

dense with sulfathiazole even when heated at 160–170° for two hours.

Succinic acid condensed with the sulfonamides, when heated at a temperature of 150–170° for one to two hours, to give the anils II and 5–7% of the diamides IV. Hydrolysis of the anils II with 5–10% alkali gave the corresponding acid amides I. Condensation of glutaric, adipic and sebacic

acids with the sulfonamides led to the isolation of the acid amides I and diamides III, in varying proportions.

*p*-Succinimidobenzenesulfonyl chloride condensed with 2-aminothiazole, under varying conditions, to give N<sup>4</sup>-succinylsulfathiazole and an unidentified product.

GLENOLDEN, PA.

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[CONTRIBUTION FROM THE KEDZIE CHEMICAL LABORATORY, MICHIGAN STATE COLLEGE]

## The Condensation of Some Secondary Aliphatic Alcohols with Benzene in the Presence of Aluminum Chloride

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Previous work in this Laboratory has shown that *t*-aliphatic alcohols condense with benzene and phenol in the presence of aluminum chloride to give the expected *t*-alkylbenzenes.<sup>1a-3</sup> Secondary aliphatic alcohols have been condensed with benzene too, but the nature of the products was not determined.<sup>1a</sup> The purpose of the present investigation was to extend the study of the condensation of secondary aliphatic alcohols with benzene, using aluminum chloride as catalyst, and to determine the nature of the products obtained.

*s*-Propyl, butyl, amyl, hexyl and nine of the *s*-heptyl alcohols were condensed with benzene. That isopropyl and *s*-butyl alcohols gave the expected hydrocarbons, cumene and *s*-butylbenzene, was shown by their monoacetamino derivatives whose melting points agreed with those in the literature.<sup>4</sup> The other monoalkylbenzenes were nitrated yielding the *p*-nitro derivatives which were then reduced to the amines. Phenols were prepared from the latter through the diazonium salts. The  $\alpha$ -naphthylurethans of the phenols were then prepared. By comparison with the melting points of the  $\alpha$ -naphthyl-urethans of known *t*-alkylphenols<sup>2,3</sup> and by mixed melting point determinations with these compounds, it was established that 2-methylbutanol-3, 2-methylpentanol-3, 2-methylhexanol-3 and 3-methylhexanol-4 gave the *t*-alkylbenzenes, 2-methyl-2-phenylbutane, 2-methyl-2-phenylpentane, 2-

methyl-2-phenylhexane and 3-methyl-3-phenylhexane.

The *p*-hydroxy derivatives and their  $\alpha$ -naphthylurethans of 2-phenylpentane, 3-phenylpentane, 2-phenylhexane, 3-phenylhexane, 3-methyl-2-phenylpentane, 2-methyl-4-phenylpentane, 2,2-dimethyl-3-phenylbutane, 2-phenylheptane, 3-phenylheptane, 4-phenylheptane, 2-methyl-4-phenylhexane, 2-methyl-5-phenylhexane, 3-methyl-2-phenylhexane, and 2,2-dimethyl-3-phenylpentane were synthesized. The condensation of pinacolyl alcohol with benzene gave an alkylbenzene which was converted into a phenol identical with synthesized 2,2-dimethyl-3-*p*-hydroxyphenylbutane. The other alcohols, pentanol-2, pentanol-3, hexanol-2, hexanol-3, 3-methylpentanol-2, 2-methylpentanol-4, heptanol-2, heptanol-3, heptanol-4, 2-methylhexanol-4, 2-methylhexanol-5, 3-methylhexanol-2 and 2,2-dimethylpentanol-3 undoubtedly gave mixtures of monoalkylbenzenes such as might be formed by the splitting out of water and the condensation of the resulting olefin in either of the two possible positions. This formation of mixtures in the condensation of the *s*-amyl alcohols with benzene and phenol and in the condensation of the secondary hexylphenols has been observed by others<sup>5,6,7</sup> and it is quite possible that the same phenomenon occurs with the higher homologs. The formation of tertiary products in the condensation of *s*-aliphatic alcohols with methyl groups adjacent to the carbinol group has also been reported.<sup>5,6,7</sup>

(1) From a thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

(1a) Huston and Hsieh, *THIS JOURNAL*, **58**, 439 (1936).

(2) Huston and Hedrick, *ibid.*, **59**, 2001 (1937).

(3) Huston and Guile, *ibid.*, **61**, 69 (1939).

(4) Ipatieff and Schmerling, *ibid.*, **59**, 1056 (1937).

(5) Ipatieff, Pines and Schmerling, *J. Org. Chem.*, **5**, 253 (1941).

(6) Huston and Esterdahl, Master's Thesis, Michigan State College (1940).

(7) Huston and Curtis, *ibid.* (1941).

TABLE I  
 MONOALKYLBENZENES FROM *s*-ALIPHATIC ALCOHOLS

<i>s</i> -Aliphatic alcohol condensed with benzene	% Yield of monoalkylbenzene	B. p., °C.	Mm.	$d_{20}^{20}$	$n_D^{20}$	Surface tension		%C	%H
						drop weight	Du Nouy		
Propanol-2	71	151	759	0.8600	1.4858	27.78	29.28		
Butanol-2	81	171	759	.8597	1.4878	28.20	29.40		
Pentanol-2	83	190	759	.8599	1.4864	28.49	29.72	88.89	10.98
						Calcd. for C <sub>11</sub> H <sub>16</sub>		89.12	10.88
Pentanol-3	65	189-190.5	757	.8605	1.4877	28.51	29.65	88.97	10.83
2-Methylbutanol-3	54	188.5-190	760	.8684	1.4908	28.60	29.97	89.23	10.79
Hexanol-2	72	208-210	760	.8608	1.4866	28.79	30.16	88.86	11.06
						Calcd. for C <sub>12</sub> H <sub>18</sub>		88.82	11.18
2-Methylpentanol-4	50	205-206	760	.8754	1.4932	28.79	29.84	88.53	11.31
Hexanol-3	65	209-211	760	.8580	1.4845	28.93	29.84	88.67	11.11
3-Methylpentanol-2	56	207-211	760	.8760	1.4951	29.28	30.55	89.17	10.94
2-Methylpentanol-3	66	208-209	760	.8702	1.4900	28.96	29.78	89.00	11.04
2,2-Dimethylbutanol-3	62	205-207	760	.8763	1.4942	28.92	30.16	88.96	10.99
Heptanol-2	72	226-227	760	.8585	1.4837	28.94	29.72	88.47	11.40
						Calcd. for C <sub>13</sub> H <sub>20</sub>		88.56	11.49
Heptanol-3	67	227-228	762	.8569	1.4828	28.73	30.03	88.55	11.59
2-Methylhexanol-3	62	225-226	762	.8688	1.4893	29.08	30.09	88.19	11.56
3-Methylhexanol-4	60	224-226	762	.8727	1.4913	29.88	30.91	88.27	11.63
2-Methylhexanol-4	54	224-225	762	.8654	1.4873	28.74	29.84	88.13	11.40
2-Methylhexanol-5	44	223-226	760	.8777	1.4929	29.06	29.97	88.43	11.31
3-Methylhexanol-2	56	224-225.5	762	.8767	1.4939	29.14	30.09	88.99	11.52
2,2-Dimethylpentanol-3	58	221-223	762	.8720	1.4912	28.67	29.65	88.63	11.30
Heptanol-4	63	226-229	760	.8613	1.4847	29.03	29.78	88.29	11.62

Alcohols listed in Table I were prepared by the Grignard method. Some of their physical constants were redetermined. Other alcohols used showed constants which agreed with those in the literature.

**Condensation of the Secondary Aliphatic Alcohols with Benzene.**—All condensations were carried out in the same manner. One-half mole of the alcohol, dissolved in 50 ml. of benzene, was added dropwise and with vigorous stirring to a suspension of 50 g. of anhydrous aluminum chloride in 400 ml. of ice-cold anhydrous, thiophene-free benzene. Dry hydrogen chloride gas was bubbled through the reaction mixture at the same time at a rate such that the bubbles could just be counted. The reaction mixture was stirred one hour after the addition of the alcohol and then permitted to stand eight hours at room temperature.

In the case of the straight-chain alcohols, refluxing the reaction mixture eight hours longer, while bubbling in hydrogen chloride gas, was found to improve the yields. This practice was omitted in the condensation of the branched alcohols, since poorer yields were obtained.

The reaction mixture was then poured on ice; hydro-

chloric acid was added, and the benzene layer was separated and washed once with water, twice with a dilute sodium bicarbonate solution and once more with water. After drying over anhydrous sodium sulfate, the benzene was removed *in vacuo*. The residual liquid was distilled at atmospheric pressure using a ten-inch Vigreux column.

**Derivatives of the Monoalkylbenzenes.**—Acetamino derivatives were prepared by the method of Ipatieff and Schmerling.<sup>4</sup> The *p*-nitroalkylbenzenes, *p*-aminoalkylbenzenes and *p*-hydroxyalkylbenzenes were prepared by the methods given in Fisher's test.<sup>8</sup>  $\alpha$ -Naphthylurethans were prepared by the method of French and Wirtel.<sup>9</sup>

**Synthesis of the *s*-Alkylbenzenes.**—These compounds were prepared by a modification of the method of Klages.<sup>10</sup> The alkyl Grignard reagent was treated with acetophenone or its homologs. The tertiary alcohol formed was not isolated but converted directly into an olefin by refluxing, using a Dean-Stark moisture trap<sup>11</sup> to collect the water which was eliminated. The product was then distilled and

(8) Fisher, "Laboratory Manual of Organic Chemistry," 4th ed., 1938, John Wiley and Sons, Inc., New York, N. Y.

(9) French and Wirtel, THIS JOURNAL, 48, 1736 (1926).

(10) Klages, Ber., 36, 622 (1903).

(11) Dean and Stark, Ind. Eng. Chem., 12, 486 (1920).

TABLE II  
 DERIVATIVES OF THE MONOALKYLBENZENES

Secondary alcohols	<i>p</i> -Nitro		<i>p</i> -Amino		<i>p</i> -Hydroxy		$\alpha$ -Naphthylurethan		
	B. p., °C.	P, mm.	B. p., °C.	P, mm.	B. p., °C.	P, mm.	M. p., °C.	Nitrogen, %	Found
Pentanol-2	112-114	2	101-102	2	100-104	2	99-99.5	4.12	4.13
Pentanol-3	111-117	2	103-105.5	2	100-101	2	97.5-98.5	4.12	4.18
2-Methylbutanol-3	113-118	2	99-103	2	110-114	3	125-126.5	4.12	4.17
					m. p. 89-90				
Hexanol-2	133-141	3	111-114	2	108-113	2	95-96.5	4.03	3.99
2-Methylpentanol-4	134-138	3	124-125	3	115-119	3	108-112	4.03	3.97
Hexanol-3	122.5-124	2	121.5-122	3	117-119	3	95-96	4.03	4.03
3-Methylpentanol-2	124-127	2	112-113	2	117-121	3	103-105.5	4.03	3.99
2-Methylpentanol-3	123.5-127	2	111-113	2	116-119	3	123.5-125	4.03	4.00
2,2-Dimethylbutanol-3	117-125 <sup>a</sup>	2	115-118 <sup>b</sup>	2	115-118 <sup>c</sup>	3	109-110	4.03	3.98
					m. p. 122				
Heptanol-2	154-156	3	124-127	2	120-122	2	94.5-96.5	3.87	3.82
Heptanol-3	143-149	3	124-126	2	125-127	2	95.5-97.5	3.87	3.86
Heptanol-4	146-150	3	129-130	2	117-121	2	93.5-94	3.87	3.82
2-Methylhexanol-3	140-146	3	127-129	2	123-127	3	125-126	3.87	3.83
3-Methylhexanol-4	143-148	3	124-126	2	128-131	3	101-103	3.87	3.87
2-Methylhexanol-4	136-143	3	120-124	2	122-129	3	119-121	3.87	3.79
2-Methylhexanol-5	139-142	3	123-127	2	123-126	3	119-121	3.87	3.86
3-Methylhexanol-2	135-139	3	120-125	2	121-125	3	106-108	3.87	3.83
2,2-Dimethylpentanol-3	139-141	3	120-126	2	131-133	3	114-115	3.87	3.79

<sup>a</sup> Calcd. for C<sub>12</sub>H<sub>17</sub>O<sub>2</sub>N: N, 6.73. Found: N, 6.68. <sup>b</sup> Calcd. for C<sub>17</sub>H<sub>19</sub>N: N, 7.87. Found: N, 7.74. <sup>c</sup> Calcd. for C<sub>12</sub>H<sub>18</sub>O: C, 80.85; H, 10.18. Found: C, 80.63; H, 10.35.

 TABLE III  
 SYNTHESIZED *s*-ALKYLBENZENES AND DERIVATIVES

Alkylbenzenes	Name	B. p., °C.	P, mm.	<i>p</i> -Nitro		<i>p</i> -Amino		B. p., °C.	<i>p</i> -Hydroxy		Carbon, %	Hydrogen, %
				B. p., °C. (2 mm.)	Nitrogen, %	B. p., °C. (2 mm.)	Nitrogen, %		B. p., °C. (2 mm.)	Calcd.		
	3-Phenylpentane	189-191	741	110-115	7.25 7.18	107-116 <sup>a</sup>	8.58 8.43	108-117 <sup>b</sup>	...	...	...	...
	2-Phenylpentane	191-193	762	112-118	7.25 7.21	101-104	8.58 8.49	101-103	81.19	80.83	10.48	10.33
	2-Phenylhexane	210-211	737	120-128	6.72 6.62	112-116	7.87 7.78	110-112	...	...	...	...
	4-Phenylheptane	221-224	760	140-143	6.33 6.29	128-131	7.32 7.25	121-123	81.19	80.78	10.48	10.27
	2-Methyl-4-phenylpentane	197-198	735	132-133	6.73 6.66	113-115	7.87 7.83	109-110	80.85	80.37	10.18	10.01

<sup>a</sup> 3 mm. <sup>b</sup> M. p. 75.5°.

 TABLE IV  
 SYNTHESIS OF *p*-HYDROXYPHENYLALKANES

Secondary <i>p</i> -hydroxyphenylalkane	B. p., °C.	P, mm.	Analyses, %				Starting materials
			Found		Calculated		
			C	H	C	H	
3- <i>p</i> -Hydroxyphenylhexane	133	4	80.67	10.11	80.85	10.18	<i>n</i> -Propyl bromide and <i>p</i> -methoxypropiophenone
3- <i>p</i> -Hydroxyphenylheptane	117	2	81.07	10.31	81.19	10.48	<i>n</i> -Butyl bromide and <i>p</i> -methoxypropiophenone
2,2-Dimethyl-3- <i>p</i> -hydroxyphenylpentane	108	2	80.87	10.64	81.19	10.48	<i>t</i> -Butyl chloride and <i>p</i> -methoxypropiophenone
2-Methyl-4- <i>p</i> -hydroxyphenylhexane	111	2	81.49	10.29	81.19	10.48	Isobutyl bromide and <i>p</i> -methoxypropiophenone
3-Methyl-2- <i>p</i> -hydroxyphenylpentane	120-123.5	3	80.71	9.99	80.85	10.18	<i>s</i> -Butyl bromide and <i>p</i> -methoxyacetophenone
2- <i>p</i> -Hydroxyphenylheptane	140	4	80.78	10.52	81.19	10.48	<i>n</i> -Amyl bromide and <i>p</i> -methoxyacetophenone
2-Methyl-5- <i>p</i> -hydroxyphenylhexane	123.5	2	80.79	10.20	81.19	10.48	Isoamyl bromide and <i>p</i> -methoxyacetophenone
3-Methyl-2- <i>p</i> -hydroxyphenylhexane	123-125	2	80.77	10.37	81.19	10.48	<i>s</i> -Amyl chloride and <i>p</i> -methoxyacetophenone
2,2-Dimethyl-3- <i>p</i> -hydroxyphenylbutane <sup>a</sup>	123	4	80.94	10.64	81.19	10.48	<i>t</i> -Butyl chloride and <i>p</i> -methoxyacetophenone

<sup>a</sup> M. p. 120-121°.

reduced to the hydrocarbon by dissolving 0.25 mole in 375 ml. of absolute ethanol. Forty grams of sodium was added to the boiling solution in small portions over a period of time. Water was added when all the sodium had dissolved and the mixture was extracted three times with ether. The combined ether extracts were washed free of alcohol, dried over anhydrous sodium sulfate and the ether removed by distillation. The residue was shaken thoroughly with a saturated aqueous potassium permanganate solution and the excess permanganate reduced by the addition of solid sodium bisulfite. The alkylbenzene was then extracted with ether and distilled at atmospheric pressure after drying and removing the ether. The product was then converted into the *p*-hydroxyphenylalkane (see Table III, C) through the *p*-nitro and amino derivatives. The  $\alpha$ -naphthylurethan of the phenol was then prepared.

TABLE V  
 $\alpha$ -NAPHTHYLURETHANS OF THE SYNTHESIZED *p*-HYDROXY-PHENYLALKANES

Parent compound	$\alpha$ -Naphthylurethan, m. p., °C.	Nitrogen, %	
		Calculated	Found
2- <i>p</i> -Hydroxyphenylpentane	100-101	4.12	4.09
3- <i>p</i> -Hydroxyphenylpentane	114	4.12	4.07
2- <i>p</i> -Hydroxyphenylhexane	108-109	4.03	3.98
2-Methyl-4- <i>p</i> -hydroxyphenylpentane	107	4.03	3.96
3- <i>p</i> -Hydroxyphenylhexane	95-95.5	4.03	3.99
3-Methyl-2- <i>p</i> -hydroxyphenylpentane	100-101	4.03	3.95
2- <i>p</i> -Hydroxyphenylheptane	115-116	3.87	3.85
3- <i>p</i> -Hydroxyphenylheptane	100	3.87	3.79
4- <i>p</i> -Hydroxyphenylheptane	104-105	3.87	3.88
2-Methyl-4- <i>p</i> -hydroxyphenylhexane	117-117.5	3.87	3.81
2-Methyl-5- <i>p</i> -hydroxyphenylhexane	125	3.87	3.81
3-Methyl-2- <i>p</i> -hydroxyphenylhexane	110-111	3.87	3.82
2,2-Dimethyl-3- <i>p</i> -hydroxyphenylpentane	118-119	3.87	3.82

TABLE VI  
MONOALKYLBENZENES FROM *s*-ALCOHOLS WITHOUT REARRANGEMENT

Alcohol condensed with benzene	M. p. of derivatives, °C.		Pure compound alkylbenzene	M. p. of derivatives, °C.	
	Mono-acetamino	Diacetamino		Mono-acetamino	Diacetamino
Isopropyl	105	213-214	Cumene	106 <sup>b</sup>	216 <sup>b</sup>
<i>s</i> -Butyl	126	...	2-Phenylbutane	126 <sup>b</sup>	...
Pinacolyl	<i>p</i> -Hydroxyphenol 122 <sup>a</sup>	Phenol	2,2-Dimethyl-3- <i>p</i> -hydroxyphenylbutane	M. p. of Phenol 120-121 <sup>b</sup>	

<sup>a, b</sup> Melting point of mixture of *a* and *b* showed no depression.

Table VI indicates definitely that propanol-2 condenses with benzene to form only cumene, and butanol-2 forms only 2-phenylbutane. The only other case of apparent simple replacement of the

hydroxyl with phenyl was found in the condensation of 2,2-dimethylbutanol-3 with benzene. The alkylbenzene gave, upon nitration, reduction and diazotization, a phenol which was proved by mixed melting point and melting points of derivatives to be identical with 2,2-dimethyl-3-*p*-hydroxyphenylbutane. This is especially noteworthy in view of the fact that it has been found in this Laboratory<sup>7</sup> that pinacolyl alcohol reacts with phenol in the presence of aluminum chloride at 50° to give 2,3-dimethyl-2-*p*-hydroxyphenylbutane.

Of the remaining alcohols listed (Table II), none showed simple replacement of the hydroxyl with the phenol group. The  $\alpha$ -naphthylurethan from the condensation of 3-methylpentanol-2 gave a melting point (not sharp) intermediate between that of the  $\alpha$ -naphthylurethan of 3-methyl-2-*p*-hydroxyphenylpentane (Table V) and of 3-methyl-3-*p*-hydroxyphenylpentane, while the  $\alpha$ -naphthylurethan from 3-methylhexanol-2 melted between that of 3-methyl-2-*p*-hydroxyphenylhexane and of 3-methyl-3-*p*-hydroxyphenylhexane.<sup>2</sup>

The other four alcohols in which the hydroxyl is on a carbon adjacent to one carrying tertiary hydrogen gave products identical with those obtained from tertiary alcohols. 2-Methylbutanol-3 gave an alkylbenzene which was converted into 2-methyl-2-*p*-hydroxyphenylbutane.<sup>1a</sup> 2-Methylhexanol-3 gave 2-methyl-2-*p*-hydroxyphenylhexane,<sup>2</sup> and 3-methylhexanol-4 gave 3-methyl-3-*p*-hydroxyphenylhexane.<sup>2</sup> Identification was accomplished by mixed melting points of the  $\alpha$ -naphthylurethans.<sup>12</sup> Probability of the admixture of some secondary alkylbenzene in the condensation products was indicated by the repeated crystallizations which were necessary in order to obtain the  $\alpha$ -naphthylurethans in the pure state.

All straight chained alcohols and those in which branching occurs on carbons not adjacent to the alcoholic group give mixtures of condensation products which may be accounted for by assuming the elimination of water and the reaction of the mixture of alkenes with benzene. Both 2-methylhexanol-4 and 2-methylhexanol-5 gave urethan mixtures melting at 119-121°. This is between

(12) The earlier publication reported a m. p. of 110-111° for the  $\alpha$ -naphthylurethan of 2-methyl-2-*p*-hydroxyphenylhexane and 82.3° for the  $\alpha$ -naphthylurethan of 3-methyl-3-*p*-hydroxyphenylhexane. The melting points of these derivatives, as prepared by the authors from the phenols prepared by Huston and Hedrick, were found to be 125° and 101°, respectively.

the melting points of the  $\alpha$ -naphthylurethans of 2-methyl-5-*p*-hydroxyphenylhexane and of 2-methyl-4-*p*-hydroxyphenylhexane.

Unlike 2,2-dimethylbutanol-3, 2,2-dimethylpentanol-3 apparently forms a mixture of condensation products. The melting point of the  $\alpha$ -naphthylurethan mixture is 114–115°. This is well below that of the  $\alpha$ -naphthylurethan of 2,3-dimethyl-3-*p*-hydroxyphenylpentane<sup>2</sup> (124–125°) or of 2,3-dimethyl-2-*p*-hydroxyphenylpentane<sup>2</sup> (122–123°) but is quite near that of 2,2-dimethyl-3-*p*-hydroxyphenylpentane. This leads to the suggestion that the mixture is the result of the reaction of 2,2-dimethylpentene-3 with benzene and not of methyl migration.

### Summary

1. The *s*-propyl, butyl, amyl, hexyl and nine of the *s*-heptyl alcohols were condensed with benzene in the presence of aluminum chloride.

2. The alkylbenzenes obtained in the condensations were converted to the corresponding *p*-hydroxy compounds through the *p*-nitro and *p*-amino derivatives.  $\alpha$ -Naphthylurethans of the

*p*-hydroxy compounds were also prepared as well as acetamino derivatives of some of the alkylbenzenes.

3. A number of pure *s*-alkylbenzenes and *s*-alkylphenols were synthesized and their  $\alpha$ -naphthylurethans prepared.

4. By comparison of the melting points of the acetamino derivatives of the alkylbenzenes with those in the literature and of the melting points of the phenols and of the  $\alpha$ -naphthylurethans with those synthesized and with those of *t*-alkylphenols, the following facts have been established: (a) Isopropyl, *s*-butyl and pinacolyl alcohols gave the corresponding *s*-alkylbenzenes in pure form. (b) 2-Methylbutanol-3, 2-methylpentanol-3, 2-methylhexanol-3 and 3-methylhexanol-4 gave tert-alkylbenzenes. (c) The straight chain alcohols, those having a branched methyl group remote from the carbinol group, and 2,2-dimethylpentanol-3 gave mixtures of monoalkylbenzenes. (d) 3-Methylpentanol-2 and 3-methylhexanol-2 also gave mixtures consisting, probably, of the *s* and *t*-alkylbenzenes.

EAST LANSING, MICHIGAN

RECEIVED MARCH 9, 1942

[CONTRIBUTION FROM THE CHEMICAL DIVISION OF THE WOBURN DEGREASING COMPANY OF N. J.]

## Solid 10,12-Octadecadienoic Acid-1. A New Conjugated Linoleic Acid Melting at 57°

BY J. D. VON MIKUSCH

When linoleic and linolenic acids or their glycerides are treated with an excess of alcoholic potash for prolonged periods of time, a rearrangement of the double bonds into the conjugated position has been found to take place.<sup>1</sup> In the case of linolenic acid, a solid isomer, pseudoeleostearic acid, is formed, which was identified by Kass and Burr<sup>2</sup> as 10,12,14-octadecatrienoic acid-1. Linoleic acid, on the other hand, was found by Moore<sup>1</sup> (pp. 145, 147) to give rise "to a product which remains liquid at room temperature." On alcoholic-potash isomerization of maize oil containing linoleic but no linolenic acid, "no solid acids were formed" (ref. 1, p. 143).

Burr and collaborators, however, disclose an isomerization of linoleic acid to crystalline forms as a result of treatment with sodium butylate,<sup>3</sup> and give absorption spectrum, diene number and

extinction coefficient for a solid 10,12-linoleic acid.<sup>4</sup> They also describe a solid 10,12-linoleyl alcohol.<sup>5</sup>

As a result of extensive studies in this Laboratory<sup>6</sup> a commercial conjugating process has been developed in which oils and fatty acids are isomerized with caustic soda in aqueous medium (patents pending). When oils containing a large proportion of linolenic acid, for instance linseed oil, are subjected to this process, the melting point or titer of their free fatty acids rises, indicating the formation of solid products. The fatty acids of oils containing little or no linolenic acid but a large proportion of linoleic acid experience a drop in titer.<sup>7</sup> From this it appears that linoleic acid does not yield solid isomerization products to any appreciable extent under the conditions

(4) Miller and Burr, *Chem. Reviews*, **29**, 419 (1941).

(5) Kass and Burr, *THIS JOURNAL*, **62**, 1796 (1940).

(6) Woburn Bulletins No. 121 and 123, Woburn Degreasing Company of N. J., Harrison, N. J.

(7) Titer of linseed fatty acids: 18° before, 23.1° after isomerization; of soybean fatty acids: 22° before, 12.5° after isomerization.

(1) Moore, *Biochem. J.*, **31**, 138–154 (1938).

(2) Kass and Burr, *THIS JOURNAL*, **61**, 3294 (1939).

(3) Kass, Miller and Burr, *ibid.*, **61**, 482 (1939).