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Effect of Molecular Structure on Optical Properties of Sulfoxide Systems. LX and LXI. Synthesis of Racemic m- and p-Tolylsulfoxydimethylacetic Acids and Their Resolution into Optical Antipodes

Wpływ budowy cząsteczkowej na własności optyczne układów sulfotlenkowych. LX i LXI. Synteza racemicznych kwasów m- i p-tolilosulfoksydwumetylooctowych i ich rozszczepienie na antypody optyczne

Влияние молекулярного строения на оптические свойства сульфоокисных систем. LX и LXI. Синтез рацемических m- и p-толилсульфоксидиметилуксусных кислот и их расщепление на оптические антиподы

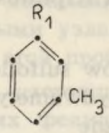
The effect of substituents having the character of straight chain and branched alkyls on optical properties of aryl-sulfinylaliphatic systems is investigated in our laboratory, using the example of suitable derivatives of phenylsulfinyldimethylacetic acids. So far we have prepared enantiomeric ortho-tolylsulfoxydimethylacetic acids and have determined their principal optical and stereochemical properties [1]. These compounds and their amides exhibit in the visible part of the spectrum normal rotatory dispersion and have high molar rotation values. Their molar rotations are considerably higher than those of the corresponding configurational reference systems i.e. phenylsulfoxydimethylacetic acids. It is possible that the observed increase of molar rotation is due to the shift of π electrons of the aromatic nucleus in the direction of the sulfinylic chirality centre caused by the hyperconjugation and the inductive effect of the methyl group. The increase of the optical activity could be also due to the deviation of one of the bulky ortho-substituents from the plane of benzene ring.

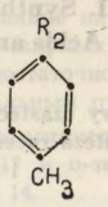
In order to obtain further experimental data we have investigated optical properties of other derivatives of the carboxyisopropylphenylsulfoxide.

In the present paper we are reporting the results of our experiments carried out in order to obtain racemic m- and -p-tolylsulfoxydimethylacetic acids and to resolve them into enantiomeric systems.

The starting substances were known [2, 3] m- and p-thiocresols 1 and 14 which, after the reaction with sodium bromoisobutyrate in an alkaline medium, gave m- and p-tolylmercaptodimethylacetic acids 2 and 15 in fairly good yields. The products were characterised as amides 3 and 16, anilides 4 and 17 and esters 5, 18 and 19.

The structure of the isomeric tolylcarboxyisopropylsulfides 2 and 15 was confirmed by their IR spectra. The characteristic bands are quoted in the experimental part.





1: $R_1=SH$
2: $R_1=S\cdot C(CH_3)_2\cdot CO\cdot OH$
3: $R_1=S\cdot C(CH_3)_2\cdot CO\cdot NH_2$
4: $R_1=S\cdot C(CH_3)_2\cdot CO\cdot NH\cdot C_6H_5$
5: $R_1=S\cdot C(CH_3)_2\cdot CO\cdot O\cdot CH_2\cdot CO\cdot C_6H_4\cdot Br$
6: $R_1=\overset{(\pm)}{SO}\cdot C(CH_3)_2\cdot CO\cdot OH$
7: $R_1=\overset{(\pm)}{SO}\cdot C(CH_3)_2\cdot CO\cdot NH_2$
8: $R_1=\overset{(-)}{SO}\cdot C(CH_3)_2\cdot CO\cdot OH\cdot CND^*$
9: $R_1=\overset{(-)}{SO}\cdot C(CH_3)_2\cdot CO\cdot OH$
10: $R_1=\overset{(+)}{SO}\cdot C(CH_3)_2\cdot CO\cdot OH\cdot HCND^{**}$
11: $R_1=\overset{(+)}{SO}\cdot C(CH_3)_2\cdot CO\cdot OH$
12: $R_1=\overset{(-)}{SO}\cdot C(CH_3)_2\cdot CO\cdot NH_2$
13: $R_1=SO_2\cdot C(CH_3)_2\cdot CO\cdot OH$
14: $R_2=SH$
15: $R_2=S\cdot C(CH_3)_2\cdot CO\cdot OH$
16: $R_2=S\cdot C(CH_3)_2\cdot CO\cdot NH_2$
17: $R_2=S\cdot C(CH_3)_2\cdot CO\cdot NH\cdot C_6H_5$
18: $R_2=S\cdot C(CH_3)_2\cdot CO\cdot O\cdot CH_2\cdot CO\cdot C_6H_4Br$
19: $R_2=S\cdot C(CH_3)_2\cdot CO\cdot O\cdot CH_2\cdot C_6H_4\cdot NO_2$
20: $R_2=\overset{(\pm)}{SO}\cdot C(CH_3)_2\cdot CO\cdot OH$
21: $R_2=\overset{(\pm)}{SO}\cdot C(CH_3)_2\cdot CO\cdot OCH_3$
22: $R_2=\overset{(\pm)}{SO}\cdot C(CH_3)_2\cdot CO\cdot NH_2$
23: $R_2=\overset{(-)}{SO}\cdot C(CH_3)_2\cdot CO\cdot OH\cdot CND^*$
24: $R_2=\overset{(-)}{SO}\cdot C(CH_3)_2\cdot CO\cdot OH$
25: $R_2=\overset{(-)}{SO}\cdot C(CH_3)_2\cdot CO\cdot NH_2$
26: $R_2=\overset{(+)}{SO}\cdot C(CH_3)_2\cdot CO\cdot OH\cdot HCND^{**}$
27: $R_2=\overset{(+)}{SO}\cdot C(CH_3)_2\cdot CO\cdot OH$
28: $R_2=SO_2\cdot C(CH_3)_2\cdot CO\cdot OH$

We obtained racemic m- and p-tolylsulfoxydimethylacetic acids 6 and 20 by oxidation of compounds 2 and 15 with 29% hydrogen peroxide at

* CND=cynchonidine.
** HCND=hydrocynchonidine

room temperature in glacial acetic acid. The resulting sulfoxides 6 and 20 gave readily crystallizing amides 7 and 22. Their methyl esters were obtained in good yields, but only the ester of acid 20 could be obtained in the crystalline state.

The infrared spectra of sulfoxides 6 and 20 (the characteristic bands are quoted in the experimental part) fully confirmed their structures. After the conversion into the corresponding sodium salt, sulfoxides 6 and 20 could be readily transformed into sulfones 13 and 28. The oxidation was carried out at 100°C in aqueous solution using an excess of the oxidising agent.

Both racemic sulfoxides 6 and 20 were resolved by fractional crystallization of their diastereomeric salts with optically active alkaloids. The first fractions of the salt of racemic acid 6 with cinchonidine consisted of the laevorotatory isomer 9. After two crystallizations from ethanol it was optically homogenous (m. pt. 175°C, $[\alpha]_D^{20} = -117°$).

In order to obtain the dextrorotatory isomer we crystallized the salt of racemic acid 6 with hydrocinchonidine from acetone. After one crystallization the salt was optically pure (m. pt. 165°C with decomposition, $[\alpha]_D^{20} = -27°$).

Enantiomeric m-tolylsulfoxydimethylacetic acids 9 and 11 liberated from their salts with alkaloids and purified by crystallization from acetone had fairly high optical activity (m. pt. 124°C with decomposition, $[\alpha]_D^{20} = +82°$ and $-84°$ in 96% ethanol).

The resolution of p-tolylsulfoxydimethylacetic acid 20 was carried out via its salts with cinchonidine and hydrocinchonidine. The cinchonidine salt was crystallized from ethanol and gave the laevorotatory antimer 24 in the first fractions. After two crystallizations it was optically homogenous (m. pt. 181°C, $[\alpha]_D^{20} = -140°$). The dextrorotatory enantiomer was obtained by crystallization of the hydrocinchonidine salt from acetone. After three crystallizations the compound was optically homogenous (m. pt. 119°C, $[\alpha]_D^{20} = +127°$). The antimeric acids 24 and 27 liberated from the salts and purified by crystallization from acetone, had slightly higher molar rotation (m. pt. 117°C with decomposition, $[\alpha]_D^{20} = \pm 98°$) than that of their meta isomers 9 and 11.

Crystallization of equimolar mixtures of antipodes 9 and 11 and also 24 and 27 led to regeneration of racemic compounds 6 and 20. The melting point of racemate 6 was lower than that of antipodes 9 and 11 ($\Delta T = 8°$) and the melting point of racemate 20 was considerably higher than that of antipodes 24 and 27 ($\Delta T = 23°$). The infrared spectra of racemic acids 6 and 20 were considerably different from the identical spectra of enantiomers 9 and 11 and 24 and 27.

The physical properties quoted above indicate that racemic acids 6 and 20 belong to the type of true racemates.

In order to obtain a larger comparative material for polarimetric studies, we prepared amides 12 and 25 of laevorotatory m- and p-tolylsulfoxydimethylacetic acids 9 and 24. Mild conditions in which the reactions were carried out make it possible to assume that they were not accompanied by racemisation. Attempted synthesis of methyl and p-nitrobenzyl esters failed. In both cases the products were oils which could not be obtained in the state of purity required for polarimetric measurements.

Molar rotations of laevorotatory m- and p-tolylsulfoxydimethylacetic acids 9 and 24 and their amides 12 and 25 were determined in the previously described apparatus [4] in methanol (M), ethanol (E), acetone (A), dioxane (D) and chloroform (Ch) at 6234, 5893, 5791 and 4358 Å. The results are shown in Table 1.

Comparison of the data shown in Table 1 leads to the conclusion that the molar rotations of the individual compounds considerably depend on the character of the solvent. The solvents can be arranged in the following series according to decreasing molar rotations:
for the free acids:

9 — M>E>D>A>Ch;
24 — M>E>Ch>D>A;
for the acid amides:
12 — Ch>M>D>E>A;
25 — M>Ch>E>D>A.

It should be emphasized that the dependence of the molar rotation of the examined systems on wave length in the visible part of the spectrum can be described by the one-term Drude equation, which indicates that the optical rotatory dispersion of these compounds is normal.

We attempted to solve the problem of determination of relative configurations of optically active m- and p-tolylsulfoxydimethylacetic acids by investigating optical rotatory dispersion in the ultraviolet part of the spectrum, circular dichroism and electronic spectra of laevorotatory enantiomers 9 and 24. These two compounds have similar chromophoric structure and for this reason the similarity of optical spectra would indicate the identity of their relative configurations.

The results of optical measurements lead to the conclusion that laevorotatory enantiomers 9 and 24 show double Cotton effects in the examined spectral range (210—300 nm). The effects observed at longer wave lengths are negative, whereas those observed in the shorter wave region of the spectrum are positive. Analogously circular dichroism curves have two maxima. The negative ones are situated at $\lambda_{\Theta max}=254$ nm acid 9 and $\lambda_{\Theta max}=251$ nm acid 24 and the positive ones at $\lambda_{\Theta max}=216$ nm acid

Table 1. Rotatory dispersion of laevorotatory m- and p-tolylsulfoxydimethyl-acetic acids and their amides

Compound	Solvent	Concn. g·100 ccm	Molar rotation $[M]_{\lambda}^{20}$				
			λ_1=623.4 nm	λ_2=589.3 nm	λ_3=579.1 nm	λ_4=546.1 nm	λ_5=435.8 nm
Laevorotatory m-tolyl-sulfoxydimethylacetic acid	Methanol	0.5	196.8	226.8	233.1	266.1	636.3
	Ethanol	0.5	174.2	190.7	196.7	227.4	523.8
	Dioxane	0.5	140.3	157.7	162.7	191.6	513.6
	Acetone	0.5	122.2	135.5	139.4	164.0	447.6
	Chloroform	0.5	108.6	124.1	127.8	150.7	384.7
Amide of laevorotatory m-tolylsulfoxydime-thylacetic acid	Methanol	0.5	167.6	186.3	195.9	230.1	574.5
	Ethanol	0.5	140.8	162.5	171.9	202.9	541.8
	Dioxane	0.5	162.2	180.3	190.9	226.1	563.2
	Acetone	0.5	136.3	155.3	162.1	202.9	526.0
	Chloroform	0.5	190.4	215.3	225.3	265.5	598.8
Laevorotatory p-tolyl-sulfoxydimethylacetic acid	Methanol	0.5	226.3	250.0	259.7	302.1	707.1
	Ethanol	0.5	203.4	222.2	231.4	266.1	609.4
	Dioxane	0.5	167.2	183.6	191.9	228.1	517.1
	Acetone	0.5	140.1	153.9	159.4	188.6	451.2
	Chloroform	0.5	180.8	196.9	208.8	245.9	595.1
Amide of laevorotatory p-tolylsulfoxydime-thylacetic acid	Methanol	0.5	212.9	237.1	244.4	284.9	669.1
	Ethanol	0.5	192.6	210.5	218.6	252.9	572.2
	Dioxane	0.5	163.4	184.2	194.5	227.3	475.3
	Acetone	0.5	155.3	175.2	184.9	213.3	429.2
	Chloroform	0.5	192.7	219.9	235.7	265.7	590.1

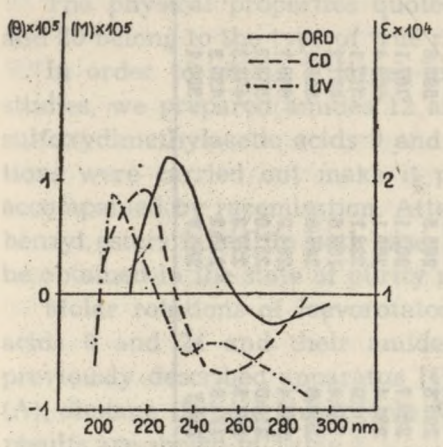


Fig. 1. Optical rotatory dispersion (ORD), circular dichroism (CD) and ultraviolet spectrum (UV) of laevorotatory m-tolylsulfoxydimethylacetic acid in 96% ethanol

ORD (c=0.007 g/100 ccm, d=0.02 dcm);

tr $[M]^{26}_{277\ nm}$ =−25861°, α=−0.016°,

z $[M]^{26}_{257\ nm}$ =0°, (α=0.000°);

pk $[M]^{26}_{228\ nm}$ =119605°, (α=0.074°);

z $[M]^{26}_{212\ nm}$ =0°, (α=0.000°).

Ampl. 1454.66°.

CD (c=0.000309 mole/litre, d=0.2 cm);

$[\Theta]^{26}_{254\ nm}$ =−69339, (ΔA=−0.0013);

$[\Theta]^{26}_{216\ nm}$ =93341, (ΔA=0.00175).

UV (c=0.00004059 mole/litre, d=1 cm);

$\varepsilon_{254\ nm}$ =5829, (A=0.2366);

$\varepsilon_{205\ nm}$ =18960, (A=0.7696).

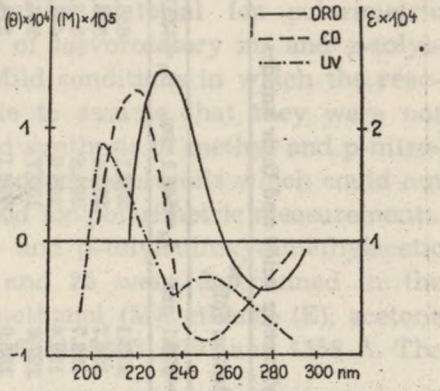


Fig. 2. Optical rotatory dispersion (ORD), circular dichroism (CD) and ultraviolet spectrum (UV) of laevorotatory p-tolylsulfoxydimethylacetic acid in 96% ethanol

ORD (c=0.007 g/100 ccm, d=0.02 dcm);

tr $[M]^{26}_{280\ nm}$ =−32326°, (α=−0.020°);

z $[M]^{26}_{257\ nm}$ =0°, (α=0.000°);

pk $[M]^{26}_{230\ nm}$ =155163°, (α=0.096°);

z $[M]^{26}_{219\ nm}$ =0°, (α=0.000°);

Ampl. 1874.89°.

CD (c=0.000309 mole/litre, d=0.2 cm);

$[\Theta]^{26}_{251\ nm}$ =−88007, (ΔA=−0.00165);

$[\Theta]^{26}_{219\ nm}$ =136020, (ΔA=0.00165);

UV (c=0.00003636 mole/litre, d=1 cm);

$\varepsilon_{250\ nm}$ =6925, (A=0.21518),

$\varepsilon_{203\ nm}$ =18671, (A=0.6788).

9 and $\lambda_{\Theta max}$=219 nm acid 24. The electronic spectra have two absorption bands in the examined region at 254 and 205 nm in the case of acid 9 and 250 and 203 nm in the case of acid 24. It should be stressed that the amplitude of the long wave Cotton effect of acid 24 is by about 25% larger than that of acid 9 in which the methyl group is in the meta position. It is significant that the characteristic points on the ORD (λ_z), CD ($\lambda_{\Theta max}$) and UV ($\lambda_{\Theta max}$) curves show a slight scatter along te wave length axis.

The above experimental facts indicate that the optically active acids having the same direction of molar rotation in the visible part of the spectrum have the same configurations. This is confirmed by Freudenberg

optical shifts corresponding to the conversion of laevorotatory acids 9 and 24 into their amides 12 and 25. It should be emphasized that almost identical Cotton effects and Freudenberg shifts are observed in the case of laevorotatory phenylsulfoxydimethylacetic acid and its o-methyl derivative [1]. This indicates that the configurations of the unsubsituted acid and the three carboxyisopropyltolylsulfoxides rotating the plane of polarised light in the same direction in the visible part of the spectrum are identical.

The results of polarimetric measurements carried out in the visible part of the spectrum in the solvents shown in Table I, indicate that the molar rotations of free p-tolylsulfoxydimethylacetic acids and their amides are much higher than those of the corresponding meta substituted acids and their amides having the same spatial structure. Taking into account the previously obtained [1] results of polarimetric determinations, the optical order in the group of examined sulfoxy compounds [phenylsulfoxydimethylacetic acids (FS), their o- (OTS), m- (MTS) and p- (PTS) methyl derivatives and acid amides] having the same spatial structure could be presented in the following sequence arranged in the order of decreasing molar rotation:

$$OTS > PTS > FS > MTS.$$

This indicates that the introduction of methyl group to the molecule of acid FS in three different positions on the benzene ring has different effects on the rotation of the system. In general, a methyl group in ortho and para positions increases the rotation whereas that situated in the meta position considerably decreases it. The distance of the substituent from the asymmetry centre is unimportant in the examined system. On the other hand, there are considerable differences between the systems with quinonoid and non-quinonoid position of the substituent with respect to the asymmetry centre.

It is possible that the observed increase of molar rotation is caused by the shift of π electrons of the aromatic nucleus in the direction of the sulfinylic chirality centre caused by the fairly strong hyperconjugation of the methyl group.

There is no doubt that the observed maximum increase of the molar rotation in the ortho substituted compounds (free acid and its amide) is also due to the deviation of one of the two bulky groups from the plane of benzene ring. The lower molar rotations of the meta substituted compounds as compared with those of the unsubstituted systems suggests the influence of the negative inductive effect ($-I$) of the methyl group which is not conjugated with the ring carbon atom directly bonded to the asymmetry centre. Although this suggestion is in agreement with predictions made by Coulson [5], Kwart and Takeshita [6], it

is not free from objections resulting from the fact that the Hammett constant of the methyl group in m-methylbenzoic acid is negative ($\sigma = -0.069$) although it is low [7].

The results of our experiments reported in the present paper do not contradict those reported previously with regard to the effect of alkyl substituents on the rotation of sulfinylic chirality centre in the group of 4,4'-alkyldiphenylsulfoxyacetic acids [8].

There is no doubt that further studies on the effect of alkyl substituents on the rotation of carbon and sulfoxide chirality centres will make it possible to formulate a more reliable and justified interpretation.

EXPERIMENTAL

The melting points are uncorrected. The polarimetric determinations were carried out in the apparatus described in previous papers [4] in the solvents quoted in the text. The IR spectra were obtained in Unicam SP-200 spectrophotometer. The ORD, CD and UV spectra were determined by means of a JASCO ORD/CD/UV/5 apparatus. The IR spectra were obtained from the compounds suspended in paraffin oil; and the ORD, CD and UV spectra from their ethanolic solutions.

1. m-Tolylmercaptodimethylacetic acid 2

31 g (0.25 mole) of m-thiocresol [2] and 42 g (0.25 mole) of α-bromoisobutyric acid [9] was introduced in to 200 ccm of 96% ethanol. The mixture was cooled to 9°C in ice bath and was treated slowly (1.5 hr) with stirring with 40 g (0.5 mole) of 50% NaOH. Then it was allowed to stand for 12 hours at 0°C and for 24 hours in room temperature and was then refluxed for 8 hours. Ethanol was distilled off (water bath) and the residue was diluted with 200 ccm of water and acidified to Congo with 50% sulphuric acid. The unreacted m-thiocresol was removed by steam distillation. The oily mercaptoacid 2 (which is not volatile with steam) soon solidified. It was filtered and after washing with water, it was dried in a vacuum desiccator over solid KOH. The product (41 g) was crystallized from petroleum ether (50 ccm). Large rhombic plates m. pt. 50°C. Yield 22 g. The compound is very readily soluble in benzene, chloroform, acetone, 96% ethanol and glacial acetic acid and is readily soluble in petroleum ether.

Analysis:

For $C_{11}H_{14}O_2S$ (210.29) — calcd.: 62.87% C, 6.71% H;
found: 62.64% C, 6.57% H.

IR (cm^{-1}): 690 νC—S; 680, 755, 890, 1040, 1080, 1120 δC_{Ar}—H (subst. 1, 3); 1580, 1600 $\nu C_{Ar}=C_{Ar}$; 820, 1165, 1180, 1370, 1470 $\nu C(CH_3)_2$; 915, 1290, 1420 δOH and νC—O(COOH); 1690 νC=O(COOH).

2. p-Tolylmercaptodimethylacetic acid 15

62 g (0.5 mole) of p-thiocresol [3] and 84 g (0.5 mole) of α-bromoisobutyric acid [9] was converted into p-tolylmercaptodimethylacetic acid as in section 1. The crude product (80 g) was crystallized from petroleum ether (300 ccm). Needles m. pt. 99°C. Yield 91 g. The compound is readily soluble in chloroform, acetone, and methanol, fairly soluble in petroleum ether and insoluble in water.

Analysis:

For $C_{11}H_{14}O_2S$ (210.29) — calcd.: 62.87% C, 6.71% H;
found: 62.94% C, 6.42% H.

IR (cm^{-1}): 700 νC—S; 810, 1010, 1120, 1210 δC_{Ar}—H (subst. 1, 4); 1460, 1500, 1600 $\nu C_{Ar}=C_{Ar}$; 1160, 1189, 1370, 1380, 1470 $\nu C(CH_3)_2$; 920, 1280, 1300, 1410 δOH and νC—O(COOH); 1690 νC=O(COOH).

3. m-Tolylmercaptodimethylacetic acid amide 3

10.5 g (0.05 mole) of powdered acid 2 was introduced in portions to 12 g (0.1 mole) of purified thionyl chloride. The suspension was refluxed for 30 minutes using an oil bath and a $CaCl_2$ guard tube. The excess of thionyl chloride was distilled off over a water bath. The oily residue (12 g) was suspended in 40 ccm (0.8 mole) of concentrated ammonia ($d=0.88$) and was shaken mechanically at room temperature for 2 hours. A fine crystalline precipitate formed. It was filtered and dried in a vacuum desiccator over sulphuric acid. The crude product (7 g) was crystallized from petroleum ether (125 ccm). Needles m. pt. 40°C. Yield 2.5 g. The compound is readily soluble in benzene, chloroform, acetone and 96% ethanol and is fairly soluble in petroleum ether.

Analysis:

For $C_{11}H_{15}NOS$ (209.3) — calcd.: 6.69% N;
found: 6.65% N.

4. p-Tolylmercaptodimethylacetic acid amide 16

10.5 g (0.05 mole) of p-tolylmercaptodimethylacetic acid 15 was converted into its amide as in section 3. The crude product (6.6 g) was crystallized from 50% methanol (38 ccm): Needles m. pt. 87°C. Yield 3.1 g.

The compound is readily soluble in benzene, chloroform, acetone and 96% ethanol and is very sparingly soluble in water.

Analysis:

For $C_{11}H_{15}NOS$ (209.30) — calcd.: 6.69% N;
found: 6.84% N.

5. m-Tolylmercaptodimethylacetic acid anilide 4

11 g (0.05 mole) of m-tolylmercaptodimethylacetic acid chloride prepared as in section 3 was added to a solution of 18 g (0.2 mole) of aniline in 50 ccm of benzene. The mixture was shaken mechanically for 2 hours at room temperature. Then it was washed with dilute hydrochloric acid (50 ccm of 10% HCl) and with water (2×100 ccm) and was dried with anhydrous magnesium sulfate. The solvent was distilled off and the residue (7.6 g) was crystallized from 90% methanol (68 ccm). Needles m. pt. 74.5°C. Yield 2.5 g. The anilide is readily soluble in benzene, chloroform, acetone and 96% ethanol and is sparingly soluble in water.

Analysis:

For $C_{17}H_{19}NOS$ (285.39) — calcd.: 4.90% N;
found: 4.80% N.

6. p-Tolylmercaptodimethylacetic acid anilide 17

11 g (0.05 mole) of p-tolylmercaptodimethylacetic acid chloride was converted into its anilide as in section 5. The crude product (7.7 g) was crystallized from cyclohexane (21 ccm). Neeedles m. pt. 86°C. Yield 3.4 g. The anilide is readily soluble in benzene, chloroform and 96% ethanol and is sparingly soluble in cyclohexane.

Analysis:

For $C_{17}H_{19}NOS$ (285.39) — calcd.: 4.90% N;
found: 5.05% N.

7. p-Bromophenacyl ester of m-tolylmercaptodimethylacetic acid 5

2.1 g (0.01 mole) of acid 2 was dissolved in 10 g of 4% NaOH and was treated with a solution of 2 g (0.007 mole) of p-bromophenacyl bromide in 25 ccm of 96% ethanol. The mixture was refluxed for 1 hour. Then it was filtered while still hot and was allowed to stand at room temperature. A fine crystalline precipitate soon formed. It was filtered (2.5 g) and was crystallized from 50% methanol (25 ccm). Needles m. pt. 83°C. Yield 1.2 g. The ester is readily soluble in chloroform, acetone and 96% ethanol.

Analysis:

For $C_{19}H_{19}BrO_3S$ (407.32) — calcd.: 56.02% C, 4.70% H;
found: 55.77% C, 4.62% H.

8. p-Bromephenacyl ester of p-tolylmercaptodimetylacetic acid 18

4.2 g (0.02 mole) of acid 15 was converted into its p-bromophenacyl ester as in section 7. The crude product was dissolved in 150 ccm of ether. The solution was washed with 5% sodium carbonate solution (50 ccm) and then with water. Ether was distilled off on water bath and the residue (2.5 g) was crystallized from 96% ethanol (20 ccm). Plates m. pt. 76°C. Yield 1.2 g. The ester is readily soluble in chloroform and in 96% ethanol.

Analysis:

For $C_{19}H_{19}BrO_3S$ (407.32) — cald.: 56.02% C, 4.70% H;
found: 55.96% C, 4.49% H.

9. p-Nitrobenzyl ester of p-tolylmercaptodimethylacetic acid 19

2.1 g (0.01 mole) of acid 15 was dissolved in 10 g of 4% NaOH. The warm solution of the sodium salt was treated with 2 g (0.007 mole) of p-nitrobenzyl bromide dissolved in 30 ccm of hot 96% ethanol and was refluxed for 1 hour. Then it was filtered while still hot and was allowed to stand at room temperature. A fine crystalline precipitate formed. It was filtered (1 g) and was crystallized from 50% ethanol (26 ccm). Needles m. pt. 75°C. Yield 0.8 g. The ester is readily soluble in chloroform, acetone and methanol.

For $C_{18}H_{19}NO_4S$ (345.41) — calcd.: 4.05% N;
found: 4.08% N.

10. Racemic m-tolylsulfoxydimethylacetic acid 6

13 g (0.06) mole) of acid 2 was dissolved in 15 ccm of glacial acetic acid. The solution was shaken mechanically and was cooled externally with water at 13—15°C. Two portions of 3.5 ccm of 29% hydrogen peroxide (0.058 mole) were added at 12 hours intervals. The solution was shaken and cooled for a further 24 hours and was evaporated to half its volume in a vacuum desiccator filled with solid KOH. A crystalline precipitate formed. It was filtered (12 g) and was crystallized from acetone (110 ccm).

Prisms m. pt. 116°C with decomposition. Yield 7 g. The racemic sulfoxide is readily soluble in benzene, chloroform and 96% ethanol and is insoluble in petroleum ether.

Analysis:

For $C_{11}H_{14}O_3S$ (226.29) — calcd.: 58.38% C, 6.24% H;
found: 58.17% C, 6.19% H.

IR (cm^{-1}): 690 νC—S; 680, 750, 890, 1040, 1075, 1120 δC_{Ar}—H (subst. 1, 3); 1510, 1600 $\nu C_{Ar}=C_{Ar}$; 798, 1170, 1365, 1465 $\nu C(CH_3)_2$; 1000 νSO; 920, 1250, 1310, 1420 δOH and νC—O(COOH); 1725 νC=O(COOH).

11. Racemic p-tolylsulfoxydimethylacetic acid 20

52.2 g (0.25 mole) of acid 15 was dissolved in 140 ccm of glacial acetic acid. The solution was shaken mechanically and was cooled externally with water at 13—15°C. Two portions of 7.3 ccm of 29% hydrogen peroxide (0.24 mole) were added at 12 hours intervals. The solution was allowed to stand for 24 hours at room temperature. A crystalline precipitate formed. It was filtered and was dried in a vacuum desiccator filled with solid KOH. The crude product (49 g) was crystallized from acetone (1 l). Prisms m. pt. 140°C with decomposition. Yield 31 g. The racemic sulfoxide is readily soluble in benzene, chloroform and 96% ethanol and is insoluble in petroleum ether.

Analysis:

For $C_{11}H_{14}O_3S$ (226.29) — calcd.: 58.38% C, 6.24% H;
found: 58.20% C, 6.01% H.

IR (cm^{-1}): 700 νC—S; 820, 1020, 1130, 1210 δC_{Ar}—H (subst. 1, 4); 1460, 1490, 1590 $\nu C_{Ar}=C_{Ar}$; 800, 1170, 1365, 1382, 1460 $C(CH_3)_2$; 1000 νSO; 920 νOH(COOH); 1260, 1305, 1405 δOH and νC—O(COOH); 1725 νC=O(COOH).

12. Amide of racemic m-tolylsulfoxydimethylacetic acid 7

A solution of 2.26 g (0.01 mole) of racemic acid 6 in 30 ccm of anhydrous methanol was cooled externally with a mixture of solid carbon dioxide and acetone and was treated (with stirring) with the stoichiometric amount (0.01 mole) of an ethereal solution of diazomethane [10]. The mixture was allowed to stand for 30 minutes at room temperature and the solvent removed by distillation under reduced pressure (12 mm Hg, bath temperature 40°C). The oily residue (2.2 g) was added to 30 ccm of methanol saturated with ammonia and the mixture was shaken mechanically

for 48 hours at room temperature. Then the reaction mixture was filtered and the solvent was removed by distillation under reduced pressure (12 mm Hg, bath temperature 40°C). The residue (2 g) was crystallized from a mixture of chloroform (15 ccm) and petroleum ether (60 ccm). Needles m. pt. 108°C. Yield 1.8 g. The amide is readily soluble in benzene chloroform, acetone and methanol and is very sparingly soluble in petroleum ether.

Analysis:

For $C_{11}H_{15}NO_2S$ (225.30) — calcd.: 6.21% N;
found: 6.25% N.

13. Methyl ester of racemic p-tolylsulfoxydimethylacetic acid 21

A solution of racemic acid 20 (4.5 g in 30 ccm of anhydrous methanol) was treated dropwise with stirring with the stoichiometric amount (0.02 mole) of an ethereal solution of diazomethane [10]. The reaction mixture was allowed to stand for 30 minutes at room temperature. The solvent was removed by distillation under reduced pressure (12 mm Hg, bath temperature 40°C). The residue (4 g) was crystallized from petroleum ether (90 ccm). Large cubes m. pt. 75°C. Yield 2.3 g. The ester is readily soluble in chloroform, glacial acetic acid and methanol and is fairly soluble in petroleum ether.

Analysis:

For $C_{12}H_{16}O_3S$ (240.31) — calcd.: 59.97% C, 6.71% H;
found: 60.24% C, 6.53% H.

14. Amide of racemic p-tolylsulfoxydimethylacetic acid 22

1.5 g (0.006 mole) of powdered ester 21 was added to 15 ccm of methanol saturated with ammonia at 10°C. The mixture was allowed to stand at room temperature until the solvent completely evaporated. The residue (1.5 g) was crystallized from a mixture of chloroform (10 ccm) and petroleum ether (40 ccm). Clusters of small crystals m. pt. 132°C. Yield 1.2 g. The ester is readily soluble in chloroform, acetone, and 96% ethanol and is very sparingly soluble in petroleum ether.

Analysis:

For $C_{11}H_{15}NO_2S$ (225.30) — calcd.: 6.21% N;
found: 6.31% N.

15. Cinchonidine salt of laevorotatory m-tolylsulfoxydimethylacetic acid 8

9.65 g (0.04 mole) of powdered racemic acid 6 was mixed with 12.5 g (0.04 mole) of cinchonidine and the mixture was dissolved in 30 ccm of boiling 96% ethanol. The solution was filtered while still hot and was allowed to stand at room temperature for crystallization. After 24 hours the first fraction of the salt was filtered off. Needles (8 g) m. pt. 174°C with decomposition, $[\alpha]_D^{20} = -100°$ ($c = 0.5$, $d = 2$, $\alpha = -1.00°$) in 96% ethanol.

After repeated crystallization of the first fraction of cinchonidine salt (8 g from 65 ccm of 96% ethanol) the product had physical properties which remained unchanged by further purification. Needles (5.5 g) m. pt. 175°C and $[\alpha]_D^{20} = -117°$ ($c = 0.5$, $d = 2$, $\alpha = -1.17°$) in 96% ethanol. The salt of the laevorotatory acid is readily soluble in chloroform and in 96% ethanol, fairly soluble in acetone and insoluble in petroleum ether.

Analysis:

For the formula: $C_{30}H_{36}N_2O_4S$ (520.67) — calcd.: 5.38% N;
found: 5.67% N.

16. Laevorotatory m-tolylsulfoxydimethylacetic acid 9

5 g (0.01 mole) of powdered salt 8 (m. pt. 175°C, $[\alpha]_D^{20} = -117°$) was suspended in 20 ccm of water and the suspension was acidified with 50 g of 4%HCl. The mixture was stirred for 2 hours at room temperature. The resulting laevorotatory enantiomer was filtered off and was dissolved in 15 ccm of water alkalized with 50 ccm of 2% NaOH. The solution was extracted with chloroform, (5×20 ccm). The alkaline layer was freed from dissolved chloroform by distillation under reduced pressure (12 mm Hg, water bath at 40°C) and was acidified to Congo with 15% HCl. A fine crystalline precipitate separated immediately. It was filtered off (1.5 g) and after washing with water, it was crystallized with acetone (10 ccm). Prisms m. pt. 124°C with decomposition, $[\alpha]_D^{20} = -84°$ ($c = 0.5$, $d = 2$, $\alpha = -0.84°$) in 96% ethanol. Yield 0.5 g. The laevorotatory enantiomer is readily soluble in chloroform and in 96% ethanol, fairly soluble in acetone and insoluble in petroleum ether.

Analysis:

For $C_{11}H_{14}O_3S$ (226.29) — calcd.: 58.38% C, 6.24% C;
found: 58.41% C, 6.10% H.

IR (cm^{-1}): 690 νC—S; 680, 760, 900, 1040, 1078, 1130 δC_{Ar}—H (subst. 1, 3); 1600 νC_{Ar}—C_{Ar}; 800, 1170, 1380, 1470 $C(CH_3)_2$; 1000 νSO; 930 δOH(COOH); 1270, 1310, 1420 δOH and νC—O(COOH); 1720 νC=O(COOH).

17. Hydrocinchonidine salt of dextrorotatory m-tolylsulfoxydimethylacetic acid 10

3.15 g (0.014 mole) of powdered racemic acid 6 was mixed with 4 g (0.014 mole) of hydrocinchonidine and the mixture was dissolved in 150 ccm of boiling acetone diluted with 15 ccm of water. The solution was filtered while still hot and was evaporated under reduced pressure (12 mmm Hg, water bath at 40°C) to half its volume. Then it was allowed to stand at room temperature. A precipitate formed and was filtered off after 24 hours. Needles m. pt. 165°C with decomposition; $[\alpha]_D^{20} = -27°$ ($c=0.5$, $d=2$, $\alpha=-0.27°$) in 96% ethanol. The physical properties of the salt remained unchanged by further purification. Needles m. pt. 165°C with decomposition; $[\alpha]_D^{20} = -27°$ ($c=0.5$, $d=2$, $\alpha=-27°$) in 96% ethanol. Yield 3 g. The salt is readily soluble in chloroform and in methanol, fairly soluble in acetone and insoluble in petroleum ether.

Analysis:

For: $C_{30}H_{38}N_2O_4S$ (522.69) — calcd.: 5.36% N;
found: 5.58% N.

18. Dextrorotatory m-tolylsulfoxydimethylacetic acid 11

2 g (0.004 mole) of powdered salt 10 (m. pt. 165°C, $[\alpha]_D^{20} = -27°$) was suspended in 20 ccm of water and the suspension was acidified with 10 g (0.01 mole) of 4% HCl. The suspension was stirred for 2 hours at room temperature. The resulting dextrorotatory antipode was filtered off and was dissolved in 10 ccm of water alkalized with 10 ccm of 3% NaOH. The solution was extracted with chloroform (5×10 ccm). The aqueous layer was freed from dissolved chloroform by distillation under reduced pressure (12 mm Hg, bath temperature 40°C) and was acidified to Congo with 15% HCl. A fine crystalline precipitate separated immediately. It was filtered off and after washing with water, it was dried in a vaccuum desiccator over sulphuric acid. Then it was crystallized with acetone (5 ccm). Prisms m. pt. 124°C with decomposition. $[\alpha]_D^{20} = +82°$ ($c=0.5$, $d=2$, $\alpha=+0.82°$) in 96% ethanol. Yield 0.5 g. The acid is readily soluble in chloroform, acetone and 96% ethanol and is insoluble in petroleum ether.

Analysis:

For $C_{11}H_{14}O_3S$ (226.29) — calcd.: 58.38% C, 6.24% H;
found: 58.33% C, 6.21% H.

19. Cinchonidine salt of laevorotatory p-tolylsulfoxydimethylacetic acid 23

8 g (0.035 mole) of powdered racemic acid 20 was mixed with 10.4 g (0.035 mole) of cinchonidine and the mixture was dissolved in 380 ccm of boiling 96% ethanol. The hot solution was filtered and was allowed to stand at room temperature for crystallization. After 24 hours the first fraction of the salt was filtered off. Needles (10 g) m. pt. 179°C, $[\alpha]_D^{20} = -134°$ ($c=0.5$, $d=2$, $\alpha=-1.34°$) in 96% ethanol. After repeated crystallization of the first fraction of the salt (10 g) from the same solvent (1200 ccm), the product had physical properties which remained unchanged by further purification. Needles m. pt. 181°C, $[\alpha]_D^{20} = -140°$ ($c=0.5$, $d=2$, $\alpha=1.40°$) in 96% ethanol. Yield 6 g. The salt is readily soluble in chloroform. The aqueous layer was freed from dissolved chloroform by petroleum ether.

Analysis:

For $C_{30}H_{36}N_2O_4S$ (520.67) — calcd.: 5.38% N;
found: 5.50% N.

20. Laevorotatory p-tolylsulfoxydimethylacetic acid 24

27 g (0.05 mole) of powdered salt 23 (m. pt. 181°C, $[\alpha]_D^{20} = -140°$) was suspended in 50 ccm of water and was acidified with 50 g (0.1 mole) of 7% HCl. The suspension was stirred for 2 hours at room temperature. The resulting laevorotatory enantiomer was filtered off and was suspended in 30 ccm of water. The suspension was neutralized to phenolphthalein with 8% NaOH. The solution of the sodium salt was extracted with chloroform. The aqueous layer was freed from dissolved chloroform by distillation under reduced pressure (12 mm Hg, bath temperature 40°C) and was acidified to Congo with 15% HCl. A fine crystalline precipitate separated immediately. It was filtered off and after washing with water it was crystallized from acetone (200 ccm). Prisms m. pt. 117°C with decomposition; $[\alpha]_D^{20} = -98°$ ($c=0.5$, $d=2$, $\alpha=-0.98°$) in 96% ethanol. Yield 6 g. The acid is readily soluble in benzene, chloroform and methanol, fairly soluble in acetone and insoluble in petroleum ether.

Analysis:
For $C_{11}H_{14}O_3S$ (226.29) — calcd.: 58.38% C, 6.24% H;
found: 58.61% C, 6.18% H.

IR (cm^{-1}): 700 νC—S; 818, 1020, 1125, 1210 δC_{Ar}—H (subst. 1, 4); 1500, 1590 $\nu C_{Ar}=C_{Ar}$; 805, 1165, 1180, 1370, 1385, 1470 $C(CH_3)_2$; 1000 νSO; 910 δOH(COOH); 1265, 1310, 1410 δOH and νC—O(COOH); 1725 νC=O (COOH).

21. Hydrocinchonidine salt of dextrorotatory p-tolylsulfoxydimethylacetic acid 26

18 g (0.08 mole) of powdered racemic acid 20 was mixed with 26 g (0.08 mole) of hydrocinchonidine and the mixture was disolved in 110 ccm of boiling acetone. The hot solution was filtered and was allowed to stand at room temperature for crystallization. After 24 hours the first fraction of the salt was filtered off. Needles m. pt. 118°C; $[\alpha]^{20}_D = +121°$ ($c=0.5$, $d=2$, $\alpha=+1.21°$) in acetone. After two crystallizations of the first fraction of the salt the product had physical properties which remained unchanged by further purification. Needles m. pt. 119°C, $[\alpha]^{20}_D = +127°$ ($c=0.5$, $d=2$, $\alpha=+1.27°$) in acetone. Yield 17 g. The salt is readily soluble in chloroform and methanol, fairly soluble in acetone and insoluble in petroleum ether.

Analysis:
For $C_{31}H_{40}N_2O_5S$ (552.71) — calcd.: 5.07% N;
found: 4.77% N.

Table 2. Fractional crystallization of cinchonidine salt of dextrorotatory p-tolysulfoxydimethylacetic acid (crystallization time 24 hours)

Fraction No.	Volume of acetone (ccm)	Yield of salt (g)	Specific rotation in acetone $(\alpha)_D^{20}$ in °	Melting point of salt in °C
1	110	29	+121	118
2	90	22	+123	118
3	80	17	+127	119
4	60	14	+127	119

22. Dextrorotatory p-tolylsulfoxydimethylacetic acid 27

13 g (0.025 mole) of powdered salt 26 (m. pt. 118°C, $[\alpha]^{20}_D = +121°$) was suspended in 40 ccm of water and the suspension was acidified with 30 g (0.03 mole) of 4% HCl. Then it was stirred for 2 hours at room temperature. The resulting antipode was filtered off and was suspended

in 20 ccm of water. The suspension was neutralized with 4% NaOH (to phenolphthalein). The solution of the sodium salt was extracted (5×20 ccm) with chloroform. The aqueous layer was freed from dissolved chloroform by distillation under reduced presure (12 mm Hg, bath temperature 40°C) and was acidified to Congo with 5% HCl. A fine crystalline precipitate separated immediately. It was filtered off (5 g) and after washing with water, it was crystallized with acetone (100 ccm). Prisms m. pt. 117°C with decomposition; $[\alpha]^{20}_D = +98°$ ($c=0.5$, $d=2$, $\alpha=+0.98°$) in 96% ethanol. Yield 3 g. The acid is readily soluble in chloroform, acetone, and 96% ethanol and is insoluble in petroleum ether.

Analysis:

For $C_{11}H_{14}O_3S$ (226.29) — 58.38% C, 6.24% H;
found: 58.12% C, 6.52% H.

23. Amide of laevorotatory m-tolylsulfoxydimethylacetic acid 12

2.26 g (0.01 mole) of laevorotatory m-tolylsulfoxydimethylacetic acid 9 was converted into its methyl ester as in section 12. 2.1 g of the ester (straw-yellow non-solidifying oil) was introduced into 30 ccm of methanol saturated at 10°C with ammonia gas and the mixture was shaken mechanically for 48 hours at room temperature. Then it was filtered and allowed to evaporate at room temperature. The residue (1.9 g) was crystallized from a mixture of chloroform (10 ccm) and petroleum ether (40 ccm). Clusters of small crystals m. pt. 119°C; $[\alpha]^{20}_D = -72°$ ($c=0.25$, $d=4$, $\alpha=-0.72°$) in 96% ethanol. Yield 1.7 g. The amide is readily soluble in chloroform, acetone and 96% ethanol and is insoluble in petroleum ether.

Analysis:

For $C_{11}H_{15}NO_2S$ (225.30) — calcd.: 6.21% N;
found: 6.42% N.

24. Amide of laevorotatory p-tolylsulfoxydimethylacetic acid 25

2.264 g (0.01 mole) of laevorotatory p-tolylsulfoxydimethylacetic acid 24 was converted into its amide as in section 23. The crude product of the reaction (1.1 g) was crystallized from a mixture of chloroform (10 ccm) and petroleum ether (40 ccm). Needles m. pt. 154°C with decomposition; $[\alpha]^{20}_D = -93°$ ($c=0.25$, $d=4$, $\alpha=-0.93°$) in 96% ethanol. Yield 0.7 g. The amide is readily soluble in chloroform, acetone and 96% ethanol and is insoluble in petroleum ether.

Analysis:
For $C_{11}H_{15}NO_2S$ (225.30) — calcd.: 6.21% N;
found: 6.16% N.

25. m-Tolylsulfoxydimethylacetic acid 13

4.5 g (0.02 mole) of acid 6 was suspended in 10 ccm of water and the suspension was neutralized to *pH* 12 with 50% NaOH. The solution of the sodium salt was heated over a water bath and was treated at 2 hours intervals with five-2 ccm portions of 29% hydrogen peroxide (0.078 mole of H_2O_2). After the addition of the last portion of the oxidising agent, the solution was allowed to stand for 12 hours at room temperature. Then it was acidified (*pH*=4) with 10% H_2SO_4. A fine crystalline precipitate formed. It was filtered off (3.6 g) and was crystallized from a mixture of chloroform (60 ccm) and petroleum ether (200 ccm) and then from chloroform alone (12 ccm). Colourless thin plates m. pt. 146°C. Yield 1.7 g. The acid is readily soluble in chloroform, acetone and methanol and is very sparingly soluble in petroleum ether.

Analysis:
For the $C_{11}H_{14}O_4S$ (242.29) — calcd.: 54.53% C, 5.82% H;
found: 54.12% C, 6.01% H.

IR (cm^{-1}): 700 νC—S; 685, 760, 900, 1040, 1080, 1125 δC_{Ar}—H (subt. 1, 3); 1580, 1600, $\nu C_{Ar}=C_{Ar}$; 810, 1180, 1370, 1470, $C(CH_3)_2$; 1150 $\nu_{as}SO_2$; 1300 ν_sSO_2; 930 δOH(COOH); 1280, 1320, 1420 δOH and νC—O(COOH); 1710 νC=O(COOH).

26. p-Tolylsulfonyldimethylacetic acid 28

4.5 g (0.02 mole) of acid 20 was converted into the corresponding sulfone as in section 25. The crude reaction product (2.2 g) was crystallized from benzene (30 ccm). Colourles needles m. pt. 124°C (lit. [11] m. pt. 124—125°C). Yield 1.7 g.

IR (cm^{-1}): 700 νC—S; 810, 1010, 1130, 1210, δC_{Ar}—H (subst. 1, 4); 1460, 1490, 1590, $\nu C_{Ar}=C_{Ar}$; 810, 1160, 1365, 1380, 1465 $C(CH_3)_2$; 1140 $\nu_{as}SO_2$; 1310 ν_sSO_2; 930 δOH(COOH); 1240, 1310, 1400 δOH and νC—O (COOH); 1710 νC=O(COOH).

REFERENCES

1. Janczewski M., Janowski W.: Ann. Univ. M. Curie-Skłodowska, Lublin, sectio AA, 31/32, 317 (1976/1977).
2. Oksengendler G., Gierasimienko I.: Zhur. Obshch. Khim. 37, 3214 (1957).

3. Vogel A.: Organic Preparations (in Polish). WNT, Warszawa 1964, 842.
4. Janczewski M.: Roczniki Chem. 35, 585 (1961).
5. Coulson A.: Trans. Faraday Soc. 38, 433 (1942).
6. Kwart A., Takeshita T.: J. Am. Chem. Soc. 86, 1161 (1964).
7. Hammett L.: Physical Organic Chemistry (in Polish). PWN, Warszawa 1976, 332.
8. Janczewski M., Dziurzyńska B.: Roczniki Chem. 48, 409 (1974).
9. Volhard I.: Ann. 242, 161 (1887).
10. Vogel A.: Organic Preparations (in Polish). WNT, Warszawa 1964, 985.
11. Troeger I., Uhder R.: J. prakt. Chem. (2), 59, 323 (1899).

STRESZCZENIE

Grupy alkilowe przejawiają prawdopodobnie dwa efekty, a mianowicie hiperkoniugacyjny, wykazujący w układach nienasyconych cechy efektu mezomerycznego (M), oraz indukcyjny, który w połączeniach o charakterze nasyconym wydaje się mieć wartości ujemne, a w układach nienasyconych wartości dodatnie. Nie jest wykluczone, że efekty te mogą wywierać pewien wpływ na rotację cząsteczkową połączeń nienasyconych oraz związków aromatyczno-tłuszczowych z heteroatomowymi węzłami chiralności. Jednoznacznych i dostatecznie uzasadnionych rozwiązań tego problemu należy szukać na drodze eksperymentalnej.

Poprzednio [1] opisana została synteza oraz podstawowe własności chiraloptyczne kwasu fenylosulfoksydwumetylooctowego oraz jego o-metylowej pochodnej. Przedmiotem bieżącego doniesienia jest synteza oraz porównanie własności optycznych enancjomerycznych kwasów m- i p-tolilosulfoksydwumetylooctowych.

Niezbędne do badań optycznie czynne układy sulfinylowe 9 i 24 otrzymano metodą krystalizacji frakcyjnej związków diastereomerycznych utworzonych przez związanie racematów 6 i 20 z zasadami alkaloidowymi (syntezy układów racemicznych 6 i 20 wraz z jednoznacznymi dowodami ich struktury podano w części doświadczalnej). Na podstawie porównania własności fizycznych poszczególnych enancjomerów oraz kwasów racemicznych można było stwierdzić, że układy optycznie bierne należą do typu prawdziwych racematów. Badania krzywych dyspersji skręcalności optycznej (ORD), dichroizmu kołowego (CD) oraz widm elektronowych (UV) w nadfioletowej części widma oraz przesunięć Freudenberga (amidy) lewoskrętnego kwasu fenylosulfoksydwumetylooctowego (FS) oraz jego metylowanych w pierścieniu aromatycznym pochodnych (OTS, MTS i PTS) wykazały, że konfiguracje sulfinylozwiązków skręcających w widzialnej części widma płaszczyznę światła spolaryzowanego w tym samym kierunku są zgodne.

Oznaczenia rotacji cząsteczkowych lewoskrętnych kwasów 9 i 24 i ich pochodnych amidowych 12 i 25 w widzialnej części widma wykonano w pięciu rozpuszczalnikach dla λ=6234, 5843, 5791, 5461 i 4358 Å. Uzyskane wyniki zestawiono w tab. 1. Wynika z nich, że na wielkość skręcalności molowych poszczególnych połączeń znaczny wpływ wywiera charakter rozpuszczalnika oraz, że w widzialnej części widma dyspersja rotacyjna badanych układów ma charakter dyspersji normalnej. Z dwu studiowanych obecnie optycznie czynnych sulfoksykwasów 9 i 24 znacznie wyższe wartości rotacji molowych w widzialnej części widma we wszystkich stosowanych do pomiarów rozpuszczalnikach wykazuje kwas p-tolilosulfoksydwumetylooctowy 24. Jeśli uwzględnić poprzednio wykonane oznaczenia polarymetryczne [1], to porządek

optyczny w grupie badanych sulfoksypołączeń o tej samej budowie przestrzennej należy przedstawić następującą sekwencją o zmniejszających się wartościach numerycznych rotacji molowych:

OTS>PTS>FS>MTS

Zaobserwowany porządek optyczny pozwala przypuszczać, iż na rotację sulfotlenkowego węzła chiralności wywierają pewien wpływ efekty: hiperkoniugacyjny i indukcyjny, wzbudzane przez grupę metylową związaną z pierścieniem benzenowym. Działanie efektu hiperkoniugacyjnego, zwiększającego rotację molową cząsteczki, ma miejsce, gdy grupa metylowa zajmuje położenie chinoidowe (orto i para). Efekt indukcyjny obniżający skręcalność cząsteczkową pojawiałby się natomiast, gdy podstawnik związany jest z rdzeniem arenowym w położeniu meta (niechinoidowym). Działanie efektu indukcyjnego nie jest zgodne z przewidywaniami opartymi na wartościach stałych σ Hammetta [7], wydaje się natomiast potwierdzać przypuszczenia Coulsona [3] i Kwarta [6]. Podane hipotezy robocze wymagają sprawdzenia na innych układach. Badania będą kontynuowane (M. J.).

РЕЗЮМЕ

Алкиловые группы, вероятно, проявляют два эффекта: гиперконъюгационный, проявляющий в ненасыщенных системах признаки мезомерного эффекта (M), и индуктивный, который в соединениях насыщенного характера имеет величны отрицательные, а в ненасыщенных — положительные. Не исключено, что эти эффекты могут оказывать некоторое влияние на молекулярную ротацию ненасыщенных соединений и ароматическо-жирных соединений с гетероатомными узлами хиральности. Однозначных и достаточно обоснованных решений этой проблемы следует искать экспериментальным путем.

Синтез и основные хиральнооптические свойства фенилсульфоксидиметилуксусной кислоты и ее о-метиловых производных были уже описаны [1]. Предметом настоящей статьи является сравнение оптических свойств энантиомерических m- и p-толилсульфоксидиметиоуксусных кислот.

Необходимые для исследований оптически активные сульфиниловые системы 9 и 24 были получены методом фракционной кристаллизации диастереомерических соединений, полученных путем связывания рацематов 6 и 20 с алкалоидными щелочами. (Синтезы рацемических систем 6 и 20 и доказательство их структуры даются в экспериментальной части). Сравнение физических свойств отдельных энантиомеров и рацемических кислот дает возможность утверждать, что оптически пассивные системы принадлежат к истинным рацематам. Исследования кривых дисперсии оптического вращения (ORD), циркулярного дихроизма (CD) и электронного спектра (UV) в ультрафиолетовой части спектра, а также смещений Фрейденберга (амиды) левовращающей фенилсульфоксидиметилуксусной кислоты (FS) и ее метилированных в ароматическом кольце производных (OTS, MTS, PTS) показали, что конфигурации сульфинилсоединений, вращающих в видимой части спектра плоскость поляризованного света в том же направлении, совпадают.

Определение молекулярных ротаций левовращающих кислот 9 и 24 и их амидопроизводных 12 и 25 в видимой части спектра производилось в пяти растворителях для λ=6234, 5843, 5791, 5461 и 4358 Å. Полученные результаты представлены в табл. 1. Из них следует, что на величину молярного вращения отдельных соединений большое влияние оказывает характер растворителя, а ро-

тационная дисперсия изучаемых систем в видимой части спектра носит характер нормальной дисперсии. Из двух изучаемых нами оптически активных сульфокислот 9 и 24 значительно высшие величины молярной ротации в видимой части спектра во всех применяемых для измерений растворителях обнаруживает р-толилсульфоксидиметилуксусная кислота 24. Если же учесть уже выполненные поляриметрические определения [1], то оптический порядок в группе изучаемых сульфоксисоединений такого же пространственного строения, следует представить следующей секвенцией с уменьшающимися численными величинами молярных ротаций:

OTS>PTS>FS>MTS

Наблюдаемый оптический порядок позволяет предполагать, что некоторое влияние на ротацию сульфоокисного узла хиральности оказывает гиперконъюгационный и индуктивный эффекты, возбуждаемые метиловой группой связанной с бензоловым кольцом. Действие гиперконъюгационного эффекта, усиливающего молярную ротацию молекулы имеет место тогда, когда метиловая группа занимает хиноидовое положение (орто и пара). Индуктивный эффект, снижающий молекулярное вращение, появлялся бы тогда, когда заместитель связан с ареновым кольцом в положении мета (нехиноидный). Действие индуктивного эффекта не соответствует предположениям, основанным на постоянных величинах Hammett'a [7], зато, как нам кажется, подтверждает предположения Coulson'a [3] и Kwart'a [6]. Такого рода рабочие гипотезы требуют проверки на других системах. Исследования будут продолжаться (М. Я.).