MECHANISM OF ISOMERISATION OF ortho OR para BROMO PHENOLS IN SUPERACIDS

by Jean-Claude JACQUESY and Marie-Paule JOUANNETAUD

Laboratoire de Chimie XII "Synthèse et Réactivité de Produits Naturels" E.R.A. n° 556 40, Avenue du Recteur Pineau - 86022 Poitiers, France

<u>Abstract</u>: In superacids ortho or para bromo phenols are isomerised into the meta bromo isomers. In SbF_5 -HF, the process is intramolecular and proceeds by a 1,2-Br shift. In CF_3SO_3H , the mechanism involves loss of bromine, followed by meta bromination.

Under usual conditions, bromination of phenols is known to give ortho and para bromo compounds by the directing effect of the hydroxyl group.

In superacid and at low temperature, direct meta bromination is observed on para alkyl or 2,6-dialkyl phenols but phenol itself gives 4-bromo phenol².

We report here our results on the isomerisation in superacids of ortho or para bromo phenols into the corresponding meta isomers at 0° or at room temperature.

In a typical experiment, the bromo compound (2,9 mmoles) is added under stirring to the superacid SbF_5 -HF (15 ml-molar ratio 25) and the reaction mixture is maintained at a given temperature.

Aliquot parts of the homogeneous solution are removed at intervals, quenched with Na_2CO_3 -ice-water and after usual work-up, analyzed by GPC.

The results (see table) show that all compounds give the meta bromo isomer in good yield. In superacid compounds Ic, IIb, IVb are recovered unchanged in the reaction conditions.



ĩΠa







τνь



Starting material	Reaction time (h)	Temperature	Products (%)
Ia	1	20°C	Ia(97) + Ib(1) + Ic(2)
	4	20°C	Ia(83) + Ib(4) + Ic(13)
	48	20°C	Ic(80) [§]
ІЪ	6	20°C	Ib(69) + Ic(30)
	48	20°C	Ic(90) [§]
IIa	48	20°C	IIЬ(80) [§]
IIIa	2	o°c	IIIa(34) + IIIb(66)
	48	0°C	IIIb(85) [§]
IVa	1	0°C	IVa(6) [§] + IVb(85) [§]

Table

§ - Yields for isolated products after chromatography over SiO₂. Other yields have been determined by G.P.C

To determine the mechanism of the isomerisation the reactions were conducted with an excess of the methyl ether of the corresponding phenol. For example, when compound Ia and anisole³ (3 eq.) are dissolved in SbF_5 -HF, only isomer Ic is obtained, without any bromination of the phenol ether. Similar results are obtained with compounds Ib, <u>1Ia-IVa</u>, showing that the process is intramolecular. It implies 1,2-Br shifts and can be accounted for the following mechanism as examplified by compounds Ia and Ib.



Protonation of Ia gives ion V which undergoes an irreversible 1,2 shift of bromine. The resulting ion VI leads to compound Ic and to ion VIII also obtained by protonation of compound Ib.

In the reaction conditions, compaund Ic is further protonated to the stable ion VII⁴.

The mechanism is in agreement with the observation that compounds Ib and Ic are both obtained from isomer Ia, and only compound Ic from isomer Ib.

It appears that the mechanism of the isomerisation is superacid dependent. At room temperature and in triflic acid, which is less acidic that the SbF_5 -HF system, similar isomerisations are observed but the mechanism is different. When phenol <u>IIIa</u> is dissolved in CF_3SO_3H it gives compound <u>IIIb</u>. If the reaction is performed with a mixture of compounds <u>IIIa</u> and <u>IX</u> (3 eq.) the relative percentage of the bromo compounds <u>IIIa</u>, <u>X</u> and <u>XI</u>, observed in the medium are 52, 24, 24% after 2 hrs, and 6, 1, 93 after 24 hrs.

This result implies exchange of bromine and can be explained by the following mechanism.



Similar reactions are observed starting from bromo compounds Ia, Ib, IIa, IVa. Our results have to be compared to those of de la Mare⁵. The 1,2-Br shift suggested $(\underline{V} \longrightarrow \underline{VI})$ is in fact only operative in very acidic media like SbF₅-HF, loss of (Br⁺) being preferred in triflic acid. Consequently, in CF₃SO₃H, the meta bromo compound <u>III</u>b appears to be formed by a direct meta bromination of the paracresol.

In conclusion meta bromo phenols can be easily prepared from the corresponding phenols, either by a direct meta bromination², or by isomerisation of the ortho or para bromo isomer.

We thank CNRS for financial support.

References

¹Presented at International Symposium "Chemistry of Carbocations", September 1981, Bangor, Wales.

^{2a}J.C. JACQUESY, M.P. JOUANNETAUD, S. MAKANI, Nouv. J. Chim., 1980, <u>4</u>, 747

^bJ.C. JACQUESY and M.P. JOUANNETAUD, Tetrahedron, 1981, 37, 747.

³In superacid phenols ethers are more rapidly brominated than the corresponding phenols (see ref. 2a).

⁴G.A. OLAH and Y.K. MO, J. Org. Chem., 1973, 38, 2212.

⁵J.M. BRITTAIN, P.B.D. de la MARE and P.A. NEWMAN, Tetrahedron Letters, 1980, <u>21</u>, 4111.

(Received in France 26 January 1982)