

SYNTHESIS, EVALUATION, ANTIBACTERIAL AND ANTIFUNGAL ACTIVITIES OF N, N-DIMETHYLNAPHTHYLAMINE AND ITS COMPLEXES WITH I-B AND IIB METALS

Hafiz Muhammad Farooq

Institute of Chemistry, University of the Punjab, Lahore, Pakistan.
(Present address: Government Islamia College Railway Road, Lahore.)

Contact: farooqchem@yahoo.com

ABSTRACT: *N,N*-dimethylnaphthylamine and its complexes with IB and II-B metals are reported. Physical properties of ligand such as miscibility, relative density, viscosity, surface tension, refractive index and λ_{max} are determined. Compounds are examined on the basis of spectroscopic and analytical data. Antibacterial and antifungal activities of *N,N*-dimethylnaphthylamine and its metal complexes are reported against some pathogenic bacteria by diffusion plane method.

Key words: Tertiary arylamine, *N,N*-dimethylnaphthylamine, antibacterial and antifungal activities,

INTRODUCTION

Bock and co-workers [1-2] reported the synthesis of *N,N*-dialkyl naphthylamine by irradiating with ultra violet or visible light or heating a mixture of substituted or unsubstituted aromatic compounds and *N*-chloro dialkylamine in acidic medium. Shoro and co-workers [3] treated halonaphthalene with dialkylamine in the presence of sodium amide to give *N,N*-dialkyl arylamine.

Amination of naphthalene sulphate with $R-NH_2$ ($R =$ methyl, ethyl, *n*-propyl, iso-propyl, *n*-butyl, cyclohexyl) in the presence of sodium amide was reported by Kenichi and co-workers [4]. Shiryar and co-worker [5] reported *N*-alkylation of alpha or beta naphthylamine with meta or para $C_6H_4(SO_3Me)_2$, $1,3,5-C_6H_3(SO_3Me)_3$, $1,5-C_{10}H_6(SO_3Me)_2$ to obtain *N,N*-dimethylammoniumnaphthalene. Another facile *N*-alkylation of naphthylamine by condensing with diisopropylamine in the presence of iodine was reported by Schmerling [6].

Only few reports are available in literature regarding the reaction of *N,N*-dimethylnaphthylamine and their derivatives with metals. Reaction of 8-(dimethyl amino) naphthyl lithium with $CuBr$ in diethyl ether was carried out by Erik [7] and a tetramer copper complex was obtained. Its crystal structure revealed a tetra nuclear Cu -aggregate in which the copper atoms are arranged in the parallelogram and are three contred, two electron bridges by carbon of the naphthyl group. The amines coordinate pairwise to opposite copper atoms. Two distinct types of copper atoms i.e., two nucleophilic with four coordinate sites exist [7,8].

MATERIALS AND METHODS:

All chemicals used were of Analar grade. Solvents were of reagent quality and dried prior to use. *N,N*-dimethylnaphthylamine was prepared by reacting alpha bromonaphthalene with dimethylamine under reflux for 4^h. *N,N*-dimethylnaphthylamine complexes with IB and IIB metals were obtained by refluxing metal salt and ligand (1:2) in ethanol-water mixture (2:1). The product was filtered off, washed with distilled water, ethanol and *n*-hexane and dried through vacuum line to get the compound.

Melting/Decomposition points of the complexes were taken on Gallenkamp M.P. Apparatus and reported uncorrected. Viscosity of the ligand was determined by using Technico-VS 250 viscometer size No. B.S/1P/RF. Water was used as reference solvent. The surface tension of the ligand was measured by Stalagmometer and refractive index was taken on Abbe's Refractometer.

λ_{max} of the ligand was taken in ethanol (absolute) on Hitachi UV-visible Spectrophotometer. Model U-2000. Infrared spectra of the ligand and complexes were recorded in thin film and nujol mulls respective by in the spectral range of $4000-400\text{ cm}^{-1}$ on Hitachi Infrared Spectrophotometer, Model 270-30. Estimation of metal was carried out on varian Atomic Absorption Spectrophotometer, Model AA-1275 and estimation of nitrogen was s Kjeldahl's method.

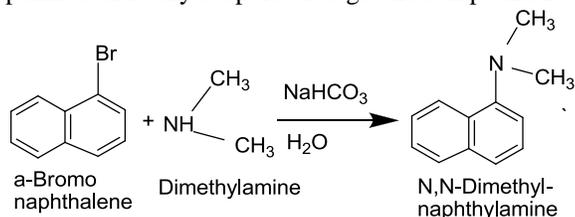
The antibacterial and antifungal activities of the ligand and its complexes were investigated by diffusion plate method. The antibacterial activities present in different compounds were determined by using diffusion plate method. *Micrococcus luteus*, *Staphylococcus aureus* *Bacillus subtilis*, *Escherichia coli* were used as test organism.

Biological activities 11, 12 of metal ions, ligand and their complexes were determined by diffusion plat method against some species of bacteria such as *Bacillus subtilis* (B.S), *Escherichia coli* (E.c), *Micrococcus luteus* (M.I.) and *staphylococcus aureus* (S.a) and a fungus *Aspergillus flavus*. Assay medium was set before the addition of agar. The nutrient agar was also used for the bioassay. The bioassay medium consisted of (g/L):- beef extract 1.0, yeast extract 2.0, peptone 5.0, NaCl 5.0, agar 15.0, and water 1000 mL. pH of the medium was adjusted to 7 before the addition of agar. The medium was then dispensed in 250 mL Erlenmeyer flask and sterilized at 15 psi pressure for 30 minutes. The petri plates were washed and sterilized in the oven at 120^oC overnight. 20 mL of the molten bio-assay medium was poured in the sterile plates and allowed to set. 4.0 mL of the molten assay medium incubated with predetermined concentrations of the microorganisms and spread uniformly over the first layer. After setting the second layer, four wells of 0.8 cm were made in the plates, aseptically using stainless borer. An emulsion of the sample in Gum acacia was used for

testing its biological activities, 0.12 mL of the emulsion was added to a hole incubated at 37°C for 24 hours. Clear zones of inhibition were developed and the diameter of the zones of inhibition were measured in mm.

SYNTHESIS OF N, N-DIMETHYLNAPHTHYLAMINE:

α -Bromonaphthalene (35 mL, 0.5 mole), carbon tetrachloride (250 mL), NaHCO₃ (42 g, 0.5 mole) and distilled water (100 mL) were taken in a quickfit flask equipped with water condenser. Dimethylamine (25.3 mL, 0.5 mole) was added to the reaction mixture through condenser with the help of a separating funnel dropwise to avoid fuming. The mixture condenser with the help of a separating funnel dropwise to avoid fuming. The mixture was refluxed for 4h. The mixture was allowed to cool down and then filtered off. The filtrate was transferred to a separating funnel where two layers were formed. The organic layer (lower) was collected and passed through column packed with silica gel No. 60 (70-230 mesh ASTM). Ethanol eluted light yellow layer which was further purified on rotary evaporator to get the compound I.



Yield 72.18%, b.p. 303±2°C, Relative Density 1.634g/mL at 20°C., Viscosity 4.632g/cm⁻¹ Sec-1, Surface Tension 60.60 Dynes cm⁻¹ at 20°C. Refractive Index: 1.733 at 25°C, λ_{max} : 225 nm in ethanol (absolute). Infrared absorption bands are noted at wave number(cm⁻¹) 3375 broad, 3025vs, 2940w, 1700m, 1600vs, 1580vs, 1510vs, 1400vs, 1350m, 1270vs, 1220vs, 1150vs, 1080vs, 1040vs, 980vs, 880vs, 820vs.

REACTION OF N,N-DIMETHYLANAPH-THLAMINE WITH:

a) Copper(II) Chloride

N,N-dimethylnaphthylamine (0.33 mL, 2.0 mmol) in ethanol (20mL) was mixed solution of CuCl₂ (0.170g, 1.0mmol) in distilled H₂O (10mL). The reaction mixture was refluxed for 3h to get light green solid which was filtered, washed thrice with distilled water, ethanol and n-hexane and dried through vacuum line to get compound II. (d.p/m.p) 124.5±2°C, yield = 41.5%, %M Exp. (Theor.) 25.3 (27.3). Infrared absorption bands are noted at wave number (cm⁻¹) 3300 broad, 3100w, 2800m, 1680m, 1580vs, 1320w, 1220w, 1030w, 950w, 850w, 650w, 530w.

b) Silver Nitrate

N,N-dimethylnaphthylamine (0.33 mL, 2.0 mmol) in ethanol (10mL) was mixed with clear solution of AgNO₃ (0.169, 1.0 mmol in distilled H₂O) (10mL). The reaction mixture was stirred for 3h to get light black coloured crystals. The crystals were filtered, washed thrice with distilled water, ethanol and n-hexane and dried through vacuum line to get he compound III. (d.p/m.p. 167.0 ± 2°C, yield = 47.4%, %M Exp. (Theor.) 36.0 (38.8). Infrared absorption bands are noted at wave

numbers (cm⁻¹) 3400 broad, 3100w, 1720w, 1680m, 1580w, 1550m, 1320m, 1180w, 1140w, 1080w, 1050w, 980m, 940w, 880s, 840m, 820w, 780s, 500m.

c) Gold (III) Chloride

N, N-dimethylnaphthylamine (0.33 mL, 2.0 mmol) in ethanol (10mL) was mixed with yellow solution of AuCl₃ (0.393g, 1.0 mmol) in distilled water (10 mL). The reaction mixture was stirred for 3h to get brown solid, which was filtered, washed with distilled water, ethanol and n-hexane and dried through vacuum line to get the compound (IV) (d.p/m.p = 180, ±2°C, yield = 30.9%, %M: Exp. (Theor.) 51.1 (53.8). Infrared absorption bands are noted at wave numbers (cm⁻¹) 3460m, 3380 broad, 3150m, 1640m, 1580w, 1550w, 1320w, 1280w, 1230w, 1180w, 1020w, 940m, 920m, 850m, 790w, 510w.

d) Zinc (II) Chloride

N,N-dimethylnaphthylamine (0.33 mL, 2.0 mmol) in ethanol (20 mL) was mixed with clear solution of ZnCl₂ (1.36 g, 1.0 mmol) in distilled H₂O (10 mL). The reaction mixture was refluxed for 3h to get white solid which was filtered, washed thrice with distilled water, ethanol and n-hexane and dried through vacuum line to get compound (v), (d.p/m.p 160 ± 2°C, yield = 37.2%, %M: Exp. (Theor.) 23.7 (24.1). Infrared absorption bands are noted at wave number (cm⁻¹) 3300 broad, 3070w, 2830m, 1680m, 1530vs, 1320w, 1220w, 1030w, 940w, 810w, 645w, 555w.

e) Cadmium(II) Chloride

N,N-dimethylnaphthylamine (0.33 mL, 2.0 mmol) in ethanol (20 mL) was mixed with clear solution of CdCl₂ (0.201 g, 1.0 mmol) in distilled H₂O (10 mL). The reaction mixture was refluxed for 3h to get off-white solid which was filtered, washed thrice with distilled water, ethanol and n-hexane and dried to get compound (VI). (d.p/m.p: 140o ± C, yield = 35.3%, %M: Exp. (Theor.) 33.5 (35.2) Infrared absorption bands are noted at wave numbers (cm⁻¹) 3310 broad, 3040w, 2850m, 1680m, 1500vs, 1300w, 1200w, 1015w, 9600m, 830m, 665m, 575w.

f) Mercury (II) Chloride

N, N-dimethylnaphthylamine (0.33 mL, 2.0 mmol) in ethanol (20mL) was mixed with clear solution of HgCl₂ (0.2712g, 1.0 mmol) in distilled H₂O (10 mL). The reaction mixture was refluxed for 3h to get yellow solid which was filtered, washed thrice with distilled water, ethanol and n-hexane and dried to get compound (VII). (d.p/m.p 140 ±2°C, yield = 55.1%, %M: Exp. (Theor.) 47.5 (49.5) (49.3) Infrared absorption bands are noted at wave numbers (cm⁻¹) 3300 broad, 3050w, 2810m, 1650m, 1540vs, 1310s, 1220m, 1010m, 960m, 800m, 670m, 550w.

RESULTS AND DISCUSSION

N, N-dimethylnaphthylamine was prepared which forms stable complexes with IB and IIB metals. Infrared absorption spectrum of N, N-dimethylnaphthylamine indicates Ar-H stretching frequency at 3025 cm⁻¹. The infrared band at 2940 cm⁻¹ is assigned to C-H stretching vibration for methyl groups C-H bending for methyl groups is indicated at 1400 and 1350 cm⁻¹ due to symmetrical and unsymmetrical

vibration respectively. Aromatic C = C vibration is observed at 1600 cm^{-1} and absorption band at 1040 cm^{-1} may be assigned to in plane bending of =C-H⁹. In case of N, N-dimethylnaphthylamine complexes with IB and IIB metals lowering of frequency occurs in the region of $1600\text{-}1300\text{ cm}^{-1}$ and is indicative of coordinate bond formation. Certain new bands appeared below 600 cm^{-1} which may be assigned to M-N bonds [9-12].

Estimation of metal by AAS technique indicates 1:1 ratio of metal to the ligand. N, N-dimethylnaphthylamine and its metal complexes were screened for their antibacterial and antifungal activities by diffusion plate method. Results of antibacterial activities indicate that N, N-dimethylnaphthylamine has very little activity. In case of IB metal complexes maximum activity was exhibited by Cu(II) and Au>(III) complexes against *Staphylococcus aureus* (S.a) and *Escherichia coli* (E.C), respectively.

Cu(II) complex shows antibacterial activity against four bacteria in the order:

Bacillus subtilis > *Micrococcus luteus* > *Staphylococcus aureus* > *Escherichia coli*

In case of IIB metal complexes, it was observed that antibacterial activity increases down the group i.e.,

Zn(II) Complex < Cd(II) Complex < Hg(II) Complex

And maximum activity exhibited by Hg(II) complex against *Micrococcus luteus* (M.I).

Antifungal activities of N, N-dimethylnaphthylamine and its complexes with IB and IIB metals were investigated against *aspergillus flavus*. The ligand shows very little activity against *Aspergillus flavus* but its metal complexes are found to be very much active against the fungus. The cadmium (II) complex shows maximum activity. The overall trend of antifungal activity of metal complexes observed against *Aspergillus flavus* is as under:

Cd(II) Complex > Hg (II) Complex > Zn(II) Complex

Cu(II) Complex > Au(III) Complex > Ag(I) Complex

Table-I: Antibacterial activities exhibited by N, N-dimethylnaphthylamine and its metal complexes

Compound	Inhibition Zone Diameter (mm)			
	E.c	B.s	S.a	M.I
I	10	12	8	8
II	10	13	14	11
III	10	12	9	8
IV	14	12	13	9
V	13	15	13	14
VI	20	20	22	27
VII	22	27	13	29

Table-II: Antifungal activities of N,N-dimethyl-naphthylamine & its IB and IIB metals complexes

No. of Compound	Inhibition Zone Diameter (mm)
I	9
II	17
Compound-III	12
Compound-IV	16
Compound-V	18
Compound-VI	29
Compound-VII	28

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