

온화한 반응조건에서 One Pot 다성분 반응을 통해 이종원자고리를 포함 한 새로운 시프염기의 쉽고 편리한 합성 및 특성

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Facile and Convenient Synthesis and Characterization of Novel Schiff Bases Involving Heterocyclic Ring through One Pot Multicomponent Reactions under Mild Conditions

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요 약. 이종원자고리 알데히드, 수산화 암모늄, 그리고 다른 알데히드, 이 세가지 성분을 사용한 새로운 시프 염기 one pot 합성은 편리하고 효과적인 방법이다. 또한 몇가지 편리하고 이점 있는 시프 염기들을 알데히드와 디아민으로 합성할 수 있었다. 이 반응에서 원하는 생성물을 온화한 조건에서 짧은 반응시간 및 높은 수율로 쉽게 얻을 수 있었다.

주제어: 시프 염기(이민), 이종원자고리 알데히드, 지방족 알데히드, 수산화 암모늄

ABSTRACT. A convenient and efficient procedure for one pot preparation of novel Schiff bases through three component reactions of heterocyclic aldehyde, ammonium hydroxide and other aldehydes is described. Also, some convenient and benefit Schiff bases have been prepared by two component reaction, from aldehyd and diamine. In this reaction, the desired products were easily obtained in excellent yields and in short reaction times under mild conditions.

Keywords: Schiff Base, Heterocyclic Aldehyde, Aliphatic Aldehyde, Ammonium Hydroxide

INTRODUCTION

Schiff base ligands have been extensively studied over past few decades of the various classes of Schiff bases which can be prepared by condensation of different types of amines and carbonyl compounds. The salicylaldimines, potential O, N-donors are very popular due to divers chelating ability.¹ Schiff bases that have solvent dependent Uv-Vis spectra (solvatochromicity) can be suitable NLO (non linear optical active) materials.² These ligands offer a versatile and flexible series of compounds having properties for practical applications.³ Tetradentate Schiff bases with N₂O₂ donor atom set are

well known to coordinate various metal ions, and this has attracted the interest of many authors.⁴⁻⁷

Schiff base complexes find many applications such as a model compounds for the study of the active sites of metallo-enzymes,⁸ solid phase extraction of metal ions⁹ and etc. With attention to the importance of these ligands, each year many papers instead literature have been published regarding the synthesis¹⁰ and their application^{11,12} in different fields for various purposes.

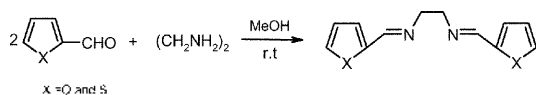
Recently multi-component reactions constitute an especially attractive synthetic strategy for rapid and efficient generation due to the fact that the products are formed in a single step and the diversity can be

achieved simply by varying the reacting components.¹³ The importance of these one-pot three component reactions in such synthesis has been demonstrated in the Mannich, Ugi, Biginell and aza-Baylish-Hillman reactions.¹⁴⁻¹⁷

In continuation of our current efforts on research,^{11,18-30} we are focused on the development of the multi-component reaction and the utilization of these processes toward the synthesis of novel Schiff bases. In this study, we report a practical and efficient three component reactions by reacting heterocyclic aldehydes with other aldehydes and ammonium hydroxide at room temperature. Also, we report treatment of heterocyclic aldehydes and ethylenediamine under mild conditions.

RESULTS AND DISCUSSIONS

As shown in *Scheme 1*, when 2 mols heterocyclic aldehyde were treated with 1 mol ethylenediamine at room temperature, a pail yellow substance obtained with high yield. In this reaction, heterocyclic aldehydes have been applied and corresponding products were obtained. The results and conditions



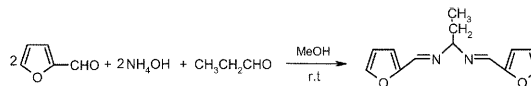
Scheme 1. The reaction of heterocyclic aldehydes with ethylene diamine.

of the reactions are presented in *Table 1*.

As can be seen in our previously reported works on synthesis of Schiff bases from ortho-hydroxy aldehyde^{11,12} and ortho-hydroxyl ketone,¹⁸⁻²⁰ the presence of hydroxyl group in ortho situation is accelerated condensation reaction. While, in used heterocyclic aldehydes, with respect to absence of *o*-hydroxy group, the corresponding Schiff bases were obtained in high yields and appropriate reaction times (*Table 1*, Entries 1, 2).

With attention to the importance of the multi-component reaction, in continuation of this study, the preparation of Schiff base ligands have been investigated via one pot three component reactions. When 1 mol of propanal, 2 mols of ammonium hydroxide and 2 mols of furfural in methanol solution at room temperature were reacted together at one step reaction, the yellow product, 2,2'-[1,1-propanediylbis-(nitrilomethylidene)] bis-furane was produced with excellent yield at short reaction time (*Scheme 2*).

When the above mentioned reaction was performed in the presence of salicylaldehyde, furfural and ammonium hydroxide in methanol solution at room temperature, corresponding product, N,N'-bis



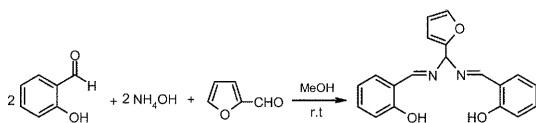
Scheme 2. Three component reaction of furfural, ammonium hydroxide and propanal.

Table 1. Preparation of Schiff base containing heterocyclic rings through two and three component reaction

Entry	Substrate(1)	Substrate(2)	Product	Time (h)	M.P (°C)	Yield ^a (%)
1		Ethylenediamine		3.4	78-80	85
2		Ethylenediamine		4.5	90-92	85
3 ^b		Propanal		4	84-86	95
4 ^b		Furfural		3	88-90	95

^a) Isolated product yields

^b) Third substrate is ammonium hydroxide



Scheme 3. Synthesis of N,N'-bis(2-hydroxybenzylidene)-1,1'-(2-furylmethane)diamine.

(2-hydroxybenzylidene)-1,1'-(2-furylmethane)-diamine was obtained with excellent yield and short reaction time (Scheme 3). The results of these investigations were summarized in Table 1.

The structures of the products were confirmed by spectroscopic methods. In the IR spectra, the characteristic Schiff base C=N stretching frequency is formed in the region between $\nu=1600-1700\text{ cm}^{-1}$ as a signal strong band. The O-H stretching frequency is found at $\nu=3400\text{ cm}^{-1}$ with particular width. The stretching vibration of C-H in the alkyl groups appear at region between $\nu=2700-2800\text{ cm}^{-1}$ with sharp absorptions. In the $^1\text{H NMR}$ spectra, the broad signal with $\delta=12.4\text{ p.p.m.}$ is assigned to the O-H groups. Two protons of C=N have the same chemical shifts in $\delta=8.30-8.46\text{ p.p.m.}$ and the signal around the $\delta=4.0-6.0\text{ p.p.m.}$ is assigned to the protons of the NCHN.

CONCLUSION

In this study, we have been reported an efficient, convenient and mild two and three component method for synthesis of some novel Schiff base ligands containing heterocyclic ring. The products have been afforded in excellent yields and short reaction times under mild conditions.

EXPERIMENTAL

Materials

All the materials were of commercial reagent grade. The salicylaldehyde and other aldehyde compounds were purified by standard procedures. The purity of them was determined by thin layer chromatography (TLC) and gas chromatography (GC).

Apparatus

Chemicals were purchased from the Merck Chemical Company in high purity. IR spectra were recorded as KBr pellet on a Perkin-Elmer 781 Spectrophotometer and an Impact 400 Nicolet FTIR Spectrophotometer. $^1\text{H NMR}$ spectra were recorded in CDCl_3 with (400 MHz) Spectrometer using of TMS as an internal reference. Melting points were obtained with a Yanagimoto micro melting point apparatus are uncorrected. Mass spectra were recorded on a Finnigan MAT 44S, by Electron Ionization (EI) mode with an ionization voltage of 70 eV. The elemental analyses (C, H, N) were obtained from a Carlo ERBA Model EA 1108 analyzer. The purity determination of the substrates and the reactions monitoring were accomplished by TLC on silica-gel polygram SII.G/UV 254 plates.

General Procedure for Synthesis of 2, 2'-[1,2-ethanediylbis-(nitrilomethylidene)]bis-furane

To the stirred solution of furfural (4 mmol) in 5 ml MeOH ethylenediamine (2 mmol) was added at room temperature. The reaction was continued for 3.4 h. The progress of the reaction was monitored by TLC. After the reaction was completed, the brown oil was collected and dissolved in hot petroleum ether. After cooling pail yellow solid product was obtained. The precipitate was filtered off and washed with cold MeOH. The crude product was purified by recrystallization in ethanol and the pure Schiff base, 2,2'-[1,2-ethanediylbis-(nitrilomethylidene)]bis-furane was obtained in 85% yield, m.p.=78-80 °C. The structure of the Schiff base was confirmed by physical and spectroscopic methods.

General Procedure for Synthesis of N,N'-bis(2-hydroxybenzylidene)-1,1'-(2-furylmethane)diamine

To the stirred mixture of salicylaldehyde (0.4 g, 3.27 mmol) and furfural (0.16 g, 1.64 mmol) in MeOH, NH_4OH (0.25 g, 3.27 mmol) was added. The reaction was continued to 3 h at room temperature. The progress of the reaction was monitored by TLC. After the reaction was completed, the reaction mixture turned yellow. After cooling, the solid product was formed and then this product was filtered off

and washed with cold MeOH. The crude product was purified by recrystallization in ethanol and the pure Schiff base, *N,N'*-bis(2-hydroxybenzylidene)-1,1-furylmethanediamine was obtained in 95% yield, m.p.=88-90 °C. The Schiff base products were identified by physical and spectroscopic methods.

2,2'-[1,2-ethanediylbis-(nitrilomethylidene)]bis-furane: mp 78-80 °C; IR (KBr)/ ν (cm⁻¹) 3050, 2900, 1627 (s, C=N), 1450, 1540 (Ar); ¹H NMR/CDCl₃/ δ p.p.m 3.96 (s, 4 H, 2 CH₂N), 6.5-7.2 (m, 6 H, Ar), 8.2 (s, 2 H). ¹³C NMR /CDCl₃/ δ p.p.m; 170, 148, 142, 120, 110, 43; MS: m/z=217 (M⁺+1, 6%), 216 (M⁺, 10), 108 (55), 39(90), 29 (97), Anal. Calcd. For C. H. N.: C, 66.67, H, 5.56; N, 12.96; O, 14.81; Found; C, 66.58; H, 5.61; N, 12.96, O, 14.85.

2,2'-[1,2-ethanediylbis-(nitrilomethylidene)]bis-thiophene: mp 90-92 °C; IR (KBr)/ ν (cm⁻¹) 3050, 2900, 1623 (s, C=N), 1450, 1540 (Ar); ¹H NMR/CDCl₃/ δ p.p.m 3.6 (s, 4 H, 2 CH₂N), 6.6-7.3 (m, 6 H, Ar), 8.3 (s, 2 H); ¹³C NMR /CDCl₃/ δ p.p.m; 171, 149, 144, 123, 118, 45. MS: m/z=249 (M⁺+1, 5%), 248 (M⁺, 10), 123 (42), 58 (85), 45 (87), 39 (92); Anal. Calcd. For C. H. N.: C, 58.06; H, 4.84; N, 11.29; S, 25.81; Found; C, 58.22; H, 4.82; N, 11.26; S, 25.70.

2,2'-[1,1-propanediylbis-(nitrilomethylidene)]bis-furane: mp 84-86 °C; IR (KBr)/ ν (cm⁻¹) 3050, 2900, 1625 (s, C=N), 1450, 1550 (Ar); ¹H NMR/CDCl₃/ δ p.p.m 0.9 (t, 3 H, CH₃), 1.8 (qu, 2 H, CH₂), 4 (t, 1 H, NCHN), 6.9-7.4 (m, 6 H), 8.2 (s, 2 H, HC=N); ¹³C NMR/CDCl₃/ δ p.p.m; 171, 147, 143, 120, 114, 82, 25, 20; MS: m/z =231 (M⁺+1, 4%), 230 (M⁺, 8), 136 (78), 41(66), 39 (88), 29 (95); Anal. Calcd. For C. H. N.: C, 67.83; H, 6.09; N, 12.17; O, 13.91; Found; C, 67.98; H, 6.06; N, 12.14; O, 13.82.

***N,N'*-bis(2-hydroxybenzylidene)-1,1-(furylmethane)-diamine:** mp 88-90 °C; IR (KBr)/ ν (cm⁻¹) 3400-3700 (br, OH), 3100, 2900, 1625 (s, C=N), 1485, 1576 (Ar); ¹H NMR/DMSO/ δ p.p.m 6 (s, 1 H, NCHN), 6.2-7.8 (m, 11 H, Ar), 8.3 (s, 2 H, HC=N), 12.4 (s, 2 H, OH); ¹³C NMR/CDCl₃/ δ p.p.m; 174, 156, 148, 137, 130, 128, 122, 120, 118, 113, 92; MS: m/z=

321 (M⁺+1, 3%), 320 (M⁺, 8), 91 (85), 79 (80), 77(60), 39 (85), 29 (90); Anal. Calcd. For C. H. N.: C, 71.25; H, 5.00; N, 8.75; O, 15.0; Found; C, 71.41; H, 4.97; N, 8.71; O, 14.91.

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