

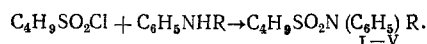
SYNTHESIS AND REPELLENT PROPERTIES OF N-ALKYLANILIDES AND ESTERS OF BUTANESULFONIC ACID

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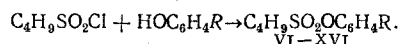
There are compounds possessing expressed repellent activity in relation to insects [1-3] among disubstituted amides and esters of organic sulfonic acids. In this connection, it was of interest to us to synthesize and examine a series of N-alkylanilides and esters of butanesulfonic acid as insect repellents, all the more because, according to literature data [4], certain acyl derivatives of alkyylanilides, for example butylacetanilide, are active mite repellents.

N-Alkylanilides (I-V) were obtained by reaction of butanesulfonyl chloride with N-alkylanilines in the presence of pyridine.



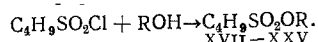
These are thick pale-yellow liquids or colorless crystalline materials without odor (Table 1).

Esters of butanesulfonic acids (VI-XVI) were synthesized by reaction of butanesulfonyl chloride with basic solutions of phenols at room temperature [5-7].



The obtained aromatic esters are thick light-yellow liquids; a portion of the compounds are colorless crystalline materials (Table 2).

Aliphatic esters of butanesulfonic acid (XVII-XXV) were synthesized by reaction of butanesulfonyl chloride with alcohols in pyridine.



These compounds are colorless or lightly yellow liquids having a unique odor; methoxy- and ethoxyethyl esters (XXIV and XXV) darken strongly upon standing in air. Constants of the synthesized compounds are presented in Table 3.

The repellent activity of the obtained compounds was studied by the method developed at the Military-Medicinal Academy [8]. The preparations were applied to a cotton diagonal in a dose of 40 g/m², using the flea *Ceratophyllus tesquorum* as the biological model. The effectiveness of the investigated materials was evaluated from the size of coefficients of repellent effect (CRE) on the day of treatment of the fabric, and in the case of sufficiently expressed repellent properties, additionally after each two weeks until CRE fell below 70%.

All experiments were set in five repetitions using 100 fleas in each of them. Examination was carried out at a temperature of 20-22°C and a relative humidity of the air of 55-75%. Experimental samples were

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TABLE 1. N-Alkylanilides of Butanesulfonic Acid

Compound	R	Yield, %	bp deg		mp	²⁰ n _D	Found, %				Empirical formula	Calculated, %			
							C	H	N	S		C	H	N	S
I	CH ₃	92,1	143—145 (0,3 mm)	52—54	—	—	58,15	7,87	6,03	13,96	C ₁₁ H ₁₇ NO ₂ S	58,12	7,54	6,16	14,10
II	C ₂ H ₅	41,5	142—145 (0,3 mm)	—	—	1,5159	58,20	8,00	5,80	13,82	C ₁₂ H ₁₉ NO ₂ S	59,72	7,93	5,80	13,28
III	C ₃ H ₇	44,5	178—180 (0,75 mm)	—	—	1,5099	59,68	8,13	6,00	12,57	C ₁₃ H ₂₁ NO ₂ S	61,14	8,29	5,49	12,55
IV	C ₄ H ₉	87,4	145—148 (0,2 mm)	30—31	—	—	61,10	8,18	5,95	12,35	C ₁₄ H ₂₃ NO ₂ S	62,42	8,61	5,19	11,90
V	C ₅ H ₁₁	46,6	140—142 (0,25 mm)	27—28	—	—	62,34	8,47	5,66	11,83	C ₁₅ H ₂₅ NO ₂ S	63,34	8,86	4,93	11,27

TABLE 2. Aromatic Esters of Butanesulfonic Acid

Com- pound	R	Yield, %	mp (deg)	²⁰ d ₄	²⁰ n _D	Found, %			Empirical formula	Calculated, %		
						C	H	S		C	H	S
VI ^a	H	73,4	123—126 (1—2 mm)	—	1,5026	—	—	—	—	—	—	—
VII ^a	o-CH ₃	55,3	118—121 (0.5 mm)	—	1,5040	—	—	—	C ₁₁ H ₁₀ O ₃ S	57,86	7,06	14,04
VIII	m-CH ₃	71,1	124—127 (0.6 mm)	1,1433	1,5042	57,47	7,23	13,60	C ₁₁ H ₁₀ O ₃ S	57,86	7,06	14,04
IX	p-CH ₃	61,9	122—125 (0.5 mm)	1,1408	1,5038	57,80	6,85	13,91	C ₁₁ H ₁₀ O ₃ S	57,86	7,06	14,04
X ^a	o-CH ₃ O	66,4	138—142 (0.6 mm)	—	—	57,71	6,75	13,85	C ₁₁ H ₁₀ O ₄ S	54,08	6,60	13,12
XI	m-CH ₃ O	71,3	134—138 (0.2 mm)	1,1964	1,5101	53,73	7,05	12,92	C ₁₁ H ₁₀ O ₄ S	54,08	6,60	13,12
XII	p-CH ₃ O	70,1	150—152 (0.6 mm)	1,1947	1,5108	53,85	7,03	12,94	C ₁₁ H ₁₀ O ₄ S	54,08	6,60	13,12
XIII	2-iso-C ₃ H ₇ -	43,0	138—140 (0.8 mm)	1,0802	1,5102	53,88	6,85	12,81	C ₁₁ H ₁₀ O ₄ S	54,08	6,60	13,12
XIV ^a	o-Cl	68,2	125—129 (0.7 mm)	—	1,5170	54,00	7,10	13,43	C ₁₄ H ₂₂ O ₃ S	62,18	8,21	11,86
XV ^a	p-Cl	79,0	144—146 (1 mm)	—	1,5162	53,77	6,95	13,16	C ₁₄ H ₂₂ O ₃ S	62,18	8,21	11,86
XVI ^a	o,p-Cl	78,5	128—132 (0.3 mm)	1,3496	1,5295	62,02	8,70	12,00	C ₁₀ H ₁₂ Cl ₂ O ₃ S	—	—	—
						62,52	8,54	11,80	—	—	—	—
						42,59	4,65	10,92	—	42,41	4,27	11,31
						42,38	4,30	10,99	—	—	—	—

* Literature data: VI, bp. 166° (10 mm), ²⁰n_D 1.5011 [5]; VII, bp 150—152° (5 mm), ²⁰n_D 1.5035 [6]; XIV, bp 180—181° (13 mm), ²⁰n_D 1.5120 [7]; XV, bp 186—189° (7 mm), ²⁰n_D 1.5165 [5].

† bp 42.5—43.5°.

‡ Found, %: Cl 24.65; 24.81. Calculated, %: Cl 25.07.

TABLE 3. Aliphatic Esters of Butanesulfonic Acid

Com- pound	R	Yield, %	Bp(deg)	d_4^{20}	n_D^{20}	Found, %			Empirical formula	Calculated, %		
						C	H	S		C	H	S
XVII	C_9H_{11}	68,8	110—114 (0,9 mm)	1,0128	1,4361	51,92	10,08	15,18	$C_9H_{20}O_3S$	51,88	9,67	15,38
XVIII	iso- C_9H_{11}	68,3	104—107 (1 mm)	1,0411	1,4360	51,99	9,87	14,87	$C_9H_{20}O_3S$	51,88	9,67	15,38
XIX	C_9H_{13}	77,9	115—117 (0,7 mm)	1,0066	1,4384	51,95	10,13	15,12	$C_{10}H_{22}O_3S$	54,02	9,97	14,42
XX	C_7H_{15}	74,2	140—143 (1 mm)	0,9916	1,4420	53,80	9,97	14,33	$C_{11}H_{24}O_3S$	55,89	10,24	13,57
XXI	C_8H_{17}	78,8	140—144 (1 mm)	0,9806	1,4423	53,92	9,99	14,17	$C_{12}H_{26}O_3S$	57,56	10,47	12,81
XXII	C_9H_{19}	76,1	153—155 (1 mm)	0,9760	1,4440	56,24	10,70	12,74	$C_{13}H_{28}O_3S$	59,04	10,67	12,12
XXIII	$C_{10}H_{21}$	75,5	150—157 (1 mm)	0,9607	1,4454	58,15	10,53	12,53	$C_{14}H_{30}O_4S$	60,38	10,86	11,52
XXIV	$CH_3CH_2OCH_3$	33,7	95—98 (0,6 mm)	1,1311	1,4400	59,62	10,75	12,57	$C_7H_{16}O_4S$	42,84	8,21	16,34
XXV	$CH_3CH_2OC_2H_5$	69,0	125—127 (0,4 mm)	1,0986	1,4384	60,22	11,14	11,40	$C_8H_{18}O_4S$	45,69	8,62	15,25
						60,16	10,90	11,35				
						42,89	8,56	16,22				
						42,55	8,55	16,02				
						45,13	8,71	14,89				
						45,33	8,82	14,78				

TABLE 4. Repellent Activity of Derivatives of Butanesulfonic Acid in Relation to Fleas *C. tesquorum* (dose 40 g/m², exposure 1 min)

Com- pound	CRE(%)						Compound	CRE. %					
	after treatment of the cloth	weeks after treatment						after treatment of the cloth	weeks after treatment				
		2	4	6	8	10			2	4	6	8	10
I	87	73	16	—	—	—	XIV	90	77	84	62	—	—
II	93	68	—	—	—	—	XV	81	61	—	—	—	—
III	49	—	—	—	—	—	XVI	64	—	—	—	—	—
IV	18	—	—	—	—	—	XVII	81	65	—	—	—	—
V	0	—	—	—	—	—	XVIII	100	62	—	—	—	—
VI	90	77	84	69	—	—	XIX	90	47	—	—	—	—
VII	95	67	—	—	—	—	XX	91	63	—	—	—	—
VIII	87	83	75	80	88	55	XXI	76	63	—	—	—	—
IX	75	68	—	—	—	—	XXII	91	46	—	—	—	—
X	63	—	—	—	—	—	XXIII	92	63	—	—	—	—
XI	81	56	—	—	—	—	XXIV	98	91	81	17	—	—
XII	90	62	—	—	—	—	XXV	97	96	81	75	73	45
XIII	47	—	—	—	—	—	N,N-Di- ethyl-m- toluamide	100	100	85	46	—	—

stored under these same conditions. Diethyltoluamide served as a standard. Results of examinations are presented in Table 4. As is seen, of the synthesized groups of compounds the most effect had the aliphatic esters of butanesulfonic acid, the CRE of the majority of which was greater than 90% upon fresh impregnation of the cloth. However, with the exception of the methoxyethyl (XXIV) and ethoxyethyl (XXV) esters, similar in strength and duration of effect to diethyltoluamide, taken as a standard, all compounds of this group were found to be unstable and virtually lost activity already in the course of the first two weeks.

All compounds of the group of aromatic esters of butanesulfonic acid also showed significant repellent activity, but among the most strongly acting of them, the phenyl (VI), o-cresyl (VII), m-cresyl (VIII), p-methoxyphenyl (XII), and o-chlorophenyl (XIV) esters, only (VI), (VIII), and (XIV) did not yield in length of effect to diethyltoluamide.

Of the N-alkylanilides of butanesulfonic acid, the methyl- and ethylanilides (I and II) showed expressed effectiveness, but at low stability. The remaining compounds of the given homologous series were found to be virtually inactive.

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