v. 3, n. 1, 2022

Journal of
Engineering
Research

GREEN SYNTHESIS OF NEW CHIRAL HALOGENATED IMINES

María Guadalupe Silvia Hernández Téllez
Lab. Síntesis de Complejos. Chemistry Science Courses. Benemérita Universidad Autónoma de Puebla. Puebla, Mexico

Gloria Elizabeth Moreno Morales
Lab. Síntesis de Complejos. Chemistry Science Courses. Benemérita Universidad Autónoma de Puebla. Puebla, Mexico

Ángel Mendoza Martínez
Lab. Síntesis de Complejos. Chemistry Science Courses. Benemérita Universidad Autónoma de Puebla. Puebla, Mexico

René Gutiérrez Pérez
Lab. Síntesis de Complejos. Chemistry Science Courses. Benemérita Universidad Autónoma de Puebla. Puebla, Mexico

Abstract: This research deals with the synthesis of chiral imines, also known as Schiff bases, using the "Solvent Free" method of Green Chemistry, which allows the development of processes that reduce or eliminate the use and generation of substances hazardous to human health and the environment. environment. On the other hand, chiral imines show versatile coordination behavior in the formation of metal complexes, allowing the synthesis of a large number of interesting structures with potential applications in the areas of biology, catalysis, as well as thermal, magnetic, and electrical properties. This paper reports the synthesis of chiral imines, from 4-chlorobenzaldehyde and optically active halogenated aromatic primary amines: (R)-(+)-1-(4-fluorophenyl) ethylamine, (S)-(-)-1-(4-chlorophenyl)ethylamine and (S)-(-)-1-(4-bromophenyl)ethylamine, in the absence of solvent. The structure of the imines was fully confirmed by X-ray diffraction studies.
Keywords: Green chemistry, chiral, imines.

INTRODUCTION

The Green Chemistry philosophy is focused on eliminating or at least reducing the sources of contamination with the intention that new products and processes do not endanger any form of life. Chemistry plays an important role in the investigation and establishment of the necessary conditions to achieve sustainable development, achieve new approaches to solve problems caused to the environment and avoid causing new problems. In the coming years, the concepts of Sustainable Development and Green Chemistry will continue to take an important place within sectors such as the industrial, governmental and social sectors, in order to achieve, this way, favorable decisions for the environment. The simple fact of considering the impact that a new substance that is obtained through Green Chemistry implies, either at an environmental or human level; it is a key difference from conventional chemistry.

The means used by Green Chemistry focus on the reduction or elimination of the use of toxic chemical products and the recycling of waste produced by technological progress, in a creative way in such a way that a minimum impact on human beings is achieved. and the environment, without sacrificing scientific and technological progress.

One of the principles of Green Chemistry proposes the use of benign solvents, which are not flammable, toxic and do not produce emissions of volatile organic compounds derived from their use as a reaction medium in the chemical and pharmaceutical industry, in order to minimize the production of contaminants and by-products. To provide a solution, the development of a compound synthesis technique known as "Solvent Free" is proposed. This technique drastically reduces the production of effluent waste and air pollution; In addition to this methodology, it also has other advantages such as greater reactivity, a maximum concentration of reagents, and greater productivity due to the smaller amount of material in the same volume of the reactor. Also, washing and extraction processes are simplified, or possibly avoided. (Tanaka and Toda, 2000)

Most organic reactions have been studied in solution, one reason for this is due to Aristotle's famous philosophy, "No Coopora nisi Fluida". Most of the reactions are carried out with solvent even though there is no special reason. In some cases organic reactions in the solid state occur more efficiently and selectively than in solution. (All. 1995). Schiff's bases are biologically active compounds, including antibacterial, fungicidal, and anticancer activity. (Vanco et al., 2008)

DEVELOPMENT

The synthesis of three new chiral imines from 4-chlorobenzaldehyde and optically active halogenated aromatic primary amines is reported: (R)-(+)-1-(4-fluorophenyl) ethylamine, (S)-(-)- 1-(4-chlorophenyl) ethylamine and (S)-(-)-1-(4-bromophenyl) ethylamine in the absence of solvent using a Green Chemistry technique: "reactions in dry medium" a medium free of solvent, which which resulted in an excellent yield of the imines (Figure 1). Reactions in dry media in many cases occur more selectively and efficiently than reactions in solution, since in these, the molecules in a crystal are arranged in a compact and regular manner. In addition, reactions in a dry medium have many advantages: reduced contamination, low cost, simplicity in processes and handling. (Tanaka. 2003)

IR spectra were recorded on the Perkin Elmer Spectrum One FT-IR spectometer Universal ATR. The 1H NMR and 13C NMR spectra were performed on the Bruker-500 equipment (500 MHz); chemical shifts are expressed in ppm towards low fields taking tetramethylsilane (TMS) (δ=00) as reference. The mass spectra were carried out using the electronic impact (IE) technique, they were recorded with a JEOL JMS-SX 102a spectrometer operated in the positive ion mode at 70 eV, the data are expressed in mass/charge units (m/z). Optical rotation was measured on a Perkin-Elmer 241 polarimeter. Melting points were determined on the Electrothermal MEL-TEMP 3.0 apparatus.

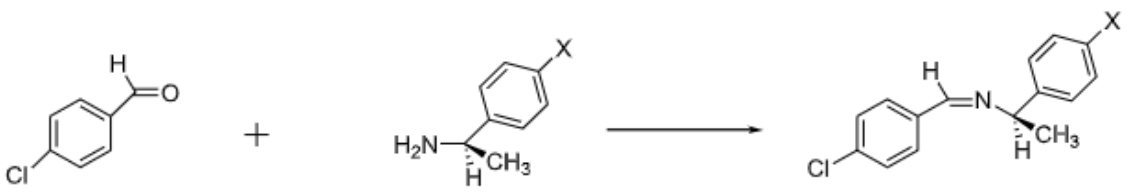
RESULTS AND DISCUSSIONS

The reaction of 4-chlorobenzaldehyde in the presence of halogenated chiral amines in equimolar proportions led to the formation of the corresponding imines.

SYNTHESIS OF FLUORINATED IMINE

The synthesis of the compound (R)-(-)-[1-(4-fluorophenyl)-N-1-(4-chlorophenylmethylidene)]ethylamine was carried out by reacting 4-chlorobenzaldehyde (213.9 mg, 1.52 mmol) and (R)-(+)-1-(4-fluorophenyl)ethylamine (211.8 mg, 1.52 mmol) by means of the technique in a dry medium, obtaining a white solid, with a yield of 99%, a melting point between:79-80 °C y un $[\alpha]_D^{25^\circ}$ = - 87.5 (c = 1, $CHCl_3$).

FT-IR vmax: 1634 cm-1(C=N), ^{1}H RMN ($CDCl_3$/TMS): δ = 1.58 (d, 3H $CHCH_3$, C3), 4.54 (q, 1H, $CHCH_3$, C1), 7.07 (m, 2H; H-Ar;), 7.41 (m, 4H; H-Ar;), 7.73 (m, 2H; H-Ar;) 8.34 (s, 1H; HC=N, C2). ^{13}C RMN (CDCl3/TMS): δ = 25.02 ($CHCH_3$, C3), 69.07 ($CHCH_3$, C1), 115.14, 115.31, 128.06, 128.12, 128.86, 129.47,



4 - chlorobenzaldehyde

X=Fluorine, chlorine, bromine

Imines

Figure 1. General reaction for the synthesis of halogenated imines from aldehyde and halogenated chiral primary amines.

134.73, 136.63, 140.68, 140.70, 160.83, 162.78, (C-Ar, C4, C5-9, C6-8, C7, C10, C11-15, C12-14, C13), 158.20 (HC=N, C2).

The mass spectrum allows us to observe the molecular ion of the compound I.E. (m/z): 261 M•+ and confirms the proposed molecular formula: $C_{15}H_{13}ClFN$. The structure of this new compound was confirmed by X-ray diffraction of the single crystal (Figure 2).

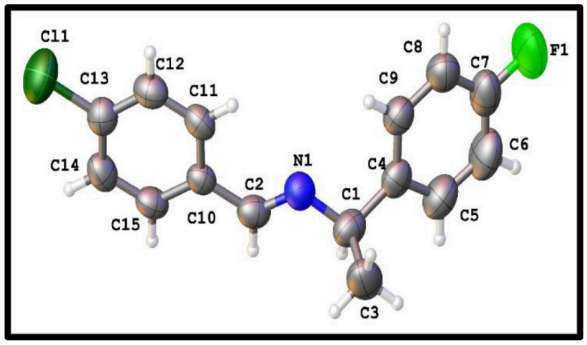


Figure 2. X-ray structure of (R)-(-)-[1-(4-fluorophenyl)-N-1-(4-chlorophenylmethylidene)] ethylamine.

CHLORINATED IMINE SYNTHESIS

The synthesis of the compound (S)-(-)-[1-(4-chlorophenyl)-N-1-(4-chlorophenylmethylidene)]ethylamine was carried out by reacting 4-chlorobenzaldehyde (200.5 mg, 1.42 mmol) and (S)-(-)-1-(4-chlorophenyl) ethylamine (222.0 mg, 1.42 mmol) by means of the technique in dry medium, obtaining a white solid with a yield of 92% and a melting point: 69-71 °C, y $[\alpha]_D^{25^\circ}$= +96.4 (c = 1, $CHCl_3$).

FT-IR vmax: 1634 cm-1(C=N), 1H RMN ($CDCl_3$/TMS): δ = 1.57 (d, 3H $CHCH_3$,C3), 4.52 (q, 1H, $CHCH_3$, C2), 7.33 (m, 2H; H-Ar;), 7.39 (m, 4H; H-Ar;), 7.73 (m, 2H; H-Ar;) 8.34 (s, 1H; HC=N, C1). 13C RMN ($CDCl_3$/TMS): δ = 24.97 ($CHCH_3$, C3), 69.09 ($CHCH_3$, C2), 127.98, 128.58, 128.87, 129.48, 132.57, 134.67, 136.69, 143.50, (C-Ar, C4, C5-9, C6-8, C7, C10, C11-15, C12-14, C13), 158.39 (HC=N, C1).

The mass spectrum allows us to observe the molecular ion of the compound I.E. (*m/z*): 277 $M^{\bullet+}$ and confirms the proposed molecular formula: $C_{15}H_{13}Cl_2N$. The structure of this new compound was confirmed by X-ray diffraction of the single crystal (Figure 3).

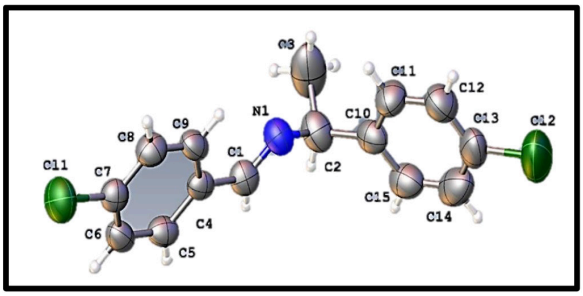


Figure 3. X-ray structure of (S)-(+)-[1-(4-chlorophenyl)-N-1-(4-chlorophenylmethylidene)] ethylamine.

SYNTHESIS OF THE BROMINATED IMINE

The synthesis of the compound (S)-(+)-[1-(4-bromophenyl)-N-1-(4-chlorophenylmethylidene)]ethylamine was carried out by reacting 4-chlorobenzaldehyde (195.3 mg, 1.38 mmol) and (S)-(-)-1-(4-bromophenyl) ethylamine (278.0 mg, 1.38 mmol) by means of the technique in a dry medium, obtaining a white solid, with a yield of 95% and a melting point between:86-88 °C and $[\alpha]_D^{25^\circ}$= +68.7 (c = 1, $CHCl_3$).

FT-IR vmax: 1633 cm^{-1}(*C*=N), ^{1}H RMN ($CDCl_3$/TMS): δ = 1.57 (d, 3H $CHCH_3$, C2), 4.51 (q, 1H, $CHCH_3$ C1), 7.32 (m, 2H; *H*-Ar;), 7.40 (m, 2H; *H*-Ar;), 7.48 (m, 2H; *H*-Ar;),7.73 (m, 2H; *H*-Ar;) 8.34 (s, 1H; *H*C=N, C1).^{13}C RMN ($CDCl_3$/TMS): δ = 24.94 ($CHCH_3$, C2), 69.14 ($CHCH_3$, C1), 120.68, 128.37, 128.88, 129.48, 131.53, 134.66, 136.70, 144.03, (*C*-Ar, C3, C4-8, C5-7, C6, C10, C11-15, C12-14, C13), 158.43 (HC=N, C9).

The mass spectrum allows us to observe the molecular ion of the compound I.E. (*m/z*): 322 $M^{\bullet+}$ and confirms the proposed molecular formula: $C_{15}H_{13}BrClN$.

The structure of this new compound was confirmed by single crystal X-ray diffraction (Figure 4).

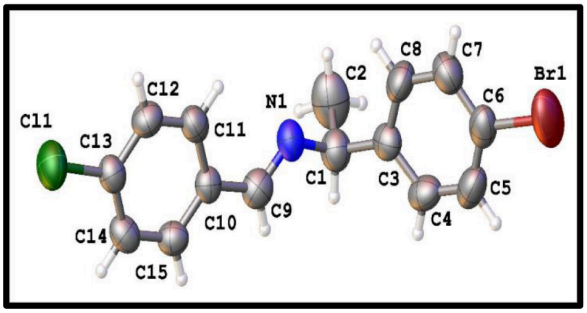


Figure 4. X-ray structure of (S)-(+)-[1-(4-bromophenyl)-N-1-(4-chlorophenylmethylidene)] ethylamine.

CONCLUSIONS

Using Green Chemistry, the new halogenated chiral imines have been synthesized, obtaining excellent yields, improving the image of traditional Chemistry, obtaining friendly products with the environment and human health. These compounds will be used to synthesize metal complexes, to later study their behavior in catalytic and pharmacological studies. The products were characterized using spectroscopic techniques: IR, Nuclear Magnetic Resonance: ^{1}H y ^{13}C and the structures of the synthesized imines were confirmed by X-ray diffraction.

REFERENCES

Tanaka K., Toda F. (2000). *Chem. Rev*. 100: 1025–1074.

Tanaka K., (2003). Solvent-free Organic Synthesis. Wiley-VCH GmbH & Co KGaA, p. 294.

Toda F., (1995). Solid State Organic Chemistry: Efficient Reactions, Remarkable Yields, and Stereoselectivity. *Acc. Chem. Res.*, 28: 480-486.

Vanco J., Marek J., Travnicek Z., Racanska E., Muselik J., Svajlenova O. (2008). *J. Inorg. Biochem*., 102: 595.