Micellar Spectral, Potentiometric and Biological Investigations on Mn (II)- Thiosemicarbazone Systems

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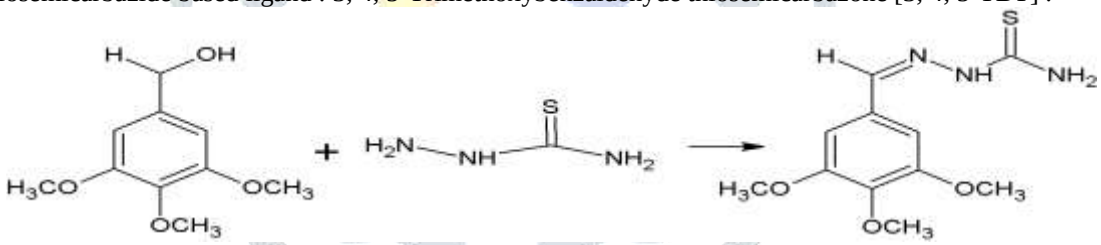
***Abstract* :** The therapeutic importance of thiosemicarbazone group containing ligands has promoted the selection of this class of ligands and their complexes for the study. Ligand 3, 4, 5-Trimethoxybenzaldehyde thiosemicarbazone [3, 4, 5-TBT] has been synthesized. The present work describes the synthesis, characterization, solution and biological investigations on Mn (II)-thiosemicarbazone complexes. Solution studies on the complexes have also been carried out in different micellar [HTAB, SDS, TX-100] systems at 25°C and data have been compared with ethanol water mixture. Stability constants and molar ions in 60% ethanol were determined. Metal – ligand (M/L) ratio and formation constants have been determined in Brij-35 and TX-100 micellar system by conductometric method.

***Keyword**:* Thiosemicarbazone, biological, formation constants, Brij-35 and TX-100

I. INTRODUCTION

Thiosemicarbazones have been the subject of studies not only for coordination chemistry reasons, but for pharmacological as well, due to their good complexing properties and significant biological activity [1]. Thiosemicarbazones have attracted a crescent interest in recent years due to their biological properties, such as antiviral, antibacterial, anti-malarial, antifungal and antitumoral activities [2]. The research on coordination chemistry and analytical applications of thiosemicarbazones and its metallic derivatives has increased considerably [3].

In this paper we are reporting the synthesis, stability constant, association constant and Gibbs Free energies of Mn (II) complexes with thiosemicarbazide based ligand : 3, 4, 5-Trimethoxybenzaldehyde thiosemicarbazone [3, 4, 5-TBT] .



3, 4, 5-Trimethoxybenzaldehyde Thiosemicarbazide 3, 4, 5-TrimethoxybenzaldehydeThiosemicarbazone

Synthesis of ligands

II. MATERIALS AND METHODS

Materials

All the chemicals used were of AR grade and procured from Himedia. Metal salt were purchased from E. Merck and were used as received. All solvent used were of standard/spectroscopic grade.

Synthesis of ligand:

A hot solution of thiosemicarbazide (1.82 g, 20 mmol) in presence of methanol was added to benzaldehyde. A constant stirring was given to mixture and refluxed for 4 hours. The mixture was filtered and concentrated by slow evaporation. After some time crystals were washed with cold ethanol and dried in vacuum [4].

Metal ligand complexes were formed by potentiometric titrations. Ligands and metal complexes were analyzed by TLC method.

3. PROCEDURE

Potentiometric titration :

pH metric studies has been done with the help of pH meter (pH meter 802). The pH meter was switched on half an hour before begin the titrations. Instrument was calibrated with aqueous standard buffer solution of pH 4.0, 7.0, 9.0 prepared from buffer tablets. The experiment procedure involved the titration of

Solution (i): *1.00 ml HNO_3 (0.004 M) + 5 ml KNO_3 (0.1 M)*
Solution (ii): Solution (i) + 1.25 ml of ligand (0.0005M) and
Solution (iii): Solution (ii) + 0.625 ml of $CoCl_2$. nH_2O (0.00025 M)
Volume of all these reaction mixtures was made up to 25 ml using 60% ethanol. For the titration in micellar system, 1.20 ml (5 mmol) of TX-100, 2.25 ml (5 mmol) of SDS and 2.0 ml of HTAB (5 mmol) were added separately in each set of the above reaction mixtures before making up the volume. The reaction mixtures of ethanol and water – ethanol (1:1) solutions were also prepare . The reaction mixtures were titrated individually against standard 0.05 M KOH.
After each addition of a certain amount of alkali to the the reaction mixture the change in the pH of the solution is measured. The graphs were plotted against values of pH and volume of alkali added. Using Irving and Rossotti stability constants of the metal ligand complexes were calculated from the titration curves [5].
Biological study:
Biological investigation has been carried out by disc diffusion method. The agar was prepared in plate and microorganisms were cultivated on to the surface of the agar plate. Broth was applied on agar plate then filter paper discs impregnated with different type of samples, were placed on the agar. After incubation of the plates the diameter of the zone of inhibition (ZI) of microorganism growth around each disc was measured [6].

4. RESULT AND DISCUSSION
Potentiometric titration:
Proton-ligand stability constants (pK)
The proton–ligand formation curves were estimated by plotting graphs between the values $(\bar{n}_A)$ Vs pH readings. The pK values were obtained from formation curve by noting the pH at which $(\bar{n}_A)$ = 0.5 and $(\bar{n}_A)$= 1.5. The proton-ligand formation number $(\bar{n}_A)$ were calculated by Irving and Rossotti expression [5]. The result indicated that the ligand was mono dissociable.

$$\bar{n}_A = Y - \frac{(V_L - V_a)(N + E^0)}{(V_0 + V_a)T_L}$$

----------(1)

Where, V^0 = Initial volume of solution (25 ml), E^0 = Initial concentration of free acid (HNO_3), Y= Number of dissociable protons from ligand, T_L is concerntration of ligand in solution, $(V_L - V_a)$ = Volume of alkali (KOH) consumed by acid and ligand on the same pH **[7]**.

Metal ligand stability constant (logK):
The average number of metal ions associated with the ligand $(\bar{n})$ at different pH values was estimated from the curve plotted between n- and pH. Metal ligand stability constant (logK) were obtained by the half integral method by plotting graph between $(\bar{n})$ vs. pL.

---------- (2)

$$\bar{n} = \frac{(V_M - V_L)(N + E^0)}{(V_0 + V_L)n_A^- T_m}$$

$$pL = \log_{10}\left[\frac{\sum_{n=0}^{n=i} \beta_n^N (\text{anti}\log pH)}{T_L - n^- T_M} \cdot \frac{V_0 + V_M}{V_0}\right]$$

---------- (3)

Where N, E^0, V^0 and V_L have same significance as in equation (1), V_M is the volume of KOH added in the metal ions titration to attain the given pH reading and T_M total concentration of metal present in solution. log $K_1$and logK_2 were calculated from the formation curve by the known value of pL at which $(\bar{n})$ =0.5 and $(\bar{n})$ =1.5 corresponding to the values of logK_1 and logK_2, respectively [8].

Sr.		Alc.+water

Table (i)- The $\overline{n}_A$ and pH values of Ligand 3, 4, 5 TBT in Alc. + water and Alcohol

	pH	$\overline{n}_A$
1	4.4	1.1036759
2	4.65	1.2245861
3	4.9	1.2849832
4	5.15	1.2892318
5	5.4	1.3151079
6	5.65	1.3366637
7	5.9	1.3452685
8	6.15	1.3538861
9	6.4	1.3624885
10	6.65	1.3667892
11	6.9	1.3754045
12	7.15	1.3840038
13	7.4	1.3926174
14	7.65	1.4141733
15	7.9	1.4141237
16	8.15	1.427048
17	8.4	1.4399712
18	8.65	1.4442492
19	8.9	1.4398834
20	9.15	1.4398132
21	9.4	1.4397605
22	9.65	1.435397
23	9.9	1.4267071
24	10.15	1.4309657
25	10.4	1.4351711
26	10.65	1.4350497
27	10.9	1.5038679
28	11.15	1.42601
29	11.4	1.3264787
30	11.65	1.2229545
31	11.9	1.1453509

Sr. No.		Alcohol
	pH	$\overline{n}_A$
1	4.4	1.0345531
2	4.65	0.9741069
3	4.9	1.0258993
4	5.15	1.0345269
5	5.4	1.0345186
6	5.65	1.0301989
7	5.9	1.0172531
8	6.15	1.0172517
9	6.4	1.0172503
10	6.65	1.0215621
11	6.9	1.0215603
12	7.15	1.0215586
13	7.4	1.0258693
14	7.65	1.0258672
15	7.9	1.0258652
16	8.15	1.0258641
17	8.4	1.0301724
18	8.65	1.0344814
19	8.9	1.0344786
20	9.15	1.0344759
21	9.4	1.0344731
22	9.65	1.0301604
23	9.9	1.0344676
24	10.15	1.0258466
25	10.4	1.0215371
26	10.65	1.0387637
27	10.9	1.0645985
28	11.15	1.0861175
29	11.4	1.0860866
30	11.65	1.141992
31	11.9	1.1590954
32	12.15	1.4037223

Table- (ii)- The $\overline{n}_A$ and pH values of Ligand 3,4,5 TBT in HTAB, SDS and TX-100 medium

Sr. No.		HTAB	Sr. No.		SDS	Sr. No.		TX-100
	pH	$\overline{n}_A$		pH	$\overline{n}_A$		pH	$\overline{n}_A$
1	4.4	1.159808	1	4.4	1.1425543	1	4.15	1.1079568
2	4.65	1.1856412	2	4.65	1.1381958	2	4.4	1.0820013
3	4.9	1.1726481	3	4.9	1.1122526	3	4.65	1.0776637
4	5.15	1.1596676	4	5.15	1.0820013	4	4.9	1.0690151
5	5.4	1.1466922	5	5.4	1.0301953	5	5.15	1.0819456
6	5.65	1.2113672	6	5.65	1.0215655	6	5.4	1.0819391
7	5.9	1.1250749	7	5.9	1.017251	7	5.65	1.0819325
8	6.15	1.1250649	8	6.15	1.0258765	8	5.9	1.0776141
9	6.4	1.1293723	9	6.4	1.0215621	9	6.15	1.0819227
10	6.65	1.133674	10	6.65	1.0301869	10	6.4	1.0819162
11	6.9	1.1379806	11	6.9	1.0258724	11	6.65	1.0819096
12	7.15	1.1422868	12	7.15	1.0301845	12	6.9	1.0862172
13	7.4	1.1336474	13	7.4	1.0301821	13	7.15	1.0775862
14	7.65	1.1422641	14	7.65	1.0344938	14	7.4	1.07758
15	7.9	1.1422527	15	7.9	1.0344924	15	7.65	1.0818867

16	8.15	1.1465576	16	8.15	1.034491	16	7.9	1.0818802
17	8.4	1.1422357	17	8.4	1.0431121	17	8.15	1.090492
18	8.65	1.1422244	18	8.65	1.0431086	18	8.4	1.0991063
19	8.9	1.142213	19	8.9	1.0560412	19	8.65	1.0990944
20	9.15	1.1378925	20	9.15	1.0603496	20	8.9	1.1077027
21	9.4	1.1335674	21	9.4	1.0689683	21	9.15	1.1163143
22	9.65	1.1335567	22	9.65	1.0775831	22	9.4	1.1206126
23	9.9	1.1507778	23	9.9	1.0862035	23	9.65	1.137832
24	10.15	1.1593683	24	10.15	1.0818867	24	9.9	1.1550487
25	10.4	1.1938263	25	10.4	1.1163654	25	10.15	1.167956
26	10.65	1.2325637	26	10.65	1.1551105	26	10.4	1.2454545
27	10.9	1.2670069	27	10.9	1.1808973	27	10.65	1.3098996
28	11.15	1.3229279	28	11.15	1.3014114			
29	11.4	1.4003986	29	11.4	1.3357379			
			30	11.65	1.4389194			

Table (iii)- - The $\bar{n}$ And pL values of Ligand 3, 4, 5-TBT with Mn (II) in Alc.+water

Sr. No.	pH	pL	$\bar{n}$
1	4.4	4.4714819	0.4148878
2	4.65	4.1204922	0.2186663
3	4.9	3.8370127	0.1478531
4	5.15	3.5775377	0.12724
5	5.4	3.3114051	0.0919037
6	5.65	3.0520976	0.0710399
7	5.9	2.8020287	0.0705798
8	6.15	2.557756	0.0828783
9	6.4	2.3105627	0.088683
10	6.65	2.0721946	0.1136576
11	6.9	1.8337364	0.1380392
12	7.15	1.5983014	0.1683457
13	7.4	1.3720011	0.2168675
14	7.65	1.1296444	0.2318579
15	7.9	0.8919481	0.2562422
16	8.15	0.662478	0.29623
17	8.4	0.4555157	0.3774338
18	8.65	0.3003816	0.5435239
19	8.9	0.1546823	0.7068416

Table (iv)- -The $\bar{n}$ And pL values of Ligand 3, 4, 5-TBT with Mn (II) in Alcohol

Sr. No.	pH	pL	$\bar{n}$
1	4.4	4.4028429	0.1502957
2	4.65	4.2939357	0.4253015
3	4.9	4.0798262	0.4880785
4	5.15	3.8771687	0.5673671
5	5.4	3.6021996	0.5255271
6	5.65	3.3485912	0.519271
7	5.9	3.0974669	0.5172942
8	6.15	2.8425246	0.508774
9	6.4	2.5876114	0.5002552
10	6.65	2.3364471	0.4981238
11	6.9	2.0815905	0.4896428
12	7.15	1.8267622	0.481163
13	7.4	1.5708431	0.4707164
14	7.65	1.3208912	0.4706798
15	7.9	1.066145	0.4622388
16	8.15	0.820964	0.4706249
17	8.4	0.555702	0.4435146
18	8.65	0.304731	0.4416496
19	8.9	0.0547811	0.4416156

Table (v)- - -The $\bar{n}$ And pL values of Ligand 3, 4, 5-TBT with Mn (II) in HTAB

Sr. No.	pH	pL	$\bar{n}$
1	4.4	4.366347	0.1713044
2	4.65	4.0742494	0.0801079
3	4.9	3.834904	0.1030605
4	5.15	3.6028839	0.1414051
5	5.4	3.3789245	0.1956522
6	5.65	3.1553325	0.2492664
7	5.9	2.9670305	0.3680119
8	6.15	2.7212102	0.3756522
9	6.4	2.5083356	0.4429359
10	6.65	2.2879156	0.4944707
11	6.9	2.0546769	0.5228923
12	7.15	1.8354179	0.5737453

Table (vi)- - -The $\bar{n}$ And pL values of Ligand 3, 4, 5-TBT with Mn (II) in SDS

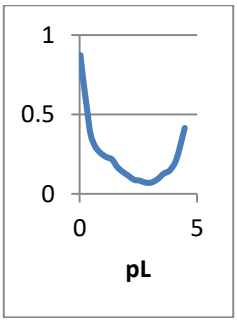
Sr. No.	pH	pL	$\bar{n}$
1	4.4	4.3876955	0.1966042
2	4.65	4.1419383	0.2048904
3	4.9	3.9173649	0.2561909
4	5.15	3.687208	0.2951692
5	5.4	3.4622816	0.343349
6	5.65	3.2273282	0.3715403
7	5.9	2.9919797	0.398524
8	6.15	2.7540979	0.420397
9	6.4	2.5192506	0.4474672
10	6.65	2.2719462	0.452093
11	6.9	2.0325948	0.4707714
12	7.15	1.7959793	0.4939152

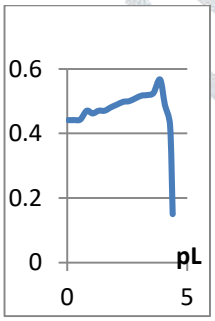
13	7.4	1.6166174	0.6236839
14	7.65	1.3879807	0.6566956
15	7.9	1.1579018	0.6868405
16	8.15	0.9316008	0.7218296
17	8.4	0.7150573	0.7697844
18	8.65	0.4978653	0.8150089

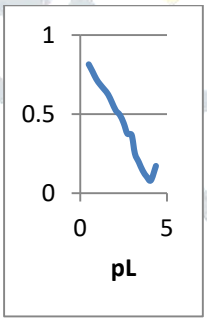
13	7.4	1.5509019	0.5022477
14	7.65	1.3095013	0.5168262
15	7.9	1.0794114	0.5501486
16	8.15	0.8497788	0.5834684
17	8.4	0.6174987	0.6116873
18	8.65	0.4047534	0.6694983

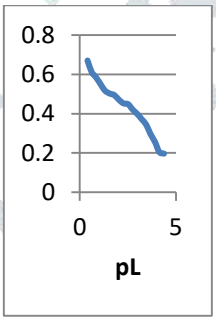
Table (vii)- -The $\bar{n}$ And pL values of Ligand 3, 4, 5-TBT with Mn (II) in TX-100

Sr. No.	pH	pL	$\bar{n}$
1	3.9	4.5548375	0.0934879
2	4.15	4.3360027	0.1595063
3	4.4	4.1018807	0.1921242
4	4.65	3.8685887	0.2259312
5	4.9	3.6214072	0.2311852
6	5.15	3.3914367	0.2710247
7	5.4	3.1619244	0.3108583
8	5.65	2.9293617	0.344101
9	5.9	2.6914242	0.3666128
10	6.15	2.4587359	0.3984628
11	6.4	2.226398	0.4303252
12	6.65	1.9978832	0.4682495
13	6.9	1.7779535	0.5199585
14	7.15	1.5519796	0.5599362
15	7.4	1.3351695	0.613429
16	7.65	1.1106982	0.6532138
17	7.9	0.8626259	0.6559323
18	8.15	0.624741	0.6742332
19	8.4	0.3904634	0.6977048
20	8.65	0.1795948	0.7544803









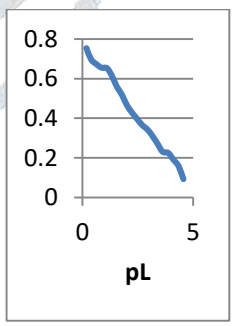


Fig- 1 Fig- 2 Fig-3 Fig- 4 Fig-5

Figures 1-5 show plots between $\bar{n}$ And pL values of ligand 3, 4, 5-TBT with Mn (II) in Alc.+water, alcohol, HTAB, SDS and TX-100 medium respectively.

Biological study

Zone of inhibition has been shown (mm) in fig-6.

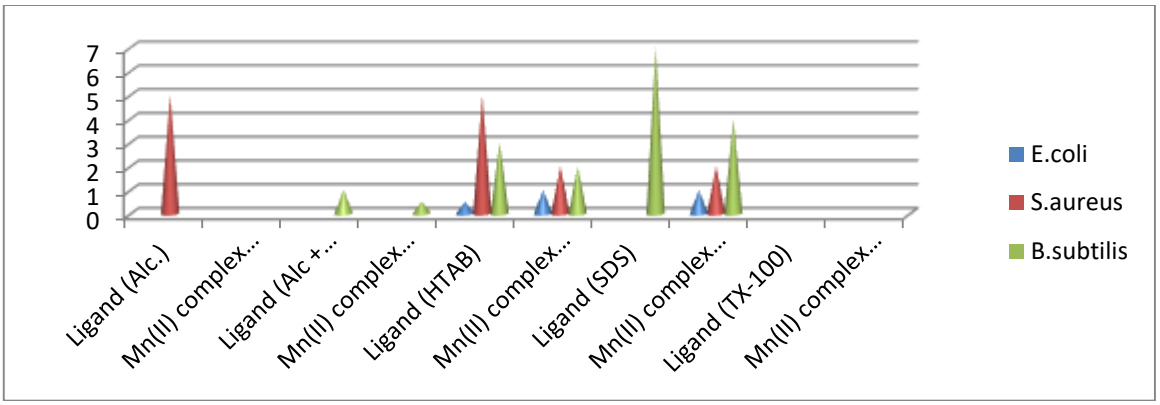


Fig- 6 Biological activity of thiosemicarbazone group containing , ligand and their Mn (II) complexes against *E coli., S.aureus, B.subtilis* in different medium

5. CONCLUSION

The values of log K are greater than zero, which exhibits the formation of metal ligand complexs by potentiometrically.

Maximum zone of inhibition is found for ligand in SDS micellar system against *B. subtilis*.

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