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| **CHEM202 LABORATORY REPORT** | | **Name:** | | Harry Stanley |
| **Experiment 4** | **Lab Day:** | **Thursday** | **Date:** | **3/04/25** |

***Synthesis of a substituted quinoline***

**Abstract**

In this experiment, a mono-substituted quinoline was synthesised via the Skraup synthesis by refluxing a substituted aniline with glycerol under strongly acidic and oxidizing conditions (conc. H2SO4, I2, FeSO4). Glycerol dehydrated to form acrolein, followed by coupling of the aniline with the acrolein to produce a quinoline ring system. After 90 minutes of reflux at 150oC the reaction mixture was then neutralized and worked up by extraction, drying and removing solvent. The product was then analysed using 1H NMR, including COSY and NOESY data which allowed for precise assignment of proton signal and confirmation of the unknown starting aniline.

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**Experimental**

The experiment was performed as detailed in the CHEM202 laboratory manual (p29), without modification. The accurate masses used of the reagents are detailed below.

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| **Substance** | **Formula** | **Mr** | **mass (g)** | **amount (mmol)** |
| 4-(tert-butyl)aniline | C10H15N | 149.23 | 0.863 | 5.78 |
| Glycerol | C3H8O3 | 92.09 | 3.09 | 33.55 |

During the reaction acid vapours were minimised by maintaining a proper reflux under the fume hood. After the reaction was completed the acid solution containing the product was neutralised using 5M NaOH until it tested basic on litmus paper. The celite used to gravity filter the solution was disposed of in the celite waste container. After washing of the solution, the aqueous layer was disposed of down the fume hood sink with excess water, the organic extract was dried using anhydrous MgSO4 which was filtered of and disposed of down the fume hood sink with excess water. Diethyl ether was distilled of from the product using the rotary evaporator.

**Results and calculations**

### Percentage yield calculation

The limiting reagent in this reaction was (**4-(tert-butyl)aniline**).

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| --- | --- | --- | --- | --- | --- |
| ∴ n (product) expected | = | 0.00578 | mol | | |
| M (product) | = | 185.270 | g mol-1 | | |
| Theoretical yield | = | N | x | M |  |
|  | = | 0.00578 | mol x | 185.270 | g mol-1 |
|  | = | 1.071 | g | | |
| Actual yield | = | 0.192 | g | | |
| ∴ Percentage yield | = |  | | | |
|  | = | 17.92 | % | | |

### A chemical structure with letters and numbers AI-generated content may be incorrect.

### 1H NMR (500 MHz, CDCl3)

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| --- | --- | --- | --- | --- | --- |
| **/pm** | **Integration** | **multiplicity** | **J / Hz** | **COSY shows coupling to** | **Assignment** |
| 8.85 | 1H | dd | J1,27.7, J1,31.7 | H2 | H1 |
| 8.12 | 1H | d | J3,28.2 | H2 | H3 |
| 8.05 | 1H | d | J7,68.9 | H6 | H7 |
| 7.81 | 1H | dd | J6,78.9, J6,42.2 | H4, H7 | H6 |
| 7.72 | 1H | d | J4,62.2 | H6 | H4 |
| 7.36 | 1H | dd | J2,38.2, J2,14.2 | H1, H3 | H2 |
| 1.43 | 12H | s | ~ | ~ | H5 |

**ESI-MS**

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| --- | --- |
| ***m/z*** | **[Assignment]charge** |
| 171.09 | **[C13H16N – CH3]+** |
| 186.12 | **[C13H16N]-** |
| 187.13 | **[C13H16N + H]+** |

### Discussion

### To assign the proton resonances of our substituted quinoline we began by assigning the chemical shift and coupling constants of the H-2, H-3 and H-4 pyridine protons and the four benzene protons in unsubstituted quinoline. We then compared these with the provided COSY/NOESY spectra of the product derived from our unknown aniline and matched theses to the 1H NMR spectrum of our final product. The most downfield signal at 8.85 ppm (dd, J = 7.7, 1.7 Hz) was assigned to H1 the proton adjacent to ring nitrogen as the electronegativity of nitrogen shift the signal downfield. The 7.36 ppm (dd, J = 8.2, 4.2 Hz) was assigned to H2 as ortho-coupling (6-10 Hz) with H1 was observed on the COSY and NOESY spectra, additionally this allowed us to identify the signal at 8.12 ppm (d, J = 8.2 Hz) as H3 ortho-coupling with H2 was observed.

On the benzene ring the doublet of doublets at 7.81 ppm (J = 8.9, 2.2 Hz) was assigned to H6(ortho-coupled to H7, meta coupled to H4); the doublet at 8.05 ppm (J = 8.9 Hz) to H7; and the doublet at 7.72 ppm (J = 2.2 Hz) to H4. The singlet at 1.43 ppm with a integration of 12 H was characteristic of a tert-butyl group (H5)

The ESI-MS of the product shows a protonated molecular ion at m/z 187.13 ([C13H16N + H]+) and a fragment at 171.09 ([M-CH3]+) consistent with the lost of a methyl from the tert-butyl group. These peaks help confirm the molecular weight and presence of tert-butyl group, mass spectroscopy can’t confirm the positional isomers of the molecule. Regioselective assignment relied on 2D NMR correlations.

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* *Remember to append to your report your risk assessment form, and* ***all*** *spectral data.*
* *Make sure each appended item is clearly labelled with a title and explanatory legend.*