prepared from 2-bromo-6-methylanisole and sodium amide. This was converted to the quaternary methiodide which was decomposed at reduced pressure. The product was treated with acetic anhydride and distilled, giving 3-methoxy-4-methyldimethylaniline; b.p. 67.5° (1 mm.), n_D^{20} 1.5514. A *picrate* melted 160.5–161°.

Lithium dimethylamide and 2-bromo-3-methylanisole. A mixture of 20.1 g. (0.1 mole) of 2-bromo-3-methylanisole and 0.12 mole of lithium dimethylamide in ether was refluxed with stirring for 22.5 hours and hydrolyzed with dilute hydrochloric acid. This gave: 1.5 g. (12%) of *m*-methylanisole;[6] 7.6 g. (38%) of recovered 2-bromo-3-methylanisole; and 6.0 g. (28%) of a bromine-containing amine, boiling at 64–66°. (1 mm.), n_D^{20} 1.5664 (Second run, n_D^{20} 1.5690). A *picrate* of this material melted 145–145.5°.

Anal. Calc'd for $C_{15}H_{15}BrN_4O_7$: C, 40.66; H, 3.41; N, 12.64. Found: C, 40.46; H, 3.68; N, 12.77.

To 1.5 g. of magnesium in 50 ml. of ether was added a solution of 7.4 g. of the amine in 50 ml. of ether. After spontaneous refluxing ceased, the mixture was refluxed for one hour and then was hydrolyzed with 100 ml. of water. This gave 2.45 g. (53%) of N,N-dimethyl-*m*-toluidine; b.p. 52.5° (1.5 mm.), n_D^{20} 1.5497.[7]

A *picrate* melted at 126–127.5°[8] and a *trinitrobenzene derivative* at 105–106°.[7] These did not depress the melting points of authentic samples.

Lithium dimethylamide and anisole. A mixture of 53.5 g. (0.5 mole) of anisole and 0.6 mole of lithium dimethylamide in 200 ml. of ether was refluxed with stirring for 20 hours and hydrolyzed with water. This gave 1.1 g. (2%) of N,N-dimethylaniline.

When the reaction was carried out in anisole as solvent, at the reflux temperature, a 7% yield of N,N-dimethylaniline was isolated. The product was identified by a *picrate* melting at 158.5–159.5°,[9,10] which did not depress the melting point of an authentic sample.

Lithium dimethylamide and o-bromoanisole. A mixture of 93.5 g. (0.5 mole) of *o*-bromoanisole and 0.9 mole of lithium dimethylamide in 500 ml. of ether was refluxed with stirring for 19 hours and then was hydrolyzed with water. This gave: 5.0 g. (7%) of N,N-dimethyl-*o*-anisidine, n_D^{20} 1.5420, *picrate* m.p. 141–142°;[11] 24.1 g. (32%) of N,N-dimethyl-*m*-anisidine, n_D^{20} 1.5579, *picrate* m.p. 142.5–143.5°; 9.3 g. (17%) of anisole;[6] 16.5 g. (18%) of recovered *o*-bromoanisole; 1.5 g. (2%) of N,N,N′,N′-tetramethyl-*m*-phenylenediamine, *trinitrobenzene derivative* m.p. 122–123°;[12] and 2.7 g. of material, b.p. 110.5–111° (1.5 mm.), n_D^{20} 1.5480, which was not identified. The mixture melting points of the derivatives with authentic samples were not depressed. The *picrate* of the *ortho* isomer depressed the melting point of the *picrate* of the *meta* isomer. The *trinitrobenzene derivative* was analyzed.

Anal. Calc'd for $C_{16}H_{19}N_5O_6$: C, 50.92; H, 5.07; N, 18.56. Found: C, 50.92; H, 5.25; N, 18.74.

Lithium dimethylamide and N,N-dimethyl-m-anisidine. A mixture of 30.2 g. (0.2 mole) of N,N-dimethyl-*m*-anisidine and 0.2 mole of lithium dimethylamide in 200 ml. of ether was refluxed with stirring for 20 hours and then was hydrolyzed with 100 ml. of water. Nothing other than 28.0 g. (93%) of starting material could be isolated.

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The Dissociation Constants and Infrared Spectra of Some Nitratoacids[1]

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In connection with a general program on the chemistry of organic nitrates, it was of interest to obtain some idea of the electrical effect of the nitrate ester function. Accordingly, several nitratocarboxylic acids were synthesized and their dissociation constants and infrared spectra were obtained. α-Nitratoacids have previously been prepared by nitration of the corresponding hydroxyacids, but in several cases the acids were reported as unstable yellow oils. For this work the nitratoacids were all prepared by reaction of silver nitrate in acetonitrile[2] with the corresponding bromo- or iodoacids. The acids obtained in this way were quite stable and could readily be purified by distillation. The physical properties of the nitratoacids along with the yields obtained are summarized in Table II. The acids were all colorless solids or liquids, and the close correspondence of their neutral equivalents with the theoretical values is indicative of their high purity.

Freezing point measurements[3] and infrared spectra[4] have shown that carboxylic acids exist largely as monomers in polar solvents and as dimers in nonpolar solvents. Accordingly, the infrared spectra of the nitratoacids were measured in carbon tetrachloride solution and the carbonyl frequencies of the acids so were established. The dimer frequency was preferred since the carbonyl frequency of the monomer is strongly dependent on solvent. The dimer frequencies of the nitratoacids along with those of the bromoacids and the unsubstituted acids, as a standard of comparison, are summarized in Table I. The acid strengths of the nitratoacids were also determined and their *p*K values along with those of the bromo and unsubstituted acids[5] are tabulated in Table I. No hydrolysis of the nitrate ester function occurred during the titration of the nitratoacids. This was indicated by the sharp end points obtained, and also by the fact that a 10^{-4}M solution of nitratoacetic acid did not change in conductance over a several hour period.

As might be anticipated α-nitratoacids are somewhat stronger acids than the corresponding bromoacids, and a fairly constant difference of 0.60 in *p*K value is actually observed. According to accepted theory this difference is due to electrostatic repul-

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[1] This research was carried out under Army Ordnance Contract W-01-021-ORD-334.

[2] Ferris, McLean, Marks, and Emmons, *J. Am. Chem. Soc.*, **75**, 4078 (1953).

[3] Lassettre, *Chem. Revs.*, **20**, 277 (1937).

[4] Flett, *J. Chem. Soc.*, 962 (1951).

[5] Washburn, Editor, *International Critical Tables*, *Vol.* **VI**, McGraw-Hill, New York, N. Y., 1929, p. 259 ff.

TABLE I

Carbonyl Stretching Frequencies and Acid Strengths of a Series of Nitratocarboxylic Acids and the Correspondingly Substituted Bromoacids

Acid	*p*K	ν (C=O), cm^{-1}
Acetic	4.74	1711
α-Bromoacetic	2.87	1720
α-Nitratoacetic	2.26	1740
Propionic	4.88	1712
α-Bromopropionic	2.98	1721
α-Nitratopropionic	2.39	1736
β-Bromopropionic	4.02	1717
β-Nitratopropionic	3.97	1720
Butyric	4.82	1709
α-Bromobutyric	2.99	1720
α-Nitratobutyric	2.39	1731

sion in the undissociated acid between the very electronegative nitrato group and the ionizable proton; hence less work is required to remove the proton from the nitratoacid than from the bromoacid.[6] It is interesting to note, however, that the carbonyl frequencies of the nitrato acids are considerably higher even than those of the bromoacids. This simply reflects the tightening up of the carbon-oxygen bond of the carbonyl group caused by the strong electrostatic repulsion between the carbonyl and nitrate dipoles (with its formally charged atoms).[7] This repulsion in the undissociated nitrato acid has the effect of markedly increasing its energy content relative to either the bromoacid or unsubstituted acid. The free energy contents of each of the corresponding anions, however, may well be much closer to one another since the resonance energy of the carboxylate function and solvation energies and entropies will tend to mask differences in free energy arising from dipole interactions. On this basis it would also appear reasonable to assign the higher acid strength of nitratoacids as compared with bromoacids to the difference in free energy content of the undissociated acids rather than of the carboxylate anions.

Acknowledgment. We are indebted to Dr. M. F. Hawthorne for helpful discussion of this problem.

EXPERIMENTAL

The nitratoacids with the exception of β-nitratopropionic acid were all prepared from the corresponding bromides. The latter compound was obtained from β-iodopropionic acid and silver nitrate. The physical properties and yields of pure acids are summarized in Table II, and as a typical example the preparation of α-nitratopropionic acid is described below.

TABLE II

Preparation of Nitratoacids

Acid	B.p. °C.	mm.	Neutral Equivalent Calc'd	Found	Yield, %
Nitratoacetic[a]	45[d]	1.0	121.0	121.0	27
α-Nitratopropionic[b]	68	0.3	135.1	135.0	25
β-Nitratopropionic[c]	90[e]	0.7	135.1	135.0	64
α-Nitratobutyric[b]	85	0.3	149.1	149.3	35

[a] Duval, *Bull. soc. chim.*, [3], **29**, 601 (1903). [b] Duval, *Compt. rend.*, **137**, 1263 (1903). [c] *Anal.* Calc'd for $C_3H_5NO_5$: C, 26.67; H, 3.70; N, 10.37. Found: C, 26.60; H, 3.82; N, 10.63. [d] Sublimed, m.p. 55° after recrystallization from carbon tetrachloride. [e] M.p. 48–50° after recrystallization from carbon tetrachloride.

α-Nitratopropionic acid. To a solution of 25.5 g. (0.15 mole) of silver nitrate in 100 ml. of dry acetonitrile was added 15.3 g. (0.1 mole) of α-bromopropionic acid in 50 ml. of the same solvent. The resulting solution was heated with stirring under reflux for 25 minutes. At this point oxides of nitrogen were evolved so the solution was cooled to room temperature and allowed to stand overnight. The silver bromide (18.1 g. 96%) was collected on a filter and the acetonitrile was removed at reduced pressure. At this point some silver salts precipitated so 50 ml. of methylene chloride was added and the solution was filtered. The solvent then was evaporated, and the residue was distilled. After 2.0 g. of forerun, b.p. 65–68° (0.3 mm), had been obtained, a center cut was collected b.p. 68–70° (0.3 mm), yield 3.8 g. (25%). This sample was redistilled just before its *p*K was determined.

Infrared spectra. The spectra of the acids were obtained from 0.02 *M* solutions in carbon tetrachloride in cells of 0.5 mm. light path using a Perkin-Elmer Model 21 spectrophotometer with a sodium chloride prism.

Acid dissociation constants. Samples of from 0.2–0.3 g. of each acid were dissolved in 100 ml. of distilled water and titrated with carbonate-free 0.1 *N* sodium hydroxide. The *p*H of the solution was read from a Beckman Model G *p*H meter previously standardized against the Beckman *p*H-7 buffer. At least 20 readings were taken after successive additions of sodium hydroxide. The *p*K was calculated from the *p*H at each point, correcting for hydrolysis and repression of the ionization of the acid.[8] These values then were averaged to obtain the tabulated values. The difference from the *p*H at half neutralization was significant due to the strength of the acids.

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[6] Wheland, *Advanced Organic Chemistry*, John Wiley and Sons, New York, N. Y., 1949, pp. 440–450.

[7] This electrostatic repulsion is actually the vectorial sum of two terms, *i.e.*, an inductive effect operating through polarization of the carbon σ-bonds and a dipole-dipole field effect operating through space.

[8] Bennett, Brooks, and Glasstone, *J. Chem. Soc.*, 1821 (1935).

The Preparation of 2,6-Dimethoxybenzoic Acid

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2,6-Dimethoxybenzoic acid is the key intermediate in the preparation of *gamma*-resorcylic acid which has been described as having activity against rheumatic fever.[1] The demethylation of 2,6-dimethoxybenzoic acid with aluminum chloride

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[1] Reid, Watson, Cochran, and Sproull, *Brit. Med. J.*, **2**, 321 (1951).