

Review on application of N-(4-nitrobenzylidene) naphthalen-1-amine Schiff base: Prospects and potentials

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ABSTRACT

N-(4-nitrobenzylidene)naphthalen-1-amine is a simple and easily to be synthesized Schiff base with a characteristic two functional group moieties capable of easy binding to metal to form organometallic compounds, which can be applied in myriad dimensions of applications, spanning from catalysis, antifungal, antiviral, antibacterial, anticancer and analytical tools. Hence the need to maximize its potential for prospective productive and useful Schiff base compounds.

Keywords: Applications, N-(4-nitrobenzylidene)naphthalen-1-amine, Schiff base.

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Introduction

Schiff base compounds play significant role in the development of coordination chemistry related to enzymatic reaction, magnetism and molecular architectures (Wen, 2005, Ismail, 2000, Li and Zhang, 2004). They have various applications as coordinating ligands (Naiya et al., 2011, Neelakantan et al., 2010, Zhou et al., 1999, Abdel-Latif et al., 2007, Valent et al., 2002 and Xie et al., 2010), as catalysts (Gupta and Sutar, 2008, Meneghetti et al., 2000 and Small et al., 1998) in electrochemistry (Goldsby et al., 1989 and Kasumov, 2002) and medicinal values it's also known to have significant potency against pathogenic bacteria (Ibrahim et al., 2011) and it was discovered to exhibit some light sensitive Fluorometric Analytical Reagents (Ibrahim and Sharif, 2007) and range of biological activities. Schiff's bases are aldehyde- or ketone compounds where the carbonyl group is replaced by an azomethine or imine group. Schiff's bases are aldehyde- or ketone compounds where the carbonyl group is replaced by an azomethine or imine group. These are commonly used for industrial purposes. These are the most widely

used organic compounds which are used as intermediates in organic synthesis, catalysts, pigments and dyes, polymer stabilizers, etc. Schiff bases have remained assessed in relation to a wide range of environments, including antimicrobial, antiviral and anticancer activity. They have additionally been measured for the inhibition of amyloid- β aggregation (Bajema et al., 2019).

It has been discovered that the biological activity of some Schiff base ligands became enhanced upon chelation with metal ions (Wang et al., 2005 and Canpolat and Kaya, 2004). In some cases, however, the free ligands do possess higher activity than the corresponding metal complexes (Nair et al., 2006) an indication that activity does not depend solely on the presence of metal ions but rather a synergistic effect of many factors. The activity of the antimicrobial activity some Schiff bases was dependent on the type of the Schiff base moiety (Hamed et al., 2020) Many Schiff base metal complexes have been prepared and screened for their antimicrobial activity. The general structure of a Schiff Base is depicted below.

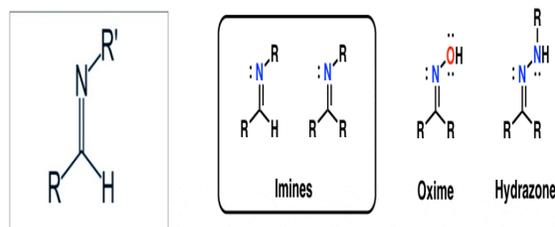


Fig 1. General structure of a Schiff Base

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N-(4-nitrobenzylidene)naphthalen-1-amine
N-(4-nitrobenzylidene)naphthalen-1-amine compound is made up of nitrobenzene and a naphthalene moiety; the substitutes for **R** and **R'** is denoted by nitrobenzene and naphthalene moieties as depicted from the structure diagram of the compound below:-

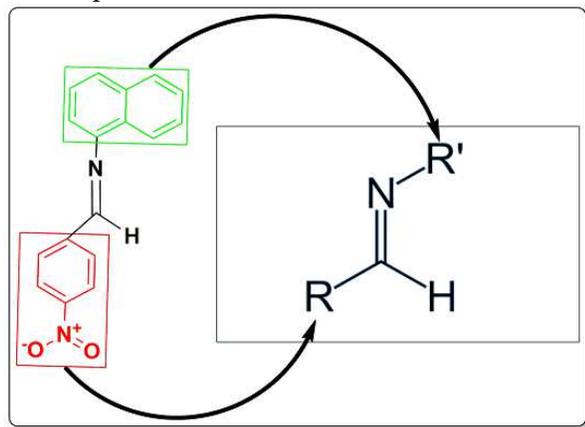
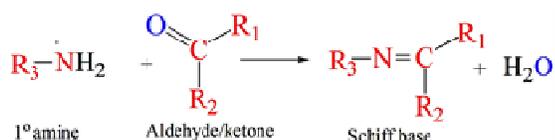


Fig 2. Structure of *N*-(4-nitrobenzylidene)naphthalen-1-amine showing the naphthalene and nitrobenzene moieties fitting into Schiff base framework

Preparation of a typical Schiff base



Scheme 1. General synthesis route for Schiff bases. R is -alkyl or -aryl functionality (Bayehet et al., 2020).

Crystal structure of *N*-(4-nitrobenzylidene)naphthalen-1-amine

The compound's IUPAC name is *N*-(4-nitrobenzylidene)naphthalen-1-amine and sterically could be named (*E*)-*N*-(4-nitrobenzylidene)naphthalen-1-amine but is also called naphthalen-1-yl-(4-nitro-benzylidene)-amine by Wen (2005) and is the first to report its established spatial comprehensive arrangements of crystal structure of *N*-(4-nitrobenzylidene)naphthalen-1-amine.

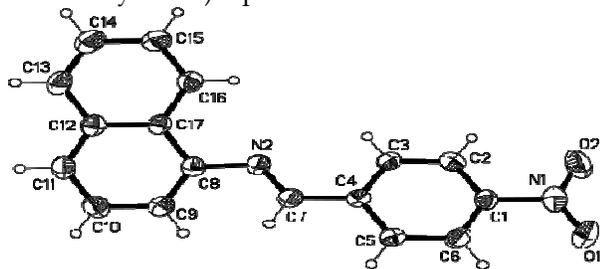


Fig 3. Crystal structure of *N*-(4-nitrobenzylidene)naphthalen-1-amine

The crystal structure of the named compound is built up by only the $\text{C}_{17}\text{H}_{12}\text{N}_2\text{O}_2$ molecules, within which all the bond lengths are in normal ranges (Montalvo-González and Ariza-Castolo, 2003). The dihedral angle between the C1 - C6 phenyl ring and the C8 - C17 naphthalene system is $33.8(4)^\circ$, and the torsion angles are $178.1(2)^\circ$ for C2-C3-C4-C7 and $-177.7(3)^\circ$ for C7-C4-C5-C6. As expected, the molecule adopts a trans configuration about the C7N2 bond. The C7N2 bond length of $1.267(3) \text{ \AA}$ conforms to the value for a normal CN double bond. Because of conjugation through the imino double bond C7N2, the C1 - C6 phenyl ring and the C8 - C17 naphthalene system show a weak distortion. The C7-C4 bond length of $1.469(3) \text{ \AA}$ is shorter than C-C(C) of 1.51 \AA .

Physical Properties *N*-(4-nitrobenzylidene)naphthalen-1-amine

Colour: dark yellow (Ibrahim et al., 2011); solid powder **m.p.** $164\text{-}165 \text{ }^\circ\text{C}$; However when the crystal is grown for ten days it was found to be yellow prismatic in appearance (Wan, 2005).

Properties of *N*-(4-nitrobenzylidene)naphthalen-1-amine

- It is a deep yellow powder
- Its melting point is $164\text{-}165^\circ\text{C}$
- Its very soluble in dimethylsulfoxide (DMSO) but insoluble in water (polar solvent).

Chemical properties of Imines

Imine reactions

Hexafluoroacetone imine is an atypical primary ketimine that is readily isolable.

Imines are susceptible to hydrolysis to the subsequent amine and carbonyl compound.

Imines participate in many reactions that are comparable to the reactions of aldehydes as well as ketones:

-An imine is lowered in reductive amination.

An imine reacts together with an amine to an aminal, see for instance the synthesis of cucurbituril.

-An imine reacts along with dienes in the Aza Diels-Alder reaction to a tetrahydropyridine.

Precursors towards heterocycles:

Unhindered imines incline to oligomerize. This behavior is common place for imines stemmed from formaldehyde, such as $\text{CH}_3\text{N}=\text{CH}_2$, which trimerizes toward the hexahydrotriazine.

Imines are commonly used as intermediates in the synthesis of heterocycles. Aromatic imines reacts with an enol ether to a quinoline in the

Povarov reaction. The C=N bond in imines is reactive toward cycloadditions. Imines react, thermally, along with ketenes in [2+2] cycloadditions to form β -lactams in the Staudinger synthesis. An imine can be dissolved with meta-chloroperoxybenzoic acid (mCPBA) to give an oxaziridine.

A tosylimine reacts along with an α,β -unsaturated carbonyl compound to an allylic amine in the Aza-Baylis-Hillman reaction.

Imines are mediates in the alkylation of amines together with formic acid in the Eschweiler-Clarke reaction.

A change in carbohydrate chemistry including an imine is the Amadori rearrangement.

A methylene transfer reaction of an imine by an unestablished sulphonium ylide can give an aziridine system. Imine reacts with dialkylphosphite in the Pudovik reaction and Kabachnik-Fields reaction.

Acid-base reactions:

Rather like the parent amines, imines are somewhat simple and reversibly protonate to give up iminium salts. Iminium by-products are particularly susceptible to reduction to the amines utilizing transfer hydrogenation or by the stoichiometric act of sodium cyanoborohydride. Ever Since imines derived from unsymmetrical ketones are prochiral, their reduction is a beneficial method for the synthesis of chiral amines.

As ligands:

Imines are common place ligands in coordination chemistry. The compression of salicylaldehyde and ethylenediamine give families of imine-containing chelating agents such as salen.

Imine reductions:

An imine can be abridged to an amine via hydrogenation for instance in a synthesis of *m*-tolylbenzylamine.

Imine hydrogenation:

Other reducing agents are lithium aluminium hydride and sodium borohydride.

The first asymmetric imine reduction was reported in 1973 by Kagan using Ph(Me)C=Nbn and PhSiH_2 in a hydrosilylation with chiral ligand DIOP and rhodium catalyst $(\text{RhCl}(\text{CH}_2\text{CH}_2)_2)_2$. Many systems have since been investigated.

Applications of N-(4-nitrobenzylidene)naphthalen1-amine

It has been used to prepare Cu and Mn metal complexes which were found to be effective anti-

pathogenic toward pathogenic bacteria and fungi (Yerima and Aliyu, 2013).

Anti-Bacteria and Anti-Fungal Properties potential: Ibrahim et al. (2011) carried out an antibacterial and antifungal study of N-(4-nitrobenzylidene)naphthalen1-amine compound it was found that their antimicrobial effect was not observed of nitrobenzylidene)naphthalen1-amine against all bacteria tested. However, Yerima and Aliyu in 2013 confirmed the effective pathogenic effect of N-(4-nitrobenzylidene)naphthalen1-amine copper (II) and manganese(II) complexes²⁴ in contrast, no effect was observed when N-(4-nitrobenzylidene)naphthalen1-amine compound was used alone against all bacteria tested by Ibrahim et al. (2011).

Metal Complexation potential of N-(4-nitrobenzylidene)naphthalen1-amine:

Yerima and Aliyu (2013) reported successful complexation of N-(4-nitrobenzylidene)naphthalen1-amine ligand with copper and magnesium.

Prospects and Potentials of N-(4-nitrobenzylidene)naphthalen1-amine

Due to its easiness to prepare and to form crystals, and complex with transition metals easily via its two moieties in the structure of the compound there is wide potential to harness multidimensional metallic complexes and apply the complexes in catalysis, antimicrobial and anti-cancer applications. Coupled with very little application that was reported on the use and application of N-(4-nitrobenzylidene)naphthalen1-amine.

Conclusion

More application of N-(4-nitrobenzylidene)naphthalen1-amine towards metal complexation; followed by antibacterial, antifungal antiviral and anticancer investigation. This however need to be preceded with a comprehensive and authentic toxicity test of each of the new compounds that might be synthesized.

Reference

- Abdel-Latif S, Hassib H and Issa Y (2007). Studies on some salicylaldehyde Schiff base derivatives and their complexes with Cr (III), Mn (II), Fe (III), Ni (II) and Cu (II). *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*, 67(3-4): 950-957.
- Bajema EA, Roberts KF and Meade TJ (2019). Cobalt-Schiff base complexes: preclinical research and potential therapeutic uses.

- Essential metals in medicine: therapeutic use and toxicity of metal ions in the clinic, *Metal ions in life sciences*, 19: 267-295.
- Bayeh Y, Mohammed F, Gebrezgiabher M, Elemo F, Getachew M and Thomas M (2020). Synthesis, Characterization and Antibacterial Activities of Polydentate Schiff Bases, Based on Salicylaldehyde. *Advances in Biological Chemistry*, 10(5): 127-139.
- Canpolat E and Kaya M (2004). Studies on mononuclear chelates derived from substituted Schiff-base ligands (part 2): synthesis and characterization of a new 5-bromosalicylidene-p-aminoacetophenone oxime and its complexes with Co (II), Ni (II), Cu (II) and Zn (II). *Journal of Coordination Chemistry*, 57(14): 1217-1223.
- Goldsby KA, Blaho JK, Hoferkamp LA (1989). Oxidation of nickel (II) bis (salicylaldimine) complexes: solvent control of the ultimate redox site. *Polyhedron*, 8(1): 113-115.
- Gupta K and Sutar AK (2008). Catalytic activities of Schiff base transition metal complexes. *Coordination Chemistry Reviews*, 252(12-14): 1420-1450.
- Hamed AA, Abdelhamid IA, Saad GR, Elkady NA and Elsabee MZ (2020). Synthesis, characterization and antimicrobial activity of a novel chitosan schiff bases based on heterocyclic moieties. *International journal of biological macromolecules*, 153: 492-501.
- Ibrahim MN and Sharif SE (2007). Synthesis, characterization and use of Schiff bases as fluorimetric analytical reagents. *E-journal of Chemistry*, 4(4): 531-535.
- Ibrahim MN, Sharif SA, El-Tajory AN and Elamari AA (2011). Synthesis and antibacterial activities of some schiff bases. *E-journal of chemistry*, 8(1): 212-216.
- Ismail KZ (2000) Synthesis, spectroscopic, magnetic and biological activity studies of copper (II) complexes of an antipyrine Schiff base. *Transition metal chemistry*, 25(5): 522-528.
- Kasumov VT (2002). Synthesis, spectroscopic and redox properties of nickel (II) salicylaldimine complexes containing sterically hindered phenols. *Transition metal chemistry*, 27(2): 228-233.
- Li ZX and Zhang XL (2004). [N, N'-Bis (2-oxidonaphthylmethylidene) ethane-1, 2-diamine-κ4O, N, N', O'] copper (II). *Acta Crystallographica Section E: Structure Reports Online*, 60(7): 958 - 959.
- Meneghetti PS, Kress J and Lutz PJ (2000). Structural investigation of poly (olefin) s and copolymers of ethylene with polar monomers prepared under various reaction conditions in the presence of palladium catalysts. *Macromolecular Chemistry and Physics*, 201(14): 1823-1832.
- Montalvo-González R and Ariza-Castolo A (2003). Molecular structure of di-aryl-aldimines by multinuclear magnetic resonance and X-ray diffraction. *Journal of molecular structure*, 655(3): 375-389.
- Nair R, Shah A, Baluja S and Chanda S (2006). Synthesis and antibacterial activity of some Schiff base complexes. *Journal of the Serbian Chemical Society*, 71(7): 733-744.
- Naiya S, Wang HS, Drew MG, Song Y and Ghosh A (2011). Structural and magnetic studies of Schiff base complexes of nickel (ii) nitrite: change in crystalline state, ligand rearrangement and a very rare μ-nitrito-1 κO: 2 κN: 3 κO' bridging mode. *Dalton Transactions*, 40(12): 2744-2756.
- Neelakantan M, Esakkiammal M, Mariappan S, Dharmaraja J and Jeyakumar T (2010). Synthesis, characterization and biocidal activities of some schiff base metal complexes. *Indian Journal of Pharmaceutical Sciences*, 72(2): 216.
- Small BL, Brookhart M and Bennett AM (1998). Highly active iron and cobalt catalysts for the polymerization of ethylene. *Journal of the American Chemical Society*, 120(16): 4049-4050.
- Valent A, Melník M, Hudecová D, Dudová B, Kivekäs R and Sundberg MR (2002). Copper (II) salicylidene-glycinate complexes as potential antimicrobial agents. *Inorganica Chimica Acta*, 340: 15-20.
- Wang X, Du Y, Fan L, Liu H and Hu Y (2005). Chitosan-metal complexes as antimicrobial agent: synthesis, characterization and structure-activity study. *Polymer Bulletin*, 55(1): 105-113.
- Wen PH (2005). Crystal structure of naphthalen-1-yl-(4-nitro-benzylidene)-amine,

- C17H12N2O2. Zeitschrift für Kristallographie-New Crystal Structures, 220 (3): 397-398.
- Xie M, Li L, Yang XD, Liu W, Yan S, Niu Y and Meng ZH (2010). A new insulin-enhancing agent:[N, N'-bis (4-hydroxysalicylidene)-o-phenylene-diamine] oxovanadium (IV) and its permeability and cytotoxicity. European journal of medicinal chemistry, 45(6): 2327-2335.
- Yerima I and Aliyu H (2013). Synthesis, physicochemical, antibacterial and antifungal studies of mn (ii) and cu (ii) complexes of n-(4-nitrobenzylidene) naphthalene-1-ylamine Schiff base. Journal of Pharma. and Cosmetic Sci., 1(4): 57-60.
- Zhou YM, Ye XR, Xin FB and Xin XQ (1999). Solid state self-assembly synthesis of cobalt (II), nickel (II), copper (II) and zinc (II) complexes with a bis-Schiff base. Transition Metal Chemistry, 24(1): 118-120.
