

Green preparation and characterization of 1-(*p*-aminophenyl)-2,5-dimethylpyrrole

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Introduction

Paal-Knorr pyrrole synthesis is formed by the reaction of ammonia or primary amine with a 1,4-dicarbonyl compound¹. An application of the Paal-Knorr synthesis is the reaction between the aniline and the 2,5-hexanedione; typical experiments is suggested in heterocyclic chemistry college courses (proposed in 1992 by Shaw *et al*)².

Therefore, recently in our research group was obtained the 1-(*p*-nitrophenyl)-2,5-dimethylpyrrole using the typical procedure of Paal-Knorr pyrrole synthesis. In this work, the reduction of this compound was carried out and 1-(*p*-aminophenyl)-2,5-dimethylpyrrole was obtained as an organic procedure approach environmentally friendly. The nitro group reduction was performed by reaction of 1-(*p*-nitrophenyl)-2,5-dimethylpyrrole with ammonium formate (NH₄HCO₂), palladium supported on charcoal (Pd/C), dissolved in ethyl acetate (AcOEt) under an inert nitrogen atmosphere and promoted by ultrasound (as an alternative chemical activation source), using the context of green chemistry. The solid obtained was purified by column chromatography in a system hexane/ethyl acetate, using silica gel (SiO₂) gave a clear yellow solid whose formula is C₁₂H₁₄N₂. The reaction yield was 90%, finally the compound was characterized by spectroscopic methods: infrared (IR), proton nuclear magnetic resonance (¹H NMR) and carbon-13 nuclear magnetic resonance (¹³C NMR); clear yellow crystals was obtained by cristalization from dichloromethane/hexane mixture, and its structure was confirmed by X-ray diffraction; melting point also was determined (96°C).

Experimental procedure

The preparation was performed under the following experimental procedure: In a two-necked flask were placed 50 mL of 200 mg (0.925 mmol) of 1-(*p*-nitrophenyl)-2,5-dimethylpyrrole, 291.5 mg (4.625 mmol, 5 eq) of ammonium formate

(NH₄HCO₂) and 98 mg (0.1 eq, 10% mol) of Pd/C (10 wt%) and dissolved in 5 mL of ethyl acetate (EtOAc) under inert nitrogen atmosphere. The reaction mixture was sonicated (Figure 1) and monitored every 10 minutes until complete consumption of starting materials (1 hour) by thin layer chromatography (SiO₂, CH₂Cl₂/hexane 1:1).

The reaction mixture was filtered in a Buchner funnel with glass filter type integrated with celite (approximately 3 cm), and washed with EtOAc and the organic phases were collected and concentrated *in vacuo* using a rotary evaporator. The crude reaction was purified by column chromatography in one system hexane/ethyl acetate, using silica gel (SiO₂) gave a clear yellow solid whose formula is C₁₂H₁₄N₂. Finally, the 1-(*p*-aminophenyl)-2,5-dimethylpyrrole pure was stored under nitrogen to prevent future oxidation³.

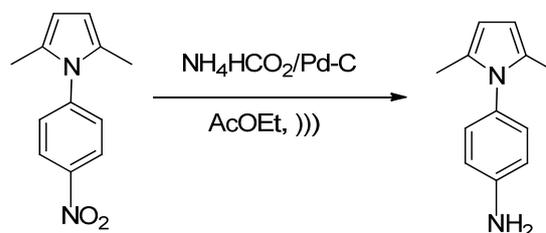


Fig. 1 – Green preparation of 1-(*p*-aminophenyl)-2,5-dimethylpyrrole.

Melting point determination: It was obtained by adding 45 mL of edible oil to a Thiele tube. It was placed, a small sample of the compound 1-(*p*-aminophenyl)-2,5-dimethylpyrrole in properly sealed capillary tube on one side immediately after the capillary tube was subjected to a thermometer and was placed inside the tube Thiele after was heated using a Bunsen burner and determined the melting point⁴.

Crystallization: Yellow crystals was obtained from 100 mg of 1-(*p*-aminophenyl)-2,5-dimethylpyrrole diluting with 15 mL of dichloromethane and 15 mL of hexane. X-ray diffraction was carry out and crystalline structure of 1-(*p*-aminophenyl)-2,5-dimethylpyrrole was obtained (figure 2).

Results and discussion

Ultrasound reaction was performed using a Cole-Palmer ultrasonic bath model 08890-21. Gave a light yellow solid, with the formula C₁₂H₁₄N₂, its corresponding molecular weight is 186.25 g/mol, the reaction yield is 90% and specific melting point is 96°C. The spectroscopic interpretation results are:

Infrared (IR) signals shown in aromatic region at 3030 cm⁻¹, with test signals at 1600 and 1500 cm⁻¹ to near 825 cm⁻¹, there are bands corresponding to the aromatic nucleus replacement in positions 1.4 (*p*), at 2920 cm⁻¹ shows a characteristic signal of methyl groups, which test signal is observed at 1400 cm⁻¹, at 3400 and 1610 cm⁻¹, signals are identified primary aromatic amine group. In 1310 and 1270 cm⁻¹ were found characteristic signals attributed to tertiary amine *N*-substituted pyrrole^{5,6}.

Proton Nuclear Magnetic Resonance (¹H NMR) (CDCl₃, 500 MHz), between 6.7 and 7 ppm are two typical signals for hydrogens in *p*-substituted benzene ring, two triple double signals at 6.96 ppm (d, *J*=2.5, 8.5 Hz, 2H) and 6.68 ppm (d, *J*=2.5, 8.5 Hz, 2H), respectively, is seen at 5.86 ppm singlet for integrating two hydrogens, 3.74 ppm singlet is observed that integrates for two hydrogens of the amine primary observed at 2.01 ppm singlet 6 integrates intense hydrogens, which may be assigned to the two methyl groups^{5,6}.

Carbon-13 Nuclear Magnetic Resonance (¹³C NMR) (CDCl₃, 125 MHz) (Figure 3), at 145.8 ppm and 129.6 ppm are ipso carbons of the aromatic ring, at 129 ppm has a signal for two ipso carbons of the pyrrole ring, signal at 128.9 ppm corresponding to two carbons of the benzene ring, at 115.0 ppm other signal is localized for two carbons in benzene ring; at 104.9 ppm is identified a signal assigned to two carbons of pyrrole ring and finally at 12.9 ppm is observed a signal for two methyl groups.

The resulting crystal structure is shown in Figure 2.

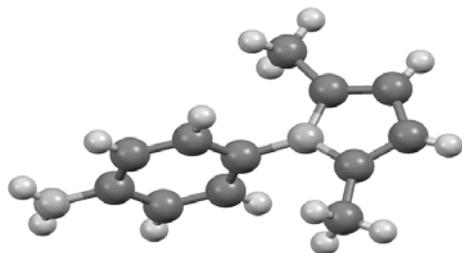


Figure 2 – Crystal structure of 1-(*p* aminophenyl)-2,5-dimethylpyrrole.

Conclusions

Using ultrasonic radiation to carry out the reaction allowed us to improve the performance and response time, compared with reported data, and applied some of the principles of green chemistry and the use of solvents less aggressive to the environment and the use of alternative energy chemical activation. With the compound spectroscopic characterization (IR, ¹H NMR and ¹³C NMR) and crystallographic study result, it was found that the proposed structure corresponds with the expected structure.

Acknowledgements

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