone and amino acids have been reported in the past [9-15]. The present paper deals with the synthesis and characterization of mixed-ligand complexes of Cu(II) metal ion with drug dapsone and different amino acids in aqueous solution.

## EXPERIMENTAL SECTION

### Materials

Pure drug sample of dapsone was obtained from pharmaceutical industries. All chemicals are used were Ana lR grade or of high purity. Metal ion used as sulphate. All solutions were prepared in doubly distilled water.

### Method

**Preparation of Cu(II) hydroxide**:- In this step precipitation is done by using 0.2M sodium hydroxide solution.25ml aqueous solution of sodium hydroxide (0.2M) was added to 25 ml aqueous solution of copper sulphate with constant stirring. When precipitation is completed then precipitate was filtered and washed by cold water untill all sulphate was removed.

**Synthesis of Cu(II) complexes :-**Precipitated copper(II) hydroxide was taken in different beakers and added an equimolar amount of drug and different amino acids .Mixture of Cu (II) hydroxide, drug and different amino acids was heated on water bath for 2-4 hours. Filter the hot solution and concentrated on water bath. The pH of solution was kept 7.0, because ternary complexes are formed at this pH easily. The solid complexes are blue in colour which are separated by slow evaporation and recrystallized with double distilled water. Complexes are dried in vaccum at $70^0$.

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## RESULT AND DISCUSSION

### Elemental analysis

To establish the composition of mixed-ligand copper complexes, the percent composition of carbon ,hydrogen ,nitrogen ,oxygen ,sulfur and metal were determined by elemental analysis,which gives proposed formulation of the complexes.The elemental data of the ternary complexes are given in table 1.

**Table 1: Elemental data of synthesized ternary complexes.**

| S.N | Name of complexes | Molecular formula of complexes | Colour | % analysis found (cal.) | | | | | | Molecular weight found(cal.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | C % | H% | N% | O% | S% | M% | |
| 1. | Dapsone | $C_{12}H_{12}N_2O_2S$ | White | 58.06% 57.90% | 4.83% 4.15% | 11.29% 11.16% | 12.90% 12.35% | 12.90% 12.26% | ------- | 248 |
| **2.** | [Cu(dap)(arg)].4$H_2O$ | [Cu($C_{18}H_{26}N_6O_4S$].4$H_2O$ | Blue | 38.74% (38.26) | 6.09% (6.25) | 15.06% (15.11) | 22.95% (22.74) | 5.73% (5.62) | 11.39% (10.35) | 557.5 |
| **3.** | [Cu(dap)(threo)].5$H_2O$ | [Cu($C_{16}H_{21}N_3O_5S$)].5$H_2O$ | Blue | 36.88% (36.45) | 5.95% (5.84) | 8.06% (8.01) | 30.73% (30.64) | 6.14% (6.11) | 12.19% (12.00) | 520.5 |
| **4.** | [Cu(dap)(val)].3 $H_2O$ | [Cu($C_{17}H_{23}N_3O_4S$)].3$H_2O$ | Blue | 42.45% (42.32) | 6.01% (6.00)) | 8.70% (8.44) | 23.21% (23.11) | 6.63% (6.45) | 13.16% (13.11) | 482.5 |
| **5.** | [Cu(dap)(pro)].6$H_2O$ | [Cu($C_{17}H_{21}N_3O_4S$)].6$H_2O$ | Blue | 39.96% (38.99) | 4.50% (4.84) | 5.48% (5.74) | 3.34% (3.25) | 6.26% (6.11) | 12.43% (12.25) | 510.5 |
| **6.** | [Cu(dap)(ala)].7 $H_2O$ | [Cu($C_{15}H_{19}N_3O_4S$)].7$H_2O$ | Blue | 34.18% (34.00) | 6.26% (6.10) | 7.97% (7.25) | 33.42% (33.14) | 6.07% (6.00) | 12.06% (11.52) | 526.5 |
| **7.** | [Cu(dap)(lue)].4$H_2O$ | [Cu($C_{18}H_{25}N_4O_4S$].4$H_2O$ | Blue | 43.68% (43.55) | 6.67% (6.33) | 8.49% (8.43) | 21.84% (21.23) | 6.47% (6.25) | 12.84% (12.56) | 494.5 |
| **8.** | [Cu(dap)(meth)].5$H_2O$ | [Cu($C_{17}H_{16}N_3O_4$].5$H_2O$ | Blue | 37.53% (37.00) | 4.78% (4.12) | 7.72% (7.55) | 26.49% (26.44) | 5.88% (5.67) | 11.68% (11.55) | 543.5 |
| **9.** | [Cu(dap)(glu)].3$H_2O$ | [Cu($C_{17}H_{21}N_3O_6$].3$H_2O$ | Blue | 42.27% (42.11) | 5.59% (5.45) | 8.70% (8.64) | 23.62% (23.61) | 6.63% (6.61) | 13.16% (13.60) | 482.5 |
| **10.** | [Cu(dap)(gly)].7$H_2O$ | [Cu($C_{14}H_{17}N_3O_4$].7$H_2O$ | Blue | 32.78% (31.62) | 6.04% (6.01) | 8.19% (8.11) | 34.34% (33.34) | 6.24% (6.22) | 12.39% (12.22) | 512.5 |
| **11.** | [Cu(dap)(phen)].5$H_2O$ | [Cu($C_{21}H_{23}N_3O_4$].5$H_2O$ | Blue | 44.48% (44.21) | 5.82% (5.44) | 7.4% (7.2) | 25.41% (25.23) | 5.64% (5.62) | 11.20% (10.20) | 566.5 |

### UV-Visible spectra

UV-Visible spectra of synthesized complexes were recorded in aqueous solution with a 1.0 cm quartz cell in the range 200-800 nm and the data are listed in table 2.

The electronic spectra of free dapsone ligand display bands at 260 and 290 nm assigned to π-π* and n-π* transitions of the conjugated system of dapsone respectively. These two transitions are shifted to longer wavelength and shows bathochromic effect in all the complexes [16]. In octahedral field, Cu(II) ion has spectroscopic ground state term $^2D$ ($d^9$ electronic configuration), which will be split into two energy levels $^2T_{2g}$ and $^2E_g$.Maximum absorption and extinction coefficient values indicate that the geometry of the ternary complexes are tetragonally distorted octahedron [17].

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**Table 2: UV-Visible spectral data of different ternary complexes.**

| S.N. | Name of complexes | Λmax | Absorbance | Wave no. (cm-1) | Energy (eV) | Frequency (THz) | $\varepsilon_{max}$ ($M^{-1}cm^{-1}$) |
|---|---|---|---|---|---|---|---|
| **1.** | [Cu(dap)(arg)].4$H_2O$ | 624 | 0.432 | 16025.64 | 1.986 | 480 | 43.20 |
| **2.** | [Cu(dap)(threo)].5$H_2O$ | 656 | 0.117 | 15243.90 | 1.890 | 456 | 11.70 |
| **3.** | [Cu(dap)(val)].3H2O | 641 | 0.239 | 15586.03 | 1.9342 | 467 | 23.90 |
| **4.** | [Cu(dap)(pro)].6$H_2O$ | 615 | 0.624 | 16260.16 | 2.0160 | 487 | 62.40 |
| **5.** | [Cu(dap)(ala)].7$H_2O$ | 658 | 0.144 | 15188.34 | 1.8820 | 455 | 14.40 |
| **6.** | [Cu(dap)(lue)].4H2O | 624 | 0.432 | 16025.64 | 1.985 | 480 | 43.00 |
| **7.** | [Cu(dap)(meth)].5H2O | 658 | 0.144 | 15188.34 | 1.8820 | 455 | 14.40 |
| **8.** | [Cu(dap)(glu)].3H2O | 615 | 0.624 | 16260.16 | 2.0160 | 487 | 62.40 |
| **9.** | [Cu(dap)(gly)].7H2O | 626 | 0.405 | 15974.44 | 1.9806 | 478 | 40.50 |
| **10.** | [Cu(dap)(phen)].5H2O | 620 | 0.168 | 16129.03 | 1.9997 | 483 | 16.80 |

**Infrared spectral analysis**

The most important IR bands of prepared ternary complexes providing conclusive evidence for the coordination mode are presented at table 3.

The free dapsone ligand display a strong band in the range 3223 $cm^{-1}$, which is described to the stretching vibration of $–NH_2$ group. However, this band disappear in the spectrum of the ternary complexes. The stretching vibration of the C-O group appearing in the range 1435 $cm^{-1}$ is shifted to lower frequencies in some ternary complexes while shifted to higher frequencies in another complexes, suggesting the involvement of this group in the coordination with the metal ion. On the other hand, the presence of hydrated or coordinated water molecules in the prepared ternry complexes is verified by the presence of broad or shoulder bands in the high frequency region at 3300-3550 $cm^{-1}$ in the IR spectra, attributed to the -OH vibration of water. Further, the appearance of a strong band in the range 804-898 $cm^{-1}$ is assignable to the OH vibration.

A distinct band appearing in 1608-1662 $cm^{-1}$ region in the spectra of various complexes is typical of the stretching vibration of a coordinated $–NH_2$ group. Another band observed at 1404-1496 cm-1 occur in the spectrum of free amino acids are shifted to lower frequencies in complexes, which indicate the symmetric vibration frequency of coordinated $COO^-$ group of amino acids. The stretching vibration frequency of $–NH_2$ group in the free amino acids are disappeared in the spectrum of the some ternary complexes like [Cu (dap)(val)].3$H_2O$ and [Cu(dap)(pro)].6$H_2O$ .This change indicate that this group is in coordination with the central metal ion. The stretching vibration band of the $–NH_2$ group in free amino acids appeared in th spectrum of some ternary complexes such as [Cu(dap)(threo)].5$H_2O$ and [C(dap)(arg)].4$H_2O$ etc., which shows that this group is not coordinated with the metal ion.

From the given band positions, it may be concluded that involved drug and amino acids in the complexes are bidantate co-ordinating through $–NH_2$ (both in drug and amino acids) and –COOH groups respectively [18-26].

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**Table 3: Infrared spectral data of ternary complexes.**

| Name of complexes | ν(NH2) | ν(C=O) | ν(C-O) | Δ(C=O) | Π(c=o) | ν(MN) | c-w |
|---|---|---|---|---|---|---|---|
| 1.Dapsone | 3223.16 | 1589.40 | 1435.09 | --------- | 563.23 | 428.21 | 825.56<br>833.28 |
| 2.[Cu(dap)(arg)].4$H_2O$ | 3371.68<br>3290.67<br>3342.75<br>3232.80 | 1454.38 | 1302.2<br>1454.8 | 752<br>785 | 549<br>505 | 443<br>426<br>406 | 877 |
| 3.[Cu(threo)(dap)].5$H_2O$ | 3232.80<br>3263.66<br>3302.24<br>3363.97<br>3394.83 | 1581.68 | 1392.5 | 777.34 | 545.87<br>596.02 | 422.42<br>461 | 813.9<br>846.8<br>898.6 |
| 4.[Cu(dap)(val)].3$H_2O$ | _____ | _____ | 1379.5 | ____ | 545.87<br>586.38 | 424.35 | ___ |
| 5.[Cu(dap)(pro)].6$H_2O$ | ____ | _____ | ____ | _____ | _____ | | ____ |
| 6.[Cu(dap)(ala)].7$H_2O$ | 3240.52<br>3279.10 | 146.02<br>1572.04 | 1338.4<br>1352.4<br>1361.9 | 707.90<br>767.69<br>786.98 | 572.88 | _____ | 852.6 |
| 7.[Cu(dap)(lue)].4$H_2O$ | 3201.21<br>3390.16 | 1470.36 | 1360.5 | 780.40 | 561.36 | 441.36 | 840.9 |
| 8.[Cu(dap)(meth)].5$H_2O$ | ---------- | 1448.05 | 1368.6 | 749.60 | 534.68 | 420.58 | 855.2 |
| 9.[Cu(dap)(glu)].3$H_2O$ | 3356.24 | ---------- | 1345.2 | 784.15 | 522.46 | 481.54 | 879.6 |
| 10.[Cu(dap)(gly)].7$H_2O$ | 3326.58<br>3356.12 | ---------- | 1329.4 | 713.54 | 541.87 | 465.21 | 875.4 |
| 11.[Cu(dap)(phen)].5$H_2O$ | 3298.45<br>3345.87<br>3368.14 | 1468.24 | 1384.5 | 754.23 | 526.89 | 495.35 | 864.2 |

**ESR spectral analysis**

The ESR spectra were carried out for the solid complexes at room temperature. All copper complexes shows $g_{II}>g_{I}$ .The value of $g_{II}$ may give information about environment surrounding copper metal. The ESR spectral data of complexes indicates that complexes are paramagnetic in nature with one unpaired electron having $d^9$ electronic configuration.The ESR data are shown in table 4.

**Table 4: Electron spin resonance spectral data of ternary complexes.**

| S.N. | Complexes | ESR Parameters | | | | |
|---|---|---|---|---|---|---|
| | | $g_{II}$ | $g_{I}$ | $g_{av}$ | $A_{II}$ | $A_{I}$ |
| **1.** | [Cu(dap)(arg)].4 $H_2O$ | 2.476 | 2.041 | 2.133 | 230 | 17.87 |
| **2.** | [Cu(dap)(threo)].3$H_2O$ | 2.476 | 2.092 | 2.193 | 230 | 22.35 |
| **3.** | [Cu(dap)(val)].3$H_2O$ | 2.523 | 2.079 | 2.166 | 150 | 12.25 |
| **4.** | [ Cu(dap)(pro)].6$H_2O$ | 2.422 | 2.092 | 2.133 | 200 | 22.20 |
| **5.** | [Cu(dap)(ala)].7$H_2O$ | 2.531 | 2.092 | 2.166 | 590 | 22.21 |
| **6.** | [Cu(dap)(lue)].7$H_2O$ | 2.531 | 2.187 | 2.333 | 260 | 92.23 |
| **7.** | [Cu(dap)(meth)].5$H_2O$ | 2.457 | 2.173 | 2.200 | 220 | 81.09 |
| **8.** | [Cu(dap)(glu)].3$H_2O$ | 2.336 | 2.143 | 2.166 | 150 | 61.12 |
| **9.** | [Cu(dap)(gly)].7$H_2O$ | 2.422 | 2.159 | 2.000 | 200 | 71.62 |
| **10.** | [Cu(dap)(phen)].5$H_2O$ | 2.350 | 2.168 | 2.166 | 160 | 81.09 |

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**Magnetic measurement**

The magnetic moment values are indicate that the synthesized complexes are paramagnetic in nature with the presence of one unpaired electron in the outer orbital of metal ion.These values are in the range 1.2-1.7 B.M.

**Table 5: Magnetic measurement data of ternary complexes.**

| S.N. | Complexes | Mol. Weight | Susceptibility Mass | Susceptibility Mol. | $\mu_{eff.}$ (B.M.) |
|---|---|---|---|---|---|
| **1.** | [Cu(dap)(arg)].4$H_2O$ | 557.5 | 1.82E-06 | 0.001014 | 1.5 |
| **2.** | [Cu(dap)(threo)].5$H_2O$ | 520.5 | 1.89E-06 | 0.000983 | 1.5 |
| **3.** | [Cu(dap)(val)].3$H_2O$ | 482.5 | 2.16E-06 | 0.001042 | 1.5 |
| **4.** | [ Cu(dap)(pro)].6$H_2O$ | 510.5 | 2.67E-06 | 0.001363 | 1.7 |
| **5.** | [Cu(dap)(ala)].7$H_2O$ | 526.5 | 1.96E-06 | 0.003542 | 1.5 |
| **6.** | [Cu(dap)(lue)].4$H_2O$ | 494.5 | 1.49E-06 | 0.001031 | 1.3 |
| **7.** | [Cu(dap)(meth)].5$H_2O$ | 543.5 | 1.32E-06 | 0.000717 | 1.2 |
| **8.** | [Cu(dap)(glu)].3$H_2O$ | 482.5 | 1.56E-06 | 0.000752 | 1.3 |
| **9.** | [Cu(dap)(gly)].7$H_2O$ | 512.5 | 2.07E-06 | 0.001060 | 1.5 |
| **10.** | [Cu(dap)(phen)].5$H_2O$ | 566.5 | 1.90E-06 | 0.001076 | 1.5 |

**Thermal analysis**

Thermal analysis of the metal complexes were also studied starting from ambient temperature to 900$^0$C with controlled heating rate of 10$^0$C $min^{-1}$ under nitrogen atmosphere.TGA data of complexes are given in table 6.

**Table 6: Thermal analytical data of ternary complexes.**

| S.N. | Name of complexes | Dacomposition temperature | |
|---|---|---|---|
| | | Steps | Temp.($^0$C) |
| 1. | [Cu(dap)(arg)].4$H_2O$ | I<br>II<br>III<br>IV | 175$^0$C<br>210$^0$C<br>225$^0$C<br>400$^0$C |
| 2. | [Cu(dap)(threo)].5$H_2O$ | I<br>II<br>III | 175$^0$C<br>225$^0$C<br>410$^0$C |
| 3. | [Cu(dap)(val)].3$H_2O$ | I<br>II<br>III<br>IV | 135$^0$C<br>205$^0$C<br>230$^0$C<br>425$^0$C |
| 4. | [Cu(dap)(pro)].6$H_2O$ | I<br>II<br>III<br>IV<br>V | 190$^0$C<br>225$^0$C<br>290$^0$C<br>325$^0$C<br>450$^0$C |
| 5. | [Cu(dap)(ala)].7$H_2O$ | I<br>II<br>III | 160$^0$C<br>300$^0$C<br>350$^0$C |
| 6. | [Cu(dap)(lue)].4$H_2O$ | I<br>II<br>III | 170$^0$C<br>200$^0$C<br>350$^0$C |
| 7. | [Cu(dap)(meth)].5$H_2O$ | I<br>II<br>III | 180$^0$C<br>250$^0$C<br>300$^0$C |
| 8. | [Cu(dap)(glu)].3$H_2O$ | I | 175$^0$C |

| | | | |
|---|---|---|---|
| | | II<br>III | 270$^0$C<br>350$^0$C |
| 9. | [Cu(dap)(gly)].7$H_2O$ | I<br>II<br>III | 165$^0$C<br>240$^0$C<br>350$^0$C |
| 10. | [Cu(dap)(phen)].5$H_2O$ | I<br>II<br>III | 180$^0$C<br>240$^0$C<br>360$^0$C |

## CONCLUSION

The ternary complexes of Cu(II) ion with drug dapsone and amino acids are synthesized and characterized by elemental analysis, thermal analysis and different types of spectral analysis like UV-visible, IR and ESR spectroscopy etc. Magnetic measurement of complexes are also done. From the elemental data of complexes we found the general formula of complexes, which is given below,

$$[Cu(dap)(L)].\ x\ H_2O$$

Where L is amino acid and x is the number of water molecules.

The stoichiometry has been found to be 1:1:1 for all the complexes. Based on the magnetic measurement and spectral data a tetragonally distorted octahedron geometry of the complexes has been proposed.

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