Supporting Information

Biobased synthesis of acrylonitrile from glutamic acid

Jérôme Le Nôtre,[a] Elinor L. Scott,[a*] Maurice C. R. Franssen,[b] Johan P. M. Sanders[a]

General Information:
All reactions were carried out in standard glassware except for palladium-catalysed reactions performed in Schlenk tubes glassware under a positive pressure of nitrogen. Sensitive liquids and solutions were transferred via syringe. Concentration of solution was carried out by using a rotary evaporator, and generally followed by removal of residual solvents on a vacuum line. Unless otherwise stated, all commercial reagents and solvents were used without additional purification. Proton nuclear magnetic resonance spectra (^{1}H NMR) were recorded on a Bruker AM-400 (400 MHz). Chemical shifts were quoted in parts per million (ppm) referenced to the appropriate solvent peak or 0 ppm for TMS. Coupling constants, J, were reported in Hertz (Hz). Carbon 13 nuclear magnetic resonance spectroscopy (^{13}C NMR) was recorded on Bruker AM-400 (100 MHz) and was fully decoupled by broad band decoupling. Chemical shifts were reported in ppm referenced to the centre line of a triplet at 77.0 ppm of chloroform-d. GC-MS analyses were performed on a CE Instrument GC 8000 Top (capillary column SGE-Forte, 30 m x 0.25 mm, 0.25 μm) chromatograph linked to an Automass II Finnigan MAT (70 eV) apparatus.

Oxidative Decarboxylation of Glutamic acid to 3-cyanopropanoic acid (5).

Using N-bromosuccinimide (NBS) or 1,3-dibromo-5,5-dimethylhydantoin (DBDMH):[1]
To a stirred solution of glutamic acid (2.93 g, 20 mmol) in a pH 5 phosphate buffer (90 mL) was slowly added a solution of *N*-bromosuccinimide (NBS, 1.07 g, 60 mmol) in 20 mL of DMF. (For each aliquot addition the reaction mixture turned slightly yellow and a strong CO_2 evolution is observed while the coloration disappeared). At the end of the addition the orange solution was stirred overnight at room temperature. The reaction was carefully quenched with $Na_2S_2O_3.5H_2O$ till the coloration disappeared, and then extracted with Et_2O (3 x 50 mL). After washes and drying over $MgSO_4$ the solvent was removed by evaporation. ^{1}H NMR analysis of the crude showed a mixture of the product and succinimide. The crude was extracted with a minimum amount of Et_2O (30 mL) to solubilise the product, succinimide was filtered off and re-extracted two times following the same procedure. The three filtrate solutions were collected and concentrated to afford 3-cyanopropanoic acid (**5**, 713 mg, 36% yield).
The reaction was repeated with 30 mmol of 1,3-dibromo-5,5-dimethylhydantoin (DBDMH) instead of NBS and after purification the product (**5**) was isolated in 40% yield (801 mg).

Using bromide salt and sodium hypochlorite:
In an ice-bathed round bottom flask were introduced glutamic acid (2.93 g, 20 mmol), NaBr (0.21 g, 10 mol%), and 50 mL H_2O. NaOCl solution (15 wt% in H_2O, 24.8 mL, 60 mmol) was added dropwise under a good stirring (for each drop of NaOCl

solution, the reaction mixture turned orange and a strong CO_2 evolution was observed while the coloration disappeared). After 1 hour stirring at 4 ^oC the reaction mixture was carefully quenched with $Na_2S_2O_3.5H_2O$. NaCl was then added till saturation and the reaction mixture was extracted with Et_2O (4 x 30 mL). The collected organic layers were dried over $MgSO_4$ and evaporated to dryness. ^1H NMR analysis of the crude showed 3-cyanopropanoic acid (**5**, 850 mg, 43% yield) as the major product and the corresponding aldehyde as a minor product (85% purity). A 94% purity towards 3-cyanopropanoic acid (**5**) was obtained after one recrystallisation in Et_2O.
An alternative work-up procedure consisted in evaporating the water after reaction and quenching. The resulting paste was extracted with Et_2O (4 x 30 mL), the collected organic layers were dried over $MgSO_4$ and evaporated to dryness. NMR analyses of the crude showed 3-cyanopropanoic acid (**5**, 1.39 g, 70% yield, 90% purity).

3-Cyanopropanoic acid (**5**): ^1H NMR (D_2O): δ = 2.79-2.74 (m, 2H), 2.73-2.68 (m, 2H); ^{13}C NMR (D_2O): δ = 174.9, 120.8, 29.3, 12.4; IR (cm^{-1}): 3202, 2253, 1692.

Decarbonylation-Elimination of 3-cyanopropanoic acid (5):[2]
In a Schlenk tube under a positive pressure of nitrogen were introduced palladium(II) chloride (26.8 mg, 3 mol%), bis(2-diphenylphosphinophenyl)ether (DPE-Phos, 244.3 mg, 9 mol%), 3-cyanopropanoic acid (500 mg, 5.0 mmol), and hydroquinone (0.2 mg, 40 ppm). Dry 1,3-Dimethyl-3,4,5,6-tetrahydro-2(1H)-pyrimidinone (DMPU, 30 mL) was then added followed by degassed acetic anhydride (1.0 mL, 10 mmol) and degassed triethylamine (0.7 mL, 5 mmol). The reaction mixture was heated at 110 ^oC for 18 hours. After reaction, an aliquot of the mixture was analysed by ^1H NMR spectroscopy. Another aliquot was filtered through a short plug of silica and the solution was diluted and analysed by GC-MS. The rest of the crude reaction mixture was submitted to distillation under atmospheric pressure. The second fraction showed a steady boiling temperature (bp: 76-78 ^oC), was analysed by NMR spectroscopy and GC-MS, and corresponds to acrylonitrile (**3**, 46 mg, 17% yield).

Acrylonitrile (**3**): ^1H NMR ($CDCl_3$): δ = 6.22 (dd, 1H, J = 17.9 Hz, 0.87 Hz), 6.07 (dd, 1H, J = 11.7 Hz, 0.87 Hz), 5.65 (dd, 1H, J = 17.9 Hz, 11.7 Hz); ^{13}C NMR ($CDCl_3$): δ = 137.2, 116.9, 107.7; MS (EI): m/z (%) = 53 (100) [M+], 52 (80), 51 (35).

References

1 G. Laval, B. T. Golding, *Synlett*, 2003, 542-546.
2 J. Le Nôtre, M. C. R. Franssen, E. L. Scott, J. P. M. Sanders, *Tetrahedron Lett.*, 2010, **51**, 3712-3715.