Tetrahedron Letters No.43, pp. 4259-4260, 1967. Pergamon Press Ltd. Printed in Great Britain.

PHOTOCHEMICAL ALKYLATION OF NITROGEN HETEROAROMATICS BY CARBOXYLIC ACIDS UNDER DECARBOXYLATION

H. Nozaki, M. Katô, R. Noyori and M. Kawanisi

Department of Industrial Chemistry, Kyôto University, Kyôto, Japan

(Received in Japan 17 July 1967)

We wish to report that the title reaction as applied to a combination of quinoline and acetic acid proceeds under irradiation of the benzene solution with 200W high pressure mercury arc and gives a mixture of 2-methyl-, 4-methyl- and 2,4-dimethylquinolines. Extention to other couples of benzopyridines and carboxylic acids gave results as summarized in Table 1.

The mechanism of this novel type of alkylation should account for following observations made:

A. Pyridine itself remained unchanged upon similar treatment.

B. The alkylation occurred formally at the electron-deficient positions in the ground state (1).

C. An increase of the carbon number of fatty acids gave better yields.

D. No skeletal change was observed in the alkyl part of isovaleric acid.

E. Attempted reaction of phenanthrene and acetic acid failed. The reaction of quinoline and acetic acid in the presence of 0.2-0.5 mole ratio of phenanthrene gave no methylated phenanthrene.

F. The methylation of quinoline proceeded unaffected by the presence of equimolar quantity of dodecyl mercaptan.

G. The photochemical action of sodium acetate in aqueous dioxane or ethyl acetate in benzene failed to effect the methylation of quinoline.

At the moment we may point out that the initial product of this alkylation would very probably be alkyldihydrobenzopyridines which are produced by photochemical decarboxylation of benzopyridinium carboxylates. The dehydrogenation may proceed by the catalysis of contaminated oxygen (2). Dihydrobenzopyridines can competitively act as a hydrogen acceptor. Further investigations are progressing (3).

TABLE 1

Photochemical Alkylation of Nitrogen Heteroaromatics [a]

Substrate	R Group in RCOOH	Position of R-Substitution [b] (Yield in %)	Recovery of Substrate, %
Quinoline	CH_3-	2- (20), 4- (10), 2,4-di- (5)	40
Quinoline	CH_3CH_2-	2- (23), 2,4-di- (6) [c,d]	34
Quinoline	$(CH_3)_2CH$-	2- (27), 4- (20), 2,4-di- (6) [e,f]	22
Quinoline	$(CH_3)_2CHCH_2$-	2- (37) [f]	30
Isoquinoline	CH_3-	1- (10)	50
Isoquinoline	CH_3CH_2-	1- (20)	40
Acridine	CH_3-	9- (12)	12

[a] The substrate and fatty acid were dissolved in benzene (concn. both 0.5 M) and the solution was placed in a silica tube (10 x 40 mm) and irradiated externally for 5 hr. During the irradiation the evolution of carbon dioxide was observed.

[b] The GLC analyses were carried out on Apiezon L column. Each product was isolated by preparative GLC and was identified by IR, NMR and elemental analyses, which gave correct values. Yields were based on the consumed substrates.

[c] 4-Ethylquinoline was not detected. Instead, 4-ethyl-1,2,3,4-tetrahydroquinoline was isolated and identified (16% yield).

[d] A new compound. The picrate melted at 173-174° (from EtOH).

[e] A new compound. The picrate melted at 156-157° (from EtOH).

[f] In these runs 4-isopropyl-1,2,3,4-tetrahydroquinoline and 4-isobutyl-1,2,3,4-tetrahydroquinoline, respectively, were also detected (yield undetermined).

REFERENCES

1. The orientation of the present alkylation recalls us to the aromatic methylation with methylsulphinylcarbanion previously reported. H. Nozaki, Y. Yamamoto and R. Noyori, Tetrahedron Letters 1123 (1966). See also G. A. Russell and S. A. Weiner, J. Org. Chem. **31**, 248 (1966).

2. (a) J. D. Roberts and M. C. Caserio, Basic Principles of Organic Chemistry, p. 1000. W. A. Benjamin, Inc. New York (1964); (b) H. Blaschke and V. Boekelheide, J. Am. Chem. Soc. **89**, 2747 (1967).

3. For photochemical reaction of benzene with acetic acid, see E. Farenhorst and A. F. Bickel, Tetrahedron Letters 5911 (1966).

ACKNOWLEDGEMENT. The authors are grateful to Prof. K. Sisido for help and encouragement. This work was partially supported by Scientific Research Fund administered by the Ministry of Education, Japanese Government.