On phthalides and 1,3-indandiones. LIV.
The synthesis of 3-(2-alkyloxy-1-naphthylmethylene)phthalides and 2-(2-alkyloxy-1-naphthyl)-1,3-indandiones

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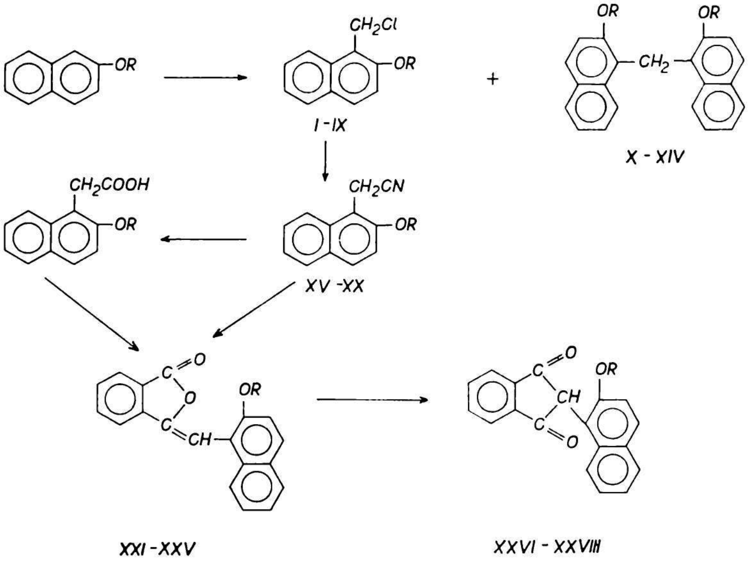
The synthesis of new derivatives of phthalides and 1,3-indandiones starting from 2-alkyloxy-1-naphthylacetic acids or the corresponding nitriles is described. It has been found that nitriles, under conditions of the Gabriel modification of the Perkin synthesis, react at 260°C similarly as the corresponding acids. The 3-(2-alkyloxy-1-naphthylmethylene)phthalides thus formed undergo rearrangement to furnish 2-(2-alkyloxy-1-naphthyl)-1,3-indandiones. 1-Chloromethyl-2-alkyloxynaphthalenes, bis(2-alkyloxy-1-naphthyl)methanes, 2-alkyloxy-1-naphthylacetonitriles, and 2-(2-methylpropoxy)-1-naphthylacetic acid were the intermediates hitherto not reported.

This paper extends our previous work on phthalides and 1,3-indandiones [1]. The aim of this contribution was to find out the reaction conditions of the reaction between phthalic anhydride and 2-alkyloxy-1-naphthylacetic acids or their nitriles and also to work out the synthesis of the starting 2-alkyloxy-1-chloromethylnaphthalenes. The latter are, due to the alkyloxy group, very reactive and can be of importance for various nucleophilic displacement reactions. Of this type of compounds only the methoxy derivative has been described. The prepared compounds were suggested to have an inhibition effect on the growth of plants analogously as some derivatives of 1-naphthylacetic acid [2, 3].

As known, the chloromethylation of naphthalene is about 20 times faster than that of benzene [4]. The activation of the naphthalene ring with a substituent belonging to the first category accelerates the subsequent side reaction to yield higher condensation products. It has been reported [4] that the reactivity of naphthalene ring is about 9 times higher due to the methyl substitution. The majority of chloromethylations was carried out according to [5, 6]. 2-Alkyloxynaphthalenes and other highly reactive aromatic compounds have to be chloromethylated under mild conditions [7]. Because of the high reactivity, 2-alkyloxy-1-chloromethylnaphthalenes undergo in the reaction medium further displacement or decomposition reactions [2, 4, 7, 8]. The unchanged 2-alkyloxynaphthalene gave, upon condensation with 2-alkyloxy-1-chloromethylnaphthalene, bis(2-alkyloxy-1-naphthyl)methanes. The yield of this chloromethylation can be improved by the proper reaction conditions up to 80%.

1-Chloromethyl-2-alkyloxy derivatives of naphthalene gave, when in reaction with potassium cyanide in the presence of catalytical amount of potassium iodide, the corresponding arylmethyl cyanides [9]. The solvent of this reaction was acetone and water, the ratio of which was chosen to satisfy two conditions: the good solubility of the starting materials and the low solubility of the reaction products.



Scheme 1

The final reaction product of nitriles R—CH_2—CN with carbonyl-containing compounds can have, in the Perkin synthesis, the —CN group either retained [10], or split off [11]. It is assumed that the degradation of the —CN group can take place with some intermediate, since the —CN group once retained on the phthalide ring is extraordinarily difficult to hydrolyze [11].

Substituents on the naphthalene ring having a +M or +I effect deactivate the first stage of the Perkin synthesis, *i.e.* the dissociation of the proton from the methylene group. Thus 2-methyl-1-naphthylacetic acid has a diminished reaction ability for the given synthesis when compared with that of the unsubstituted acid [12]. In nitriles and acids under study the effect of the alkyloxy group is exerted in that the reaction proceeds only at 260°C and, as a result, mostly the degradation of the —CN group takes place.

The yields of phthalides are higher with nitriles. In sodium methoxide the phthalides isomerize to 2-(2-alkyloxy-1-naphthyl)-1,3-indandiones in about 90% yield.

Syntheses of these substances are illustrated in Scheme 1. Compounds *XV*, *XVI*, *XXI*, and *XXII* (Tables 3 and 4) were tested on herbicidal activity; neither the concentration of 15 kg per 0.363 acre preemergently, nor 5 kg per 0.102 acre postemergently were found to inhibit the growth.

Table 1

Characteristic data of 2-alkyloxy-1-chloromethylnaphthalenes

Compound	Alkyl	Formula	*M*	Calculated/found % C	 % H	 % Cl	CCl_4 [ml]	Yield [%]	M.p. [°C]
I	Ethyl	$C_{13}H_{13}OCl$	220.70	70.74 70.61	5.93 5.82	16.06 15.88	30	81	102–103
II	Propyl	$C_{14}H_{15}OCl$	234.73	71.63 71.40	6.44 6.28	15.10 14.91	40	71.5	76.7
III	-Propyl	$C_{14}H_{15}OCl$	234.73	71.63 71.51	6.44 6.33	15.10 14.74	90	40	49–50
IV	Butyl	$C_{15}H_{17}OCl$	248.76	72.42 72.59	6.88 7.06	14.25 13.96	40	77	61–62
V	2-Butyl	$C_{15}H_{17}OCl$	248.76	72.42 72.31	6.88 6.46	14.25 14.15	40	83	92.5–93.5
VI	Pentyl	$C_{16}H_{19}OCl$	262.78	73.13 73.39	7.28 7.44	13.49 13.50		70.5	75–76
VII	(2-Methyl)butyl	$C_{16}H_{19}OCl$	262.78	73.13 73.21	7.28 7.09	13.49 13.70	25	66.5	75–77
VIII	Hexyl	$C_{17}H_{21}OCl$	276.81	73.76 73.56	7.64 7.51	12.81 12.36		83	55.5–56.5
IX	Octyl	$C_{19}H_{25}OCl$	304.86	74.85 74.92	8.26 8.14	11.61 11.49	30		41–42

Experimental

Infrared spectra of the respective nujol mulls were recorded with a UR-20 Zeiss, Jena spectrophotometer. The procedure for herbicidal tests is described in [13]. 2-(2-Methylpropoxy)-1-naphthylacetic acid prepared according to [2] was crystallized from xylene, or benzene—petrol. M.p. 94.5—95.5°C.

For $C_{16}H_{18}O_3$ (258.30) calculated: 74.40% C; 7.02% H; found: 74.68% C, 7.28% H; $\tilde{\nu}(C{=}O)$ 1700 cm^{-1}, $\tilde{\nu}(C{-}O{-}C)$ 1086 and 1272 cm^{-1}.

1-Chloromethyl-2-alkyloxynaphthalenes (I—IX)

A CCl_4 solution of 2-alkyloxynaphthalene (0.1 mole) was added to a chloromethylation mixture prepared according to [7] and heated within 15 minutes to 30°C. Then, while passing dry gaseous hydrogen chloride and vigorous stirring, the mixture was allowed to cool what took additional 60 minutes. The desired product was separated from the chloromethylation mixture, cooled (—5 to —10°C), the crystals were quickly filtered, and washed twice with both ice-cold water and methanol (20 ml each). Crystals were dried in an air stream and recrystallized consecutively from benzene—hexane, toluene—hexane, and hexane. The detailed reaction conditions and characteristic data are given in Table 1.

Bis(2-alkyloxy-1-naphthyl)methanes (X—XIV)

To a solution of 2-alkyloxynaphthalene (0.01 mole) in acetic acid (15 ml) 2 N-HCl in acetic acid (25 ml), water (5 ml), and formaldehyde (40%, 0.4 ml) were added and allowed to stand for 90 minutes. The reaction mixture was then heated to 55°C and cooled to 20°C. The separated precipitate was filtered, washed with 80% and 50% acetic acid, then with water (5 ml each), and crystallized from acetone—methanol. Compounds thus prepared are listed in Table 2.

Table 2

Characteristic data of bis(2-alkyloxy-1-naphthyl)methanes

Compound	Alkyl	Formula	*M*	Calculated/found % C	 % H	Yield [%]	M.p. [°C]
X	Propyl	$C_{27}H_{28}O_2$	384.49	84.34 84.37	7.34 7.63	80	124—125
XI	Butyl	$C_{29}H_{32}O_2$	412.57	84.43 84.12	7.82 8.17	88	106—108
XII	2-Butyl	$C_{29}H_{32}O_2$	412.57	84.43 84.44	7.82 8.18	82	125—126
XIII	Hexyl	$C_{33}H_{40}O_2$	468.65	84.57 84.30	8.60 8.87	60	80.5—81
XIV	Octyl	$C_{37}H_{48}O_2$	524.79	84.68 84.80	9.22 9.25	30	57.5—58.5

Table 3

Characteristic data of 1-cyanomethyl-2-alkyloxynaphthalenes

Compound	Alkyl	Formula	*M*	Calculated/found			Yield	M.p.	$\tilde{\nu}$(C≡N)	$\tilde{\nu}$(C—O—C)
				% C	% H	% N	[%]	[°C]	[cm^{-1}]	[cm^{-1}]
XV	2-Propyl	$C_{15}H_{15}ON$	225.29	79.96	6.71	6.22	83	45.5—46.5	2249	1072
				79.82	6.83	6.38				1265
XVI	2-Butyl	$C_{16}H_{17}ON$	239.32	80.30	7.16	5.85	55	80.5—81.5	2248	1080
				80.16	7.34	6.17				1279
XVII	Pentyl	$C_{17}H_{19}ON$	253.34	80.59	7.56	5.53	68	76—78	2248	1080
				80.36	7.50	5.44				1270
XVIII	(2-Methyl)butyl	$C_{17}H_{19}ON$	253.34	80.59	7.56	5.53	64	83—83.5	2248	1080
				80.28	7.58	5.65				1271
XIX	Hexyl	$C_{18}H_{21}ON$	267.37	80.86	7.91	5.24	54	83.5—84.5	2245	1080
				80.62	7.89	5.20				1270
XX	Octyl	$C_{20}H_{25}ON$	295.42	81.31	8.53	4.74	55	73.5—74	2246	1080
				81.04	8.44	4.74				1269

Table 4

Characteristic data of 3-(2-alkyloxy-1-naphthylmethylene)phthalides

Compound	Alkyl	Formula	M	Calculated/found			Yield [%]		M.p. [°C]	$\tilde{\nu}$(C=O) [cm^{-1}]	$\tilde{\nu}$(C−O−C) [cm^{-1}]	$\tilde{\nu}$(C≡N) [cm^{-1}]
				% C	% H	% N	*a*	*b*				
XXI	Ethyl	$C_{21}H_{16}O_3$	316.36	79.72	5.09	—	65	42	154.5	1774	1272	—
				79.61	5.21	—					1081	
XXII	Propyl	$C_{22}H_{18}O_3$	330.38	79.97	5.49	—	63	40	157	1779	1272	—
				80.26	5.80	—					1080	
XXIII	2-Butyl	$C_{23}H_{20}O_3$	344.41	80.20	5.85	—	56	—	117	1778	1273	—
				80.21	5.84	—					1080	
XXIV	Butyl	$C_{23}H_{20}O_3$	344.41	80.20	5.85	—	60	44	124—126	1777	1082	—
				80.08	5.92	—					1272	
XXV	Octyl	$C_{28}H_{27}O_3N$	425.53	79.03	6.39	3.29	52	—	125.5	1805	1270	2212
				79.15	6.42	3.14					1075	

a) Yield from nitriles in %.
b) Yield from acids in %.

2-Alkyloxy-1-naphthylacetonitriles (XV—XX)

A solution of potassium cyanide (0.2 mole) and potassium iodide (0.001 mole) in water (200—300 ml) was gradually added into 1-chloromethyl-2-alkyloxynaphthalene (0.1 mole) in acetone (450—600 ml) at 20—30°C during 4—5 hours. Cooling at —10°C caused separation of needles which were filtered, washed with a small amount of acetone—water and then thoroughly with water (removal of CN^-). Crystallization either from acetone—water, or acetone—methanol, or benzene—hexane. Synthesized compounds are listed in Table 3.

3-(2-Alkyloxy-1-naphthylmethylene)phthalides (XXI—XXV)

A mixture consisting of fused phthalic anhydride (0.03 mole), 2-alkyloxy-1-naphthylacetonitrile (or the corresponding acid, 0.02 mole) and potassium acetate (1 g) was heated at 260°C and poured under stirring into cold water. To this mixture sodium hydrocarbonate (3 g) was added and allowed to stand for 24 hours. The precipitate was filtered, washed several times with water, and crystallized from ethanol. Characteristic data of phthalides obtained as fine yellow crystals are given in Table 4.

2-(2-Alkyloxy-1-naphthyl)-1,3-indandiones (XXVI—XXVIII)

Synthesized according to [14] were crystallized from diethyl ether—benzene or diethyl ether—ethanol and listed in Table 5.

Table 5

Characteristic data of 2-(2-alkyloxy-1-naphthyl)-1,3-indandiones

Compound	Alkyl	Formula	*M*	Calculated/found		M.p.	$\tilde{\nu}$(C=O)	$\tilde{\nu}$(C—O—C)
				% C	% H	[°C]	[cm^{-1}]	[cm^{-1}]
XXVI	Ethyl	$C_{21}H_{16}O_3$	316.36	79.73 79.62	5.09 5.21	172	1720 1752	1274 1062
XXVII	Propyl	$C_{22}H_{18}O_3$	330.38	79.98 79.88	5.49 5.35	166	1720 1751	1270 1063
XXVIII	Butyl	$C_{23}H_{20}O_3$	344.41	80.21 80.16	5.85 5.89	175	1715 1750	1275 1062

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References

1. Lácová, M., *Chem. Zvesti* ***27***, 123 (1973).
2. Julia, M. and Baillargé, M., *Bull. Soc. Chim. Fr.* ***20***, 640 (1953).
3. Takeda, A., *Contrib. Boyce Thompson Inst.* ***20***, 197 (1959); *Chem. Abstr.* ***53***, 20642*f* (1956).

4. Vavon, G., Bolle, J., and Calin, J., *Bull. Soc. Chim. Fr.* ***6***, 1025 (1939).
5. Cambron, A., *Can. J. Research* ***178***, 10 (1939); *Chem. Abstr.* ***33***, 53873 (1939).
6. Darzens, G., *C. R. Acad. Sci.* (Paris) ***208***, 818 (1939); *Chem. Zbl.* ***II***, 376 (1939).
7. Komínek, A., *Thesis*. Faculty of Natural Sciences, Komenský University, Bratislava, 1968.
8. Ruffová, E., *Thesis*. Faculty of Natural Sciences, Komenský University, Bratislava, 1958.
9. Cook, A. H., *J. Chem. Soc.* ***1941***, 502; *Chem. Abstr.* ***36***, 4093 (1942).
10. Gabriel, S., *Ber.* ***18***, 1264 (1885).
11. Hrnčiar, P., *Chem. Zvesti* ***17***, 666 (1963).
12. Lácová, M., preliminary results.
13. Lácová, M. and Synák, J., Patent pending PV 2377-70.
14. Lácová, M., *Chem. Zvesti* ***23***, 450 (1969).

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