

Synthesis and structural studies of bis[(*N*-2-bromo-3-phenyl-allylidene)thiosemicarbazone and bis[4-(*N*-2-bromo-3-phenyl-allylidene)-phenyl] ether: as Schiff bases

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Abstract: Preparation of two Schiff bases via efficient condensation of α -bromocinnamaldehyde and thiosemicarbazide or bis(4-aminophenyl) ether is described in high yield at 100 °C, methanol solvent and neutral PH. The elemental analyses, FT-IR, ¹H NMR and ¹³C NMR spectroscopy are agreed with two new Schiff bases structures.

Keywords: Schiff base, α -Bromocinnamaldehyde, Thiosemicarbazone, Ether, Amine.

Introduction

The carbon-nitrogen double bond plays a vital role in the progresses of chemistry science [1]. In 1864 Schiff Hugo Josef first discovered Schiff bases as compounds including the carbon-nitrogen double bond [2]. They usually synthesize from an primary amine and a carbonyl compound by nucleophilic addition forming a hemiaminal, followed by a dehydration to generation imine [2]. Schiff bases have been widely studied as ligands in the field of coordination chemistry mainly due to their facile syntheses, nitrogen easily availability, electronic properties and good solubility in common solvents [3,4]. They can also bind with different metal centers involving various coordination sites and lead to successful synthesis of metallic complexes with interesting stereochemistry [3-5]. Azomethines (Schiff bases) use for antiviral, antibacterial, anticancer therapeutics, antiinflammatory, anticonvulsant, antimicrobial and biological activities [6-15]. For example, some Schiff bases derived from benzoin, salicylaldehyde, amino phenol and 2,4-dinitrophenyl hydrazine have anti

tumor activity [16] or [Cu(Pyimpy)Cl₂] has anticancer potential [17]. Some other azomethines also apply as liquid crystal [18]. Therefore, the synthesis of Schiff bases still is important and interesting for chemists.

We describe synthesis of two new Schiff bases named bis[(*N*-2-bromo-3-phenyl-allylidene)thiosemicarbazone 3 and bis[4-(*N*-2-bromo-3-phenyl-allylidene)-phenyl] ether 5 through the reaction α -bromocinnamaldehyde 1 with thiosemicarbazide 2 and/or bis(4-aminophenyl) ether 4 at 100 °C in methanol solvent, respectively (Schemes 1 and 2).

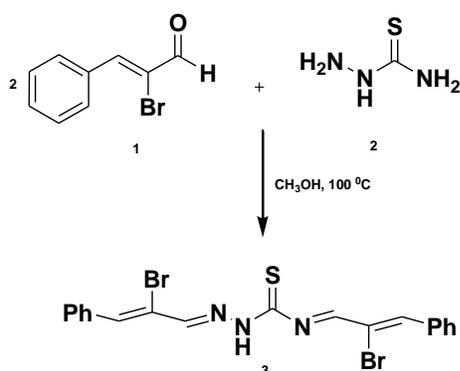
Results and discussion

The reactions led to generation of Schiff bases 3 and 5 in 78–85% yields (Schemes 1 and 2). Structures of compounds 3 and 5 were assigned by elemental analyses, FT-IR, ¹H NMR and ¹³C NMR.

Bis[(*N*-2-bromo-3-phenyl-allylidene)thiosemicarbazone 3 was easily synthesized, with a relatively excellent yield (85%). This Schiff base formed of the reaction of α -bromocinnamaldehyde 1 with thiosemicarbazide 2 (neutral PH), in the molar ratio 2:1 (Scheme 1). The obtained compound 3 was a yellow

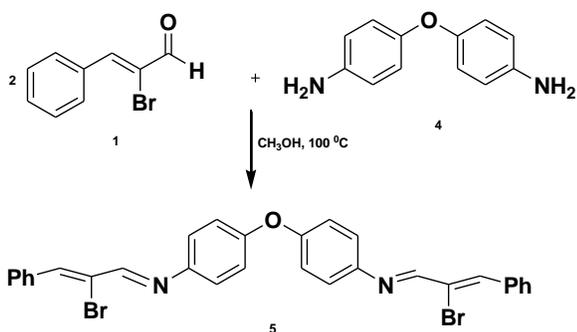
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solid. The structure of 3 was determined by elemental analyses, FT-IR and NMR spectroscopy. Its FT-IR spectrum appeared absorption of C=N at 1603 cm^{-1} . The NMR data were agreement with 3 structures. The ^{13}C NMR spectrum of 3 showed C=N ($\delta=141.3$ and 149.8 ppm), thiocarbonyl ($\delta=178.9$ ppm), and aromatic ($\delta=134.5, 132.8, 131.1, 129.6, 128.2, 127.5, 126.3$ and 125.6 ppm) carbons (Scheme 1). Melting point of this reagent obtained $234\text{--}236\text{ }^\circ\text{C}$. This compound is highly soluble in solvents such as DMSO. It is not soluble in methanol. In addition, this reagent is less soluble in ethanol. This reagent may be stored for long period in the absence of air and moisture.



Scheme 1: Synthesis of bis[(*N*-2-bromo-3-phenyl-allylidene] thiosemicarbazone 3

Bis[4-(*N*-2-bromo-3-phenyl-allylidene)-phenyl] ether 5 was easily synthesized, with a relatively excellent yield (78%). This Schiff base prepared by the reaction of α -bromocinnamaldehyde with bis(4-aminophenyl) ether (neutral pH), in the molar ratio 2:1 (Scheme 2).



Scheme 2: Synthesis of bis[4-(*N*-2-bromo-3-phenyl-allylidene)-phenyl] ether 5.

The obtained compound was a white solid. The structure of 5 was determined by elemental analyses, FT-IR and NMR spectroscopy. Its FT-IR spectrum appeared one absorption of C=N at 1609 cm^{-1} . The

NMR data were agreement with 5 structures. The ^{13}C NMR spectrum of 5 showed C=N ($\delta =142.3$ ppm), aromatic ($\delta =132.0, 131.7, 131.5, 131.1, 130.7, 130.4, 129.7$ and 129.3 ppm) carbons. Melting point of this reagent obtained $211\text{--}213\text{ }^\circ\text{C}$. This compound is highly soluble in solvents such as DMSO. It is not soluble in methanol. In addition, this reagent is less soluble in ethanol. This reagent may be stored for long period in the absence air and moisture.

The reaction mixtures were thoroughly stirred for 120 minutes at $100\text{ }^\circ\text{C}$ and neutral pH. The neutral pH is suitable for these reactions because amines are basic compounds. If amines are protonated, they become non-nucleophilic and carbinolamine formation (as intermediate) cannot occur. During the reaction, the color of mixture changed from colorless to yellow or white, providing visual means for ascertaining the progress of imine formation. The Schiff bases 3 and 5 afforded higher yields with shorter reaction times. The Schiff base products (3 and 5) can be easily isolated by simple filtration and evaporation of solvent.

Schiff bases usually form a sequence of two types of reactions, addition followed by elimination. A tentative mechanism for this transformation is proposed in Scheme 3. Thiosemicarbazide 2 and/or bis(4-aminophenyl) ether 4 as a nucleophile molecule were attacked to α -bromocinnamaldehyde 1. They (as amine) are a stronger nucleophile than methanol (as an alcohol). These reactions were progressed through the intermediate formation of a carbinolamine. These reactions were completed by separation of productions (3 and 5) and removal of water.

These Schiff bases can be used as potential ligands for complexation with metal ions. They prove to be many advantages as compared with similar Schiff bases including: easier preparations, application to PH sensitive molecules, high yields, short reaction times, lower aldehyde/amine ratio, lower solvent requirement and simple work-up.

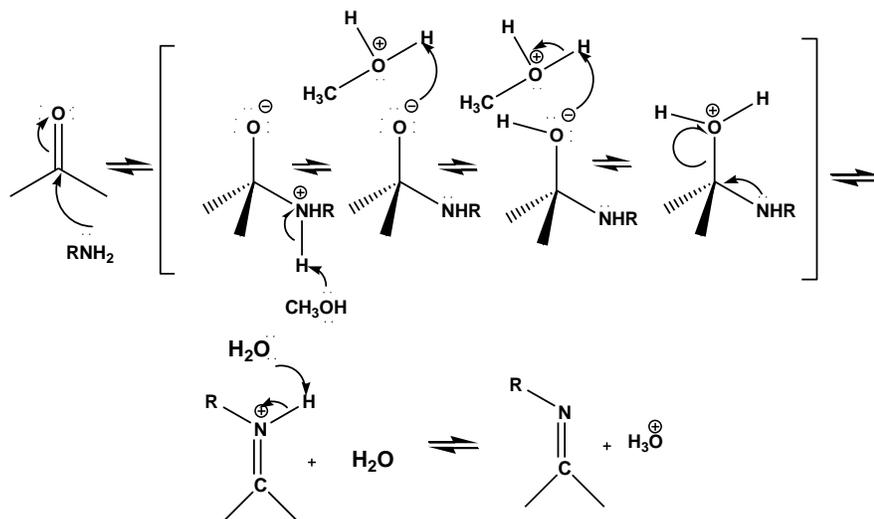
Conclusion

Two new Schiff base, bis[(*N*-2-bromo-3-phenyl-allylidene] thiosemicarbazone 3 and bis[4-(*N*-2-bromo-3-phenyl-allylidene)-phenyl] ether 5, easily synthesized with a relatively excellent yield (78-85%). The elemental analyses, FT-IR, ^1H NMR, and ^{13}C NMR spectroscopy were agreed with two new Schiff bases structures. Strong vibrational band at 1603.8 and 1609.6 cm^{-1} were confirmed the presence of imine bonds ($\text{C}=\text{N}$) in bis[(*N*-2-bromo-3-phenyl-allylidene] thiosemicarbazone and bis[4-(*N*-2-bromo-3-phenyl-allylidene)-phenyl] ether, respectively.

Experimental

Compounds were obtained from Merk and were used without further purification. Melting points were measured on an Electro thermal 9100 apparatus. Elemental analyses were performed for C, H, and N using a Heraeus CHN-O-Rapid analyzer. IR spectra

Scheme 3: General mechanism



Synthesis of Bis[(N-2-bromo-3-phenyl-allylidene)thiosemicarbazone 3]:

For synthesis of this Schiff base, α -bromocinnamaldehyde (0.422 g, 2 mmol) was dissolved in 20 ml methanol and was carefully added to thiosemicarbazide (0.091 g, 1 mmol) dissolved in 10 ml methanol over 5 min with stirring at 100 °C. After 2h, a yellow solid precipitated and were collected on a sintered glass funnel. The solid was washed with methanol several times and dried under vacuum. The purity of synthesized compounds was checked by TLC using silica gel G (Yield: 0.406 g, 85%; mp 234-236 °C). FT-IR ν_{max} (KBr) 3430, 1603, 1546, 1350, 1220 cm^{-1} ; ^1H NMR (DMSO- d_6 , 500 MHz) δ 7.3-7.7 (10H, m, -Ph), 7.8 (1H, s, -CH=CBr), 7.9 (1H, s, -CH=CBr), 8.4 (1H, s, N=CH), 8.6 (1H, s, N=CH), 11.7 (1H, s, =N-NH). ^{13}C NMR (DMSO- d_6 , 125 MHz) δ 110.1 (C=*CBr), 111.3 (C=*CBr), 125-135 (-2Ph), 135.4 (BrC=C*-Ph), 141.3 (C=N), 143.6 (BrC=C*-Ph), 149.8 (C=N), 178.9 (C=S). Anal. C 47.65%, H 3.39%, N 8.63%, Calcd for $\text{C}_{19}\text{H}_{15}\text{N}_3\text{SBr}_2$, C 47.82%, H 3.17%, N 8.81%.

Synthesis of Bis[4-(N-2-bromo-3-phenyl-allylidene)-phenyl] ether 5:

For synthesis of this Schiff base, α -bromocinnamaldehyde (0.422 g, 2 mmol) was

were recorded on a Bomen FT-IR-MB100 Spectrometer. ^1H NMR and ^{13}C NMR spectra was determined using BRUKER-DRX500 AVANCE instrument (in DMSO at 500 and 125 MHz, respectively). The results were agreed favorably with the calculated values.

dissolved in 20 ml methanol and was carefully added to bis(4-aminophenyl) ether (0.200 g, 1 mmol) dissolved in 10 ml methanol over 5 min with stirring at 100 °C. A white solution was obtained after 60 minutes. After 2h, a white bloated solid precipitated. The solid were collected on a sintered glass funnel. That was washed with methanol several times and dried under vacuum. The purity of synthesized compounds was checked by TLC using silica gel G (Yield: 0.457 g, 78%; mp 211-213 °C). FT-IR ν_{max} (KBr) 1654, 1609, 1454, 1211 cm^{-1} ; ^1H NMR (DMSO- d_6 , 500 MHz) δ 7.0-7.4 (10H, m, -Ph), 7.5-8.0 (8H, dd, -OPh), 8.4 (2H, s, CH=CBr), 9.4 (2H, s, -N=CH). ^{13}C NMR (DMSO- d_6 , 125 MHz) δ 112 (Br*C=C), 129-132 (4Ph), 138 (BrC=C*-Ph), 142.3 (C=N). Anal. C 61.52%, H 3.47%, N 4.43%, Calcd for $\text{C}_{30}\text{H}_{22}\text{N}_2\text{OBr}_2$, C 61.46%, H 3.78%, N 4.78%.

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