Syntheses of di-Schiff’s bases: A comparative study using benzene and water (concept of green chemistry) as solvents

Muhamad Thufail¹, Gita Chawla²*

¹M.Pharm Student, ²Professor, Dept. of Pharmaceutical Chemistry, School of Pharmaceutical Education and Research, Jamia Hamdard (Deemed to be University), New Delhi, India

*Corresponding Author: Gita Chawla
Email: gchawla@jami.hamdard.ac.in

Abstract
Di-Schiff’s bases are normally synthesized from aldehyde and diamine using organic solvents under conditions that remove water azeotropically. Here is a report for the preparation of di-Schiff’s base using both the conventional method and pure water without a catalyst and results were compared. It was observed that yields are better and reaction time is comparatively less when water is used as a solvent.

Keywords: Benzene, Water, Green chemistry.

Introduction
Di-Schiff’s bases are used in organic synthesis and metal ion complexation.¹,² These are reported to have great use as analytical, medicinal, polymer and liquid crystalline materials. Aliphatic and aromatic aldehydes condense with aliphatic diamine to give N, N'-substituted di-Schiff’s base. The preparation of di-Schiff’s base has been carried out by refluxing the mixture of aliphatic diamine and aromatic aldehyde in organic solvents like toluene and benzene in Dean-Stark apparatus under azeotropic condition in order to separate the water formed.³,⁴ The use of solvents is a constant source of worry since it gives rise to toxicity, environmental hazard, pollution and waste treatment issues. Moreover, solvents generally account for the major source of the wasted mass of a given process or a synthetic pathway. From a strictly Green Chemistry point of view, the best answer to this problem would be to run the reactions under neat conditions. The concept of Green Chemistry has been defined as the design of chemical products and processes to reduce or eliminate the use and generation of hazardous substances. Consequently, many efforts have been devoted to the finding of sustainable reaction media, and notably the use of water as solvent has attracted much interest in recent years. Indeed, water offers many advantages because it is a cheap, readily available, non-toxic and non-flammable solvent, thus being very attractive from both an economical and an environmental point of view.⁵ The solvents that currently remain the basis of our chemical operations are still largely organic and contain various health and environmental concerns. Discovering the new applications for ancient reaction media is thus a subject that has been of interest for both Green Chemistry and Environment researchers. There are major opportunities to extend the use of water as a solvent for organic reactions.⁶ In recent years environmentally benign synthetic methods have received considerable attention and some solvent free protocols like water based reaction, microwave irradiation and grindstone method were developed.⁷ Previously, synthesis of di-Schiff’s bases was reported from our laboratory using benzene as the solvent. These compounds were used as intermediates for the formation of tetrahydropyrimidazoles.⁸-¹⁰ Here we are reporting

Results and Discussion
The compounds were synthesized as per the following scheme-

![Scheme used for the preparation of di-Schiff’s bases (1a-h)](image)

In method 1, dry benzene was used as the solvent. Appropriate aldehyde (double the mole of ethylenediamine) and ethylenediamine were refluxed together in dry benzene under Dean Stark assembly to remove the water azeotropically using molecular sieves of A4 size. Reaction mixture was then processed as per the detail given below. In method 2, aldehyde and ethylenediamine were taken in water and stirred at room temperature without using any drying agent or catalyst. Results for the reaction between various aldehydes and ethylenediamine are given in the table 1. It was found that method 1 gave compounds with % yield in the range of 60-92% and reaction time was 8h. While when water was used as the solvent, % yield was from 80-95% and reaction time was 1-3h.

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Table 1: Data of the synthesized compounds

| 1(a-h) | R                                | Reaction time (h) | Yield (%) | M.P. (°C) |
|--------|----------------------------------|-------------------|-----------|-----------|
| (a)    | 4-CH₃O                          | 2                 | 80        | 103-106   |
| (b)    | H                               | 3                 | 80        | 58-62     |
| (c)    | 4-Cl                             | 1                 | 80        | 130-132   |
| (d)    | 4-F                             | 2.5               | 84        | 153-137   |
| (e)    | 4-((CH₃)₂)N                     | 2                 | 84        | 170-174   |
| (f)    | 3,4-OCH₃                        | 2                 | 80        | 150-153   |
| (g)    | 4-OH                            | 1                 | 95        | 90-92     |
| (h)    | *(using cinnamaldehyde C₆H₅CH = CHCHO)* | 3                | 88        | 116-120   |

*compound formed is N1, N₂-bis (3-phenylallylidene) ethane-1, 2-diamine

Materials and Methods

The chemicals and solvents used for the experimental work were commercially procured from different chemical suppliers, such as E. Merck India Ltd. Mumbai (India), S.D. Fine-Chem Ltd. Mumbai (India), CDH Mumbai (India), and Qualigens, Mumbai (India). The solvents and reagents were of laboratory reagent grade. All the synthesized compounds were dried in vacuum desiccators over silica gel. The melting point (M.P.) of each compound was determined using open capillary tubes in the HICON digital instrument (India). Completion of the reaction was monitored using thin-layer chromatography (TLC). The spots were visualized either by exposing the developed and dried plates to iodine vapors or in the ultraviolet (UV) chamber. The 1H NMR spectra of the compounds were recorded on the Bruker DPX-300 NMR spectrometer (Germany) at 300 MHz, using CDCl₃ as solvent. Tetramethylsilane was used as an internal standard, and the values of the chemical shift were given in the δ scale.

Preparation of (1a) is representative of the general procedure employed in two methods.

Method 1

Preparation using organic solvent (benzene)

Anisaldehyde (3 mmol, 0.4 g) and ethylenediamine (1.5 mmol, 0.09 g) were taken in dry benzene (25 mL) and refluxed under Dean-Stark assembly in order to remove the water azeotropically. Molecular sieves of 4 Å size were also added. After removal of water the mixture was refluxed for another 8 h. Excess benzene was distilled off and the solid mass so obtained was recrystallized using methanol.

Method 2

Preparation using water

Anisaldehyde (3 mmol, 0.4 g) was taken in water (30 mL) and ethylenediamine (1.5 mmol, 0.09 g) was added to the mixture. The reaction mixture was continuously stirred on magnetic stirrer at room temperature (time mentioned in the table). The solid thus obtained was filtered off and washed with cold water and dried under vacuum. The solid was recrystallized form mixture of dichloromethane and petroleum ether.

N 1, N₂-bis (4-methoxybenzylidene) ethane-1, 2-diamine

1. (0.32 g, 85%): white prism, mp 103-106°C

1H NMR: 8.2(2H, s, 2×CH=N), 7.62-7.64(4H, d, 2, 6, 2', 6' Ar-H), 6.88-6.9(4H, d, 3, 5, 3', 5' Ar-H), 3.91(4H, s, 2×CH₂), 3.8(6H, s, 2×OCH₃).

N₁, N₂-bis (dibenzylidene) ethane-1, 2-diamine

1b. (0.26 g, 83%): very light yellow prism, mp 58-62°C

1H NMR: 8.27(2H, s, 2×CH=N), 7.70-7.69(4H, d, 2, 6, 2', 6' Ar-H), 7.38-7.36(4H, d, 3, 5, 3', 5' Ar-H), 3.9(4H, s, 2×CH₂).

N₁, N₂-bis (4-chlorobenzylidene) ethane-1, 2-diamine

1c. (0.33 g, 80%): white crystals, 130-132°C

1H NMR: 8.21(2H, s, 2×CH=N), 7.61-7.54(9H, d, 2, 6, 2', 6' Ar-H), 7.34-7.32(4H, d, 3, 5, 3', 5' Ar-H), 3.93(4H, s, 2×CH₂).

N₁, N₂-bis (4-fluorobenzylidene) ethane-1, 2-diamine

1d. (0.35 g, 84%): very light yellow prism, mp 135-137°C

1H NMR: 8.65(2H, s, 2×CH=N), 7.81(4H, d, 3, 5, 3', 5' Ar-H), 7.36(4H, d, 2, 6, 2', 6' Ar-H), 3.95(4H, s, 2×CH₂).

N₁, N₂-bis (4-dimethylaminobenzylidene) ethane-1, 2-diamine

1e. (0.33 g, 84%): light yellow prism, mp 170-174°C

1H NMR: 8.14(2H, s, 2×CH=N), 7.57-7.55(4H, d, 2, 6, 2', 6' Ar-H), 6.66-6.64(4H, d, 3, 5, 3', 5' Ar-H), 3.86(4H, s, 2×CH₂), 2.97(12H, s, 2×N(CH₃)₂).

N₁, N₂-bis (3, 4-dimethoxybenzylidene) ethane-1, 2-diamine

1f. (0.36 g, 80%): light yellow prisms, 150-153°C

1H NMR: 8.17(2H, s, 2×CH=N), 7.24(2H, d, 2, 2', Ar-H), 7.10-7.07(2H, d, 6, 6' Ar-H), 3.90-3.88(16H, s, 4×OCH₃, 2×CH₂).

N₁, N₂-bis (4-hydroxybenzylidene) ethane-1, 2-diamine

1g. (0.27 g, 95%): greenish yellow prisms, mp 90-92 °C

1H NMR: 8.3(2H, s, 2×CH=N), 6.7-7.4(8H, m Ar-H), 3.9(4H, s, 2×CH₂).

N₁, N₂-bis (3-phenylallylidene) ethane-1, 2-diamine

1h. (0.42 g, 88%): yellow plates, mp 116-120 °C

1H NMR: 8.05(2H, d, 2×CH=N), 7.45(2H, d, 2×CH=CH), 7.26-7.37(8H, m Ar-H), 6.87-6.97(2H, m, 2×CH=CH), 3.85(4H, s, 2×CH₂).

Conclusion

We have synthesized di-Schiff’s bases by using different solvents. Di-Schiff’s base formation using water required less time compared to the time consumed by the synthesis in organic solvent (dry benzene). The percentage yield was also high in the aqueous method compared to the synthesis in organic solvent. The method 2, i.e. using water is convenient.
easy to use, did not require any drying agent or catalyst, fast and gives better yield.

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**Conflict of Interest**
None.

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