

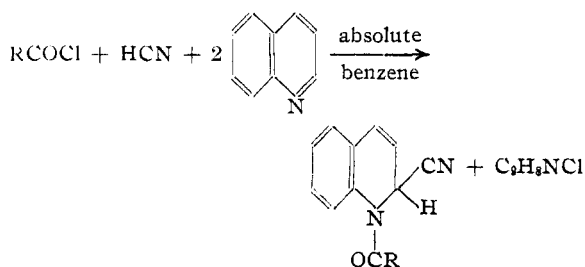
[CONTRIBUTION FROM THE DEPARTMENT OF CHEMISTRY, BANTING INSTITUTE, UNIVERSITY OF TORONTO]

**Preparation of 1-Acyl-1,2-dihydroquinaldonitriles and their Hydrolysis to Aldehydes\***

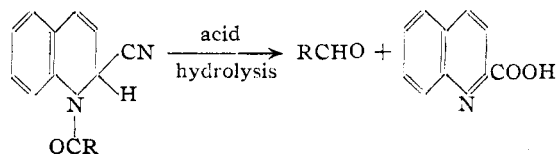
BY J. M. GROSHEINTZ AND HERMANN O. L. FISCHER

By shaking quinoline with benzoyl chloride and an aqueous solution of potassium cyanide, Reissert<sup>1</sup> prepared 1-benzoyl-1,2-dihydroquinaldonitrile. This compound was remarkable in that it split on acid hydrolysis into benzaldehyde and quinaldinic acid. The availability of substances differing from Reissert's original compound only in the nature of the acetyl group would therefore afford the possibility of a new method for the conversion of acid chlorides into aldehydes. With the object of doing this Sugawara and Tsuda<sup>2</sup> duplicated the experiments of Reissert, using various aromatic acid chlorides. However, the ready hydrolysis of many aliphatic acid chlorides vitiates Reissert's original method. Woodward<sup>3</sup> investigated the formation of Reissert's compound in non-aqueous media. He found that benzoyl and cinnamoyl chloride reacted smoothly with quinoline and potassium cyanide in liquid sulfur dioxide to give the corresponding 1-acyl-1,2-dihydroquinaldonitriles, but he failed to obtain the desired addition compounds with aliphatic acid chlorides.

With these results in mind we investigated further the use of non-aqueous media and found that, when one mole of acid chloride was brought into reaction with one mole of hydrocyanic acid and *two* moles of quinoline in absolute benzene or other inert solvents, the formation of 1-acyl-1,2-dihydroquinaldonitriles was preponderant. It may be noted that this procedure resembles that of Claisen<sup>4</sup> for the preparation of keto-nitriles. In fact, keto-nitriles in some cases appear concurrently with the 1-acyl-1,2-dihydroquinaldonitriles.



\* Original manuscript received July 24, 1940.

(1) Reissert, *Ber.*, **38**, 1610 (1905).(2) S. Sugawara and T. Tsuda, *J. Pharm. Soc. Japan*, **56**, 557 (1936); *C. A.*, **32**, 5836 (1938); *Chem. Zentr.*, **107**, II, 3670 (1936).(3) R. B. Woodward, *THIS JOURNAL*, **62**, 1626 (1940).(4) L. Claisen, *Ber.*, **31**, 1023 (1898).

In this manner we prepared a number of 1-acyl-1,2-dihydroquinaldonitriles as shown in the accompanying table.

On hydrolysis of these compounds with sulfuric acid, quinaldinic acid and the respective aldehydes were formed in excellent yields.

For the purpose of preparing the aldehydes it is not necessary to isolate the intermediary products. In most cases one may start with the acid from which the corresponding aldehyde is to be prepared, transform it to the chloride, bring it into reaction with quinoline and hydrocyanic acid and steam distil the entire mixture with sulfuric acid, thus obtaining the aldehyde in one operation.

On the other hand, some acid chlorides, of more complicated molecular structure than those mentioned here, led to the formation of dark resinous oils when brought into reaction with quinoline and hydrocyanic acid. No 1-acyl-1,2-dihydroquinaldonitriles could be isolated, although their presence in some cases could be traced by subsequent hydrolysis and formation of quinaldinic acid and aldehydes. We are at present investigating the action of these acid chlorides and hydrocyanic acid on quinoline and other tertiary bases under varied conditions, with the object of forming new addition products capable of splitting on hydrolysis into the desired aldehydes.

**Experimental**

**General Procedure.**—2–3 cc. of water-free hydrocyanic acid was poured at about  $-5^{\circ}$  into 14 g. (0.1 mole) of freshly distilled quinoline. Under further cooling a solution of 0.05 mole of acid chloride in 10–20 cc. of absolute benzene was added through a dropping funnel during a period of ten minutes. After standing at room temperature for about sixteen hours quinoline hydrochloride had separated out. The reaction mixture was treated with 100–200 cc. of ether and the resulting solution was successively washed three times with 10 cc. of water, three times with 20 cc. of 5 *N* sulfuric acid, several times with 10 cc. of saturated sodium bicarbonate solution, until no further evolution of carbon dioxide occurred, and twice with 10 cc. of distilled water. In cases where the 1-acyl-1,2-dihydro-

TABLE I

Acyl chloride	Yield, %		% Alc. solvent		1,2-Dihydroquinaldonitriles								Hydrolysis with H <sub>2</sub> SO <sub>4</sub> , N	Aldehyde- p-Nitro-phenylhydrazones		
					M. p., °C.	C, %	H, %	N, %	Calcd.	Found	Calcd.	Found		Yield, %	M. p., °C.	Yield, %
Acetyl-	74	50			96 - 97	72.7	72.8	5.04	5.02	14.1	14.0		5, dist.	Not isol.	127.5-128	99
Propionyl- <sup>a</sup>	10	50			49 - 50	73.6	73.7	5.66	5.82	13.2	13.3		5, dist.	Not isol.	128-129	92
Butyryl-	64	70			97.5-98	74.3	74.2	6.20	6.20	12.4	12.6		5, dist.	Not isol.	90-91	97
Isobutyryl- <sup>a</sup>	28	80			129 -129.5	74.3	74.3	6.20	6.21	12.4	12.5		5, dist.	Not isol.	131.5-132	98
n-Valeryl- <sup>b</sup>														Not isol.	96-98 <sup>c</sup>	42 <sup>c</sup>
Isovaleryl-	64	60			90 - 90.5	75.0	75.2	6.66	6.60	11.6	11.7		5, st. dist.	Not isol.	122-123 <sup>c</sup>	98
2-Methoxybenzoyl-	66	60			164 -164.5	74.5	74.4	4.83	4.90	9.66	9.80		10, st. dist.	97	208	92
4-Methoxybenzoyl-	88	50			120.5-121.5	74.5	74.7	4.83	4.65	9.66	9.64		10, st. dist.	98	162	95
o-Chlorobenzoyl-	80	70			165 -166	69.4	69.2	3.74	3.66	9.53	9.53		10, st. dist.	94	247-248	98
m-Chlorobenzoyl- <sup>a</sup>	28	60 and 90			116 -119	69.4	69.3	3.74	3.67	9.53	9.53		10, st. dist.	96	220	91
p-Chlorobenzoyl-	77	70			140 -143	69.4	69.2	3.74	3.82	9.53	9.53		10, st. dist.	92	219	95
Cinnamoyl- <sup>d</sup>	91	96			154 -155	79.7	80.0	4.89	4.93	9.79	9.80		10, st. dist.	82	169.5-170.5	92
Benzoyle-	96	96			154 -155								10, st. dist.	Not isol.	193-194	98

<sup>a</sup> Direct preparation without isolation of the 1-acyl-1,2-dihydroquinaldonitrile improved the yields as follows: propional 36%, isobutanal 56%, *m*-chlorobenzaldehyde 65%. <sup>b</sup> Intermediary *n*-valeryl-1,2-dihydroquinaldonitrile not isolated. <sup>c</sup> M. p. and yield refer to 2,4-dinitrophenylhydrazones. <sup>d</sup> Previously prepared according to Reissert,<sup>1,3</sup> and checked by mixed m. p.

quinaldonitrile is not easily soluble in ether, it may partially crystallize out during this operation. After evaporation of the ether and crystallization of the residue from a mixture of ethanol and water, the 1-acyl-1,2-dihydroquinaldonitrile was obtained. The percentage of alcohol in the solvent for the recrystallization, melting point, yield and analytical data of the 1-acyl-1,2-dihydroquinaldonitriles are given in the accompanying table, with the corresponding acyl groups.

**Hydrolysis.**—The hydrolysis of the 1-acyl-1,2-dihydroquinaldonitriles was carried out with 5 to 10 *N* sulfuric acid. Where aldehydes with boiling points below 100° were to be obtained, 0.01 mole of the substance was boiled with 30 cc. of 5 *N* sulfuric acid down to half volume, and the escaping aldehyde precipitated in a solution of *p*-nitrophenylhydrazine (or 2,4-dinitrophenylhydrazine) in 2 *N* hydrochloric acid for quantitative measurement. Aldehydes with boiling points over 100° were obtained in a similar way by steam distillation of 0.01 mole of substance

in 10 *N* sulfuric acid and the aldehyde was isolated in the usual way.

### Summary

A number of 1-acyl-1,2-dihydroquinaldonitriles were prepared by the interaction of acid chlorides, hydrocyanic acid and 2 moles of quinoline in non-aqueous media. On acid hydrolysis the corresponding aldehydes and quinaldinic acid were obtained in excellent yields. For the purpose of preparing aldehydes, the intermediary 1-acyl-1,2-dihydroquinaldonitriles need not be isolated. The reaction mixture may be steam distilled with sulfuric acid, thus yielding the aldehyde in one operation from the corresponding acid or acid chloride.

TORONTO, CANADA

RECEIVED MAY 14, 1941

## NOTES

### Removal of Acyl Groups

BY RICHARD BALTZLY AND JOHANNES S. BUCK

It has been shown recently, especially by Reichstein,<sup>1</sup> that esters often can be cleaved under much milder alkaline conditions than had generally been supposed. As the authors were interested in compounds stable only in the absence of alkalinity, the generality of a similar exchange reaction with an acid catalyst was examined. The literature gave some indications that such a

method was feasible. Thus Fischer<sup>2</sup> reported the formation of  $\alpha$ -methyl glucoside when penta-acetylglucose stood for three days in methanolic hydrogen chloride, and Mannich<sup>3</sup> found that acetyl groups were removed from a catechol derivative under similar conditions.

Some esters of acetic and propionic acids were therefore examined, the esters being chosen so that both they and the corresponding alcohols had melting points satisfactory for identification.

(2) Fischer, *Ber.*, **26**, 2400 (1893).

(3) Mannich and Hahn, *ibid.*, **44**, 1542 (1911).

(1) Reichstein and Buw, *Helv. Chim. Acta*, **21**, 1181 (1938).