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Di and Trimerization of Acrylic reagents

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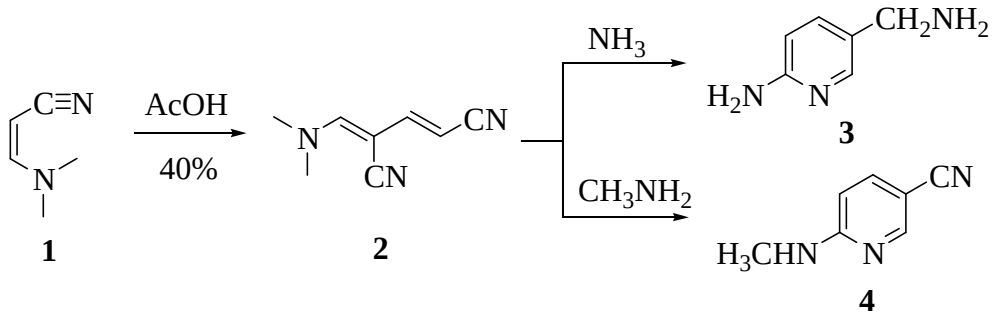
ABSTRACT

Trimerization of methyl-3-(dimethylamino) acrylate leading to 1,3,5-bezene tricarboxylate methyl ester and dimerization of 3-dimethylamino acrylonitrile leading to amino methylenated glutaconic acid dinitrile catalyzed by different acids in 1,2-dimethoxy ethane solvent is reported.

Keywords: 3-(dimethylamino) acrylate reagents, dimerization, trimerization.

INTRODUCTION

Dimerization of 3-(dimethylamino) acrylonitrile **1** was reported by Scotti and Frazza [1] during 1964 to give aminomethylenated glutaconic acid dinitrile **2.** Helmut Kraus from Bayer reported [2] better yields (90%) in making **2** and used this intermediate to prepare 2-amino-5-aminomethyl pyridine derivative **3** [3] which is an important intermediate in the preparation of insecticides of the nitromethylene class and 6-amino-nicotononitriles **4** [4] are intermediates for synthesizing pharmaceutical and agrochemical active compounds.



1 **2** **3** **4**

Scheme 1: Dimerization of 1 to 2 and its pyridine derivatives

MATERIALS AND METHODS

^{1}H & ^{13}C NMR spectra are recorded using a Bruker 400 Spectrometer (400 & 100 MHz respectively) with TMS as internal standard. Mass spectra are recorded on a Perkin-Elmer mass spectrometer operating at 70 eV. IR spectra are recorded on Perkin Elmer Spectrophotometer as KBr pellets or neat. Analytical TLC is conducted on E-Merck 60F254 aluminum-packed silica gel plates (0.2mm). Developed plates are visualized using UV light or Iodine chamber. HPLC spectra are recorded on shimadzu 2010.

General procedure for the synthesis of 1,3,5-benzene tricarboxylate methyl ester (7)

To a solution of methyl-3-(dimethylamino) acrylate **5** (20.0gms, 0.155 M) in 1,2-dimethoxy ethane (40ml), sulphuric acid (15.19gms, 0.155 M) was added at 20-25°C. The reaction mixture was stirred for 24 hours at rt. (The completion of the reaction was monitored by TLC). After completion of the stating material, the reaction mass was quenched into ice water (100ml) and product **5** was extracted with ethylacetate (100ml X 2). The combined organic layers were washed with water (20ml), and the organic layer was dried over anhydrous sodium sulphate. Concentration of the solvent under reduced pressure at 50°C to gave crude product (10.0gms). Purification of crude compound on columm chromatography furnished white powder of 1,3,5-benzene tricarboxylate methyl ester **7** (7.8gms). Yield 60%; mp: 142.3-144.6°C; GC purity: 99.79%; FT-IR (cm^{-1}): 1732 (C=O), 1255; ^{1}H NMR (ppm, $CDCl_3$): δ 8.86 (s, 3H), 3.98 (s, 9H); ^{13}C NMR (ppm, $CDCl_3$): 165.33, 134.51, 131.09, 52.55; ESI-MS (m/z %): 253.1(M+1).

General procedure for the synthesis of *N,N*-dimethylamino methylene-glutaconicacid dinitrile (2)

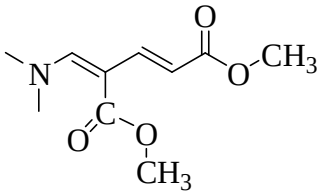
To a solution of 3-dimethylamino acrylonitrile **1** (2.0gms, 0.0208M) in 1,2-dimethoxy ethane (6ml), orthophosphoric acid (2.03gms, 0.0208M) was added at rt. The reaction mixture was stirred for 3 hours at rt. (Completion of the reaction was monitored by TLC). After completion of stating material, the reaction mixture was quenched into ice water (10ml) and stirred for 30min at 10°C. The precipitated solid was collected through filtration and recrystallised from 10% methanol in toluene to get pale orange colour solid **2** (0.90gms). Yield: 60%; mp: 119.2-120.2°C; GC purity: 99.0%; FT-IR (cm^{-1}): 2205 (CN), 1638, 1591, 1402, 968. ^{1}H NMR (ppm, DMSO): δ 7.44 (s, 1H), 7.18 (d, 2H, *J*=15.69Hz), 4.97 (d, 1H, *J*=15.67Hz), 3.23 (d, 6H, *J*=27.22Hz); ^{13}C NMR (ppm, $CDCl_3$): 156.97, 151.26, 120.57, 117.64, 82.24, 75.07, 46.98, 38.29; ESI-MS (m/z %): 148.1(M+1).

General procedure for the synthesis of *N,N*-dimethylamino methylene-glutaconicacid dinitrile (2) in Acetic acid

To a stirred and cold (20°C) solution of glacial acetic acid (200ml), 3-dimethylamino acrylonitrile **1** (19.2gms, 0.2M) was added and stirred at rt (25-28°C) for 17hours.Acetic acid was evaporated under vacuum at 50°C, and the residue was stirred with water (130ml). The obtained solid product was filtered under suction and washed with water, the material **2** was dried at 50°C to get 12.9gms (80%) of pale orange solid.

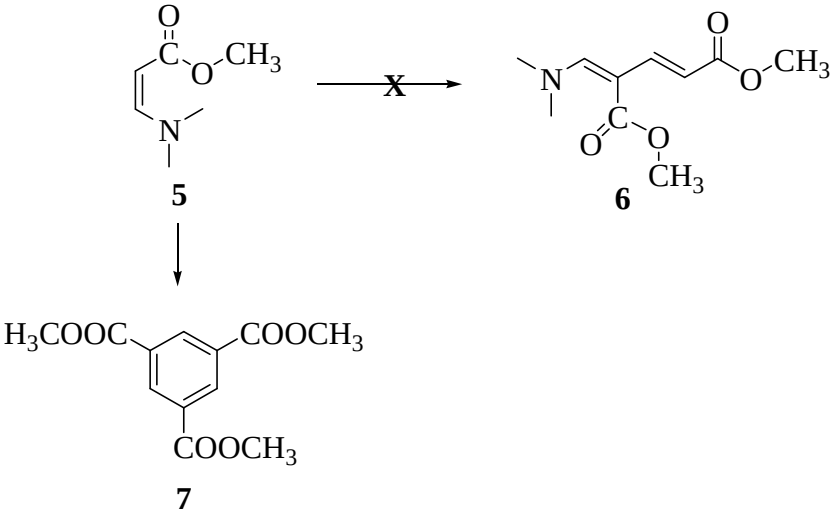
RESULTS AND DISCUSSION

For our ongoing research programme we are interested in making compound **6** (aminomethylenated glutaconic acid dimethylate) from methyl-3-(dimethylamino) acrylate **5.**



6

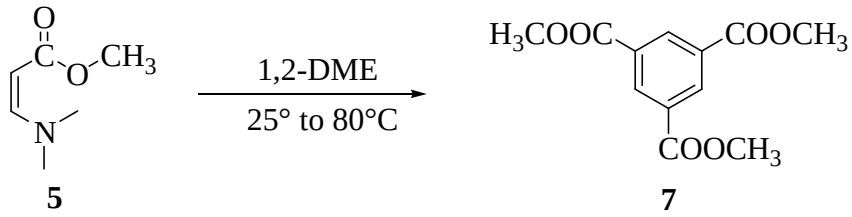
We tried to synthesize compound **6** by Krass method as shown in **(Scheme 2)**. To our surprise we got a different product, which by ^{1}H-NMR has only two peaks at δ 8.86 (3H of phenyl) and δ 3.98 (9H of 3 ester methyls). It became obvious by the ^{1}H-NMR spectra that the product obtained is not a dimer but a trimer **7**. The product is conformed by other spectral methods and to the authentic sample.



Scheme 2: Trimerization of compound 5 instead of dimerization

Dimerization of **5** was tried in various catalytic acid conditions in 1,2-dimethoxy ethane as solvent medium (Table-1) to isolate **6**, but all our efforts lead to trimerization product **7** only.

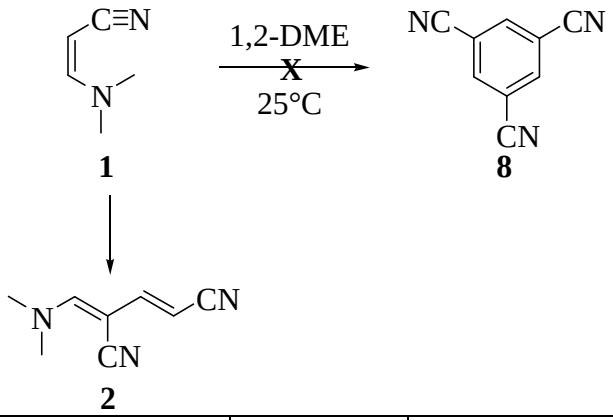
Table 1: Trimerization of acrylate ester 5 to give 7.



Entry	**Catalyst**	**Solvent**	**Temp/ Time**	**Yield** (%)
01	Sulphuric acid	1,2-dimethoxyethane	25°C/24hours	60
02	Orthophosphoric acid	1,2-dimethoxyethane	80°C/6hours	45
03	Borontrifluoride etherate	1,2-dimethoxyethane	25°C/18hours	32
04	Aluminium chloride	1,2-dimethoxyethane	25°C/6hours	32
05	Silicontetrachloride	1,2-dimethoxyethane	60°C/2hours	40
07	Para toluenesulfonic acid	1,2-dimethoxyethane	80°C/10hours	30
08	Titaniumtetrachloride	1,2-dimethoxyethane	25°C/12hours	40
09	Glacial acetic acid	1,2-dimethoxyethane	25°C/17hours	47

With these results in hand, we tried the trimerization of **1** in different acid catalysts and 1,2-dimethoxy ethane as solvent medium (table 2) to get tricyano benzene, but all our efforts are invain. We also have ended with the dimerization of **1** to **2** only.

Table 2: Dimerization of 1 instead of trimerization in acid and DME solvent



Entry	Catalyst	Time/ temp	solvent	%yield
01	-	25°C/17hours	Glacial acetic acid	80
02	Orthophosphoric acid	25°C/3hours	1,2-dimethoxyethane	60
03	Perchloric acid	25°C/4hours	1,2-dimethoxyethane	26
04	Aluminium chloride	25°C/12hours	1,2-dimethoxyethane	35
05	Silicon tetrachloride	80°C/2hours	1,2-dimethoxyethane	40
06	Borontrifluoride etherate	25°C/13hours	1,2-dimethoxyethane	30
07	Conc. HCl	25°C/3hours	1,2-dimethoxyethane	35

The results obtained by us are in accordance with the results of Kochetkov [5] reaction with β-aminovinylmethyl ketones to 1,3,5-triacetyl benzene [6]. The question remains unanswered why 3-dimethylamino acrylonitrile stopped at dimerization where as the ester and ketone derivatives lead to trimerization without the dimerization product.

CONCLUSION

Methyl-3-(dimethylamino) acrylate **5** undergoes trimerization directly without the dimerization product, where as 3-dimethylamino acrylonitrile **1** undergoes only dimerization instead of trimerization in 1,2-dimethoxy ethane solvent and various acid catalysts.

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