

SYNTHESIS OF 2-ALKYL-6-PHENYL-3, 4-CYCLOHEPTENOPYRYLIUM SALTS

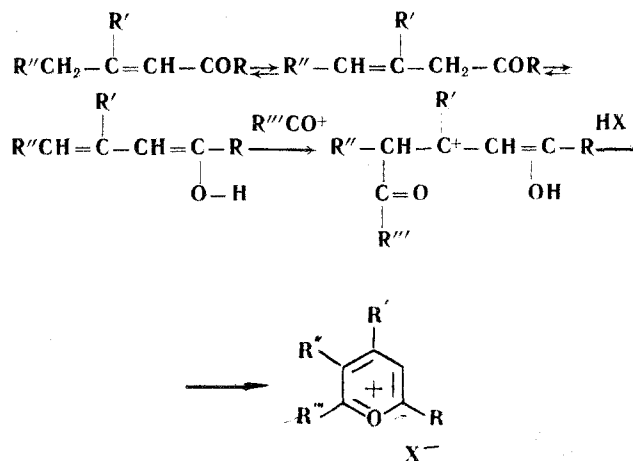
Yu. A. Zhdanov, G. N. Dorofeenko, and V. A. Palchkov

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A method is given for synthesizing 2-alkyl-6-phenyl-3, 4-cycloheptenopyrylium perchlorates, obtained in 45-55% yields by acylating cycloheptenylacetophenone with anhydrides of aliphatic acids in the presence of 70% perchloric acid. Treatment of the pyrylium salts with ammonia gives a good yield of 2-alkyl-6-phenyl-3, 4-cycloheptenopyridine.

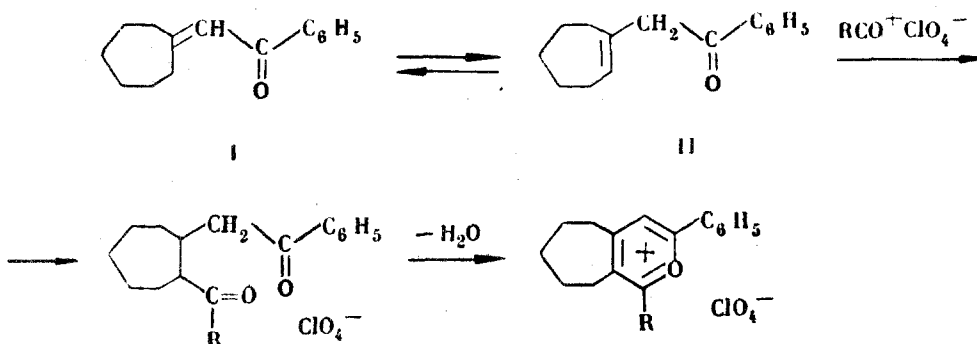
Use of 70% perchloric acid for acylating unsaturated compounds [1], makes it possible to readily obtain high yields of pyrylium salts of various structures. Because of the high reactivities of their pyrylium rings they are convenient starting materials for synthesizing various aromatic and heterocyclic compounds [2].

The method of preparing pyrylium salts, containing different substituents at different positions in the ring, by catalytic acylation of α, β -unsaturated ketones with carboxylic acid anhydrides, considerably extends synthetic possibilities in the chemistry of pyrylium salts. The mechanism of transformation of α, β -unsaturated ketones was recently explained [3, 4]. A hypothesis has been put forward [5, 6] that under the reaction conditions α, β -unsaturated ketones are readily isomerized to β, γ unsaturated compounds, the latter readily reacting as an enol form [7]



The present paper describes a method of preparing perchlorates of 2-alkyl-6-phenyl-3, 4-cycloheptenopyrylium perchlorates by acylating cycloheptenylacetophenone with carboxylic acid anhydrides in the presence of 70% perchloric acid, this being a development of research on synthesis of 5, 6, 7, 8-tetrahydroisochromylium [7, 8] and 3, 4, 5, 6-bis(cycloalkeno) pyrylium salts [9]. In the present work cycloheptenylacetophenone was prepared by condensing cycloheptanone with acetophenone at room temperature in the presence of sodium ethoxide, the yield being 6% (55-60% on the reacted cycloheptanone). By raising the reaction temperature and amount of catalyst the yield of condensation product is raised to 16%, but then side reactions take place with formation of gummy products.

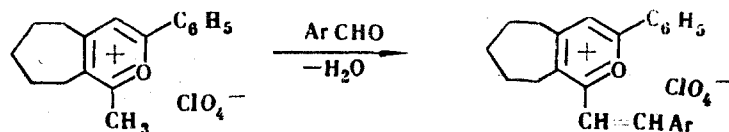
The acylation of cycloheptenylacetophenone with acid anhydrides, catalyzed by 70% perchloric acid, takes place readily at room temperature to give 2-alkyl-6-phenyl-3, 4-cycloheptenopyrylium perchlorates, the formula being



The pyrylium salts are obtained in 45-55% yield, as crystals. Some decrease in the pyrylium salt yields as compared with those obtained in such reactions [10] may be ascribed to the cycloheptanoneacetophenone condensation product existing in two forms, cycloheptylideneacetophenone (I) and cycloheptenylacetophenone (II). Probably I predominates, as was shown for cycloheptenylacetone [11].

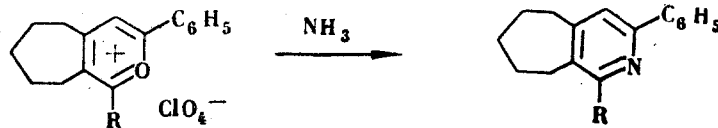
IR spectra support the structure of the pyrylium salts synthesized (band with an absorption maximum at 1622-1629 and 1580-1585 cm^{-1} characteristic of compounds of that class [12]).

2-Methyl-6-phenyl-3, 4-cycloheptenopyrylium perchlorate was condensed with aromatic aldehydes



The yields are good, and reaction proceeds as readily as the condensation of aldehydes with 1-methyl-3-phenyl-5,6,7,8-tetrahydroisochromylium perchlorate [13].

Reaction with aqueous ammonia of the pyrylium salts prepared led to isolation of good yields of the corresponding 2-alkyl-6-phenyl-3, 4-cycloheptenopyridines



The individual natures of the pyridines synthesized were shown by thin layer chromatography on aluminum oxide, while their structures were confirmed by their IR spectra (presence of intense absorption maxima in the regions 1596, 1557, 1496 cm^{-1}).

Experimental

Cycloheptenylacetophenone. A mixture of 45 g (0.4 mole) cycloheptanone and 48 g (0.4 mole) acetophenone with 100 ml 5% sodium ethoxide was left for a few hours in a refrigerator, and afterwards for three days at room temperature. The reaction products were poured into water, the organic layer separated off, washed with water, then with dilute acetic acid, and dried over calcium chloride. On vacuum-distilling acetophenone and cycloheptanone distilled over first, then the reaction product, yield 5.1 g (6%), or 58% calculated on the reacted cycloheptanone. Bp 185-190° (14 mm); d_4^{22} 1.065; n_D^{22} 1.5583. Found: C 83.74; H 8.25%. M_{rD} 65.21. Calculated for $C_{15}H_{18}O$: C 84.06; H 8.46%. M_{rD} 64.89; IR spectrum: 1688, 1661 cm^{-1} .

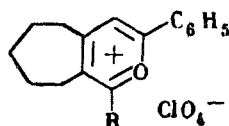
2-Methyl-6-phenyl-3, 4-cycloheptenopyrylium perchlorate. 1 ml 70% perchloric acid was added from a dropping funnel to a stirred mixture of 2.1 g (0.01 mole) cycloheptenylacetophenone and 6 ml acetic anhydride initially at 0°, and kept cool, then left 3 days at room temperature. The crystals which separated were filtered off, washed with ether, and air dried. Yield of 2-methyl-6-phenyl-3, 4-cycloheptenopyrylium perchlorate 1.7 g (52%), mp 163-165° (from acetic acid). Similarly other anhydrides of carboxylic acids (propionic, n-butyric, n-valeric, isobutyric, and isovaleric) were used to synthesize other pyrylium salts, yields and properties being given in Table 1.

2-Methyl-6-phenyl-3, 4-cycloheptenopyridine. 5 ml concentrated aqueous ammonia was added to 1.68 g (0.005 mole) 2-methyl-6-phenyl-3, 4-cycloheptenopyrylium perchlorate. After 24 hr the organic material was extracted with ether and washed with water. Then the ether solution was twice extracted with 20 ml 10% hydrochloric acid. The hydrochloric acid solution was separated off, washed with ether, made alkaline with sodium hydroxide, the pyridine which separated extracted with ether and the solution dried over potassium hydroxide. The ether was distilled off, and the residue vacuum-distilled to give a cut 200°-205° (7 mm). Yield 0.73 g (70%). 2-Methyl-6-phenyl-3,4-cycloheptenopyridine was a viscous yellow oil, R_f 0.80, solvent toluene-chloroform 2:3, visualizer iodine). Picrate mp 147° (from ethanol).

The other 2-alkyl-6-phenyl-3, 4-cycloheptenopyrylium salts, were similarly converted by ammonia to the corresponding pyridines, purified by chromatographing on an alumina column, solvent toluene. Table 2 gives data on the

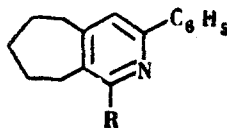
properties of the pyridines obtained.

Table 1



R	Mp, °C	IR spectrum, cm ⁻¹	Formula	Found, %			Calculated, %			Yield, %
				C	H	Cl	C	H	Cl	
CH ₃	163—165	1530, 1585, 1627	C ₁₇ H ₁₉ ClO ₅	60.22	5.39	10.75	60.27	5.65	10.47	52
C ₂ H ₅	184	1530, 1582, 1627	C ₁₈ H ₂₁ ClO ₅	60.91	5.80	10.16	61.28	6.00	10.05	51
C ₃ H ₇	182	1534, 1581, 1629	C ₁₉ H ₂₃ ClO ₅	61.96	5.95	9.52	62.21	6.32	9.66	54
<i>i</i> -C ₃ H ₇	165	1528, 1580, 1625	C ₁₉ H ₂₃ ClO ₅	61.95	5.97	9.90	62.21	6.32	9.66	40
<i>n</i> -C ₄ H ₉	159—160	1530, 1580, 1622	C ₂₀ H ₂₅ ClO ₅	62.58	6.36	9.49	63.02	6.62	9.31	55
<i>i</i> -C ₄ H ₉	193—195	1530, 1580, 1624	C ₂₀ H ₂₅ ClO ₅	62.75	6.30	9.33	63.02	6.62	9.31	45

Table 2



R	R _f	IR spectrum, cm ⁻¹	Formula	Found, %		Calculated, %		Picrate, mp, %	Yield, %
				C	H	C	H		
CH ₃	0.80	1596, 1557, 1496, 1439	C ₁₇ H ₁₉ N	86.13	7.64	86.03	8.07	142	70
C ₂ H ₅	0.82	1593, 1558, 1495, 1435	C ₁₈ H ₂₁ N	85.82	8.31	86.01	8.42	125	65
C ₃ H ₇	0.86	1592, 1552, 1496, 1437	C ₁₉ H ₂₃ N	85.92	8.56	85.98	8.73	109—111	70
<i>i</i> -C ₃ H ₇	0.81	1591, 1555, 1493, 1439	C ₁₉ H ₂₃ N	85.68	8.49	85.98	8.73	80—83	64
<i>n</i> -C ₄ H ₉	0.89	1596, 1557, 1496, 1439	C ₂₀ H ₂₅ N	85.80	8.66	85.97	9.02	—	85
<i>i</i> -C ₄ H ₉	0.83	1592, 1555, 1495, 1439	C ₂₀ H ₂₅ N	85.82	8.68	85.97	9.02	—	60

2-(3, 4-Dimethoxystyryl)-6-phenyl-3, 4-cycloheptenopyrylium perchlorate. 0.5 g (0.003 mole) veratric aldehyde, 3 ml acetic acid, and 1 drop 70% perchloric acid were added to 0.67 g (0.002 mole) 2-methyl-6-phenyl-3, 4-cycloheptenopyrylium perchlorate, and the whole was refluxed for 20 min. The reaction product was precipitated with ether. Yield 0.77 g (80%), mp 139-140° (from acetic acid). Found: C 64.28; H 5.42; Cl 7.00%. Calculated for C₂₆H₂₇ClO₇: C 64.13; H 5.59; Cl 7.28%.

Heating for 2 hr with benzaldehyde gave 2-styryl-6-phenyl-3, 4-cycloheptenopyrylium perchlorate, yield 52%, mp 125-128° (from acetic acid).

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Rostov-on-Don State University